STAGE I TOTAL MAXIMUM DAILY LOAD (TMDL)

for

Siltation and Habitat Alteration

in the

Lower Hatchie River Watershed (HUC 08010208)

Chester, Fayette, Hardeman, Haywood, Lauderdale, Madison, and Tipton Counties, Tennessee

FINAL

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TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 SCOPE OF DOCUMENT 1

3.0 WATERSHED DESCRIPTION 1

4.0 PROBLEM DEFINITION 6

5.0 TARGET IDENTIFICATION 16

6.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET 20

7.0 SOURCE ASSESSMENT 21

7.1 Point Sources 21
7.2 Nonpoint Sources 26

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS 28

8.1 TMDL Development Methodology 28
8.2 Stage I TMDLs for Impaired Subwatersheds 29
8.3 Stage I Waste Load Allocations (WLAs) for Point Sources 29
8.4 Load Allocations for Nonpoint Sources 31
8.5 Margin of Safety 32
8.6 Seasonal Variation 32

9.0 IMPLEMENTATION PLAN 34

9.1 Point Sources 34
9.2 Nonpoint Source 36
9.3 Evaluation of TMDL Effectiveness 37

10.0 PUBLIC PARTICIPATION 39

11.0 FURTHER INFORMATION 40

REFERENCES 41

APPENDICES

		Page
Appendix A	Example Stream Assessment (Richland Creek)	A-1
Appendix B	Watershed Sediment Loading Model	B-1
Appendix C	MRLC Land Use of Stage I Impaired Subwatersheds and Drainage Areas	C-1
Appendix D	Sediment Loading Analysis Methodology for Development of Stage I TMDLs, WLAs, and LAs	D-1
Appendix E	Estimate of Existing Point Source Loads for NPDES Permitted Ready Mixed Concrete Facilities & Mining Sites	E-1
Appendix F	Waste Load Allocations for NPDES Permitted Construction Stormwater Sites	F-1
Appendix G	Public Notice Announcement	G-1
Appendix H	Public Comments Received	H-1
Appendix I	Response to Public Comments	I-1

LIST OF FIGURES

		Page
Figure 1	Location of the Lower Hatchie River Watershed	3
Figure 2	Level IV Ecoregions in the Lower Hatchie River Watershed	4
Figure 3	MRLC Land Use in the Lower Hatchie River Watershed	5
Figure 4	Waterbodies in the Lower Hatchie River Watershed Impaired Due to Siltation/Habitat Alteration	9
Figure 5	Reference Sites in Level IV Ecoregions 65e, 74a, and 74b	19
Figure 6	NPDES Regulated RMCFs and Mining Sites Located in Stage I Impaired Subwatersheds	24
Figure 7	Location of NPDES Permitted Construction Stormwater Sites in the Lower Hatchie River Watershed	25
Figure 8	Location of TDA Best Management Practices in the Lower Hatchie River Watershed	38
Figure A-1	Richland Creek at RM 1.5, Stream Survey (4 pages)	A-2
Figure A-2,3	Photo of Richland Creek at RM 1.5 – March 31, 2000	A-6

LIST OF TABLES

		Page
Table 1	Land Use Distribution – Lower Hatchie River Watershed	6
Table 2	*2008 303(d) List* - Stream Impairment Due to Siltation/Habitat Alteration in the Lower Hatchie River Watershed	7
Table 3	Water Quality Assessment of Waterbodies Impaired Due to Siltation/Habitat Alteration In Stage I Impaired Subwatersheds and Drainage Areas	12
Table 4	Average Annual Sediment Loads of Level IV Ecoregion Reference Sites	18
Table 5	Existing Sediment Loads in Subwatersheds with Impaired Waterbodies	20
Table 6	NPDES Regulated Ready Mixed Concrete Facilities Located in Stage I Impaired Subwatersheds and Drainage Areas	23
Table 7	NPDES Regulated Mining Sites Located in Stage I Impaired Subwatersheds and Drainage Areas	23
Table 8	Stage I Sediment TMDLs for Impaired Subwatersheds and Drainage Areas	30
Table 9	Summary of Stage I WLAs and LAs	33
Table B-1	Calculated Erosion - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Stage I)	B-6
Table B-2	Calculated Sediment Delivery to Surface Waters - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Stage I)	B-7
Table B-3	Unit Loads - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Stage I)	B-7
Table C-1	Lower Hatchie River Watershed – Stage I Impaired Subwatershed Land Use Distribution	C-2
Table D-1	Average Annual Precipitation for Impaired Subwatersheds	D-10
Table D-2	Stage I TMDLs for Impaired Subwatersheds	D-11
Table D-3	Summary of Stage I WLAs & LAs	D-12
Table D-4	Summary of Average Annual Allowable Loads	D-13
Table E-1	Estimate of Existing Loads - Ready Mixed Concrete Facilities	E-3
Table E-2	Estimate of Existing Loads - NPDES Permitted Mining Sites	E-4
Table E-3	Estimates of Existing Subwatershed Loads from RMCFs & Mining Sites	E-5
Table F-1	Determination of Instream Sediment Load Due to Discharges from Construction Stormwater Sites	F-4

LIST OF ABBREVIATIONS

ADB	USEPA/TDEC Assessment Database
ARS	Agriculture Research Station
BMP	Best Management Practices
CFR	Code of Federal Regulations
DEM	Digital Elevation Model
EFO	Environmental Field Office
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NHD	National Hydrography Dataset
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
NRI	National Resources Inventory
RM	River Mile
RMCF	Ready Mixed Concrete Facility
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil and Geographic Database
STP	Sewage Treatment Plant
SWMP	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

LOWER HATCHIE RIVER WATERSHED (HUC 08010208)

Stage I Total Maximum Daily Loads for Waterbodies Impaired Due to Siltation/Habitat Alteration

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Impaired Waterbody Information:

State: Tennessee
Counties: Chester, Fayette, Hardeman, Haywood, Lauderdale, Madison, and Tipton
Watershed: Lower Hatchie River Watershed (HUC 08010208)
Watershed Area: 1,450 mi^2
Constituent of Concern: Siltation/Habitat Alteration
Impaired Waterbodies: 2008 303(d) List

Waterbody ID	Impacted Waterbody	Miles Impaired
TN08010208001_0800	Wade Creek	26.9
TN08010208001_1700	Gamble Branch	6.0
TN08010208009_1000	Poplar Creek	17.8
TN08010208011_2000	Bear Creek	7.9
TN08010208017_0100	Potters Creek	10.2
TN08010208029_0100	Dry Creek	22.1
TN08010208030_0100	Turkey Branch	5.6
TN08010208031_1000	Sugar Creek	10.5
TN08010208032_1000	Cypress Creek	19.2
TN08010208033_0100	Camp Creek	20.2
TN08010208034_0300	Hyde Creek	5.7
TN08010208056_1000	Flat Creek	8.1
TN08010208062_1000	Jeffers Creek	10.8
TN08010208065_1000	Mathis Creek	11.3
TN08010208072_1000	Richland Creek	11.0
TN08010208073_1000	Richland Creek	11.0

Designated Uses: Fish & Aquatic Life, Irrigation, Livestock Watering & Wildlife, and Recreation

Scope of TMDLs: TMDLs for waterbodies in west Tennessee that have been identified as impaired due to loss of biological integrity due to siltation, physical substrate habitat alteration, and habitat loss due to alteration in stream-side or littoral vegetative cover will be developed using a staged approach. HUC-12 subwatersheds or delineated waterbody drainage areas that contain impaired headwater or tributary streams (wadeable), excluding streams impaired as a result of channelization only, is the focus of Stage I TMDLs. Stage II TMDLs will address larger, non-wadeable waterbodies. This document presents details of Stage I TMDL development and uses the term “subwatershed” to mean either HUC-12 subwatershed area or delineated drainage area.

Applicable Water Quality Standards: Most stringent narrative criteria applicable to Fish & Aquatic Life use classification.

Turbidity, Total Suspended, Solids, or Color:	There shall be no turbidity, total suspended solids, or color in such amounts or of such character that will materially affect fish and aquatic life. In wadeable streams, suspended solid levels over time should not be substantially different than conditions found in reference streams.
Biological Integrity:	The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under 1200-4-3-.06. Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion and (b) is of the appropriate stream order specified for the bioregion, and (c) contains the habitat (riffle or rooted bank) specified for the bioregion, may be made using the most current revision of the Department's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys and/or other scientifically defensible methods. Interpretation of this provision for all other wadeable streams, lakes, and reservoirs may be made using Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA/841-B-99-002) or Lake and Reservoir Bioassessment and Biocriteria (EPA 841-B-98-007), and/or other scientifically defensible methods. Interpretation of this provision for wetlands or large rivers may be made using 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 stream habitat shall provide for the development of a diverse aquatic community that meets regionally-based biological integrity goals. Types of habitat loss include, but are not limited to: channel and substrate alterations, rock and gravel removal, stream flow changes, accumulation of silt, precipitation of metals, and removal of riparian vegetation. For wadeable streams, 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 Target: Developed from Level IV ecoregion reference site data.

Level IV Ecoregion	Average Annual Sediment Load [lbs/ac/yr]
65e	355.8
74a	710.4
74b	976.9

TMDL Development

Sediment Loading Analysis Methodology:

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

- Target sediment loads (lbs/acre/year) were based on the calculated average annual instream sediment load from biologically healthy watersheds (Level IV Ecoregion reference sites). In cases where a subwatershed is in multiple ecoregions, an area-weighted composite target value was calculated.

- The percent reduction in average annual instream sediment load required for a subwatershed containing impaired waterbodies relative to the appropriate target load was calculated.

- Since the Total Suspended Solids (TSS) component of Sewage Treatment Plant (STP) discharges is generally composed of primarily organic material and is considered to be different in nature than the sediments produced from erosional processes, TSS discharges from STPs were not considered in the TMDL analysis.

- In each impaired subwatershed, an overall Waste Load Allocation (WLA), equal to 5% of the target load, was reserved to account for loading from Ready Mixed Concrete Facilities (RMCFs) and regulated mining sites. Most loading from these sources is very small compared to total subwatershed loading. The overall WLA applies to discharges from existing and future facilities. WLAs for individual RMCFs and mining sites are equal to the requirements of their existing NPDES permits.

- WLAs for NPDES regulated construction stormwater discharges are expressed as technology-based average annual erosion loads per unit area disturbed.

- WLAs for Municipal Separate Storm Sewer Systems (MS4s) and Load Allocations (LAs) for nonpoint sources are expressed as a percent reduction in average annual instream sediment loading required for discharges from these sources to impaired subwatersheds.

- Allowable daily loads for precipitation induced loading sources (construction sites, MS4s, & nonpoint sources) were derived by dividing the appropriate annual loads by the average annual precipitation in each impaired subwatershed. Existing permits for RMCFs and mining sites include daily maximum concentration limits for TSS.

Critical Conditions: Methodology takes into account all flow conditions.

Seasonal Variation: Methodology addresses all seasons.

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

TMDLs

Summary of Stage I TMDLs

HUC-12 Subwatershed (08010208___) or Drainage Area	Waterbody ID	Waterbody Impaired by Siltation/ Habitat Alteration	Level IV Ecoregion	Level IV Ecoregion Target *	TMDL	
					Required Overall Load Reduction	Daily Maximum Load
				[lbs/ac/yr]	[% Reduction]	[lbs/ac/in. precip.]
Wade Creek DA	TN08010208001_0800	Wade Creek	65e	355.8	13.2	6.4
Potters Creek DA	TN08010208017_0100	Potters Creek	65e	355.8	56.5	6.5
Dry Creek DA	TN08010208029_0100	Dry Creek	65e	355.8	80.6	6.5
Bear Creek DA	TN08010208011_2000	Bear Creek	65e,74b	855.3	28.4	15.6
Turkey Branch DA	TN08010208030_0100	Turkey Branch	65e,74b	877.6	73.1	16.0
Gamble Branch DA	TN08010208001_1700	Gamble Branch	65e	355.8	67.5	6.5
0506	TN08010208031_1000	Sugar Creek	74b	976.9	61.3	18.4
Poplar Creek DA	TN08010208009_1000	Poplar Creek	74b	976.9	27.6	18.1
Jeffers Creek DA	TN08010208062_1000	Jeffers Creek	65e,74b	814.7	25.2	14.8
Richland Creek DA (0509)	TN08010208072_1000	Richland Creek	65e,74b	800.4	10.7	14.6
0510	TN08010208032_1000	Cypress Creek	74b	976.9	67.2	18.4
Hyde Creek DA	TN08010208034_0300	Hyde Creek	74a, 74b	834.5	57.1	15.7
Camp Creek DA	TN08010208033_0100	Camp Creek	74b	976.9	70.2	18.4
Flat Creek DA	TN08010208056_1000	Flat Creek	74b	976.9	63.5	18.4
Richland Creek DA (0802)	TN08010208073_1000	Richland Creek	74b	976.9	47.2	18.4
0805	TN08010208065_1000	Mathis Creek	74a, 74b	883.0	69.6	16.7

* For subwatersheds in multiple Level IV ecoregions, target values are area-weighted composites.

WLAs & LAs

Summary of Stage I WLAs & LAs

HUC-12 Subwatershed (08010208___) or Drainage Area	WLAs					LAs [c]	
	RMCFs & Mining	Construction Stormwater [b]		MS4 [c]		Required Reduction	Daily Maximum Load
	Overall Annual Average Load [a]	Annual Average Load	Daily Maximum Load	Required Reduction	Daily Maximum Load		
	[lbs/ac/yr]	[lbs/ac/yr]	[lbs/ac/in. precip.]	[%]	[lbs/ac/in. precip.]	[%]	[lbs/ac/in. precip.]
Wade Creek DA	17.8	6,000	107.1	26.1	5.4	26.1	5.4
Potters Creek DA	17.8	6,000	109.1	62.3	5.6	62.3	5.6
Dry Creek DA	17.8	6,000	109.1	83.0	5.7	83.0	5.7
Bear Creek DA	42.8	6,000	109.1	33.8	14.4	33.8	14.4
Turkey Branch DA	43.9	6,000	109.1	75.0	14.8	75.0	14.8
Gamble Branch DA	17.8	6,000	109.1	72.5	5.5	72.5	5.5
0506	48.8	6,000	113.2	63.9	17.2	63.9	17.2
Poplar Creek DA	48.8	6,000	110.9	32.4	16.8	32.4	16.8
Jeffers Creek DA	40.7	6,000	109.1	29.7	13.9	29.7	13.9
Richland Creek DA (0509)	40.0	6,000	109.1	17.4	13.5	17.4	13.5
0510	48.8	6,000	113.2	69.1	17.4	69.1	17.4
Hyde Creek DA	41.7	6,000	113.2	60.3	14.6	60.3	14.6
Camp Creek DA	48.8	6,000	113.2	72.2	17.2	72.2	17.2
Flat Creek DA	48.8	6,000	113.2	65.9	17.2	65.9	17.2
Richland Creek DA (0802)	48.8	6,000	113.2	50.5	17.3	50.5	17.3
0805	44.2	6,000	113.2	71.6	15.5	71.6	15.5

Notes: a. Value listed for each subwatershed is the overall WLA for all existing and future RMCF & mining operations. WLAs for existing individual facilities are equal to the requirements of their NPDES permit. Future facilities may be permitted as long as the overall WLA is not exceeded. RMCF and mining permits contain Daily Maximum concentration limits.
b. Applicable as site erosion per acre disturbed.
c. Applicable as instream sediment reduction at the pour point of the HUC-12 subwatershed.

STAGE I TOTAL MAXIMUM DAILY LOAD (TMDL) FOR SILTATION/HABITAT ALTERATION LOWER HATCHIE RIVER WATERSHED (HUC 08010208)

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 waterbodies 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 SCOPE OF DOCUMENT

TMDLs for waterbodies in west Tennessee that have been identified as impaired due to loss of biological integrity due to siltation, physical substrate habitat alteration, and habitat loss due to alteration in stream-side or littoral vegetative cover will be developed using a staged approach. HUC-12 subwatersheds or delineated waterbody drainage areas that contain impaired headwater or tributary streams (wadeable), excluding streams impaired as a result of channelization only, is the focus of Stage I TMDLs. Stage II TMDLs will address larger, non-wadeable waterbodies. This document presents details of Stage I TMDL development and uses the term “subwatershed” to mean either HUC-12 subwatershed area or delineated drainage area.

3.0 WATERSHED DESCRIPTION

The Lower Hatchie River Watershed, Hydrologic Unit Code (HUC) 08010208, is located in West Tennessee (ref.: Figure 1) and includes parts of Chester, Fayette, Hardeman, Haywood, Lauderdale, Madison, and Tipton counties. The watershed lies within four Level IV ecoregions as shown in Figure 2 (USEPA, 1997)/ (TDEC, 2007):

- Northern Hilly Gulf Coastal Plain (65e) contains several north-south trending bands of sand and clay formations. With elevations reaching over 650 feet, and more rolling topography and more relief than the Loess Plains to the west, streams have increased gradient, generally sandy substrates, and distinctive faunal characteristics for West Tennessee.

- Within Tennessee, the Northern Holocene Meander Belts (73a) is a relatively homogenous region of Quaternary alluvial deposits of sand, silt, clay, and gravel. It is bounded distinctly on the east by the Bluff Hills (74a) and on the west by the Mississippi

River. The two main distinctions in the Tennessee portion of the ecoregion are between areas of loamy, silty, and sandy soils with better drainage, and areas of more clayey soils of poor drainage that may contain wooded swampland and oxbow lakes.

- Along the western edge of the Bluff Hills (74a) ecoregion, bordering the Mississippi Alluvial Plain, are deep loess hilly areas, often called bluff hills. Consisting of sand, clay, silt, and lignite, the bluffs are capped by loess greater than 60 feet deep. The disjunct ecoregion in Tennessee encompasses those thick loess areas that are generally the steepest, most dissected, and forested. Smaller streams of the Bluff Hills have localized reaches of increased gradient and small areas of gravel substrate that create aquatic habitats that are distinct from those of the Loess Plains (74b) to the east.

- The Loess Plains (74b) ecoregion within Tennessee consists of gently rolling, irregular plains, with 100-200 feet of local relief. The loess can be over 50 feet thick. Several large river systems and their tributaries cross the ecoregion with wide flood plains that are distinct from the adjacent uplands. Streams of the ecoregion are low-gradient and murky, with silt and sand bottoms. Many of the streams have been deforested and channelized. Valley plugs or channel blockages, where channel aggradation and driftwood accumulation combine to change flow patterns, are common along the low gradient alluvial streams in this region.

The Lower Hatchie River Watershed has approximately 2,534 miles of streams (based on USEPA/TDEC Assessment Database (ADB)) and drains approximately 1,450 square miles. 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 1990-1993. Although changes in the land use of the Lower Hatchie River watershed have occurred since 1993 as a result of development, this is the most current land use data readily available for use with GIS-interfaced sediment model input. Land use for the Lower Hatchie River watershed is summarized in Table 1 and shown in Figure 3. Predominate land use in the Lower Hatchie River watershed is agriculture (49.6%) followed by forest (48.3%). Urban areas represent approximately 1.2% of the total drainage area of the watershed.

Figure 1 Location of the Lower Hatchie River Watershed

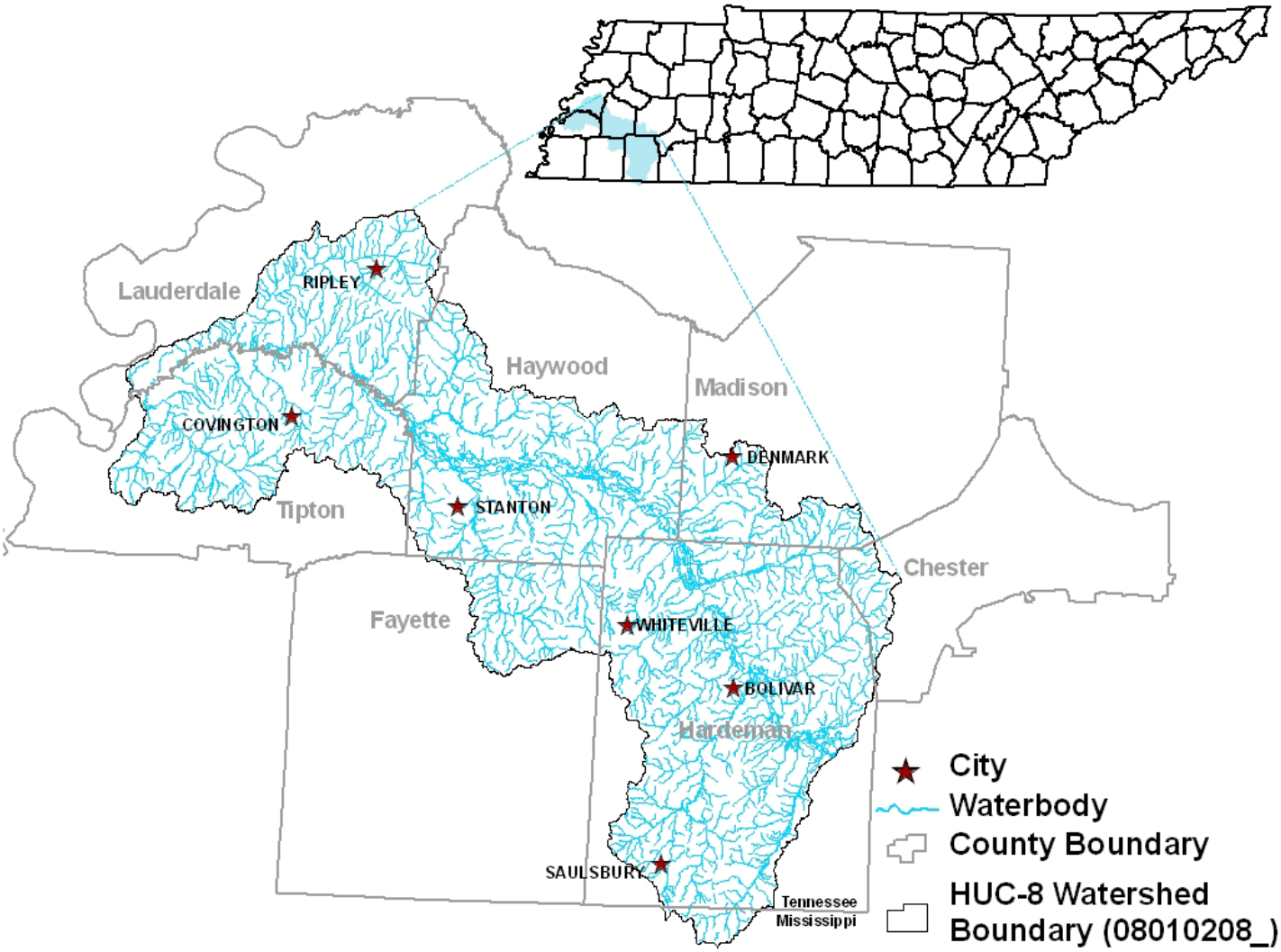


Figure 2 Level IV Ecoregions in the Lower Hatchie River Watershed

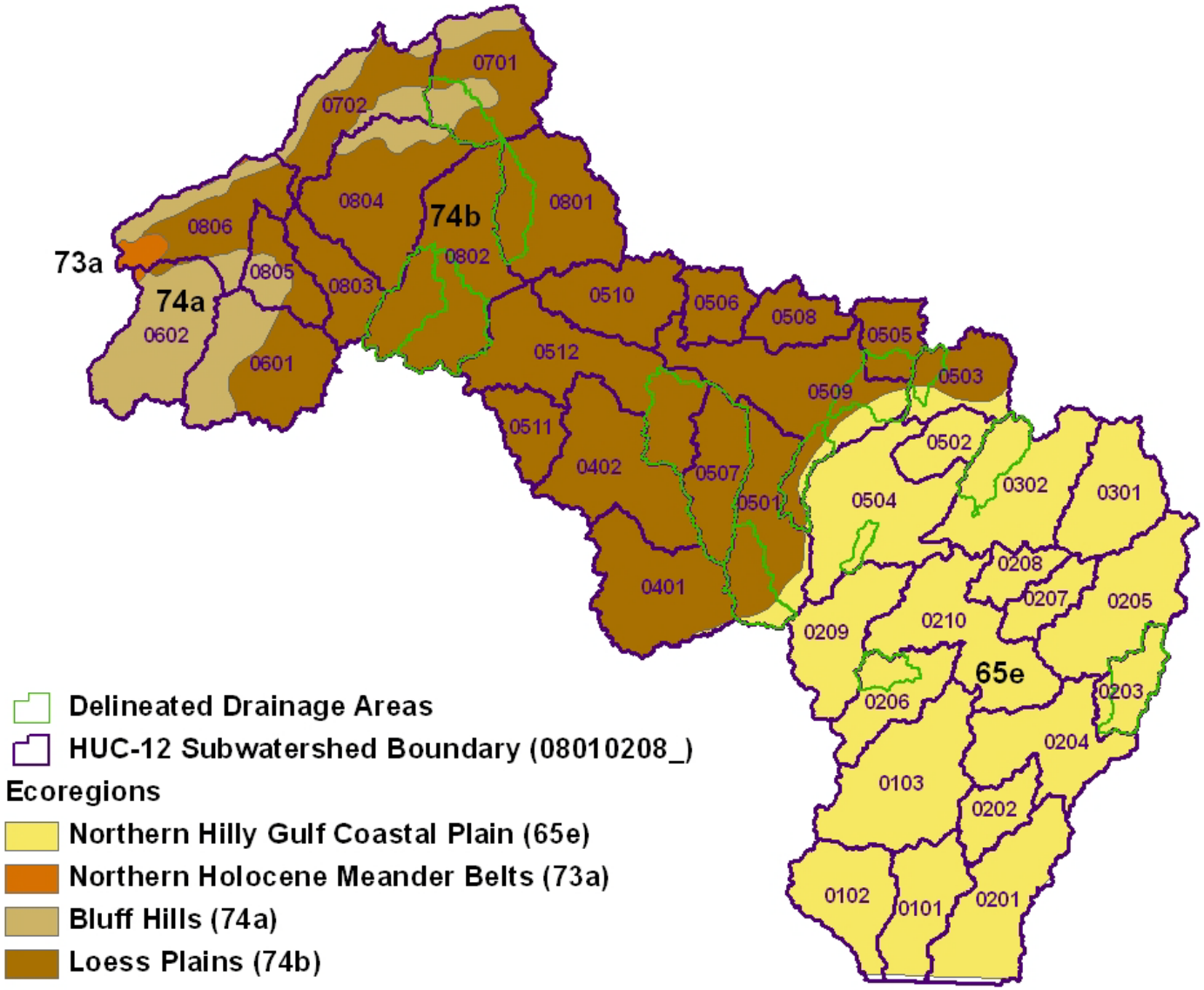


Figure 3 MRLC Land Use in the Lower Hatchie River Watershed

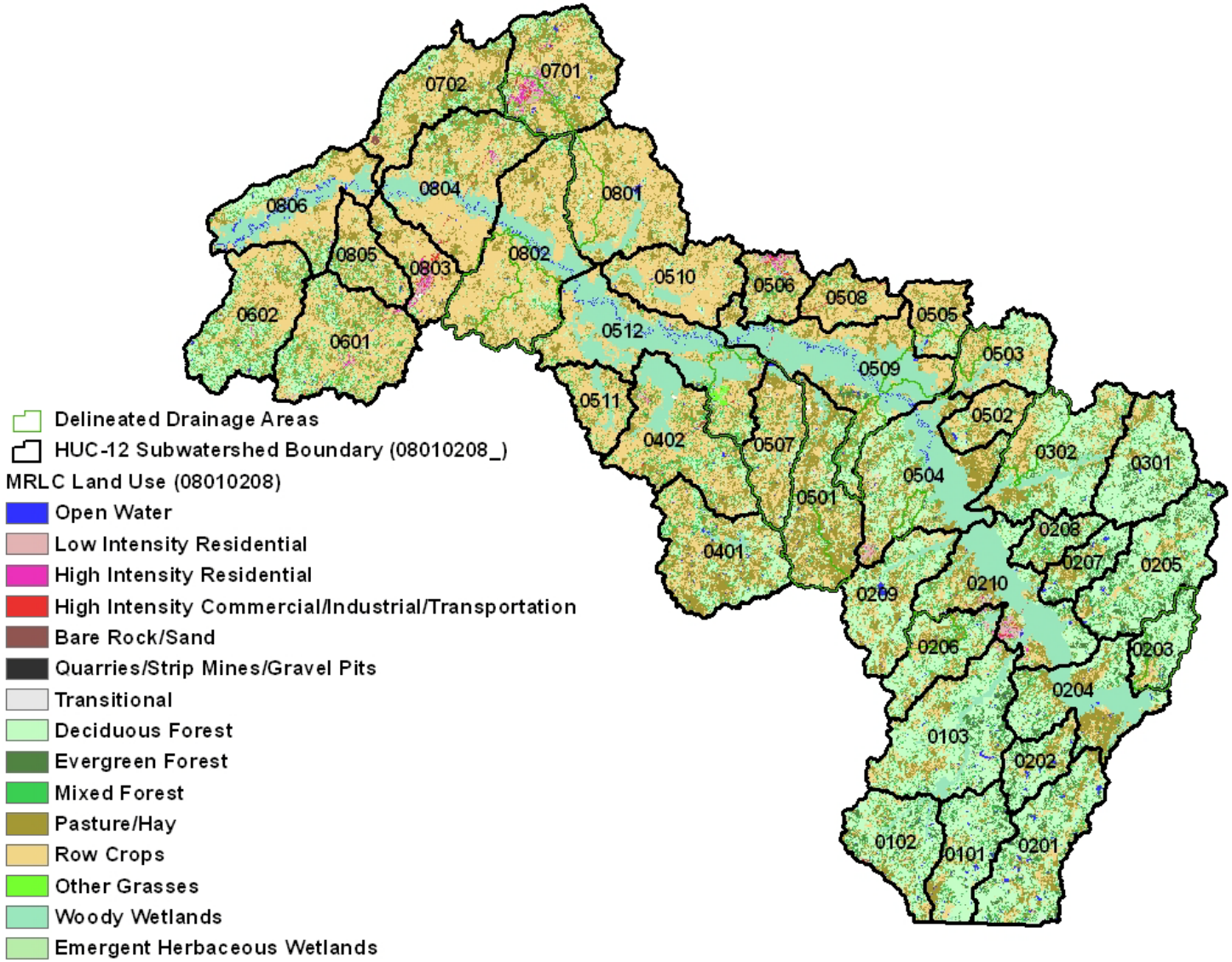


Table 1 Land Use Distribution – Lower Hatchie River Watershed

Land Use	Area		
	[acres]	[mi^2]	[%]
Open Water	8,469	13.23	0.91
Low Intensity Residential	5,764	9.01	0.62
High Intensity Residential	1,895	2.96	0.20
High Intensity Commercial/Industrial/Transportation	1,935	3.02	0.21
Bare Rock/Sand Clay	167	0.26	0.02
Quarries/Strip Mines/Gravel Pits	11	0.02	0.00*
Transitional	1,654	2.58	0.18
Deciduous Forest	241,465	377.29	26.01
Evergreen Forest	28,031	43.80	3.02
Mixed Forest	66,105	103.29	7.12
Pasture/Hay	169,194	264.37	18.23
Row Crops	290,754	454.30	31.33
Small Grains	473	0.74	0.05
Other Grasses (Urban/recreational)	928	1.45	0.10
Woody Wetlands	111,242	173.82	11.98
Emergent Herbaceous Wetlands	94	0.15	0.01
Total	**928,182**	**1,450.28**	**100.00**

* < 0.005%. Note: A spreadsheet was used for this calculation and values are approximate due to rounding.

4.0 PROBLEM DEFINITION

The State of Tennessee's *2008 303(d) List* (TDEC, 2008) identified a number of waterbodies in the Lower Hatchie River Watershed as not fully supporting designated use classifications due, in part, to siltation and/or habitat alteration issues associated with agriculture, urban runoff, land development, bank modification, and channelization. These waterbodies are summarized in Table 2 and shown in Figure 4. The designated use classifications for these waterbodies include Fish & Aquatic Life, Irrigation, Livestock Watering & Wildlife, and Recreation. (TDEC, 2007a).

Table 2 2008 303(d) *List* - Stream Impairment Due to Siltation/Habitat Alteration in the Lower Hatchie River Watershed

Waterbody ID	Impacted Waterbody	Miles/ Acres Impaired	Cause / TMDL Priority	Pollutant Source	TMDL Development Stage
TN08010208001_0800	Wade Creek	26.9	Loss of Biological Integrity due to Siltation Physical Substrate Habitat Alterations	Nonirrigated Crop Production Channelization	I
TN08010208001_1100	Cub Creek	24.3	Physical Substrate Habitat Alterations	Channelization	N/A*
TN08010208001_1110	UT to Cub Creek	4.16	Iron Physical Substrate Habitat Alterations	Upstream Impoundment	N/A*
TN08010208001_1500	Short Creek	19.2	Physical Substrate Habitat Alterations	Channelization	N/A*
TN08010208001_1700	Gamble Branch	6.0	Loss of Biological Integrity due to Siltation	Nonirrigated Crop Production	I
TN08010208001_1800	Hickory Creek	25.5	Loss of Biological Integrity due to Siltation Physical Substrate Habitat Alterations	Channelization	N/A*
TN08010208002_1000	Indian Creek	12.1	Physical Substrate Habitat Alterations Escherichia Coli	Channelization Undetermined Source	N/A*
TN08010208007_1000	Big Muddy Creek	7.5	Physical Substrate Habitat Alterations	Channelization	N/A*
TN0801020809_0100	London Creek	6.9	Physical Substrate Habitat Alterations	Channelization	N/A*
TN08010208009_1000	Poplar Creek	17.8	Loss of Biological Integrity due to Siltation	Nonirrigated Crop Production Channelization	I
TN08010208011_2000	Bear Creek	7.9	Nitrate+Nitrite Total Phosphorus Physical Substrate Habitat Alterations Loss of Biological Integrity due to Siltation	Nonirrigated Crop Production Channelization	I
TN08010208017_0100	Potters Creek	10.2	Alteration to Littoral or Stream-Side Vegetation	Pasture Grazing	I
TN08010208029_0100	Dry Creek	22.1	Loss of Biological Integrity due to Siltation Physical Substrate Habitat Alterations	Nonirrigated Crop Production Channelization	I
TN08010208030_0100	Turkey Branch	5.6	Loss of Biological Integrity due to Siltation	Nonirrigated Crop Production	I
TN08010208031_1000	Sugar Creek	10.5	Loss of Biological Integrity due to Siltation	Nonirrigated Crop Production Discharges From MS4 Area Highway/Bridge Construction	I
TN08010208032_1000	Cypress Creek	19.2	Loss of Biological Integrity due to Siltation Low Dissolved Oxygen	Nonirrigated Crop Production	I

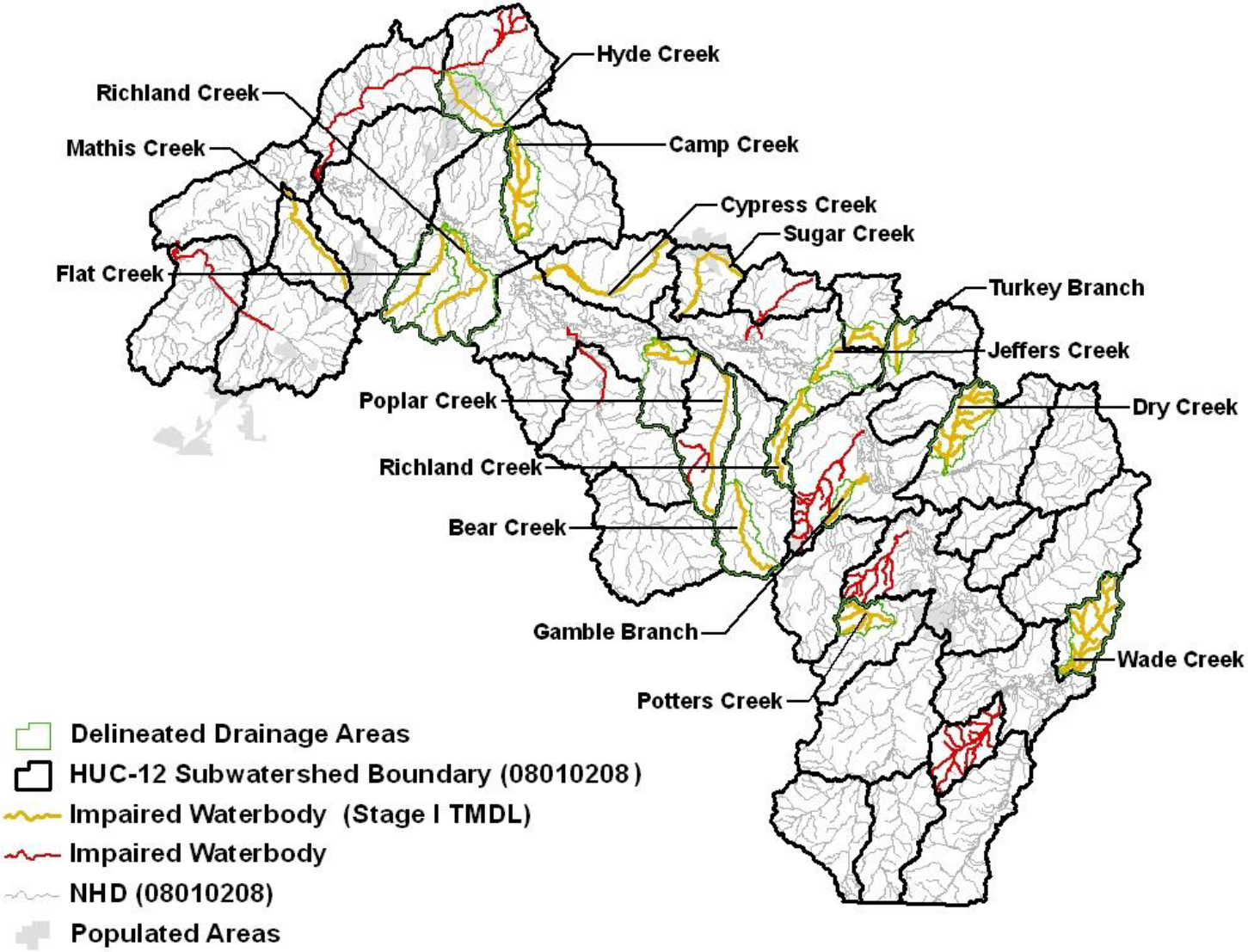
*Impaired due to siltation/habitat alteration due to channelization only and is therefore not applicable to TMDL development using this methodology.

Table 2 (Cont.) 2008 303(d) List - Stream Impairment Due to Siltation/Habitat Alteration in the Lower Hatchie River Watershed

Waterbody ID	Impacted Waterbody	Miles/ Acres Impaired	Cause / TMDL Priority	Pollutant Source	TMDL Development Stage
TN08010208033_0100	Camp Creek	20.2	Low Dissolved Oxygen Physical Substrate Habitat Alterations	Nonirrigated Crop Production	I
TN08010208034_0200	Nelson Creek	10.6	Physical Substrate Habitat Alterations	Channelization	N/A*
TN08010208034_0300	Hyde Creek	5.7	Nitrate+Nitrite Escherichia Coli Loss of Biological Integrity due to Siltation	Major Industrial Point Source Collection System Failure Channelization Urbanized High Density Area	I
TN08010208034_1000	Cane Creek	14.1	Nitrate+Nitrite Physical Substrate Habitat Alterations	Major Industrial Point Source Channelization	N/A*
TN08010208034_2000	Cane Creek	4.5	Copper Nitrate+Nitrite Total Phosphorus Physical Substrate Habitat Alterations Escherichia coli	Major Industrial Point Source Collection System Failure Channelization	N/A*
TN08010208034_3000	Cane Creek	1.0	Nitrate+Nitrite Physical Substrate Habitat Alterations Escherichia coli	Major Industrial Point Source Collection System Failure Channelization	N/A*
TN08010208056_1000	Flat Creek	8.1	Total Phosphorus Loss of Biological Integrity due to Siltation Physical Substrate Habitat Alterations Escherichia Coli	Nonirrigated Crop Production Channelization Undetermined Source	I
TN08010208062_1000	Jeffers Creek	10.8	Loss of Biological Integrity due to Siltation	Nonirrigated Crop Production	I
TN08010208065_1000	Mathis Creek	11.3	Physical Substrate Habitat Alteration Escherichia Coli	Nonirrigated Crop Production Undetermined Source	I
TN08010208072_1000	Richland Creek	11.0	Loss of Biological Integrity due to Siltation Physical Substrate Habitat Alterations	Nonirrigated Crop Production	I
TN08010208073_1000	Richland Creek	11.0	Low Dissolved Oxygen Total Phosphorus Loss of Biological Integrity due to Siltation Physical Substrate Habitat Alterations Escherichia Coli	Nonirrigated Crop Production Channelization Undetermined Source	I
TN080102081866_1000	Carter Creek	6.4	Physical Substrate Habitat Alterations	Channelization	N/A*

*Impaired due to siltation/habitat alteration due to channelization only and is therefore not applicable to TMDL development using this methodology.

Figure 4 Waterbodies in the Lower Hatchie River Watershed Impaired Due to Siltation/Habitat Alteration



A description of the stream assessment process in Tennessee can be found in *2008 305(b) Report, The Status of Water Quality in Tennessee* (TDEC, 2008b). This document states that "the most satisfactory method for identification of impairment due to silt has been biological surveys that include habitat assessments." With respect to biological integrity and the fish and aquatic life use classification, the document further states that "biological surveys using macroinvertebrates as the indicator organisms are the preferred method for assessing use support." The waterbody segments listed in Table 2 were assessed as impaired based primarily on biological surveys. The results of these assessment surveys for stage I TMDL streams are summarized in Table 3. The assessment information presented is excerpted from the Assessment Database (ADB) and is referenced to the waterbody IDs in Table 2. ADB information may be accessed at:

http://gis3.memphis.edu/wpc/

An example of a typical stream assessment (Richland Creek at RM 1.5) is shown in Appendix A.

> *Note: Assessments for wadeable streams (Stage I) were based primarily on biological surveys, whereas assessments for non-wadeable waterbodies, such as the main stem of the Hatchie River, were primarily based on chemical data.*

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

Siltation (sedimentation) is the most frequently cited cause of waterbody impairment in Tennessee, impacting over 5,500 miles of streams and rivers (TDEC, 2008b). Unlike many chemical pollutants, sediments are typically present in waterbodies in natural or background amounts and are essential to normal ecological function. Excessive sediment loading, however, is a major ecosystem stressor that can adversely impact biota, either directly or through changes to physical habitat.

Excessive sediment loading has a number of adverse effects on Fish & Aquatic Life in surface waters. As stated in excerpts from *Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteri*a (USEPA, 2006):

> Excessive suspended sediment in aquatic systems decrease light penetration, directly impacting productivity that is especially important in estuarine and marine habitats, where trophic interrelationships tend to be more complex and marginal when compared to freshwater aquatic systems. Decreased water clarity impairs visibility and associated behaviors such as prey capture and predator avoidance, recognition of reproductive cues, and other behaviors that alter reproduction and survival. At very high levels, suspended sediments can cause physical abrasion and clogging of filtration and respiratory organs.

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

The U.S. Geological Survey (USGS), in cooperation with the West Tennessee River Basin Authority (WTRBA), conducted a study of sediment accumulation in the Hatchie River and its tributaries. The results of the study were reported in *Shoals and Valley Plugs in the Hatchie River Watershed* (Diehl, 2000). The report evaluates sediment transport in certain tributaries, the formation of valley plugs and shoals, and the effects of these formations on flooding and sediment loading to the Hatchie River.

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 Lower Hatchie River Watershed listed as impaired due to siltation (excess inorganic sediment produced by erosional processes) and/or appropriate cases of habitat alteration. The TSS in STP effluent is considered to be a distinctly different pollutant and, therefore, is excluded in sediment loading calculations.

Table 3 Water Quality Assessment of Waterbodies Impaired Due to Siltation/Habitat Alteration in Stage I Impaired Subwatersheds

Waterbody ID	Impacted Waterbody	Comments
TN08010208001_0800	Wade Creek (Hatchie River to headwaters)	2001 TDEC biorecon and chemical sampling at mile 2.2 (u/s of U.S. Highway 64). 4 EPT families, zero intolerant, 14 total families. Biorecon score = 7. Habitat score = 78. Habitat assessment on three unnamed trib for antidegradation review for Highway 64 widening project. Scores = 97 61, & 52.
TN08010208001_1700	Gamble Branch (Hatchie River to headwaters)	Hatchie River from Mississippi River to beginning of next cataloging unit (near Little Hatchie Creek). 2004 TDEC biorecon station at mile 2.1 (u/s Vildo Road). Zero EPT families, zero intolerant, 3 total families. Biorecon score = 3. Habitat score = 76.
TN08010208009_1000	Poplar Creek (Hatchie River to headwaters)	Exceptional Tennessee water within the Hatchie National Wildlife Refuge. Randomly selected for the 2007 Tennessee Wadeable Streams Assessment project. Station located at mile 14.7 (u/s Dancyville-Eukaton Road). One elevated ammonia. One NO2+NO3 value and two phosphorus values elevated. Zero out of 5 E. coli observations over 941 cfu. August, 2007 geo mean of 5 E. coli observations = 24 cfu. SQSH results: 2 EPT genera, 26 total genera. Index score = 12. Habitat score = 64. Scored poorly for embeddedness, channel alteration, and riparian. 2003 TWRA biorecon station at mile 6.9 (u/s of Carney Road). 3 EPT genera, zero intolerant, 13 total genera. Biorecon score = 5. Habitat score = 75. 2001 TDEC biorecon and chemical sampling at mile 6.9 (u/s of Carney Road). 1 EPT families, zero intolerant, 10 total families. Biorecon score = 5. Habitat score = 108. Also 2001 TDEC chemical station at mile 11.4 (Caldwell Road).
TN08010208011_2000	Bear Creek (Confluence of Little Creek to headwaters)	2006 TDEC SQSH survey at mile 9.6 (Fayette Corners Road). 2 EPT genera, 28 total genera. Index score = 12. Habitat score = 60. 2004 TDEC chemical station at mile 9.6 (Fayette Corners Road). Two out of 11 E. coli observations over 941. Violations may be rain events. 2000 TDEC chemical station at mile 9.6 (Fayette Corners Road). Stream channelized at this point.
TN08010208017_0100	Potters Creek (Pleasant Run to headwaters)	2004 TDEC biorecon station at mile 0.4 (d/s Russell Road). 4 EPT families, zero intolerant, 16 total families. Biorecon score = 9. Habitat score = 92.

Table 3 (Cont.) Water Quality Assessments of Waterbodies Impaired Due to Siltation/Habitat Alteration in Stage I Impaired Subwatersheds

Waterbody ID	Impacted Waterbody	Comments
TN08010208029_0100	Dry Creek (Clover Creek to headwaters)	2002 TDEC biorecon station at mile 1.2 (u/s Teague Road). 4 EPT families, zero intolerant, 7 total families. Biorecon score = 7. Habitat score = 69.
TN08010208030_0100	Turkey Branch (Big Black Creek to headwaters)	2005 TDEC biorecon station at mile 1.4 (u/s Estanallie Road). Zero EPT families, 1 intolerant, 6 total families. Biorecon score = 5. Habitat score = 53.
TN08010208031_1000	Sugar Creek (Hatchie River to headwaters)	Exceptional Tennessee water within the Hatchie National Wildlife Refuge. 2004 TDEC biorecon station at mile 1.5 (Sunny Creek Road). 4 EPT families, zero intolerant, 17 total families. Biorecon score = 9. Habitat score = 91. 2001 TDEC biorecon and chemical sampling at mile 1.5 (u/s Sugar Creek Road, 2 miles due west of Sunnyhill). 1 EPT families, zero intolerant, 10 total families. Biorecon score = 5. Habitat score = 109. Urban runoff from Brownsville area.
TN08010208032_1000	Cypress Creek (Wolf River to headwaters)	2003 TDEC RBPIII at mile 1.2 (North Watkins Street). Zero EPT genera, 23 total genera. Index score = 12. Habitat score = 79. Failed biocriteria (32 score goal). DO = 1.68 on day of survey. 2003 TDEC ambient chemical stations at mile 0.4 (Pumping Station), mile 1.2 (North Watkins Street), and at mile 4.8 (Summer Ave). At mile 0.4: 7 out of 15 E.coli observations over 941. One low DO. Elevated total phosphorus and lead levels. At mile 1.2: 14 out of 22 E.coli observations over 941. 11 low DO observations. Total phosphorus levels elevated. At mile 4.8: 8 out of 13 E.coli observations over 941. One low DO. Elevated total phosphorus levels.
TN08010208033_0100	Camp Creek (Lagoon Creek to headwaters)	2005 TDEC chemical station at mile 1.8 (Hwy 87). One out of 12 E. coli observations over 941. Violations were rain events samples. Several low DOs. 2004 TDEC biorecon survey at mile 2.0 (Hwy 87). Zero EPT family, zero intolerant, 8 total families. Biorecon score = 5. Habitat score = 75. Low DO - 3.27 mg/L. Several low DOs in stream, but stream is very stagnant due to low flows. TDEC chemical station at mile 1.8 (Highway 87).

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

Waterbody ID	Impacted Waterbody	Comments
TN08010208034_0300	Hyde Creek (Cane Creek to headwaters)	A site-specific copper study established the chronic criteria of 357.0 ug/L in this stream. Randomly selected for the 2007 Tennessee Wadeable Streams Assessment project. Station located at mile 2.7 (d/s RR tracks and impoundment in Ripley). Two low DOs (4.46 & 4.31 mg/L). One elevated ammonia and suspended solids. One NO2+NO3 values and three phosphorus values elevated. Zero out of 5 E. coli observations over 941 cfu. July, 2007 geo mean of 5 E. coli observations = 103 cfu. SQSH results: 1 EPT genera, 30 total genera. Index score = 20. Habitat score = 71. Scored poorly for ripaean and substrate. 2004 TDEC biorecon survey at mile 1.0 (Glimp Road). Zero EPT family, zero intolerant, 4 total families. Biorecon score = 3. Habitat score = 67. TDEC chemical monitoring station at mile 1.6. Nitrate-nitrite, conductivity, also high.
TN08010208056_1000	Flat Creek (Hatchie River to headwaters)	2006 TDEC SQSH sample at mile 1.8 (Antioch Road). 2 EPT genera, 30 total genera. Index score = 12. Habitat score = 57. 2005 TDEC chemical station at mile 1.8 (Antioch Road). Two out of 12 E. coli observations over 941. Three low DOs. 2004 TDEC biorecon station at mile 1.8 (Antioch Road). 1 EPT families, zero intolerant, 10 total families. Biorecon score = 5. Habitat score = 69. Low DO - 4.41 mg/L. 2000 TDEC chemical station at mile 1.8 (Antioch Road). Old 303(d) Listing. Nutrients elevated. August 2000 fecal coliform level of 3100.
TN08010208062_1000	Jeffers Creek (Jeffers Creek to headwaters)	2004 TDEC biorecon station at mile 3.4 (u/s Bachelor Levee Road). Zero EPT families, 1 intolerant, 8 total families. Biorecon score = 7. Habitat score = 85. 2001 TDEC chemical station at mile 4.2 (Bachelor Levee Road).
TN08010208065_1000	Mathis Creek (Hatchie River to headwaters)	2000 TDEC chemical monitoring station at mile 4.6 (Bennett Road). E. coli level elevated. Three out of twelve E. coli observations over 941. 2004 TDEC SQSH at mile 5.8 (u/s Bride Road). 2 EPT genera, 22 total genera. Index score = 26. Habitat score = 88.

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

Waterbody ID	Impacted Waterbody	Comments
TN08010208072_1000	Richland Creek (Hatchie River to headwaters)	2004 TDEC biorecon station at mile 1.7 (d/s Hillville-Vildo Road). Zero EPT families, zero intolerant, 10 total families. Biorecon score = 5. Habitat score = 93. Stream very warm on day of survey - 33.3 C. 2000 TDEC biological and chemical sampling survey at mile 0.8 (Hillville-Vildo Rd). 5 EPT families, 15 total. Habitat very impacted by sand accumulations. Very poor habitat score = 63.
TN08010208073_1000	Richland Creek (Hatchie River to headwaters)	2005 TDEC SQSH and chemical station at mile 1.8 (Antioch Road). Zero EPT genera, 26 total genera. Index score = 18. Habitat score = 51. Three out of 12 E. coli observations over 941. Two low DOs. 2000 TDEC chemical station at mile 1.8 (Antioch Road). New data doesn't support change of assessment. Nutrients and fecals elevated.

5.0 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, June 2008* (TDEC, 2008a):

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 and 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 and Industrial Water Supply use classifications (Industrial Water Supply shown):

> Turbidity or Color - There shall be no turbidity or color in amounts or characteristics that cannot be reduced to acceptable concentrations by conventional water treatment processes.

Applicable to the Recreation use classification:

> Total Suspended Solids, Turbidity or Color - There shall be no total suspended solids, turbidity or color in such amounts or character that will result in any objectionable appearance to the water, considering the nature and location of the water.

Applicable to the Fish & Aquatic Life use classification:

> Turbidity, Total Suspended Solids, or Color - There shall be no turbidity, total suspended solids, or color in such amounts or of such character that will materially affect fish and aquatic life. In wadeable streams, suspended solid levels over time should not be substantially different than conditions found in reference streams.
>
> Biological Integrity - The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under 1200-4-3-.06.
>
> Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion and (b) is of the appropriate stream order specified for the bioregion, and (c) contains the habitat (riffle or rooted bank) specified for the bioregion, may be made using the most current revision of the Department's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys and/or other scientifically defensible methods.

> Interpretation of this provision for all other wadeable streams, lakes, and reservoirs may be made using Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA/841-B-99-002) or Lake and Reservoir Bioassessment and Biocriteria (EPA 841-B-98-007), and/or other scientifically defensible methods. Interpretation of this provision for wetlands or large rivers may be made using 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 stream habitat shall provide for the development of a diverse aquatic community that meets regionally-based biological integrity goals. Types of habitat loss include, but are not limited to: channel and substrate alterations, rock and gravel removal, stream flow changes, accumulation of silt, precipitation of metals, and removal of riparian vegetation. For wadeable streams, 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 and aquatic life will protect all other use classifications for the identified waterbodies from adverse alteration due to sediment loading or habitat alteration.

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 and aquatic life. Biologically healthy watersheds were identified from the State’s ecoregion reference sites (ref.: Figure 5). These ecoregion reference sites have similar characteristics and conditions as the majority of streams within that ecoregion. Detailed information regarding Tennessee ecoregion reference sites can be found in *Tennessee Ecoregion Project, 1994-1999* (TDEC, 2000). In general, land use in ecoregion reference watersheds consist of less pasture, cropland, and urban areas and more forested areas compared to the impaired watersheds. The biologically healthy (reference) watersheds are considered the “least impacted” in an ecoregion and, as such, sediment loading from these watersheds may serve as an appropriate target for the TMDL.

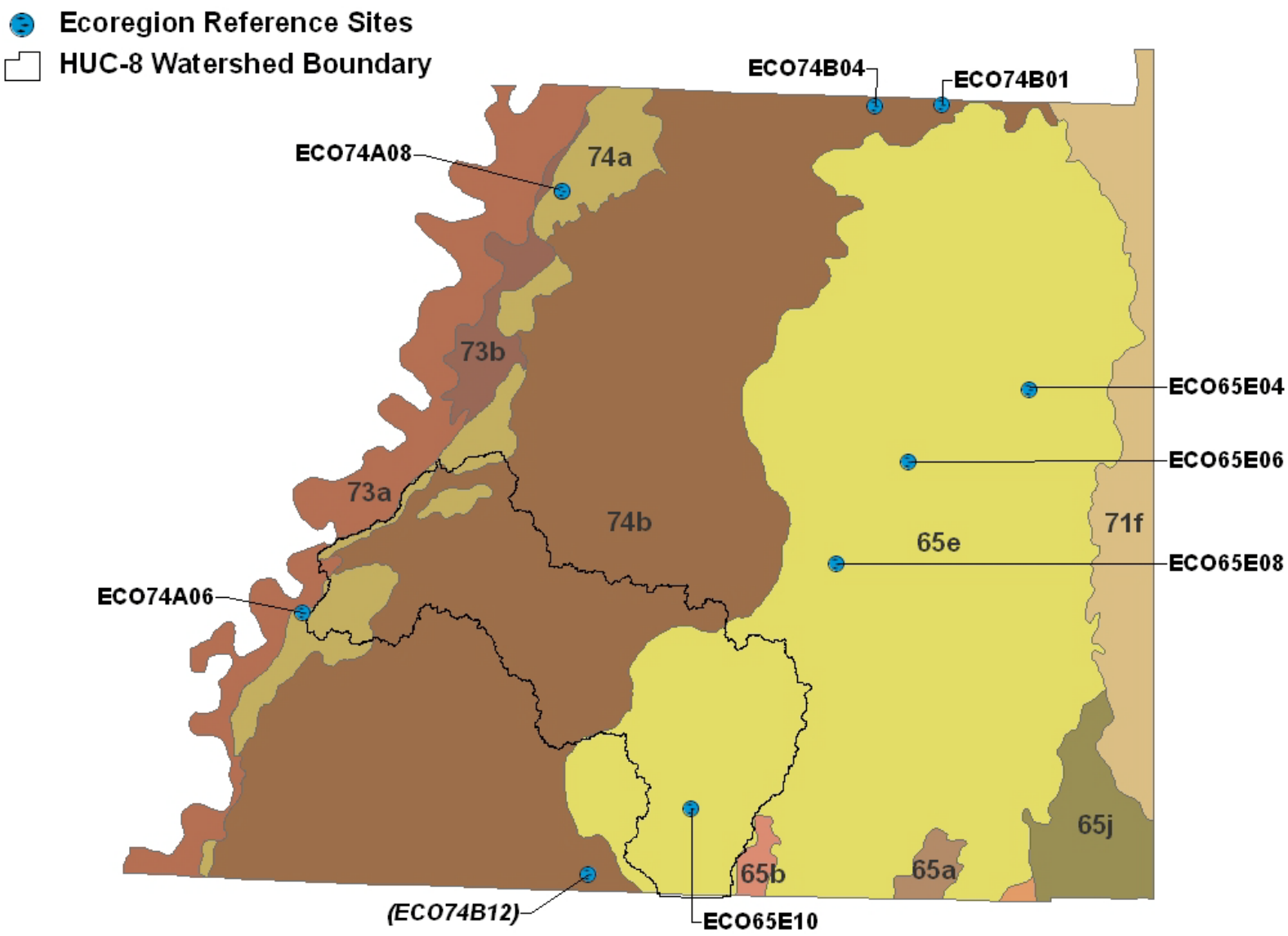
Using the methodology described in Appendix B, the Watershed Characterization System (WCS) Sediment Tool was used to calculate the average annual sediment load for each of the biologically healthy (reference) watersheds in Level IV ecoregions 65e, 74a, and 74b. The geometric mean of the average annual sediment loads of the reference watersheds in each Level IV ecoregion was selected as the most appropriate target for that ecoregion. The average annual sediment loads for reference sites and corresponding TMDL target values for Level IV ecoregions 65e, 74a, and 74b are summarized in Table 4.

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]
65e	Eco65e04	Blunt Creek	11,275	216.5
	Eco65e06	Griffin Creek	2,448	333.0
	Eco65e08	Harris Creek	12,374	562.1
	Eco65e10	Marshall Creek	4,117	395.5
			Geometric Mean (Target Load)	**355.8**
74a	Eco74a06	Sugar Creek	1,614	1,249.8
	Eco74a08	Paw Paw Creek	4,733	403.8
			Geometric Mean (Target Load)	**710.4**
74b *	Eco74b01	Terrapin Creek	29,397	988.0
	Eco74b04	Powell Creek	13,810	965.9
			Geometric Mean (Target Load)	**976.9**

* Note: Ecoregion reference site ECO74b12 (Wolf River) was not included in the Stage I target calculation for Level IV ecoregion 74b due to the size of its drainage area (134,513 acres).

Figure 5 Reference Sites in Level IV Ecoregions 65e, 74a, and 74b



6.0 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 instream sediment load for all Stage I impaired subwatersheds and delineated drainage areas in the Lower Hatchie River Watershed (ref.: Figure 4). Existing sediment loads for subwatersheds and drainage areas with waterbodies listed on the 2008 303(d) List as impaired for siltation/habitat alteration are summarized in Table 5.

Table 5 Existing Sediment Loads in Subwatersheds with Impaired Waterbodies

Waterbody	HUC-12 Subwatershed (08010208____) or Drainage Area	Level IV Ecoregion	Target Load	Existing Sediment Load
			[lbs/ac/yr]	[lbs/ac/yr]
Wade Creek	DA	65e	355.8	410
Potters Creek	DA	65e	355.8	819
Dry Creek	DA	65e	355.8	1,833
Bear Creek	DA	65e,74b	855.3	1,195
Turkey Branch	DA	65e,74b	877.6	3,258
Gamble Branch	DA	65e	355.8	1,094
Sugar Creek	0506	74b	976.9	2,523
Poplar Creek	DA	74b	976.9	1,349
Jeffers Creek	DA	65e,74b	814.7	1,089
Richland Creek	DA	65e,74b	800.4	897
Cypress Creek	0510	74b	976.9	2,979
Hyde Creek	DA	74a, 74b	834.5	1,946
Camp Creek	DA	74b	976.9	3,282
Flat Creek	DA	74b	976.9	2,676
Richland Creek	DA	74b	976.9	1,849
Mathis Creek	0805	74a, 74b	883.0	2,901

7.0 SOURCE ASSESSMENT

An important part of 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. In 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) stormwater 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.

7.1 Point Sources

7.1.1 NPDES Regulated Sewage Treatment Plants

As stated in Section 4.0, the TSS component of STP discharges is generally composed of primarily organic material and is considered to be different in nature than the sediments produced from erosional processes. Therefore, TSS discharges from STPs are <u>not</u> included in the TMDLs developed for this document.

7.1.2 NPDES Regulated Ready Mixed Concrete Facilities

Discharges from regulated Ready Mixed Concrete Facilities (RMCFs) may contribute sediment to surface waters as TSS discharges (TSS discharged from RMCFs is composed of primarily inorganic material and is therefore included as a source for TMDL development). Most of these facilities obtain coverage under NPDES Permit No. TNG110000, *General NPDES Permit for Discharges of Stormwater Runoff and Process Wastewater Associated with Ready Mixed Concrete Facilities* (TDEC, 2007b). This permit establishes a daily maximum TSS concentration limit of 50 mg/l on process wastewater effluent and specifies monitoring procedures for stormwater discharges. Facilities are also required to develop and implement stormwater pollution prevention plans (SWPPPs). Discharges from RMCFs are generally intermittent, and contribute a small portion of total sediment loading to impaired subwatersheds (ref.: Appendix E). In some cases, for discharges into impaired waters, sites may be required to obtain coverage under an individual NPDES permit. Of the six permitted RMCFs in the Lower Hatchie River Watershed, only one discharges to a Stage I impaired subwatershed. This facility is listed in Table 6 and shown in Figure 6.

7.1.3 NPDES Regulated Mining Sites

Discharges from regulated mining activities may contribute sediment to surface waters. Primary sources of solids loading from active mines include dewatering operations, runoff from areas disturbed by resource extraction, and runoff from access and haul roads. Discharges from permitted inactive mines are only in response to storm events. Inactive sites with successful surface reclamation contribute relatively little solids loading. As of May, 2009, there are two permitted mining sites in the Lower Hatchie River Watershed that have discharges to waterbodies in impaired subwatersheds for which Stage I TMDLs were developed. These sites have a technology-based Daily Maximum TSS limit of 40 mg/l for discharges associated with construction sand and gravel mining. Mines permitted to discharge to waterbodies in impaired subwatersheds are listed in Table 7 and shown in Figure 6.

7.1.4 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 stormwater 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. TNR100000, *General NPDES Permit for Stormwater Discharges Associated With Construction Activity* (TDEC, 2005). Since construction activities at a site are of a temporary, relatively short-term nature, the number of construction sites covered by the general permit at any instant of time varies. As of May, 2009, there were 74 active construction sites (see Figure 7) in the Lower Hatchie River Watershed, with 24 located in subwatersheds for which Stage I TMDLs were developed.

Table 6 NPDES Regulated Ready Mixed Concrete Facilities Located in Stage I Impaired Subwatersheds & Drainage Areas

HUC-12 Subwatershed (08010208__) Or Drainage Area	NPDES Permit No.	Facility Name	Receiving Stream
Hyde Creek DA	TNG110109	51 Concrete Ripley Ready Mix Plant	UT to Hyde Creek

Table 7 NPDES Regulated Mining Sites Located in Stage I Impaired Subwatersheds & Drainage Areas

HUC-12 Subwatershed (08010208__) Or Drainage Area	NPDES Permit No.	Site Name	Receiving Stream
0805	TN0072541	Memphis Stone & Gravel Company	UT to Mathis Creek
	TN0079154	Delashmit Hauling - Jones Pit	UT to Mathis Creek

Figure 6 NPDES Regulated RMCFs and Mining Sites Located in Stage I Impaired Subwatersheds

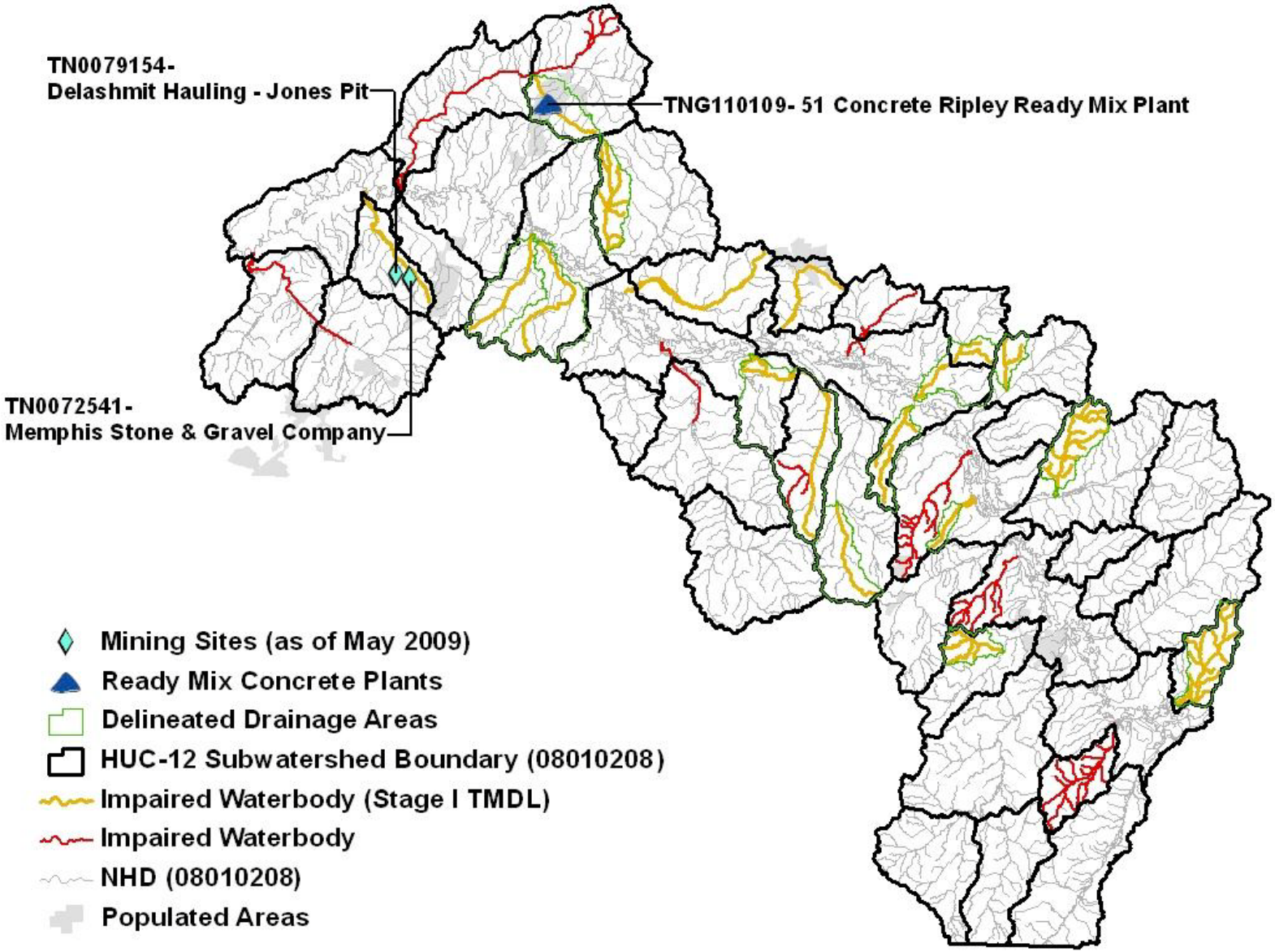
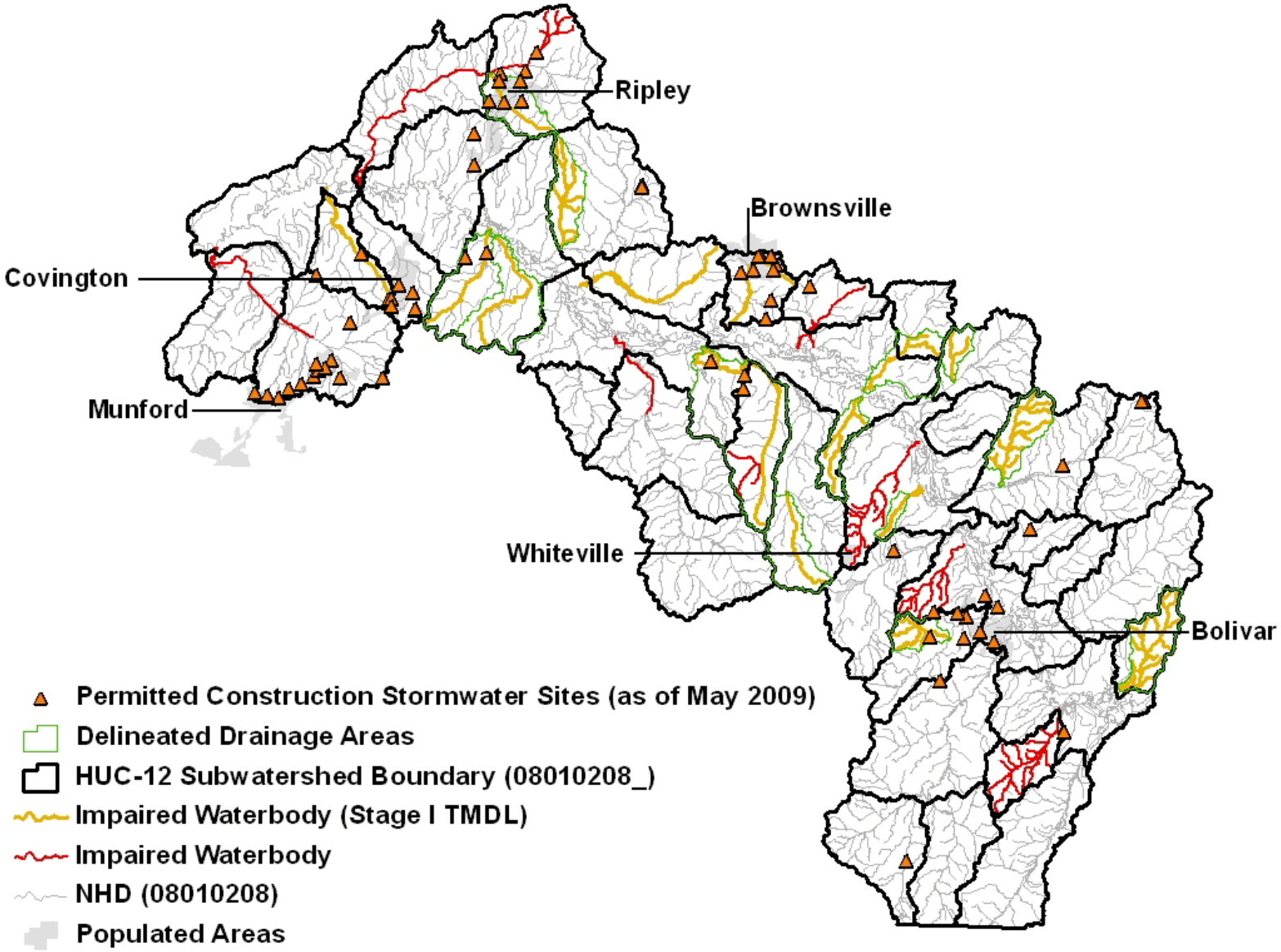


Figure 7 Location of NPDES Permitted Construction Stormwater Sites in the Lower Hatchie River Watershed



7.1.5 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

MS4s may discharge solids to waterbodies in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. These systems convey urban runoff from surfaces such as bare soil and wash-off of accumulated street dust and litter from impervious surfaces during rain events. Phase I of the EPA stormwater program requires large and medium MS4s to obtain NPDES stormwater permits. Large and medium MS4s are those located in incorporated places or counties serving populations greater than 100,000 people. At present, there are no large or medium MS4s in the Lower Hatchie River Watershed.

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

NPDES Permit Number	Permittee Name
TNS075191	Brownsville

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

Information regarding stormwater permitting in Tennessee may be obtained from the TDEC website at: http://www.state.tn.us/environment/wpc/stormh2o/.

7.2 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.
- Channelization and channel modification include activities such as straightening, widening, deepening, and clearing of channels of debris and sediment (USEPA, 2007a). Channelization activities can play a critical role in NPS pollution by increasing the timing and delivery of sediment that enter the water. Channelization can also be a cause of higher flows during storm events, increasing the erosive power and carrying capacity of the waterbody.
- Streambank erosion is the wearing away of material in the area landward of the bank along streams and rivers (USEPA, 2007a). Streambank erosion occurs when the force of flowing water in a river or stream exceeds the ability of soil and vegetation to hold the banks in place. Eroded material is carried downstream and redeposited in the channel bottom or in point bars located along bends in the waterway. It is important to note that streambank erosion is a natural process and that natural background levels of erosion exist. However, human activities along or adjacent to streambanks may increase erosion.

  Note: In general, streambank erosion and channelization are more significant sources with respect to larger, non-wadeable waterbodies and will be more fully addressed in Stage II TMDL development.

For impaired waterbodies within the Lower Hatchie River Watershed, the primary sources of nonpoint sediment loads come from agriculture and channelization. Watershed land use distribution based on the 1992 MRLC satellite imagery databases is shown in Appendix C for impaired HUC-12 subwatersheds and delineated drainage areas.

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

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 instream 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. It should be noted, however, that as a result of a recent court decision, EPA has recommended that all TMDLs, WLAs, and LAs include “a daily time increment in conjunction with other temporal expressions that may be necessary to implement relevant water quality standards” (USEPA, 2007). The TMDLs and allocations developed in this document are in accordance with this guidance.

8.1 TMDL Development Methodology

8.1.1 Area Basis for TMDL Analysis

The basic area unit of analysis for Stage I TMDL development was the headwater HUC-12 subwatershed containing one or more waterbodies identified as impaired due to siltation and/or habitat alteration on the 2008 303(d) List. In some cases, for impaired tributaries in non-headwater subwatersheds, TMDLs were developed for the impaired waterbody drainage area only. In this document references to subwatersheds refers to HUC-12 subwatershed areas and delineated drainage areas. HUC-12 subwatershed and delineated drainage area boundaries are shown in Figure 4.

8.1.2 Sediment Loading Analysis

Sediment loading analysis for impaired subwatersheds in the Lower Hatchie River Watershed was conducted using the Watershed Characterization System (WCS) Sediment Tool. WCS is an ArcView geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development. The Sediment Tool is an extension of WCS that utilizes available GIS coverages (land use, soils, elevations, roads, etc), the Universal Soil Loss Equation (USLE) to calculate potential erosion, and sediment delivery equations to calculate sediment delivery to the stream network (see Appendix B).

Using the Sediment Tool, the existing average annual instream sediment load of each impaired subwatershed was determined. This value was compared to the appropriate ecoregion-based target load and the <u>overall</u> required percent reduction in instream sediment loading calculated. (In cases where an impaired subwatershed was located in more than one Level 4 ecoregion, an area-

weighted composite target value was used). A portion of the target load was reserved to account for discharges from NPDES permitted RMCFs, mining sites, and construction sites, with the remainder allocated to MS4s and nonpoint source loading. Daily expressions of allowable loads were developed for precipitation-based sources by dividing the calculated average annual target load by the average annual precipitation.

The sediment loading analysis methodology is described in detail in Appendix D.

8.2 Stage I TMDLs for Impaired Subwatersheds

Stage I TMDLs for impaired subwatersheds were developed according to the procedure described in Appendix D and are summarized in Table 8. For each impaired subwatershed or drainage area, the TMDL consists of two parts: a) the overall percent reduction in instream sediment loading required to meet the appropriate target load and b) the allowable daily instream sediment load per unit area per inch of precipitation (lbs/ac/in. precipitation).

8.3 Stage I Waste Load Allocations (WLAs) for Point Sources

8.3.1 WLAs for NPDES Regulated Ready Mixed Concrete Facilities and Mining Sites

For each impaired subwatershed, an overall WLA, equal to 5% of the target load, was assigned to discharges from ready mixed concrete facilities (RMCFs) and mining sites (see Table 9). WLAs for individual RMCFs and mining sites are equal to the loads authorized by their existing permits. These permits contain Daily Maximum limits for total suspended solids (TSS). Since solids loading from these facilities is very small (ref.: Appendix E) compared to the total loading for impaired subwatersheds, further reductions were not considered warranted. Future RMCFs and mining sites may be permitted as long as the overall WLA for each subwatershed is not exceeded.

Table 8 Stage I Sediment TMDLs for Impaired Subwatersheds

2Subwatershed (08010208___) or Drainage Area	Waterbody ID	Waterbody Impaired By Siltation/ Habitat Alteration	Level IV Ecoregion	Level IV Ecoregion Target *	TMDL	
					Required Overall Load Reduction	Daily Maximum Load
				[lbs/ac/yr]	[% Reduction]	[lbs/ac/in. precip.]
Wade Creek DA	TN08010208 001_0800	Wade Creek	65e	355.8	13.2	6.4
Potters Creek DA	TN08010208 017_0100	Potters Creek	65e	355.8	56.5	6.5
Dry Creek DA	TN08010208 029_0100	Dry Creek	65e	355.8	80.6	6.5
Bear Creek DA	TN08010208 011_2000	Bear Creek	65e,74b	855.3	28.4	15.6
Turkey Branch DA	TN08010208 030_0100	Turkey Branch	65e,74b	877.6	73.1	16.0
Gamble Branch DA	TN08010208 001 –1700	Gamble Branch	65e	355.8	67.5	6.5
0506	TN08010208 031_1000	Sugar Creek	74b	976.9	61.3	18.4
Poplar Creek DA	TN08010208 009_1000	Poplar Creek	74b	976.9	27.6	18.1
Jeffers Creek DA	TN08010208 062_1000	Jeffers Creek	65e,74b	814.7	25.2	14.8
Richland Creek DA (0509)	TN08010208 072_1000	Richland Creek	65e,74b	800.4	10.7	14.6
0510	TN08010208 032_1000	Cypress Creek	74b	976.9	67.2	18.4
Hyde Creek DA	TN08010208 034_0300	Hyde Creek	74a, 74b	834.5	57.1	15.7
Camp Creek DA	TN08010208 033_0100	Camp Creek	74b	976.9	70.2	18.4
Flat Creek DA	TN08010208 056_1000	Flat Creek	74b	976.9	63.5	18.4
Richland Creek DA (0802)	TN08010208 073_1000	Richland Creek	74b	976.9	47.2	18.4
0805	TN08010208 065_1000	Mathis Creek	74a, 74b	883.0	69.6	16.7

* For subwatersheds in multiple Level IV ecoregions, target values are area-weighted composites.

8.3.2 Waste Load Allocations for NPDES Regulated Construction Activities

Point source discharges of stormwater 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 (ref.: Section 6.1.4). Since these discharges have the potential to transport sediment to surface waters, WLAs are provided for this category of activities. WLAs for construction site discharges were derived from EPA estimates of the reductions in sediment runoff that can be achieved through the proper design, installation, and maintenance of erosion and sediment BMPs. WLAs are equal to a) an average annual erosion load from the construction site of 6,000 lbs/ac/yr and b) an allowable daily erosion load per unit area per inch of precipitation (lbs/ac/in. precipitation. WLAs for regulated construction activities are summarized in Table 9.

Note: WLAs for construction stormwater discharges are technology-based and are specified as allowable erosion loads from construction sites. TMDLs, other WLAs, and LAs are discussed in terms of instream sediment loading. The relationship between erosion and sediment delivered to surface waters is discussed in Appendices B, D and F.

8.3.3 Waste Load Allocations for NPDES Regulated Municipal Separate Storm Sewer Systems

WLAs for Municipal separate storm sewer systems (MS4s) are calculated in Appendix D for impaired subwatersheds and are expressed as: a) the required percent reduction in the average annual instream sediment loading and b) the allowable daily instream sediment load per unit area per inch of precipitation (lbs/ac/in. precipitation). Instream sediment loads are evaluated at the pour point of the subwatershed or drainage area. Stage I WLAs for MS4s are tabulated in Table 9 and apply to MS4 discharges in the impaired subwatershed or drainage area for which the WLA was developed. WLAs will be implemented as Best Management Practices (BMPs) as specified in Phase I and II MS4 permits. WLAs should not be construed as numeric limits.

8.4 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). LAs are calculated in Appendix D for impaired subwatersheds and are expressed as: a) the required percent reduction in the average annual instream sediment loading and b) the allowable daily instream sediment load per unit area per inch of precipitation (lbs/ac/in. precipitation). LAs are summarized in Table 9 and are evaluated at the pour point of the impaired subwatershed or drainage area.

8.5 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 is incorporated. Conservative modeling assumptions 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).

8.6 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.

Table 9 Summary of Stage I WLAs & LAs

HUC-12 Subwatershed (08010208___) or Drainage Area	WLAs					LAs [c]	
	RMCFs & Mining	Construction Stormwater [b]		MS4 [c]		Required Reduction	Daily Maximum Load
	Overall Annual Average Load [a]	Annual Average Load	Daily Maximum Load	Required Reduction	Daily Maximum Load		
	[lbs/ac/yr]	[lbs/ac/yr]	[lbs/ac/in. precip.]	[%]	[lbs/ac/in. precip.]	[%]	[lbs/ac/in. precip.]
Wade Creek DA	17.8	6,000	107.1	26.1	5.4	26.1	5.4
Potters Creek DA	17.8	6,000	109.1	62.3	5.6	62.3	5.6
Dry Creek DA	17.8	6,000	109.1	83.0	5.7	83.0	5.7
Bear Creek DA	42.8	6,000	109.1	33.8	14.4	33.8	14.4
Turkey Branch DA	43.9	6,000	109.1	75.0	14.8	75.0	14.8
Gamble Branch DA	17.8	6,000	109.1	72.5	5.5	72.5	5.5
0506	48.8	6,000	113.2	63.9	17.2	63.9	17.2
Poplar Creek DA	48.8	6,000	110.9	32.4	16.8	32.4	16.8
Jeffers Creek DA	40.7	6,000	109.1	29.7	13.9	29.7	13.9
Richland Creek DA (0509)	40.0	6,000	109.1	17.4	13.5	17.4	13.5
0510	48.8	6,000	113.2	69.1	17.4	69.1	17.4
Hyde Creek DA	41.7	6,000	113.2	60.3	14.6	60.3	14.6
Camp Creek DA	48.8	6,000	113.2	72.2	17.2	72.2	17.2
Flat Creek DA	48.8	6,000	113.2	65.9	17.2	65.9	17.2
Richland Creek DA (0802)	48.8	6,000	113.2	50.5	17.3	50.5	17.3
0805	44.2	6,000	113.2	71.6	15.5	71.6	15.5

Notes: a. Value listed for each subwatershed is the overall WLA for all existing and future RMCF & mining operations. WLAs for existing individual facilities are equal to the requirements of their NPDES permit. Future facilities may be permitted as long as the overall WLA is not exceeded. RMCF and mining permits contain Daily Maximum concentration limits.
b. Applicable as site erosion per acre disturbed.
c. Applicable as instream sediment reduction at the pour point of the HUC-12 subwatershed.

9.0 IMPLEMENTATION PLAN

9.1 Point Sources

9.1.1 NPDES Regulated Ready Mixed Concrete Facilities

WLAs for existing and future RMCFs discharging in impaired subwatersheds will be implemented through NPDES Permit No. TNG110000, *General NPDES Permit for Discharges of Stormwater Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2007a).

9.1.2 NPDES Regulated Mining Sites

WLAs for existing and future mining sites discharging in impaired subwatersheds will be implemented through the NPDES permit requirements for these sites. The Mining Section of the Division of Water Pollution Control (DWPC) will be responsible for ensuring that loading from permitted mining sites will not exceed the specified overall WLA in each impaired subwatershed.

9.1.3 NPDES Regulated Construction Stormwater

The WLAs provided to existing and future NPDES regulated construction activities will be implemented through appropriate erosion prevention and sediment controls and Best Management Practices (BMPs) as specified in NPDES Permit No. TNR10-0000, *General NPDES Permit for Stormwater Discharges Associated With Construction Activit*y (TDEC, 2005). This permit requires the development and implementation of a site-specific Stormwater 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 stormwater discharges and describe practices to be used to reduce pollutants in those discharges. In addition, the permit specifies a number of special requirements for discharges entering high quality waters, waters identified as impaired due to siltation, and waters that have an approved TMDL for a pollutant of concern. The permit does <u>not</u> authorize discharges that would result in a violation of a State water quality standard.

Unless otherwise stated, full compliance with the requirements of the *General NPDES Permit for Stormwater Discharges Associated with Construction Activit*y is considered to be consistent with the WLAs specified in Section 8.3.2 of this TMDL document.

9.1.4 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

For existing and future regulated discharges from municipal separate storm sewer systems (MS4s), WLAs will be implemented through Phase I and II MS4 permits. These permits will require the development and implementation of a Stormwater Management Plan (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards. Both the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003) and the TDOT individual MS4 permit (TNS077585) require SWMPs to include the following six minimum control measures:

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

The permits also contain requirements regarding control of discharges of pollutants of concern into impaired waterbodies, implementation of provisions of approved TMDLs, and description of methods to evaluate whether stormwater controls are adequate to meet the requirements of approved TMDLs. In order to evaluate SWMP effectiveness and demonstrate compliance with specified WLAs, MS4s must develop and implement appropriate monitoring programs including, at a minimum, the following:

- Biological stream sampling performed utilizing the Semi-Quantitative Single Habitat (SQSH) Method as identified in the Division's *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys* (TDEC 2006). At least one sample per stream segment listed in the TMDL must be collected, with all segments in the MS4 jurisdiction sampled in a five-year period. The standard operating procedure can be found online at:

  http://state.tn.us/environment/wpc/publications/bugsop06.pdf

- Visual Stream Surveys and Impairment Inventories, performed in an effort to identify and prioritize MS4 stream impairment sources. It is strongly recommended that visual stream surveys be performed throughout the entire HUC-12 subwatershed of a stream segment listed in the TMDL. At a minimum, a survey must be performed immediately upstream and downstream of each MS4 outfall that discharges into a TMDL listed stream segment. There are many existing protocols available through the Environmental Protection Agency, Natural Resources Conservation Service, U.S. Fish and Wildlife Services, Center for Watershed Protection, and states such as Maryland. MS4s have the flexibility to select or modify a protocol to complement the existing MS4 program, as long as the main objective is accomplished. All TMDL listed stream segments in the MS4 jurisdiction must be surveyed in a five-year period.

9.2 Nonpoint Sources

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

http://cfpub.epa.gov/safewater/sourcewater/sourcewater.cfm?action=Protection&view=general

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:

- Visual Stream Surveys
- 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) and the Natural Resource Conservation Service (NRCS) fund, implement, and keep record of BMPs in Tennessee. Of the 505 TDA BMPs in the Lower Hatchie River Watershed as of March 2009, 121 are in Stage I sediment-impaired subwatersheds (ref.: Figure 8).

One good example of stakeholder involvement in the Lower Hatchie River Watershed is The Nature Conservancy's (TNC) project to involve the local community in protecting and restoring the Hatchie River Watershed. The TNC has created a five year plan designed to reduce sediment flows to the river and protect important bottomland forest habitat. Support from the Save Wild Tennessee Campaign will help the West Tennessee staff:

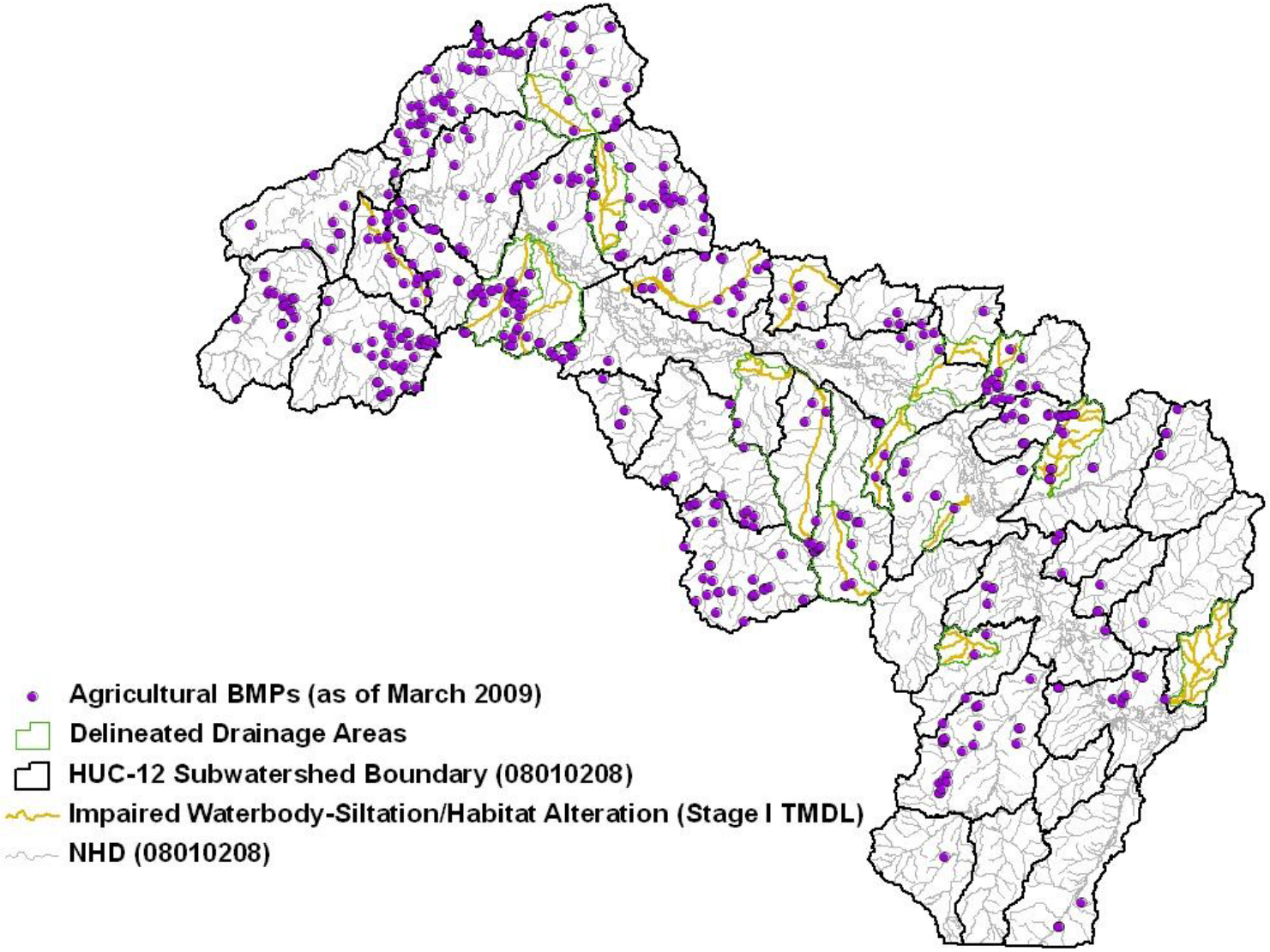
- Launch a pioneering tributary restoration project throughout the Lower Hatchie River Watershed as well as in watersheds throughout West Tennessee.
- Work with U.S. Fish and Wildlife Service to more than double the size of the Lower Hatchie National Wildlife Refuge in Tipton and Lauderdale Counties.
- Conduct aggressive species monitoring for mussel populations, the alligator snapping turtle and the northern madtom.

For more information please visit:
http://www.nature.org/wherewework/northamerica/states/tennessee/preserves/art10171.html

9.3 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 subwatershed. 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 TDA Best Management Practices in the Lower Hatchie River Watershed



10.0 PUBLIC PARTICIPATION

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

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

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was in one of the NPDES permit Public Notice announcements, which was sent to approximately 200 interested persons or groups who have requested this information.

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

TN0072541	Memphis Stone & Gravel Company
TN0079154	Delashmit Hauling - Jones Pit
TNG110109	51 Concrete Ripley Ready Mix Plant

4) A letter was sent to identified water quality partners in the Lower Hatchie River Watershed advising them of the proposed sediment TMDLs and their availability on the TDEC website and invited comments. These partners include:

Natural Resources Conservation Service
Tennessee Department of Agriculture
The Nature Conservancy
Friends of West Tennessee Refuges
West Tennessee River Basin Authority
United States Geological Survey

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

TNS075191	Brownsville
TNS075604	Madison County
TNS077585	Tennessee Department of Transportation

11.0 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:

Keli P. McInnes, Watershed Management Section
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Sherry H. Wang, Ph.D., Watershed Management Section
E-mail: Sherry.Wang@tn.gov

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APPENDIX A

Example Stream Assessment (Richland Creek)

Figure A-1 Richland Creek at RM 1.5, Stream Survey (4 Pages)

REAM SURVEY INFORMATION — STORET# RICHL_001.5 HY

REAM: Richland Creek
REAM LOCATION: U/S Hillville Vildo Rd.

UNTY CODE:(FIPS) 38 FIPOTS FIELD#
JOR BASIN Hatchie River
BID#/HUC:
BID NAME:
T/LONG DEG:
T/LONG DEC:
GS QUAD:
ains to: Hatchie R. rm rm
OLOGICAL SUBREGION: Loess Plains (74B)
BJECTIVES: Watershed Assess

ASSESSORS: ASF JJN
DATE: 3/31/00
TIME: 9:12
STREAM MILE: 1.5
STREAM ORDER:
REACH FILE #
3Q20:
ELEVATION (ft):

AMPLES COLLECTED — METERS USED:

IEMICALS Y or N Life Assessed? Macroinvertebrates Fish Algae Other:
ditional List Attached? Yes / No Samples returned ? Y or N Sampling Method:

ELD ANALYSIS:

	6.63	SU	
ONDUCTIVITY 78.0	12.54	UMHOS	
MPERATURE	12.58	C	

DISSOLVED OXYGEN 9.30 PPM
TIME 0912
OTHERS

evious 48 hours Precip: UNKNOWN NONE LITTLE MODERATE HEAVY FLOODING
nbient Weather: SUNNY CLOUDY BREEZY RAIN SNOW

flow < 0.5

ATERSHED CHARACTERISTICS App. % of watershed observed:

PSTREAM SURROUNDING LAND USE: (estimated %)

ASTURE		URBAN		RESID	
ROPS	95%	INDUSTRY		OTHER	
OREST	5%	MINING			

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

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

HYSICAL STREAM CHARACTERISTICS — LENGTH OF STREAM AREA ASSESSED (m):

URROUNDING LAND USE (facing downstream) :

STIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
ASTURE	8		URBAN			RESID.		
ROPS	95	95	INDUSTRY			OTHER		
OREST	5	5	MINING					

% CANOPY COVER: 15 Open(0-10) Partly Shaded(11-45) Mostly Shaded(46-80) Shaded(>80)
ANK HEIGHT (m): 3 HIGH WATER MARK (m): 0.5 m

EDIMENT DEPOSITS: NONE SLIGHT MODERATE EXCESSIVE BLANKET
TYPE: SLUDGE MUD SAND SILT NONE OTHER Contaminated Y or N
URBIDITY CLEAR SLIGHT MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? NONE SLIGHT MODERATE CHOKING
QUATIC VEGET. ROOTED FLOATING TYPE
ADDITIONAL COMMENTS:(oil sheen, odor, colors) Inverts collected in very small areas of next zone. Most of stream bed filled with sand

Page 1

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)		0.02	0.05
WIDTH (m)		1.0	2.0
REACH LENGTH (m)		25	2.0

Staff Gauge/Bench Ht: _____
VELOCITY (CFS) _____
FLOW (CFS) _____
HABITAT ASSESSMENT SCORE #:
RR # _____ GP # _____

Gradient (sample reach): Flat Low Mode. High Cascade
Size (stream width) : V. Small (<1.5m) Small (1.5-3m) Med (3-10m) Large (10-25m) Very Lrg (>25m)

SUBSTRATE (%) (Visual estimates)

	RIFFLE	RUN	POOL		RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	%	CLAY (slick)	%	%	%
COBBLE (2.5-10")	%	%	%	SILT	%	5 %	05 %
GRAVEL (0.1-2.5")	%	%	%	DETRITUS (CPOM)	%	%	%
BEDROCK	%	%	%	MUCK-MUD (FPOM)	%	%	%
SAND (gritty)	%	95 %	95 %	MARL (shell frags.)	%	%	%

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES: _____

RELATIVE ABUNDANCE OF TAXA HABITAT

DOMINANT (>=50): _____
VERY ABUND.(30-49): _____
ABUNDANT (10-29): _____
COMMON (3-9): _____
RARE (<3): _____

STREAM USE SUPPORT: SPECIFICALLY CLASSIFIED FOR: (circle)

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

WATER WITHDRAWL NOTED N

IS STREAM POSTED? (circle) Fish Tissue Advis.: Do Not Consume Precautionary
Bacteriological Advis.

BASED ON OBSERVATIONS AND DATA, STREAM IS:(circle)

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

COMMENTS: photos? Y or N Roll # Photo #

STREAM SKETCH

DRAFT REVISION—July 28, 1997

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME Richland Creek	LOCATION u/s Hillville - Villo Rd.	
STATION # _____ RIVERMILE _____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN Hatchie River	
STORET #	AGENCY WPC	
INVESTIGATORS AJF JJW		
FORM COMPLETED BY JJW	DATE 3/31/00 TIME _____ AM PM	REASON FOR SURVEY Watershed Assess.

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 (1) 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 (6)	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 (2) 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 (2) 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 (2) 1 0

13

DRAFT REVISION—July 28, 1997

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 7 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 7 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 8 (LB)	Left Bank 10	8 7 6	5 4 3	2 1 0
SCORE 7 (RB)	Right Bank 10	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 63

Figure A-2 Upstream View of Richland Creek at RM 1.5 – March 31, 2000

Figure A-3 Downstream View of Richland Creek at RM 1.5 – March 31, 2000

APPENDIX B

Watershed Sediment Loading Model

WATERSHED SEDIMENT LOADING MODEL

Determination of target average annual sediment loading values for reference watersheds and the sediment loading analysis of waterbodies impaired for siltation/habitat alteration was accomplished utilizing the Watershed Characterization System (WCS) Sediment Tool (v.3). WCS is an ArcView geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development. WCS consists of an initial set of spatial and tabular watershed data, stored in a database, and allows the incorporation of additional data when available. It provides a number of reporting tools and data management utilities to allow users to analyze and summarize data. Program extensions, such as the sediment tool, expand the functionality of WCS to include modeling and other more rigorous forms of data analysis (USEPA, 2001).

Sediment Analysis

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

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

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

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

Sediment analyses can be performed for single or multiple watersheds.

Universal Soil Loss Equation

Erosion potential is based on the Universal Soil Loss Equation (USLE), developed by Agriculture Research Station (ARS) scientists W. Wischmeier and D. Smith. It has been the most widely accepted and utilized soil loss equation for over 30 years. The USLE is a method to predict the average annual soil loss on a field slope based on rainfall pattern, soil type, topography, crop system and management practices. The USLE only predicts the amount of soil loss resulting from sheet or rill erosion on a single slope and does not account for soil losses that might occur from gully, wind, or tillage erosion. Designed as a model for use with certain cropping and management systems, it is also applicable to non-agricultural situations (OMAFRA, 2000). While the USLE can

be used to estimate long-term average annual soil loss, it cannot be applied to a specific year or a specific storm. Based on its long history of use and wide acceptance by the forestry and agricultural communities, the USLE was considered to be an adequate tool for estimating the relative long-term average annual soil erosion of watersheds and evaluating the effects of land use changes and implementation of BMP measures.

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

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

where:

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

Evaluating the factors in USLE:

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

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

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

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

<u>LS - Topographic Factor</u>

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

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

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

P - Conservation Practice Factor

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

Estimates of the USLE parameters, and thus the soil erosion as computed from the USLE, are provided by the Natural Resources Conservation Service's (NRCS) National Resources Inventory (NRI) 1994. The NRI database contains information of the status, condition, and trend of soil, water and related resources collected from approximately 800,000 sampling points across the country.

The soil losses from the erosion processes described above are localized losses and not the total amount of sediment that reaches the stream. The fraction of the soil lost in the field that is eventually delivered to the stream depends on several factors. These include, the distance of the source area from the stream, the size of the drainage area, and the intensity and frequency of rainfall. Soil losses along the riparian areas will be delivered into the stream with runoff-producing rainfall.

Sediment Modeling Methodology

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

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

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

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

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

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

2. The watershed was delineated into subwatersheds containing impaired headwater or tributary streams. These delineations are shown in Figure 4. All of the sediment analyses

were performed on the basis of these subwatersheds. Land use distribution for the impaired subwatersheds is summarized in Appendix C.

The following steps are accomplished using the WCS Sediment Tool:

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

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

5. For each 30 by 30 meter grid cell within the subwatershed, the Sediment Tool calculates the potential erosion using the USLE based on the specific cell characteristics. The model then calculates the potential sediment delivery to the stream grid network. Sediment delivery can be calculated using one of the four available sediment delivery equations:

   - Distance-based equation (Sun and McNulty, 1998)
     Mad = M * (1-0.97 * D/L)
     L = 5.1 + 1.79 * M
     where: Mad = mass moved from each cell to closest stream network (tons/acre/yr)
     M = sediment mass eroded (ton)
     D = least cost distance from a cell to the nearest stream grid (ft)
     L = maximum distance the sediment may travel (ft)

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

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

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

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

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

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

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

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

   Calculated erosion, sediment loads delivered to surface waters and unit loads (per unit area) for subwatersheds that contain Stage I waters on the *2008 303(d) List* as impaired for siltation and/or habitat alteration are summarized in Tables B-1, B-2, and B-3, respectively.

Table B-1 Calculated Erosion - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Stage I)

HUC-12 Subwatershed (08010208__) or Drainage Area	*EROSION*				
	Road [tons/yr]	Source [tons/yr]	Total [tons/yr]	%Road	%Source
Wade Creek DA	1,365.9	2,594.6	3,960.5	34.5	65.5
Potters Creek DA	382.9	3,594.4	3,977.3	9.6	90.4
Dry Creek DA	1,270.6	18,655.8	19,926.4	6.4	93.6
Bear Creek DA	1,949.1	12,628.7	14,577.8	13.4	86.6
Turkey Branch DA	470.3	12,422.8	12,893.1	3.6	96.4
Gamble Branch DA	168.0	1,673.7	1,841.7	9.1	90.9
0506	3,577.7	34,013.9	37,591.6	9.5	90.5
Poplar Creek DA	4,123.4	50,403.7	54,527.1	7.6	92.4
Jeffers Creek DA	1,031.9	19,532.0	20,563.9	5.0	95.0
Richland Creek DA (0509)	872.4	6,235.0	7,107.4	12.3	87.7
0510	4,880.7	124,980.0	129,860.7	3.8	96.2
Hyde Creek DA	3,666.0	14,298.5	17,964.5	20.4	79.6
Camp Creek DA	1,156.2	33,857.1	35,013.3	3.3	96.7
Flat Creek DA	1,197.0	41,595.0	42,792.0	2.8	97.2
Richland Creek DA (0802)	1,579.5	37,441.6	39,021.1	4.0	96.0
0805	3,100.6	43,677.5	46,778.1	6.6	93.4

Table B-2 Calculated Sediment Delivery to Surface Waters – Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Stage I)

HUC-12 Subwatershed (08010208__) or Drainage Area	*SEDIMENT*				
	Road	Source	Total	%Road	%Source
	[tons/yr]	[tons/yr]	[tons/yr]		
Wade Creek DA	493.7	1,252.8	1,746.5	28.3	71.7
Potters Creek DA	147.1	1,359.6	1,506.6	9.8	90.2
Dry Creek DA	437.5	6,515.0	6,952.5	6.3	93.7
Bear Creek DA	836.4	4,511.3	5,347.6	15.6	84.4
Turkey Branch DA	239.8	4,132.5	4,372.3	5.5	94.5
Gamble Branch DA	88.0	759.7	847.7	10.4	89.6
0506	1,584.9	11,724.9	13,309.8	11.9	88.1
Poplar Creek DA	1,656.4	16,749.2	18,405.6	9.0	91.0
Jeffers Creek DA	223.4	4,342.6	4,566.0	4.9	95.1
Richland Creek DA (0509)	392.3	1,991.2	2,383.6	16.5	83.5
0510	1,450.1	30,336.0	31,786.1	4.6	95.4
Hyde Creek DA	1,655.1	4,932.7	6,587.8	25.1	74.9
Camp Creek DA	466.0	10,801.2	11,267.2	4.1	95.9
Flat Creek DA	387.9	13,521.6	13,909.5	2.8	97.2
Richland Creek DA (0802)	454.3	10,985.6	11,439.9	4.0	96.0
0805	1,215.3	16,901.5	18,116.8	6.7	93.3

Table B-3 Unit Loads - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Stage I)

HUC-12 Subwatershed (08010208__) or Drainage Area	Area	*UNIT LOADS*			
		Erosion		Sediment	
	[acres]	[tons/ac/yr]	[lbs/ac/yr]	[tons/ac/yr]	[lbs/ac/yr]
Wade Creek DA	8,522	0.465	929	0.205	410
Potters Creek DA	3,680	1.081	2,162	0.409	819
Dry Creek DA	7,586	2.627	5,253	0.916	1,833
Bear Creek DA	8,952	1.628	3,257	0.597	1,195
Turkey Branch DA	2,684	4.804	9,607	1.629	3,258
Gamble Branch DA	1,550	1.188	2,376	0.547	1,094
0506	10,550	3.563	7,126	1.262	2,523
Poplar Creek DA	27,293	1.998	3,996	0.674	1,349
Jeffers Creek DA	8,383	2.453	4,906	0.545	1,089
Richland Creek DA (0509)	5,317	1.337	2,673	0.448	897
0510	21,342	6.085	12,169	1.489	2,979
Hyde Creek DA	6,772	2.653	5,306	0.973	1,946
Camp Creek DA	6,867	5.099	10,198	1.641	3,282
Flat Creek DA	10,396	4.116	8,232	1.338	2,676
Richland Creek DA (0802)	12,377	3.153	6,305	0.924	1,849
0805	12,490	3.745	7,490	1.451	2,901

APPENDIX C

MRLC Land Use of Stage I Impaired Subwatersheds and Drainage Areas

Table C-1 Lower Hatchie River Watershed – Stage I Impaired Subwatershed Land Use Distribution

Land Use	Impaired Subwatershed (08010208____) or Drainage Area							
	Wade Creek DA		Potters Creek DA		Dry Creek DA		Bear Creek DA	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Open Water	21	0.25	19	0.52	3	0.04	76	0.85
Low Intensity Residential	25	0.29	0	0	0	0	0	0
High Intensity Residential	2	0.02	0	0	0	0	0	0
High Intensity Commercial/Industrial/ Transportation	4	0.05	0	0	2	0.03	1	0.01
Bare Rock/Sand Clay	0	0	0	0	0	0	0	0
Quarries/Strip Mines/ Gravel Pits	0	0	0	0	0	0	0	0
Transitional	3	0.04	3	0.08	6	0.08	59	0.66
Deciduous Forest	5,184	60.83	1,453	39.48	2,999	39.53	1,628	18.19
Evergreen Forest	995	11.68	89	2.42	183	2.41	71	0.79
Mixed Forest	970	11.38	370	10.05	492	6.49	337	3.76
Pasture/Hay	506	5.94	1,087	29.54	1,401	18.47	4,467	49.90
Row Crops	753	8.84	661	17.96	2,466	32.51	2,279	25.46
Small Grains	0	0	0	0	0	0	0	0
Other Grasses (Urban/recreational)	0	0	0	0	0	0	0	0
Woody Wetlands	61	0.72	0	0	34	0.45	33	0.37
Emergent Herbaceous Wetlands	0	0.00	0	0	0	0	0	0
Urban	34	0.40	3	0.08	8	0.11	60	0.67
Agriculture	1,259	14.77	1,748	47.50	3,867	50.98	6,746	75.36
Forest	7,210	84.60	1,912	51.96	3,708	48.88	2,069	23.11
Open Water	21	0.25	19	0.52	3	0.04	76	0.85
Total	**8,522**	**100.00**	**3,680**	**100.00**	**7,586**	**100.00**	**8,952**	**100.00**

Table C-1 (Cont.) Lower Hatchie River Watershed – Stage I Impaired Subwatershed Land Use Distribution

Land Use	Impaired Subwatershed (08010208____) or Drainage Area							
	Turkey Branch DA		Gamble Branch DA		0506		Poplar Creek DA	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Open Water	0	0	5	0.32	73	0.69	277	1.01
Low Intensity Residential	0	0	0	0	788	7.47	39	0.14
High Intensity Residential	0	0	0	0	281	2.66	0	0
High Intensity Commercial/Industrial/ Transportation	1	0.04	0	0	209	1.98	89	0.33
Bare Rock/Sand Clay	0	0	0	0	0	0.00	0	0
Quarries/Strip Mines/ Gravel Pits	0	0	0	0	0	0	0	0
Transitional	0	0	38	2.45	9	0.09	35	0.13
Deciduous Forest	199	7.41	722	46.58	1,349	12.79	3,616	13.25
Evergreen Forest	33	1.23	23	1.48	105	1.00	252	0.92
Mixed Forest	193	7.19	150	9.68	796	7.55	1,684	6.17
Pasture/Hay	686	25.56	397	25.61	2,330	22.09	6,809	24.95
Row Crops	1,564	58.27	214	13.81	4,478	42.45	10,466	38.35
Small Grains	0	0	0	0	0	0	201	0.74
Other Grasses (Urban/recreational)	0	0	0	0	97	0.92	432	1.58
Woody Wetlands	8	0.30	0	0	34	0.32	3,390	12.42
Emergent Herbaceous Wetlands	0	0	0	0	0	0	4	0.01
Subtotal-Urban	1	0.04	38	2.45	1,287	12.20	163	0.60
Subtotal-Agriculture	2,250	83.83	611	39.42	6,808	64.53	17,476	64.03
Subtotal-Forest	433	16.13	895	57.74	2,381	22.57	9,378	34.36
Open Water	0	0.00	5	0.32	73	0.69	277	1.01
Total	**2,684**	**100.00**	**1,550**	**100.00**	**10,550**	**100.00**	**27,293**	**100.00**

Table C-1 (Cont.) Lower Hatchie River Watershed – Stage I Impaired Subwatershed Land Use Distribution

Land Use	Impaired Subwatershed (08010208____) or Drainage Area							
	Jeffers Creek DA		Richland Creek DA (0509)		0510		Hyde Creek DA	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Open Water	70	0.84	22	0.41	89	0.42	66	0.97
Low Intensity Residential	0	0	0	0	18	0.08	953	14.07
High Intensity Residential	0	0	0	0	3	0.01	426	6.29
High Intensity Commercial/Industrial/ Transportation	0	0	1	0.02	14	0.07	196	2.89
Bare Rock/Sand Clay	0	0	0	0	0	0	0	0
Quarries/Strip Mines/ Gravel Pits	0	0	0	0	0	0	0	0
Transitional	0	0	34	0.64	2	0.01	16	0.24
Deciduous Forest	796	9.50	1,924	36.19	1,633	7.65	777	11.47
Evergreen Forest	64	0.76	155	2.92	67	0.31	63	0.93
Mixed Forest	215	2.56	609	11.45	473	2.22	397	5.86
Pasture/Hay	818	9.76	1,442	27.12	3,124	14.64	1,668	24.63
Row Crops	2,887	34.44	1,042	19.60	14,259	66.81	2,111	31.17
Small Grains	0	0	0	0	0	0	0	0
Other Grasses (Urban/recreational)	0	0	0	0	1	0	98	1.45
Woody Wetlands	3,533	42.14	86	1.62	1,660	7.78	0	0
Emergent Herbaceous Wetlands	0	0	1	0.02	0	0	0	0
Urban	0	0	35	0.66	37	0.17	1,591	23.49
Agriculture	3,705	44.20	2,484	46.72	17,383	81.45	3,779	55.80
Forest	4,608	54.97	2,775	52.19	3,834	17.96	1,335	19.71
Open Water	70	0.84	22	0.41	89	0.42	66	0.97
Total	**8,383**	**100.00**	**5,317**	**100.00**	**21,342**	**100.00**	**6,772**	**100.00**

Table C-1 (Cont.) Lower Hatchie River Watershed – Stage I Impaired Subwatershed Land Use Distribution

Land Use	Impaired Subwatershed (08010208____) or Drainage Area							
	Camp Creek DA		Flat Creek DA		Richland Creek DA (0802)		0805	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Open Water	10	0.15	17	0.16	17	0.14	43	0.34
Low Intensity Residential	0	0	3	0.03	4	0.03	39	0.31
High Intensity Residential	0	0	0	0	0	0	51	0.41
High Intensity Commercial/Industrial/ Transportation	1	0.01	15	0.14	11	0.09	12	0.10
Bare Rock/Sand Clay	0	0	0	0	0	0	0	0
Quarries/Strip Mines/ Gravel Pits	0	0	0	0	0	0	0	0
Transitional	3	0.04		0.00	0	0	3	0.02
Deciduous Forest	663	9.65	498	4.79	1,337	10.80	1,592	12.75
Evergreen Forest	17	0.25	20	0.19	32	0.26	101	0.81
Mixed Forest	174	2.53	164	1.58	504	4.07	1,186	9.50
Pasture/Hay	1,208	17.59	1,461	14.05	1,852	14.96	2,810	22.50
Row Crops	4,578	66.67	8,054	77.47	8,289	66.97	6,631	53.09
Small Grains	35	0.51	0	0	0	0	0	0
Other Grasses (Urban/recreational)	0	0	113	1.09	0	0	4	0.03
Woody Wetlands	179	2.61	50	0.48	330	2.67	19	0.15
Emergent Herbaceous Wetlands	0	0	0	0	0	0	0	0
Urban	4	0.06	18	0.17	15	0.12	105	0.84
Agriculture	5,821	84.77	9,515	91.53	10,141	81.93	9,441	75.59
Forest	1,033	15.04	845	8.13	2,203	17.80	2,902	23.23
Open Water	10	0.15	17	0.16	17	0.14	43	0.34
Total	**6,867**	**100.00**	**10,396**	**100.00**	**12,377**	**100.00**	**12,490**	**100.00**

APPENDIX D

Sediment Loading Analysis Methodology for Development of Stage I TMDLs, WLAs, & LAs

Sediment Loading Analysis

Sediment loading analysis was conducted on impaired subwatersheds using the Watershed Characterization System (WCS) Sediment Tool (for the purposes of this document, impaired subwatersheds are 12-digit hydrologic unit code (HUC-12) subwatershed containing waterbodies identified as impaired due to siltation and/or habitat alteration on the 2008 303(d) List). This ArcView geographic information system (GIS) based model is described in Appendix B and was utilized to develop TMDLs, WLAs for MS4s, and LAs for nonpoint sources according to the procedure described below:

Development of TMDLs

1. As stated in Section 5.0, the WCS Sediment Tool was used to determine sediment loading to Level IV ecoregion reference site watersheds. These are considered to be biologically healthy watersheds and serve as appropriate targets for TMDL development (ref.: Table 4). The targets are expressed as average annual instream sediment loads per unit drainage area (lbs/ac/yr).

   In cases where impaired subwatersheds are located in more than one Level IV ecoregion, an area-weighted target load was determined by the following:

$$\text{Target}_{SubWS} = \frac{[(\text{Target}_{65e})\,(A_{65e}) + (\text{Target}_{74a})\,(A_{74a}) + (\text{Target}_{74b})\,(A_{74b})]}{[(A_{65e}) + (A_{74a}) + (A_{74b})]}$$

   where:

   Target_{65e} = Target for Level IV ecoregion 65e [lbs/ac/yr] (See Table 4)

   Target_{74a} = Target for Level IV ecoregion 74a [lbs/ac/yr] (See Table 4)

   Target_{74b} = Target for Level IV ecoregion 74b [lbs/ac/yr] (See Table 4)

   A_{65e} = Area of subwatershed or drainage area in Level IV ecoregion 65e [acres]

   A_{74a} = Area of subwatershed or drainage area in Level IV ecoregion 74a [acres]

   A_{74b} = Area of subwatershed or drainage area in Level IV ecoregion 74b [acres]

2. The Sediment Tool was also used to determine the existing average annual instream sediment loads of impaired subwatersheds (ref.: Tables B-1, B-2, & B-3). As with the ecoregion targets, the existing loads were normalized to subwatershed area.

3. The existing average annual instream sediment load of each impaired subwatershed was compared to the average annual instream sediment load of the appropriate reference (biologically healthy) watershed and an <u>overall</u> required percent reduction in instream sediment loading calculated:

$$(\text{Required Reduction})_{Overall} = \frac{(\text{Existing Load}) - (\text{Target Load})}{(\text{Existing Load})} \times 100$$

WLAs for Ready Mix Concrete Facilities and Mining Sites

4. In each impaired subwatershed, 5% of the ecoregion-based target load was reserved for WLAs for discharges from NPDES permitted Ready Mix Concrete Facilities (RMCFs) and mining sites. WLAs for existing facilities were considered to be equal to existing NPDES permit limits, which are expressed as daily maximum TSS concentrations. The estimated existing loads from these facilities were verified to be less than the five percent reserved in each impaired subwatershed or drainage area (see Appendix E). Any difference between the existing load and the 5% reserved load in each subwatershed provide capacity for future facilities. The Division of Water Pollution Control (DWPC) Mining Section will manage the permitting of individual mining sites to ensure that the overall WLA is not exceeded within each impaired subwatershed or drainage area.

WLAs for NPDES Regulated Construction Stormwater (CSW) Discharges

5. In each impaired subwatershed, a portion of the ecoregion-based target load was also reserved for WLAs for NPDES permitted stormwater discharges from construction sites (see Appendix F). The *Environmental Assessment for Proposed Effluent Guidelines and Standards for the Construction and Development Category* (USEPA, 2002) states that the *Economic Analysis of the Final Phase II Stormwater Rule* (USEPA, 1999a), estimated that, "in the absence of controls, construction sites on average generate approximately 40 tons of TSS per acre per year. In addition the Phase II Economic Analysis estimated that properly designed, installed, and maintained erosion and sediment (E & S) control BMPs, in combination, can potentially achieve a 90 to 95 percent reduction in sediment runoff" (USEPA, 2002). Based on this, a technology-based WLA equal to 6,000 lbs/ac/yr was selected for NPDES permitted stormwater discharges from construction sites. This WLA is interpreted as erosion from the construction site.

   Note: The WLA was converted to the equivalent instream sediment load and normalized to the impaired subwatershed area, in order to facilitate mass balance calculations (see Appendix F).

WLAs for MS4s and LAs for Nonpoint Sources

6. The allowable load for discharges from MS4s and nonpoint sources can be derived from the basic equation:

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

This equation can be expressed as:

$$Load_{TMDL} = Load_{RMCF} + Load_{Mining} + Load_{CSW} + Load_{MS4} + Load_{NPS} + MOS$$

Substituting:

$Load_{TMDL}$ = (Target) (A_{SubWS})

$Load_{RMCF} + Load_{Mining}$ = (0.05) ($Load_{TMDL}$) [ref.: Step 4]

$Load_{CSW}$ = $(Equiv.\ Load)_{CSW}$ (A_{SubWS}) [equivalent instream load, ref.: Step 5]

$Load_{MS4}$ = $(Unit\ Load)_{MS4}$ (A_{MS4})

$Load_{NPS}$ = $(Unit\ Load)_{NPS}$ (A_{NPS})

MOS = 0, due to an implicit margin of safety

where:

Unit Load = Load per unit area [lbs/ac]

A_{SubWS} = Area of impaired subwatershed or drainage area [acres]

A_{MS4} = Area associated with the MS4 [acres]

A_{NPS} = Area associated with nonpoint source loading [acres]

Specifying that:

$(Unit\ Load)_{MS4} = (Unit\ Load)_{NPS}$

The equation can be solved for the allowable unit load for MS4s and nonpoint sources:

$$(Unit\ Load)_{NPS,MS4} = \frac{(Target)\ (A_{SubWS}) - [(0.05)\ (Target)\ (A_{SubWS})] - (Equiv.\ Load)_{CSW}(A_{SubWS})}{(A_{MS4} + A_{NPS})}$$

Noting that:

$$(A_{MS4}) + (A_{NPS}) = (A_{SubWS}) - (A_{CSW}) - (A_{RMCF}) - (A_{Mining}) = (A_{SubWS})\ (1 - \%_{CSW} - \%_{RMCF\&Mining})$$

where:

($\%_{CSW}$) = Fraction of subwatershed or drainage area considered to be disturbed by construction activities at any time (see Appendix F).

$(\%_{RMCF\&Mining})$ = Fraction of subwatershed or drainage area associated with RMCF and/or mining operations (see Appendix E).

The resulting equation for the allowable unit load for MS4s and nonpoint sources is:

$$(\text{Unit Load})_{NPS,MS4} = \frac{(\text{Target})\,(A_{SubWS}) - [(0.05)\,(\text{Target})\,(A_{SubWS})] - (\text{Equiv. Load})_{CSW}\,A_{SubWS})}{(A_{SubWS})\,(1 - \%_{CSW} - \%_{RMCF\&Mining})}$$

Simplifying:

$$(\text{Unit Load})_{NPS,MS4} = \frac{[(0.95)\,(\text{Target})] - (\text{Equiv. Load})_{CSW}}{(1 - \%_{CSW} - \%_{RMCF\&Mining})}$$

7. For each impaired subwatershed or drainage area, WLAs for MS4s and LAs for nonpoint sources were considered to be the percent load reduction required to decrease the existing average annual instream sediment unit load (Step 2) to the allowable unit load for MS4s and nonpoint sources calculated in Step 6.

$$WLA_{MS4s} = LA_{LAs} = \frac{(\text{Existing Load}) - (\text{Unit Load})_{NPS,MS4}}{(\text{Existing Load})} \times 100$$

TMDLs for impaired subwatersheds are summarized in Table D-2. WLAs for RMCFs, Mining activities, and construction stormwater discharges are shown in Tables E-1, E-2, and F-1 respectively. WLAs for MS4s and LAs for nonpoint sources are tabulated in Table D-3.

Daily Expression of TMDL, WLAs, & LAs

Current EPA guidance states that daily load expressions be included in TMDLs calculated using allocation time frames greater than daily (USEPA, 2007). In accordance with this guidance, daily expressions of TMDL, WLA, and LA loads were developed for all impaired subwatersheds and drainage areas.

TMDLs

An allowable daily load for each impaired subwatershed was determined by dividing the appropriate average annual instream target load (Step 1) by the average annual precipitation for the subwatershed. A composite average annual precipitation for each subwatershed or drainage area (Table D-1) was determined using a GIS coverage downloaded from the Natural Resources Conservation Service climate mapping website (USDA, 2007):

http://datagateway.nrcs.usda.gov/

The TMDL for each impaired subwatershed consists of: a) the required overall percent reduction in instream sediment loading and b) the allowable daily instream sediment load per unit area per inch of precipitation (lbs/ac/in. precipitation). TMDLs are summarized in Table D-2.

WLAs for Ready Mix Concrete Facilities and Mining Sites

WLAs for RMCFs and mining sites (Step 4) were considered to be equal to existing permit requirements, which, in each case, include daily maximum concentration limits.

WLAs for NPDES Regulated Construction Stormwater (CSW) Discharges

As with TMDLs, a daily expression of the WLA for construction stormwater activities was derived by dividing the allowable erosion load (Step 5) by the average annual precipitation for the subwatershed. The construction stormwater WLA for each impaired subwatershed consists of: a) the allowable technology-based average annual erosion load and b) the allowable daily erosion load per unit area per inch of precipitation (lbs/ac/in. precipitation).

WLAs for MS4s and LAs for Nonpoint Sources

A daily expression of the MS4 WLA and the LA for nonpoint sources was derived by dividing the allowable unit load (Step 6) by the average annual precipitation for the subwatershed. The MS4 WLA and LA for each impaired subwatershed consists of: a) the required percent reduction in instream sediment loading (Step 7) and b) the allowable daily instream load per unit area per inch of precipitation (lbs/ac/in. precipitation). Daily MS4 WLAs and LAs should be interpreted as per unit area of the MS4 or area associated with nonpoint source loading.

Subwatershed Load Accounting – Verification of Consistency of Allocations with TMDL

For each subwatershed, in order to verify that the sum of all WLAs and LAs are in accordance with the specified TMDL, the following method of load accounting was utilized for each subwatershed:

- The overall allowable load corresponding to the TMDL is equal to the target load (ref.: Table D-2) multiplied by the subwatershed area (ref.: Table C-1).

- The allowable load corresponding to the WLA for all RMCF and mining discharges is equal to 5% of the overall allowable load.

- The allowable load corresponding to the WLA for construction storm water discharges is equal to the "Instream Sediment Load Due to CSW" (ref.: Table F-1) multiplied by the subwatershed area (ref.: Table C-1).

- The allowable load corresponding to the WLA for MS4s and LA for nonpoint sources is equal to the $(\text{Unit Load})_{NPS,MS4}$ calculated in Step 6 multiplied by the area associated with these discharges. The area associated with MS4s and nonpoint sources is calculated by subtracting the RMCF area (ref.: Table E-1), the mining site area (ref.: Table E-2), and the estimated area disturbed by construction activities (1.5% of the subwatershed area – see Table F-1) from the total subwatershed area.

Subwatershed load accounting is shown in Table D-4.

Example Calculation for Subwatershed 080102080805 - TMDL, WLAs, & LAs

Step 1 Area-weighted target for ecoregions 74A & 74b:

$$\text{Target}_{0805} = \frac{[(710.4 \text{ lbs/ac/yr})\ (4{,}402 \text{ ac}) + (976.9 \text{ lbs/ac/yr})\ (8{,}088 \text{ ac})]}{[(4{,}402 \text{ ac}) + (8{,}088 \text{ ac})]} = 883.0 \text{ lbs/ac/yr}$$

Step 2 Erosion Unit Load = 7,490 lbs/ac/yr [ref.: Table B-3]
Sediment Unit Load (Instream) = 2,901 lbs/ac/yr [ref.: Table B-3]
Subwatershed Area = 12,490 acres [ref.: Table C-1]

Step 3

$$(\text{Required Reduction})_{\text{Overall}} = \frac{(2{,}901 \text{ lbs/ac/yr}) - (883.0 \text{ lbs/ac/yr})}{(2{,}901 \text{ lbs/ac/yr})} \times 100 = 69.6\%$$

Step 4 $(\text{WLA}_{\text{Overall}})_{\text{RMCF \& Mining}} = (0.05) \times (883.0 \text{ lbs/ac/yr}) = 44.2 \text{ lbs/ac/yr}$

$(\text{WLA}_{\text{Individual Facility}})_{\text{RMCF \& Mining}}$ = Existing Permit Requirements

Step 5 Percent of subwatershed area disturbed (used for calculations) = 1.5% [ref.: Table F-1]
Equivalent instream sediment unit load = 34.8 lbs/ac/yr [ref.: Table F-1]

Step 6 Area associated with RMCFs and mining operations = 116.5 acres [ref.: Tables E-1 & E-2]
Fraction of subwatershed area associated with RMCFs and mining operations:

$$\%_{\text{RMCF\&Mining}} = \frac{116.5 \text{ ac}}{12{,}490 \text{ ac}} = 0.0093$$

$$(\text{Unit Load})_{\text{NPS,MS4}} = \frac{[(0.95)\ (883.0 \text{ lbs/ac/yr})] - (34.8 \text{ lbs/ac/yr})}{[(1) - (0.0093) - (0.015)]} = 824.1 \text{ lbs/ac/yr}$$

Step 7

$$(\text{Required Reduction})_{\text{NPS,MS4}} = \frac{(2{,}901 \text{ lbs/ac/yr}) - (824.1 \text{ lbs/ac/yr})}{(2{,}901 \text{ lbs/ac/yr})} \times 100 = 71.6\%$$

Daily Expression of TMDL, WLAs, & LAs

Average annual precipitation = 53.0 in. precip./yr [ref.: Table D-1]

Note: Value for construction stormwater (CSW) is site erosion, all other values are instream sediment at the pour point of the subwatershed or drainage area.

TMDL: Daily Maximum Load = $\frac{(883.0 \text{ lbs/ac/yr})}{(53.0 \text{ in. precip./yr})}$ = 16.7 lbs/ac/in. precip.

Mining: Per NPDES Permit No. TN0072541 and TN0079154, Daily Maximum Limit for TSS = 40 mg/l [ref.: Table E-2]

Construction Stormwater (CSW):

Daily Maximum Load = $\frac{(6{,}000 \text{ lbs/ac/yr})}{(53.0 \text{ in. precip./yr})}$ = 113.2 lbs/ac/in. precip.

MS4s & Nonpoint Sources:

Daily Maximum Load = $\frac{(824.1 \text{ lbs/ac/yr})}{(53.0 \text{ in. precip./yr})}$ = 15.5 lbs/ac/in. precip.

Subwatershed Load Accounting – Verification of Consistency of Allocations with TMDL

Note: Calculations were performed using a spreadsheet. For purposes of these sample calculations, in order to avoid confusion, some values below reflect spreadsheet figures rather than rounded values used in Tables E-2 & F-1.

Overall Allowable Load = (883.0 lbs/ac/yr) (12, 490 ac) = 11,028,670 lbs/yr

$(\text{Load})_{\text{RMCF,Mining}}$ = (0.05) (11,028,670 lbs/yr) = 551,434 lbs/yr

$(\text{Load})_{\text{CSW}}$ = (34.83 lbs/ac/yr) (12,490 ac) = 435,027 lbs/yr

$(\text{Area})_{\text{NPS,MS4}}$ = (12,490 ac) – (116.5 ac) – [(0.015) (12,490 ac)] = 12,186 ac

$(\text{Load})_{\text{NPS,MS4}}$ = (824.0776 lbs/ac/yr) (12,186 ac) = 10,042,210 lbs/yr

Table D-1 Average Annual Precipitation for Impaired Subwatersheds

HUC-12 Subwatershed (08010208_____) or Drainage Area	Annual Average Precipitation [in/yr]
Wade Creek DA	56.0
Potters Creek DA	55.0
Dry Creek DA	55.0
Bear Creek DA	55.0
Turkey Branch DA	55.0
Gamble Branch DA	55.0
0506	53.0
Poplar Creek DA	54.1
Jeffers Creek DA	55.0
Richland Creek DA (0509)	55.0
0510	53.0
Hyde Creek DA	53.0
Camp Creek DA	53.0
Flat Creek DA	53.0
Richland Creek DA (0802)	53.0
0805	53.0

Table D-2 Stage I TMDLs for Impaired Subwatersheds

HUC-12 Subwatershed (08010208_____) or Drainage Area	Level IV Ecoregion	Subwatershed Area	Existing Load	Target Load	Overall Allowable Load	TMDL *	
						Required Load Reduction	Daily Maximum Load
		[acres]	[lbs/ac/yr]	[lbs/ac/yr]	[lbs/yr]	[%]	[lbs/ac/in. precip.]
Wade Creek DA	65e	8,522	410	355.8	3,032,128	13.2	6.4
Potters Creek DA	65e	3,680	819	355.8	1,309,344	56.5	6.5
Dry Creek DA	65e	7,586	1,833	355.8	2,699,099	80.6	6.5
Bear Creek DA	65e,74b	8,952	1,195	855.3	7,656,646	28.4	15.6
Turkey Branch DA	65e,74b	2,684	3,258	877.6	2,355,478	73.1	16.0
Gamble Branch DA	65e	1,550	1,094	355.8	551,490	67.5	6.5
0506	74b	10,550	2,523	976.9	10,306,295	61.3	18.4
Poplar Creek DA	74b	27,293	1,349	976.9	26,662,532	27.6	18.1
Jeffers Creek DA	65e,74b	8,383	1,089	814.7	6,829,630	25.2	14.8
Richland Creek DA (0509)	65e,74b	5,317	897	800.4	4,255,727	10.7	14.6
0510	74b	21,342	2,979	976.9	20,849,000	67.2	18.4
Hyde Creek DA	74a, 74b	6,772	1,946	834.5	5,651,234	57.1	15.7
Camp Creek DA	74b	6,867	3,282	976.9	6,708,372	70.2	18.4
Flat Creek DA	74b	10,396	2,676	976.9	10,155,852	63.5	18.4
Richland Creek DA (0802)	74b	12,377	1,849	976.9	12,091,091	47.2	18.4
0805	74a, 74b	12,490	2,901	883.0	11,028,670	69.6	16.7

* Applicable to instream sediment at pour point of subwatershed or drainage area.

Table D-3 Summary of Stage I WLAs & LAs

HUC-12 Subwatershed (08010208___) or Drainage Area	WLAs					LAs [c]	
	RMCFs & Mining	Construction Stormwater [b]		MS4 [c]		Required Reduction	Daily Maximum Load
	Overall Annual Average Load [a]	Annual Average Load	Daily Maximum Load	Required Reduction	Daily Maximum Load		
	[lbs/ac/yr]	[lbs/ac/yr]	[lbs/ac/in. precip.]	[%]	[lbs/ac/in. precip.]	[%]	[lbs/ac/in. precip.]
Wade Creek DA	17.8	6,000	107.1	26.1	5.4	26.1	5.4
Potters Creek DA	17.8	6,000	109.1	62.3	5.6	62.3	5.6
Dry Creek DA	17.8	6,000	109.1	83.0	5.7	83.0	5.7
Bear Creek DA	42.8	6,000	109.1	33.8	14.4	33.8	14.4
Turkey Branch DA	43.9	6,000	109.1	75.0	14.8	75.0	14.8
Gamble Branch DA	17.8	6,000	109.1	72.5	5.5	72.5	5.5
0506	48.8	6,000	113.2	63.9	17.2	63.9	17.2
Poplar Creek DA	48.8	6,000	110.9	32.4	16.8	32.4	16.8
Jeffers Creek DA	40.7	6,000	109.1	29.7	13.9	29.7	13.9
Richland Creek DA (0509)	40.0	6,000	109.1	17.4	13.5	17.4	13.5
0510	48.8	6,000	113.2	69.1	17.4	69.1	17.4
Hyde Creek DA	41.7	6,000	113.2	60.3	14.6	60.3	14.6
Camp Creek DA	48.8	6,000	113.2	72.2	17.2	72.2	17.2
Flat Creek DA	48.8	6,000	113.2	65.9	17.2	65.9	17.2
Richland Creek DA (0802)	48.8	6,000	113.2	50.5	17.3	50.5	17.3
0805	44.2	6,000	113.2	71.6	15.5	71.6	15.5

Notes: a. Value listed for each subwatershed is the overall WLA for all existing and future RMCF & mining operations. WLAs for existing individual facilities are equal to the requirements of their NPDES permit. Future facilities may be permitted as long as the overall WLA is not exceeded. RMCF and mining permits contain Daily Maximum concentration limits.
b. Applicable as site erosion per acre disturbed.
c. Applicable as instream sediment reduction at the pour point of the HUC-12 subwatershed.

Table D-4 Summary of Average Annual Allowable Loads

HUC-12 Subwatershed (08010208___) or Drainage Area	Overall Allowable Load	Overall RMCF and Mining WLAs	Overall CSW WLA	Overall Allowable Load for MS4s & Nonpoint Source
	[lbs/yr]	[lbs/yr]	[lbs/yr]	[lbs/yr]
Wade Creek DA	3,032,128	151,606	338,238	2,542,283
Potters Creek DA	1,309,344	65,467	125,525	1,118,352
Dry Creek DA	2,699,099	134,955	238,276	2,325,868
Bear Creek DA	7,656,646	382,832	295,685	6,978,129
Turkey Branch DA	2,355,478	117,774	81,889	2,155,816
Gamble Branch DA	551,490	27,575	64,170	459,746
0506	10,306,295	515,315	336,123	9,454,857
Poplar Creek DA	26,662,532	1,333,127	830,253	24,499,152
Jeffers Creek DA	6,829,630	341,482	167,492	6,320,656
Richland Creek DA (0509)	4,255,727	212,786	160,308	3,882,633
0510	20,849,000	1,042,450	470,591	19,335,959
Hyde Creek DA	5,651,234	282,562	223,679	5,144,993
Camp Creek DA	6,708,372	335,419	199,006	6,173,948
Flat Creek DA	10,155,852	507,793	304,083	9,343,977
Richland Creek DA (0802)	12,091,091	604,555	326,381	11,160,155
0805	11,028,670	551,434	435,027	10,042,210

APPENDIX E

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

Determination of Sediment Loads from Existing RMCFs & Mining Sites

In general, the total solids load discharged from NPDES-permitted ready mix concrete facilities (RMCFs) and mining sites located in impaired subwatersheds is small compared to the allowable target load. In order to demonstrate compliance with the overall WLA assigned to these facilities, existing solids loads were estimated using the procedure described below.

Ready Mixed Concrete Facilities (RMCFs)

Total loading from RMCFs is the sum of loading from both process wastewater and stormwater discharges. Estimates of loading (ref.: Table E-1) from RMCFs located in an impaired subwatershed were determined as described below.

The existing loading from process wastewater discharge for RMCFs is based on facility design flow, the daily maximum permit limit for TSS, and the area of the HUC-12 subwatershed in which the facilities are located. Loads are expressed as average annual loads per unit area and are summarized in Table E-1.

$$AAL_{RMCF} = \frac{(Q_d) \times (DMax)\ (8.34\ \text{lb-l/gal-mg})\ (365\ \text{days/yr})}{(A_{Subwatershed})}$$

where: AAL_{RMCF} = Average annual load [lb/ac/yr]
Q_d = Facility design flow [MGD]
DMax = Daily maximum concentration limit for TSS [mg/l]
$A_{Subwatershed}$= Area of impaired HUC-12 subwatershed or drainage area [acres]

The existing loading from stormwater runoff for RMCFs is based on an assumed runoff from the site drainage area, the benchmark concentration for TSS, and the area of the HUC-12 subwatershed or drainage area in which each facility is located (ref.: Table C-1). Site runoff was estimated by assuming that one-half of the annual precipitation falling on the site drainage area results in runoff. Annual precipitation for subwatersheds in the Lower Hatchie River Watershed is shown in Table D-1.

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

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

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

HUC-12 Subwatershed (08010208__) or Drainage Area	Subwatershed Area	NPDES Permit No.	Process Wastewater			Stormwater Runoff			Total Average Annual Load
			Estimated Flow	Daily Maximum TSS Limit	Average Annual Load	Site Drainage Area	TSS Benchmark Concentration	Average Annual Load	
			[MGD]	[mg/l]	[lb/ac/yr]	[acres]	[mg/l]	[lb/ac/yr]	[lb/ac/yr]
Hyde Creek DA	6,772	TNG110109	0.0001	50	0.0022	6	150	0.7981	0.8003

Mining Sites

Existing loads for permitted mining sites are based on an assumed runoff from the site drainage area, the daily maximum permit limit for TSS, and the area of the HUC-12 subwatershed or drainage area in which the mining site is located (ref.: Table E-2). Site runoff was estimated by assuming that one half of the annual precipitation falling on the site area results in runoff. Annual precipitation for impaired subwatersheds in the Lower Hatchie River Watershed is shown in Table D-1.

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

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

Table E-2 Estimate of Existing Loads - NPDES Permitted Mining Sites

HUC-12 Subwatershed (08010208___) or Drainage Area	Subwatershed Area	NPDES Permit No.	Site Drainage Area	Daily Maximum TSS Limit	Average Annual Load
	[acres]		[acres]	[mg/l]	[lb/ac/yr]
0805	12,490	TN0072541	102.0	40	1.9616
		TN0079154	14.5	40	0.2789

Total Existing Point Source Loads for Impaired Subwatersheds

Estimated point source loads were summed for each impaired subwatershed and then compared to both existing and target subwatershed sediment loads (ref.: Table E-3). It should be noted that in each case, the estimated load from existing facilities is less than one percent of the subwatershed target load.

Table E-3 Estimate of Existing Subwatershed Loads from RMCFs & Mining Sites

HUC-12 Subwatershed (08010208__) or Drainage Area	NPDES Permit No.	Facility Type	Average Annual Point Source Load	Existing Subwatershed Load	Point Source Percentage of Existing Load	Subwatershed Target Load	Point Source Percentage of Target Load
			[lb/ac/yr]	[lb/ac/yr]	[%]	[lb/ac/yr]	[%]
Hyde Creek DA	TNG110109	RMCF	**0.800**	**1,945.6**	**0.04**	**834.5**	**0.10**
0805	TN0072541	Mining	1.962				
	TN0079154	Mining	0.279				
	Subwatershed Total		**2.240**	**2,901.0**	**0.08**	**355.8**	**0.63**

APPENDIX F

Waste Load Allocations for NPDES Permitted Construction Stormwater Sites

Waste Load Allocations (WLAs) for Stormwater Discharges from Construction Sites

In the description of the WCS Sediment Tool in Appendix B, it was stated that model output consists of both erosion and sediment parameters. The composite erosion value is the estimated erosion from road and land cover, while the composite sediment parameter is the fraction of soil erosion from road and land cover that is delivered to the stream network. The composite sediment value for a subwatershed represents the instream sediment load at the "pour point" of the subwatershed. TMDLs, WLAs, and LAs are primarily developed from composite sediment values. WLAs assigned to construction stormwater (CSW) sites are an exception, however, in that the WLAs are technology-based and interpreted as erosion from construction sites.

In the *Environmental Assessment for Proposed Effluent Guidelines and Standards for the Construction and Development Category* (USEPA, 2002), it is stated that

> EPA's methodology for estimating construction site pollutant loadings builds upon the methodology used in the *Economic Analysis of the Final Phase II Stormwater Rule* (USEPA, 1999a). ·····
>
> The Phase II EA estimated that in the absence of any controls, construction sites on average generate approximately 40 tons of TSS per acre per year. In addition, the Phase II EA estimated that properly designed, installed and maintained erosion and sediment (E&S) control BMPs, in combination, can potentially achieve a 90 to 95 percent reduction in sediment runoff.

This indicates that TSS discharges from CSW sites with properly designed, installed, and maintained erosion and sediment control BMPs should range from 4,000 lbs/ac/yr to 8,000 lbs/ac/yr. An erosion load of 6,000 lbs/ac/yr was selected an achievable, technology-based WLA for construction activities. A "daily expression" of the technology-based WLA was determined by dividing the allowable erosion load by the Average Annual precipitation for each impaired subwatershed or drainage area (see Table D-1).

In order to account for the WLA assigned to CSW sites, the following procedure was used (HUC-12 subwatershed 080102080805 used as an example):

1. The total disturbed area of all permitted construction stormwater sites in an impaired subwatershed was determined from permit records and the percent of total subwatershed area disturbed calculated.

$$\%(A)_{CSW} = \frac{\Sigma\, A_{CSW}}{A_{Subwatershed}} \times (100)$$

For subwatershed 080102080805:

$$\%(A)_{CSW} = \frac{(8.8 \text{ acres})}{(12{,}490 \text{ acres})} \times (100) = 0.07\%$$

2. In order to account for the transitory nature of construction activities, the area disturbed due to permitted construction activities, used in subsequent calculations, was estimated as follows:

   a. For percent of total subwatershed area disturbed less than 1.25%, a value of 1.5% was used for subsequent calculations.

   b. For percent of total subwatershed area disturbed equal to or greater than 1.25%, a value of 120% of the percent of total subwatershed area disturbed, rounded up to the nearest tenth of a percent was used for subsequent calculations.

   The resulting value is considered to be a reasonable indication of subwatershed area under construction at any time. For subwatershed 080102080805, 1.5% was used.

3. The composite erosion and composite <u>instream</u> sediment loads calculated in Appendix B (Tables B-1 & B-2) were noted and the ratio of total subwatershed erosion to total instream sediment calculated. This ratio was considered to be representative for the entire subwatershed.

   For subwatershed 080102080805:

$$\text{S/E Ratio} = \frac{(\text{Sediment Load})_{0805}}{(\text{Erosion Load})_{0805}} = \frac{(18{,}116 \text{ tons/yr})}{(46{,}778 \text{ tons/yr})} = 0.387$$

4. The erosion load due to CSW sites in the subwatershed, normalized to the subwatershed area, was derived from the subwatershed area, CSW WLA of 6,000 lbs/ac/yr, and percent of subwatershed area disturbed by construction activities (ref.: Step 2).

$$(\text{Erosion Load})_{CSW} = \frac{\cancel{(A_{0805})} \times (\%_{CSW}/100) \times (WLA_{CSW})}{\cancel{(A_{0805})}}$$

   For subwatershed 080102080805:

$$(\text{Erosion Load})_{CSW} = (0.015) \times (6{,}000 \text{ lbs/ac/yr}) = 90 \text{ lbs/ac/yr}$$

5. The erosion load due to construction activities calculated in Step 4 was converted to an equivalent instream sediment load (at the subwatershed "pour point") using the sediment to erosion ratio determined in Step 3.

$$(\text{Sediment Load})_{CSW} = (\text{Erosion Load})_{CSW} \times (\text{S/E Ratio})$$

   For subwatershed 080102080805:

$$(\text{Sediment Load})_{CSW} = (90 \text{ lbs/ac/yr}) \times (0.387) = 34.8 \text{ lbs/ac/yr}$$

   This value, the <u>instream</u> sediment load at the subwatershed "pour point" due to discharges from CSW sites, is used in the analysis procedure described in Appendix D to calculate WLAs for MS4s and LAs for nonpoint sources. Instream sediment loads for other impaired subwatersheds and drainage areas are summarized in Table F-1.

Table F-1 Determination of Instream Sediment Load Due to Discharges from Construction Stormwater Sites

HUC-12 Subwatershed (08010208__) or Drainage Area	Subwatershed Area	CSW Disturbed Area	Actual CSW % (A_{CSW}/ A_{SubWS})	1.2 x Actual CSW % (if Actual CSW % >1.25%)	Value Used for Calcs.	Instream Sediment Load	Erosion Load	Sediment to Erosion (S/E) Ratio	Erosion Load From CSW	Instream Sediment Load Due to CSW
	[acres]	[acres]	[%]	[%]	[%]	[tons/yr]	[tons/yr]		[lbs/ac/yr]	[lbs/ac/yr]
Wade Creek DA	8,522	0*	0	NA	1.5	1,746.5	3,960.5	0.441	90.0	39.7
Potters Creek DA	3,680	7.0	0.19	NA	1.5	1,506.6	3,977.3	0.379	90.0	34.1
Dry Creek DA	7,586	0*	0	NA	1.5	6,952.5	19,926.4	0.349	90.0	31.4
Bear Creek DA	8,952	0*	0	NA	1.5	5,347.6	14,577.8	0.367	90.0	33.0
Turkey Branch DA	2,684	0*	0	NA	1.5	4,372.3	12,893.1	0.339	90.0	30.5
Gamble Branch DA	1,550	0*	0	NA	1.5	847.7	1,841.7	0.460	90.0	41.4
0506	10,550	48.5	0.46	NA	1.5	13,309.8	37,591.6	0.354	90.0	31.9
Poplar Creek DA	27,293	35.0	0.13	NA	1.5	18,405.6	54,527.1	0.338	90.0	30.4
Jeffers Creek DA	8,383	0*	0	NA	1.5	4,566.0	20,563.9	0.222	90.0	20.0
Richland Creek DA (0509)	5,317	0*	0	NA	1.5	2,383.6	7,107.4	0.335	90.0	30.2
0510	21,342	0*	0	NA	1.5	31,786.1	129,860.7	0.245	90.0	22.1
Hyde Creek DA	6,772	8.5	0.13	NA	1.5	6,587.8	17,964.5	0.367	90.0	33.0
Camp Creek DA	6,867	0*	0	NA	1.5	11,267.2	35,013.3	0.322	90.0	29.0
Flat Creek DA	10,396	4.7	0.05	NA	1.5	13,909.5	42,792.0	0.325	90.0	29.3
Richland Creek DA (0802)	12,377	0*	0	NA	1.5	11,439.9	39,021.1	0.293	90.0	26.4
0805	12,490	8.8	0.07	NA	1.5	18,116.8	46,778.1	0.387	90.0	34.8

* Although there were no active construction stormwater sites in HUC-12 subwatershed or drainage area as of May, 2009, the WLA was developed for the subwatershed to account for future construction activities.

APPENDIX G

Public Notice Announcement

STATE OF TENNESSEE

DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR SILTATION & HABITAT ALTERATION IN THE LOWER HATCHIE RIVER WATERSHED (HUC 08010208), TENNESSEE

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

A number of waterbodies in the Lower Hatchie River Watershed are listed on Tennessee's final Year 2008 303(d) list as not supporting designated use classifications due, in part, to loss of biological integrity due to siltation and habitat alteration associated with channelization and agriculture. The TMDLs utilize Tennessee's general water quality criteria, ecoregion reference site data, land use data, digital elevation data, a sediment loading and delivery model, and an appropriate Margin of Safety (MOS) to establish reductions in sediment loading which will result in reduced in-stream concentrations and the attainment of water quality standards. The TMDLs require reductions in sediment loading of approximately 10% to 80% in the listed waterbodies.

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

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

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

Bruce R. Evans, P.E., Watershed Management Section
Telephone: 615-532-0668
e-mail: Bruce.Evans@tn.gov

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

Persons wishing to comment on the TMDLs are invited to submit their comments in writing no later than August 17, 2009 to:

Division of Water Pollution Control
Watershed Management Section
7th Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1534

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

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

APPENDIX H

Public Comments Received

Tel: (865) 522-7007
Fax: (865) 525-4988
info@tcwn.org
www.tcwn.org

TCWN
TENNESSEE CLEAN WATER NETWORK

P.O. Box 1521
Knoxville, Tennessee 37901
123A South Gay Street
Knoxville, TN 37902

August 14, 2009

Ms. Sherry H. Wang
Tennessee Department of Environment and Conservation
Division of Water Pollution Control
Watershed Management Section
7th Floor, L&C Annex
401 Church Street
Nashville, TN 37243-1534

BY EMAIL

Re: Proposed Stage I Total Maximum Daily Load (TMDL) for Siltation in the Lower Hatchie River Watershed (HUC 08010208)

Dear Ms. Wang:

These comments are submitted on behalf of the Tennessee Clean Water Network regarding the proposed Stage I Total Maximum Daily Load (TMDL) for Siltation in the Lower Hatchie River Watershed, dated June 29, 2009. We appreciate the opportunity to participate in the TMDL development and review process.

There are some positive elements in the proposed TMDL for which we support your efforts. However, we do not believe the proposed TMDL satisfies federal regulations.

The WLAs can not be summed as required of a TMDL.

A TMDL is defined in 40 C.F.R. § 130.2(i):

> *Total maximum daily load (TMDL). The sum of the individual WLAs for point sources and LAs for nonpoint sources and natural background. If a receiving water has only one point source discharger, the TMDL is the sum of that point source WLA plus the LAs for any nonpoint sources of pollution and natural background sources, tributaries, or adjacent segments. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.* (Emphasis added)

The TMDLs are provided in Table 8 on page 30 as "Daily Maximum Loads" in lbs/ac/in. precipitation for each impaired sub-watershed. However, Table 9 on page 33 provides a WLA in lbs/ac/yr for RMCFs. The WLAs for RMCFs can not be summed with the WLAs for other point source categories or with the LAs.

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A Member of COMMUNITY SHARES

August 14, 2009
Ms. Wang, TDEC

The TMDL does not allow for a reduction in pollutant loads.

As noted through out the TMDL document and the reasoning for the development of the TMDL, the sub-watersheds are impaired as a result of siltation. This means the waterbodies are already polluted, and the amount of the sediment loading into them must be *lowered* to achieve water quality standards. However, the TMDL provides for the maintenance of existing loads and the potential increase in loads.

While as defined a WLA does provide for allocation to future point sources (40 C.F.R. § 130.2(h)), these waterbodies are impaired and therefore have no capacity for additional sediment loads. While a significant portion of the total sediment load entering these waterbodies is being attributed to nonpoint source activities, it is the regulated facilities which can be limited to the sediment being discharged into these impaired waters. In order to achieve the percent reductions necessary for these waterbodies to have any water quality improvements additional facilities can not be allocated load portions into these waters. For example, there are currently no permitted facilities in several of the sub-watersheds which discharge sediment. Therefore a WLA of zero would be appropriate for these sub-watersheds until they are no longer impaired and have regained an assimilative capacity to handle new loads. Already existing facilities are part of the problem so additional facilities can not be allowed. An overall reduction must be achieved, but the allocation of additional discharges will ensure these reductions are never met.

We appreciate the opportunity to submit these comments and request the Division respond to TCWN when the response to these comments is completed. We request the Division also revise the proposed TMDL in accordance with the requirements of 40 C.F.R. §§ 130.2. Thank you again for the opportunity to submit these comments.

Sincerely,

Dana L. Wright

Dana L. Wright
Director of Policy and Legislative Affairs

Cc: Paul Davis, Water Pollution Control, TN Department of Environment & Conservation
Katherine Sciera, Region 4, USEPA

APPENDIX I

Response to Public Comments

This appendix contains responses to comments received during the Public Notice period for the TMDL. As a result of this process the TMDL document has been revised to present information demonstrating the relationship between subwatershed TMDLs and the component allocations.

Response to Tennessee Clean Water Network Comments (July 17, 2009)

1. <u>The WLAs cannot be summed as required of a TMDL</u>

Response:
Section 4.0 of the TMDL document states that waterbodies in the Lower Hatchie River watershed, identified on the 2008 303(d) List as impaired due to loss of biological integrity due to siltation or habitat alteration, were assessed as impaired primarily based on biological surveys. These surveys are summarized in Table 3.

Tennessee Water Quality Criteria do not contain numerical criteria for siltation, but instead, specify narrative criteria relating to solids, deposits, turbidity, biological integrity, and habitat. Since siltation deposition and the resultant impact to biological communities occurs over an extended period of time, the average annual sediment load for biologically healthy waterbodies located in the same Level 4 ecoregion as an impaired waterbody was considered to be the most appropriate numerical interpretation of the narrative criteria. TMDL target loads were developed using the Watershed Characterization System (WCS) Sediment Tool to determine annual average loading for ecoregion reference sites (Section 5.0 & Appendix B). Target loads were expressed on a unit area basis for comparison to impaired subwatersheds.

In order to develop source allocations and to ensure that the sum of these allocations did not exceed the target (allowable) loads, watershed load accounting was performed using total annual average load (lbs/yr) for each impaired subwatershed. Appendix D of the TMDL document has been revised to clearly relate subwatershed allowable loads and source allocations.

2. <u>The TMDL does not allow for a reduction in pollutant loads</u>

Response:
In the Allocations Section of *Protocol for Developing Sediment TMDLs* (USEPA 1999), the use of a portion of the allowable loading capacity in a watershed for future growth is recognized. The TMDL defines the overall load reduction required to meet the water quality target. Allocations developed for categories of point source discharges and nonpoint sources are components (along with the MOS) of the TMDL. The sum of the allocations must not exceed the TMDL. It is possible to realize an overall reduction in loading if increases in one category of discharges are offset by decreases in other categories of discharges.

The TMDLs developed for impaired subwatersheds in the Lower Hatchie watershed require overall reductions in average annual sediment loading of 10.7% to 80.6% to meet ecoregion-based targets. In developing an allocation scenario, the DWPC considered it reasonable to make allowance for future growth. In most cases the WLAs specified for RMCFs, mining, and construction activities constitute less than 10% (ranges from 7.3% to 16.6%) of allowable loading. Appendix D of the TMDL document has been revised to demonstrate that the sum of all allocations does not exceed the TMDL.