TOTAL MAXIMUM DAILY LOAD (TMDL)
For
Siltation and Habitat Alteration
In The
Watts Bar Lake Watershed (HUC 06010201)
Bledsoe, Cumberland, Loudon, McMinn, Meigs, Monroe, Rhea, and Roane Counties, Tennessee

FINAL

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LIST OF ABBREVIATIONS

ADB	USEPA/TDEC Assessment Database
ARS	Agriculture Research Station
BMP	Best Management Practices
CFR	Code of Federal Regulations
DEM	Digital Elevation Model
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
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
NRI	National Resources Inventory
RM	River Mile
RMCF	Ready Mixed Concrete Facility
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil and Geographic Database
STP	Sewage Treatment Plant
SWMP	Storm Water Management Plan
SWPPP	Storm Water Pollution Prevention Plan
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids

LIST OF ABBREVIATIONS, Cont.

TVA	Tennessee Valley Authority
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

WATTS BAR LAKE WATERSHED (HUC 06010201)

Total Maximum Daily Load for Siltation/Habitat Alteration in Waterbodies Identified on the State of Tennessee's *2006 303(d) List*

Impaired Waterbody Information:

State: Tennessee
Counties: Bledsoe, Cumberland, Loudon, McMinn, Meigs, Monroe, Rhea, and Roane
Watershed: Watts Bar Lake (HUC 06010201)
Watershed Area: 693 mi^2
Constituent of Concern: Siltation/Habitat Alteration
Impaired Waterbodies: *2006 303(d) List*

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired
TN06010201013_1000	Pond Creek	13.57
TN06010201015_1000	Sweetwater Creek	29.3
TN06010201040_0600	Black Creek	16.7
TN06010201065_1000	Steekee Creek	11.0
TN06010201621_1000	Caney Creek	13.2

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

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 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.

TMDL Development

General Analysis Methodology:

- Analysis performed using the Watershed Characterization System Sediment Tool (based on Universal Soil Loss Equation (USLE)) 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 Waste Load Allocations (WLAs) for Ready Mixed Concrete Facilities (RMCFs) and regulated mining sites. Most loading from these sources is small compared to total loading. Since the Total Suspended Solids (TSS) component of Sewage Treatment Plant (STP) discharges is generally composed of primarily organic material and is considered to be different in nature than the sediments produced from erosional processes, TSS discharges from STPs were not considered in the TMDL analysis (ref.: Sections 3.0 and 6.0).

- WLAs for Municipal Separate Storm Sewer Systems (MS4s), WLAs for National Pollution Discharge Elimination System (NPDES) regulated construction storm water discharges, and Load Allocations (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, and LAs for Nonpoint Sources:

HUC-12 Subwatershed (06010201___)	Waterbody ID	Waterbody	Level IV Ecoregion	TMDL (Required Overall Load Reduction)	Required Load Reduction	
					WLA (MS4s and Construction SW)	LA (Nonpoint Sources)
				[%]	[%]	[%]
0302	06010201065_1000	Steekee Creek	67f	46.4	49.1	49.1
0304	06010201015_1000	Sweetwater Creek		42.9	45.7	45.7
0305	06010201013_1000	Pond Creek		42.4	45.3	45.3
0402	06010201621_1000	Caney Creek	67i	53.1	55.4	55.4
0503	06010201040_0600	Black Creek	68c	77.3	78.4	78.4

Note: Calculations were conducted for all HUC-12 subwatersheds containing waterbodies identified as impaired for siltation/habitat alteration.

WLAs for the RMCFs and Mining Site:

WLAs for the NPDES regulated RMCF and mining site located in an impaired subwatershed are equal to existing permit limits for TSS.

RMCF Permitted to Discharge TSS and Located in Impaired Subwatersheds

HUC-12 Subwatershed (06010201___)	NPDES Permit No.	Facility Name	TSS Daily Max Limit	TSS Cut-off Conc. (SW Discharge)
			[mg/l]	[mg/l]
0402	TNG110214	Midtown Ready Mix Concrete	50	200

Mining Site Permitted to Discharge TSS and Located in Impaired Subwatersheds

HUC-12 Subwatershed (06010201___)	NPDES Permit No.	Name	TSS Daily Max Limit
			[mg/l]
0402	TN0071552	Addington Enterprises, Inc.	40

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR SILTATION/HABITAT ALTERATION WATTS BAR LAKE WATERSHED (HUC 06010201)

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 Watts Bar Lake Watershed, Hydrologic Unit Code (HUC) 06010201, is located in Southeast Tennessee (ref.: Figure 1) in Bledsoe, Cumberland, Loudon, McMinn, Meigs, Monroe, Rhea, and Roane counties. The Watts Bar Lake Watershed lies within two Level III ecoregions (Ridge and Valley and Southwestern Appalachians) and contains five Level IV subecoregions as shown in Figure 2 (USEPA, 1997):

- **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 uses, as well as areas of thick forest. White oak forest, bottomland oak forest, and sycamore-ash-elm riparian forests are the common forest types. Grassland barrens intermixed with cedar-pine glades also occur here.

- **Southern Shale Valleys (67g)** consist of lowlands, rolling valleys, 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.

- **Southern Dissected Ridges and Knobs (67i)** contain crenulated, broken, or hummocky ridges. The ridges on the east side of Tennessee's Ridge and Valley tend to be associated with the Ordovician 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 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 white oak, mixed mesophytic forest, and tulip poplar on the lower slopes, knobs, and draws.

- **Cumberland Plateau (68a)** tablelands and open low mountains are about 1,000 feet higher than the Eastern Highland Rim (71g) to the west, and receive slightly more precipitation with cooler annual temperatures than the surrounding lower-elevation ecoregions. The plateau surface is less dissected with lower relief compared to the Cumberland Mountains (69d) or the Plateau Escarpment (68c). Elevations are generally 1,200-2,000 feet, with the Crab Orchard Mountains reaching over 3,000 feet. Pennsylvanian-age conglomerate, sandstone, siltstone, and shale is covered by well-drained, acid soils of low fertility. Bituminous coal that has been extensively surface and underground mined underlies the region. Acidification of first and second order streams is common. Stream siltation and mine spoil bedload deposits continue as long-term problems in these headwater systems. Pockets of severe acid mine drainage persist.

Figure 1 Location of the Watts Bar Lake Watershed

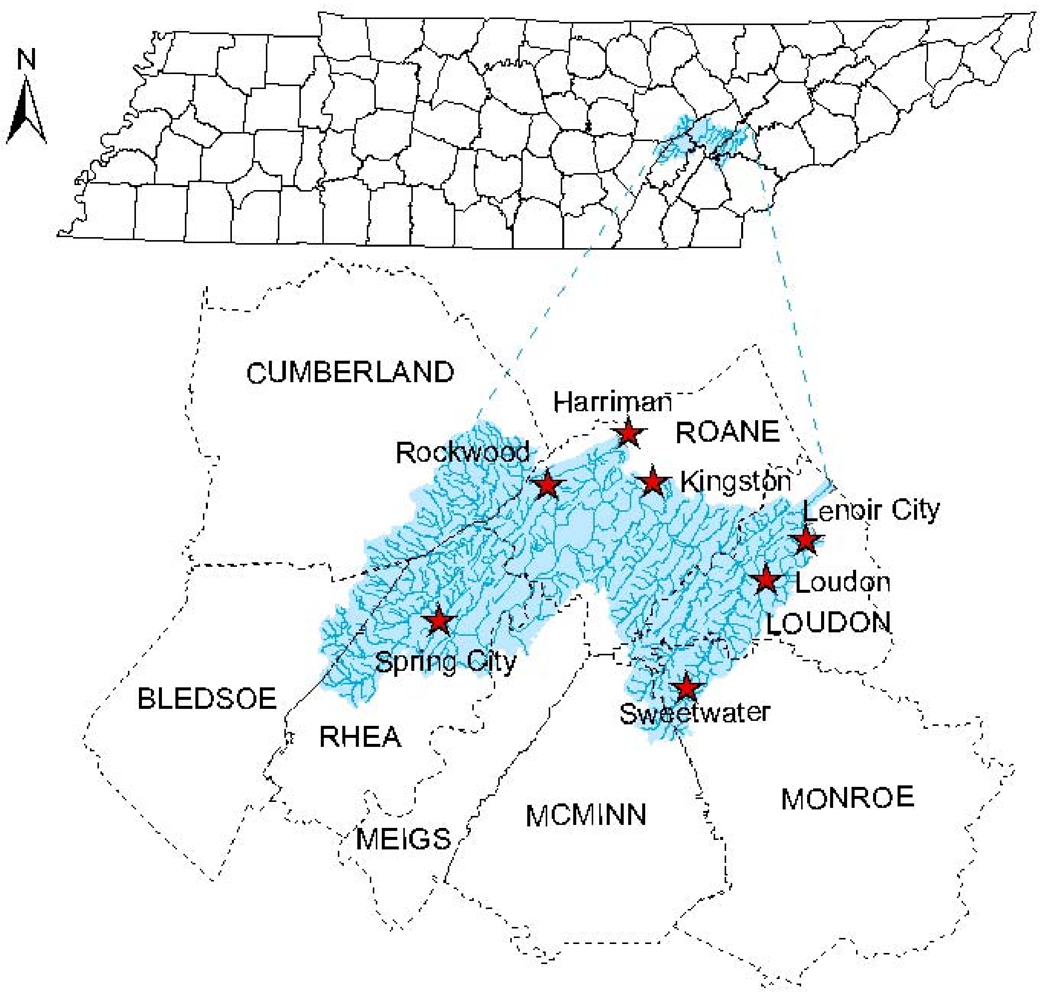
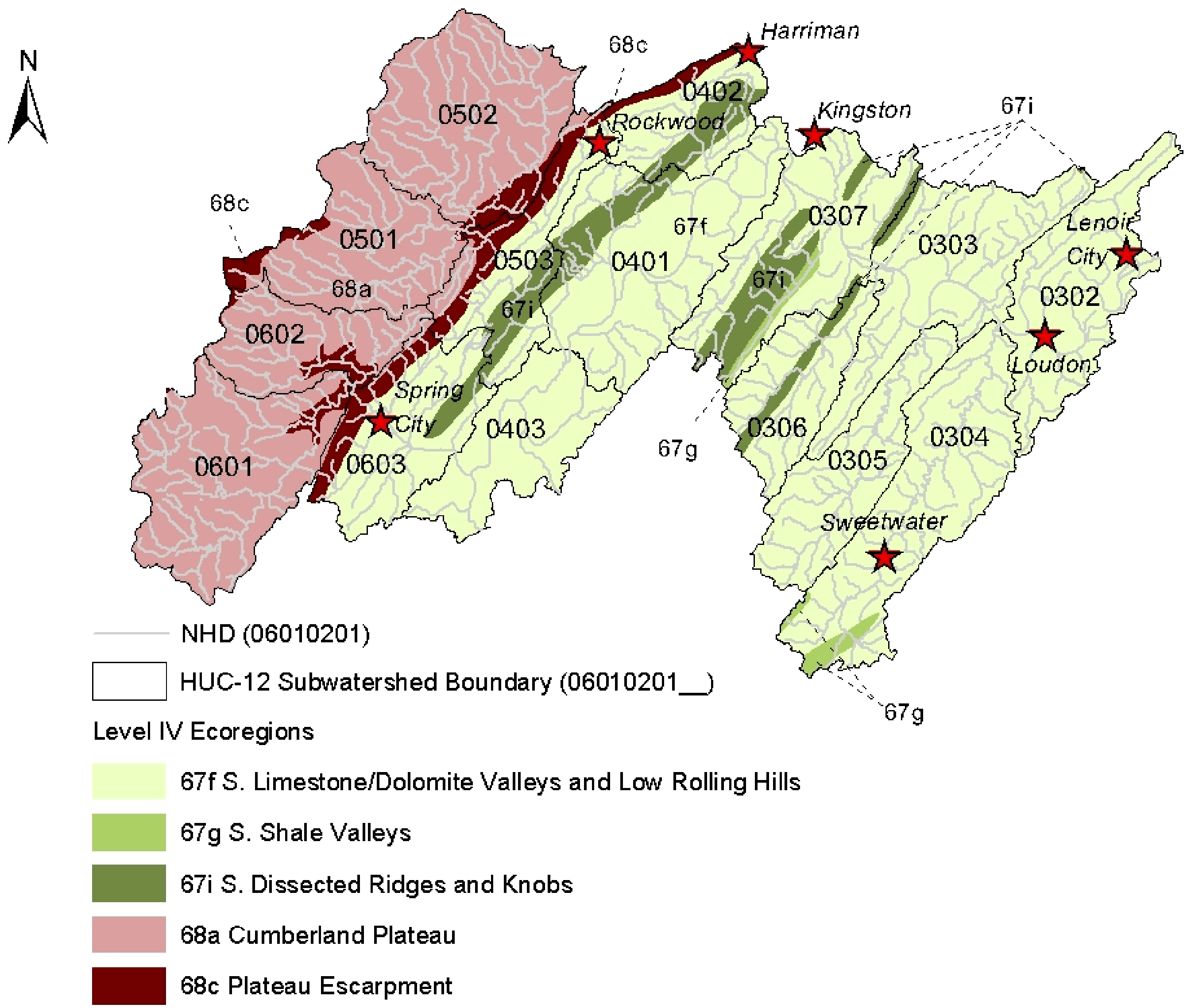


Figure 2 Level IV Ecoregions in the Watts Bar Lake Watershed



- **Plateau Escarpment (68c)** is characterized by steep, forested slopes and high velocity, high gradient streams. Local relief is often 1,000 feet or more. The geologic strata include Mississippian-age limestone, sandstone, shale, and siltstone, and Pennsylvanian-age shale, siltstone, sandstone, and conglomerate. Streams have cut down into the limestone, but the gorge talus slopes are composed of colluvium with huge angular, slabby blocks of sandstone. Vegetation community types in the ravines and gorges include mixed oak and chestnut oak on the upper slopes, mesic forests on the middle and lower slopes (beech-tulip poplar, sugar maple-basswood-ash-buckeye), with hemlock along rocky streamsides and river birch along floodplain terraces.

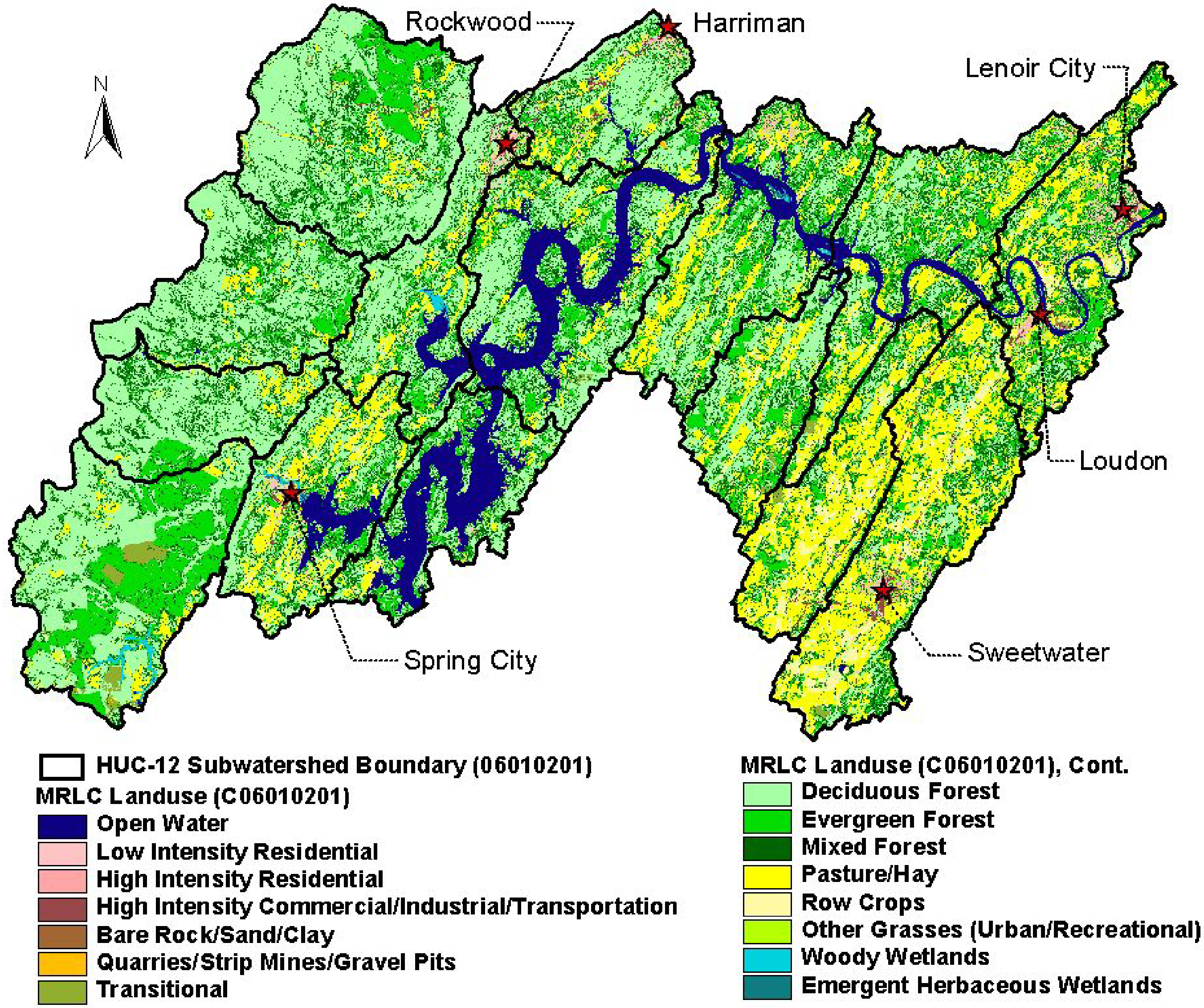
The Watts Bar Lake Watershed (HUC 06010201) has approximately 6,795 miles of streams (based on NHD) and drains approximately 693 square miles to the Tennessee River. Watershed land use distribution is based on the 1992 Multi-Resolution Land Characteristic (MRLC) satellite imagery databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Land use for the Watts Bar Lake Watershed is summarized in Table 1 and shown in Figure 3.

Table 1 Land Use Distribution - Watts Bar Lake Watershed

Land use	Area		
	[acres]	[mi^2]	[% of watershed]
Bare Rock/Sand/Clay	0	0.0	0.0
Deciduous Forest	165,892	259.2	37.4
Emergent Herbaceous Wetlands	253	0.4	0.1
Evergreen Forest	63,977	100.0	14.4
High Intensity Commercial/Industrial/Transportation	3,283	5.1	0.7
High Intensity Residential	681	1.1	0.2
Low Intensity Residential	5,510	8.6	1.2
Mixed Forest	82,605	129.1	18.6
Open Water	31,165	48.7	7.0
Other Grasses (Urban/Recreational)	3,209	5.0	0.7
Pasture/Hay	67,674	105.7	15.3
Quarries/Strip Mines/Gravel Pits	44	0.1	0.0
Row Crops	15,042	23.5	3.4
Transitional	2,949	4.6	0.7
Woody Wetlands	1,031	1.6	0.2
Total	443,314	692.7	100.0

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

Figure 3 MRLC Land Use in the Watts Bar Lake Watershed



3.0 PROBLEM DEFINITION

The State of Tennessee's *2006 303(d) List* (TDEC, 2006) identified a number of waterbodies in the Watts Bar Lake 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 Tennessee 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, domestic water supply, trout stream, naturally reproducing trout stream and/or navigation (TDEC, 2004).

A description of the stream assessment process in Tennessee can be found in *2006 305(b) Report, The Status of Water Quality in Tennessee* (TDEC, 2006a). 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 USEPA/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/

An example of a typical stream assessment (Pond Creek at RM 2.3 and at RM 8.3) 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 lakebeds. 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 5,800 miles of streams and rivers (TDEC, 2006a). 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 *Framework For Developing Suspended And Bedded Sediments (SABS) Water Quality Criteri*a (USEPA, 2006):

> Excessive suspended sediment in aquatic systems decrease light penetration, directly impacting productivity that is especially important in estuarine and marine habitats, where trophic interrelationships tend to be more complex and marginal when compared to freshwater aquatic systems. Decreased water clarity impairs visibility and associated behaviors such as prey capture and predator avoidance,

Table 2 *2006 303(d) List* - Stream Impairment Due to Siltation/Habitat Alteration in the Watts Bar Lake Watershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	CAUSE/TMDL Priority	Pollutant Source
06010201013_1000	Pond Creek	13.57	Nitrates/Physical Substrate Habitat Alteration/Escherichia coli	Pasture Grazing/Livestock in Stream/Animal Feeding Operations (NPS)
06010201015_1000	Sweetwater Creek	29.3	Nitrates/Loss of biological integrity due to siltation/ Escherichia coli	Municipal Point Source Discharge/Channelization/ Pasture Grazing/Land Development/Animal Feeding Operation (NPS)
06010201040_0600	Black Creek	16.7	Polycyclic Aromatic Hydrocarbons (PAHs)/Physical Substrate Habitat Alterations/Escherichia coli Nutrients	Municipal Point Source Discharges/Collection System Failures/RCRA Hazardous Waste/Channelization
06010201065_1000	Steekee Creek	11.0	Physical Substrate Habitat Alterations/Loss of biological integrity due to siltation/ Escherichia coli	Pasture Grazing
06010201621_1000	Caney Creek	13.2	Physical Substrate Habitat Alteration/Loss of biological integrity due to siltation/ Escherichia coli	Pasture Grazing/Collection System Failure

Figure 4 Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2006 303(d) List*)

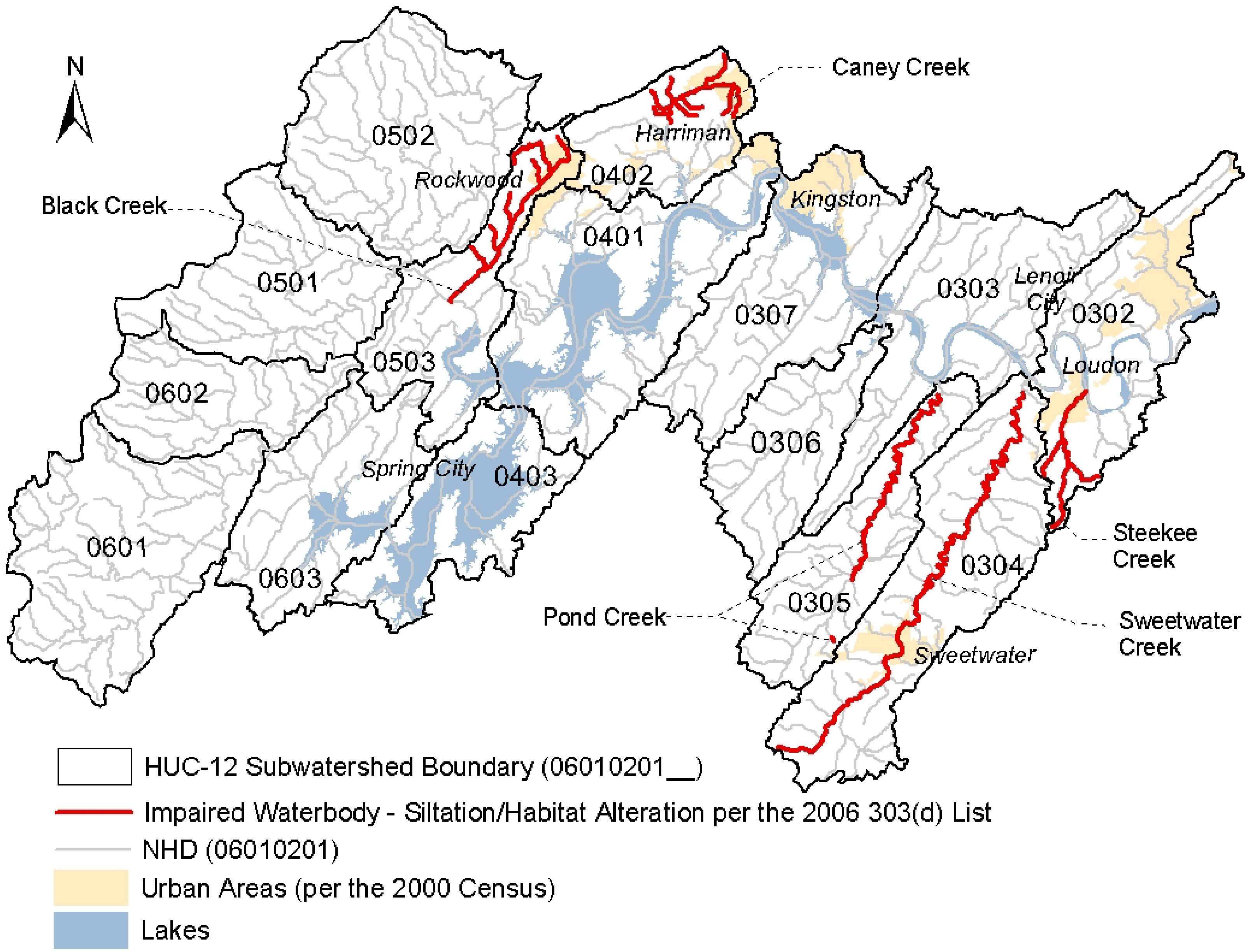


Table 3 Water Quality Assessment of Waterbodies Impaired Due to Siltation/Habitat Alteration

Waterbody ID	Impacted Waterbody	Comments
06010201013_1000	Pond Creek (from Watts Bar Reservoir to confluence of Greasy Creek)	2001 TDEC RBPIII station at mile 2.3 (Bradshaw Road). 13 EPT genera, 33 total genera. Index score = 42. Habitat score = 173. Passed biocriteria, but this site may not be representative of the rest of the stream. 2001 TDEC RBPIII station at mile 8.2 (Bright Road). 5 EPT genera, 21 total genera. Index score = 20. Habitat score = 100. Failed biocriteria. Monitored by University of Tennessee students in 2001 at 4 stations: Bradshaw Rd., Jim Dyke Rd., Pond Cr. Rd., & New Hope Church Rd. 24 out of 33 E. coli observations over 1,000. 1996 TVA biorecon at mile 6.0 (Prospect Rd). 11 EPT families, 30 total. Fish IBI = 28.
06010201015_1000	Sweetwater Creek (from Watts Bar Reservoir to headwaters)	2002 TDEC RBPIII, chemical, and bacteria station at mile 3.2 (Roberson Spring Road). 7 EPT genera, 16 total genera. Index score = 34. Habitat score = 133. Passed biocriteria. 3 out of 12 pathogen samples over 940. 2002 TDEC RBPIII, chemical, and bacteria station at mile 9.3 (McCray Street). 5 EPT genera, 17 total genera. Index score = 26. Habitat score = 92. Failed biocriteria. 7 out of 12 pathogen samples over 940. 2002 TDEC RBPIII, chemical, and bacteria station at mile 17.3 (Highway 11). 2 EPT genera, 21 total genera. Index score = 14. Habitat score = 123. Failed biocriteria. 9 out of 12 pathogen samples over 940. 2002 TDEC RBPIII, chemical, and bacteria station at mile 19.4 (Highway 322, just u/s STP). 5 EPT genera, 26 total genera. Index score = 30. Habitat score = 98. Failed biocriteria. 5 out of 12 pathogen samples over 940. 2002 TDEC RBPIII, chemical, and bacteria station at mile 23.3 (Head of Creek Spring Road). 7 EPT genera, 25 total genera. Index score = 36. Habitat score = 90. Passed biocriteria. 2 out of 12 pathogen samples over 940. 2001 TVA survey at mile 3.0 (Loudon City Park). 5 EPT families, 14 intolerant, 16 total. Failed biorecon criteria. 1996 TVA biorecon (same location). 6 EPT families, 20 total. Remediation at Langdale Superfund site has removed contaminated sediment.
06010201040_0600	Black Creek (from Whites Creek to headwaters)	2002 TDEC RBPIII and bacteria station at mile 3.2 (Highway 27). 3 EPT genera, 18 total genera. Index score = 26. Habitat score = 131. Failed biocriteria. 3 out of 10 pathogen samples over 940. E. coli g.m. = 375. 1996 TVA biological survey at mile 1.2 (Glen Alice). 4 EPT families, 19 total families. Fish IBI = 20. Sludge deposits below Rockwood. PAHs from CERCLA site.

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

Waterbody ID	Impacted Waterbody	Comments
06010201065_1000	Steekee Creek (from Watts Bar Reservoir to headwaters)	2002 TDEC RBPIII and bacteria station at mile 0.7 (private driveway, second bridgge from mouth). 6 EPT genera, 31 total genera. Index score = 24. Habitat score = 103. Failed biocriteria. 5 out of ten pathogen samples over 940. E. coli g.m. = 637. 1996 TVA biological survey at mile 1.8 (Highway 72). 9 EPT families, 24 total families. To be reassessed.
06010201621_1000	Caney Creek (from Watts Bar Reservoir to headwaters)	2002 TDEC RBPIII biorecon and bacteria station at mile 4.3 (Highway 27). 4 EPT genera, 27 total genera. Index score = 24. Habitat score = 86. Failed biocriteria. Eight out of ten pathogen samples over 940. E. coli g.m. = 1,236. 1996 TVA biological survey at mile 4.2 (Highway 61). 7 EPT families, 23 total families. Fish IBI = 36. 1999 TVA biological survey. 5 EPT families, 19 total families.

recognition of reproductive cues, and other behaviors that alter reproduction and survival. At very high levels, suspended sediments can cause physical abrasion and clogging of filtration and respiratory organs.

In flowing waters, bedded sediments are likely to have a more significant impact on habitat and biota than suspended sediments; while most organisms can tolerate episodic occurrences of increased levels of suspended sediments, impacts can become chronic once the sediment is settled. When sediments are deposited or shift longitudinally along the streambed, infaunal or epibenthic organisms and demersal eggs are vulnerable to smothering and entrapment. In smaller amounts, excess fine sediments can fill in gaps between larger substrate particles, embedding the larger particles, and eliminating interstitial spaces that could otherwise be used as habitat for reproduction, feeding, and cover for invertebrates and fish. A noteworthy example of effects of bedded sediments in streams and rivers is the loss of spawning habitat for salmonid fishes due to increased embeddedness. Increased sedimentation can limit the amount of oxygen in the spawning beds, which can reduce hatching success, trap the fry in the sediment after hatching, or reduce the area of habitat suitable for development.

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 Watts Bar Lake 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, 2004a):

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 & aquatic life designated use classification. TMDLs established to protect fish & 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 consist of 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 67f, 67g, 67i, 68a, and 68c. 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 67f, 67g, 67i, 68a, and 68c are summarized in Table 4. Reference site locations are shown in Figure 5.

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 Watts Bar Lake Watershed (ref.: Figure 4). Existing precipitation-based sediment loads for subwatersheds with waterbodies listed on the *2006 303(d) List* as impaired for siltation/habitat alteration are summarized in Table 5.

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 <u>not</u> included in the TMDLs developed for this document.

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

Level 4 Ecoregion	Reference Site	Stream	Drainage Area (acres)	Average Annual Sediment Load [lbs/acre/yr]
67f	Eco67f06	Clear Creek	1,963	513.0
	Eco67f13	White Creek	1,724	366.4
	Eco67f17	Big War Creek	30,062	543.8
			Geometric Mean (Target Load)	467.6
67g	Eco67g05	Bent Creek	21,058	524.0
	Eco67g08	Brymer Creek	4,237	552.0
	Eco67g09	Harris Creek	3,054	571.1
	Eco67g10	Flat Creek	13,236	578.8
	Eco67g11	N Prong Fishdam Creek	1,019	766.8
			Geometric Mean (Target Load)	593.0
67i	Eco67i12	Mill Branch	681	284.3
			Target Load	284.3
68a	Eco68a01	Rock Creek	3,718	49.0
	Eco68a03	Laurel Fork Of Station Camp Creek	10,828	79.4
	Eco68a08	Clear Creek	98,904	160.0
	Eco68a13	Piney Creek	8,947	175.4
	Eco68a20	Mullens Creek	7,388	123.3
	Eco68a26	Daddys Creek	110,980	464.8
	Eco68a28	Rock Creek	16,036	100.5
			Geometric Mean (Target Load)	130.0
68c	Eco68c12	Ellis Gap Branch	810	95.5
	Eco68c13	Mud Creek	1,777	216.8
	Eco68c15	Crow Creek	12,653	109.7
	Eco68c20	Crow Creek	12,614	102.7
			Geometric Mean (Target Load)	123.6

Figure 5 Reference Sites in Level IV Ecoregions 67f, 67g, 67i, 68a, and 68c

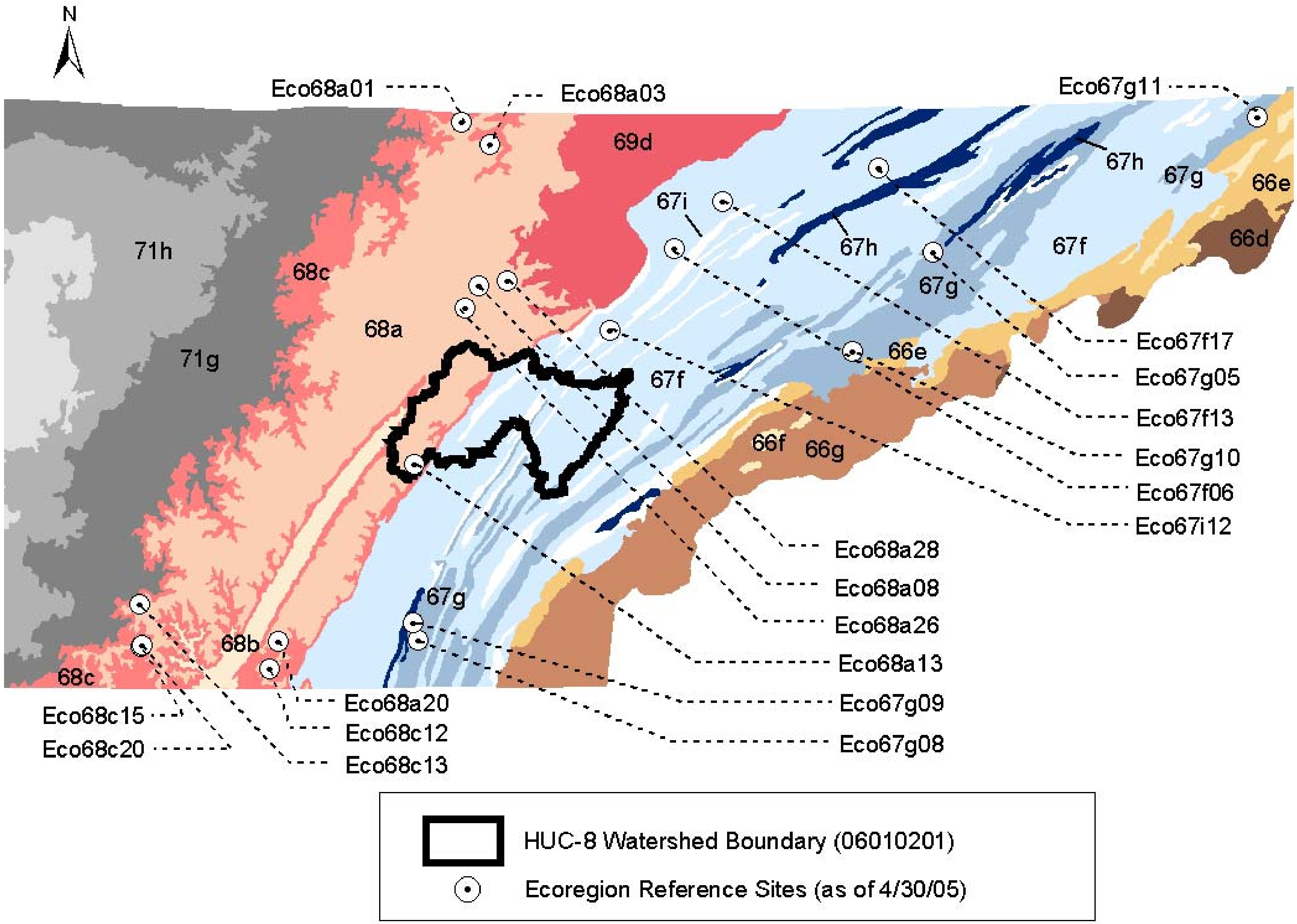


Table 5 Existing Sediment Loads in Subwatersheds With Impaired Waterbodies

HUC-12 Subwatershed (06010201____)	Level IV Ecoregion	Existing Sediment Load
		[lbs/ac/yr]
0302	67f	872
0304		818
0305		812
0402	67i	606
0503	68c	545

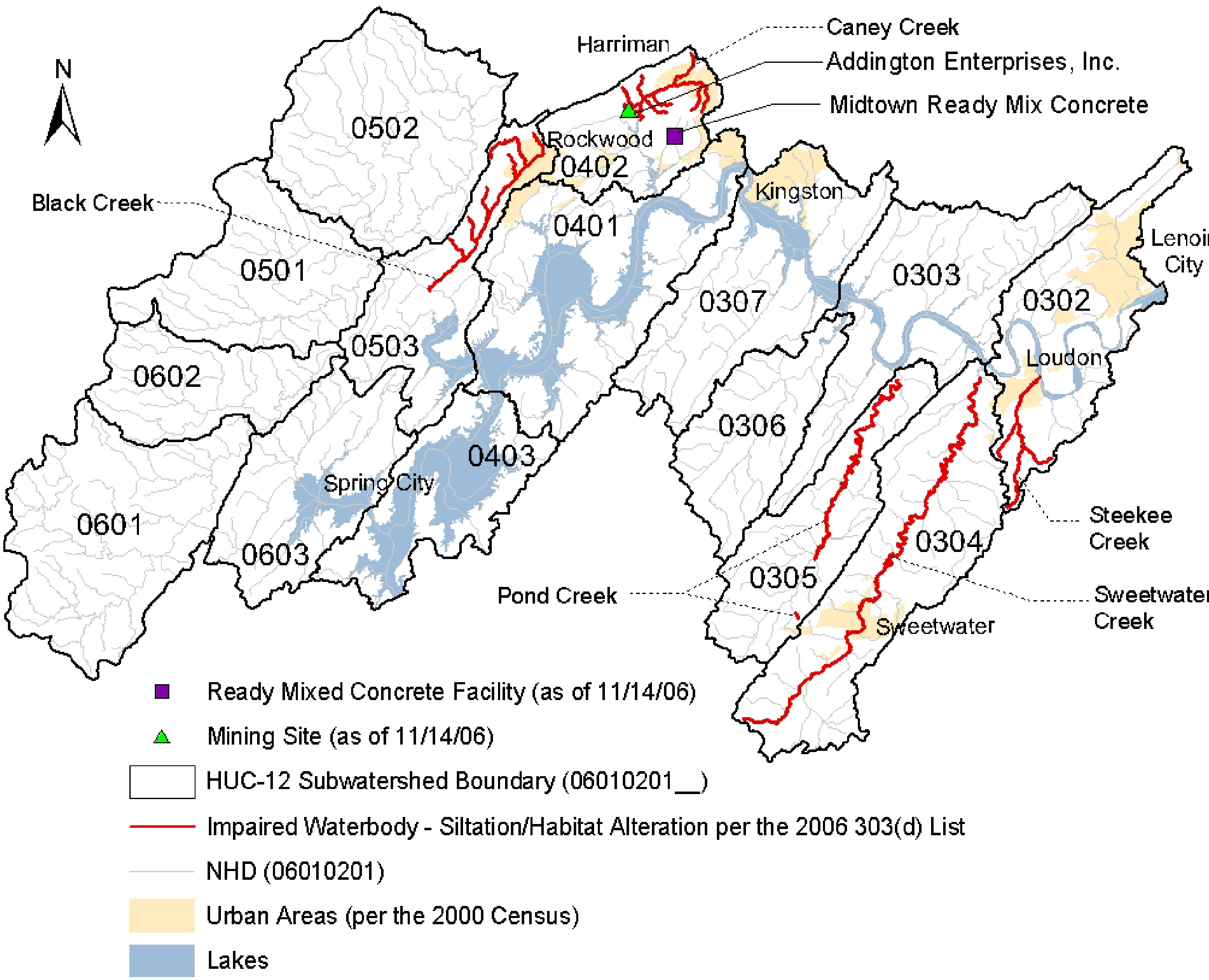
6.1.2 NPDES Regulated Ready Mixed Concrete Facilities

Discharges from regulated Ready Mixed Concrete Facilities (RMCFs) may contribute sediment to surface waters as TSS discharges (TSS discharged from RMCFs 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 total sediment loading to HUC-12 subwatersheds (ref.: Appendix D). In some cases, for discharges into impaired waters, sites may be required to obtain coverage under an individual NPDES permit. The only permitted RMCF in the Watts Bar Lake Watershed as of November 14, 2006, is in an impaired subwatershed. This facility is listed in Table 6 and shown in Figure 6.

Table 6 NPDES Regulated Ready Mixed Concrete Facilities Located in Impaired Subwatersheds (as of November 14, 2006)

HUC-12 Subwatershed (06010201___)	NPDES Permit No.	Facility Name	TSS Daily Max Limit	TSS Cut-off Conc. (SW Discharge)
			[mg/l]	[mg/l]
0402	TNG110214	Midtown Ready Mix Concrete	50	200

Figure 6 NPDES Regulated RMCF and Mining Site Located in an Impaired Subwatershed



6.1.3 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 three permitted mining sites in the Watts Bar Lake Watershed as of November 14, 2006, one is located in an impaired subwatershed. It is listed in Table 7 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).

Table 7 NPDES Regulated Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds (as of November 14, 2006)

HUC-12 Subwatershed (06010201___)	NPDES Permit No.	Name	TSS Daily Max Limit
			[mg/l]
0402	TN0071552	Addington Enterprises Inc.	40

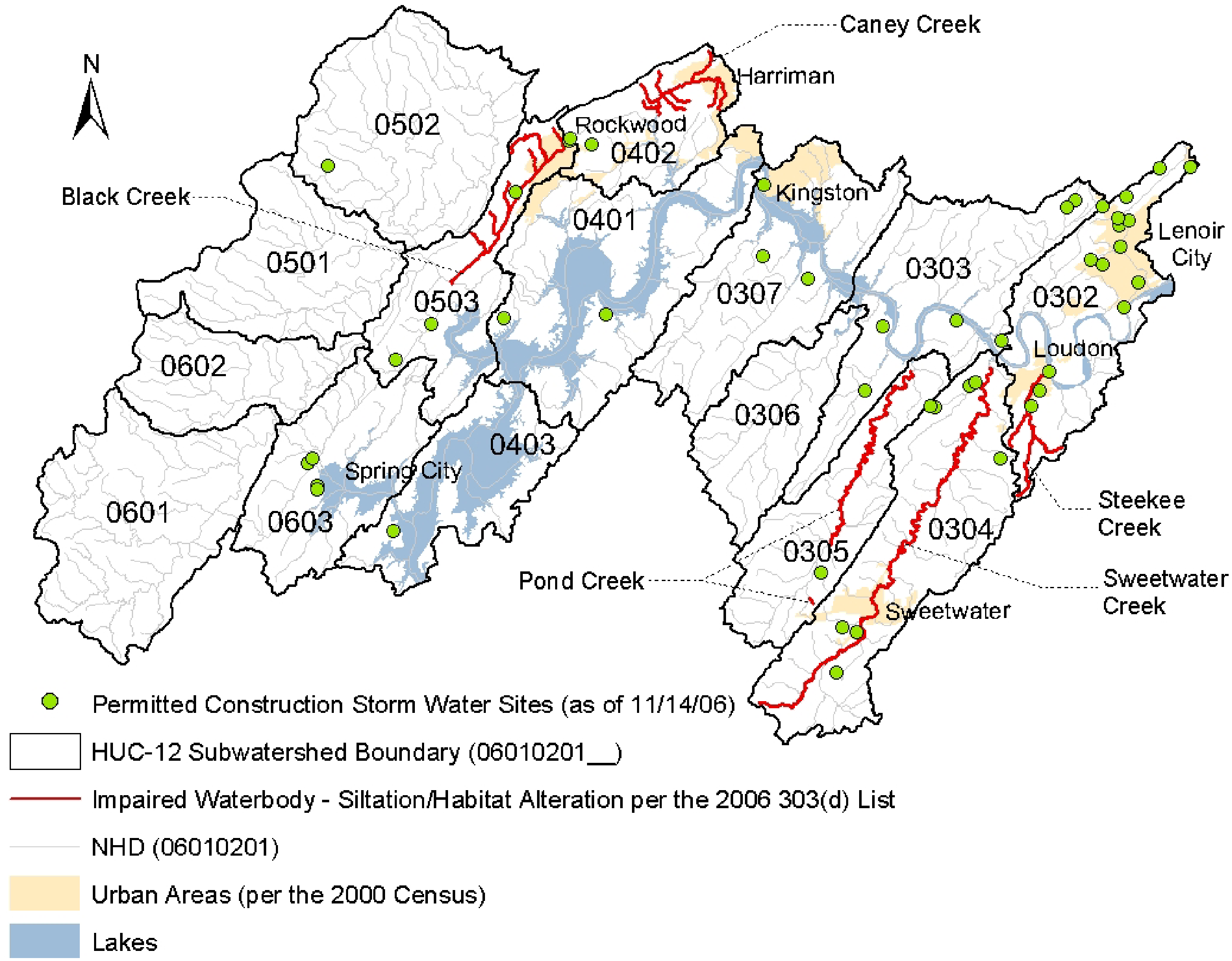
6.1.4 NPDES Regulated Construction Activities

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, 2005). 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. Of the 48 permitted active construction storm water sites in the Watts Bar Lake Watershed on November 14, 2006, 31 were in impaired subwatersheds (ref.: Figure 7).

6.1.5 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

MS4s may 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. Phase I of the EPA storm water program requires large and medium MS4s to obtain NPDES storm water permits. Large and medium MS4s are those located in incorporated places or counties serving populations greater than 100,000 people. At present, there are no MS4s of these sizes in the Watts Bar Lake Watershed.

Figure 7 Location of NPDES Permitted Construction Storm Water Sites in the Watts Bar Lake Watershed



As of March 2003, regulated small MS4s in Tennessee must also obtain NPDES permits in accordance with the Phase II storm water program. A small MS4 is designated as *regulated* if: a) it is located within the boundaries of a defined urbanized area that has a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile; b) it is located outside of an urbanized area but within a jurisdiction with a population of at least 10,000 people, a population density of 1,000 people per square mile, and has the potential to cause an adverse impact on water quality; or c) it is located outside of an urbanized area but contributes substantially to the pollutant loadings of a physically interconnected MS4 regulated by the NPDES storm water program. Most regulated small MS4s in Tennessee obtain coverage under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003a). There are two permitted Phase II small MS4s in the Watts Bar Lake Watershed:

NPDES Permit Number	Permittee Name
TNS075591	Loudon County
TNS077798	Lenoir City

The Tennessee Department of Transportation (TDOT) has been issued an individual MS4 permit (TNS077585) that authorizes discharges of storm water runoff from State road and interstate highway right-of-ways that TDOT owns or maintains, discharges of storm water runoff from TDOT owned or operated facilities, and certain specified non-storm water discharges. This permit covers all eligible TDOT discharges statewide, including those located outside of urbanized areas.

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 impaired waterbodies within the Watts Bar Lake Watershed, the primary sources of nonpoint sediment loads come from 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 code (HUC-12) area basis for subwatersheds containing waterbodies identified as impaired due to siltation and/or habitat alteration on the *2006 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 sediment TMDLs in the Watts Bar Lake Watershed.

Sediment loading analysis for waterbodies impaired due to siltation/habitat alteration in the Watts Bar Lake 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 Watts Bar Lake 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 *2006 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 <u>overall</u> required percent reduction in loading calculated. For each impaired HUC-12 subwatershed, the TMDL is equal to this <u>overall</u> required reduction:

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

  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 RMCFs and mining sites. 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.

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

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

It is expected 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 Ready Mixed Concrete Facilities

The only Ready Mixed Concrete Facility (RMCF) in the Watts Bar Lake Watershed with an NPDES permit is located in an impaired subwatershed (ref.: Table 6 and Figure 6). Since sediment loading from RMCFs located in impaired subwatersheds is small (ref.: Appendix D) compared to the total loading for impaired subwatersheds, the WLA is considered to be equal to the existing permit requirements for this facility.

7.3.2 Waste Load Allocations for NPDES Regulated Mining Activities

Of the three mining sites in the Watts Bar Lake Watershed with NPDES permits, one is located in an impaired subwatershed (ref.: Table 7 and Figure 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 WLA is considered to be equal to the existing permit requirements for this site.

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 *2006 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, 2005). 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 (06010201___)	Waterbody ID	Waterbody Impaired by Siltation/ Habitat Alteration	Level IV Ecoregion	Existing Sediment Load	Target Load	TMDL (overall required load reduction)
				[lbs/ac/yr]	[lbs/ac/yr]	[%]
0302	06010201065_1000	Steekee Creek	67f	872	467.6	46.4
0304	06010201015_1000	Sweetwater Creek		818		42.9
0305	06010201013_1000	Pond Creek		812		42.4
0402	06010201621_1000	Caney Creek	67i	606	284.3	53.1
0503	06010201040_0600	Black Creek	68c	545	123.6	77.3

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

HUC-12 Subwatershed (06010201__)	Level IV Ecoregion	Percent Reduction – Average Annual Sediment Load	
		WLAs (Construction SW and MS4s)	LAs (Nonpoint Sources)
		[%]	[%]
0302	67f	49.1	49.1
0304		45.7	45.7
0305		45.3	45.3
0402	67i	55.4	55.4
0503	68c	78.4	78.4

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 *2006 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 an impaired subwatershed, relative to the estimated average annual sediment loading (minus the 5% allocated to RMCFs and regulated mining sites) of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion (ref.: Table 9). WLAs apply to MS4 discharges in the impaired subwatershed for which the WLA was developed and will be implemented as Best Management Practices (BMPs) as specified in Phase I and II MS4 permits. WLAs should not be construed as numeric 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 *2006 303(d) List* as impaired due to siltation and/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).

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 RMCFs and mining sites 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 Ready Mixed Concrete Facilities

The only NPDES regulated RMCF in the Watts Bar Lake Watershed is located in an impaired subwatershed (ref.: Table 6 and Figure 6). The WLA 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).

8.1.2 NPDES Regulated Mining Sites

One of the three NPDES regulated mining sites in the Watts Bar Lake Watershed is located in an impaired subwatershed (ref.: Table 7 and Figure 6). The WLA will be implemented through the existing permit requirements for this site.

8.1.3 NPDES Regulated Construction Storm Water

The WLAs provided to existing and future NPDES regulated construction activities will be implemented through appropriate erosion prevention and sediment controls and Best Management Practices (BMPs) as specified in NPDES Permit No. TNR10-0000, *General NPDES Permit for Storm Water Discharges Associated With Construction Activity* (TDEC, 2005). This 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. In addition, the permit specifies a number of special requirements for discharges entering high quality waters or waters identified as impaired due to siltation. The permit does not authorize discharges that would result in a violation of a State water quality standard.

Unless otherwise stated, full compliance with the requirements of the *General NPDES Permit for Storm Water Discharges Associated With Construction Activit*y is considered to be consistent with the WLAs specified in Section 7.3.3 of this TMDL document.

8.1.4 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

For existing and future regulated discharges from municipal separate storm sewer systems (MS4s), WLAs will be implemented through Phase I and II MS4 permits. These permits will require the development and implementation of a Storm Water Management Plan (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. Both the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003a) and the TDOT individual MS4 permit (TNS077585) require SWMPs to include the following six minimum control measures:

1) Public education and outreach on storm water impacts;
2) Public involvement/participation;
3) Illicit discharge detection and elimination;
4) Construction site storm water runoff control;
5) Post-construction storm water management in new development and re-development;
6) Pollution prevention/good housekeeping for municipal (or TDOT) operations.

The permits also contain requirements regarding control of discharges of pollutants of concern into impaired waterbodies, implementation of provisions of approved TMDLs, and description of methods to evaluate whether storm water controls are adequate to meet the requirements of approved TMDLs.

In order to evaluate SWMP effectiveness and demonstrate compliance with specified WLAs, MS4s must develop and implement appropriate monitoring programs. An effective monitoring program could include:

- Effluent monitoring at selected outfalls that are representative of particular land uses or geographical areas that contribute to pollutant loading before and after implementation of pollutant control measures.
- Analytical monitoring of pollutants of concern in receiving waterbodies, both upstream and downstream of MS4 discharges, over an extended period of time.
- Instream biological monitoring at appropriate locations to demonstrate recovery of biological communities after implementation of storm water control measures.

The appropriate Environmental Field Office (ref.: http://tennessee.gov/environment/eac/) should be consulted for assistance in the determination of monitoring strategies, locations, frequency, and methods within 12 months after the approval date of this TMDL. Details of the monitoring plan and monitoring data should be included in the annual report required by the MS4 permit.

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 USEPA's Nonpoint Source Pollution website (ref.: http://www.epa.gov/owow/nps/pubs.html) relating to the implementation and evaluation of nonpoint source pollution control measures.

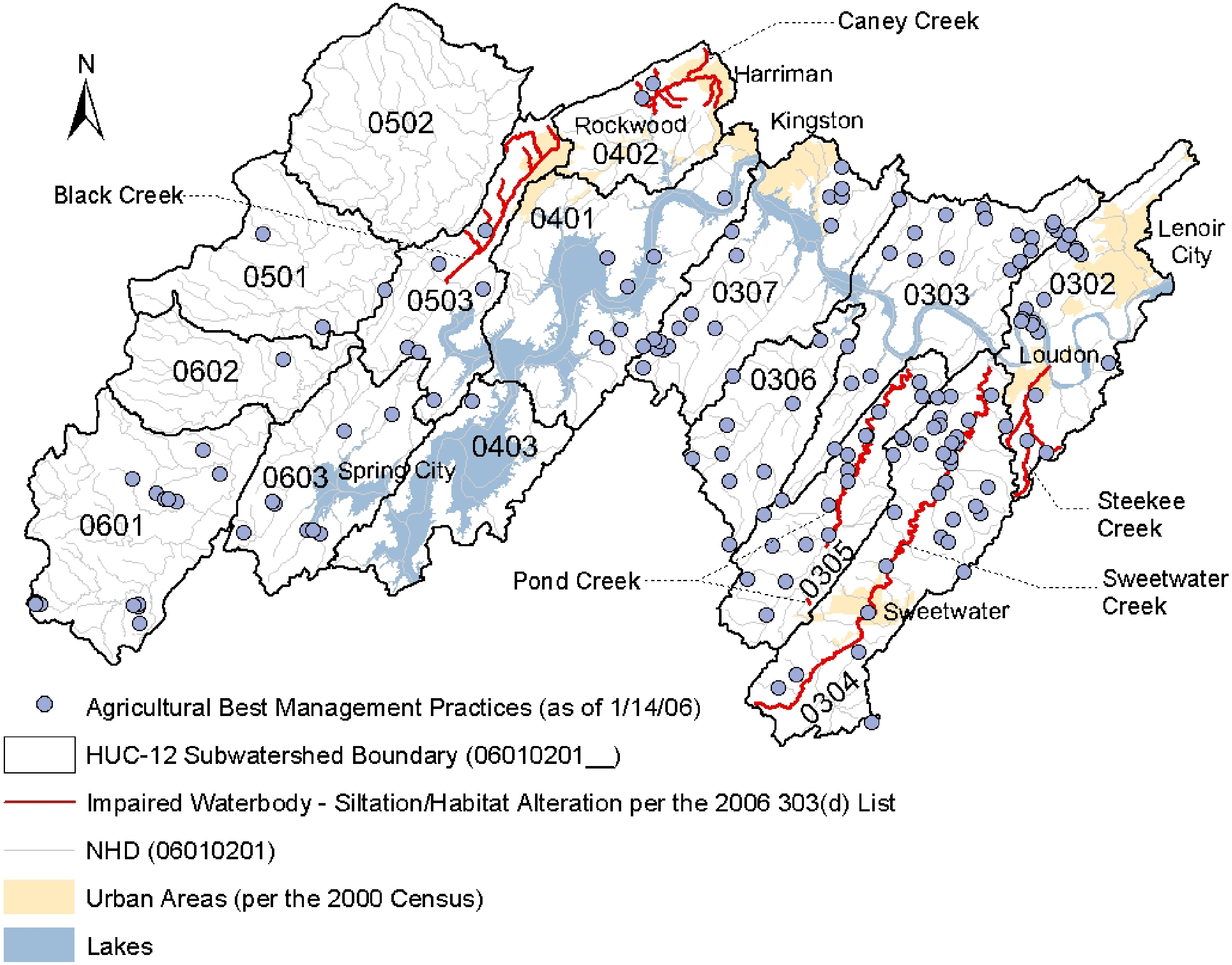
TMDL implementation activities will be accomplished within the framework of Tennessee's Watershed Approach (ref.: http://www.state.tn.us/environment/wpc/watershed/). The Watershed Approach is based on a five-year cycle and encompasses planning, monitoring, assessment, TMDLs, WLAs/LAs, and permit issuance. 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. The Tennessee Department of Agriculture (TDA) keeps a database of BMPs implemented in Tennessee. Of the 232 BMPs in the Watts Bar Lake Watershed as of January 4, 2006, 129 are in sediment-impaired subwatersheds (ref.: Figure 8).

One example of excellent stakeholder involvement is the proposed two-year research project by a UT Master's-level student to develop and evaluate a novel approach to potentially identify sources of non-point source pollutants and estimate the relative contributions of sediment sources on a watershed scale. This project would include analyzing the mineralogy and the minor and trace elemental composition of soils, soil sediments, and soil particulates (size and density separates) to develop a sediment "fingerprint". This fingerprint would then be statistically related to the fingerprints of potential sources. While this research is planned for the Pond Creek watershed (see Appendix A), with reference samples as in two other watersheds as well, the research is expected to have applications for watersheds across Tennessee and elsewhere (UT, 2006). For more information, contact UT Biosystems Engineering and Soil Science at 865-974-7266.

Figure 8 Location of Agricultural Best Management Practices in the Watts Bar Lake Watershed



Another example of excellent stakeholder involvement is the Oak Ridge Reservation Local Oversight Committee (ORRLOC). The ORRLOC is a non-profit regional organization that represents the interests of local governments regarding Department of Energy's environmental management program and the operation of the Oak Ridge Reservation (ORR). The Board of Directors of the LOC is composed of elected and appointed officials from the seven surrounding and downstream counties and the City of Oak Ridge, plus the Chair of the LOC's Citizens' Advisory Panel (CAP). The CAP has up to 20 members with diverse backgrounds representing the greater ORR region, studies problems in-depth, and provides advice to the LOC Board and other governmental agencies. For more information, call toll-free 888-770-3073 or e-mail loc@icx.net.

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.

9.0 PUBLIC PARTICIPATION

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

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, which was sent to approximately 90 interested persons or groups who had requested this information.

3) A letter was sent to following point source facilities in the Watts Bar Lake 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:

TNG110214	Midtown Ready Mix Concrete
TN0071552	Addington Enterprises, Inc.

4) A letter was sent to identified water quality partners in the Watts Bar Lake Watershed advising them of the proposed sediment TMDLs and their availability on the TDEC website and inviting comments. These partners included:

   National Park Service

   Natural Resources Conservation Service

   United States Geological Survey Water Resources Programs – Tennessee District

   U.S. Fish and Wildlife Service

   Tennessee Valley Authority (TVA)

   Tennessee Department of Agriculture

   Tennessee Wildlife Resources Agency

   University of Tennessee - Biosystems Engineering and Soil Science

   Oak Ridge Reservation Local Oversight Committee

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

TNS075591	Loudon County
TNS077798	Lenoir City
TNS077585	Tennessee Department of Transportation (TDOT)

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

REFERENCES

Midwest Plan Service. 1985. Livestock Waste Facilities Handbook, 2nd Edition. US Department of Agriculture and various universities. MWPS-18. Figure 11-12b. http://www.mwps.org/index.cfm?fuseaction=c_products.view&catID=719&productID=6341

OMAFRA. 2000. *Factsheet: Universal Soil Loss Equation (USLE*). Ontario Ministry of Agriculture, Food and Rural Affairs website: http://www.omafra.gov.on.ca/english/engineer/facts/00-001.htm

Sun, G. and S.G. McNulty. 1998. *Modeling Soil Erosion and Transport on Forest Landscape*. Proceedings of Conference 29, International Erosion Control Association. pp.187-198. http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=902

Swift, Lloyd W. 2000. *Equation to Dissipate Sediment from a Gridcell Downslope*. U.S. Forest Service.

TDEC. 2000. *Tennessee Ecoregion Project 1994 - 1999.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, December 2000. http://www.state.tn.us/environment/wpc/publications/Ecoregion%20report%20for%20web.pdf

TDEC. 2002. *Tennessee Erosion and Sediment Control Handbook, Second Edition*. State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, March 2002. http://www.state.tn.us/environment/permits/conststrm.php

TDEC. 2003. *General NPDES Permit for Discharges of Storm Water Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (Permit No. TNG110000). State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, December 2003. http://www.state.tn.us/environment/permits/concrete.php

TDEC. 2003a. *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, February 2003. http://www.state.tn.us/environment/wpc/stormh2o/MS4II.shtml

TDEC. 2004. *Rules of Tennessee Department of Environment and Conservation.* Tennessee Water Quality Control Board, Division of Water Pollution Control, Chapter 1200-4-4 Use Classification for Surface Waters, January 2004. http://www.state.tn.us/sos/rules/1200/1200-04/1200-04-04.pdf

TDEC. 2004a. *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. http://www.state.tn.us/sos/rules/1200/1200-04/1200-04-03.pdf

TDEC. 2005. *General NPDES Permit for Storm Water Discharges Associated With Construction Activity.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, June 2005. This document is available on the TDEC website: http://www.state.tn.us/environment/permits/conststrm.php

REFERENCES, cont.

TDEC. 2006. *Final Version, Year 2006 303(d) List.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, October 2006. http://state.tn.us/environment/wpc/publications/2006pf_303d.pdf

TDEC. 2006a. *2006 305(b) Report*, *The Status of Water Quality in Tennessee.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, April 2006. http://www.tennessee.gov/environment/wpc/publications/2006305b.pdf

USDASCS. 1983. *Sedimentation*. National Engineering Handbook, Section 3, Chapter 6. U.S. Department of Agriculture Soil Conservation Service. http://www.info.usda.gov/CED/ftp/CED/neh3-all.pdf

USEPA. 1991. *Guidance for Water Quality-based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991. http://www.epa.gov/OWOW/tmdl/decisions/ or http://www.epa.gov/waterscience/library/modeling/SASD0109.pdf

USEPA. 1997. *Ecoregions of Tennessee*. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Corvallis, Oregon. EPA/600/R-97/022. http://www.ntis.gov/search/product.asp?ABBR=PB97156863&starDB=GRAHIST

USEPA. 1999. *Protocol for Developing Sediment TMDLs*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 841-B-99-004, October 1999. http://www.epa.gov/owow/tmdl/sediment/pdf/sediment.pdf

USEPA. 2001. *Watershed Characterization System - User's Manual*. U.S. Environmental Protection Agency, Region 4, Atlanta, Georgia. http://wcs.tetratech-ffx.com/Documentation/index.htm

USEPA. 2006. *Framework For Developing Suspended And Bedded Sediments (SABS) Water Quality Criteria*. U.S. Environmental Protection Agency, Office of Water, Office of Research and Development, Washington, DC. EPA 822-R-06-001, May 2006. http://www.epa.gov/med/Prods_Pubs/framework_sabs_20060601.pdf

University of Tennessee (UT). 2006. *Proposal for Improving the Design and Implementation of Total Total Daily Maximum Loads (TMDLs) through the Development of a Method for Identifying the Sources of In-Stream Sediments.* UT, Biosystems Engineering and Soil Science, Knoxville, TN.

Yagow, E.R., V.O. Schanholtz, B.A. Julian, and J.M. Flagg. 1998. *A Water Quality Module for CAMPS*. American Society of Agricultural Engineers Meeting Presentation Paper No. 88-2653.

APPENDIX A

Example of a Typical Stream Assessment (Pond Creek)

Figure A-1 Pond Creek at RM 2.3, front of field sheet – August 14, 2006

Division of Water Pollution Control
SOP for Macroinvertebrate Stream Surveys
Revision 3
Effective Date: November 2003
Appendix B: Page 4 of 12

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Pond Creek	LOCATION Bradshaw Rd ford
STATION # POND002.3LO	ECOREGION 67F
LAT LONG	RIVER BASIN Watts Bar
WBID/HUC 06010201	INVESTIGATORS JEB/DBH
FORM COMPLETED BY JEB	DATE 8/14/06 TIME 10:10 (AM) PM

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 16	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 13	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 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 16	20 19 18 17 (16)	15 14 13 12 11	10 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 clay silt 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 bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition
SCORE 12	20 19 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 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

temp = 22.38 °C
d.o. = 8.37 mg/l
cond = 345
pH = 7.93

Figure A-2 Pond Creek at RM 2.3, back of field sheet – August 14, 2006

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (BACK)

Station ID POND012.3-LO Date 8/14/06

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern. fcd	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 16	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 15	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 8 (LB)	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
SCORE 8 (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 9 (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 9 (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 9 (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0

TOTAL SCORE 156

-27
-17
44

Figure A-3 Pond Creek at RM 8.3, front of field sheet – August 14, 2006

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Pond Creek	LOCATION Pond Creek Rd/Bright Rd, Bar Four
STATION # POND008.3LO	ECOREGION 67F
LAT LONG	RIVER BASIN Watts Bar
WBID/HUC 06010201	INVESTIGATORS JEB & DBH
FORM COMPLETED BY JEB	DATE 8/14/06 TIME 11:45 (AM) PM

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 14	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 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 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 16	20 19 18 17 (16)	15 14 13 12 11	10 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 clay silt 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 bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition
SCORE 9 ~~11~~	20 19 18 17 16	15 14 13 12 ~~(11)~~	10 (9) 8 7 6	5 4 3 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

temp = 23.12 °C
d.o. = 6.83 mg/l
Cond = 368
pH = 7.59

Figure A-4 Pond Creek at RM 8.3, back of field sheet – August 14, 2006

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (BACK)

Station ID POND008.3LO Date 8/14/06

Habitat Parameter	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 13	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. 6:1	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 14	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 5 (LB)	Left Bank 10 9	8 7 6	(5) 4 3	2 1 0
SCORE 6 (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 6 (LB)	Left Bank 10 9	8 7 (6)	5 4 3	2 1 0
SCORE 5 (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 4 (LB)	Left Bank 10 9	8 7 6	5 (4) 3	2 1 0
SCORE 4 (RB)	Right Bank 10 9	8 7 6	5 (4) 3	2 1 0

TOTAL SCORE 123

-34
-43
-77

Figure A-5   Photos of Pond Creek at RM 2.3 – August 14, 2006

Figure A-6 Photos of Pond Creek at RM 8.3 – August 14, 2006

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:

<u>R - Rainfall Erosivity Index</u>

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.

<u>K - Soil Erodibility Factor</u>

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.

<u>LS - Topographic Factor</u>

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.

<u>C - Crop/Vegetation and Management Factor</u>

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. All of the sediment analyses were performed on the basis of these drainage areas. Land use distribution for impaired subwatersheds is summarized in Appendix C.

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 National Hydrology 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 Watts Bar Lake 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 *2006 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 *2006 303(d) List*)

HUC-12 Subwatershed (06010201__)	***EROSION***				
	Road [tons/yr]	**Source** [tons/yr]	**Total** [tons/yr]	**%Road**	**%Source**
0302	14,386.1	15,436.9	29,823	48.2	51.8
0304	10,916.1	31,853.1	42,769	25.5	74.5
0305	4,383.1	19,922.9	24,306	18.0	82.0
0402	7,302.4	3,647.5	10,950	66.7	33.3
0503	9,039.8	4,472.7	13,513	66.9	33.1

Table B-2 Calculated Sediment Delivery to Surface Waters - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2006 303(d) List*)

HUC-12 Subwatershed (06010201__)	*SEDIMENT*				
	Road [tons/yr]	Source [tons/yr]	Total [tons/yr]	%Road	%Source
0302	7,784.7	5,138.8	12,924	60.2	39.8
0304	5,717.0	10,796.0	16,513	34.6	65.4
0305	2,189.3	7,329.9	9,519	23.0	77.0
0402	3,873.3	1,372.9	5,246	73.8	26.2
0503	4,319.3	2,092.6	6,412	67.4	32.6

Table B-3 Unit Loads - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2006 303(d) List*)

HUC-12 Subwatershed (06010201__)	HUC-12 Subwatershed Area	*UNIT LOADS*			
		Erosion		Sediment	
	[acres]	[tons/ac/yr]	[lbs/ac/yr]	[tons/ac/yr]	[lbs/ac/yr]
0302	29,630	1.007	2,013	0.436	872
0304	40,364	1.060	2,119	0.409	818
0305	23,444	1.037	2,074	0.406	812
0402	17,309	0.633	1,265	0.303	606
0503	23,543	0.574	1,148	0.272	545

APPENDIX C

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

Table C-1 Watts Bar Lake Watershed - Impaired Subwatershed Land Use Distribution

Land Use	Subwatershed (06010201__)									
	0302		0304		0305		0402		0503	
	[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	4,376	14.8	5,488	13.6	2,912	12.4	8,421	48.7	11,471	48.7
Emergent Herbaceous Wetlands	1	0.0	0	0.0	0	0.0	0	0.0	38	0.2
Evergreen Forest	5,001	16.9	4,283	10.6	2,646	11.3	1,642	9.5	2,288	9.7
High Intensity Commercial/ Industrial/Transportation	597	2.0	707	1.8	281	1.2	487	2.8	202	0.9
High Intensity Residential	279	0.9	82	0.2	1	0.0	70	0.4	111	0.5
Low Intensity Residential	1,431	4.8	803	2.0	50	0.2	535	3.1	684	2.9
Mixed Forest	6,683	22.6	7,324	18.1	3,791	16.2	3,503	20.2	4,366	18.5
Open Water	1,692	5.7	75	0.2	40	0.2	377	2.2	1,588	6.7
Other Grasses (Urban/Recreational)	827	2.8	623	1.5	68	0.3	392	2.3	211	0.9
Pasture/Hay	6,705	22.6	16,087	39.9	10,532	44.9	1,531	8.8	1,902	8.1
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	1,942	6.6	4,756	11.8	2,935	12.5	300	1.7	423	1.8
Transitional	81	0.3	137	0.3	187	0.8	50	0.3	17	0.1
Woody Wetlands	14	0.0	0	0.0	0	0.0	0	0.0	240	1.0
Total	**29,630**	**100.0**	**40,364**	**100.0**	**23,444**	**100.0**	**17,309**	**100.0**	**23,543**	**100.0**

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

Land Use	Ecosite Subwatershed									
	Eco67f06		Eco67f13		Eco67f17		Eco67g05		Eco67g08	
	[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	1,678	85.6	1,505	87.3	17,329	57.6	2,690	12.8	1,076	25.4
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	43	2.2	76	4.4	2,869	9.5	2,154	10.2	721	17.0
High Intensity Commercial/ Industrial/Transportation	1	0.0	0	0.0	22	0.1	101	0.5	23	0.5
High Intensity Residential	0	0.0	0	0.0	0	0.0	24	0.1	1	0.0
Low Intensity Residential	2	0.1	0	0.0	16	0.1	114	0.5	64	1.5
Mixed Forest	233	11.9	132	7.6	4,178	13.9	3,787	18.0	1,087	25.6
Open Water	0	0.0	0	0.0	4	0.0	7	0.0	2	0.1
Other Grasses (Urban/Recreational)	0	0.0	0	0.0	10	0.0	193	0.9	46	1.1
Pasture/Hay	6	0.3	10	0.6	5,296	17.6	10,049	47.7	1,019	24.0
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	77	0.3	0	0.0	0	0.0
Row Crops	0	0.0	1	0.1	258	0.9	1,933	9.2	198	4.7
Transitional	0	0.0	0	0.0	4	0.0	0	0.0	0	0.0
Woody Wetlands	0	0.0	0	0.0	0	0.0	8	0.0	0	0.0
Total	**1,963**	**100.1**	**1,724**	**100.0**	**30,062**	**100.0**	**21,058**	**100.0**	**4,237**	**100.0**

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

Land Use	Ecosite Subwatershed									
	Eco67g09		Eco67g10		Eco67g11		Eco67i12		Eco68a01	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand	0	0.0	0	0.0	0	0.0	0	0.0	1,427	38.4
Deciduous Forest	1,603	52.5	3,165	23.9	719	70.6	457	67.1	0	0.0
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	696	22.8	2,669	20.2	162	15.9	93	13.7	921	24.8
High Intensity Commercial/ Industrial/Transportation	1	0.0	17	0.1	0	0.0	1	0.2	0	0.0
High Intensity Residential	2	0.1	6	0.0	0	0.0	0	0.0	0	0.0
Low Intensity Residential	48	1.6	48	0.4	0	0.0	3	0.5	0	0.0
Mixed Forest	497	16.3	2,619	19.8	138	13.5	112	16.4	1,369	36.8
Open Water	1	0.0	4	0.0	0	0.0	0	0.1	0	0.0
Other Grasses (Urban/Recreational)	10	0.3	16	0.1	0	0.0	0	0.0	0	0.0
Pasture/Hay	156	5.1	4,420	33.4	0	0.0	12	1.7	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	40	1.3	272	2.1	0	0.0	2	0.4	0	0.0
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	**3,054**	**100.0**	**13,236**	**100.0**	**1,019**	**100.0**	**681**	**100.0**	**3,718**	**100.0**

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

Land Use	Ecosite Subwatershed									
	Eco68a03		Eco68a08		Eco68a13		Eco68a20		Eco68a26	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
Deciduous Forest	3,536	32.7	46,284	46.8	4,070	45.5	4,550	61.6	58,385	52.7
Emergent Herbaceous Wetlands	0	0.0	0	0.0	1	0.0	0	0.0	8	0.0
Evergreen Forest	3,011	27.8	15,790	16.0	2,365	26.4	519	7.0	11,272	10.2
High Intensity Commercial/ Industrial/Transportation	2	0.0	176	0.2	0	0.0	3	0.0	553	0.5
High Intensity Residential	0	0.0	0	0.0	0	0.0	0	0.0	33	0.0
Low Intensity Residential	11	0.1	258	0.3	1	0.0	25	0.3	784	0.7
Mixed Forest	3,977	36.7	24,815	25.1	942	10.5	2,217	30.0	21,382	19.3
Open Water	0	0.0	73	0.1	9	0.1	0	0.0	940	0.8
Other Grasses (Urban/Recreational)	3	0.0	236	0.2	0	0.0	10	0.1	716	0.6
Pasture/Hay	259	2.4	9,207	9.3	501	5.6	9	0.1	13,864	12.5
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0	312	0.3
Row Crops	28	0.3	1,564	1.6	40	0.5	7	0.1	1,398	1.3
Transitional	0	0.0	501	0.5	725	8.1	48	0.6	456	0.4
Woody Wetlands	0	0.0	0	0.0	292	3.3	0	0.0	788	0.7
Total	**10,828**	**100.0**	**98,904**	**100.0**	**8,947**	**100.0**	**7,388**	**100.0**	**110,890**	**100.0**

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

Land Use	Ecosite Subwatershed									
	Eco68a28		Eco68c12		Eco68c13		Eco68c15		Eco68c20	
	[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	10,209	63.7	518	63.9	1,280	72.0	9,965	78.7	9,928	78.7
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	1,487	9.3	48	6.0	68	3.8	871	6.9	871	6.9
High Intensity Commercial/ Industrial/Transportation	21	0.1	0	0.0	8	0.4	48	0.4	48	0.4
High Intensity Residential	0	0.0	0	0.0	0	0.0	11	0.1	11	0.1
Low Intensity Residential	89	0.6	0	0.0	22	1.3	111	0.9	111	0.9
Mixed Forest	3,574	22.3	244	30.1	254	14.3	1,234	9.8	1,232	9.8
Open Water	1	0.0	0	0.0	2	0.1	37	0.3	37	0.3
Other Grasses (Urban/Recreational)	44	0.3	0	0.0	12	0.7	40	0.3	40	0.3
Pasture/Hay	469	2.9	0	0.0	93	5.2	181	1.4	181	1.4
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	139	0.9	0	0.0	36	2.1	38	0.3	38	0.3
Transitional	3	0.0	0	0.0	2	0.1	116	0.9	116	0.9
Woody Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**16,036**	**100.0**	**810**	**99.9**	**1,777**	**100.0**	**12,653**	**100.0**	**12,614**	**100.0**

APPENDIX D

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

Determination of Existing Point Source Sediment Loads

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

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-1) from the RMCF located in an impaired subwatershed 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 facilities are located. Loads are expressed as average annual loads per unit area and are summarized in Table D-1.

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

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-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 each facility is located (ref.: Table D-1). Site runoff was estimated by assuming that one-half of the annual precipitation falling on the site drainage area results in runoff. Annual precipitation for the Watts Bar Lake Watershed is approximately 52 in/yr (Midwest Plan Service, 1985).

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

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

Table D-1 Estimate of Existing Loads - Ready Mixed Concrete Facilities

HUC-12 Subwatershed (06010201__)	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]
0402	17,309	TNG110214	0.0001	50	0.0009	1.0	200	0.0681	0.069

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-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 Watts Bar Lake Watershed is approximately 52 in/yr (Midwest Plan Service, 1985).

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

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

Table D-2 Estimate of Existing Load – NPDES Permitted Mining Sites

HUC-12 Subwatershed (06010201___)	Subwatershed Area [acres]	NPDES Permit No.	Site Drainage Area [acres]	Daily Maximum TSS Limit [mg/l]	Annual Average Load [lb/ac/yr]
0402	17,309	TN0071552	4.0	40	0.054

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

HUC-12 Subwatershed (06010201__)	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]	[%]
0402	TNG110214	RMCF	0.069				
	TN0071552	Mining	0.054				
	Subwatershed 0402 Total		**0.123**	606	**0.02**	284.3	**0.04**

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

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR SILTATION & HABITAT ALTERATION IN THE WATTS BAR LAKE WATERSHED (HUC 06010201), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Loads (TMDLs) for siltation and/or habitat alteration in the Watts Bar Lake Watershed located in East Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

A number of waterbodies in the Watts Bar Lake Watershed are listed on Tennessee's final *2006 303(d) List* as not supporting designated use classifications due, in part, to siltation and habitat alteration associated with land development, agricultural sources, and municipal point source discharges. The TMDLs utilize Tennessee's general water quality criteria, ecoregion reference site data, land use data, digital elevation data, a sediment loading and delivery model, and an appropriate Margin of Safety (MOS) to establish reductions in sediment loading which will result in reduced in-stream concentrations and the attainment of water quality standards. The TMDLs require reductions in sediment loading of approximately 42% to 77% in the listed waterbodies.

The proposed siltation/habitat alteration TMDLs may be downloaded from the Department of Environment and Conservation website:

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

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

Mary Wyatt, Watershed Management Section
Telephone: 615-532-0714
e-mail: Mary.Wyatt@state.tn.us

Sherry H. Wang, Ph.D., Watershed Management Section
Telephone: 615-532-0656
e-mail: Sherry.Wang@state.tn.us

Persons wishing to comment on the TMDLs are invited to submit their comments in writing no later than February 26, 2007 to:

Division of Water Pollution Control
Watershed Management Section
6th Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1534

All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Pollution Control, 6th Floor, L & C Annex, 401 Church Street, Nashville, Tennessee. They may be inspected during normal office hours. Copies of the information on file are available on request.