TOTAL MAXIMUM DAILY LOAD (TMDL)

for

Pathogens

in the

Lower Clinch Watershed (HUC 06010207)

Anderson, Campbell, Grainger, Knox, Loudon, Morgan, Roane, and Union Counties, Tennessee

FINAL

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LIST OF ABBREVIATIONS

ADB	Assessment Database
AFO	Animal Feeding Operation
BMP	Best Management Practices
BST	Bacteria Source Tracking
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DWPC	Division of Water Pollution Control
E. coli	Escherichia coli
EPA	Environmental Protection Agency
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - Fortran
HUC	Hydrologic Unit Code
LA	Load Allocation
LDC	Load Duration Curve
LSPC	Loading Simulation Program in C^{++}
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
NHD	National Hydrography Dataset
NMP	Nutrient Management Plan
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PCR	Polymerase Chain Reaction
PDFE	Percent of Days Flow Exceeded
PFGE	Pulsed Field Gel Electrophoresis
Rf3	Reach File v.3
RM	River Mile
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
SWMP	Storm Water Management Plan
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USGS	United States Geological Survey
UCF	Unit Conversion Factor
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

Total Maximum Daily Load for Pathogens in Lower Clinch Watershed (HUC 06010207)

Impaired Waterbody Information

State: Tennessee
Counties: Anderson, Campbell, Grainger, Knox, Loudon, Morgan, Roane, and Union
Watershed: Lower Clinch (HUC 06010207)
Constituents of Concern: Pathogens

Impaired Waterbodies Addressed in This Document:

Waterbody ID	Waterbody	Miles Impaired
TN06010207011 – 1000, 2000 & 3000	BEAVER CREEK	43.7
TN06010207014 – 1000 & 3000	BULLRUN CREEK	23.2
TN06010207016 – 3000	HINDS CREEK	8.9
TN06010207026 – 1000 & 2000	EAST FORK POPLAR CREEK	21.0
TN06010207029 – 1000	COAL CREEK	10.9

Designated Uses:

The designated use classifications for waterbodies in the Lower Clinch watershed include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Portions of Beaver Creek and Bullrun Creek are also designated for domestic and/or industrial water supply.

Water Quality Goal:

Derived from *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, January, 2004* for recreation use classification (most stringent):

The concentration of the E. coli group shall not exceed 126 colony forming units per 100 mL, as a geometric mean based on a minimum of 5 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having an E. coli concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL. In addition, the concentration of the E. coli group in any individual sample taken from a lake, reservoir, State Scenic River, or Tier II or III stream (1200-4-3-.06) shall not exceed 487 colony forming units per 100 mL. The concentration of the E. coli group in any individual sample taken from any other waterbody shall not exceed 941 colony forming units per 100 mL.

Additionally, consistent with current TMDL methodology, standards from *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, October 1999* for recreation use classification:

The concentration of a fecal coliform group shall not exceed 200 per 100 mL nor shall the concentration of the *E. coli* group exceed 126 per 100 mL, as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having a fecal coliform group or *E. coli* concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 mL.

TMDL Scope:

Waterbodies identified on the Final 2004 303(d) list as impaired due to E. coli and/or fecal coliform. TMDLs are generally developed for impaired waterbodies on a HUC-12 basis.

Analysis/Methodology:

The TMDLs for impaired waterbodies in the Lower Clinch watershed were developed using the load duration curve methodology to assure compliance with the E. Coli 126 counts/100 mL geometric mean and 941 counts/100 mL maximum standards while also incorporating the fecal coliform 200 counts/100 mL geometric mean and 1,000 counts/100 mL maximum concentration as surrogates. A duration curve is a cumulative frequency graph that represents the percentage of time during which the value of a given parameter is equaled or exceeded. Load duration curves are developed from flow duration curves and can illustrate existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the portion of the waterbody flow regime represented by these existing loads. Load duration curves were used to determine the load reductions required to meet the target maximum concentrations for E. coli and fecal coliform (standard - MOS). When sufficient data were available, load reductions were also determined based on geometric mean criteria.

Critical Conditions:

Water quality data collected over a period of 10 years for load duration curve analysis were used to assess the water quality standards representing a range of hydrologic and meteorological conditions.

Seasonal Variation:

The 10-year period used for LSPC model simulation period and for load duration curve analysis included all seasons and a full range of flow and meteorological conditions.

Margin of Safety (MOS):

Explicit – 10% of the water quality standard for each impaired subwatershed.

Summary of TMDLs, WLAs, & LAs for Impaired Waterbodies

HUC-12 Subwatershed (06010103__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	WLAs: WWTFs[a] (Monthly Avg.) E. Coli	WLAs: Leaking Collection Systems[b]	WLAs: CAFOs	WLAs: MS4s[c]	LAs: Precipitation Induced Nonpoint Sources	LAs: Other Direct Sources[d]
			[% Red.]	[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
0302	BEAVER CREEK	TN06010207011 – 1000 & 2000	**86.0**	**6.200 x 10^{10}**	**0**	**NA**	**86.0**	**86.0**	**0**
0301	BEAVER CREEK	TN06010207011 – 3000	**79.7**	**NA***	**NA**	**NA**	**79.7**	**79.7**	**0**
0202	BULL RUN CREEK[e]	TN06010207014 – 1000	**62.9**	**1.431 x 10^{9}**	**0**	**NA**	**62.9**	**62.9**	**0**
0201	BULL RUN CREEK[e]	TN06010207014 – 3000	**45.6**	**NA***	**NA**	**NA**	**NA**	**45.6**	**0**
0102	HINDS CREEK	TN06010207016 – 3000	**49.5**	**NA***	**NA**	**NA**	**49.5**	**49.5**	**0**
0503	EAST FORK POPLAR CREEK	TN06010207026 – 1000 & 2000	**68.1**	**4.769 x 10^{10}**	**0**	**NA**	**68.1**	**68.1**	**0**
0101	COAL CREEK	TN06010207029 – 1000	**56.2**	**4.531 x 10^{9}**	**0**	**NA**	**56.2**	**56.2**	**0**

Note: NA = Not Applicable.

* Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.

a. WLAs for WWTFs expressed as E. coli loads (counts/day).

b. The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

c. Applies to any MS4 discharge loading in the subwatershed.

d. The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

e. Load reductions were determined based on comparison of the geometric mean of all monitoring data (excluding highest and lowest values) to the 30-day geometric mean target concentrations. Additional monitoring is recommended.

PATHOGEN TOTAL MAXIMUM DAILY LOAD (TMDL)
LOWER CLINCH WATERSHED (HUC 06010207)

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 uses 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

This document presents details of TMDL development for waterbodies in the Lower Clinch watershed, identified on the Final 2004 303(d) list as not supporting designated uses due to E. coli and/or fecal coliform. TMDL analyses are performed primarily on a 12-digit hydrologic unit area (HUC-12) basis. In some cases, where appropriate, TMDLs are developed for an impaired waterbody drainage area only.

3.0 WATERSHED DESCRIPTION

The Lower Clinch watershed (HUC 06010207) is located in East Tennessee (Figure 1), primarily in Anderson, Knox, Roane, and Union Counties. The Lower Clinch watershed lies within three Level III ecoregions (Ridge and Valley, Southwestern Appalachians, Central Appalachians) and contains five Level IV ecoregions as shown in Figure 2 (USEPA, 1997):

- **The Southern Limestone/Dolomite Valleys and Low Rolling Hills (67f)** form a heterogeneous region composed predominantly of limestone and cherty dolomite. Landforms are mostly low rolling ridges and valleys, and the solids vary in their productivity. Landcover includes intensive agriculture, urban and industrial, or areas of thick forest. White oak forests, bottomland oak forests, and sycamore-ash-elm riparian forests are the common forest types, and grassland barrens intermixed with cedar-pine glades also occur here.
- **The Southern Dissected Ridges and Knobs (67i)** contain more crenulated, broken, or hummocky ridges, compared to smoother, more sharply pointed sandstone ridges. Although shale is common, there is a mixture and interbedding of geologic materials. The ridges on the east side of Tennessee's Ridge and Valley tend to be associated with the Ordovician-age Sevier shale, Athens shale, and Holston and Lenoir limestones. These can include calcareous shale, limestone, siltstone, sandstone, and conglomerate. In the central and western part of the ecoregion, the shale ridges are associated with

the Cambrian-age Rome Formation: shale and siltstone with beds of sandstone. Chestnut oak forests and pine forests are typical for the higher elevations of the ridges, with areas of white oak, mixed mesophytic forest, and tulip poplar on the lower slopes, knobs, and draws.

- **Cumberland Plateau (68a)** tablelands and open low mountains are about 1000 feet higher than the Eastern Highland Rim (71g) to the west, and receive slightly more precipitation with cooler annual temperatures than the surrounding lower-elevation ecoregions. The plateau surface is less dissected with lower relief compared to the Cumberland Mountains (69d) or the Plateau Escarpment (68c). Elevations are generally 1200-2000 feet, with the Crab Orchard Mountains reaching over 3000 feet. Pennsylvanian-age conglomerate, sandstone, siltstone, and shale is covered by well-drained, acid soils of low fertility. Bituminous coal that has been extensively surface and underground mined underlies the region. Acidification of first and second order streams is common. Stream siltation and mine spoil bedload deposits continue as long-term problems in these headwater systems. Pockets of severe acid mine drainage persist.
- **Plateau Escarpment (68c)** is characterized by steep, forested slopes and high velocity, high gradient streams. Local relief is often 1000 feet or more. The geologic strata include Mississippian-age limestone, sandstone, shale, and siltstone, and Pennsylvanian-age shale, siltstone, sandstone, and conglomerate. Streams have cut down into the limestone, but the gorge talus slopes are composed of colluvium with huge angular, slabby blocks of sandstone. Vegetation community types in the ravines and gorges include mixed oak and chestnut oak on the upper slopes, mesic forests on the middle and lower slopes (beech-tulip poplar, sugar maple-basswood-ash-buckeye), with hemlock along rocky streamsides and river birch along floodplain terraces.
- **Cumberland Mountains (69d),** in contrast to the sandstone-dominated Cumberland Plateau (68a) to the west and southwest, are more highly dissected, with narrow-crested steep slopes, and younger Pennsylvanian-age shales, sandstones, siltstones, and coal. Narrow, winding valleys separate the mountain ridges, and relief is often 2000 feet. Cross Mountain, west of Lake City, reaches 3534 feet in elevation. Soils are generally well-drained, loamy, and acidic, with low fertility. The natural vegetation is a mixed mesophytic forest, although composition and abundance vary greatly depending on aspect, slope position, and degree of shading from adjacent landmasses. Large tracts of land are owned by lumber and coal companies, and there are many areas of stripmining. Acid mine drainage is primarily limited to first and second order systems. Siltation as surface run-off remains the primary pollutant from past mining, timber harvest and unpaved roads.

The Lower Clinch watershed, located in Anderson, Campbell, Grainger, Knox, Loudon, Morgan, Roane, and Union Counties, Tennessee, has a drainage area of approximately 631 square miles (mi^2). Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Although changes in the land use of the Lower Clinch watershed have occurred since 1993 as a result of development, this is the most current land use data available. Land use for the Lower Clinch watershed is summarized in Table 1 and shown in Figure 3. Predominant land use in the Lower Clinch watershed is forest (75.1%) followed by agriculture (15.6%). Urban areas represent approximately 5.3% of the total drainage area of the watershed. Details of land use distribution of impaired subwatersheds in the Lower Clinch watershed are presented in Appendix A.

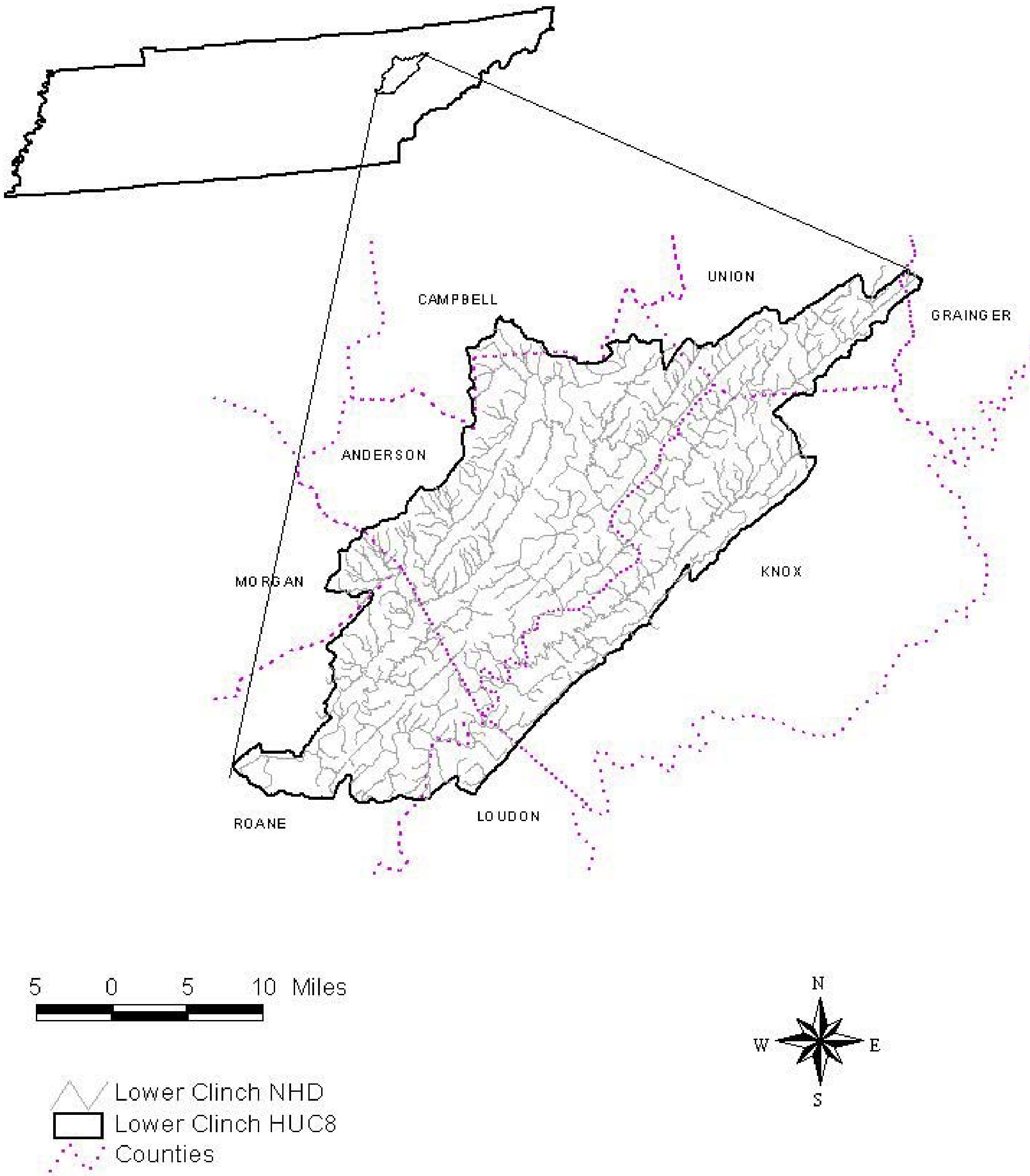

Figure 1. Location of the Lower Clinch Watershed.

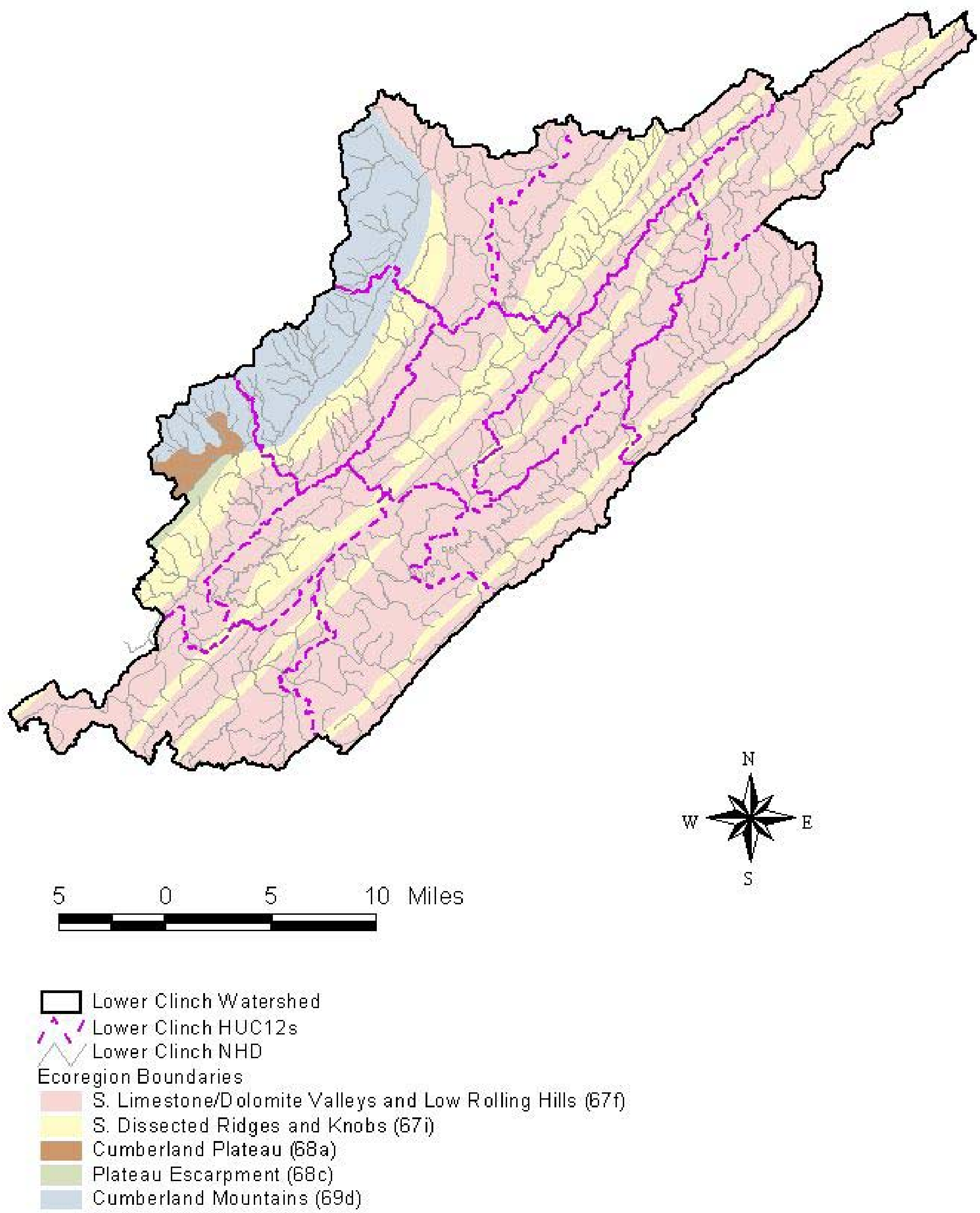

Figure 2. Level IV Ecoregions in the Lower Clinch Watershed.

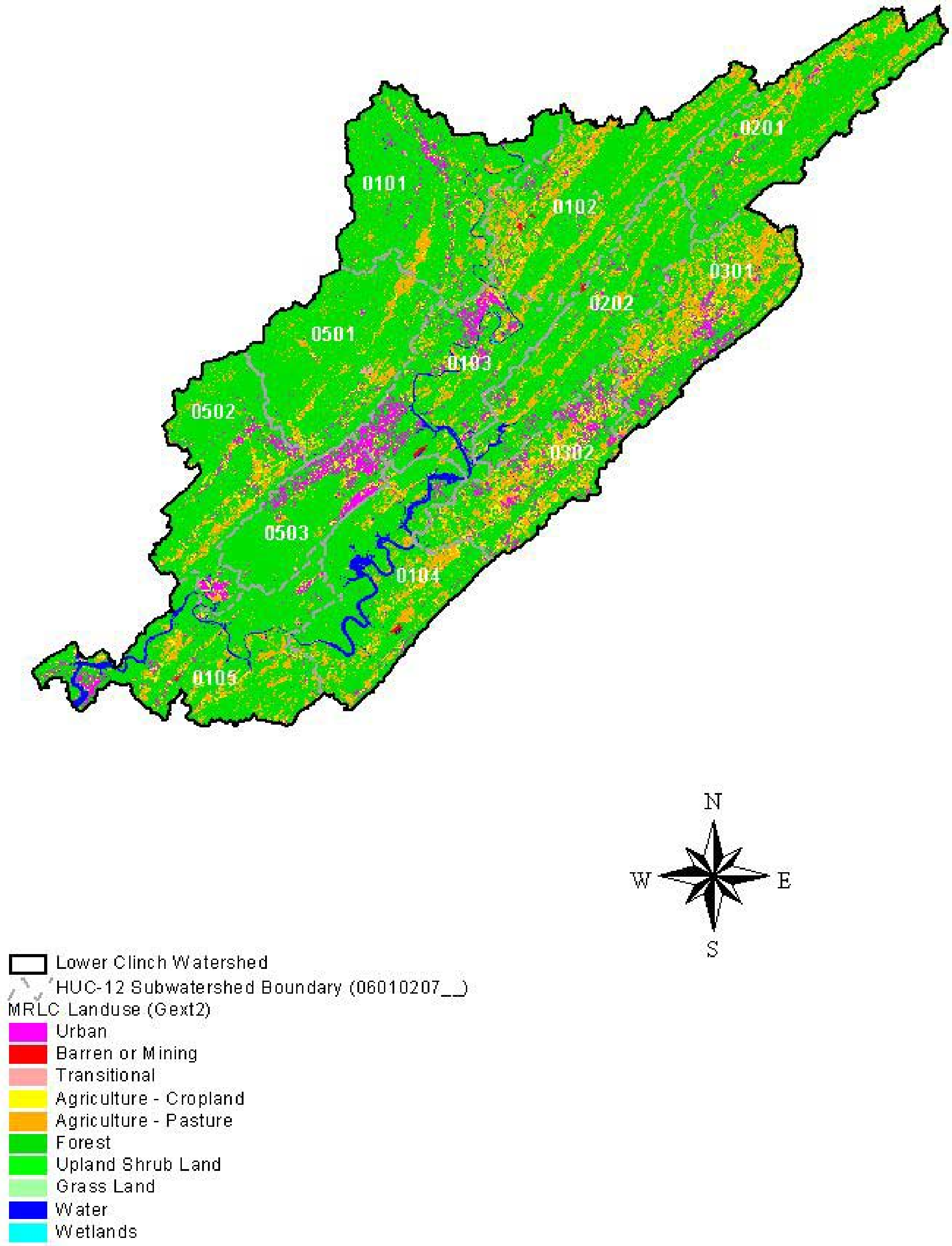

Figure 3. Land Use Characteristics of the Lower Clinch Watershed.

Table 1. MRLC Land Use Distribution – Lower Clinch Watershed

Land Use	Area	
	[acres]	[%]
Bare Rock/Sand/Clay	1	0.0
Deciduous Forest	160,247	39.7
Emergent Herbaceous Wetlands	6	0.0
Evergreen Forest	53,255	13.2
High Intensity Commercial/Industrial/ Transportation	6,998	1.7
High Intensity Residential	1,676	0.4
Low Intensity Residential	13,223	3.3
Mixed Forest	90,133	22.3
Open Water	7.256	1.8
Other Grasses (Urban/recreational)	8,021	2.0
Pasture/Hay	53,511	13.2
Quarries/Strip Mines/ Gravel Pits	400	0.1
Row Crops	8,690	2.2
Transitional	556	0.1
Woody Wetlands	37	0.0
Total	**404,010**	**100.0**

4.0 PROBLEM DEFINITION

The State of Tennessee's final 2004 303(d) list (TDEC, 2004a) was approved by the U.S. Environmental Protection Agency (EPA), Region IV in August of 2005. The list identified eight waterbodies in the Lower Clinch watershed as not supporting designated use classifications due, in part, to E. coli and/or fecal coliform (see Table 2). The designated use classifications for these waterbodies include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Portions of Beaver Creek and Bullrun Creek are also designated for domestic and/or industrial water supply.

When used in the context of waterbody assessments, the term pathogens is defined as disease-causing organisms such as bacteria or viruses that can pose an immediate and serious health threat if ingested or introduced into the body. The primary sources for pathogens are untreated or inadequately treated human or animal fecal matter. The fecal coliform and E. coli groups are indicators of the presence of pathogens in a stream.

The waterbody segments listed in Table 2 were assessed as impaired based on sampling data and/or biological surveys. The results of these assessment surveys are summarized in Table 3 and shown in Figure 4. The assessment information presented is excerpted from the EPA/TDEC Assessment Database (ADB) and is referenced to the waterbody ID in Table 2. ADB information may be accessed at:

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

5.0 WATER QUALITY GOAL

As previously stated, the designated use classifications for the Lower Clinch waterbodies include fish & aquatic life, recreation, irrigation, and livestock watering & wildlife. Portions of Beaver Creek and Bullrun Creek are also designated for domestic and/or industrial water supply. Of the use classifications with numeric criteria for pathogens, the recreation use classification is the most stringent and will be used to establish target levels for TMDL development. The coliform water quality criteria, for protection of the recreation use classification, is established by *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, January 2004* (TDEC, 2004b). Section 1200-4-3-.03 (4) (f) states:

> The concentration of the E. coli group shall not exceed 126 colony forming units per 100 mL, as a geometric mean based on a minimum of 5 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having an E. coli concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL.
>
> Additionally, the concentration of the E. coli group in any individual sample taken from a lake, reservoir, State Scenic River, or Tier II or III stream (1200-4-3-.06) shall not exceed 487 colony forming units per 100 mL. The concentration of the E. coli group in any individual sample taken from any other waterbody shall not exceed 941 colony forming units per 100 mL.

None of the impaired waterbodies in the Lower Clinch watershed have been classified as either Tier II or Tier III streams.

Prior to January 2004, the coliform water quality criteria, for protection of the recreation use classification, established by *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, October 1999* (TDEC, 1999), Section 1200-4-3-.03 (4) (f) states:

> The concentration of a fecal coliform group shall not exceed 200 per 100 mL, nor shall the concentration of the *E. coli* group exceed 126 per 100 mL, as a geometric mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having a fecal coliform group or *E. coli* concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 mL.

In addition to utilizing the E. coli water quality standards (with MOS) as the target, this TMDL utilizes a fecal coliform target as a surrogate for determining the attainment of the E. coli standard because of the demonstrated high correlation between E. coli and fecal coliform in this watershed. In the state of Tennessee, E. coli and fecal coliform are well correlated (R = 0.902) when evaluating all available ecoregion data (623 observations).

Therefore, this TMDL employs both the E. coli water quality standard and the surrogate fecal coliform criteria by determining the amount of load reduction required to comply with each of four criteria: 1) the geometric mean standard for E. coli of 126 counts/100mL, 2) the E. coli sample maximum of 941 counts/100 mL, 3) the geometric mean for fecal coliform of 200 counts/100 mL, and 4) the fecal coliform sample maximum of 1,000 counts/100 mL. The fecal coliform surrogate is most frequently used when insufficient monitoring data is available for E. coli or when analysis of E. coli monitoring data suggests that a listed segment is not impaired. The most protective (or highest percent of load reduction) of the four criteria will determine the percent reduction(s) required for impaired waterbodies. The analysis of fecal coliform data is only part of the methodology and is not included to comply with current water quality standards.

Note: In this document, the water quality standards are the instream goals. The term "target concentration" reflects the application of an explicit Margin of Safety (MOS) to the water quality standard. See Section 8.4 for an explanation of MOS.

Table 2. Final 2004 303(d) List for E. coli Impaired Waterbodies – Lower Clinch Watershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)	Pollutant Source
TN06010207011 – 1000	BEAVER CREEK (from Melton Hill Reservoir to Hallsdale-Powell STP)	22.5	Phosphorus Nitrate Escherichia coli Siltation Alterations of stream-side or littoral vegetative cover	Major Municipal Point Source Pasture Grazing Land Development
TN06010207011 – 2000 & 3000	BEAVER CREEK (from Hallsdale-Powell STP to headwaters)	21.2	Escherichia coli Siltation Alterations of stream-side or littoral vegetative cover	Pasture Grazing Land Development
TN06010207014 – 1000	BULLRUN CREEK (from Melton Hill Reservoir to Hwy 441)	11.8	Siltation Alterations of stream-side or littoral vegetative cover Escherichia coli	Pasture Grazing Channelization
TN06010207014 – 3000	BULLRUN CREEK (from N. Fork Bullrun to headwaters)	11.4	Escherichia coli	Pasture Grazing
TN06010207016 – 3000	HINDS CREEK (Upper Hinds Creek)	8.9	Escherichia coli	Pasture Grazing
TN06010207026 – 1000	EAST FORK POPLAR CREEK (from Clinch River embayment to Gum Hollow Rd.)	9.7	PCBs Mercury Escherichia coli Siltation Nutrients	Industrial Point Source Contaminated Sediments Collection System Failure Discharges from MS4 Area
TN06010207026 – 2000	EAST FORK POPLAR CREEK (from Gum Hollow Rd. to headwaters)	11.3	PCBs Mercury Escherichia coli Siltation Nutrients Alterations of stream-side or littoral vegetative cover	Industrial Point Source Contaminated Sediments Hydromodification Discharges from MS4 Area
TN06010207029 – 1000	COAL CREEK (from Clinch River to Beech Grove Creek)	10.9	Unknown toxicity Escherichia coli	Minor Municipal Point Source

Table 3. Water Quality Assessment of Waterbodies Impaired Due to E. coli – Lower Clinch Watershed

Waterbody ID	Segment Name	Comments
TN06010207011 – 1000	BEAVER CREEK (from Melton Hill Reservoir to Hallsdale-Powell STP)	1999 TDEC chemical stations at miles 3.5, 10.1, 12.5, and 23.5. 12 observations for E.coli GM = 147, 321, 258, and 295 respectively.
TN06010207011 – 2000	BEAVER CREEK (from Hallsdale-Powell STP to Willow Fork Crk)	1999 TDEC chemical stations at miles 23.6 and 31.8. E.coli GM = 431 and 312. Ogden station at mile 26.5. 2 EPT genera. Habitat score = 138. Fish IBI = 28.
TN06010207011 – 3000	BEAVER CREEK (from Willow Fork Crk to headwaters)	1999 TDEC chemical stations at miles 36.7 and 40.2. E.coli GM = 313 and 476. Ogden station at Stormer Rd. 9 EPT genera. Habitat score = 84.
TN06010207014 – 1000	BULLRUN CREEK (from Melton Hill Reservoir to Hwy 441)	1999 TDEC station at mile 5.2. 8 EPT, 35 total genera. NCBI = 5.43. Habitat score = 105. 1996 TVA station at mile 7.2. 11 EPT.
TN06010207014 – 3000	BULLRUN CREEK (from N. Fork Bullrun to headwaters)	1999 TDEC station at mile 34.1. 16 EPT, 45 total genera. NCBI = 4.62. Habitat score = 132. Fish IBI = 44. E.col GM = 203
TN06010207016 – 3000	HINDS CREEK (Upper Hinds Crk)	1999 TDEC station at mile 14.1. 15 EPT, 38 total genera. NCBI = 5.30. Habitat score = 156. E.coli GM = 261.
TN06010207026 – 1000	EAST FORK POPLAR CREEK (from Clinch River embayment to Gum Hollow Rd.)	Pathogens from wet weather overflows from Oak Ridge STP. 1999 DOE-O biological survey at mile 3.9 & 8.6; 4 & 5 EPT genera.
TN06010207026 – 2000	EAST FORK POPLAR CREEK (from Gum Hollow Rd. to headwaters)	Water contact advisory due to pathogens. 1999 DOE-O biological survey at mile 14.5 & 15.2; 4 & 1 EPT genera.
TN06010207029 – 1000	COAL CREEK (from Clinch River to Beech Grove Creek)	1999 TDEC station at mile 1.2. 8 EPT, 26 total genera. NCBI = 5.68. Habitat score = 161. Fish IBI = 32. E.coli GM = 137. 1999 TVA biological survey. 9 EPT, 21 total genera.

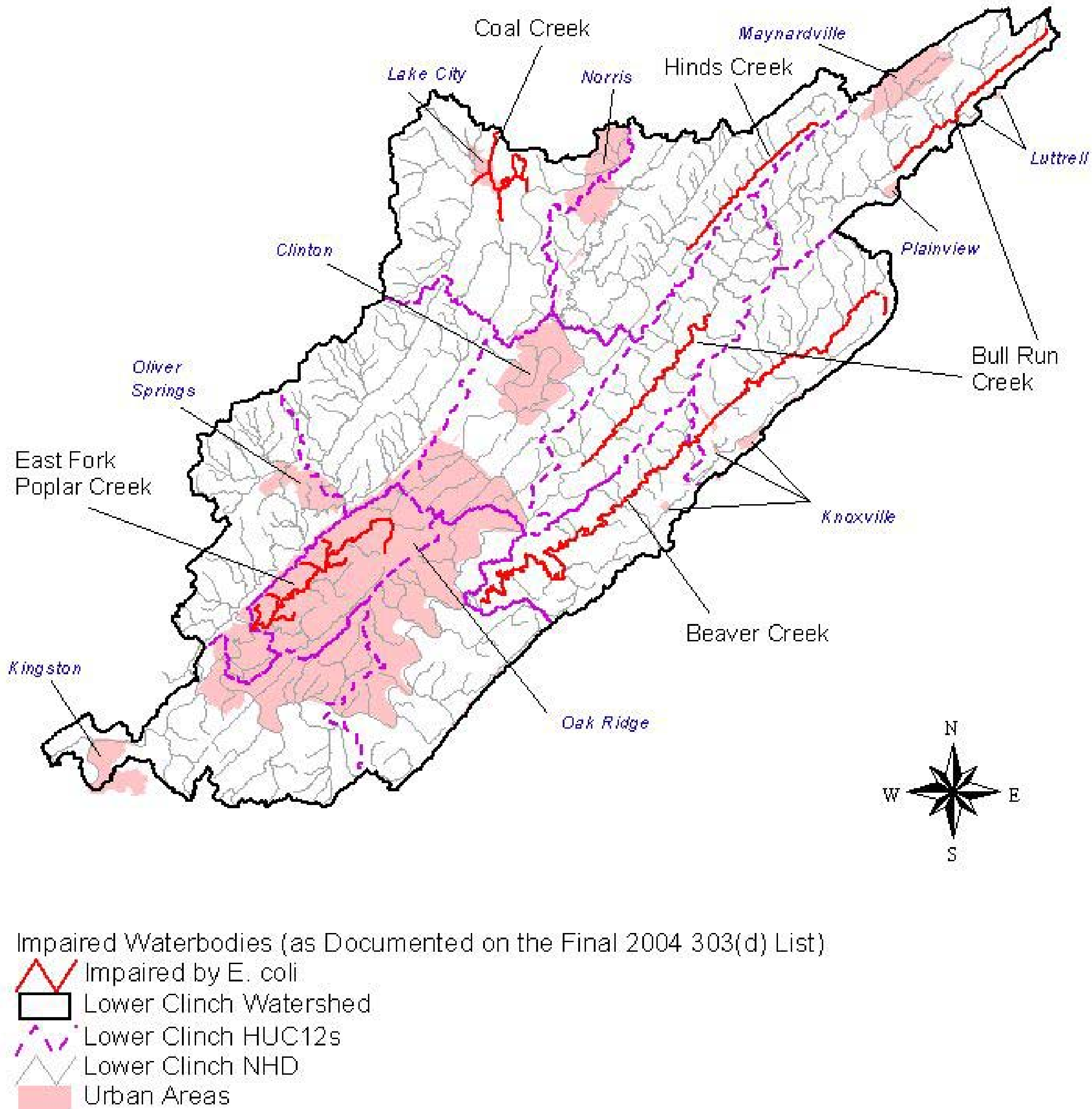

Figure 4. Waterbodies Impaired by E. Coli (as Documented on the Final 2004 303(d) List).

6.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM GOAL

There are several water quality monitoring stations that provide data for waterbodies identified as impaired for pathogens in the Lower Clinch watershed:

- Beaver Creek Subwatershed:
  - BEAVE003.5KN – Beaver Creek, at Swafford Rd. bridge
  - BEAVE010.1KN – Beaver Creek, at Coward Mill Rd. bridge
  - BEAVE012.5KN – Beaver Creek, at Westcott Blvd. bridge
  - BEAVE020.9KN – Beaver Creek, at Harrell Rd. bridge
  - BEAVE023.5KN – Beaver Creek, d/s Hallsdale Powell STP
  - BEAVE023.6KN – Beaver Creek, u/s Hallsdale Powell STP
  - BEAVE024.7KN – Beaver Creek, 100 ft. below Clinton Hwy bridge
  - BEAVE031.8KN – Beaver Creek, at Dry Gap Pike bridge
  - BEAVE036.7KN – Beaver Creek, at Hwy 33 (Halls Crossroads)
  - BEAVE038.7KN – Beaver Creek, just u/s of Brown Gap bridge
  - BEAVE040.1KN – Beaver Creek, at Stormer Rd.
- Bullrun Creek Subwatershed:
  - BULLR005.2AN – Bullrun Creek, at Clinton Hwy bridge (Hwy 25)
  - BULLR016.2KN – Bullrun Creek, at Hwy 441/70 bridge (Norris Fwy)
  - BULLR029.6UN – Bullrun Creek, at Malone Rd.
  - BULLR031.1UN – Bullrun Creek, at Hwy 144 bridge
  - BULLR034.1UN – Bullrun Creek, at first bridge
- Hinds Creek Subwatershed:
  - HINDS000.7AN – Hinds Creek, at Brushy Valley Rd. bridge
  - HINDS006.8AN – Hinds Creek, at Mountain Rd. bridge
  - HINDS012.6AN – Hinds Creek, at Hwy 170 bridge
  - HINDS014.1AN – Hinds Creek, at Hinds Creek Rd.
  - HINDS020.7UN – Hinds Creek, at Hwy 61 bridge, just u/s of Blue Springs Branch
- East Fork Poplar Creek Subwatershed
  - EFPOP003.9RO – East Fork Poplar Creek, at Oak Ridge Turnpike
  - EFPOP004.7RO – East Fork Poplar Creek, at Hwy 95
- Coal Creek Subwatershed:
  - COAL001.2AN – Coal Creek, at Lovely Spring
  - COAL005.4AN – Coal Creek, at the Wye
  - COAL010.6AN – Coal Creek, at Briceville Hwy 116 bridge

The location of these monitoring stations is shown in Figure 5. Water quality monitoring results for these stations are tabulated in Appendix B. Examination of the data shows violations of the 1,000 counts/100 mL maximum fecal coliform criterion and the 941 counts/100 mL maximum E. coli standard at many monitoring stations. Water quality monitoring results for those stations with 10% of samples in violation of water quality standards are summarized in Table 4 and Table 5.

There were not enough data to calculate the geometric mean at each monitoring station. Whenever a minimum of 5 samples was collected at a given monitoring station over a period of not more than 30 consecutive days, the geometric mean was calculated. All calculated geometric means were in violation of the 200 counts/100 mL geometric mean for fecal coliform and the 126 counts/100 mL geometric mean for E. coli.

All waterbodies listed on the Final 2004 303(d) List are provided a TMDL for pathogen loading.

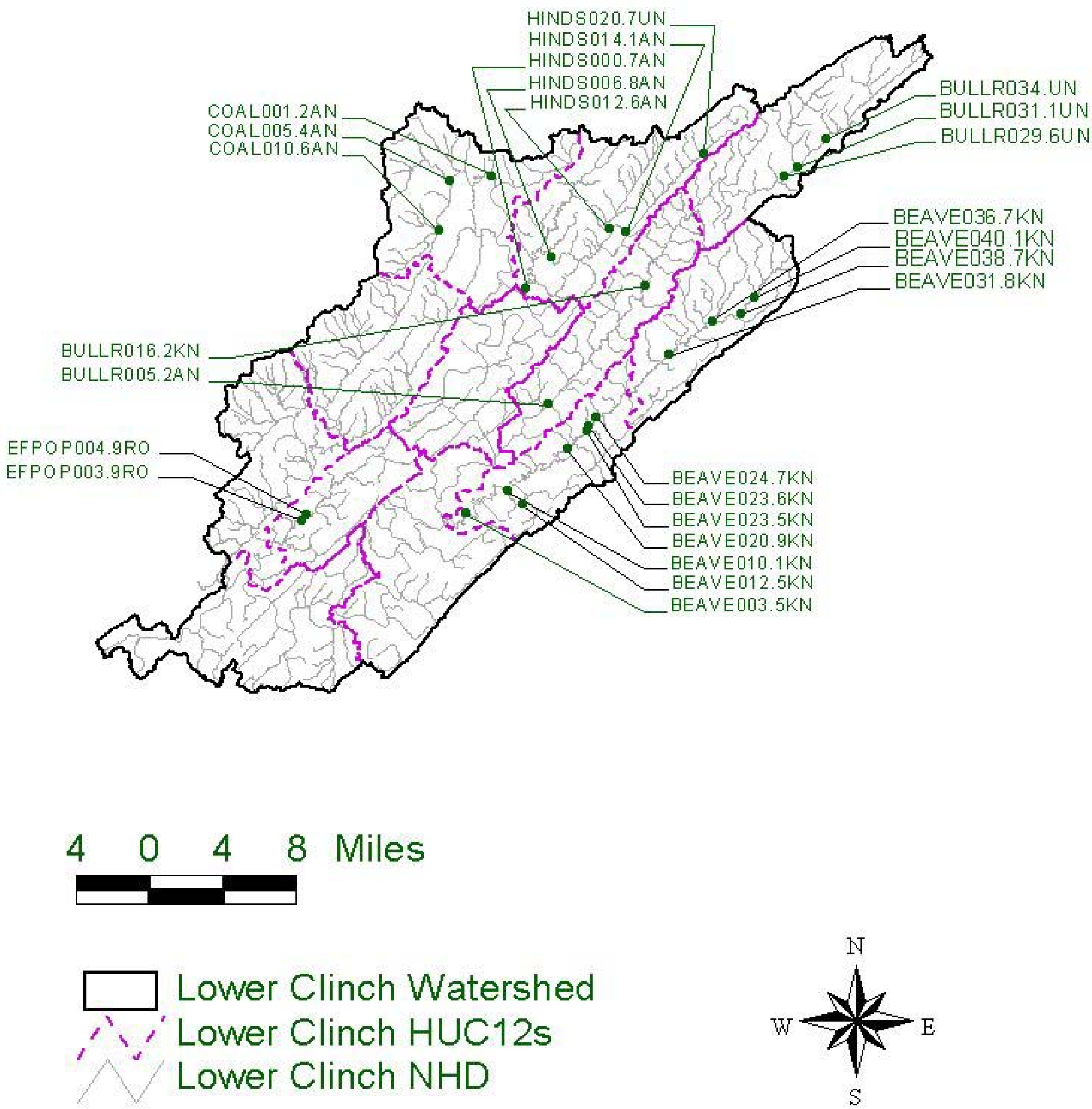

Figure 5. Water Quality Monitoring Stations in the Lower Clinch Watershed

Table 4. Summary of TDEC Water Quality Monitoring Data

Monitoring Station	Monitoring Dates	E. Coli						Fecal Coliform					
		Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.	Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.
			Min.	Avg.	Max.				Min.	Avg.	Max.		
BEAVE003.5KN	1999 – 2004	18	66	>435	>2,419	2	11.1%	18	36	569	4,800	2	11.1%
BEAVE013.5KN	2004	6	210	>840	>2,419	1	16.7%	6	260	1,457	5,600	2	33.3%
BEAVE020.9KN	2004	7	279	>1,288	>2,419	3	42.9%	7	280	2,429	7,400	4	57.1%
BEAVE023.5KN	1999 – 2000	11	19	>665	>2,419	2	18.2%	11	8	535	1,700	2	18.2%
BEAVE023.6KN	1999 – 2000	11	91	723	1,986	2	18.2%	11	120	798	2,000	3	27.3%
BEAVE024.7KN	2004	7	261	>1,011	>2,419	3	42.9%	7	220	1,446	6,500	2	28.6%
BEAVE031.8KN	1999 – 2004	18	101	>809	>2,419	6	33.3%	18	72	1,112	6,800	5	27.8%
BEAVE038.7KN	2004	7	345	>1,134	>2,419	4	57.1%	7	160	1,901	9,800	1	14.3%
BEAVE040.1KN	1999 – 2000	11	144	>1,279	>2,419	5	45.5%	11	120	1,063	5,500	2	18.2%
BULLR016.2KN	1999 – 2002	6	71	574	1,733	1	16.7%	1	156	156	156	0	0.0%
BULLR029.6UN	2001 – 2002	5	73	422	980	1	20.0%	0					
COAL001.2AN	1999 – 2003	15	22	>511	>2,419	3	20.0%	15	30	607	3,000	3	20.0%
COAL005.4AN	1999 – 2003	11	150	>722	>2,419	3	27.2%	11	150	753	2,300	3	27.2%
EFPOP004.7RO	2003	10	57	426	1,733	2	20.0%	10	120	501	2,400	2	20.0%
HINDS000.7AN	1999 – 2004	16	27	701	1,986	5	31.3%	16	24	723	2,000	5	31.3%
HINDS006.8AN	1999 – 2004	12	55	>478	>2,419	2	16.7%	12	48	548	2,100	2	16.7%
HINDS014.1AN	1999 – 2004	12	68	426	1,553	2	16.7%	12	90	428	1,700	1	8.3%

Table 5. Summary of TVA Water Quality Monitoring Data

Monitoring Station	Monitoring Dates	E. Coli						Fecal Coliform					
		Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.	Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.
			Min.	Avg.	Max.				Min.	Avg.	Max.		
BULLR005.2KN	2001 – 2002	12	54	456	1,203	2	16.7%	12	25	205	560	0	0.0%

7.0 SOURCE ASSESSMENT

An important part of TMDL analysis is the identification of individual sources, or source categories of pollutants in the watershed that affect pathogen loading and the amount of loading contributed by each of these sources.

Under the Clean Water Act, sources are classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point sources can be described by three broad categories: 1) NPDES regulated municipal and industrial wastewater treatment facilities (WWTFs); 2) NPDES regulated industrial and municipal storm water discharges; and 3) NPDES regulated Concentrated Animal Feeding Operations (CAFOs). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES regulated point sources. Nonpoint sources are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For the purposes of this TMDL, all sources of pollutant loading not regulated by NPDES permits are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

7.1 Point Sources

7.1.1 NPDES Regulated Municipal and Industrial Wastewater Treatment Facilities

Both treated and untreated sanitary wastewater contain coliform bacteria. There are 13 NPDES permitted WWTFs that require monitoring of fecal coliform and/or E. coli within the Lower Clinch watershed. The fecal coliform and E. coli permit limits for discharges from these WWTFs are in accordance with the criteria specified in the 1999 and 2004 State of Tennessee water quality standards (TDEC, 1999 and TDEC, 2004b, respectively) (ref.: Section 5.0).

Five of these facilities are located in impaired subwatersheds of the Lower Clinch watershed. The Oak Ridge Sewage Treatment Plant (STP) (TN0024155), with a design capacity of 30.0 MGD, discharges to East Fork Poplar Creek at mile 8.3. In calendar year 2004, fifty overflows were reported. The Hallsdale-Powell Utility District STP (TN0024287), with a design capacity of 9.0 MGD, discharges to Beaver Creek at mile 23.5. In calendar year 2003, 34 dry weather overflows and 16 wet weather overflows were reported. The Hallsdale-Powell Raccoon Valley STP (TN0059323), with a design capacity of 0.3 MGD, discharges to Bull Run Creek at mile 12.6. According to a recent compliance inspection, the greatest problem at the Raccoon Valley STP is increased flow due to infiltration and inflow. The West Knoxville Utility District Beaver Center Karns STP (TN0060020), with a design capacity of 4.0 MGD, discharges to Beaver Creek at mile 10.7. Between April 2004 and January 2005, 30 overflows were reported. The Lake City STP (TN0025127), with a design capacity of 0.95 MGD, discharges to Coal Creek at mile 3.3. In calendar year 2003, 76 days of bypasses of secondary treatment occurred. A collection system rehab program is in progress to reduce infiltration and inflow. All of these problems can be a significant contributor to pathogen impairment in the watershed.

7.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

Municipal Separate Storm Sewer Systems (MS4s) are considered to be point sources of pathogens. Discharges from MS4s occur in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. Large and medium MS4s serving populations greater than 100,000 people are required to obtain NPDES storm water permits. At present, there are no MS4s of this size in the Lower Clinch watershed. As of March 2003, small MS4s serving urbanized areas, or having the potential to exceed instream water quality standards, are required to obtain a permit under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2002). An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. Under the General Permit, an annual report must be submitted to the Director of TDEC Water Pollution Control Division.

Three permittees are covered under Phase II of the NPDES Storm Water Program (Figure 6). The three permitted MS4s in the Lower Clinch watershed are as follows:

NPDES Permit Number	Phase	Permittee Name	Issuance Date	Effective Date	Expiration Date
TNS075108	II	Anderson County	10/13/03	10/16/03	2/26/08
TNS075582	II	Knox County	10/2/03	10/2/03	2/26/08
TNS075591	II	Loudon County	3/8/04	10/15/03	2/26/08

The Tennessee Department of Transportation (TDOT) is also being issued MS4 permits for State roads in urban areas. Information regarding storm water permitting in Tennessee may be obtained from the TDEC website at http://www.state.tn.us/environment/wpc/stormh2o/.

7.1.3 NPDES Concentrated Animal Feeding Operations (CAFOs)

Animal feeding operations (AFOs) are agricultural enterprises where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland (USEPA, 2002a). Concentrated Animal Feeding Operations (CAFOs) are AFOs that meet certain criteria with respect to animal type, number of animals, and type of manure management system. CAFOs are considered to be potential point sources of pathogen loading and are required to obtain an NPDES permit. Most CAFOs in Tennessee obtain coverage under TNA000000, *Class II Concentrated Animal Feeding Operation General Permit*, while larger, Class I CAFOs are required to obtain an individual NPDES permit.

As of May 11, 2005, there are no Class I CAFOs with individual permits located in the watershed. There are also no Class II CAFOs in the Lower Clinch watershed with coverage under the general NPDES permit.

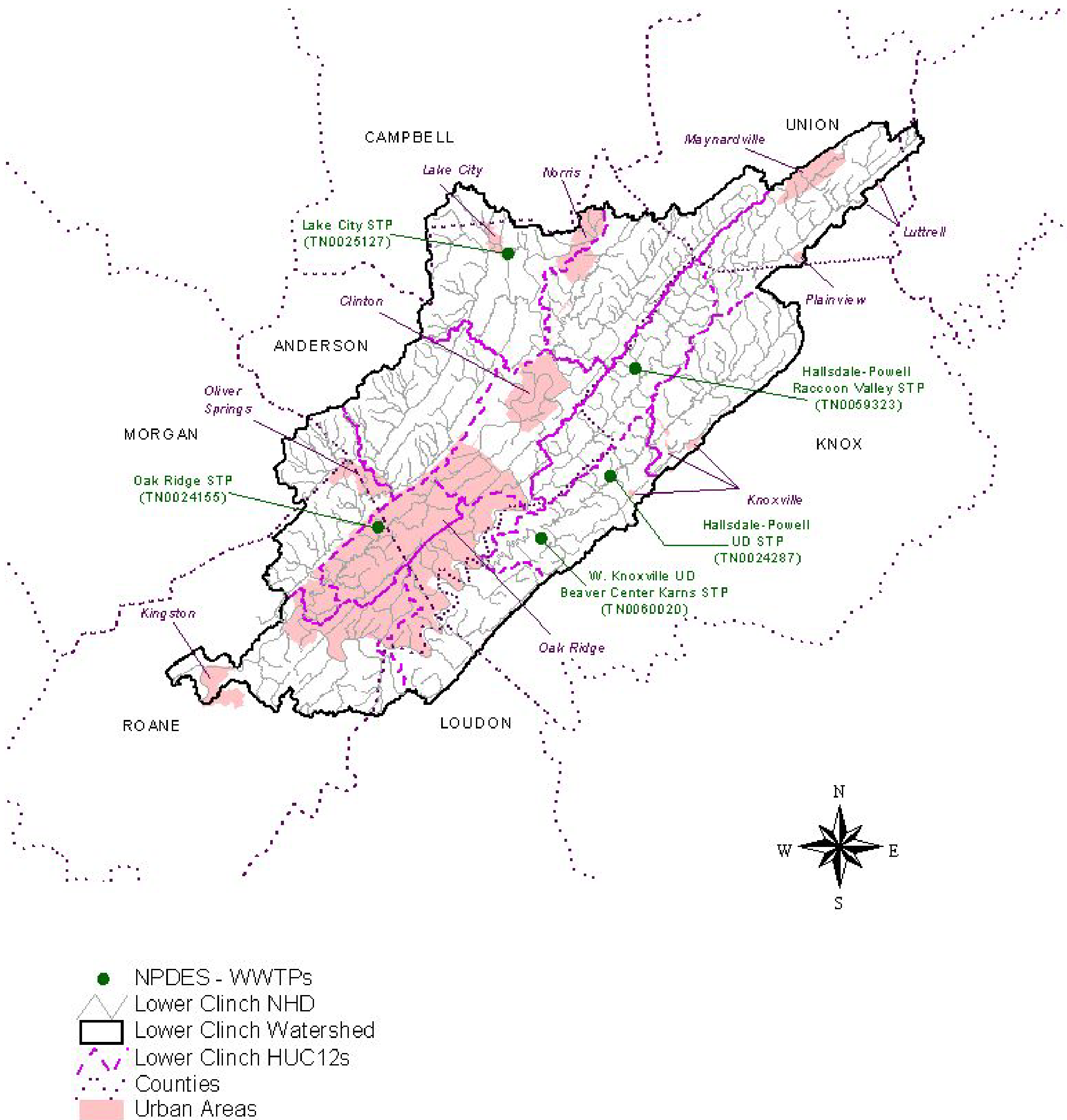

Figure 6. NPDES Regulated Point Sources in and near the Lower Clinch Watershed.

7.2 Nonpoint Sources

Nonpoint sources of coliform bacteria are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of coliform bacteria on land surfaces and wash off as a result of storm events. Nonpoint sources of pathogen loading are primarily associated with agricultural and urban land uses. The vast majority of waterbodies identified on the Final 2004 303(d) list as impaired due to E. coli are attributed to nonpoint agricultural or urban sources.

7.2.1 Wildlife

Wildlife deposit coliform bacteria, with their feces, onto land surfaces where it can be transported during storm events to nearby streams. The overall deer density for Tennessee was estimated by the Tennessee Wildlife Resources Agency (TWRA) to be 23 animals per square mile. In order to account for higher density areas and loading due to other species, a conservative density of 45 animals per square mile was used for modeling purposes. Fecal coliform loads due to deer are estimated by EPA to be 5.0×10^8 counts/animal/day.

7.2.2 Agricultural Animals

Agricultural activities can be a significant source of coliform bacteria loading to surface waters. The activities of greatest concern are typically those associated with livestock operations:

- Agricultural livestock grazing in pastures deposit manure containing coliform bacteria onto land surfaces. This material accumulates during periods of dry weather and is available for washoff and transport to surface waters during storm events. The number of animals in pasture and the time spent grazing are important factors in determining the loading contribution.
- Processed agricultural manure from confined feeding operations is often applied to land surfaces and can provide a significant source of coliform bacteria loading. Guidance for issues relating to manure application is available through the University of Tennessee Agricultural Extension Service and the Natural Resources Conservation Service (NRCS).
- Agricultural livestock and other unconfined animals often have direct access to waterbodies and can provide a concentrated source of coliform bacteria loading directly to a stream.

Potential data sources related to livestock operations include the 2002 Census of Agriculture, which was compiled for the Lower Clinch Watershed utilizing the Watershed Characterization System (WCS). WCS is an Arcview geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development. Livestock information provided in WCS is based on the ratio of watershed pasture area to county pasture area applied to the livestock population within the county. Livestock data for E. coli-impaired watersheds are summarized in Table 6. Populations were rounded to the nearest 25 cows, 50 poultry, and 5 hogs, sheep, and horses.

Table 6. Livestock Distribution in the Lower Clinch Watershed

Subwatershed	Livestock Population (WCS)					
	Beef Cow	Milk Cow	Poultry	Hogs	Sheep	Horse
Beaver Creek	2,100	150	0	145	110	615
Bull Run Creek	2,225	100	0	85	75	530
Hinds Creek	1,000	50	0	5	25	750
E.Fork Poplar Creek	425	25	0	5	10	40
Coal Creek	450	25	0	0	10	65

7.2.3 Failing Septic Systems

Some coliform loading in the Lower Clinch watershed can be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates from 1997 county census data of people in the Lower Clinch watershed utilizing septic systems were compiled using the WCS and are summarized in Table 7. In east Tennessee, it is estimated that there are approximately 2.37 people per household on septic systems, some of which can be reasonably assumed to be failing. As with livestock in streams, discharges of raw sewage provide a concentrated source of coliform bacteria directly to waterbodies.

Table 7. Population on Septic Systems in the Lower Clinch Watershed

Subwatershed	Population on Septic Systems
Beaver Creek	33,328
Bull Run Creek	19,260
Hinds Creek	8,365
E.Fork Poplar Creek	315
Coal Creek	4,745

7.2.4 Urban Development

Nonpoint source loading of coliform bacteria from urban land use areas is attributable to multiple sources. These include: stormwater runoff, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Impervious surfaces in urban areas allow runoff to be conveyed to streams quickly, without interaction with soils and groundwater. East Fork Poplar Creek has the highest percentage of urban land area for impaired waterbodies in the Lower Clinch watershed, with 15.8%. Land use for the Lower Clinch impaired drainage areas is summarized in Figures 7 thru 8 and tabulated in Appendix A.

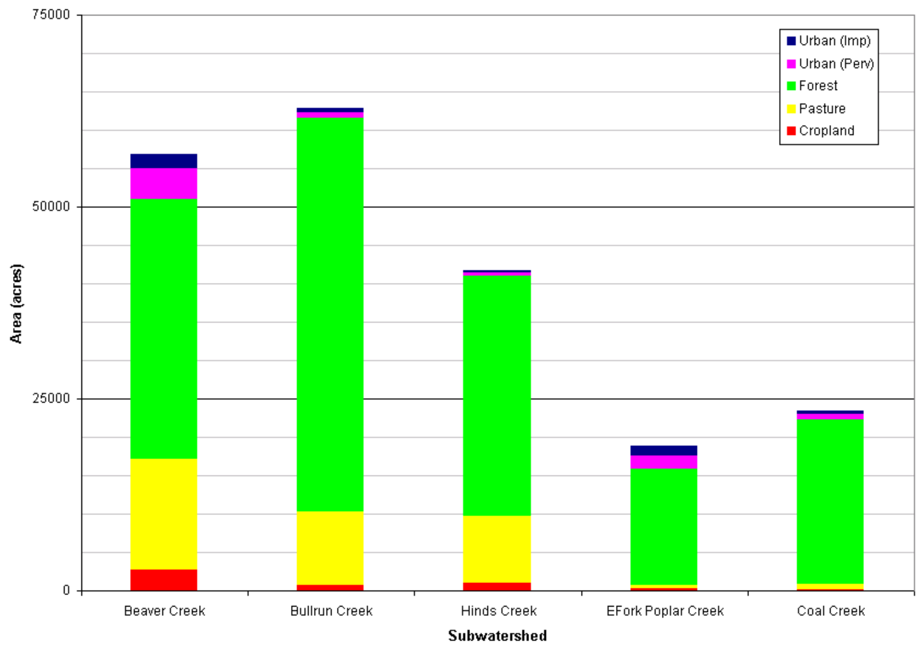

Figure 7. Land Use Area of Lower Clinch Pathogen-Impaired Subwatersheds.

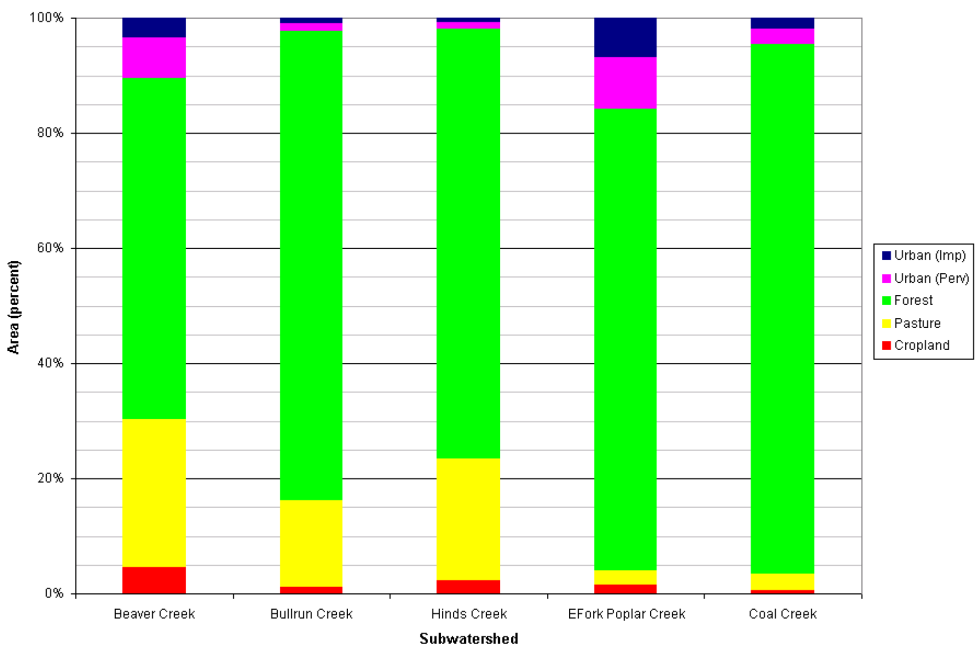

Figure 8. Land Use Percent of the Lower Clinch Pathogen-Impaired Subwatersheds.

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

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

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

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

This document describes pathogen TMDL, Waste Load Allocation (WLA), and Load Allocation (LA) development for waterbodies identified as impaired due to E. coli on the Final 2004 303(d) list. TMDL analyses are performed primarily on a 12-digit hydrologic unit area (HUC-12) basis for subwatersheds containing waterbodies identified as impaired due to E. coli on the Final 2004 303(d) list.

8.1 Expression of TMDLs, WLAs, & LAs

In this document, the pathogen TMDL is expressed as the percent reduction in instream loading required to decrease existing E. coli or fecal coliform concentrations to desired target levels. Target concentrations are equal to the desired water quality goals (see Section 5.0) minus the appropriate MOS. WLAs & LAs for precipitation-induced loading sources are also expressed as required percent reductions in pathogen loading. Allocations for loading that is independent of precipitation (WLAs for WWTFs and LAs for “other direct sources”) are expressed as counts/day.

8.2 TMDL Analysis Methodology

Establishing the relationship between in-stream water quality and source loading is an important component of TMDL development. It allows the determination of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling.

TMDLs for the Lower Clinch Watershed were developed using load duration curves for analysis of impaired waterbodies. A load duration curve (LDC) is a cumulative frequency graph that illustrates existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the portion of the waterbody flow regime represented by these existing loads. Load duration curves were considered to be well suited for analysis of periodic monitoring data collected by grab sample. LDCs were developed at monitoring site locations in impaired waterbodies and an overall load reduction calculated to meet E. coli and fecal coliform targets according to the methods described in Appendix C.

8.3 Critical Conditions and Seasonal Variation

The critical condition for non-point source fecal coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, fecal coliform bacteria builds up on the land surface, and is washed off by rainfall. The critical condition for point source loading occurs during periods of low streamflow when dilution is minimized. Both conditions are represented in the TMDL analysis.

The ten-year period from October 1, 1994 to September 30, 2004 was used to simulate flow. This 10-year period contained a range of hydrologic conditions that included both low and high streamflows. Critical conditions are accounted for in the load duration curve analysis by using the entire period of flow and water quality data available for the impaired waterbodies. In all subwatersheds, water quality data have been collected during most flow ranges. Based on the location of the water quality exceedances on the load duration curves (between the 10% and 60% duration intervals), point sources during wet weather events are the probable dominant delivery mode for pathogens in Beaver Creek and Coal Creek. However, for the remaining subwatersheds, the location of the water quality exceedances on the load duration curves does not indicate any dominant delivery mode for pathogens (see Section 9.3 and Table 11).

Seasonal variation was incorporated in the load duration curves by using the entire simulation period and all water quality data collected at the monitoring stations. The water quality data were not collected during all seasons.

8.4 Margin of Safety

There are two methods for incorporating an MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

An explicit MOS, equal to 10% of the E. coli and fecal coliform water quality goals (ref.: Section 5.0), was utilized for TMDL analysis. Explicit MOS and the resulting target concentrations are shown in Table 8.

Table 8. Explicit MOS and Target Concentrations

Pollutant	WQ Goal Type	WQ Goal [cts./100mL]	Explicit MOS [cts./100mL]	Target [cts./100mL]
E. coli	Maximum	941	94	847
	30-Day Geometric Mean	126	13	113
Fecal Coliform	Maximum	1,000	100	900
	30-Day Geometric Mean	200	20	180

8.5 Determination of TMDLs

E. coli and fecal coliform load reductions were calculated for impaired segments in the Lower Clinch Watershed using Load Duration Curves to evaluate compliance with the maximum target concentrations (Appendix C). When sufficient data were available, load reductions were also developed to achieve compliance with the 30-day geometric mean target concentrations (Appendix C). All of the instream load reductions for a particular waterbody were compared and the largest required load reduction was selected as the TMDL. These TMDL load reductions for the impaired segments are shown in Table 9 and are applied to the entire HUC-12 subwatershed in which the impaired waterbodies are located. In cases where the geometric mean could not be developed, it is assumed that achieving the load reduction based on the maximum target concentrations should result in attainment of the geometric mean criteria.

8.6 Determination of WLAs & LAs

WLAs & LAs are developed in Appendix E for point sources and nonpoint sources respectively. TMDLs, WLAs, & LAs for Lower Clinch Watershed impaired waterbodies are summarized in Table 10.

Table 9. Determination of TMDLs for Impaired Waterbodies, Lower Clinch Watershed

HUC-12 Subwatershed (06010103__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	Required Load Reduction				
			Based on 90th Percentile		Based on 30-day Geometric Mean		TMDL [%]
			Fecal Coliform	E. Coli	Fecal Coliform	E. Coli	
0302	BEAVER CREEK	TN06010207011 – 1000	**86.0**	**>65.0**			**86.0**
	BEAVER CREEK	TN06010207011 – 2000	**72.6**	**53.4**			
0301	BEAVER CREEK	TN06010207011 – 3000	**79.7**	**57.8**			**79.7**
0202	BULLRUN CREEK[a]	TN06010207014 – 1000	**NR**	**12.1**			**62.9**
0201	BULLRUN CREEK[a]	TN06010207014 – 3000	**NR**	**NR**			**45.6**
0102	HINDS CREEK	TN06010207016 – 3000	**4.7**	**11.3**	**22.9**	**49.3**	**49.3**
0503	EAST FORK POPLAR CREEK	TN06010207026 – 1000	**36.2**	**31.8**	**54.6**	**68.1**	**68.1**
	EAST FORK POPLAR CREEK	TN06010207026 – 2000	**36.2**	**31.8**	**54.6**	**68.1**	
0101	COAL CREEK	TN06010207029 – 1000	**48.9**	**56.2**	**21.8**	**33.8**	**56.2**

[a] Load reductions were determined based on comparison of the geometric mean of all monitoring data (excluding highest and lowest values) to the 30-day geometric mean target concentrations. Additional monitoring is recommended.

Table 10. WLAs & LAs for Lower Clinch Watershed, Tennessee

HUC-12 Subwatershed (06010103__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	WLAs				LAs	
			WWTFs[a] (Monthly Avg.) E. Coli	Leaking Collection Systems[b]	CAFOs	MS4s[c]	Precipitation Induced Nonpoint Sources	Other Direct Sources[d]
			[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
0302	BEAVER CREEK	TN06010207011 – 1000 & 2000	**6.200 x 10^{10}**	**0**	**NA**	**86.0**	**86.0**	**0**
0301	BEAVER CREEK	TN06010207011 – 3000	**NA***	**NA**	**NA**	**79.7**	**79.7**	**0**
0202	BULL RUN CREEK[e]	TN06010207014 – 1000	**1.431 x 10^{9}**	**0**	**NA**	**62.9**	**62.9**	**0**
0201	BULL RUN CREEK[e]	TN06010207014 – 3000	**NA***	**NA**	**NA**	**NA**	**45.6**	**0**
0102	HINDS CREEK	TN06010207016 – 3000	**NA***	**NA**	**NA**	**49.5**	**49.5**	**0**
0503	EAST FORK POPLAR CREEK	TN06010207026 – 1000 & 2000	**4.769 x 10^{10}**	**0**	**NA**	**68.1**	**68.1**	**0**
0101	COAL CREEK	TN06010207029 – 1000	**4.531 x 10^{9}**	**0**	**NA**	**56.2**	**56.2**	**0**

Note: NA = Not Applicable.
* Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.
a. WLAs for WWTFs expressed as E. coli loads (counts/day).
b. The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.
c. Applies to any MS4 discharge loading in the subwatershed.
d. The objective for all “other direct sources” is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.
e. Load reductions were determined based on comparison of the geometric mean of all monitoring data (excluding highest and lowest values) to the 30-day geometric mean target concentrations. Additional monitoring is recommended.

9.0 IMPLEMENTATION PLAN

The TMDLs, WLAs, and LAs developed in Section 8 are intended to be the first phase of a long-term effort to restore the water quality of impaired waterbodies in the Lower Clinch watershed through reduction of excessive pathogen loading. Adaptive management methods, within the context of the State's rotating watershed management approach, will be used to modify TMDLs, WLAs, and LAs as required to meet water quality goals.

9.1 Point Sources

9.1.1 NPDES Regulated Municipal and Industrial Wastewater Treatment Facilities

All present and future discharges from industrial and municipal wastewater treatment facilities are required to be in compliance with the conditions of their NPDES permits at all times. In Tennessee, permit limits for treated sanitary wastewater require compliance with coliform water quality standards (ref: Section 5.0) prior to discharge. No additional reduction is required. WLAs for WWTFs are expressed as average loads in counts per day. WLAs are derived from facility design flows and permitted E. coli limits.

In order to meet water quality criteria for waterbodies in the Lower Clinch watershed, all STPs must meet the provisions of their NPDES permits, including elimination of bypasses and overflows.

9.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

For regulated discharges from municipal separate storm sewer systems, WLAs will be implemented through Phase I & II MS4 permits. These permits will require the development and implementation of a Storm Water Management Program (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards. The *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2002) was issued on February 27, 2003 and requires SWMPs to include six minimum control measures:

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

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

BMPs to control pollutants of concern must also be identified. In addition, MS4s must implement the WLA provisions of an applicable TMDL and describe methods to evaluate whether storm water controls are adequate to meet the WLA.

Implementation of the coliform WLAs for MS4s in this TMDL document will require effluent or instream monitoring to evaluate SWMP effectiveness with respect to reduction of pathogen loading.

9.1.3 NPDES Regulated Concentrated Animal Feeding Operations (CAFOs)

WLAs provided to CAFOs will be implemented through NPDES Permit No. TNA000000, General NPDES Permit for *Class II Concentrated Animal Feeding Operation* or the facility's individual permit. Among the provisions of the general permit are:

- Development and implementation of a site-specific Nutrient Management Plan (NMP) that:
    - Includes best management practices (BMPs) and procedures necessary to implement applicable limitations and standards;
    - Ensures adequate storage of manure, litter, and process wastewater including provisions to ensure proper operation and maintenance of the storage facilities.
    - Ensures proper management of mortalities (dead animals);
    - Ensures diversion of clean water, where appropriate, from production areas;
    - Identifies protocols for manure, litter, wastewater and soil testing;
    - Establishes protocols for land application of manure, litter, and wastewater;
    - Identifies required records and record maintenance procedures.

  The NMP must submitted to the State for approval and a copy kept on-site.

- Requirements regarding manure, litter, and wastewater land application BMPs.

- Requirements for the design, construction, operation, and maintenance of CAFO liquid waste management systems that are constructed, modified, repaired, or placed into operation after April 13, 2006. The final design plans and specifications for these systems must meet or exceed standards in the NRCS Field Office Technical Guide and other guidelines as accepted by the Departments of Environment and Conservation, or Agriculture.

Provisions of individual CAFO permits are similar. NPDES Permit No. TNA000000, *Class II Concentrated Animal Feeding Operation General Permit* is available on the TDEC website at http://www.state.tn.us/environment/wpc/programs/cafo/.

9.2 Nonpoint Sources

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

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

BMPs have been utilized in the Lower Clinch watershed to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. These BMPs (e.g., animal waste management systems, waste utilization, stream stabilization, fencing, heavy use area treatment, livestock exclusion, etc.) may have contributed to reductions in in-stream concentrations of coliform bacteria in the Lower Clinch watershed during the TMDL evaluation period. The TDA keeps a database of BMPs implemented in Tennessee. Those listed in the Lower Clinch watershed are shown in Figure 9. It is recommended that additional information (e.g., livestock access to streams, manure application practices, etc.) be provided and evaluated to better identify and quantify agricultural sources of coliform bacteria loading in order to minimize uncertainty in future modeling efforts.

It is further recommended that BMPs be utilized to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. Demonstration sites for various types of BMPs should be established, maintained, and evaluated (performance in source reduction) over a period of at least two years prior to recommendations for utilization for subsequent implementation. E. coli sampling and monitoring are recommended during low-flow (baseflow) and storm periods at sites with and without BMPs and/or before and after implementation of BMPs.

An excellent example of stakeholder involvement and action for the development of TMDLs is described in *Beaver Creek Watershed Assessment* (Knox County Engineering and Public Works, 2003). Knox County Engineering and Public Works and Knox County Parks and Recreation partnered with the Knox Land and Water Conservancy (KLWC) and other interested organizations to conduct an assessment of the Beaver Creek watershed. As part of this study, sample data were collected in the Beaver Creek watershed for water quality parameters necessary to generate TMDLs for nutrients and pathogens. The results of the study will help Knox County plan more effectively for flood control, water quality, and allocation of land for open space, recreation and trails. Copies of the report are available at various branches of the Knox County Public Library.

9.3 Application of Load Duration Curves for Implementation Planning

The Load Duration Curve methodology (Appendix C) is a form of water quality analysis and presentation of data that aids in guiding implementation by targeting strategies to appropriate flow conditions. One of the strengths of this method is that it can be used to interpret possible delivery mechanisms of pathogens by differentiating between point and non-point problems. The E. coli load duration analysis was utilized for implementation planning. The E. coli load duration curve for each pathogen-impaired subwatershed (Figures 10 thru 17) was analyzed to determine the frequency with which water quality monitoring data exceed the E. coli target maximum concentration of 847 counts/100 mL (standard – MOS) under five flow conditions (low, dry, mid-range, moist, and high).

Table 11 presents Load Duration analysis statistics for E. coli in the Lower Clinch Watershed and targeted implementation strategies for each source category covering the entire range of flow (Stiles, 2003). Each implementation strategy addresses a range of flow conditions and targets point sources, non-point sources, or a combination of each. Results indicate the implementation strategy for Beaver Creek and Coal Creek will require BMPs targeting primarily non-point sources (dominant under high flow/runoff condition), while the implementation strategy for the remaining subwatersheds will require BMPs targeting a variety of sources. The implementation strategies listed in Table 11 are a subset of the categories of BMPs and implementation strategies available for application to the pathogen-impaired Lower Clinch watersheds for reduction of pathogen loading and mitigation of water quality impairment.

See Appendix C for a detailed discussion of the Load Duration Curve Methodology applied to the Lower Clinch Watershed.

9.4 Additional Monitoring

Documenting progress in reducing the quantity of pathogens entering the Lower Clinch watershed is an essential element of the TMDL Implementation Plan. Additional monitoring and assessment activities are recommended to determine whether implementation of TMDLs, WLAs, & LAs in tributaries and upstream reaches will result in achievement of instream water quality targets for fecal coliform and/or E. coli. Future monitoring activities should be representative of all seasons and a full range of flow and meteorological conditions. Monitoring activities should also be adequate to assess water quality using the 30-day geometric mean standard.

Tennessee's watershed management approach specifies a five-year cycle for planning and assessment. Each watershed will be examined (or re-examined) on a rotating basis. Generally, in years two and three of the five-year cycle, water quality data are collected in support of water quality assessment (including TMDL development) and planning activities. Therefore, a watershed TMDL is developed one to two years prior to commencement of the next cycle's monitoring period.

Additional sampling for both fecal coliform and E. coli is recommended to aid in a better understanding of the relationship between fecal coliform concentration and E. coli concentration.

Additional monitoring and assessment activities are recommended for all subwatersheds. Examination of monitoring data indicates that few sampling events have occurred during periods of high flow or low flow. Once additional monitoring representing all seasons and a full range of flow and meteorological conditions has been obtained, the required load reductions may be revised.

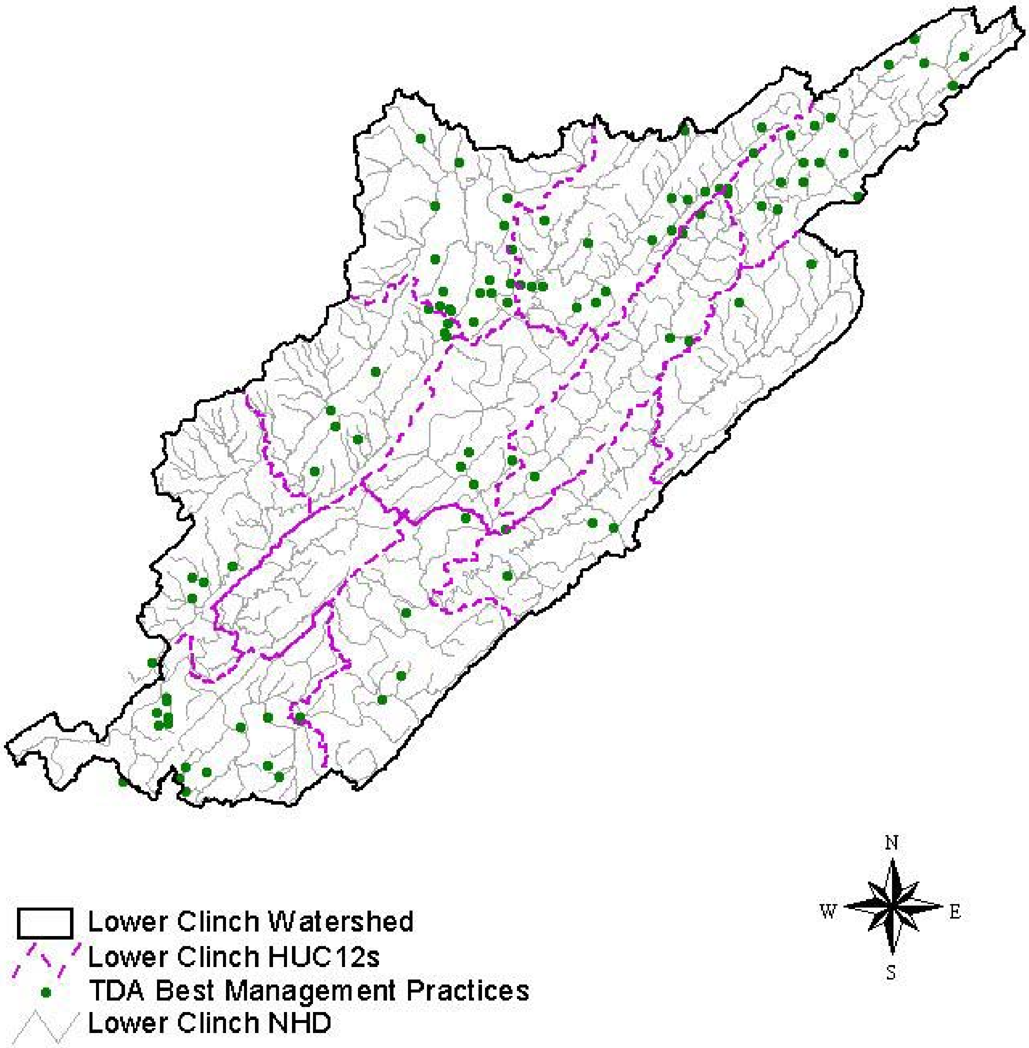

Figure 9. Tennessee Department of Agriculture Best Management Practices located in the Lower Clinch Watershed.

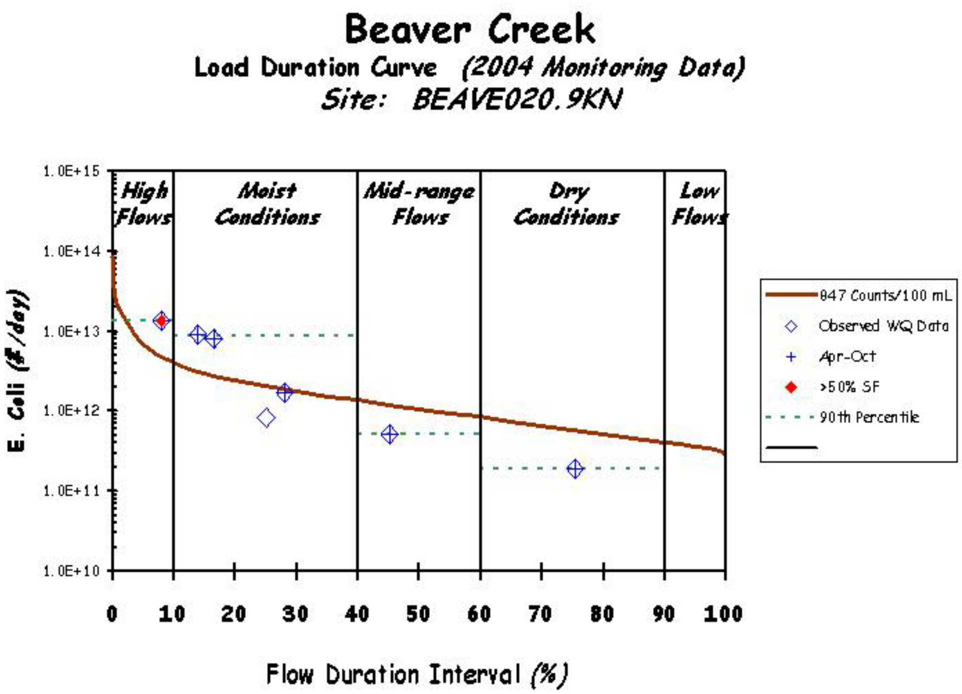

Figure 10. Load Duration Curve for Beaver Creek (Mile 20.9)

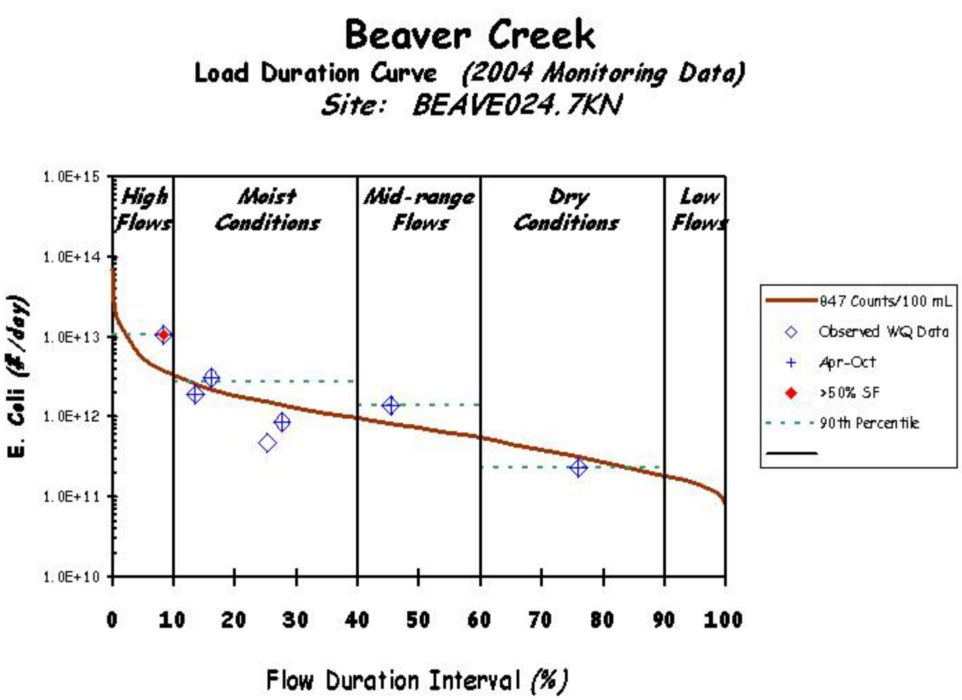

Figure 11. Load Duration Curve for Beaver Creek (Mile 24.7)

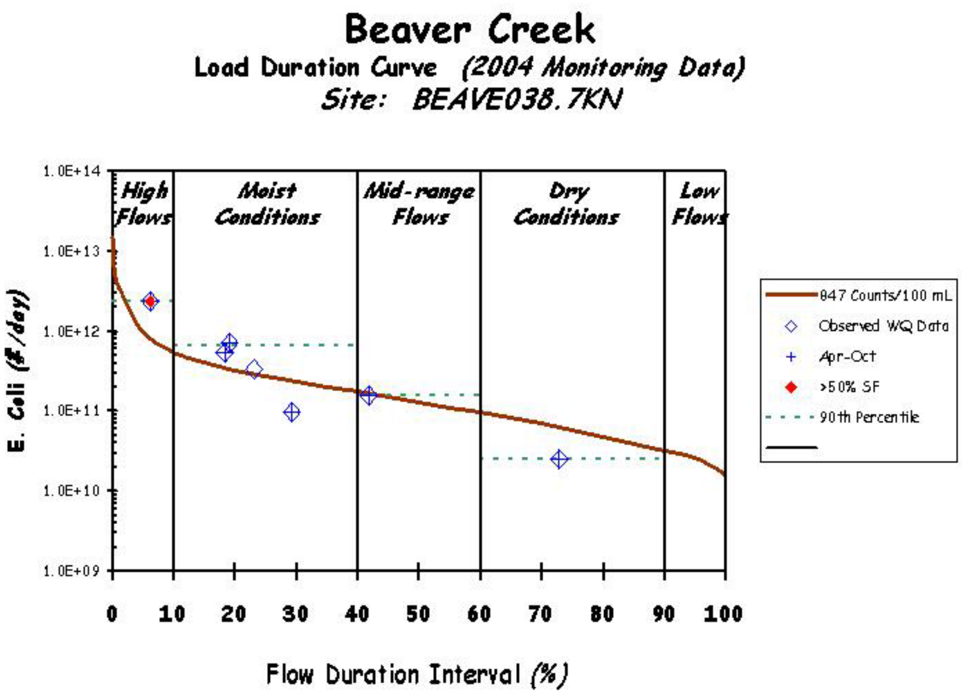

Figure 12. Load Duration Curve for Beaver Creek (Mile 38.7)

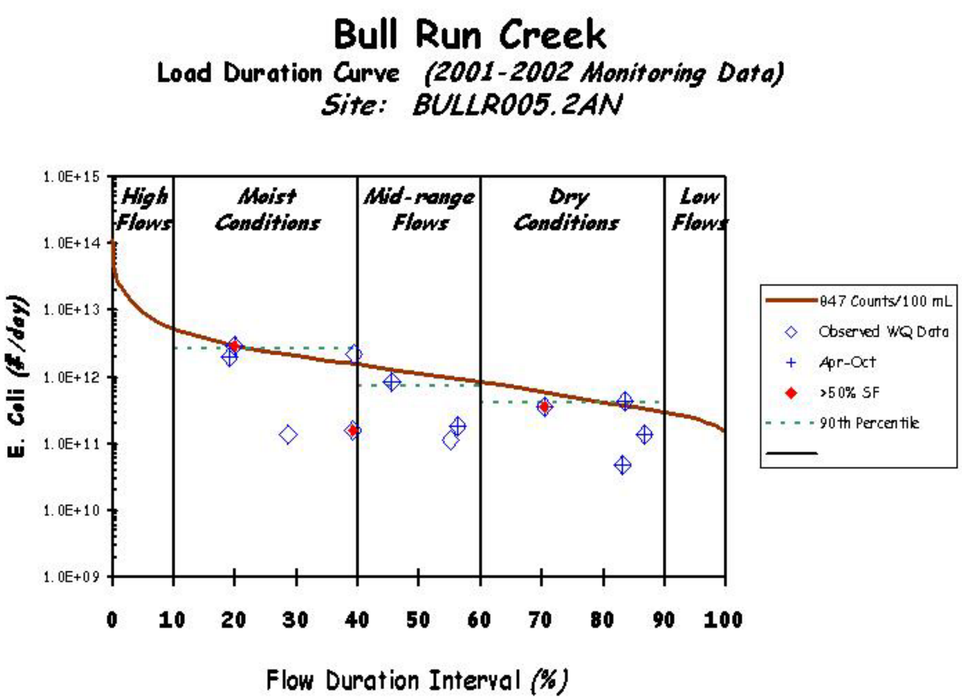

Figure 13. Load Duration Curve for Bull Run Creek (Mile 5.2)

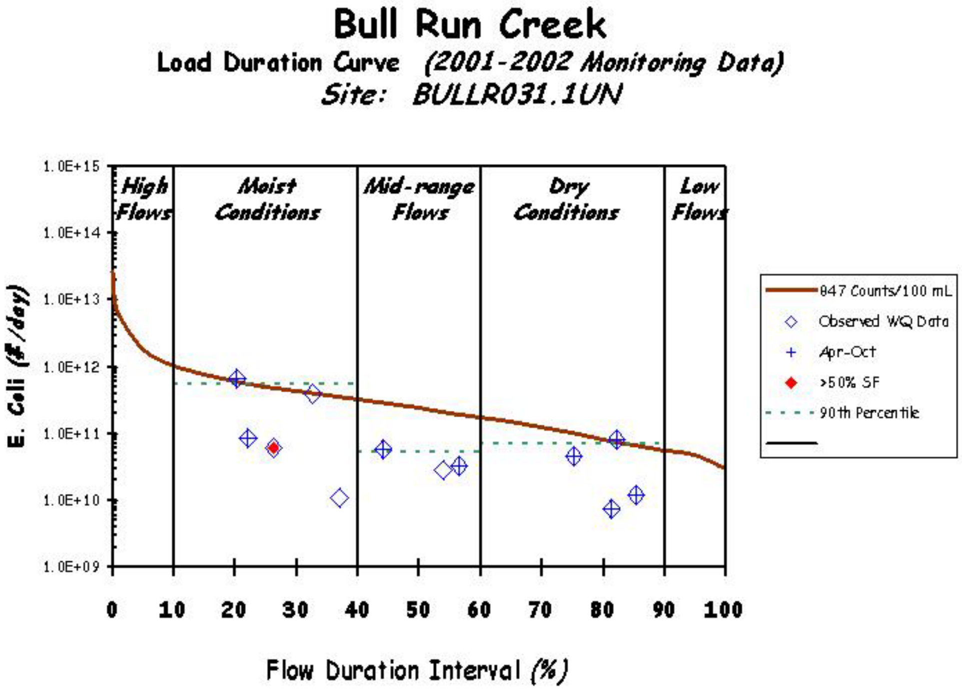

Figure 14. Load Duration Curve for Bull Run Creek (Mile 31.1)

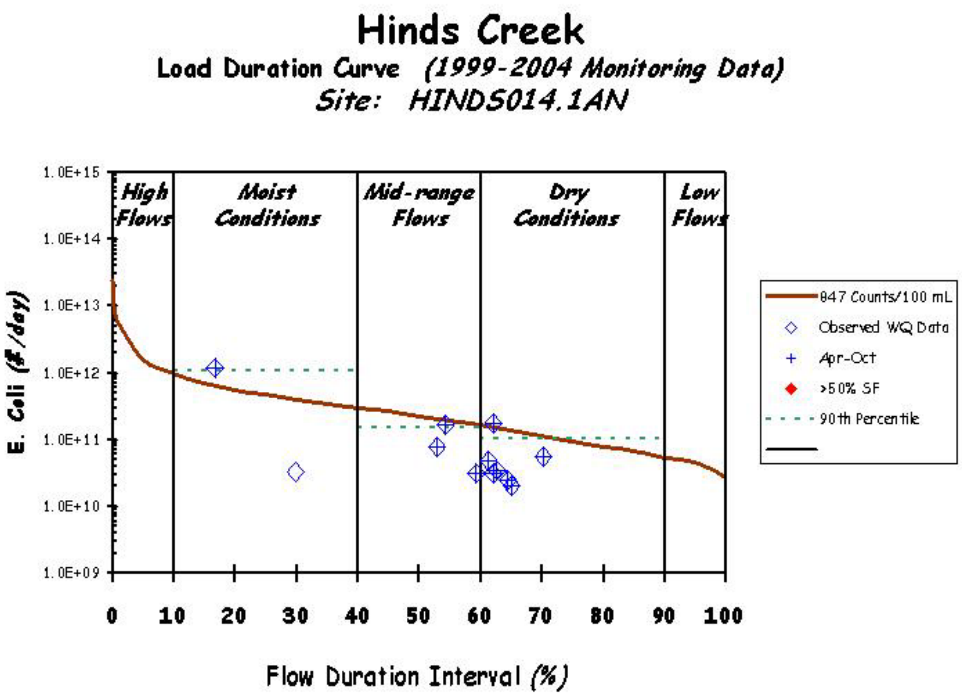

Figure 15. Load Duration Curve for Hinds Creek

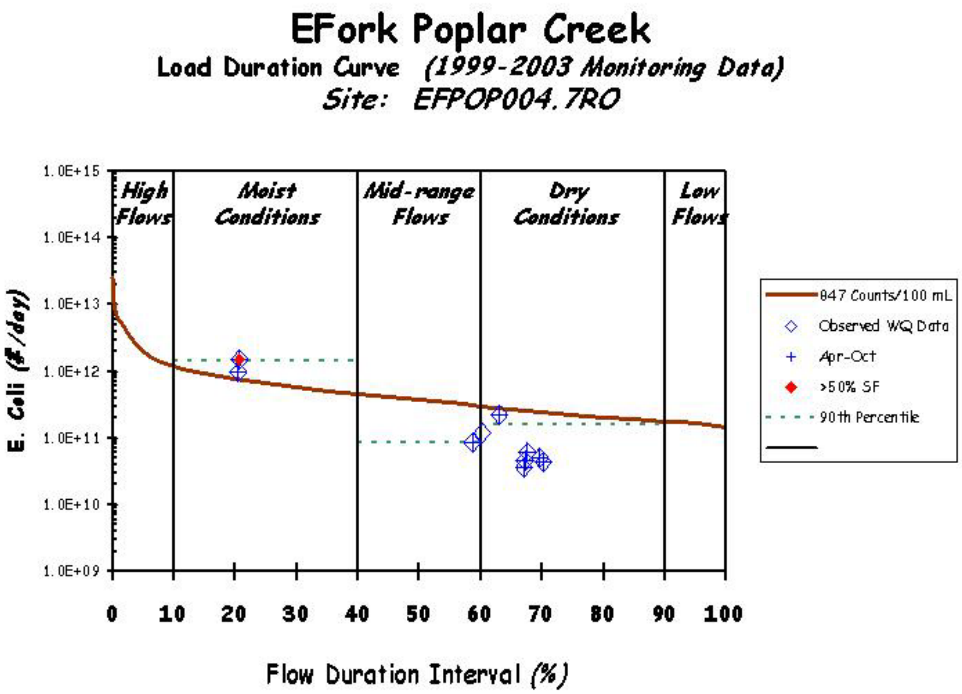

Figure 16. Load Duration Curve for E. Fork Poplar Creek

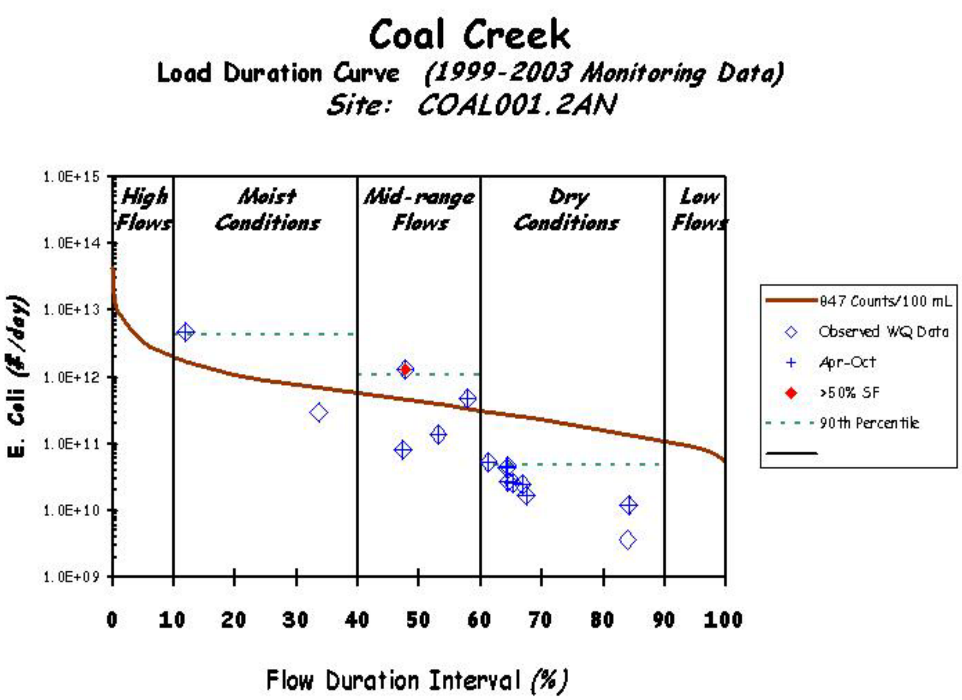

Figure 17. Load Duration Curve for Coal Creek

9.5 Source Identification

An important aspect of pathogen load reduction activities is the accurate identification of the actual sources of pollution. In cases where the sources of pathogen impairment are not readily apparent, Microbial Source Tracking (MST) is one approach to determining the sources of fecal pollution and pathogens affecting a waterbody. Those methods that use bacteria as target organisms are also known as Bacterial Source Tracking (BST) methods. This technology is recommended for source identification in E. coli impaired waterbodies.

Bacterial Source Tracking is a collective term used for various emerging biochemical, chemical, and molecular methods that have been developed to distinguish sources of human and non-human fecal pollution in environmental samples (Shah, 2004). In general, these methods rely on genotypic (also known as "genetic fingerprinting"), or phenotypic (relating to the physical characteristics of an organism) distinctions between the bacteria of different sources. Three primary genotypic techniques are available for BST: ribotyping, pulsed field gel electrophoresis (PFGE), and polymerase chain reaction (PCR). Phenotypic techniques generally involve an antibiotic resistance analysis (Hyer, 2004).

The USEPA has published a fact sheet that discusses BST methods and presents examples of BST application to TMDL development and implementation (USEPA, 2002b). Various BST projects and descriptions of the application of BST techniques used to guide implementation of effective BMPs to remove or reduce fecal contamination are presented. The fact sheet can be found on the following EPA website: http://www.epa.gov/owm/mtb/bacsortk.pdf.

A multi-disciplinary group of researchers is developing and testing a series of different microbial assay methods based on real-time PCR to detect fecal bacterial concentrations and host sources in water samples (McKay, 2005). The assays have been used in a study of fecal contamination and have proven useful in identification of areas where cattle represent a significant fecal input and in development of BMPs. It is expected that these types of assays could have broad applications in monitoring fecal impacts from Animal Feeding Operations, as well as from wildlife and human sources. Other BST projects have been conducted or are currently in progress throughout the state of Tennessee, as presented in sessions of the Thirteenth Tennessee Water Resources Symposium (Lawrence, 2003) and the Fifteenth Tennessee Water Resources Symposium (Bailey, 2005; Baldwin, 2005; Farmer, 2005).

9.6 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 pathogen loading reduction measures can be evaluated. Additional monitoring data, ground-truthing activities, and bacterial source identification actions are recommended to enable implementation of particular types of BMPs to be directed to specific areas in impaired subwatersheds. This will optimize utilization of resources to achieve maximum reductions in pathogen loading. These TMDLs will be re-evaluated during subsequent watershed cycles and revised as required to assure attainment of applicable water quality standards.

Table 11. Load Duration Curve Summary for E.Coli and/or Fecal Coliform Impaired Segments

Flow Condition		High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded		0-10	10-40	40-60	60-90	90-100
Beaver Creek at Mile 20.9	% Samples > 941 Counts/100 mL[1]	100.0	50.0	0.0	0.0	NA
Coal Creek	% Samples > 941 Counts/100 mL[1]	NA	50.0	50.0	0.0	NA
Example Implementation Strategies						
Municipal NPDES			L	M	H	H
Stormwater Management			H	H	H	
SSO Mitigation		H	H	M	L	
Collection System Repair			L	M	H	H
Septic System Repair			L	M	H	M
Livestock Exclusion[2]				M	H	H
Pasture Management/Land Application of Manure[2]		H	H	M	L	
Riparian Buffers[2]			H	H	H	
		Potential for source area contribution under given hydrologic condition (H: High; M: Medium; L: Low)				

[1] Tennessee maximum daily water quality standard for E.coli (941 Counts/100 mL).
[2] Example Best Management Practices (BMPs) for Agricultural Source reduction. Actual BMPs applied may vary.

10.0 PUBLIC PARTICIPATION

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

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

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings which is sent to approximately 90 interested persons or groups who have requested this information.

3) Letters were sent to WWTFs located in or near pathogen-impaired subwatersheds in the Lower Clinch watershed, permitted to discharge treated effluent containing pathogens, advising them of the proposed TMDLs and their availability on the TDEC website. The letters also stated that a copy of the draft TMDL document would be provided on request. A letter was sent to the following facilities:

   Hallsdale-Powell STP (TN0024287)
   Hallsdale-Powell Raccoon Valley STP (TN0059323)
   Lake City STP (TN0025127)
   Oak Ridge STP (TN0024155)
   West Knoxville UD – Beaver Center Karns STP (TN0060020)

4) A draft copy of the proposed TMDL was sent to those MS4s that are wholly or partially located in pathogen-impaired subwatersheds. A draft copy was sent to the following entities:

   Anderson County, Tennessee (TNS075108)
   Knox County, Tennessee (TNS075582)
   Loudon County, Tennessee (TNS075591)
   Tennessee Dept. of Transportation (TNS077585)

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

   Clinch River Chapter of Trout Unlimited
   Beaver Creek Watershed Association
   Beaver Creek Task Force
   Bullrun Creek Watershed Association
   Bullrun Creek Restoration Initiative
   Coal Creek Watershed Foundation
   Hinds Creek Watershed Partnership
   Oak Ridge Reservation Local Oversight Committee
   Tennessee Citizens for Wilderness Planning

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

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APPENDIX A

Land Use Distribution in the Lower Clinch Watershed

Table A-1. MRLC Land Use Distribution of Lower Clinch Subwatersheds

Land Use	Lower Clinch Subwatersheds					
	Beaver Creek		Bullrun Creek		Hinds Creek	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Deciduous Forest	9,922	17.4	30,122	47.9	15,284	36.6
Evergreen Forest	8,762	15.4	7,301	11.6	5,537	13.3
High Intensity Commercial/Industrial/Transp.	1,413	2.5	480	0.8	285	0.7
High Intensity Residential	440	0.8	67	0.1	8	0.0
Low Intensity Residential	4,033	7.1	839	1.3	479	1.2
Mixed Forest	12,348	21.7	13,220	21.0	9,626	23.1
Open Water	26	0.1	15	0.0	7	0.0
Other Grasses (Urban/recreation; e.g. parks)	2,747	4.8	5,89	0.9	594	1.4
Pasture/Hay	14,556	25.6	9,519	15.1	8,796	21.1
Quarries/Strip Mines/Gravel Pits	20	0.0	0	0.0	152	0.4
Row Crops	2,656	4.7	711	1.1	959	2.3
Transitional	22	0.0	42	0.1	41	0.1
Total	56,946	100.0	62,905	100.0	41,768	100.0

Table A-1 (Cont.). MRLC Land Use Distribution of Lower Clinch Subwatersheds

Land Use	Lower Clinch Subwatersheds			
	EFork Poplar Creek		Coal Creek	
	[acres]	[%]	[acres]	[%]
Deciduous Forest	7,560	40.1	13,656	58.3
Evergreen Forest	3,490	18.5	2,011	8.6
High Intensity Commercial/Industrial/Transp.	1,083	5.7	342	1.5
High Intensity Residential	250	1.3	96	0.4
Low Intensity Residential	1,641	8.7	636	2.7
Mixed Forest	3,566	18.9	5,565	23.8
Open Water	15	0.1	12	0.1
Other Grasses (Urban/recreation; e.g. parks)	484	2.6	255	1.1
Pasture/Hay	457	2.4	691	3.0
Quarries/Strip Mines/Gravel Pits	0	0.0	1	0.0
Row Crops	299	1.6	120	0.5
Transitional	33	0.2	36	0.2
Total	18,878	100.0	23,420	100.0

APPENDIX B

Water Quality Monitoring Data

There are a number of water quality monitoring stations that provide data for waterbodies identified as impaired for pathogens in the Lower Clinch watershed. The location of these monitoring stations is shown in Figure 5. Monitoring data recorded by TDEC at these stations are tabulated in Table B-1. Monitoring data recorded by TVA at these stations are tabulated in Table B-2

Table B-1. TDEC Water Quality Monitoring Data – Lower Clinch Subwatersheds

Monitoring Station	Date	E. Coli [cts./100 mL]	Fecal Coliform [cts./100 mL]
BEAVE003.5KN	2/23/99	147	36
	3/23/99	147	120
	4/26/99	79	82
	6/3/99	261	230
	7/27/99	172	200
	7/28/99	196	480
	8/24/99	187	172
	9/30/99	250	260
	10/25/99	88	98
	12/2/99	179	196
	1/25/00	66	50
	3/4/04	488	84
	4/13/04	>2419	4800
	5/4/04	1553	1700
	5/25/04	86	100
	6/29/04	313	200
	7/14/04	770	900
	8/3/04	435	540
BEAVE010.1KN	2/23/99	114	68
	3/23/99	435	270
	4/26/99	228	144
	6/3/99	649	1500
	7/27/99	199	320
	7/28/99	687	500
	8/24/99	613	320
	9/30/99	548	460
	10/25/99	132	138
	12/2/99	387	500
	1/25/00	548	420
BEAVE012.5KN	2/23/99	44	54
	3/23/99	816	232
	4/26/99	461	350

Monitoring Station	Date	E. Coli [cts./100 mL]	Fecal Coliform [cts./100 mL]
BEAVE012.5KN (cont'd)	6/3/99	866	1000
	7/27/99	276	300
	7/28/99	240	370
	8/24/99	291	290
	9/30/99	249	380
	10/25/99	91	161
	12/6/99	194	340
	1/25/00	84	100
	3/4/04	1046	190
BEAVE013.5KN	4/13/04	>2419	5600
	5/4/04	866	560
	5/25/04	210	260
	6/29/04	416	300
	7/14/04	548	1300
	8/3/04	579	720
BEAVE020.9KN	3/4/04	345	280
	4/13/04	>2419	7400
	5/4/04	>2419	1600
	5/25/04	279	5800
	6/29/04	>2419	520
	7/14/04	365	300
	8/3/04	770	1100
BEAVE023.5KN	2/23/99	76	92
	3/23/99	>2419	470
	4/26/99	687	400
	6/3/99	1046	1700
	7/27/99	727	1200
	7/28/99	866	600
	8/24/99	687	420
	9/30/99	179	260
	10/25/99	19	8
	12/6/99	285	320
	1/25/00	326	410
BEAVE023.6KN	2/23/99	91	120
	3/23/99	102	128
	4/26/99	816	720

Monitoring Station	Date	E. Coli [cts./100 mL]	Fecal Coliform [cts./100 mL]
BEAVE023.6KN (cont'd)	6/3/99	1986	2000
	7/27/99	411	900
	7/28/99	866	730
	8/24/99	980	1400
	9/30/99	548	420
	10/25/99	517	510
	12/6/99	816	1300
	1/25/00	816	550
BEAVE024.7KN	3/4/04	261	220
	4/13/04	>2419	6500
	5/4/04	1203	1140
	5/25/04	613	350
	6/29/04	649	380
	7/14/04	1414	1000
	8/3/04	517	530
BEAVE031.8KN	2/23/99	113	104
	3/23/99	101	72
	4/26/99	308	370
	6/3/99	1553	2100
	7/27/99	649	420
	7/28/99	313	370
	8/24/99	1553	2800
	9/30/99	201	260
	10/25/99	117	156
	12/6/99	579	590
	1/25/00	1986	1580
	3/4/04	148	174
	4/13/04	>2419	6800
	5/4/04	727	580
	5/25/04	921	340
	6/29/04	980	800
	7/14/04	687	1500
	8/3/04	1203	1000
BEAVE036.7KN	2/23/99	135	136
	3/23/99	83	48
	4/26/99	308	300

Monitoring Station	Date	E. Coli	Fecal Coliform
		[cts./100 mL]	[cts./100 mL]
BEAVE036.7KN (cont'd)	6/3/99	>2419	5000
	7/27/99	548	440
	7/28/99	326	390
	8/24/99	687	620
	9/30/99	238	330
	10/25/99	313	300
	12/6/99	197	240
	1/25/00	79	100
BEAVE038.7KN	3/4/04	980	600
	4/13/04	>2419	9800
	5/4/04	1733	850
	5/27/04	345	350
	6/29/04	1300	800
	7/14/04	816	750
	8/3/04	345	160
BEAVE040.1KN	2/23/99	148	132
	3/23/99	1046	800
	4/26/99	411	310
	6/3/99	1733	1900
	7/27/99	613	600
	7/28/99	5779	430
	8/24/99	>2419	5500
	9/30/99	248	260
	10/25/99	548	640
	12/6/99	980	1000
	1/25/00	144	120
BULLR005.2KN	2/25/99	35	44
	4/20/99	109	194
	6/22/99	579	600
	8/18/99	0.02	400
	12/28/99	33	40
	9/27/01	548	
	10/30/01	112	
	12/12/01	1203	
	7/15/02	816	
	10/7/02	517	

Monitoring Station	Date	E. Coli [cts./100 mL]	Fecal Coliform [cts./100 mL]
BULLR016.2KN	12/6/99	146	156
	9/27/01	517	
	10/30/01	71	
	12/12/01	1733	
	7/15/02	687	
	10/7/02	291	
BULLR29.6UN	9/27/01	219	
	10/30/01	73	
	12/12/01	679	
	7/15/02	980	
	10/7/02	161	
BULLR031.1UN	12/12/01	866	
	7/15/02	921	
BULLR034.1UN	12/6/99	194	200
COAL001.2AN	2/25/99	361	530
	4/20/99	148	270
	6/22/99	76	430
	8/18/99	81	94
	12/28/99	22	30
	7/24/03	1203	1400
	8/27/03	141	260
	9/9/03	292	340
	9/18/03	131	192
	9/24/03	>2419	3000
	10/16/03	150	210
	10/21/03	84	158
	10/23/03	58	92
	10/27/03	2419	2000
	10/30/03	82	106
COAL005.4AN	2/25/99	150	150
	7/24/03	411	800
	8/27/03	387	420
	9/9/03	1414	1500
	9/18/03	178	268
	9/24/03	816	620
	10/16/03	238	320

Monitoring Station	Date	E. Coli [cts./100 mL]	Fecal Coliform [cts./100 mL]
COAL005.4AN (cont'd)	10/21/03	2419	2300
	10/23/03	411	550
	10/27/03	1300	1100
	10/30/03	222	260
COAL010.6AN	2/25/99	155	1000
	7/24/03	85	174
	8/27/03	259	240
	9/9/03	687	640
	9/18/03	687	720
	9/24/03	299	490
	10/16/03	96	154
	10/21/03	214	240
	10/23/03	155	260
	10/27/03	980	1100
	10/30/03	57	172
EFPOP003.9RO	1/4/00	119	120
EFPOP004.7RO	7/24/03	345	440
	8/27/03	114	120
	9/9/03	236	122
	9/18/03	147	122
	9/24/03	1120	1300
	10/16/03	649	660
	10/21/03	167	176
	10/23/03	152	176
	10/27/03	1733	2400
	10/30/03	194	200
HINDS000.7AN	2/25/99	131	120
	4/20/99	236	240
	6/22/99	291	360
	8/18/99	186	188
	12/28/99	27	24
	7/24/03	1986	2000
	8/27/03	1553	2000
	9/9/03	687	690
	9/24/03	291	190
	9/24/03	1733	1900

Monitoring Station	Date	E. Coli [cts./100 mL]	Fecal Coliform [cts./100 mL]
HINDS000.7AN (cont'd)	10/16/03	140	116
	10/21/03	649	620
	10/23/03	1414	1200
	10/27/03	1120	1300
	10/30/03	411	420
	9/14/04	365	200
HINDS006.8AN	2/25/99	55	54
	7/24/03	1203	1900
	8/27/03	144	178
	9/9/03	272	360
	9/18/03	105	102
	9/24/03	>2419	2100
	10/16/03	387	490
	10/21/03	86	72
	10/23/03	130	120
	10/27/03	687	900
	10/30/03	59	48
	9/14/04	184	250
HINDS012.6AN	2/25/99	125	188
	9/14/04	142	120
HINDS014.1AN	2/25/99	68	90
	7/24/03	727	440
	8/27/03	260	250
	9/9/03	316	420
	9/18/03	173	144
	9/24/03	1553	1700
	10/16/03	158	170
	10/21/03	147	102
	10/23/03	125	118
	10/27/03	980	1000
	10/30/03	194	340
	9/14/04	411	360
HINDS020.7UN	9/14/04	356	300

Table B-2. TVA Water Quality Monitoring Data – Lower Clinch Subwatersheds

Monitoring Station	Date	E. Coli [cts./100 mL]	Fecal Coliform [cts./100 mL]
BULLR005.2KN (Bull Run @ Hwy 25 bridge)	9/27/01	548	25
	10/30/01	112	85
	12/12/01	1203	560
	1/9/02	101	85
	2/6/02	54	30
	3/13/02	86	25
	4/24/02	167	80
	5/8/02	548	170
	6/24/02	980	330
	7/15/02	816	313
	8/12/02	345	213
	10/7/02	517	540
BULLR016.2KN (Bull Run @ Hwy 441 bridge)	9/27/01	517	360
	10/30/01	71	30
	12/12/01	1733	610
	1/9/02	41	65
	2/6/02	42	30
	3/13/02	82	45
	4/24/02	158	95
	5/8/02	501	260
	6/24/02	548	273
	7/15/02	687	320
	8/12/02	172	160
	10/7/02	291	220
BULLR29.6UN (Bull Run @ Malone Rd.)	9/27/01	219	190
	10/30/01	73	30
	12/12/01	679	420
	1/9/02	70	65
	2/6/02	166	53
	3/13/02	31	23
	4/24/02	73	45
	5/8/02	727	100
	6/24/02	299	110
	7/15/02	980	113
	8/12/02	548	80
	10/7/02	161	150

Monitoring Station	Date	E. Coli	Fecal Coliform
		[cts./100 mL]	[cts./100 mL]
BULLR031.1UN (Bull Run @ Hwy 144 bridge)	9/27/01	172	130
	10/30/01	82	60
	12/12/01	866	430
	1/9/02	115	80
	2/6/02	108	60
	3/13/02	27	18
	4/24/02	145	140
	5/8/02	128	83
	6/24/02	921	180
	7/15/02	921	147
	8/12/02	148	80
	10/7/02	387	216

APPENDIX C

Load Duration Curve Development and Determination of Required Load Reductions

A flow duration curve is a cumulative frequency graph, constructed from historic flow data at a particular location, that represents the percentage of time a particular flow rate is equaled or exceeded. When a water quality target (or criteria) concentration is applied to the flow duration curve, the resulting load duration curve (LDC) represents the allowable pollutant loading in a waterbody over the entire range of flow. Pollutant monitoring data, plotted on the LDC, provides a visual depiction of stream water quality as well as the frequency and magnitude of any exceedances. Load duration curve intervals can be grouped into several broad categories or zones, in order to provide additional insight about conditions and patterns associated with the impairment. For example, the duration curve could be divided into five zones: high flows (exceeded 0-10% of the time), moist conditions (10-40%), median or mid-range flows (40-60%), dry conditions (60-90%), and low flows (90-100%). Impairments observed in the low flow zone typically indicate the influence of point sources, while those further left on the LDC (representing zones of higher flow) generally reflect potential nonpoint source contributions (Stiles, 2003).

C.1 Development of Flow Duration Curves

Flow duration curves are developed for a waterbody from daily discharges of flow over a period of record. In general, there is a higher level of confidence that curves derived from data over a long period of record correctly represent the entire range of flow. The preferred method of flow duration curve computation uses daily mean data from USGS continuous-record stations located on the waterbody of interest. For ungaged streams, alternative methods must be used to estimate daily mean flow. These include: 1) regression equations (using drainage area as the independent variable) developed from continuous record stations in the same ecoregion; 2) drainage area extrapolation of data from a nearby continuous-record station of similar size and topography; and 3) calculation of daily mean flow using a dynamic computer model, such as the Loading Simulation Program C++ (LSPC).

Flow duration curves for impaired waterbodies in the Lower Clinch Watershed were derived from LSPC hydrologic simulations based on parameters derived from calibration at USGS Station No. 03535000, located on Bullrun Creek near Halls Crossroads, in the Lower Clinch watershed (see Appendix D for details of calibration). For example, a flow-duration curve for Hinds Creek at RM 14.1 was constructed using simulated daily mean flow for the period from 10/1/94 through 9/31/04 (RM 14.1 corresponds to the location of monitoring station HINDS014.1AN). This flow duration curve is shown in Figure C-8 and represents the cumulative distribution of daily discharges arranged to show percentage of time specific flows were exceeded during the period of record (the highest daily mean flow during this period is exceeded 0% of the time and the lowest daily mean flow is equaled or exceeded 100% of the time). Flow duration curves for other impaired waterbodies were derived using a similar procedure and are shown in Figures C-1 thru C-10.

C.2 Development of Load Duration Curves and Determination of Required Load Reductions

E. coli and fecal coliform load duration curves for impaired waterbodies in the Lower Clinch Watershed were developed from the flow duration curves developed in Section C.1 and available water quality monitoring data. Load duration curves were developed using the following procedure (Hinds Creek is shown as an example):

1. A target load-duration curve was generated for Hinds Creek by applying the fecal coliform target concentration of 900 cts./100 mL (1,000 cts./100mL - MOS) to each of the ranked flows used to generate the flow duration curve (ref.: Section D.1) and plotting the results. The fecal coliform target maximum load corresponding to each ranked daily mean flow is:

   $(\text{Target Load})_{\text{Hinds Creek}}$ = (900 cts./100 mL) x (Q) x (UCF)

   where: Q = daily mean flow
   UCF = the required unit conversion factor

   For E. coli, the target concentration of 847 cts./100 mL was applied to generate load duration curves corresponding to the E. coli water quality standard (see Section 5.0).

2. Daily loads were calculated for each of the water quality samples collected at monitoring station HINDS014.1AN (ref.: Table B-1) by multiplying the sample concentration by the daily mean flow for the sampling date and the required unit conversion factor. HINDS014.1AN was selected for LDC analysis because it was the monitoring station on Hinds Creek with the most exceedances of the target concentration.

   Note: In order to be consistent for all analyses, the derived daily mean flow was used to compute sampling data loads, even if measured ("instantaneous") flow data was available for some sampling dates.

3. Using the flow duration curves developed in C.1, the "percent of days the flow was exceeded" (PDFE) was determined for each sampling event. Each sample load was then plotted on the load duration curves developed in Step 1 according to the PDFE. The resulting fecal coliform and E. coli load duration curves for are shown in Figures C-25 and C-26.

4. For cases where the existing load exceeded the target maximum load at a particular PDFE, the reduction required to reduce the sample load to the target load was calculated.

5. The 90^{th} percentile value for all of the fecal coliform sampling data at HINDS014.1AN monitoring site was determined. If the 90^{th} percentile value exceeded the target maximum fecal coliform concentration, the reduction required to reduce the 90^{th} percentile value to the target maximum concentration was calculated.

6. Step 5 was repeated for E. coli data at HINDS014.1AN.

7. For cases where five or more samples were collected over a period of not more than 30 consecutive days, the geometric mean fecal coliform concentration was determined and compared to the target geometric mean fecal coliform concentration of 180 cts/100 mL (200 cts/100mL – MOS). If the sample geometric mean exceeded the target geometric mean concentration, the reduction required to reduce the sample geometric mean value to the target geometric mean concentration was calculated.

8. Step 7 was repeated for the E. coli data at HINDS014.1AN.

9. The load reductions required to meet the target maximum and target 30-day geometric mean concentrations of both fecal coliform and E. coli were compared and the load reduction of the greatest magnitude selected as the TMDL for Hinds Creek. The determination of required load reductions for Hinds Creek is shown in Tables C-15 and C-16.

Load reduction curves and required load reductions of other impaired waterbodies were derived in a similar manner and are shown in Figures C-11 through C-30 and Tables C-1 through C-20.

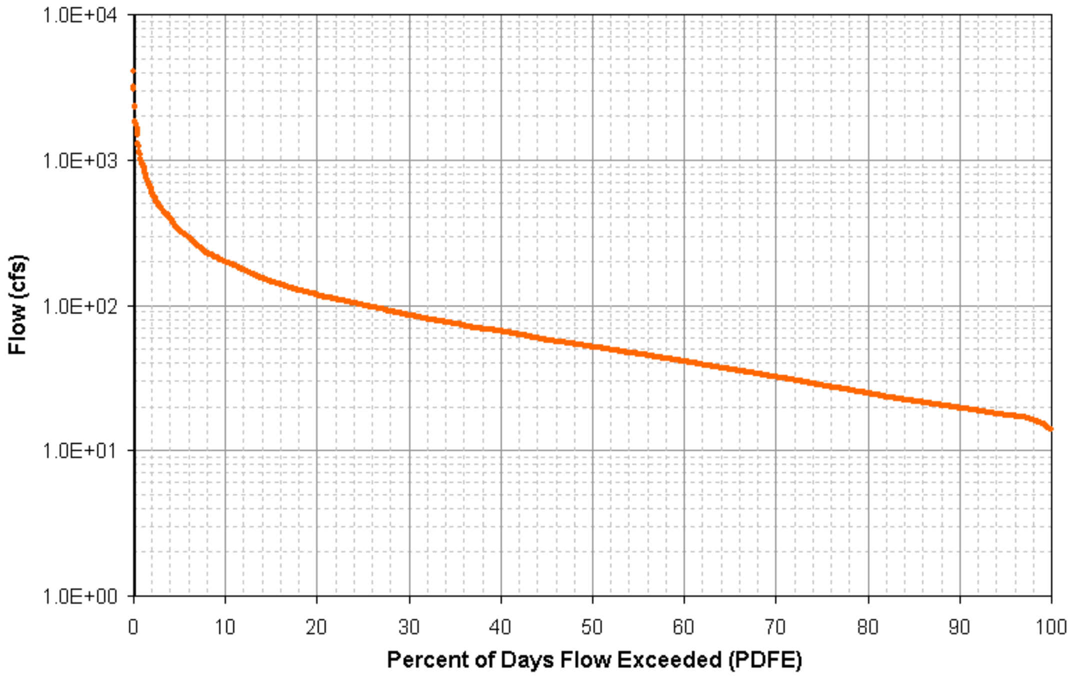

Figure C-1. Flow Duration Curve for Beaver Creek at Mile 20.9

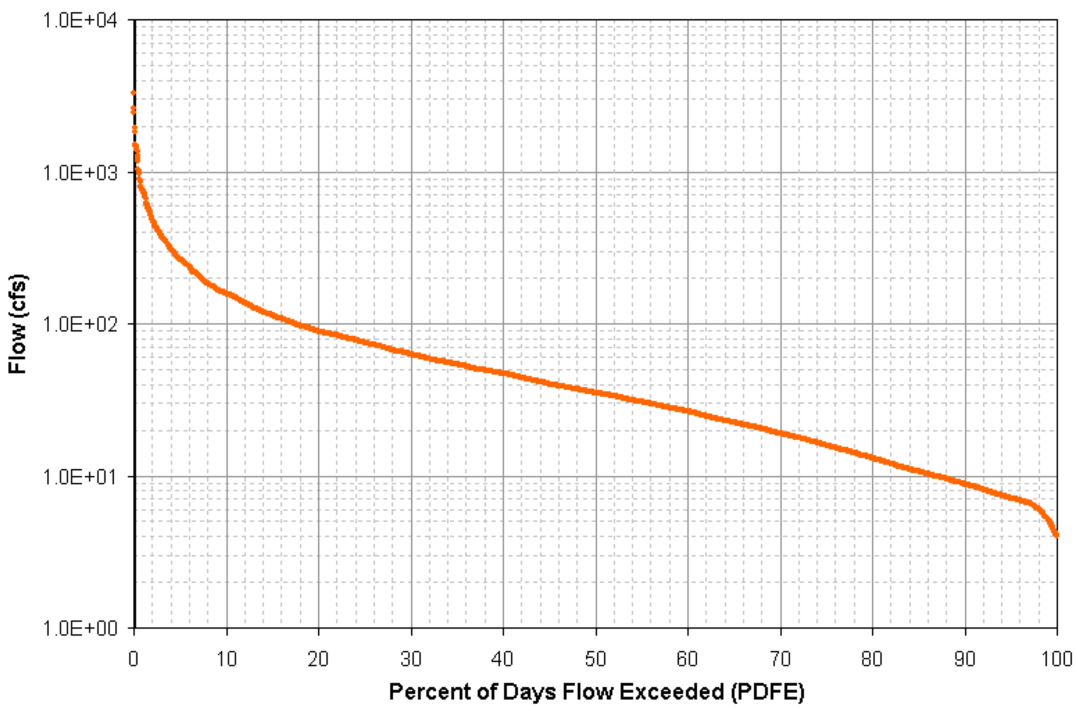

Figure C-2. Flow Duration Curve for Beaver Creek at Mile 24.7

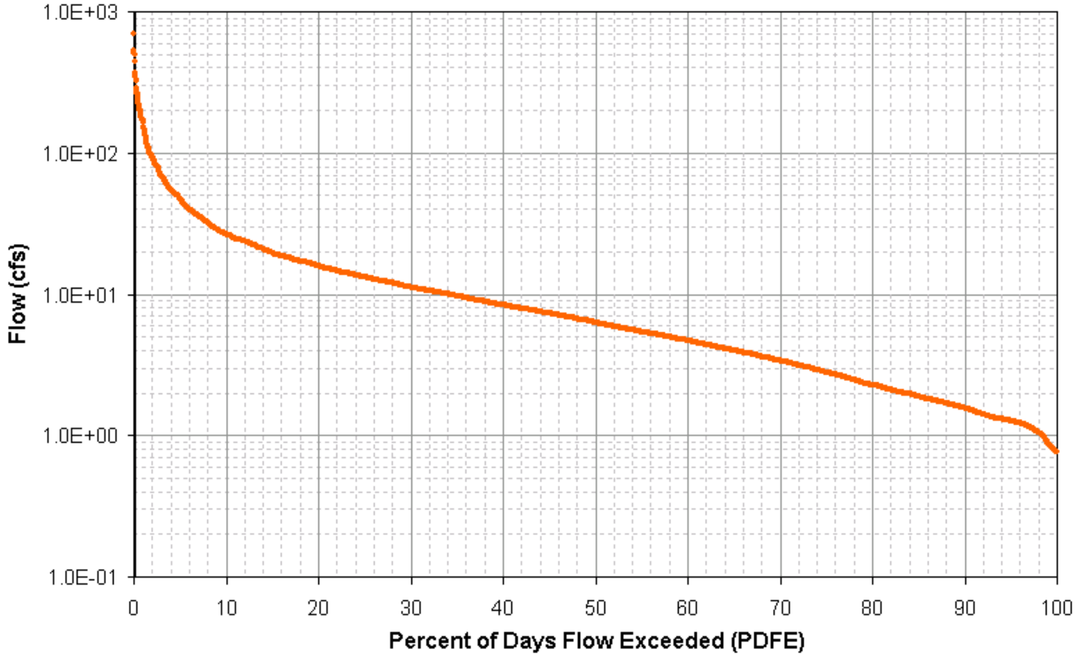

Figure C-3. Flow Duration Curve for Beaver Creek at Mile 38.7

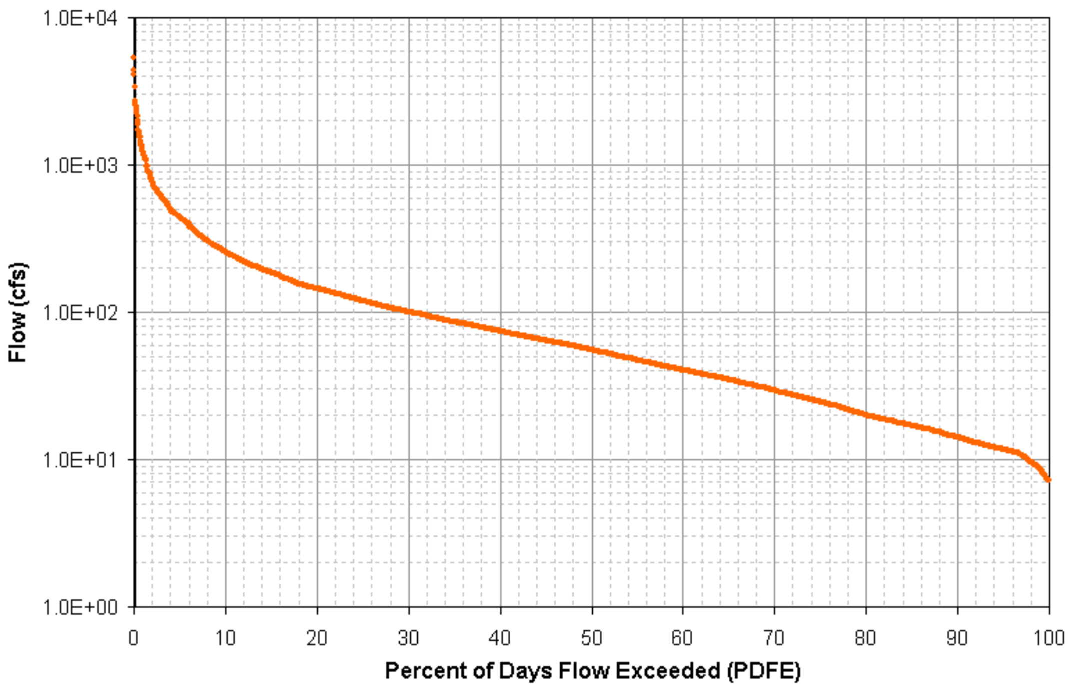

Figure C-4. Flow Duration Curve for Bull Run Creek at Mile 5.2

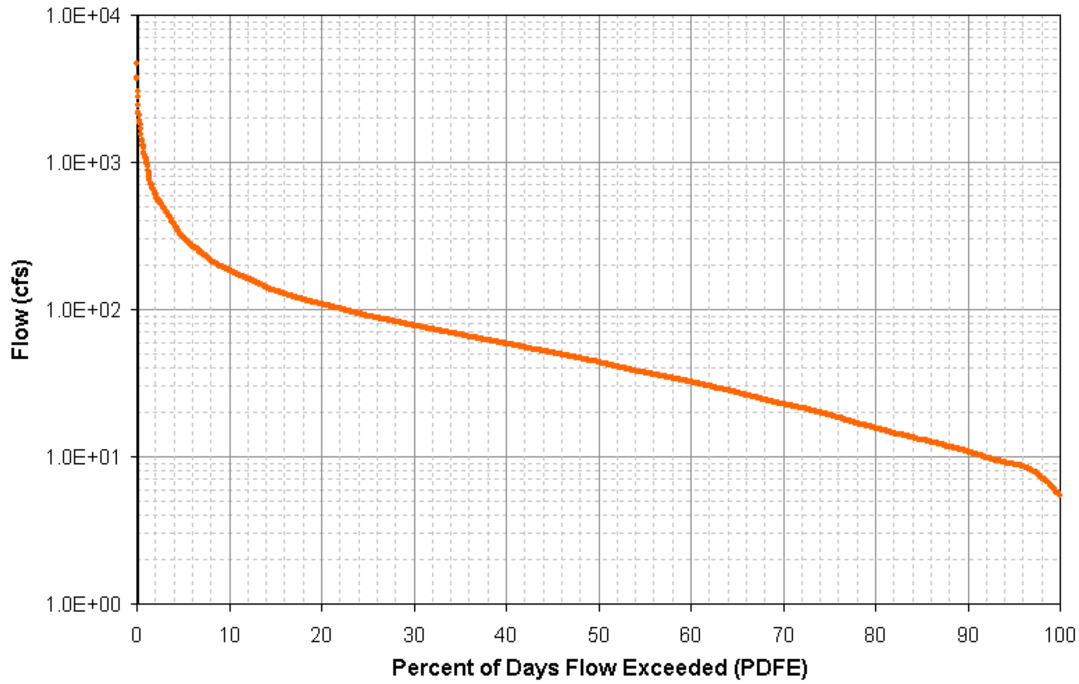

Figure C-5. Flow Duration Curve for Bull Run Creek at Mile 16.2

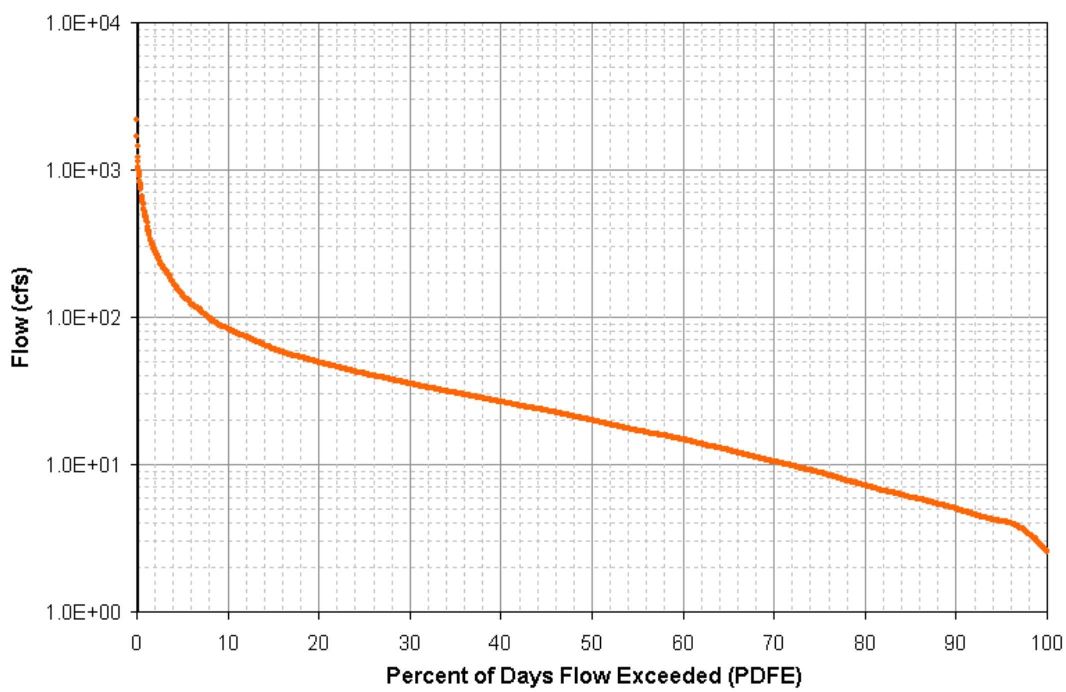

Figure C-6. Flow Duration Curve for Bull Run Creek at Mile 29.6

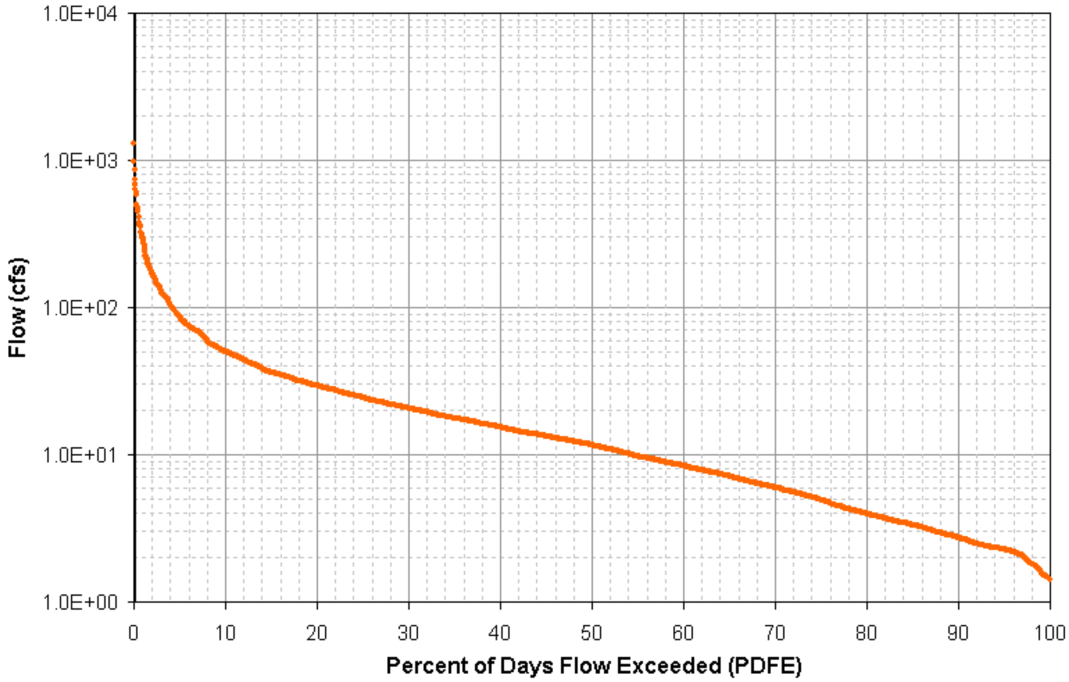

Figure C-7. Flow Duration Curve for Bull Run Creek at Mile 31.1

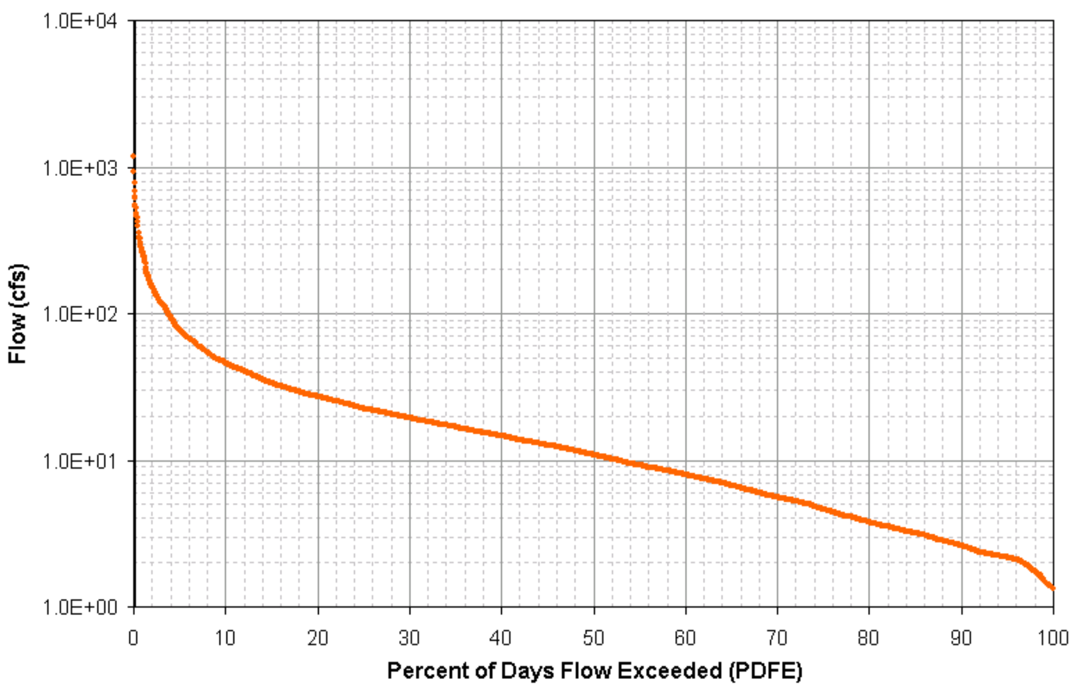

Figure C-8. Flow Duration Curve for Hinds Creek at Mile 14.1

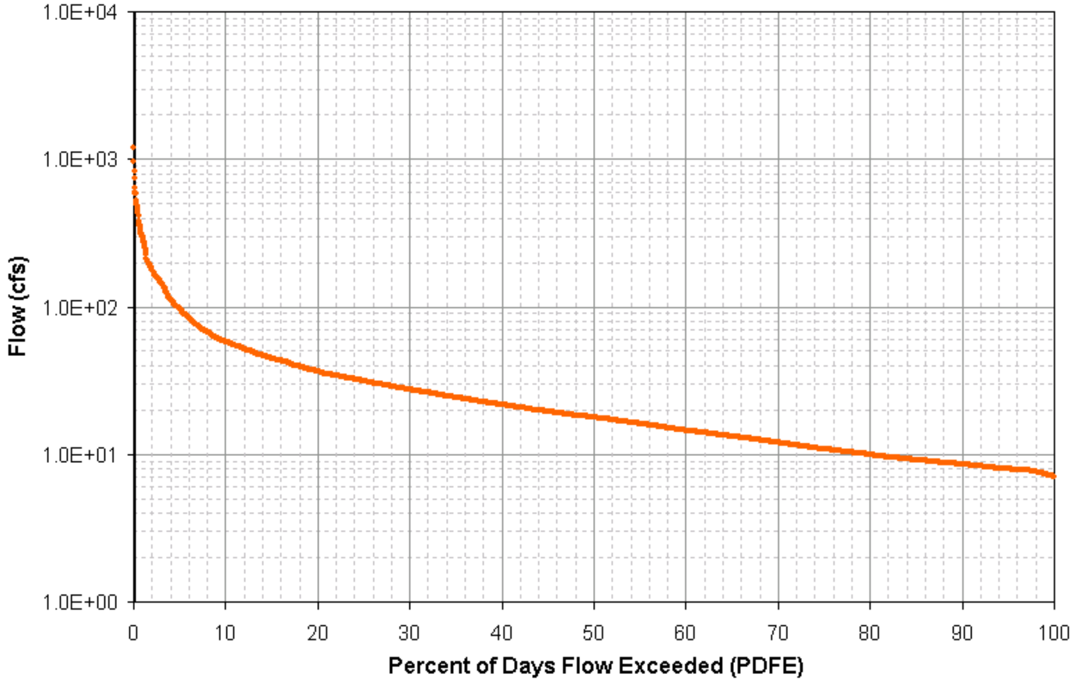

Figure C-9. Flow Duration Curve for East Fork Poplar Creek at Mile 4.7

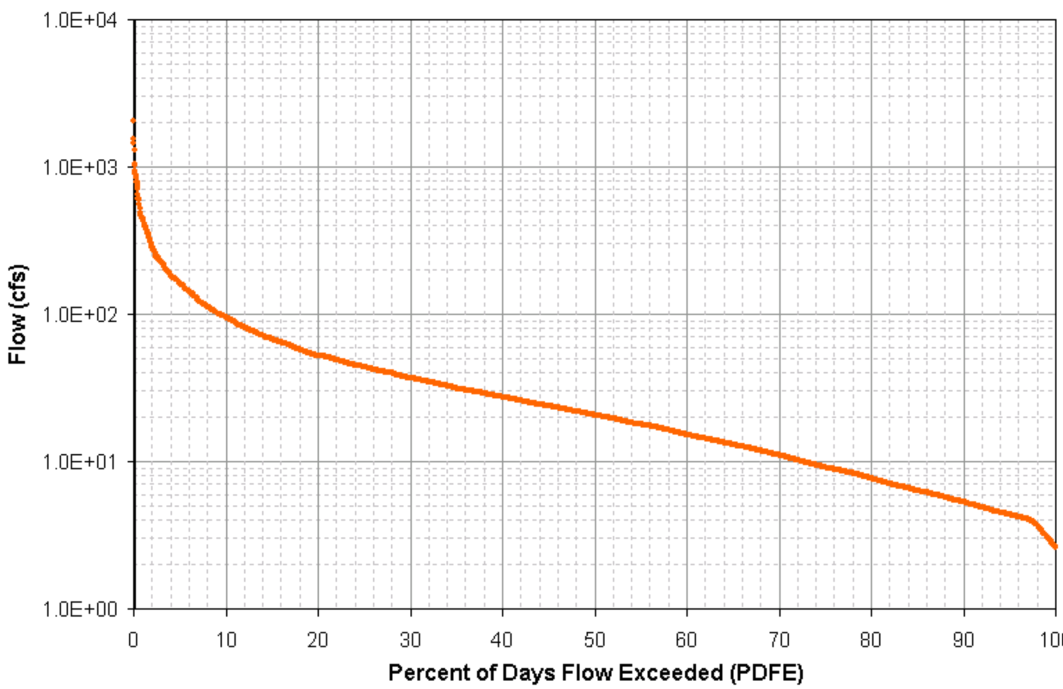

Figure C-10. Flow Duration Curve for Coal Creek at Mile 1.2

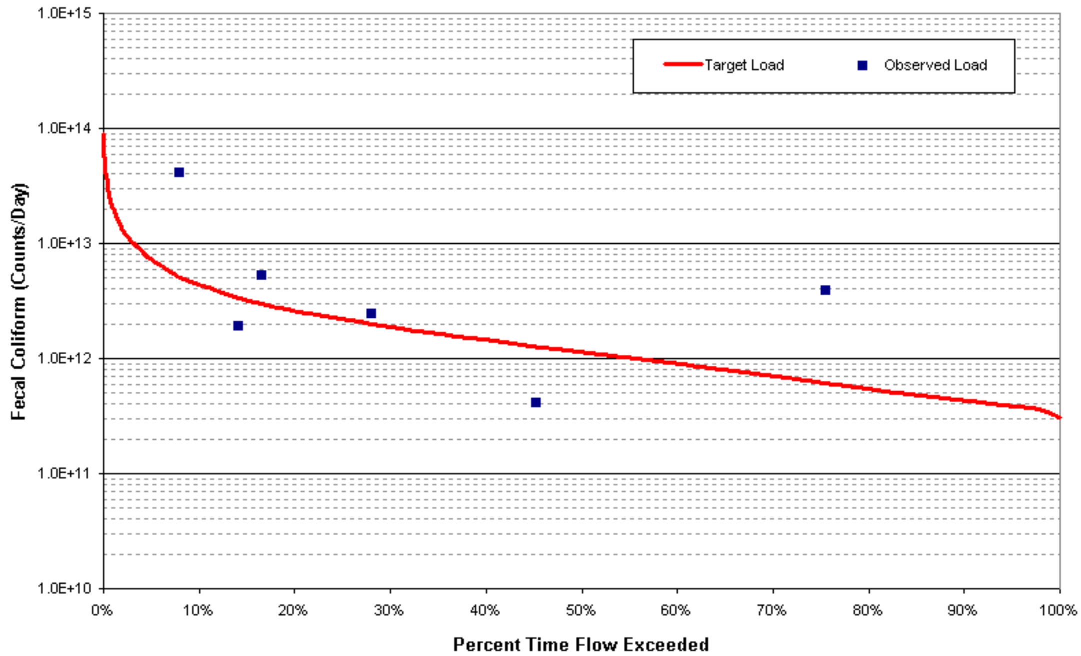

Figure C-11. Fecal Coliform Load Duration Curve for Beaver Creek at Mile 20.9

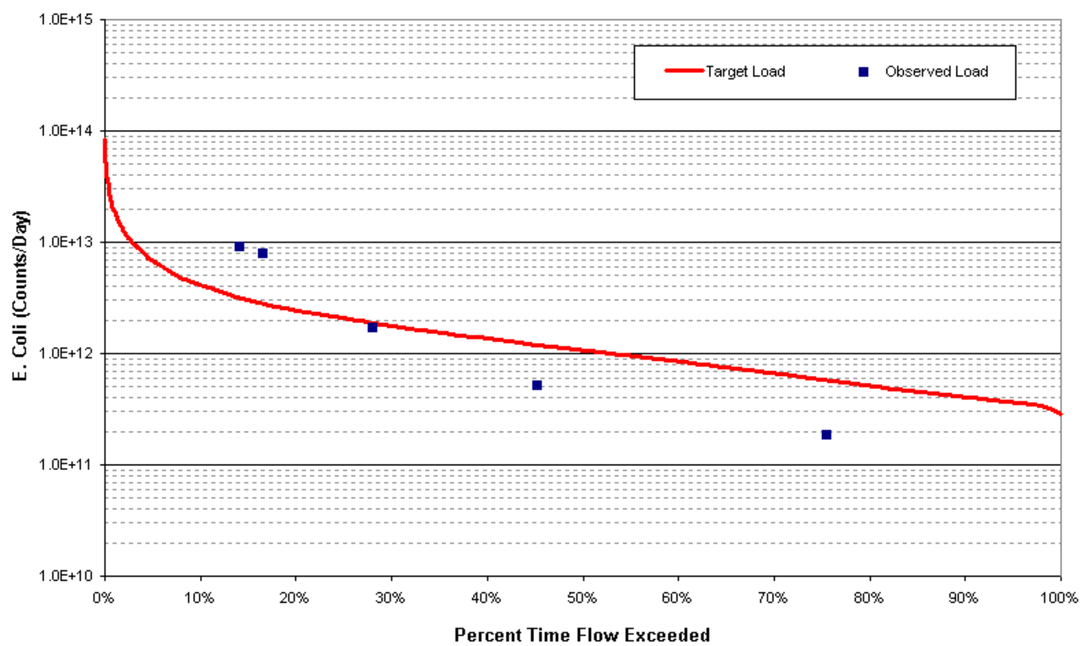

Figure C-12. E. Coli Load Duration Curve for Beaver Creek at Mile 20.9

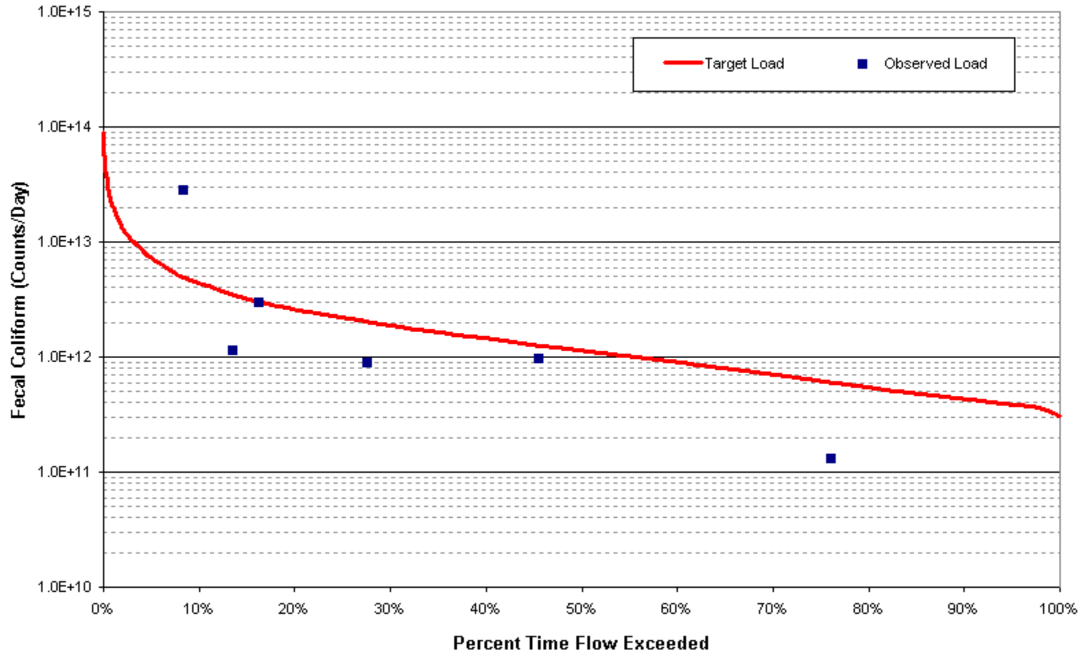

Figure C-13. Fecal Coliform Load Duration Curve for Beaver Creek at Mile 24.7

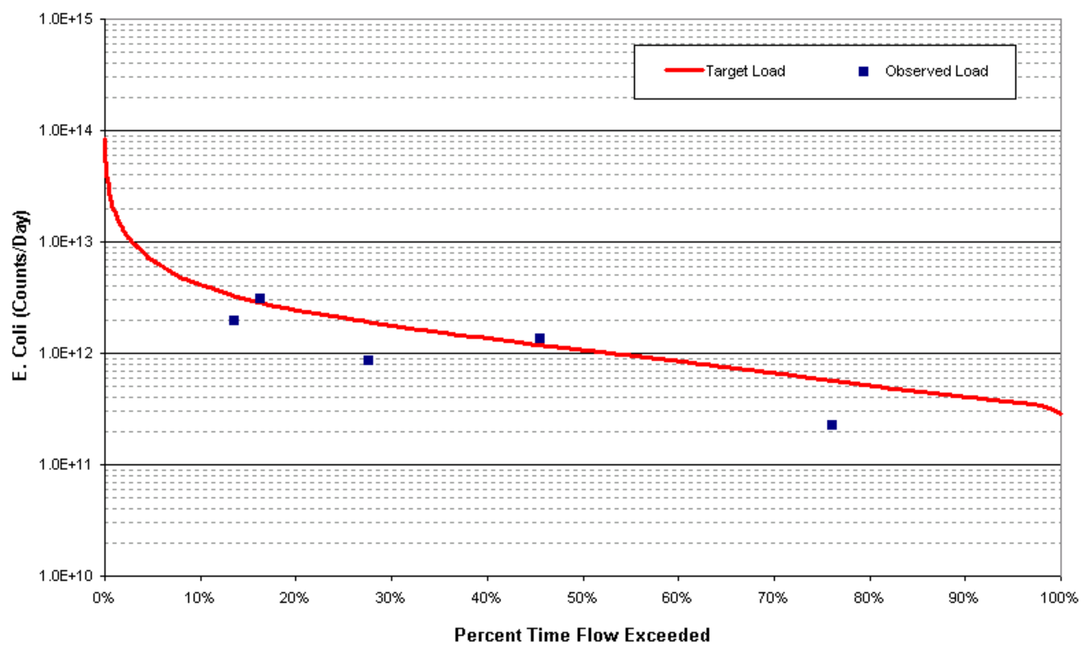

Figure C-14. E. Coli Load Duration Curve for Beaver Creek at Mile 24.7

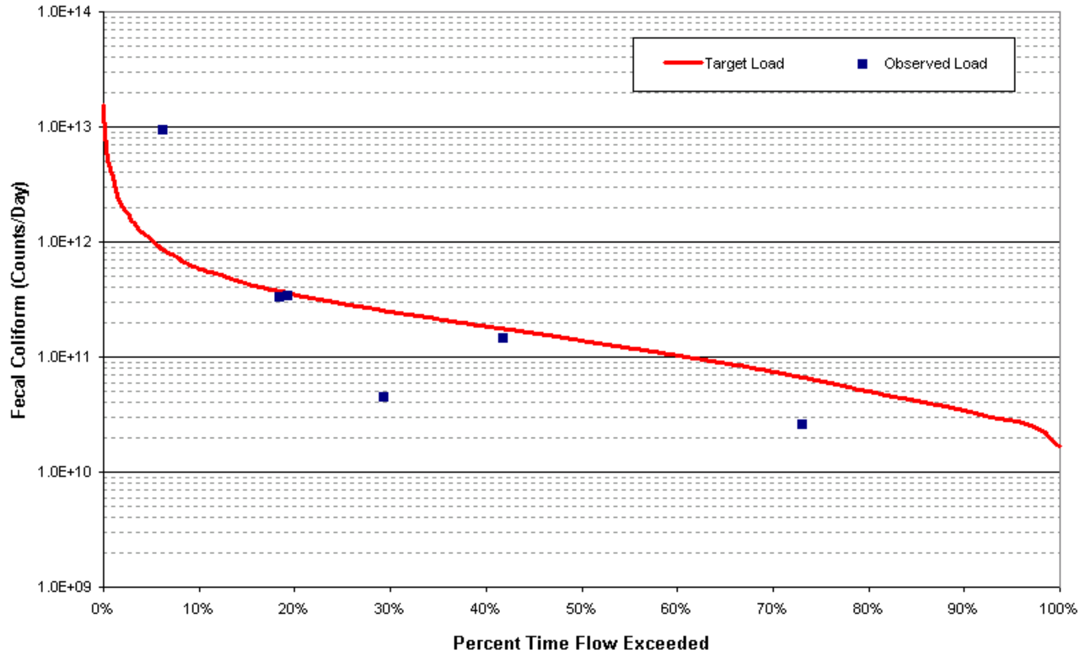

Figure C-15. Fecal Coliform Load Duration Curve for Beaver Creek at Mile 38.7

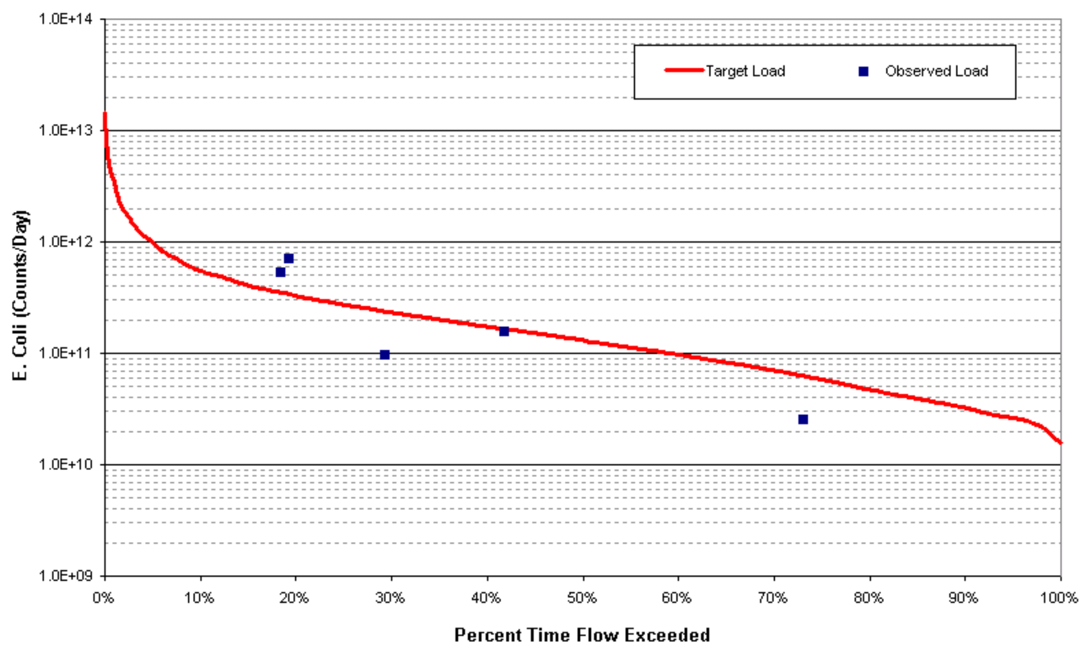

Figure C-16. E. Coli Load Duration Curve for Beaver Creek at Mile 38.7

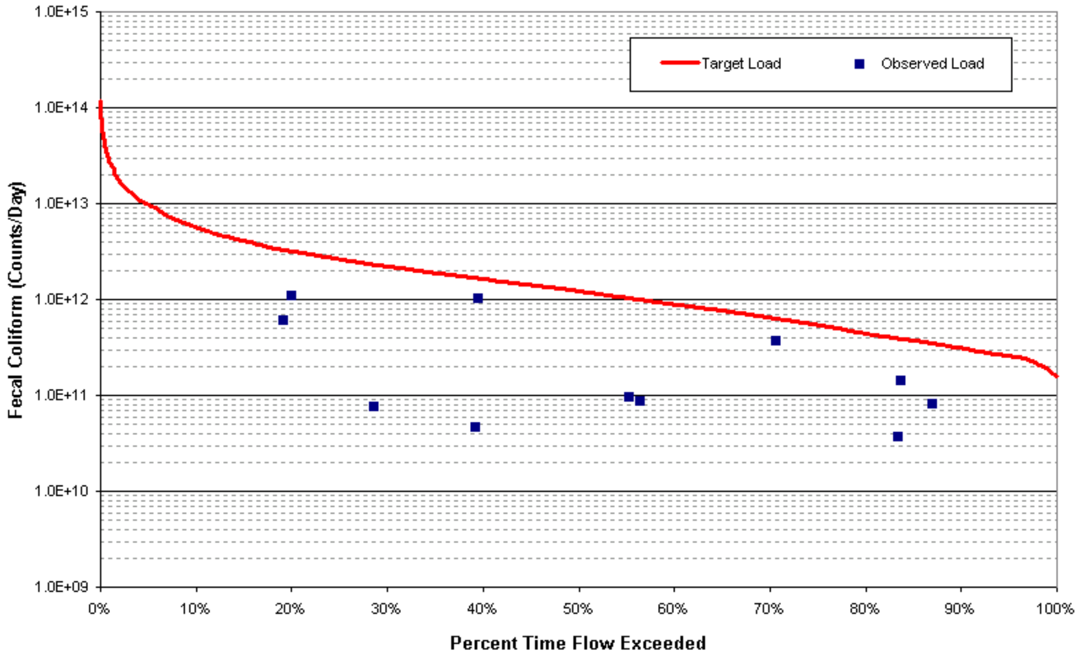

Figure C-17. Fecal Coliform Load Duration Curve for Bull Run Creek at Mile 5.2

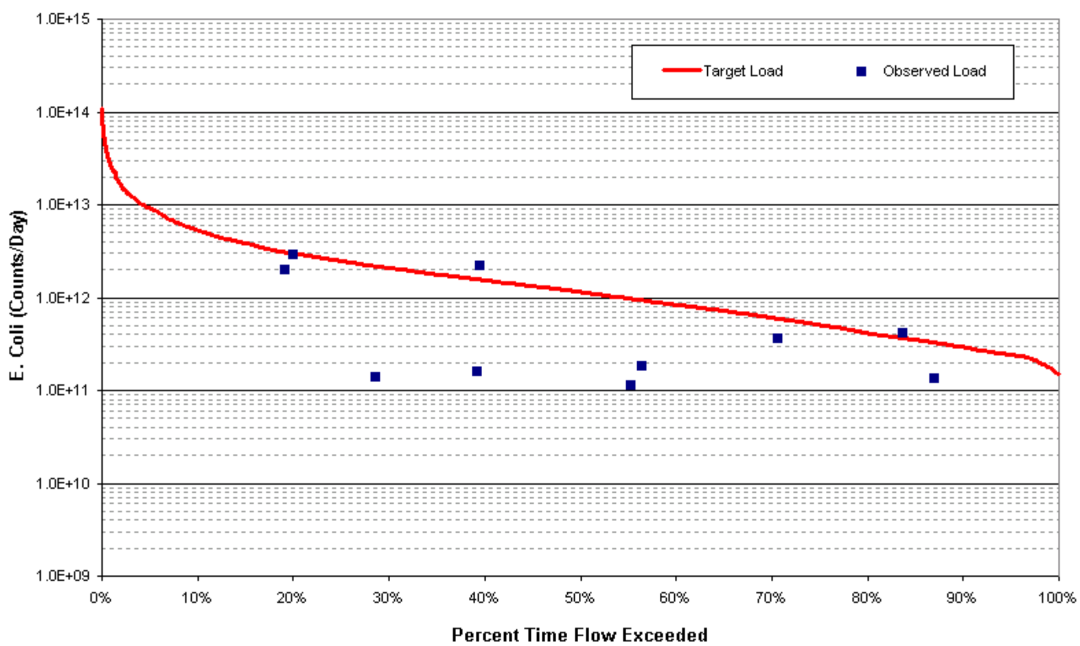

Figure C-18. E. Coli Load Duration Curve for Bull Run Creek at Mile 5.2

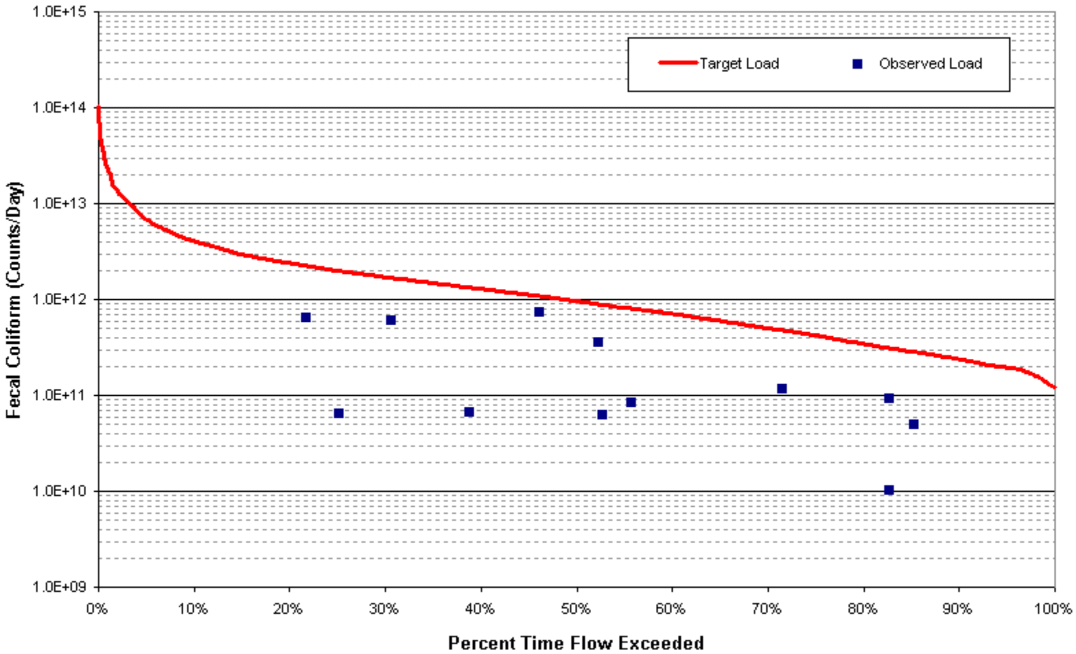

Figure C-19. Fecal Coliform Load Duration Curve for Bull Run Creek at Mile 16.2

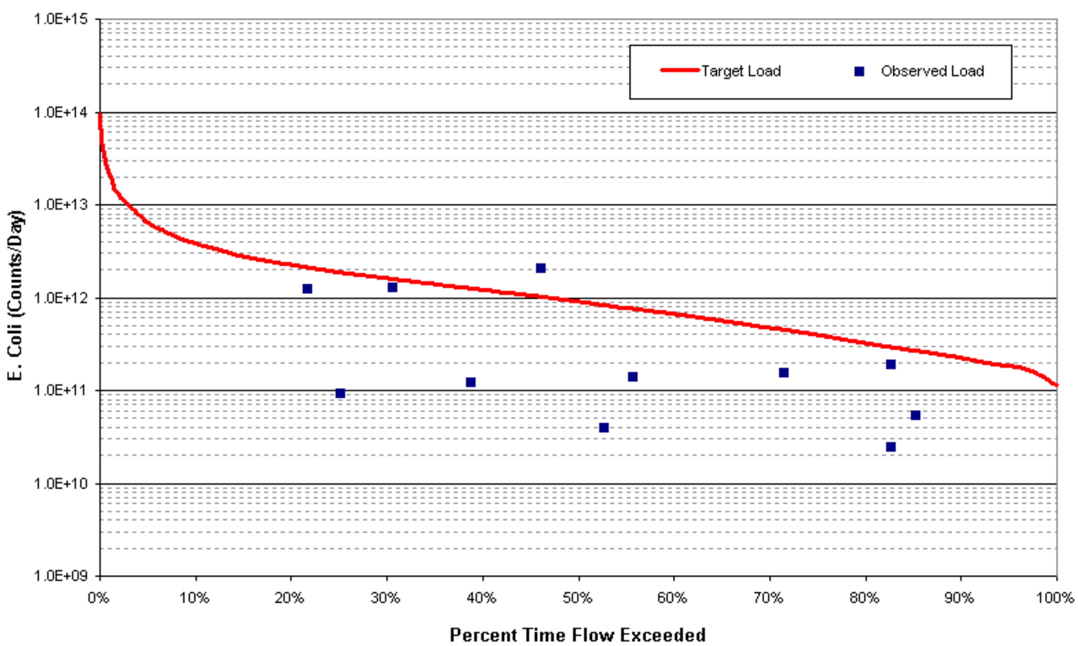

Figure C-20. E. Coli Load Duration Curve for Bull Run Creek at Mile 16.2

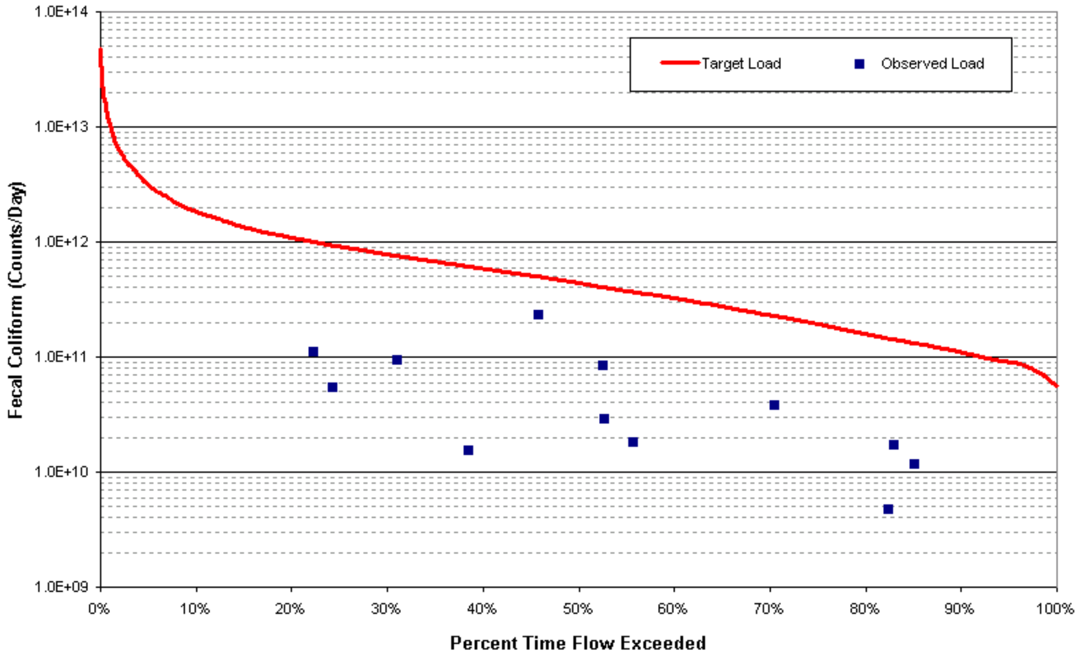

Figure C-21. Fecal Coliform Load Duration Curve for Bull Run Creek at Mile 29.6

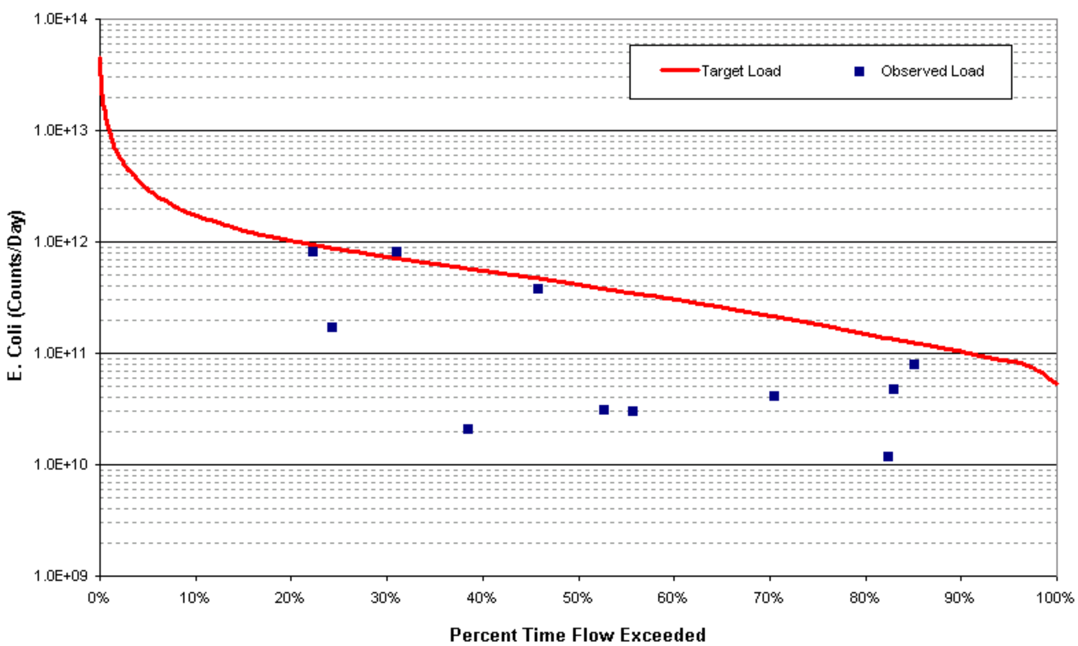

Figure C-22. E. Coli Load Duration Curve for Bull Run Creek at Mile 29.6

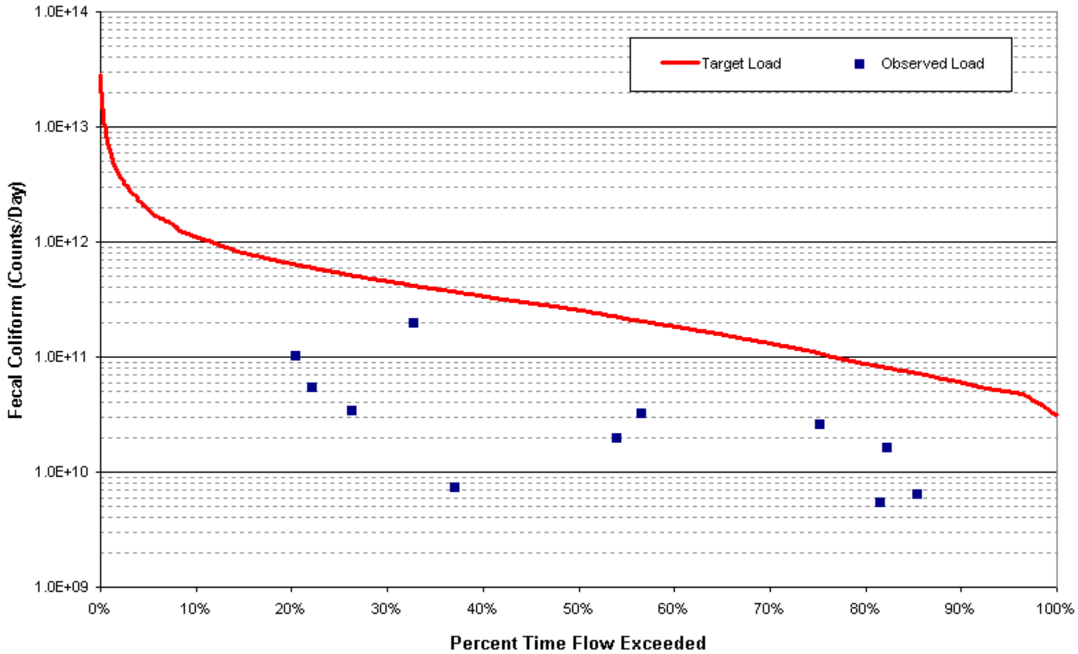

Figure C-23. Fecal Coliform Load Duration Curve for Bull Run Creek at Mile 31.1

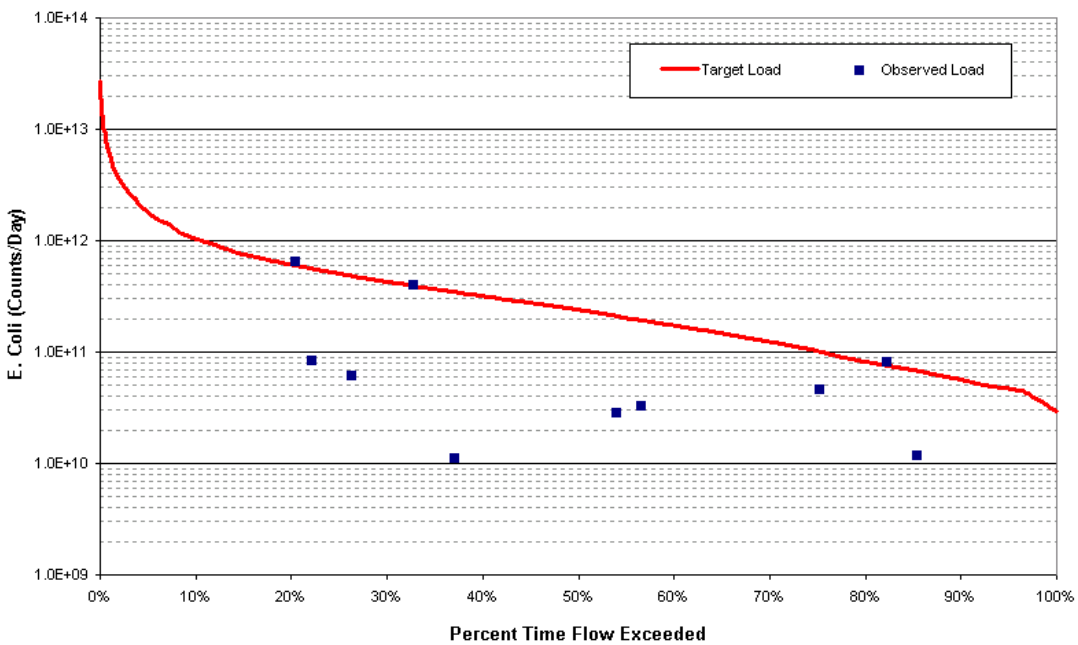

Figure C-24. E. Coli Load Duration Curve for Bull Run Creek at Mile 31.1

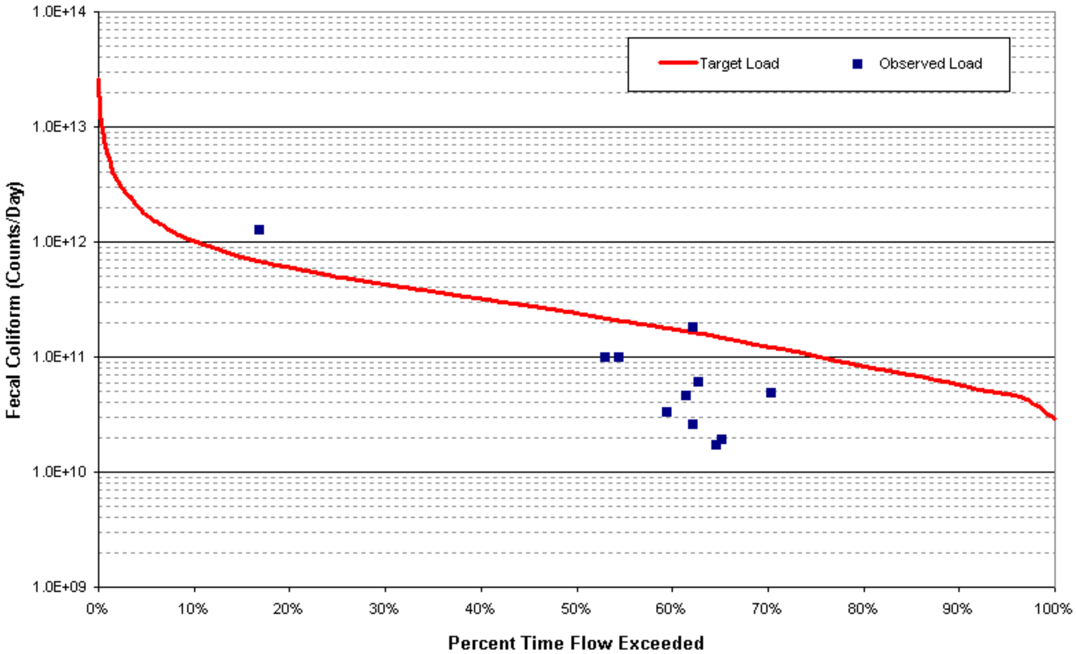

Figure C-25. Fecal Coliform Load Duration Curve for Hinds Creek at Mile 14.1

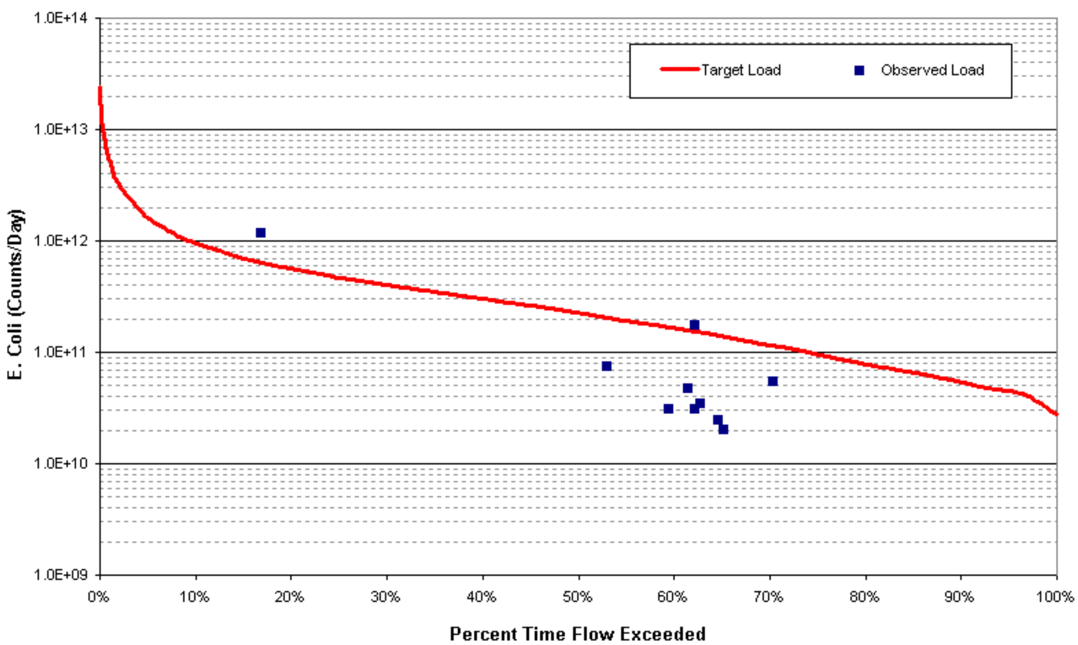

Figure C-26. E. Coli Load Duration Curve for Hinds Creek at Mile 14.1

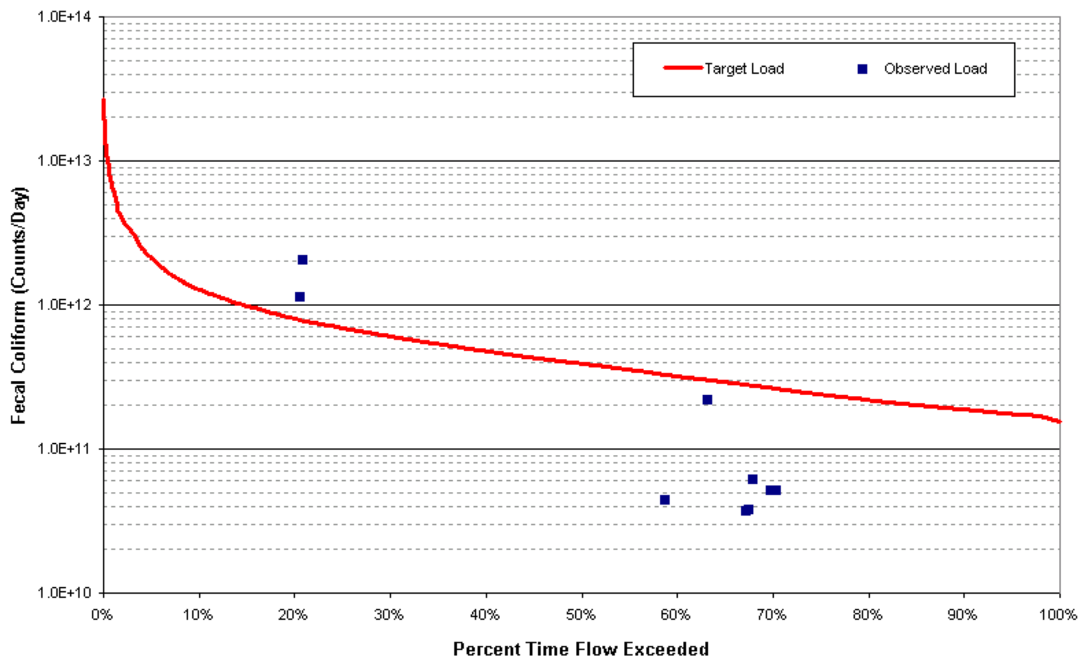

Figure C-27. Fecal Coliform Load Duration Curve for E. Fork Poplar Creek at Mile 4.7

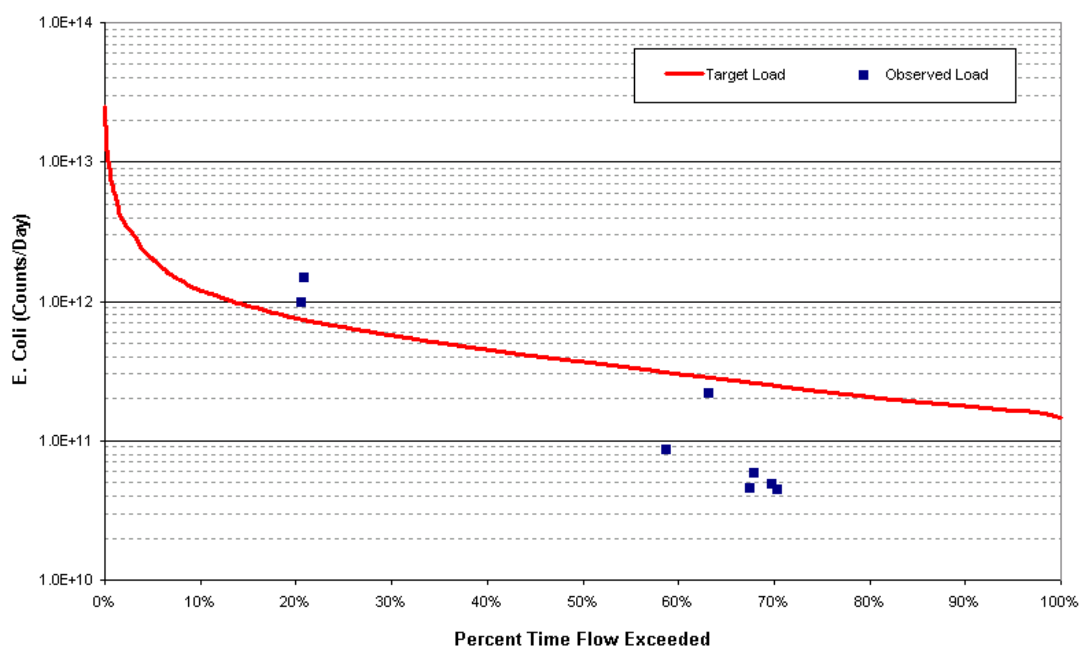

Figure C-28. E. Coli Load Duration Curve for E. Fork Poplar Creek at Mile 4.7

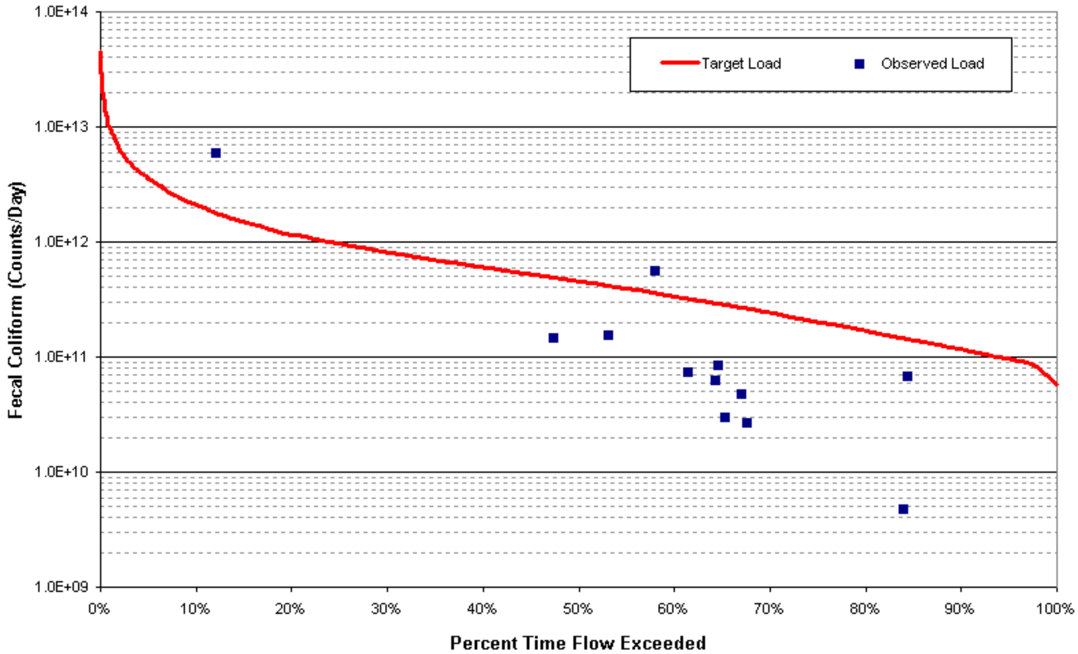

Figure C-29. Fecal Coliform Load Duration Curve for Coal Creek at Mile 1.2

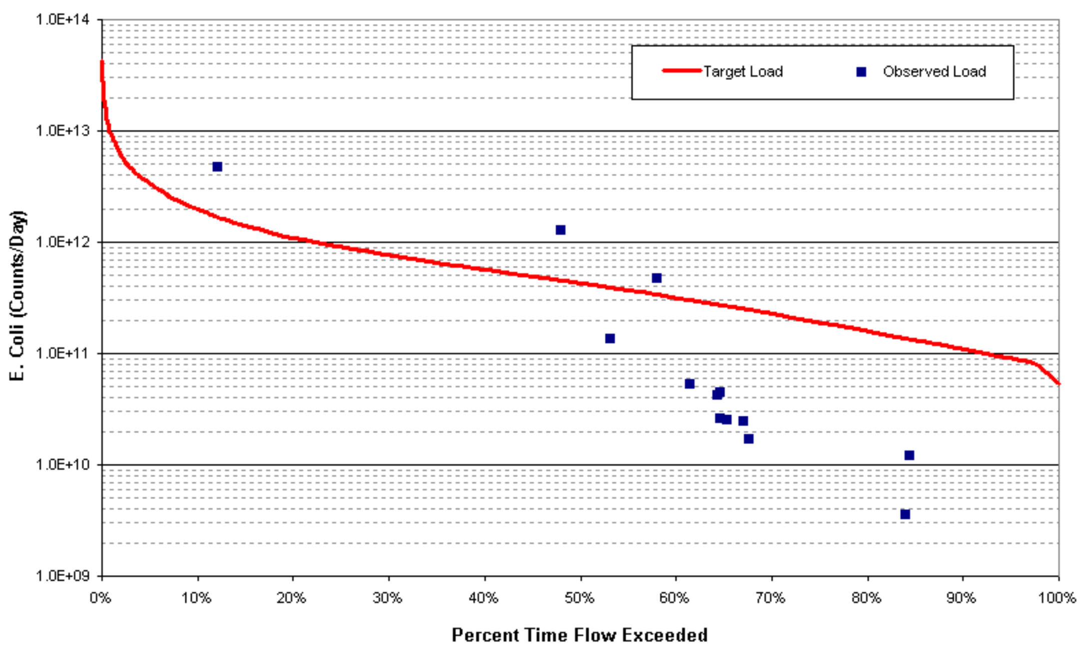

Figure C-30. E. Coli Load Duration Curve for Coal Creek at Mile 1.2

Table C-1. Required Load Reduction for Beaver Creek – Mile 20.9 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
3/4/04	99.89	25.1%	280	**NR**
4/13/04	231.97	7.9%	7,400	87.9
5/4/04	135.87	16.5%	1,600	43.8
5/25/04	27.75	75.5%	5,800	84.5
6/29/04	153.17	14.0%	520	**NR**
7/14/04	57.43	45.2%	300	**NR**
8/3/04	90.80	28.0%	1,100	18.2
		90th Percentile	**6,440**	**86.0**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-2. Required Load Reduction for Beaver Creek – Mile 20.9 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
3/4/04	99.89	25.1%	345	**NR**
4/13/04	231.97	7.9%	2,419	65.0
5/4/04	135.87	16.5%	2,419	65.0
5/25/04	27.75	75.5%	279	**NR**
6/29/04	153.17	14.0%	2,419	65.0
7/14/04	57.43	45.2%	365	**NR**
8/3/04	90.80	28.0%	770	**NR**
		90th Percentile	**2,419**	**65.0**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-3. Required Load Reduction for Beaver Creek – Mile 24.7 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
3/4/04	74.73	25.3%	220	**NR**
4/13/04	179.13	8.3%	6,500	86.2
5/4/04	107.02	16.2%	1,140	21.1
5/25/04	15.30	76.0%	350	**NR**
6/29/04	123.48	13.5%	380	**NR**
7/14/04	39.69	45.5%	1,000	**NR**
8/3/04	68.46	27.6%	530	**NR**
		90th Percentile	**3,284**	**72.6**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-4. Required Load Reduction for Beaver Creek – Mile 24.7 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
3/4/04	74.73	25.3%	261	**NR**
4/13/04	179.13	8.3%	2,419	65.0
5/4/04	107.02	16.2%	1,203	29.6
5/25/04	15.30	76.0%	613	**NR**
6/29/04	123.48	13.5%	649	**NR**
7/14/04	39.69	45.5%	1,414	40.1
8/3/04	68.46	27.6%	517	**NR**
		90th Percentile	**1,816**	**53.4**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-5. Required Load Reduction for Beaver Creek – Mile 38.7 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
3/4/04	14.10	23.2%	600	**NR**
4/13/04	39.69	6.2%	9,800	90.8
5/4/04	16.56	19.2%	850	**NR**
5/25/04	3.03	73.0%	350	**NR**
6/29/04	17.01	18.4%	800	**NR**
7/14/04	8.00	41.8%	750	**NR**
8/3/04	11.49	29.2%	160	**NR**
		90th Percentile	**4,430**	**79.7**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-6. Required Load Reduction for Beaver Creek – Mile 38.7 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
3/4/04	14.10	23.2%	980	13.6
4/13/04	39.69	6.2%	2,419	65.0
5/4/04	16.56	19.2%	1,733	51.1
5/25/04	3.03	73.0%	345	**NR**
6/29/04	17.01	18.4%	1,300	34.8
7/14/04	8.00	41.8%	816	**NR**
8/3/04	11.49	29.2%	345	**NR**
		90th Percentile	**2,007**	**57.8**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-7. Required Load Reduction for Bull Run Creek at Mile 5.2 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
9/27/01	63.26	45.6%	25	**NR**
10/30/01	17.89	83.3%	85	**NR**
12/12/01	76.13	39.4%	560	**NR**
1/9/02	47.05	55.2%	85	**NR**
2/6/02	104.83	28.6%	30	**NR**
3/13/02	76.23	39.2%	25	**NR**
4/24/02	45.41	56.4%	80	**NR**
5/8/02	149.15	19.1%	170	**NR**
6/24/02	17.68	83.7%	330	**NR**
7/15/02	144.69	20.0%	313	**NR**
8/12/02	16.01	86.9%	213	**NR**
10/7/02	28.57	70.6%	540	**NR**
90th Percentile			**519**	**NR**
Geometric Mean of All Sampling Data			**124.2**	**NR**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-8. Required Load Reduction for Bull Run Creek at Mile 5.2 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
9/27/01	63.26	45.6%	548	**NR**
10/30/01	17.89	83.3%	112	**NR**
12/12/01	76.13	39.4%	1,203	29.6
1/9/02	47.05	55.2%	101	**NR**
2/6/02	104.83	28.6%	54	**NR**
3/13/02	76.23	39.2%	86	**NR**
4/24/02	45.41	56.4%	167	**NR**
5/8/02	149.15	19.1%	548	**NR**
6/24/02	17.68	83.7%	980	13.6
7/15/02	144.69	20.0%	816	**NR**
8/12/02	16.01	86.9%	345	**NR**
10/7/02	28.57	70.6%	517	**NR**
90th Percentile			**964**	**12.1**
Geometric Mean of All Sampling Data			**305.0**	**62.9**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-9. Required Load Reduction for Bull Run Creek at Mile 16.2 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
9/27/01	14.82	81.4%	156	**NR**
10/30/01	40.57	52.2%	360	**NR**
12/12/01	14.21	82.6%	30	**NR**
1/9/02	49.65	46.0%	610	**NR**
2/6/02	40.08	52.7%	65	**NR**
3/13/02	89.80	25.1%	30	**NR**
4/24/02	60.99	38.7%	45	**NR**
5/8/02	36.81	55.6%	95	**NR**
6/24/02	102.68	21.6%	260	**NR**
7/15/02	14.16	82.7%	273	**NR**
8/12/02	77.04	30.5%	320	**NR**
10/7/02	12.96	85.2%	160	**NR**
90th Percentile			**356**	**NR**
Geometric Mean of All Sampling Data			**137.4**	**NR**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-10. Required Load Reduction for Bull Run Creek at Mile 16.2 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
9/27/01	14.82	81.4%	146	**NR**
10/30/01	40.57	52.2%	517	**NR**
12/12/01	14.21	82.6%	71	**NR**
1/9/02	49.65	46.0%	1,733	51.1
2/6/02	40.08	52.7%	41	**NR**
3/13/02	89.80	25.1%	42	**NR**
4/24/02	60.99	38.7%	82	**NR**
5/8/02	36.81	55.6%	158	**NR**
6/24/02	102.68	21.6%	501	**NR**
7/15/02	14.16	82.7%	548	**NR**
8/12/02	77.04	30.5%	687	**NR**
10/7/02	12.96	85.2%	172	**NR**
90th Percentile			**673**	**NR**
Geometric Mean of All Sampling Data			**212.6**	**46.8**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-11. Required Load Reduction for Bull Run Creek at Mile 29.6 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
9/27/01	18.37	52.5%	190	**NR**
10/30/01	6.57	82.4%	30	**NR**
12/12/01	22.79	45.8%	420	**NR**
1/9/02	18.28	52.7%	65	**NR**
2/6/02	42.22	24.3%	53	**NR**
3/13/02	27.79	38.4%	23	**NR**
4/24/02	16.76	55.7%	45	**NR**
5/8/02	45.81	22.2%	100	**NR**
6/24/02	6.48	82.9%	110	**NR**
7/15/02	34.45	31.0%	113	**NR**
8/12/02	5.98	85.1%	80	**NR**
10/7/02	10.38	70.4%	150	**NR**
90th Percentile			**186**	**NR**
Geometric Mean of All Sampling Data			**81.7**	**NR**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-12. Required Load Reduction for Bull Run Creek at Mile 29.6 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
9/27/01	18.37	52.5%	219	**NR**
10/30/01	6.57	82.4%	73	**NR**
12/12/01	22.79	45.8%	679	**NR**
1/9/02	18.28	52.7%	70	**NR**
2/6/02	42.22	24.3%	166	**NR**
3/13/02	27.79	38.4%	31	**NR**
4/24/02	16.76	55.7%	73	**NR**
5/8/02	45.81	22.2%	727	**NR**
6/24/02	6.48	82.9%	299	**NR**
7/15/02	34.45	31.0%	980	13.6
8/12/02	5.98	85.1%	548	**NR**
10/7/02	10.38	70.4%	161	**NR**
90th Percentile			**722**	**NR**
Geometric Mean of All Sampling Data			**211.2**	**46.5**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-13. Required Load Reduction for Bull Run Creek at Mile 31.1 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Concentration	Fecal Coliform Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
9/27/01	13.65	44.2%	130	**NR**
10/30/01	3.76	81.5%	60	**NR**
12/12/01	18.87	32.7%	430	**NR**
1/9/02	10.20	54.0%	80	**NR**
2/6/02	23.25	26.3%	60	**NR**
3/13/02	16.81	37.0%	18	**NR**
4/24/02	9.38	56.5%	140	**NR**
5/8/02	27.19	22.1%	83	**NR**
6/24/02	3.68	82.2%	180	**NR**
7/15/02	28.90	20.4%	147	**NR**
8/12/02	3.29	85.4%	80	**NR**
10/7/02	4.89	75.2%	216	**NR**
90th Percentile			**212**	**NR**
Geometric Mean of All Sampling Data			**107.1**	**NR**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-14. Required Load Reduction for Bull Run Creek at Mile 31.1 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
9/27/01	13.65	44.2%	172	**NR**
10/30/01	3.76	81.5%	82	**NR**
12/12/01	18.87	32.7%	866	**NR**
1/9/02	10.20	54.0%	115	**NR**
2/6/02	23.25	26.3%	108	**NR**
3/13/02	16.81	37.0%	27	**NR**
4/24/02	9.38	56.5%	145	**NR**
5/8/02	27.19	22.1%	128	**NR**
6/24/02	3.68	82.2%	921	**NR**
7/15/02	28.90	20.4%	921	**NR**
8/12/02	3.29	85.4%	148	**NR**
10/7/02	4.89	75.2%	387	**NR**
90th Percentile			**916**	**NR**
Geometric Mean of All Sampling Data			**207.6**	**45.6**

Note: NR = Not Required
* 30-day Geometric Mean could not be calculated due to insufficient data.

Table C-15. Required Load Reduction for Hinds Creek – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
2/25/99	19.49	29.8%	90	**NR**		
7/24/03	9.39	54.4%	440	**NR**		
8/27/03	7.61	61.4%	250	**NR**		
9/9/03	9.85	53.0%	420	**NR**		
9/18/03	7.43	62.1%	144	**NR**		
9/24/03	30.97	16.8%	1,700	47.1		
10/16/03	8.11	59.4%	170	**NR**		
10/21/03	6.88	64.5%	102	**NR**		
10/23/03	6.68	65.2%	118	**NR**		
10/27/03	7.44	62.1%	1,000	**NR**		
10/30/03	7.30	62.7%	340	**NR**	233.6	**22.9**
9/14/04	5.52	70.3%	360	**NR**		
		90th Percentile	**944**	**4.7**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-16. Required Load Reduction for Hinds Creek – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
2/25/99	19.49	29.8%	68	**NR**		
7/24/03	9.39	54.4%	727	**NR**		
8/27/03	7.61	61.4%	260	**NR**		
9/9/03	9.85	53.0%	316	**NR**		
9/18/03	7.43	62.1%	173	**NR**		
9/24/03	30.97	16.8%	1,553	45.5		
10/16/03	8.11	59.4%	158	**NR**		
10/21/03	6.88	64.5%	147	**NR**		
10/23/03	6.68	65.2%	125	**NR**		
10/27/03	7.44	62.1%	980	13.6		
10/30/03	7.30	62.7%	194	**NR**	223.0	**49.3**
9/14/04	5.52	70.3%	411	**NR**		
		90th Percentile	**955**	**11.3**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-17. Required Load Reduction for E. Fork Poplar Creek – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
7/24/03	14.40	60.4%	440	**NR**		
8/27/03	12.75	67.1%	120	**NR**		
9/9/03	14.91	58.7%	122	**NR**		
9/18/03	12.64	67.4%	122	**NR**		
9/24/03	35.92	20.5%	1,300	30.8		
10/16/03	13.73	63.1%	660	**NR**		
10/21/03	12.11	69.7%	176	**NR**		
10/23/03	11.93	70.3%	176	**NR**		
10/27/03	35.33	20.8%	2,400	62.5		
10/30/03	12.55	67.8%	200	**NR**	396.6	**54.6**
		90th Percentile	**1,410**	**36.2**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-18. Required Load Reduction for E. Fork Poplar Creek – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
7/24/03	14.40	60.4%	345	**NR**		
8/27/03	12.75	67.1%	114	**NR**		
9/9/03	14.91	58.7%	236	**NR**		
9/18/03	12.64	67.4%	147	**NR**		
9/24/03	35.92	20.5%	1,120	24.4		
10/16/03	13.73	63.1%	649	**NR**		
10/21/03	12.11	69.7%	167	**NR**		
10/23/03	11.93	70.3%	152	**NR**		
10/27/03	35.33	20.8%	1,733	51.1		
10/30/03	12.55	67.8%	194	**NR**	353.7	**68.1**
		90th Percentile	**1,243**	**31.8**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-19. Required Load Reduction for Coal Creek – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
2/25/99	33.00	33.7%	530	**NR**		
4/20/99	22.19	47.4%	270	**NR**		
6/22/99	6.54	84.3%	430	**NR**		
8/18/99	12.89	65.3%	94	**NR**		
12/28/99	6.59	84.0%	30	**NR**		
7/24/03	16.38	58.0%	1,400	35.7		
8/27/03	13.19	64.6%	260	**NR**		
9/9/03	18.89	53.1%	340	**NR**		
9/18/03	13.32	64.3%	192	**NR**		
9/24/03	81.80	12.0%	3,000	70.0		
10/16/03	14.58	61.4%	210	**NR**		
10/21/03	12.23	67.0%	158	**NR**		
10/23/03	12.02	67.6%	92	**NR**		
10/27/03	21.96	47.9%	2,000	55.0		
10/30/03	13.24	64.5%	106	**NR**	230.3	**21.8**
		90th Percentile	**1,760**	**48.9**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-20. Required Load Reduction for Coal Creek – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
2/25/99	33.00	33.7%	361	**NR**		
4/20/99	22.19	47.4%	148	**NR**		
6/22/99	6.54	84.3%	76	**NR**		
8/18/99	12.89	65.3%	81	**NR**		
12/28/99	6.59	84.0%	22	**NR**		
7/24/03	16.38	58.0%	1,203	29.6		
8/27/03	13.19	64.6%	141	**NR**		
9/9/03	18.89	53.1%	292	**NR**		
9/18/03	13.32	64.3%	131	**NR**		
9/24/03	81.80	12.0%	2,419	65.0		
10/16/03	14.58	61.4%	150	**NR**		
10/21/03	12.23	67.0%	84	**NR**		
10/23/03	12.02	67.6%	58	**NR**		
10/27/03	21.96	47.9%	2,419	65.0		
10/30/03	13.24	64.5%	82	**NR**	170.7	**33.8**
		90th Percentile	**1,933**	**56.2**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

APPENDIX D

Hydrodynamic Modeling Methodology

HYDRODYNAMIC MODELING METHODOLOGY

D.1 Model Selection

The Loading Simulation Program C++ (LSPC) was selected for flow simulation of pathogen-impaired waters in the subwatersheds of the Lower Clinch watershed. LSPC is a watershed model capable of performing flow routing through stream reaches. LSPC is a dynamic watershed model based on the Hydrologic Simulation Program - Fortran (HSPF)

D.2 Model Set Up

The Lower Clinch watershed was delineated into subwatersheds in order to facilitate model hydrologic calibration. Boundaries were constructed so that subwatershed "pour points" coincided with HUC-12 delineations, 303(d)-listed waterbodies, and water quality monitoring stations. Watershed delineation was based on the NHD stream coverage and Digital Elevation Model (DEM) data. This discretization facilitates simulation of daily flows at water quality monitoring stations.

Several computer-based tools were utilized to generate input data for the LSPC model. The Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to support hydrology model simulations for selected subwatersheds. This information includes land use categories, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

An important factor influencing model results is the precipitation data contained in the meteorological data files used in these simulations. Weather data from multiple meteorological stations were available for the time period from January 1970 through August 2004. Meteorological data for a selected 11-year period were used for all simulations. The first year of this period was used for model stabilization with simulation data from the subsequent 10-year period (10/1/94 – 9/30/04) used for TMDL analysis.

D.3 Model Calibration

Hydrologic calibration of the watershed model involves comparison of simulated streamflow to historic streamflow data from U. S. Geological Survey (USGS) stream gaging stations for the same period of time. A USGS continuous record station located in the Lower Clinch watershed with a sufficiently long and recent historical record was selected as the basis of the hydrology calibration. The USGS station was selected based on similarity of drainage area, Level IV ecoregion, land use, and topography. The calibration involved comparison of simulated and observed hydrographs until statistical stream volumes and flows were within acceptable ranges as reported in the literature (Lumb, et al., 1994).

Initial values for hydrologic variables were taken from an EPA developed default data set. During the calibration process, model parameters were adjusted within reasonable constraints until acceptable agreement was achieved between simulated and observed streamflow. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge.

The results of the hydrologic calibration for Bullrun Creek near Halls Crossroads, USGS Station 03535000, are shown in Table D-1 and Figures D-1 and D-2.

Table D-1. Hydrologic Calibration Summary: Bullrun Creek (USGS 03535000)

Simulation Name:	USGS03535000	**Simulation Period:**	
		Watershed Area (ac):	43607.17
Period for Flow Analysis			
Begin Date:	**10/01/80**	**Baseflow PERCENTILE:**	2.5
End Date:	**09/30/86**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**82.36**	Total Observed In-stream Flow:	**91.27**
Total of highest 10% flows:	**42.83**	Total of Observed highest 10% flows:	**47.36**
Total of lowest 50% flows:	**9.68**	Total of Observed Lowest 50% flows:	**10.06**
Simulated Summer Flow Volume (months 7-9):	**9.30**	Observed Summer Flow Volume (7-9):	**7.91**
Simulated Fall Flow Volume (months 10-12):	**14.00**	Observed Fall Flow Volume (10-12):	**15.95**
Simulated Winter Flow Volume (months 1-3):	**31.45**	Observed Winter Flow Volume (1-3):	**35.49**
Simulated Spring Flow Volume (months 4-6):	**27.61**	Observed Spring Flow Volume (4-6):	**31.92**
Total Simulated Storm Volume:	**76.18**	Total Observed Storm Volume:	**83.16**
Simulated Summer Storm Volume (7-9):	**7.76**	Observed Summer Storm Volume (7-9):	**5.88**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**-9.76**	10	
Error in 50% lowest flows:	**-3.75**	10	
Error in 10% highest flows:	**-9.57**	15	
Seasonal volume error - Summer:	**17.59**	30	
Seasonal volume error - Fall:	**-12.22**	30	
Seasonal volume error - Winter:	**-11.39**	30	
Seasonal volume error - Spring:	**-13.50**	30	
Error in storm volumes:	**-8.39**	20	
Error in summer storm volumes:	**31.99**	50	

Criteria for Median Monthly Flow Comparisons	
Lower Bound (Percentile):	25
Upper Bound (Percentile):	75

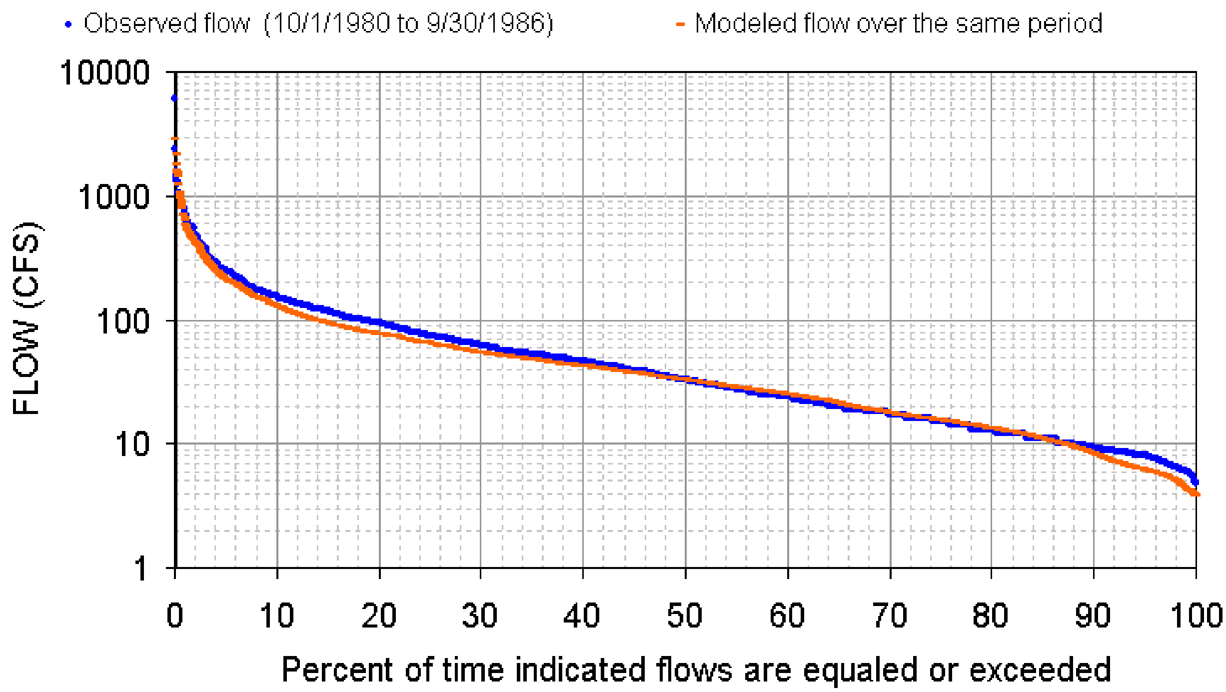

Figure D-1. Hydrologic Calibration: Bullrun Creek, USGS 03535000 (WYs1981-86)

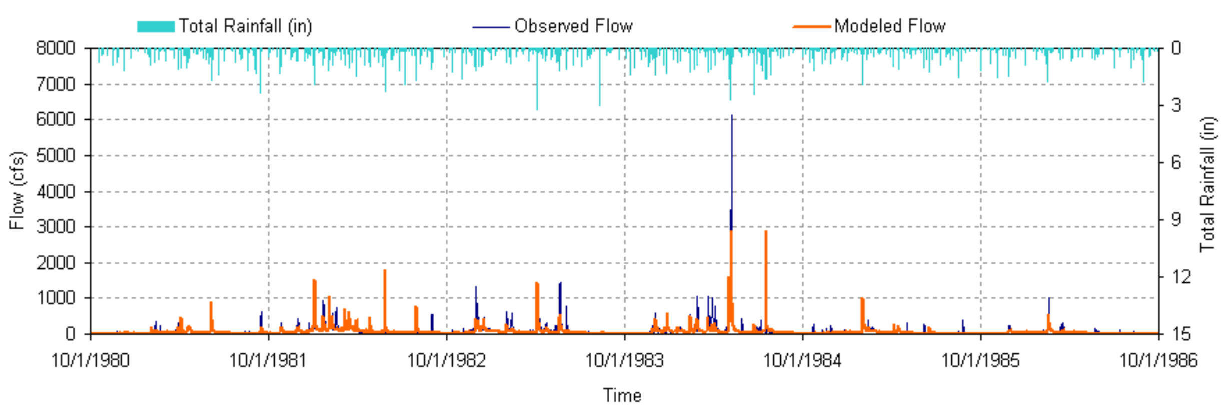

Figure D-2. 6-Year Hydrologic Comparison: Bullrun Creek, USGS 03535000

APPENDIX E

Determination of WLAs & LAs

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

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

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

For pathogen TMDLs in each impaired subwatershed, WLA terms include:

- $[\Sigma\text{WLAs}]_{WWTF}$ is the allowable load associated with discharges of NPDES permitted WWTFs located in impaired subwatersheds. Since NPDES permits for these facilities specify that treated wastewater must meet instream water quality standards at the point of discharge, no additional load reduction is required. WLAs for WWTFs are calculated from the facility design flow and the Monthly Average permit limit.
- $[\Sigma\text{WLAs}]_{CAFO}$ is the allowable load for all CAFOs in an impaired subwatershed. All wastewater discharges from a CAFO to waters of the state of Tennessee are prohibited, except when either chronic or catastrophic rainfall events cause an overflow of process wastewater from a facility properly designed, constructed, maintained, and operated to contain:
    - All process wastewater resulting from the operation of the CAFO (such as wash water, parlor water, watering system overflow, etc.); plus,
    - All runoff from a 25-year, 24-hour rainfall event for the existing CAFO or new dairy or cattle CAFOs; or all runoff from a 100-year, 24-hour rainfall event for a new swine or poultry CAFO.

  Therefore, a WLA of zero has been assigned to this class of facilities.
- $[\Sigma\text{WLAs}]_{MS4}$ is the required load reduction for discharges from MS4s. Fecal coliform and/or E. coli loading from MS4s is the result of buildup/wash-off processes associated with storm events. The percent load reductions for MS4s are considered to be equal to the load reductions developed for TMDLs.

LA terms include:

- $[\Sigma\text{LAs}]_{DS}$ is the allowable fecal coliform and/or E. coli load from "other direct sources". These sources include leaking septic systems, leaking collection systems, illicit discharges, and animals access to streams. The LA specified for all sources of this type is zero counts/day (or to the maximum extent practicable).
- $[\Sigma\text{LAs}]_{SW}$ represents the required reduction in fecal coliform and/or E. coli loading from nonpoint sources indirectly going to surface waters from all land use areas (except areas covered by a MS4 permit) as a result of the buildup/wash-off processes

associated with storm events. The percent load reductions for precipitation-induced nonpoint sources are considered to be equal to the load reductions developed for TMDLs (and specified for MS4s).

Explicit MOS has already been incorporated into TMDL development as stated in Appendix C. TMDLs, WLAs, & LAs are applied to the entire subwatershed. WLAs & LAs for Lower Clinch waterbodies are summarized in Table E-1.

Table E-1. WLAs & LAs for Lower Clinch, Tennessee

HUC-12 Subwatershed (06010103__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	WLAs				LAs	
				WWTFs[a] (Monthly Avg.) E. Coli	Leaking Collection Systems[b]	CAFOs	MS4s[c]	Precipitation Induced Nonpoint Sources	Other Direct Sources[d]
			[% Red.]	[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
0302	BEAVER CREEK	TN06010207011 – 1000 & 2000	**86.0**	**6.200×10^{10}**	**0**	**NA**	**86.0**	**86.0**	**0**
0301	BEAVER CREEK	TN06010207011 – 3000	**79.7**	**NA***	**NA**	**NA**	**79.7**	**79.7**	**0**
0202	BULL RUN CREEK[e]	TN06010207014 – 1000	**62.9**	**1.431×10^{9}**	**0**	**NA**	**62.9**	**62.9**	**0**
0201	BULL RUN CREEK[e]	TN06010207014 – 3000	**45.6**	**NA***	**NA**	**NA**	**NA**	**45.6**	**0**
0102	HINDS CREEK	TN06010207016 – 3000	**49.5**	**NA***	**NA**	**NA**	**49.5**	**49.5**	**0**
0503	EAST FORK POPLAR CREEK	TN06010207026 – 1000 & 2000	**68.1**	**4.769×10^{10}**	**0**	**NA**	**68.1**	**68.1**	**0**
0101	COAL CREEK	TN06010207029 – 1000	**56.2**	**4.531×10^{9}**	**0**	**NA**	**56.2**	**56.2**	**0**

Note: NA = Not Applicable.

* *Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.*

a. *WLAs for WWTFs expressed as E. coli loads (counts/day).*

b. *The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*

c. *Applies to any MS4 discharge loading in the subwatershed.*

d. *The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*

e. *Load reductions were determined based on comparison of the geometric mean of all monitoring data (excluding highest and lowest values) to the 30-day geometric mean target concentrations. Additional monitoring is recommended.*

APPENDIX F

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 LOAD (TMDL) FOR PATHOGENS IN LOWER CLINCH WATERSHED (HUC 06010207), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Load (TMDL) for pathogens in the Lower Clinch watershed, located in eastern 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 Clinch watershed are listed on Tennessee's Proposed Final 2004 303(d) list as not supporting designated use classifications due, in part, to discharge of pathogens from pasture land and livestock in stream and collection system failure. The TMDL utilizes Tennessee's general water quality criteria, continuous flow data from a USGS discharge monitoring station located in proximity to the watershed, site specific water quality monitoring data, a calibrated hydrologic model, load duration curves, and an appropriate Margin of Safety (MOS) to establish allowable loadings of pathogens which will result in the reduced in-stream concentrations and attainment of water quality standards. The TMDL requires reductions of pathogen loading on the order of 45-86% in the listed waterbodies.

The proposed Lower Clinch pathogen TMDL may be downloaded from the Department of Environment and Conservation website:

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

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

Vicki S. Steed, P.E., Watershed Management Section
Telephone: 615-532-0707

Sherry H. Wang, Ph.D., Watershed Management Section
Telephone: 615-532-0656

Persons wishing to comment on the proposed TMDLs are invited to submit their comments in writing no later than June 27, 2005 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.