TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Siltation and Habitat Alteration

In The

Ft. Loudoun Lake Watershed (HUC 06010201)

Blount, Knox, Loudon and Sevier Counties, Tennessee

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TDEC

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ARS	Agricultural Research Station
BMP	Best Management Practices
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DWPC	Division of Water Pollution Control
EFO	Environmental Field Office
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NHD	National Hydrography Dataset
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NSL	National Sediment Laboratory
Rf3	Reach File v.3
RM	River Mile
RMCF	Ready Mixed Concrete Facility
STATSGO	State Soil and Geographic Database
SSURGO	Soil Survey Geographic Database
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMD	Water Management Division
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

FT. LOUDOUN LAKE WATERSHED (HUC 06010201)

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

Impaired Waterbody Information:

State: Tennessee
Counties: Blount, Knox, Loudon, and Sevier
Watershed: Ft. Loudoun Lake Watershed (HUC 06010201)
Watershed Area: 660.9 mi^2
Constituent of Concern: Siltation/Habitat Alteration (excess loading of sediment produced by erosional processes – see Section 3.0)
Impaired Waterbodies: *2004 303(d) List*:

Waterbody ID	Waterbody	RM
06010201022_1000	Gallagher Creek	13.2
06010201026_0100	Roddy Branch	6.4
06010201026_0200	Caney Branch	2.0
06010201026_0300	Hollybrook Branch	2.78
06010201026_0400	Pistol Creek	7.66
06010201026_0410	Springfield Branch	5.48
06010201026_0420	Brown Creek	24.7
06010201026_0430	Laurel Bank Branch	22.72
06010201026_0500	Russell Branch	3.0
06010201026_2000	Little River	17.63
06010201027_0300	Rocky Branch	4.04
06010201027_0400	Peppermint Branch	2.7
06010201028_0100	Spicewood Branch	2.23
06010201028_0300	South Fork Crooked Creek	8.21
06010201028_0500	Flag Branch	7.8
06010201028_1000	Crooked Creek	13.91
06010201032_0810	Tipton Branch	2.5
06010201033_0400	South Fork Ellejoy Creek	2.02
06010201033_0500	Carter Branch	4.63
06010201033_2000	Ellejoy Creek	5.37
06010201034_0200	Wildwood Branch	6.26
06010201037_1000	Little Turkey Creek	14.0
06010201066_0100	Casteel Branch	2.0
06010201066_0200	Twin Branch	1.87
06010201066_0500	McCall Branch	1.73

Impaired Waterbodies: *2004 303(d) List* (Cont.):

Waterbody ID	Waterbody	RM
06010201066_1000	Stock Creek	3.77
06010201067_1000	Third Creek	20.7
06010201080_0100	Whites Creek	10.2
06010201080_1000	First Creek	16.1
06010201083_1000	Floyd Creek	7.7
06010201097_1000	Second Creek	12.8
06010201340_1000	Turkey Creek	15.8
060102011015_1000	Cloyd Creek	11.3
060102011330_2000	Sinking Creek	21.9
060102011697_1000	Fourth Creek	14.9
060102011719_1000	Williams Creek	2.8
060102011721_1000	Baker Creek	3.3
060102011723_1000	Goose Creek	4.9
060102011983_1000	Polecat Creek	1.85

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

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

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

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

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

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

TMDL Development

General Analysis Methodology:

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

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

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

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

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

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

Critical Conditions: Methodology takes into account all flow conditions.

Seasonal Variation: Methodology addresses all seasons.

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

TMDL/Allocations

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

HUC-12 Subwatershed (06010201__)	Waterbody ID	Waterbody Impaired by Siltation/ Habitat Alteration	Level IV Ecoregion	TMDL (Required Overall Load Reduction)	Required Load Reduction	
					WLA (MS4s and Construction SW)	LA (Nonpoint Sources)
				[%]	[%]	[%]
0103	06010201032_0810	Tipton Branch	66g	77.6	78.8	78.8
0104	06010201027_0300	Rocky Branch	66e	80.6	81.6	81.6
	06010201033_0400	South Fork Ellejoy Creek				
	06010201033_0500	Carter Branch				
	06010201033_2000	Ellejoy Creek				
0105	06010201026_2000	Little River	67f	46.6	49.3	49.3
	06010201027_0400	Peppermint Branch				
	06010201028_0100	Spicewood Branch				
	06010201028_0300	South Fork Crooked Creek				
	06010201028_0500	Flag Branch				
	06010201028_1000	Crooked Creek				
	06010201034_0200	Wildwood Branch				
0106	06010201026_0100	Roddy Branch	67f	51.8	54.2	54.2
	06010201026_0200	Caney Branch				
	06010201026_0300	Hollybrook Branch				
	06010201026_0500	Russell Branch				
	06010201026_2000	Little River				
	060102011983_1000	Polecat Creek				

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

TMDLs, WLAs for MS4s and Construction Storm Water Sites, LAs for Nonpoint Sources (Cont.):

HUC-12 Subwatershed (06010201__)	Waterbody ID	Waterbody Impaired by Siltation/ Habitat Alteration	Level IV Ecoregion	TMDL (Required Overall Load Reduction	Required Load Reduction	
					WLA (MS4s and Const. SW)	LA (Nonpoint Sources)
				[%]	[%]	[%]
0107	06010201026_0400	Pistol Creek	67f	78.1	79.2	79.2
	06010201026_0410	Springfield Branch				
	06010201026_0420	Brown Creek				
	06010201026_0430	Laurel Bank Branch				
0108	06010201066_0100	Casteel Branch	67h	35.3	38.6	38.6
	06010201066_0200	Twin Branch				
	06010201066_0500	McCall Branch				
	06010201066_1000	Stock Creek				
0201	060102011697_1000	Fourth Creek	67f	65.5	67.2	67.2
	060102011719_1000	Williams Creek				
	060102011721_1000	Baker Creek				
	060102011723_1000	Goose Creek				
0202	06010201080_0100	Whites Creek	67f	66.3	68.0	68.0
	06010201080_1000	First Creek				
0203	06010201097_1000	Second Creek	67f	75.2	76.5	76.5
0204	06010201067_1000	Third Creek	67f	67.2	68.8	68.8
0208	060102011330_2000	Sinking Creek	67f	59.8	61.8	61.8
0209	06010201037_1000	Little Turkey Creek	67f	47.7	50.3	50.3
	06010201340_1000	Turkey Creek				
0210	06010201022_1000	Gallagher Creek	67f	28.0	31.6	31.6
0301	06010201083_1000	Floyd Creek	67f	53.1	55.5	55.5
	060102011015_1000	Cloyd Creek				

WLAs for Mining Sites and RMCFs:

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

Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds

HUC-12 Subwatershed (06010201__)	NPDES Permit No.	Name	TSS Daily Max Limit [mg/l]
0106	TN0072761	Vulcan Construction Materials, LP – Rockford Quarry	40
0107	TN0003042	Vulcan Construction Materials, LP – Maryville Quarry	40
0201	TN0029467	Vulcan Construction Materials, LP – Riverside Drive Quarry	40
0210	TN0071862	Tennessee Marble Company – Brown Quarry	40
	TN0072061	TVM/TSW – Lambert Quarry	40
	TN0072125	TVM/TSW – Endsley Quarry	40
	TN0072621	Vulcan Construction Materials, LP – Friendsville South	40
0301	TN0066397	Greenback Crushed Stone, Inc. – Greenback Quarry	40
	TN0072222	Vulcan Construction Materials, LP – Friendsville Quarry	40
	TN0072699	Tennessee Marble Products Co. – Dabney Pit 1	40

RMCFs Permitted to Discharge TSS and Located in Impaired Subwatersheds

HUC-12 Subwatershed (06010201__)	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit [mg/l]	TSS Cut-off Conc. [mg/l]
0106	TNG110089	Harrison Ready-Mix – Topside Road	50	200
	TNG110245	Rockford Concrete Plant	50	200
0107	TNG110088	Harrison Ready-Mix – Duncan Road	50	200
	TNG110090	Harrison Ready-Mix – Matlock Bend Industrial Park	50	200
	TNG110092	Harrison Ready-Mix – Sands Road	50	200
	TNG110121	Ready Mix Concrete Company	50	200
0201	TNG110246	Rinker Materials S. Central – Neyland Drive	50	200
0204	TNG110157	Southeast Precast Corporation	50	200
0209	TNG110027	Ready Mix Concrete Company	50	200
	TNG110244	Rinker Materials S. Central – W. Knox	50	200
0301	TNG110143	Adams Redi-Mix	50	200

**TOTAL MAXIMUM DAILY LOAD (TMDL)
FOR SILTATION/HABITAT ALTERATION
FT. LOUDOUN 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 Ft. Loudoun Lake Watershed, designated by the Hydrologic Unit Code (HUC) 06010201 by the USGS, is located in East Tennessee (ref.: Figure 1), primarily in Blount, Knox, Loudon, and Sevier Counties. The Ft. Loudoun Lake Watershed lies within two Level III ecoregions (Blue Ridge Mountains and Ridge and Valley) and contains seven Level IV subecoregions as shown in Figure 2 (USEPA, 1997):

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

- Limestone Valleys and Coves (66f) are small but distinct lowland areas of the Blue Ridge, with elevations mostly between 1,500 and 2,500 feet. About 450 million years ago, older Blue Ridge rocks to the east were forced up and over younger rocks to the west. In places, the Precambrian rocks have eroded through to Cambrian or Ordovician-age limestones, as seen especially in isolated, deep cove areas that are surrounded by steep mountains. The main areas of limestone include the Mountain City lowland area and Shady Valley in the north; and Wear Cove, Tuckaleechee Cove, and Cades Cove of the Great Smoky Mountains in the south. Hay and pasture, with some tobacco patches on small farms, are typical land uses.

- The Southern Metasedimentary Mountains (66g) are steep, dissected, biologically-diverse mountains that include Clingmans Dome (6,643 feet), the highest point in Tennessee. The Precambrian-age metamorphic and sedimentary geologic materials are generally older and more metamorphosed than the Southern Sedimentary Ridges (66e) to the west and north. The Appalachian oak forests and, at higher elevations, the northern hardwoods forests include a variety of oaks and pines, as well as silverbell, hemlock, yellow poplar, basswood, buckeye, yellow birch, and beech. Spruce-fir forests, found generally above 5500 feet, have been affected greatly over the past twenty-five years by the balsam woolly aphid. The Copper Basin, in the southeast corner of Tennessee, was the site of copper mining and smelting from the 1850s to 1987, and once left more than fifty square miles of eroded earth.

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

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

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

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

The Ft. Loudoun Lake Watershed (HUC 06010201) has approximately 14,600 lake acres and 953 miles of streams (NHD) as catalogued in the EPA/TDEC Assessment Database (ADB) and drains 660.9 square miles that empty 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 Ft. Loudoun Lake Watershed is summarized in Table 1 and shown in Figure 3.

Figure 1 Location of the Ft. Loudoun Lake Watershed

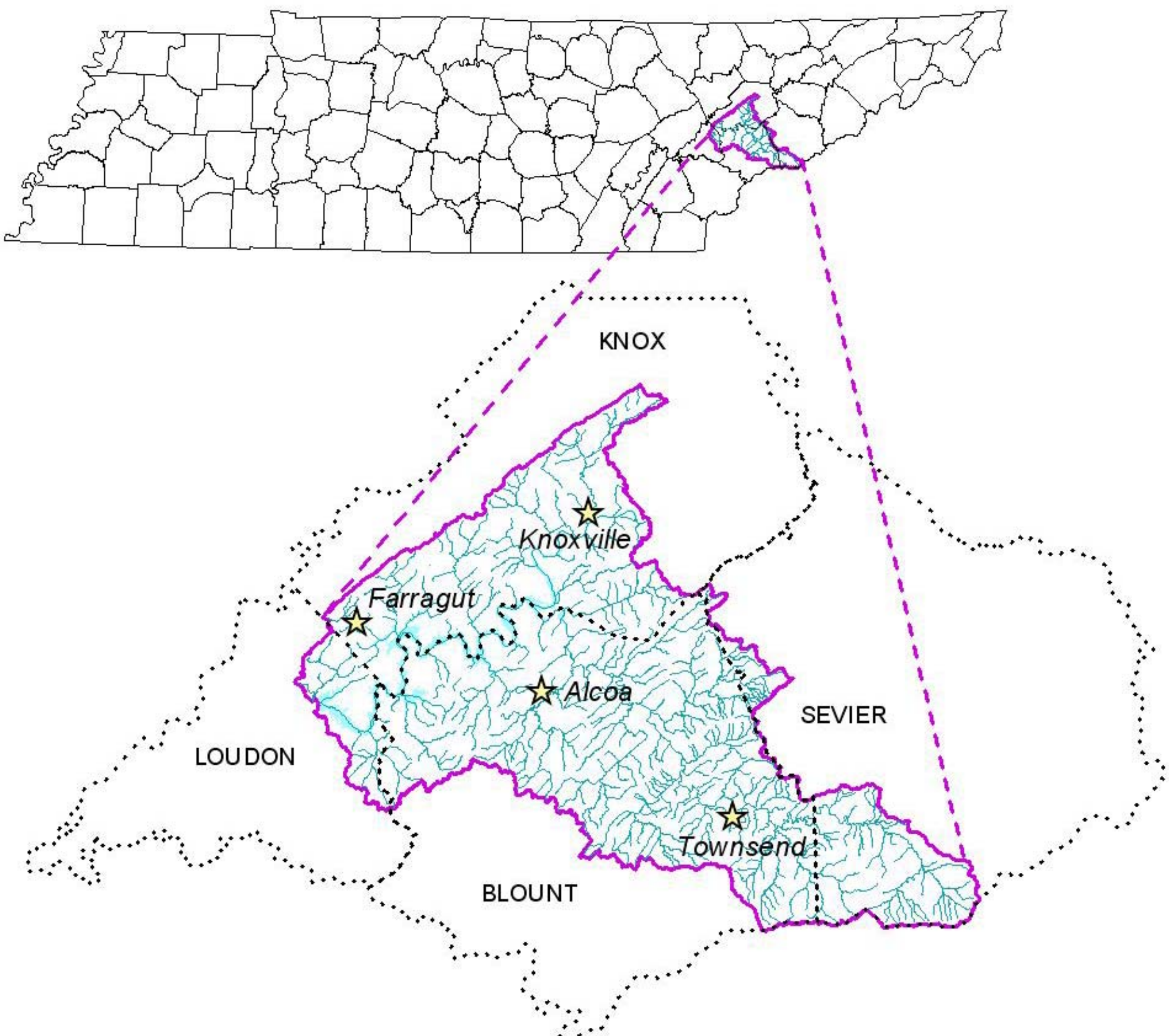


Figure 2 Level IV Ecoregions in the Ft. Loudoun Lake Watershed

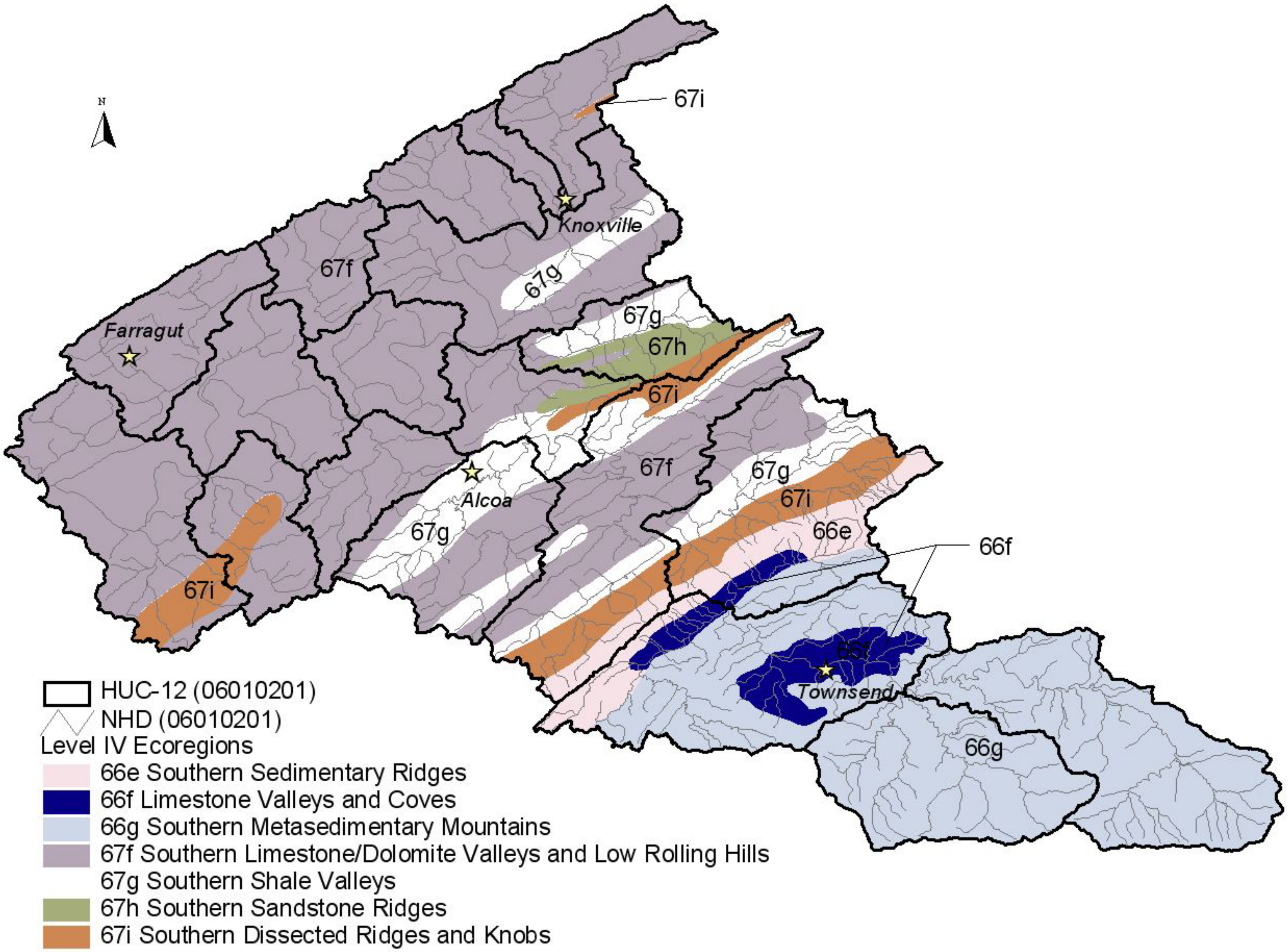
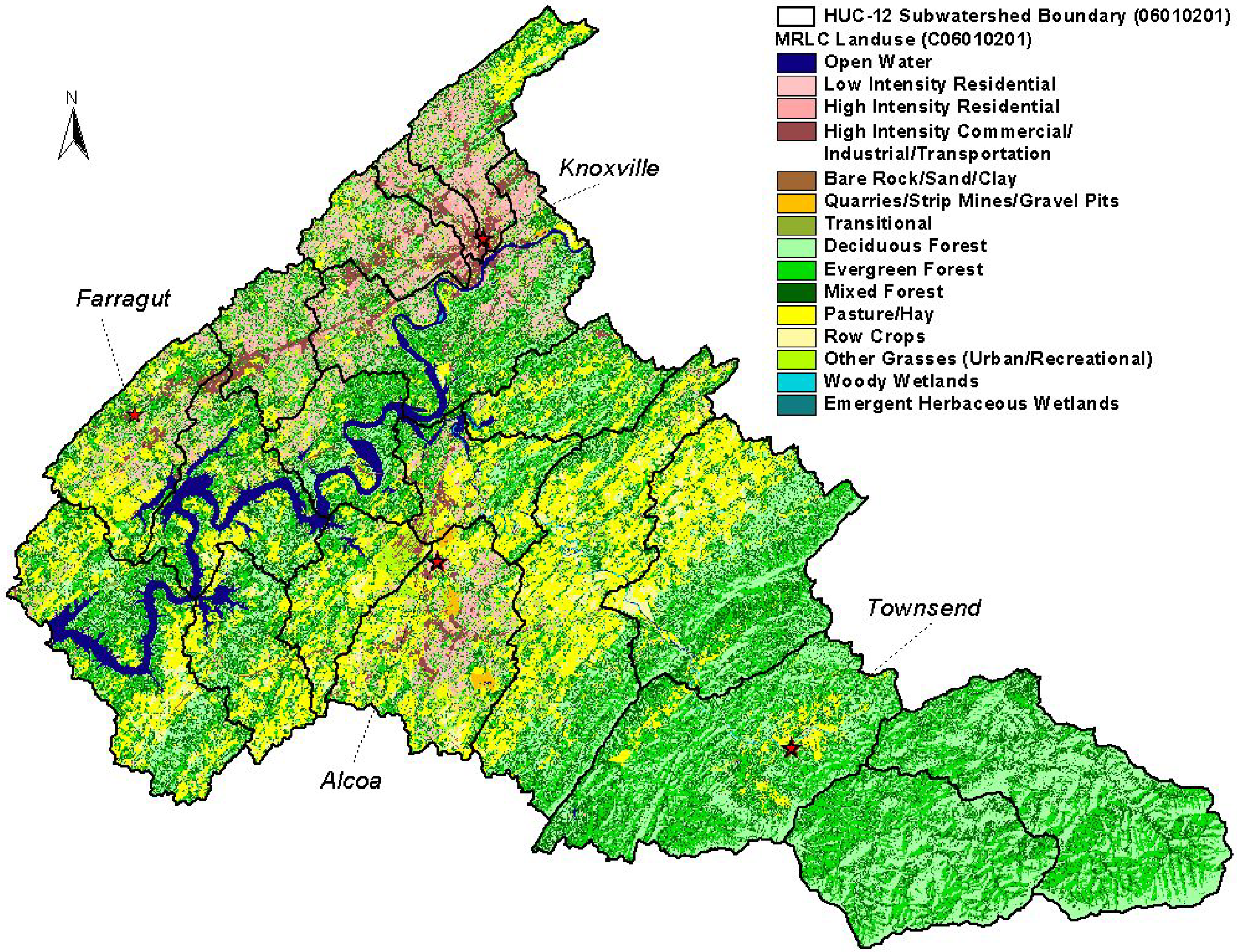


Table 1 Land Use Distribution - Ft. Loudoun Lake Watershed

Land Use	Area		
	[acres]	[mi^2]	[% of watershed]
Bare Rock/Sand/Clay	3	0.0	0.0
Deciduous Forest	93,658	146.3	22.1
Emergent Herbaceous Wetlands	37	0.1	0.0
Evergreen Forest	89,205	139.4	21.1
High Intensity Commercial/Industrial/ Transportation	11,446	17.9	2.7
High Intensity Residential	6,795	10.6	1.6
Low Intensity Residential	27,773	43.4	6.6
Mixed Forest	86,452	135.1	20.4
Open Water	13,151	20.5	3.1
Other Grasses (Urban/Recreational)	11,645	18.2	2.8
Pasture / Hay	66,955	104.6	15.8
Quarries/Strip Mines/Gravel Pits	818	1.3	0.2
Row Crops	14,359	22.4	3.4
Transitional	236	0.4	0.1
Woody Wetlands	428	0.7	0.1
Total	**422,962**	**660.9**	**100.0**

Figure 3 MRLC Land Use in the Ft. Loudoun Lake Watershed



3.0 PROBLEM DEFINITION

The State of Tennessee's *2004 303(d) List* (TDEC, 2005) identified a number of waterbodies in the Ft. Loudoun 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 Ft. Loudoun Lake and its tributaries include fish & aquatic life, irrigation, livestock watering & wildlife, and recreation. Some waterbodies in the watershed are also classified for industrial water supply and/or domestic water supply.

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

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

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

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

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

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

> In streams and rivers, fine inorganic sediments, especially silts and clays, affect the habitat for macroinvertebrates and fish spawning, as well as fish rearing and feeding behavior. Larger sands and gravels can scour diatoms and cause burying of invertebrates, whereas suspended sediment affects the light available for photosynthesis by plants and visual capacity of animals.

Table 2 ***2004 303(d) List*** **- Stream Impairment Due to Siltation/Habitat Alteration in the Ft. Loudoun Lake Watershed**

Waterbody Segment ID	Waterbody Segment Name	Miles/Acres Impaired	Cause (Pollutant)	Source (Pollutant)
06010201022_1000	Gallagher Creek	13.2	Loss of biological integrity due to siltation	Pasture Grazing
06010201026_0100	Roddy Branch	6.4	Habitat loss due to alteration in stream-side or littoral vegetative cover/Physical Substrate Habitat Alteration/Loss of biological integrity due to siltation/ Escherichia coli	Pasture Grazing/Channelization/ Removal of Riparian Habitat
06010201026_0200	Caney Branch	2.0	Physical Substrate Habitat Alteration	Sand, Gravel, Rock Mining or Quarries
06010201026_0300	Hollybrook Branch	2.78	Habitat loss due to alteration in stream-side or littoral vegetative cover/Loss of biological integrity due to siltation	Pasture Grazing
06010201026_0400	Pistol Creek	7.66	Loss of biological integrity due to siltation/Escherichia coli	Discharges from MS4 area
06010201026_0410	Springfield Branch	5.48	Loss of biological integrity due to siltation	Discharges from MS4 area
06010201026_0420	Brown Creek	24.7	Habitat loss due to alteration in stream-side or littoral vegetative cover/Nitrates/Loss of biological integrity due to siltation	Discharges from MS4 area/Land Development
06010201026_0430	Laurel Bank Branch	22.72	Loss of biological integrity due to siltation/Escherichia coli	Discharges from MS4 area
06010201026_0500	Russell Branch	3.0	PCBs/Loss of biological integrity due to siltation	Contaminated Sediment/ RCRA Hazardous Waste/ Discharges from MS4 area
06010201026_2000	Little River		This 17.63 mile section of the Little River has been identified as “threatened” due to a documented decline in diversity at biological stations at miles 7.6 and 9.6. The specific stressor is undetermined.	*(Left blank intentionally)*

Table 2 (Cont.) ***2004 303(d) List*** **- Stream Impairment Due to Siltation/Habitat Alteration in the Ft. Loudoun Lake Watershed**

Waterbody Segment ID	Waterbody Segment Name	Miles/Acres Impaired	Cause (Pollutant)	Source (Pollutant)
06010201027_0300	Rocky Branch	4.04	Habitat loss due to alteration in stream-side or littoral vegetative cover/Loss of biological integrity due to siltation	Pasture Grazing
06010201027_0400	Peppermint Branch	2.7	Loss of biological integrity due to siltation	Discharges from MS4 area/ Pasture Grazing
06010201028_0100	Spicewood Branch	2.23	Loss of biological integrity due to siltation	Streambank Modifications
06010201028_0300	South Fork Crocked Creek	8.21	Habitat loss due to alteration in stream-side or littoral vegetative cover/ Loss of biological integrity due to siltation	Pasture Grazing
06010201028_0500	Flag Branch	7.8	Habitat loss due to alteration in stream-side or littoral vegetative cover/Loss of biological integrity due to siltation	Pasture Grazing/Discharges from MS4 area
06010201028_1000	Crooked Creek	13.91	Loss of biological integrity due to siltation/Escherichia coli	Pasture Grazing/Livestock in Stream
06010201032_0810	Tipton Branch	2.5	Habitat loss due to alteration in stream -side or littoral vegetative cover/Loss of biological integrity due to siltation	Upstream Impoundments
06010201033_0400	South Fork Ellejoy Creek	2.02	Habitat loss due to alteration in stream-side or littoral vegetative cover	Pasture Grazing
06010201033_0500	Carter Branch	4.63	Habitat loss due to alteration in stream-side or littoral vegetative cover	Pasture Grazing
06010201033_2000	Ellejoy Creek	5.37	Nitrates/Loss of biological integrity due to siltation/Escherichia coli	Pasture Grazing

Table 2 (Cont.) ***2004 303(d) List*** **- Stream Impairment Due to Siltation/Habitat Alteration in the Ft. Loudoun Lake Watershed**

Waterbody Segment ID	Waterbody Segment Name	Miles/Acres Impaired	Cause (Pollutant)	Source (Pollutant)
06010201034_0200	Wildwood Branch	6.26	Habitat loss due to alteration in stream-side or littoral vegetative cover/Escherichia coli	Pasture Grazing
06010201037_1000	Little Turkey Creek	14.0	Loss of biological integrity due to siltation	Discharges from MS4 area
06010201066_0100	Casteel Branch	2.0	Loss of biological integrity due to siltation	Pasture Grazing/ Discharges from MS4 area
06010201066_0200	Twin Branch	1.87	Habitat loss due to alteration in stream-side or littoral vegetative cover/Loss of biological integrity due to siltation	Pasture Grazing/ Discharges from MS4 area
06010201066_0500	Mccall Branch	1.73	Loss of biological integrity due to siltation	Discharges from MS4 area/Streambank Modification
06010201066_1000	Stock Creek	3.77	Physical Substrate Habitat Alteration/Loss of biological integrity due to siltation/Escherichia coli	Pasture Grazing/Channelization
06010201067_1000	Third Creek	20.7	Nitrates/Loss of biological integrity due to siltation/Other Anthropogenic Habitat Alterations/Escherichia coli	Discharges from MS4 area/Urbanized High Density Area/Land Development/Collection System Failure
06010201080_0100	Whites Creek	10.2	Other Anthropogenic Habitat Alterations/Escherichia coli	Discharges from MS4 area/ Streambank Modification
06010201080_1000	First Creek	16.1	Nitrates/Loss of biological integrity due to siltation/Other Anthropogenic Habitat Alterations/Escherichia coli	Discharges from MS4 area/Urbanized High Density Area/Collection System Failure

Table 2 (Cont.) ***2004 303(d) List*** **- Stream Impairment Due to Siltation/Habitat Alteration in the Ft. Loudoun Lake Watershed**

Waterbody Segment ID	Waterbody Segment Name	Miles/Acres Impaired	Cause (Pollutant)	Source (Pollutant)
06010201083_1000	Floyd Creek	7.7	Loss of biological integrity due to siltation/Escherichia coli	Pasture Grazing
06010201097_1000	Second Creek	12.8	Other Anthropogenic Habitat Alterations/Nitrates/Loss of biological integrity due to siltation/ Escherichia coli	Discharges from MS4 area/Urbanized High Density Area/Collection System Failure
060102010340_1000	Turkey Creek	15.8	Loss of biological integrity due to siltation/Escherichia coli	Discharges from MS4 area
060102011015_1000	Cloyd Creek	11.3	Loss of biological integrity due to siltation/Physical Substrate Habitat Alteration/Escherichia coli	Pasture Grazing/Livestock in Stream
060102011330_2000	Sinking Creek	21.9	Habitat loss due to alteration in stream-side or littoral vegetative cover/Loss of biological integrity due to siltation	Discharges from MS4 area
060102011697_1000	Fourth Creek	14.9	Physical Substrate Habitat Alteration/Escherichia coli	Discharges from MS4 area/Channelization
060102011719_1000	Williams Creek	2.8	Other Anthropogenic Habitat Alterations/Escherichia coli	Discharges from MS4 area/Collection System Failure
060102011721_1000	Baker Creek	3.3	Nitrates/Other Anthropogenic Habitat Alterations /Escherichia coli	Discharges from MS4 area/Collection System Failure
060102011723_1000	Goose Creek	4.9	Loss of biological integrity due to siltation/Other Anthropogenic Habitat Alterations/ PCBs/Escherichia coli	Collection System Failure/Discharges from MS4 area/RCRA Hazardous Waste
060102011983_1000	Polecat Creek	1.85	Habitat loss due to alteration in stream-side or littoral vegetative cover/Loss of biological integrity due to siltation	Land Development/ Channelization

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

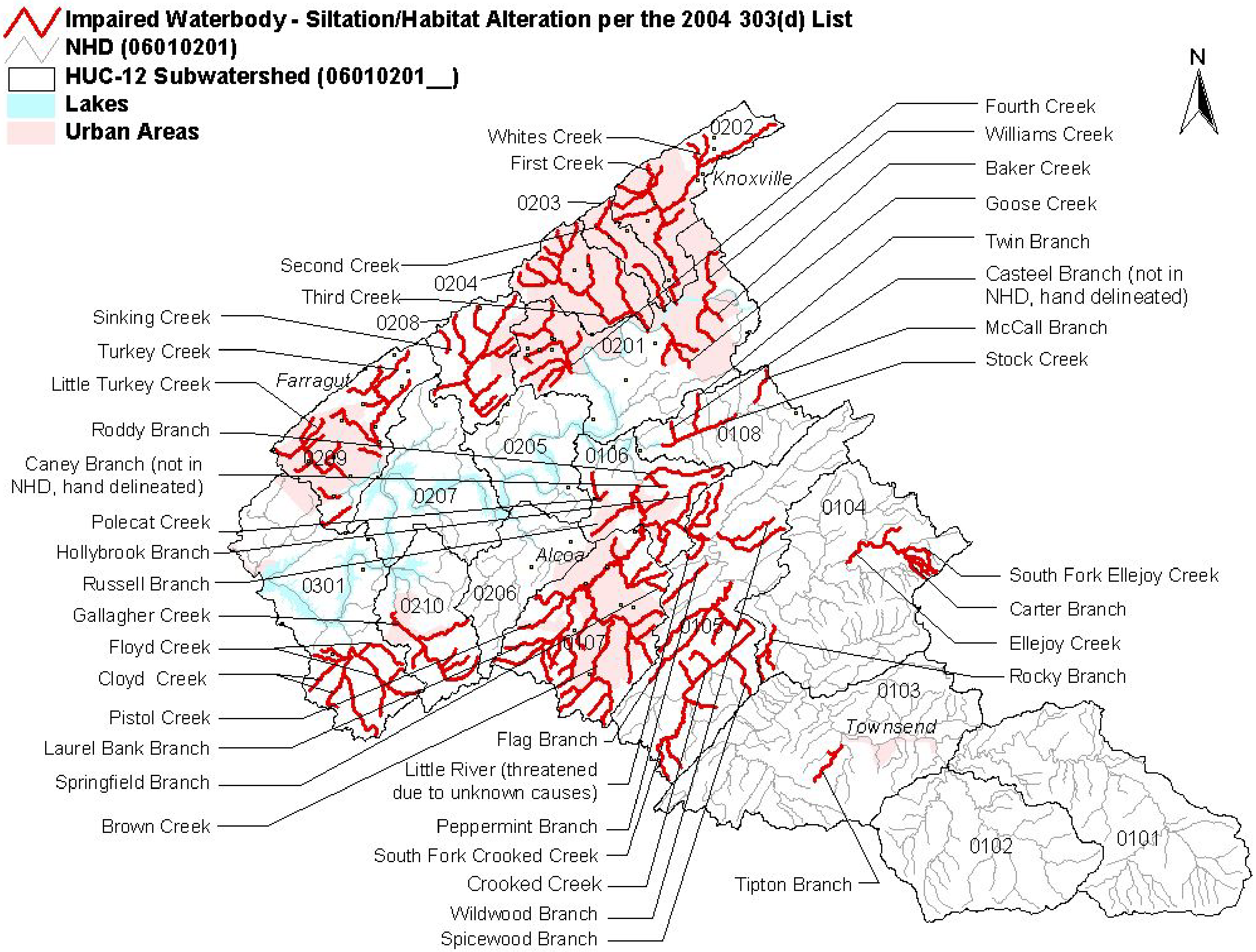


Table 3 Water Quality Assessment of Waterbodies Impaired Due to Siltation/Habitat Alteration

Waterbody Segment ID	Waterbody Segment Name	Comments
06010201022_1000	Gallagher Creek (Tennessee River to headwaters)	2003 TDEC RBPIII and chemical station at mile 2.6 (Unitia Road). One E. coli observation out of 12 over 1,000. G.M. = 267. 1997 TVA station at mile 3.2. 7 EPT families, 15 total families. Fish IBI 26 "very poor". Bacteriological data also.
06010201026_0100	Roddy Branch (Little River to headwaters)	2003 TDEC chemical station at mile 0.6 (Roddy Branch Road). One E. coli observation out of 10 over 1,000. G.M. = 282. 2000 LAB biorecon at mile 0.6 (Roddy Branch Road). 9 EPT genera, 1 intolerant, 29 total genera. BR score = 7. Habitat score = 89. 1998 TDEC biological survey 0.6. 12 EPT genera, FAL assessment based on NCBI =4.95. Habitat score = 119. 387 G.M. E.coli.
06010201026_0200	Caney Branch (Little River to headwaters)	2001 Mining Section biorecon u/s Caney Branch Road. Zero EPT genera, 1 intolerant, 16 total genera. Habitat score = 64. Failed biorecon criteria. 2000 LAB biorecon at mile 0.1 (Roddy Branch Road). Zero EPT genera, zero intolerant, 6 total genera. BR score = 3. Habitat score = 66.
06010201026_0300	Hollybrook Branch (Little River to headwaters)	2000 LAB biorecon at mile 0.5 (Martin Mill Road). 6 EPT genera, 2 intolerant, 22 total genera. BR score = 7. Habitat score = 86.
06010201026_0400	Pistol Creek (Little River to headwaters)	2000 LAB RBPIII at mile 0.2 (Singleton Road). 4 EPT genera, 32 total genera. Index Score = 28. Failed biocriteria. Habitat score = 121. 1998 TDEC biological survey mile 1.9. 2 EPT genera, 13 total taxa, NCBI 6.33. Habitat assessment =99. 299 E. coli G.M. TVA survey at mile 1.9 . 36 IBI.
06010201026_0410	Springfield Branch (Pistol Creek to headwaters)	2000 LAB biorecon at mile 0.3 (McCarther Road). 1 EPT genera, 1 intolerant, 13 total genera. BR score = 3. Habitat score = 97.
06010201026_0420	Brown Creek (Pistol Creek to headwaters)	2000 LAB biorecon at mile 0.2 (Washington Street). 5 EPT genera, 1 intolerant, 17 total genera. BR score = 5. Habitat score = 93. Duncan Branch, a trib, also assessed. 2000 LAB biorecon at mile 0.3 (Duncan Road). 1 EPT genera, zero intolerant, 14 total genera. BR score = 3. Habitat score = 99. 1999 TDEC chemical station at mile 3.9 (Highway 321). Nitrate-nitrite elevated.

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

Waterbody Segment ID	Waterbody Segment Name	Comments
06010201026_0430	Laurel Bank Branch (Pistol Creek to headwaters)	2000 LAB biorecon at mile 1.0 (Settlement Road). 6 EPT genera, 3 intolerant, 26 total genera. BR score = 5. Habitat score = 92. A trib, Culton Creek, also assessed. 2000 LAB biorecon at mile 0.1 (Highway 129). 2 EPT genera, zero intolerant, 15 total genera. BR score = 3. Habitat score = 108. 1999 TDEC station at Highway 334. Fecal coliform elevated.
06010201026_0500	Russell Branch (Little River to headwaters)	2003 TDEC pathogen station at mile 0.9 (Singleton Road). One out of 10 E. coli observations over 1,000. G.M. = 291. 2000 LAB RBPIII at mile 0.9 (Singleton Road). 3 EPT genera, 34 total genera. Index score = 26. Failed biocriteria. Habitat score = 83.
06010201026_2000	Little River (Roddy Branch to Nails Branch)	2003 TDEC chemical station at mile 7.0 (Williams Mill Road). None out of ten E. coli observations over 1,000. G.M. = 117. 2003 TDEC chemical station at mile 9.6 (Alcoa WTP). One out of ten E. coli observations over 1,000. G.M. = 183. 2000 LAB RBPIII at mile 8.0 (d/s Pistol Creek). 2 EPT genera, 25 total genera. (Couldn't be scored.) 1998 TDEC stations at 7.6 & 9.6. 1996 TVA biological station at mile 8.9 (Rockford). 12 EPT families, 27 total families.
06010201027_0300	Rocky Branch (Little River to headwaters)	2000 LAB biorecon at mile 0.8 (Cambridge Road). 6 EPT genera, 4 intolerant, 21 total genera. BR score = 7. Habitat score = 92.
06010201027_0400	Peppermint Branch (Little River to headwaters)	2000 LAB biorecon at mile 0.7 (off Hitch Road). 5 EPT genera, 2 intolerant, 20 total genera. BR score = 5. Habitat score = 102.
06010201028_0100	Spicewood Branch (Crooked Creek from Little River to headwaters)	2000 LAB biorecon at mile 0.4 (off Hatcher Road). 6 EPT genera, 7 intolerant, 21 total genera. BR score = 7. Habitat score = 119.
06010201028_0300	South Fork Crocked Creek (Crooked Creek to headwaters)	2000 LAB biorecon at mile 0.1 (Wilkinson Pike). 7 EPT genera, 2 intolerant, 22 total genera. BR score = 5. Habitat score = 89.

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

Waterbody Segment ID	Waterbody Segment Name	Comments
06010201028_0500	Flag Branch (Crooked Creek to headwaters, Includes Gravelly Creek)	2000 LAB biorecon at mile 0.7 (Centennial Road). 6 EPT genera, 2 intolerant, 21 total genera. BR score = 5. Habitat score = 113.
06010201028_1000	Crooked Creek (Little River to headwaters)	2000 LAB RBPIII at mile 1.1 (Davis Ford Road). 6 EPT genera, 38 total genera. Index score = 32. Habitat score = 76. 2000 LAB biorecon at mile 5.3 (off Hwy 73). 3 EPT genera, 2 intolerant, 17 total genera. BR score = 5. Habitat score = 92. 2003 TDEC RBPIII at mile 7.2 (Whites Mill Road). 7 EPT genera, 20 total genera. Index score = 30. Failed biocriteria. Habitat score = 129. 2000 LAB biorecon at mile 7.2 (Whites Mill Road). 7 EPT genera, 3 intolerant, 20 total genera. BR score = 9. Habitat score = 87. 1998 TDEC station at 1.1. 12 EPT genera, NCBI 4.51. Habitat assessment score = 130. 1326 G.M. E.coli. 1999 TVA station at 3.1. 30 IBI (poor). 10 EPT families, 25 total families.
06010201032_0810	Tipton Branch (Short Creek to headwaters)	2000 LAB biorecon at mile 0.4 (d/s Laurel Lake). 3 EPT genera, zero intolerant, 11 total genera. BR score = 3. Habitat score = 100. Also assessed some tribs to Laurel Lake. 2000 LAB biorecon on Slate Quarry Hollow at mile 0.1 (Laurel Valley Road). 7 EPT genera, 3 intolerant, 24 total genera. BR score = 5. Habitat score = 63. Also 2000 LAB biorecon on Cooper Hollow Hollow at mile 0.1 (Laurel Valley Road). Not enough flow to assess.
06010201033_0400	South Fork Ellejoy Creek (Ellejoy Creek to headwaters)	2000 LAB biorecon at mile 0.1 (Dripping Springs Road). 5 EPT genera, 5 intolerant, 22 total genera. BR score = 5. Habitat score = 105.
06010201033_0500	Carter Branch (Ellejoy Creek to headwaters)	2000 LAB biorecon at mile 0.1 (Old Chilhowee Road). 7 EPT genera, 5 intolerant, 22 total genera. BR score = 5. Habitat score = 99.
06010201033_2000	Ellejoy Creek (Millstone Creek to headwaters)	2003 TDEC RBPIII and chemical station at mile 8.0 (Davis Road). Three out of twelve E. coli observations over 1,000. G.M. = 421. 4 EPT genera, 20 total genera. Index score = 28. Failed biocriteria. Habitat score = 94. 2003 TDEC chemical station at mile 10.1 (Ellejoy Road). Three out of twelve E. coli observations over 1,000. G.M. = 283.

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

Waterbody Segment ID	Waterbody Segment Name	Comments
06010201034_0200	Wildwood Branch (Nails Creek to headwaters.)	2003 TDEC chemical station at mile 0.1 (Andy Harris Road). Two out of thirteen E. coli observations over 1,000. G.M. = 448. 2000 LAB biorecon at mile 0.1 (Andy Harris Road). 7 EPT genera, 2 intolerant, 22 total genera. BR score = 5. Habitat score = 148.
06010201037_1000	Little Turkey Creek (Fort Loudoun Embayment to headwaters)	2003 TDEC RBPIII and pathogen station at mile 1.4 (Virtue Road). 4 EPT genera, 19 total genera. Index score = 28. Failed biocriteria. Habitat score = 144. One E. coli sample out of twelve was over 1,000. G.M. of E. coli = 151. 1998 TVA station at mile 1.4 (Virtue Road). IBI score of 20 (very poor). 3 EPT families, 15 total families.
06010201066_0100	Casteel Branch (Stock Creek to headwaters)	2000 LAB biorecon at mile 0.5 (off Tipton Station Road). 8 EPT genera, 5 intolerant, 27 total genera. BR score = 7. Habitat score =122.
06010201066_0200	Twin Branch (Stock Creek to headwaters)	2000 LAB biorecon at mile 0.5 (off Tipton Station Road). 6 EPT genera, 4 intolerant, 25 total genera. BR score = 5. Habitat score =101.
06010201066_0500	Mccall Branch (Stock Creek to headwaters)	2003 TDEC pathogen station at mile 0.7 (off Tipton Station Road). One sample out of 12 E. coli observations were over 1,000. G.M. of samples was 208. 2000 LAB biorecon at mile 0.7 (u/s Tipton Station Road). 5 EPT genera, 1 intolerant, 20 total genera. BR score = 5. Habitat score = 110.
06010201066_1000	Stock Creek (Little River to confluence of Grandview Branch)	2003 TDEC chemical station at mile 2.0 (Hall Road). Two out of twelve E. coli observations over 1,000. G.M. = 245. 2003 TDEC RBPIII and chemical station at mile 3.2 (Martin Mill Road). Two out of twelve E. coli observations over 1,000. G.M. = 348. 7 EPT genera, 20 total genera. Index score = 30. Failed biocriteria. Habitat score = 111. 2003 TDEC chemical station at mile 4.6 (Newbert Springs Mill Road). Two out of twelve E. coli observations over 1,000. G.M. = 388.

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

Waterbody Segment ID	Waterbody Segment Name	Comments
06010201067_1000	Third Creek (Fort Loudoun to headwaters)	Water contact advisory for pathogens. 2003 TDEC RBPIII and pathogen station at mile 1.0 (Tyson Park foot bridge). 2 EPT genera, 20 total genera. Index score = 14. Failed biocriteria. Habitat score = 135. Three E. coli samples out of twelve was over 940. G.M. of E. coli = 618. 2003 TDEC pathogen station at mile 1.5 (Concord Street). One E. coli samples out of twelve was over 1,000. G.M. of E. coli = 561. Also station on East Fork Third Creek: 2003 TDEC pathogen station at mile 0.1 (Tyson Park). Three E. coli samples out of twelve was over 1,000. G.M. of E. coli = 701. TVA biological surveys at mile 4.0 (1 EPT family, 10 total families), plus at Cumberland Ave (1 EPT family, 7 total families).
06010201080_0100	Whites Creek (First Creek to headwaters)	2003 TDEC pathogen station at mile 0.1 (I-640). One E. coli sample out of twelve was over 1,000. G.M. of E. coli = 586. 1997 TVA biological survey at mile 0.6 (Nora Road). 4 EPT families, 15 total families.
06010201080_1000	First Creek (Fort Loudoun to headwaters)	2003 TDEC pathogen station at mile 0.1 (Volunteer Landing). Five E. coli samples out of twelve was over 940.. G.M. of E. coli = 806. 2003 TDEC pathogen station at mile 5.7 (I-640). One E. coli sample out of twelve was over 1,000. G.M. of E. coli = 632. TVA stations at mile 2.8 (3 EPT families, 13 total families) and at mile 6.1 (3 EPT families, 8 total families). Water contact advisory.
06010201083_1000	Floyd Creek (Fort Loudoun to headwaters)	2003 TDEC pathogen station at mile 0.5 (Kiser Station Road). Ten E. coli samples out of twelve was over 1,000. G.M. of E. coli = 1622. 1999 LAB biological survey at mile 0.5 (Kiser Station Road). 7 EPT genera, zero intolerant, 15 total genera. BR score = 7. Habitat score = 120. E. coli elevated (1733). Cows in creek. TVA station at mile 1.4. IBI = 28 (poor). 10 EPT families, 18 total.
06010201097_1000	Second Creek (Fort Loudoun to headwaters)	Long-term water contact advisory. 2003 TDEC RBPIII and pathogen station at mile 0.1 (Neyland Drive). 2 EPT genera, 21 total genera. Index score = 18. Failed biocriteria. Habitat score = 104. Ten E. coli sample out of twelve was over 1,000. G.M. of E. coli = 1838. TVA stations at Cumberland Ave (0 EPT families, 9 total families) and at Davanna Road (0 EPT families, 8 total families). Water contact advisory.
060102011015_1000	Cloyd Creek (Fort Loudoun Reservoir to headwaters)	2003 TDEC pathogen station at mile 1.5 (near Hickory Valley). Three E. coli samples out of twelve was over 1,000. G.M. of E. coli = 591. 1999 LAB biological survey at mile 1.5 (near Hickory Valley). 5 EPT genera, zero intolerant, 21 total families. BR score = 5. Habitat score = 90. E. coli elevated (2419). Cows in creek. TVA station at mile 2.6. Fish IBI = 36 (poor).

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

Waterbody Segment ID	Waterbody Segment Name	Comments
060102011330_2000	Sinking Creek (Interstate I-40 to where it emerges from the cave)	Long-term water contact advisory due to pathogens. Stream should be reassessed.
06010201340_1000	Turkey Creek (Fort Loudoun to headwaters)	2003 TDEC RBPIII and pathogen station at mile 2.6 (Kingston Pike). 4 EPT genera, 20 total genera. Index score = 30. Failed biocriteria. Habitat score = 125. Three E. coli sample out of twelve was over 1,000. G.M. of E. coli = 452. Nitrates removed from listing because levels generally lower. 1998 TVA survey. IBI = 28 (poor). 4 EPT families.
060102011697_1000	Fourth Creek (Fort Loudoun Reservoir to headwaters)	2003 TDEC RBPIII and pathogen station at mile 1.2 (d/s of Westland Drive). 2 EPT genera, 24 total genera. Index score = 30. Failed biocriteria. Habitat score = 143. Two E. coli sample out of twelve was over 1,000. G.M. of E. coli = 296. 1997 TVA station at Northshore Drive. IBI score = 20 (very poor). 2 EPT families, 10 total families.
060102011719_1000	Williams Creek (Fort Loudoun Reservoir to headwaters)	2003 TDEC RBPIII and pathogen station at mile 0.7 (Riverside Drive). 3 EPT genera, 17 total genera. Index score = 26. Failed biocriteria. Habitat score = 124. Two E. coli sample out of twelve was over 1,000. G.M. of E. coli = 231. 1997 TVA biological survey at Riverside Drive. 1 EPT family, 4 total families.
060102011721_1000	Baker Creek (Fort Loudoun Reservoir to headwaters)	2003 TDEC RBPIII and pathogen station at mile 0.3 (Lelland Drive). 2 EPT genera, 26 total genera. Index score = 24. Failed biocriteria. Habitat score = 98. Six E. coli sample out of twelve was over 1,000. G.M. of E. coli = 1188. 1997 TVA biological survey at Beech Street. 1 EPT families, 17 total families.
060102011723_1000	Goose Creek (Fort Loudoun to headwaters)	Water contact advisory. Witherspoon Superfund site. 2003 TDEC RBPIII and pathogen station at mile 0.8 (Mary Vestel Park). 1 EPT genera, 23 total genera. Index score = 24. Failed biocriteria. Habitat score = 110. Two E. coli samples out of twelve over 1,000. G.M. of E. coli = 509. 1997 TVA station at mile 0.5 (Mary Vestal Park). IBI = 30, zero EPT families, 10 total families.
060102011983_1000	Polecat Creek (Fort Loudoun Reservoir from Fort Loudoun Reservoir to headwaters)	2000 LAB biorecon at mile 1.0 (Pearly Smith Road). 1 EPT genera, zero intolerant, 14 total genera. BR score = 3. Habitat score = 78.

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

Historically, waterbodies in Tennessee have been assessed as not fully supporting designated uses due to siltation when the impairment was determined to be the result of excess loading of the inorganic sediment produced by erosional processes. In cases where impairment was determined to be caused by excess loading of the primarily organic particulate material found in sewage treatment plant (STP) effluent, the cause of pollution was listed as total suspended solids (TSS) or organic enrichment. In consideration of this practice, this document presents the details of TMDL development for waterbodies in the Ft. Loudoun 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.

Tipton Branch (Waterbody ID TN06010201032_0810) is listed on the *2004 303(d) List* as impaired due to siltation and alteration in stream-side or littoral vegetative cover due to upstream impoundment. The source “upstream impoundment” is typically associated with problems related to low dissolved oxygen or thermal modifications. Field office staff have documented a site specific problem on Tipton Branch below the Laurel Lake impoundment that is causing an increased silt load to the stream. A weir in the dike on Tipton Branch that forms Laurel Lake drains through a channel with riprap for about 70 yards and concrete for about 30 more yards. A stream survey dated October 25, 2000 indicated that the creek had bypassed the concrete channel flowing under the concrete and forming a side channel. About 100 yards downstream of the concrete, an eroded and entrenched channel was draining the ridge. The gravel/cobble bottom was embedded in silt and clay and showed evidence of continuous severe erosion during high flow/floods. Therefore, TMDLs for excess sediment were developed for Tipton Branch.

4.0 TARGET IDENTIFICATION

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

Applicable to all use classifications (Fish & Aquatic Life shown):

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

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

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

Applicable to the Fish & Aquatic Life use classification:

> Biological Integrity - The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under 1200-4-3-.06.
>
> Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion, (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 contain less pasture, cropland, and urban areas and more forested areas compared to the impaired watersheds. The biologically healthy (reference) watersheds are considered the "least impacted" in an ecoregion and, as such, sediment loading from these watersheds may serve as an appropriate target for the TMDL.

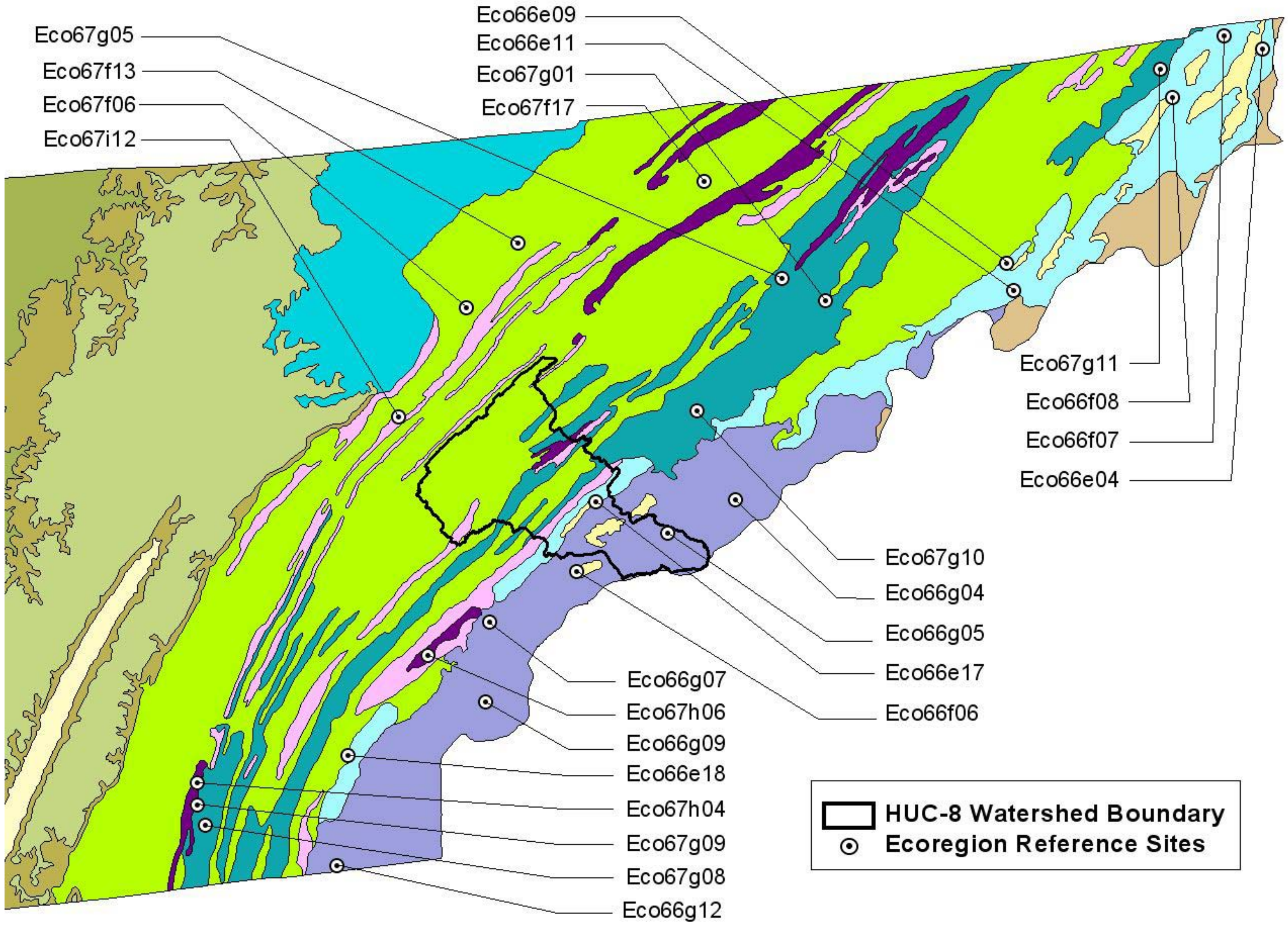
Using the methodology described in Appendix B, the Watershed Characterization System (WCS) Sediment Tool was used to calculate the average annual sediment load for each of the biologically healthy (reference) watersheds in Level IV ecoregions 66e, 66f, 66g, 67f, 67g, 67h, and 67i. The geometric mean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

> *Note: Ecoregion reference sites are continually reviewed, with sites added or deleted as circumstances warrant. Using the methodology described in Appendix B, the WCS Sediment Tool was used to determine the average annual sediment loads, due to precipitation-based sources, for the active Level IV ecoregion reference sites as of June 3, 2003. The WCS sediment tool utilizes DEM and MRLC coverages to calculate the sediment loads. The stations listed in Table 4 and shown in Figure 5 are the ecoregion reference sites as of June 3, 2003 for which the average annual sediment loads could be calculated with current information.*

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

Level 4 Ecoregion	Reference Site	Stream	Drainage Area (acres)	Average Annual Sediment Load [lbs/acre/year]
66e	Eco66e04	Gentry Creek	2,699	146.6
	Eco66e09	Clark Creek	5,886	67.6
	Eco66e11	Lower Higgins Creek	2,189	88.8
	Eco66e17	Double Branch	1,878	131.8
	Eco66e18	Gee Creek	2,728	213.4
			Geometric Mean (Target Load)	**119.9**
66f	Eco66f06	Abrams Creek	13,857	133.6
	Eco66f07	Beaverdam Creek	29,262	264.2
	Eco66f08	Stony Creek	2,477	115.8
			Geometric Mean (Target Load)	**159.9**
66g	Eco66g04	Middle Prong Little Pigeon River	12,469	85.6
	Eco66g05	Little River	19,998	68.0
	Eco66g07	Citico Creek	1,556	93.0
	Eco66g09	North River	7,470	375.5
	Eco66g12	Sheeds Creek	2,281	65.9
			Geometric Mean (Target Load)	**106.0**
67f	Eco67f06	Clear Creek	1,975	396.0
	Eco67f13	White Creek	1,724	272.0
	Eco67f17	Big War Creek	30,062	581.4
			Geometric Mean (Target Load)	**397.1**
67g	Eco67g01	Little Chucky Creek	24,024	582.3
	Eco67g05	Bent Creek	21,058	903.9
	Eco67g08	Brymer Creek	4,237	604.1
	Eco67g09	Harris Creek	3,054	726.8
	Eco67g10	Flat Creek	13,236	654.4
	Eco67g11	N Prong Fishdam Creek	1,019	865.8
			Geometric Mean (Target Load)	**712.6**
67h	Eco67h04	Blackburn Creek	653	184.5
	Eco67h06	Laurel Creek	1,793	842.1
			Geometric Mean (Target Load)	**394.2**
67i	Eco67i12	Mill Branch	681	281.0
			Geometric Mean (Target Load)	**281.0**

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



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 Ft. Loudoun Lake Watershed (ref.: Figure 4). Existing precipitation based sediment loads for subwatersheds with waterbodies listed on the *2004 303(d) List* as impaired for siltation/habitat alteration are summarized in Table 5.

Table 5 Existing Sediment Loads in Subwatersheds With Impaired Waterbodies

Huc-12 Subwatershed (06010201____)	Level IV Ecoregion	Existing Sediment Load
		[lbs/ac/yr]
0103	66g	474
0104	66e	619
0105	67f	743
0106	67f	823
0107	67f	1,812
0108	67h	609
0201	67f	1,149
0202	67f	1,178
0203	67f	1,604
0204	67f	1,209
0208	67f	987
0209	67f	759
0210	67f	551
0301	67f	848

6.0 SOURCE ASSESSMENT

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

NPDES are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

6.1 Point Sources

6.1.1 NPDES-Regulated Wastewater Treatment Facilities

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

6.1.2 NPDES-Regulated Mining Sites

Discharges from regulated mining activities may also 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. There are ten permitted mining sites in the Ft. Loudoun Lake Watershed (as of September 9, 2005). All ten permitted mining sites are located in impaired subwatersheds, as listed in Table 6 and shown in Figure 6. Sediment loads (as TSS) to waterbodies from mining site discharges are negligible in relation to total sediment loading (ref.: Appendix D).

6.1.3 NPDES-Regulated Ready Mixed Concrete Facilities

Discharges from regulated Ready Mixed Concrete Facilities (RMCFs) may contribute sediment to surface waters as TSS (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 waterbodies impaired for siltation as indicated on the *2004 303(d) List*, sites may be required to obtain coverage under an individual NPDES permit. There are twelve permitted RMCFs in the Ft. Loudoun Lake Watershed (as of October 18, 2005) and eleven are located in impaired subwatersheds. These facilities are listed in Table 7 and shown in Figure 6.

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*

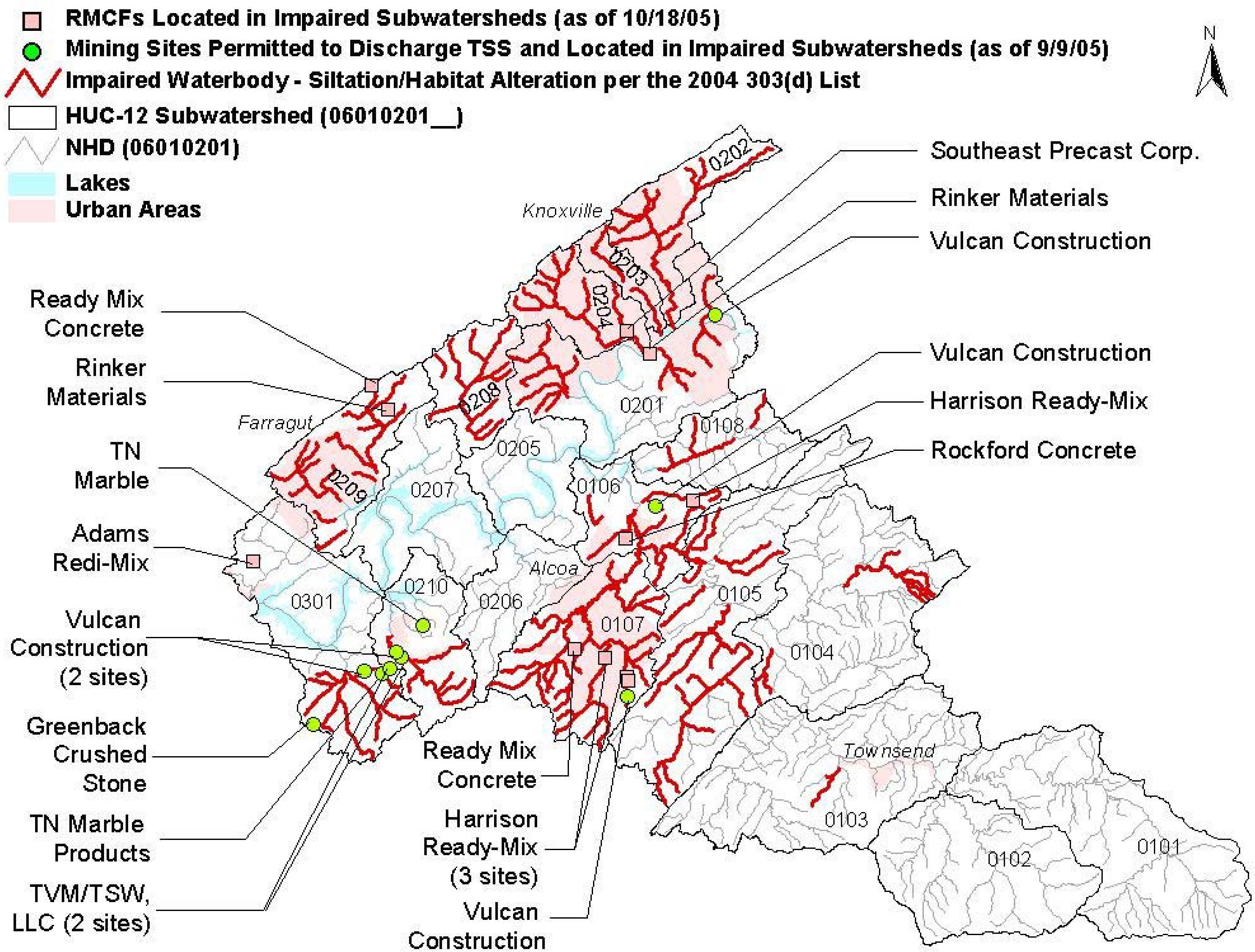
Table 6 NPDES-Regulated Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds (as of September 9, 2005)

HUC-12 Subwatershed (06010201__)	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit [mg/l]
0106	TN0072761	Vulcan Construction Materials, LP – Rockford Quarry	40
0107	TN0003042	Vulcan Construction Materials, LP – Maryville Quarry	40
0201	TN0029467	Vulcan Construction Materials, LP – Riverside Drive Quarry	40
0210	TN0071862	Tennessee Marble Company – Brown Quarry	40
	TN0072061	TVM/TSW, LLC – Lambert Quarry	40
	TN0072125	TVM/TSW – Endsley Quarry	40
	TN0072621	Vulcan Construction Materials, LP – Friendsville South	40
0301	TN0066397	Greenback Crushed Stone, Inc. – Greenback Quarry	40
	TN0072222	Vulcan Construction Materials, LP – Friendsville Quarry	40
	TN0072699	Tennessee Marble Products Co. – Dabney Pit 1	40

Table 7 NPDES-Regulated Ready Mixed Concrete Facilities Located in Impaired Subwatersheds (as of October 18, 2005)

HUC-12 Subwatershed (06010201__)	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit [mg/l]	TSS Cut-off Conc. [mg/l]
0106	TNG110089	Harrison Ready-Mix – Topside Road	50	200
	TNG110245	Rockford Concrete Plant	50	200
0107	TNG110088	Harrison Ready-Mix – Duncan Road	50	200
	TNG110090	Harrison Ready-Mix – Matlock Bend Industrial Park	50	200
	TNG110092	Harrison Ready-Mix – Sands Road	50	200
	TNG110121	Ready Mix Concrete Company	50	200
0201	TNG110246	Rinker Materials S. Central – Neyland Drive	50	200
0204	TNG110157	Southeast Precast Corporation	50	200
0209	TNG110027	Ready Mix Concrete Company	50	200
	TNG110244	Rinker Materials S. Central – W. Knox	50	200
0301	TNG110143	Adams Redi-Mix	50	200

Figure 6 NPDES-Regulated Mining Sites and Ready Mixed Concrete Facilities in Impaired Subwatersheds



(TDEC, 2005a). Since construction activities at a site are of a temporary, relatively short-term nature, the number of construction sites covered by the general permit at any instant of time varies. In the Ft. Loudoun Lake Watershed, there were 438 permitted active construction sites on October 18, 2005 (ref.: Figure 7).

6.1.5 NPDES-Regulated Municipal Separate Storm Sewer Systems

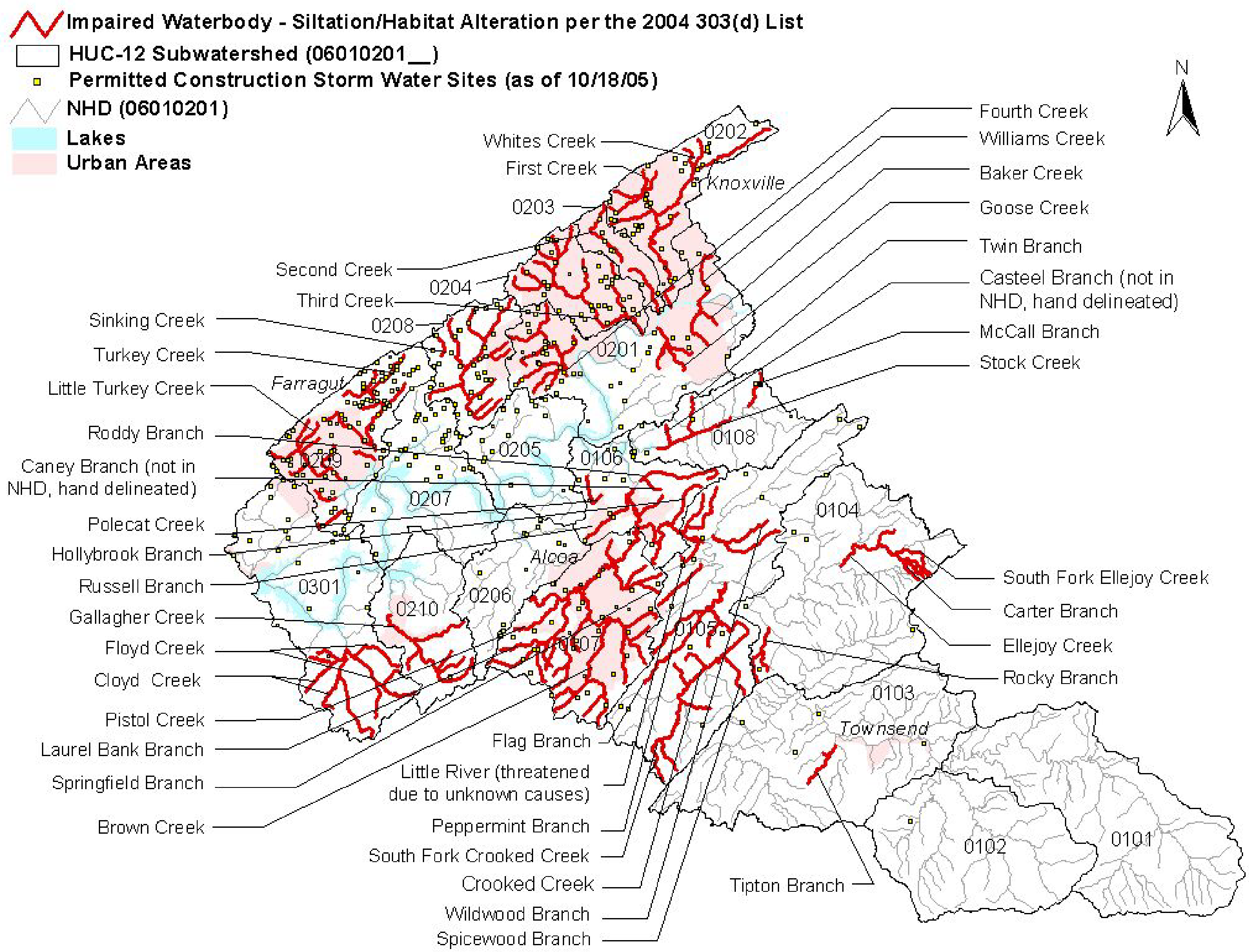
MS4s may also discharge sediment to waterbodies in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. These systems convey urban runoff from surfaces such as bare soil and wash-off of accumulated street dust and litter from impervious surfaces during rain events. Large and medium MS4s serving populations greater than 100,000 people are required to obtain NPDES storm water permits. At present, there is only one MS4 of this size in the Ft. Loudoun Lake Watershed (City of Knoxville, TNS068055). As of March 2003, small MS4s serving urbanized areas, or having the potential to exceed instream water quality standards, are required to obtain a permit under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003a). An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile. Eight permittees are covered under Phase II of the NPDES Storm Water Program. The nine permitted MS4s in the Ft. Loudoun Lake Watershed are as follows:

NPDES Permit Number	Phase	Permittee Name
TNS068055	I	City of Knoxville Municipal Separate Storm Drain System
TNS075116	II	Blount County
TNS075132	II	City of Alcoa
TNS075299	II	City of Farragut
TNS075434	II	City of Maryville
TNS075582	II	Knox County
TNS075591	II	Loudon County
TNS075655	II	Sevier County
TNS077798	II	City of Lenoir City

An NPDES Permit is pending for the University of Tennessee at Knoxville (TNS076121).

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

Figure 7 Location of NPDES Permitted Construction Storm Water Sites in the Ft. Loudoun Lake Watershed



6.2 Nonpoint Sources

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

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

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

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

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

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

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

For the listed waterbodies within the Ft. Loudoun 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:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

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

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

7.1 Analysis Methodology

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

Sediment loading analysis for waterbodies impaired due to siltation/habitat alteration in the Ft. Loudoun 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 Ft. Loudoun Lake Watershed sediment TMDLs.

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

- The existing average annual sediment load of each impaired HUC-12 watershed 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:

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

  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 mining sites and RMCFs. The existing loads from these facilities are less than the five percent reserved in each impaired HUC-12 subwatershed. Any difference between these existing loads and the 5% reserved load provide for future growth and additional MOS (ref.: Appendix D).

- For each impaired HUC-12 subwatershed, WLAs for construction storm water sites and 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.

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

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

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

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

7.2 TMDLs for Impaired Subwatersheds

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

7.3 Waste Load Allocations

7.3.1 Waste Load Allocations for NPDES-Regulated Mining Activities

All ten mining sites in the Ft. Loudoun Lake Watershed with NPDES permits are located in impaired subwatersheds (ref.: Table 6). Since sediment loading from mining sites is small (ref.: Appendix D) compared to the total loading for impaired subwatersheds, the WLAs are considered to be equal to the existing permit requirement for these sites.

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 [lbs/ac/yr]	Target Load [lbs/ac/yr]	TMDL (required load reduction) [%]
0103	06010201032_0810	Tipton Branch	66g	474	106.0	77.6
0104	06010201027_0300	Rocky Branch	66e	619	119.9	80.6
	06010201033_0400	South Fork Ellejoy Creek				
	06010201033_0500	Carter Branch				
	06010201033_2000	Ellejoy Creek				
0105	06010201026_2000	Little River	67f	743	397.1	46.6
	06010201027_0400	Peppermint Branch				
	06010201028_0100	Spicewood Branch				
	06010201028_0300	South Fork Crooked Creek				
	06010201028_0500	Flag Branch				
	06010201028_1000	Crooked Creek				
	06010201034_0200	Wildwood Branch				
0106	06010201026_0100	Roddy Branch	67f	823	397.1	51.8
	06010201026_0200	Caney Branch				
	06010201026_0300	Hollybrook Branch				
	06010201026_0500	Russell Branch				
	06010201026_2000	Little River				
	060102011983_1000	Polecat Creek				
0107	06010201026_0400	Pistol Creek	67f	1812	397.1	78.1
	06010201026_0410	Springfield Branch				
	06010201026_0420	Brown Creek				
	06010201026_0430	Laurel Bank Branch				

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

Table 8 (Cont.) 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 (required load reduction)
				[lbs/ac/yr]	[lbs/ac/yr]	[%]
0108	06010201066_0100	Casteel Branch	67h	609	394.2	35.3
	06010201066_0200	Twin Branch				
	06010201066_0500	McCall Branch				
	06010201066_1000	Stock Creek				
0201	060102011697_1000	Fourth Creek	67f	1,149	397.1	65.5
	060102011719_1000	Williams Creek				
	060102011721_1000	Baker Creek				
	060102011723_1000	Goose Creek				
0202	06010201080_0100	Whites Creek	67f	1,178	397.1	66.3
	06010201080_1000	First Creek				
0203	06010201097_1000	Second Creek	67f	1,604	397.1	75.2
0204	06010201067_1000	Third Creek	67f	1,209	397.1	67.2
0208	060102011330_2000	Sinking Creek	67f	987	397.1	59.8
0209	06010201037_1000	Little Turkey Creek	67f	759	397.1	47.7
	06010201340_1000	Turkey Creek				
0210	06010201022_1000	Gallagher Creek	67f	551	397.1	28.0
0301	06010201083_1000	Floyd Creek	67f	848	397.1	53.1
	060102011015_1000	Cloyd Creek				

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

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

7.3.3 Waste Load Allocations for NPDES-Regulated Construction Activities

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

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 (MS4s and Construction SW)	LAs (Nonpoint Sources)
		[%]	[%]
0103	66g	78.8	78.8
0104	66e	81.6	81.6
0105	67f	49.3	49.3
0106	67f	54.2	54.2
0107	67f	79.2	79.2
0108	67h	38.6	38.6
0201	67f	67.2	67.2
0202	67f	68.0	68.0
0203	67f	76.5	76.5
0204	67f	68.8	68.8
0208	67f	61.8	61.8
0209	67f	50.3	50.3
0210	67f	31.6	31.6
0301	67f	55.5	55.5

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

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

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

7.4 Load Allocations for Nonpoint Sources

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

7.5 Margin of Safety

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

- Target values based on Level IV ecoregion reference sites. These sites represent the least impacted streams in the ecoregion.

- The use of the sediment delivery process that results in the most sediment transport to surface waters (Method 2 in Appendix B).

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

7.6 Seasonal Variation

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

8.0 IMPLEMENTATION PLAN

8.1 Point Sources

8.1.1 NPDES-Regulated Mining Sites

All ten of the mining sites in the Ft. Loudoun Lake Watershed are located in impaired subwatersheds (ref.: Table 6). WLAs will be implemented through the existing permit requirements for these sites.

8.1.2 NPDES-Regulated Ready Mixed Concrete Facilities

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

8.1.3 NPDES-Regulated Construction Storm Water

The WLAs provided to existing and future NPDES-regulated construction activities will be implemented through Best Management Practices (BMPs) as specified in NPDES Permit No. TNR10-0000, *General NPDES Permit for Storm Water Discharges Associated With Construction Activit*y (TDEC, 2005a). The permit requires the development and implementation of a site-specific Storm Water Pollution Prevention Plan (SWPPP) prior to the commencement of construction activities. The SWPPP must be prepared in accordance with good engineering practices and the latest edition of the *Tennessee Erosion and Sediment Control Handbook* (TDEC, 2002) and must identify potential sources of pollution at a construction site that would affect the quality of storm water discharges and describe practices to be used to reduce pollutants in those discharges. At a minimum, the SWPPP must include the following elements:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

8.2 Nonpoint Sources

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

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

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

- Detailed surveys of impaired subwatersheds to identify additional sources of sediment loading.
- Advocacy of local area ordinances and zoning that will minimize sediment loading to waterbodies, including establishment of buffer strips along streambanks, reduction of activities within riparian areas, and minimization of road and bridge construction impacts.
- Educating the public as to the detrimental effects of sediment loading to waterbodies and measures to minimize this loading.
- Advocacy of agricultural BMPs (e.g., riparian buffer, animal waste management systems, waste utilization, stream stabilization, fencing, heavy use area treatment protection, livestock exclusion, etc.) and practices to minimize erosion and sediment transport to streams. The Tennessee Department of Agriculture (TDA) keeps a database of BMPs implemented in Tennessee. Of the 187 BMPs in the Ft. Loudoun Lake Watershed as of October 18, 2005, 174 are in sediment-impaired subwatersheds (see Figure 8).

An excellent example of stakeholder involvement for the implementation of nonpoint source load allocations (LAs) specified in an approved TMDL is the Integrated Pollutant Source Identification (IPSI) conducted by Tennessee Valley Authority (TVA), the 604(b) Little River Participatory Watershed Project, and the Pistol Creek TMDL Project. A discussion of each follows.

The IPSI was conducted by TVA in Blount County and in the Little River watershed (TVA, 2003). The IPSI provided detailed source information on a watershed scale, including the location of geographic features that are known or suspected to contribute nonpoint source pollution within the watersheds. The survey of animal operations identified beef cattle, milk cows, and horse operations and classified the sites by relative size and proximity to a stream. Analysis of geographic data also identified septic systems that were suspect. Suspect systems were defined as systems exhibiting a visible plume or drain field, or at locations that are questionable for on-site septic systems. Use of information included in an IPSI can aid in identification of pollution sources that should be targeted for pollution reduction programs.

The 604(b) Little River Participatory Watershed Project was recently completed within the Little

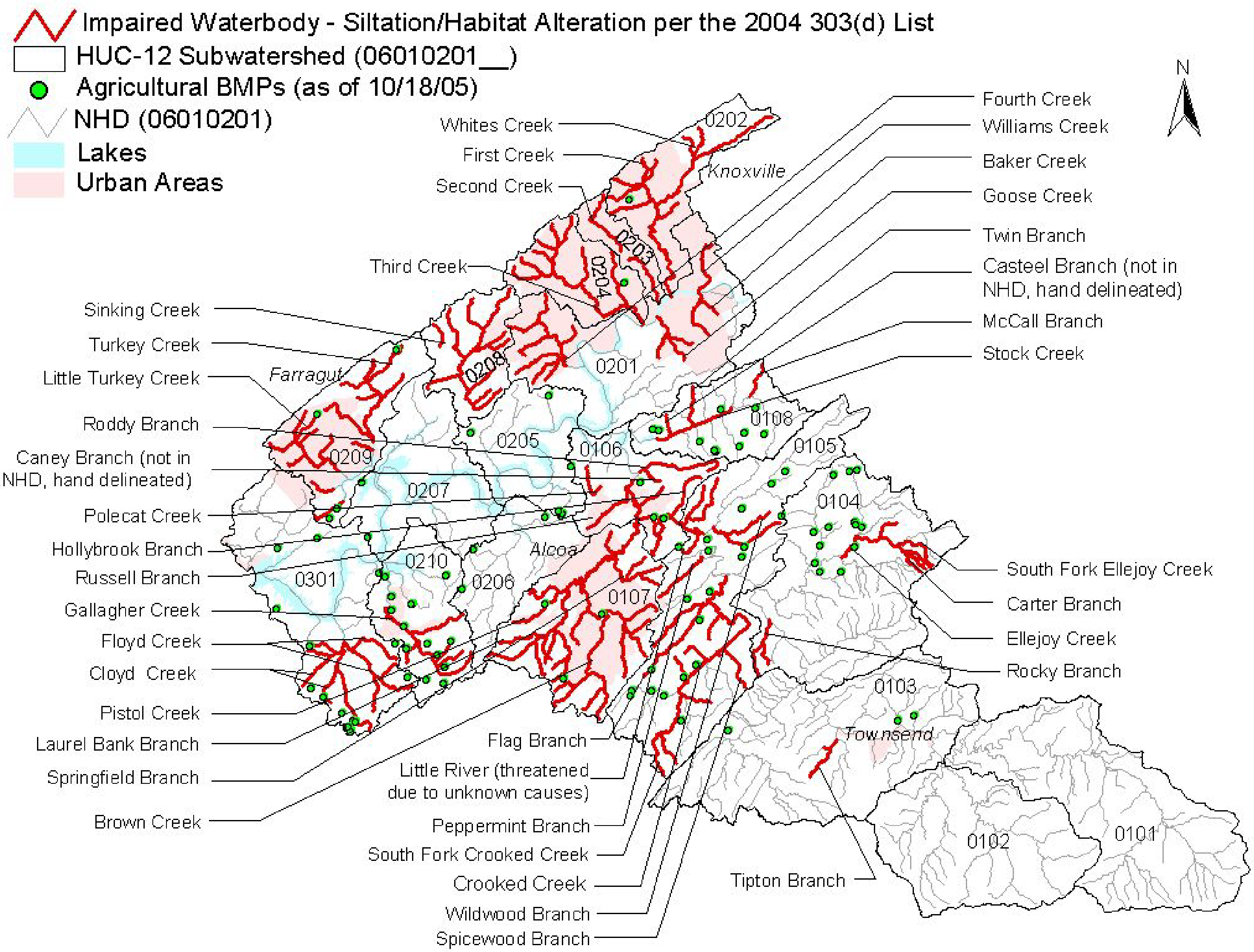
River watershed by a group of organizations, including the University of Tennessee Community Partnership Center, the Tennessee Valley Authority, the University of Tennessee Dept. of Urban and Regional Planning, and the Little River Watershed Association (ref.: Appendix E). The objective of the project was to test the effectiveness of participatory methods and tools in watershed planning, to develop new methods and tools, and to become a model for stakeholder-driven environmental planning for the nation. The project was also intended to build capacity for future watershed restoration and protection efforts.

The Pistol Creek TMDL Project is currently being funded by TDEC (ref.: Appendix F). The Blount County Extension is the lead organization for a project located in Pistol Creek, a tributary of the Little River. The objective of the project is to organize a community-based volunteer effort focused on collecting water samples, identifying pollution sources, and making recommendations for solutions.

8.3 Evaluation of TMDL Effectiveness

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

Figure 8 Location of Agricultural Best Management Plans in the Ft. Loudoun Lake Watershed



9.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed sediment TMDLs for the Ft. Loudoun 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.

3) A letter was sent to point source facilities in the Ft. Loudoun 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:

TNG110089	Harrison Ready-Mix – Topside Road
TNG110245	Rockford Concrete Plant
TNG110088	Harrison Ready-Mix – Duncan Road
TNG110090	Harrison Ready-Mix – Matlock Bend Industrial Park
TNG110092	Harrison Ready-Mix – Sands Road
TNG110121	Ready Mix Concrete Company
TNG110246	Rinker Materials South Central – Neyland Drive
TNG110157	Southeast Precast Corporation
TNG110027	Ready Mix Concrete Company
TNG110244	Rinker Materials South Central – W Knox
TNG110143	Adams Redi – Mix
TN0072761	Vulcan Construction Materials, LP – Rockford Quarry
TN0003042	Vulcan Construction Materials, LP – Maryville Quarry
TN0029467	Vulcan Construction Materials, LP – Riverside Drive Quarry
TN0071862	Tennessee Marble Company – Brown Quarry
TN0072061	TVM/TSW, LLC – Lambert Quarry
TN0072125	TVM/TSW – Endsley Quarry
TN0072621	Vulcan Construction Materials, LP – Friendsville South
TN0066397	Greenback Crushed Stone, Inc. – Greenback Quarry
TN0072222	Vulcan Construction Materials, LP – Friendsville Quarry
TN0072699	Tennessee Marble Products Co. – Dabney Pit 1

4) A letter was sent to local interagency and stakeholder groups in the Ft. Loudoun Lake Watershed advising them of the proposed sediment TMDLs and their availability on the TDEC website. The letter also stated that a written copy of the draft TMDL document would be provided upon request. A letter was sent to the following interagency and local stakeholder groups:

   Natural Resources Conservation Service
   USGS Water Resource Programs
   USDA – Forest Service
   Tennessee Valley Authority
   Tennessee Department of Agriculture
   Tennessee Wildlife Resources Agency
   Blount County Planning Commission
   Tennessee Izaak Walton League
   Little River Watershed Association

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

TNS068055	City of Knoxville Municipal Separate Storm Drain System
TNS075116	Blount County
TNS075132	City of Alcoa
TNS075299	City of Farragut
TNS075434	City of Maryville
TNS075582	Knox County
TNS075591	Loudon County
TNS075655	Sevier County
TNS077798	City of Lenoir City
TNS077585	Tennessee Department of Transportation (TDOT)
TNS076121	University of Tennessee at Knoxville

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:

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REFERENCES

Midwest Plan Service. 1985. Livestock Waste Facilities Handbook, 2nd Edition. US Department of Agriculture and various universities. MWPS-18.

OMAFRA. 2000. *Factsheet: Universal Soil Loss Equation (USLE)*. Ontario Ministry of Agriculture, Food and Rural Affairs website: www.gov.on.ca/OMAFRA/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.

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.

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. This document is available on the TDEC website: 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. This document is available on the TDEC website: 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. This document is available on the TDEC website: http://www.state.tn.us/environment/wpc/stormh2o/MS4II.php

TDEC. 2004. *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. *2004 305(b) Report, The Status of Water Quality in Tennessee.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, August 2004.

TDEC. 2005. *Final Version, Year 2004 303(d) List.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, August 2005.

TDEC. 2005a. *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.

TVA. 2003. Blount County and Little River Basin – Nonpoint Source Pollution Inventories and Pollutant Load Estimates. Tennessee Valley Authority, Little Tennessee Watershed Team. Lenoir City, Tennessee. February 2003.

USDASCS. 1983. *Sedimentation*. National Engineering Handbook, Section 3, Chapter 6. U.S. Department of Agriculture Soil Conservation Service.

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.

USEPA. 1997. *Ecoregions of Tennessee*. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Corvallis, Oregon. EPA/600/R-97/022.

USEPA, 1999. *Protocol for Developing Sediment TMDLs*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 841-B-99-004, October 1999.

USEPA. 2001. *Watershed Characterization System – User's Manual*. U.S. Environmental Protection Agency, Region 4, Atlanta, Georgia.

USEPA. 2003. *Developing Water Quality Criteria for Suspended and Bedded Sediments (SABS) – Draft* . U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. August 2003.

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.