TOTAL MAXIMUM DAILY LOAD (TMDL)

for

Pathogens

in the

Lower Duck River Watershed (HUC 06040003)

Dickson, Giles, Hickman, Humphreys, Lawrence, Lewis, Maury, and Williamson Counties, Tennessee

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January 27, 2005

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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
DMR	Discharge Monitoring Report
DWPC	Division of Water Pollution Control
EPA	Environmental Protection Agency
FCLES	Fecal Coliform Load Estimation Spreadsheet
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - Fortran
HUC	Hydrologic Unit Code
I/I	Inflow and Infiltration
LA	Load Allocation
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
NMP	Nutrient Management Plan
NOV	Notice of Violation
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PDFE	Percent of Days Flow Exceeded
Rf3	Reach File v.3
RILR	Required In-stream Load Reduction
RM	River Mile
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
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 Duck River Watershed (HUC 06040003)

<u>Impaired Waterbody Information</u>

State: Tennessee
Counties: Hickman, Humphreys, Lewis, and Maury
Watershed: Lower Duck River (HUC 06040003)
Constituents of Concern: Pathogens

Impaired Waterbodies Addressed in This Document:

Waterbody ID	Waterbody	RM not Fully Supporting
TN06040003019 – 2000	BIG BIGBY CREEK	4.6
TN06040003023 – 1000	SUGAR FORK	2.0
TN06040003041 – 0800	POTTS BRANCH	2.9
TN06040003041 – 0950	LUNNS BRANCH	2.4
TN06040003041 – 1150	DOG CREEK	2.0
TN06040003062 – 3000	BLUE CREEK	5.1

Designated Uses:

The designated use classifications for Big Bigby Creek, Sugar Fork, Potts Branch, Lunns Branch, Dog Creek, and Blue Creek include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Blue Creek is also classified for industrial water supply and Big Bigby Creek and Sugar Fork are also classified for industrial water supply and domestic 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.

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.

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 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. 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 EPA-approved 2002 303(d) list as impaired due to pathogens. TMDLs are generally developed for impaired waterbodies on a HUC-12 basis.

Analysis/Methodology:

The Big Bigby Creek and Sugar Fork TMDLs were developed using two different methodologies (below) to assure compliance with the E. Coli 941 counts/100 mL maximum standard and the fecal coliform 200 counts/100 mL geometric mean and 1,000 counts/100 mL maximum standards. The Blue Creek TMDL was developed using only the load duration methodology (E. coli and fecal coliform) due to the small size of the watershed and the fact that available water quality data were collected subsequent to availability of precipitation data required for modeling. The remaining TMDLs were developed as a data analysis and narrative summary of the enforcement case against the permitted Concentrated Animal Feeding Operation (CAFO) discharging to the three waterbodies.

<u>Dynamic Loading Model Method</u>
In order to demonstrate compliance with the 200 counts/100 mL geometric mean standard, the Loading Simulation Program C++ (LSPC) was used to simulate the buildup and washoff of fecal coliform bacteria from land surfaces, loading from point sources, and compute the resulting water quality response. From model output, instream 30-day geometric mean concentrations were computed, critical conditions identified, existing loads determined, and reductions required to meet the target concentrations (standard - MOS) calculated for impaired subwatersheds.

<u>Load Duration Curve Method</u>
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 fecal coliform and E. coli (standard - MOS).

The required load reductions that were determined using each method were compared and the largest load reduction specified as the TMDL for impaired subwatersheds.

Critical Conditions:

An LSPC model simulation period of 10 years and water quality data collected quarterly 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):

Implicit – Conservative modeling assumptions.
Explicit – 10% of the water quality standard for each impaired subwatershed.

TMDLs, WLAs, & LAs

Summary of TMDLs, WLAs, & LAs for Impaired Waterbodies

Impaired Waterbody	Impaired Waterbody ID	TMDL	WLAs						LAs	
			WWTFs[a] (Monthly Avg.)		Leaking Collection Systems[b]	CAFOs	MS4s[c]	Precipitation Induced Nonpoint Sources	Other Direct Sources[d]
			Fecal Coliform	E. Coli					
		[% Red.]	[cts./day]	[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
BIG BIGBY CREEK	TN06040003019 – 2000	**86.5**	5.376×10^9	3.387×10^9	0	NA	0	86.5	0
SUGAR FORK	TN06040003023 – 1000	**89.5**	5.376×10^9	3.387×10^9	0	NA	NA	89.5	0
POTTS BRANCH	TN06040003041 – 0800	*[e]	0	0	NA	0	NA	*[e]	0
LUNNS BRANCH	TN06040003041 – 0950	*[e]	0	0	NA	0	NA	*[e]	0
DOG CREEK	TN06040003041 – 1150	*[e]	0	0	NA	0	NA	*[e]	0
BLUE CREEK	TN06040003062 – 3000	**79.5**	3.407×10^9	2.147×10^9	0	NA	NA	79.5	0

Note: *NA = Not applicable.*

a. *WLAs for WWTFs expressed as fecal coliform and 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 pathogens.*

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 pathogens.*

e. *Detailed TMDL analyses were not performed on Potts Branch, Lunns Branch, and Dog Creek. It is assumed that water quality standards for pathogens will be attained in these waterbodies when the outstanding enforcement action(s) against Blackjack Ridge Dairy are implemented and Blackjack Ridge Dairy complies with the terms of its CAFO permit.*

PROPOSED PATHOGEN TOTAL MAXIMUM DAILY LOAD (TMDL) LOWER DUCK RIVER WATERSHED (HUC 06040003)

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 Duck River Watershed identified on the 2002 303(d) list as not supporting designated uses due to pathogens.

3.0 WATERSHED DESCRIPTION

The Lower Duck River watershed (HUC 06040003) is located in Middle Tennessee (Figure 1). The watershed lies within the Level III Interior Plateau (71) ecoregion. The Blue Creek, Potts Branch, Lunns Branch, and Dog Creek watersheds lie in the Level IV Western Highland Rim (71f) ecoregion and the Big Bigby Creek watershed (including Sugar Fork) lies in the Level IV Outer Nashville Basin (71h) and Western Highland Rim (71f) ecoregions as shown in Figure 2 (USEPA, 1997):

- The Western Highland Rim (71f) is characterized by dissected, rolling terrain of open hills, with elevations of 400-1000 feet. The geologic base of Mississippian-age limestone, chert, and shale is covered by soils that tend to be cherty and acidic with low to moderate fertility. Streams are relatively clear with a moderate gradient. Substrates are coarse chert, gravel and sand with areas of bedrock. The native oak-hickory forests were removed over broad areas in the mid-to late 1800's in conjunction with the iron-ore related mining and smelting of the mineral limonite, however today the region is again heavily forested. Some agriculture occurs on the flatter interfluves and in the stream and river valleys. The predominant land uses are hay, pasture, and cattle with some cultivation of corn and tobacco.

- The Outer Nashville Basin (71h) is a more heterogeneous region than the Inner Nashville Basin (71I), with rolling and hilly topography with slightly higher elevations. The region encompasses most of the outer areas of the generally non-cherty Ordovician limestone bedrock. The higher hills and knobs are capped by the more cherty Mississippian-age formation, and some Devonian-age Chattanooga shale, remnants of the Highland Rim.

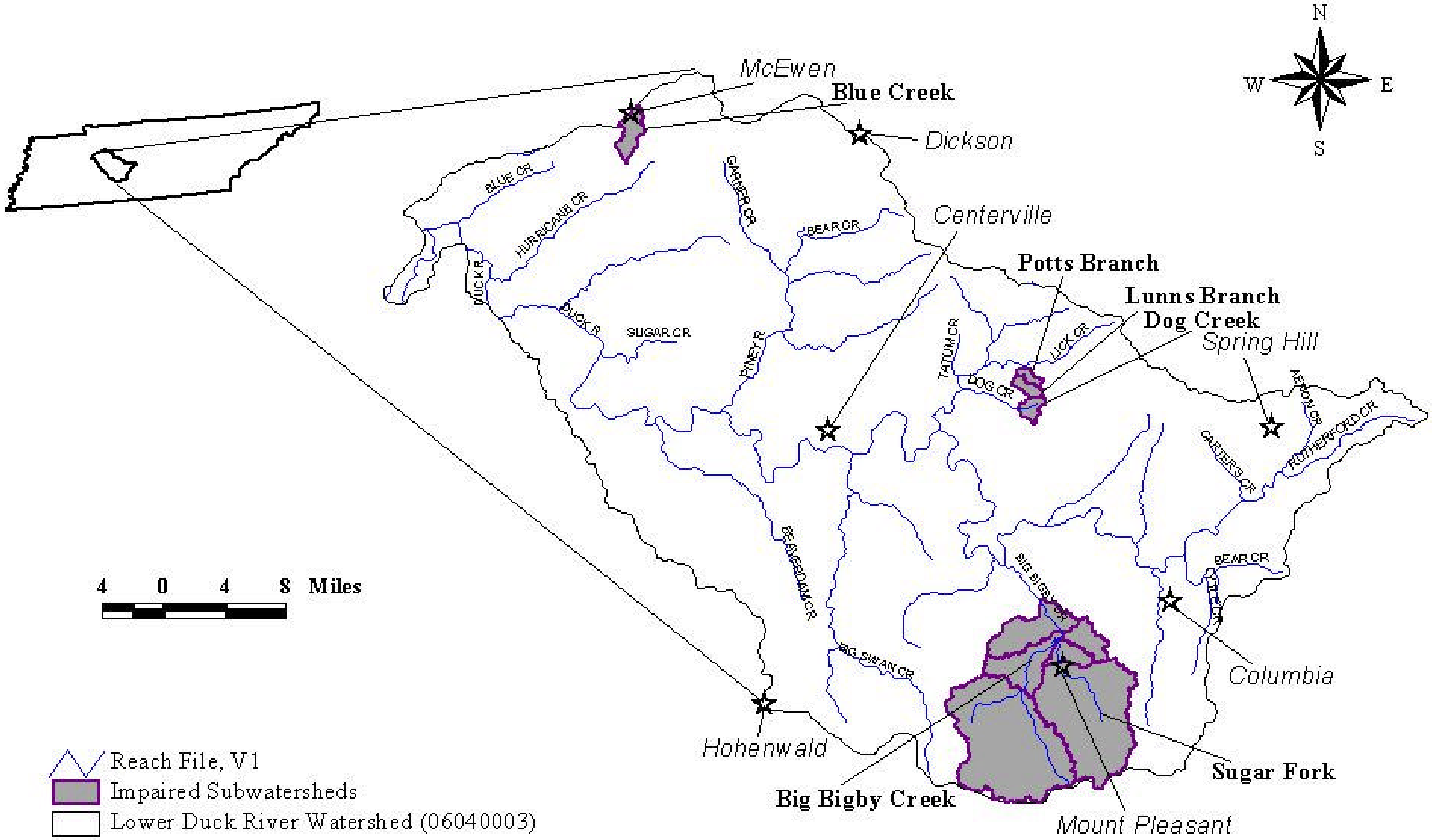

Figure 1. Location of the Lower Duck River Watershed and Impaired Subwatersheds.

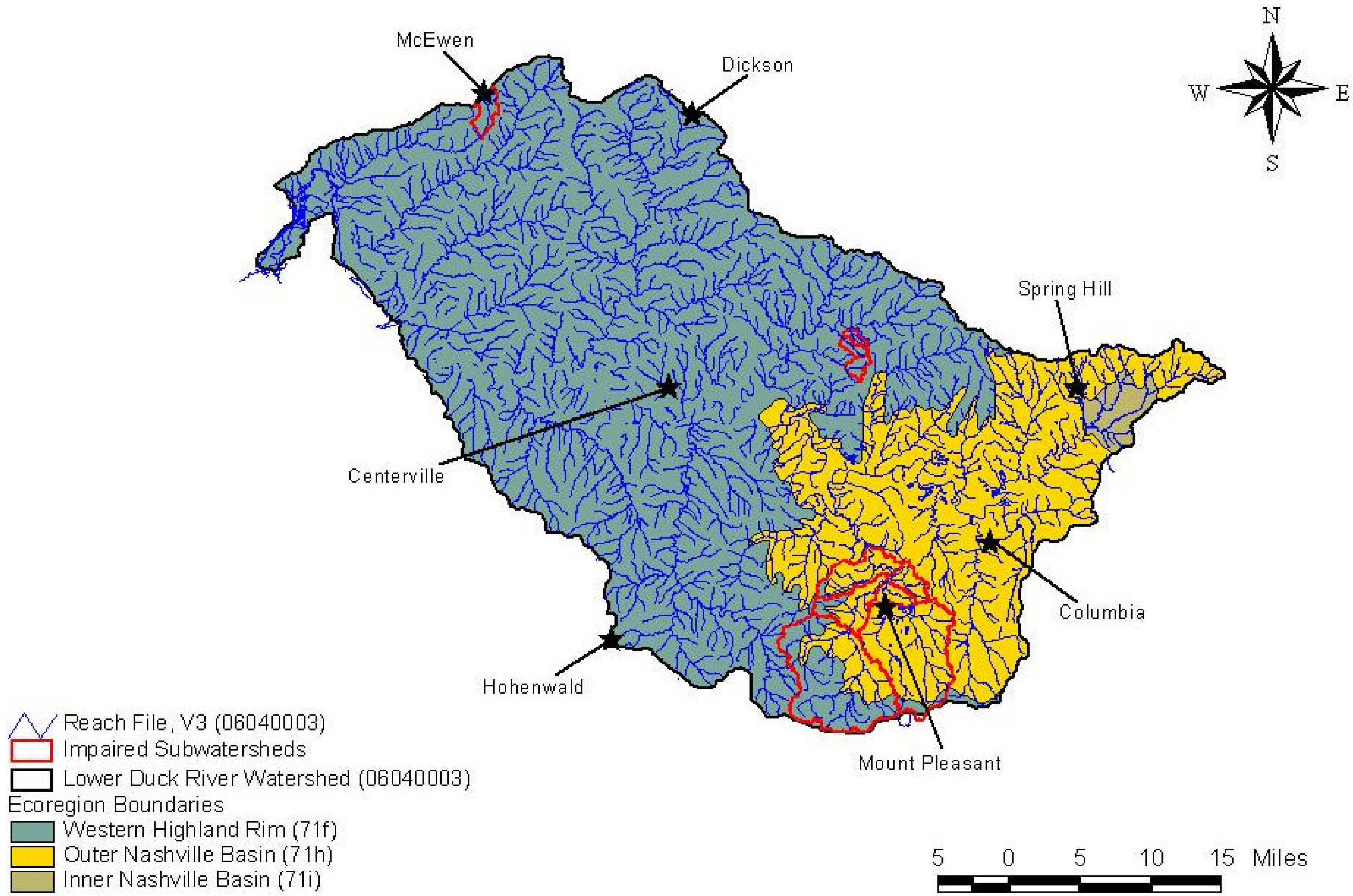

Figure 2. Level IV Ecoregions in the Lower Duck River Watershed.

> The region's limestone rocks and soils are high in phosphorus, and commercial phosphate is mined. Deciduous forest with pasture and cropland are the dominant land covers. The region has areas of intense urban development with the city of Nashville occupying the northwest region. Streams are low to moderate gradient, with productive, nutrient-rich waters, resulting in algae, rooted vegetation, and occasionally high densities of fish. The Nashville Basin has a distinctive fish population, notable for species that avoid the region, as well as those that are present.

The Lower Duck River watershed, located in Dickson, Giles, Hickman, Humphreys, Lawrence, Lewis, Maury, and Williamson Counties, Tennessee, has a drainage area of approximately 1547 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 Duck River watershed have occurred since 1993 as a result of rapid development, this is the most current land use data available. Land use for the Lower Duck River watershed is summarized in Table 1 and shown in Figure 3. Predominate land use in the Lower Duck River watershed is forest (69.8%) followed by agriculture (26.7%). Urban areas represent approximately 1.2% of the total drainage area of the watershed. Details of land use distribution of impaired subwatersheds in the Lower Duck River watershed are presented in Appendix A.

4.0 PROBLEM DEFINITION

The State of Tennessee's final 2002 303(d) list (TDEC, 2004a) was approved by the U.S. Environmental Protection Agency (EPA), Region IV in January of 2004. The list identified Big Bigby Creek, Sugar Fork, Potts Branch, Lunns Branch, Dog Creek, and Blue Creek in the Lower Duck River watershed as not fully supporting designated use classifications due to pathogens (see Table 2). The designated use classifications for these waterbodies include fish and aquatic life, irrigation, livestock watering & wildlife and recreation. Blue Creek is also classified for industrial water supply and Big Bigby Creek and Sugar Fork are also classified for industrial water supply and domestic 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.

A description of the stream assessment process in Tennessee can be found in *2002 305(b) Report, The Status of Water Quality in Tennessee* (TDEC, 2002a). 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

Table 1. MRLC Land Use Distribution – Lower Duck River Watershed

Land Use	Area	
	[acres]	[%]
Bare Rock/Sand/Clay	10	0.00
Deciduous Forest	614,480	62.07
Emergent Herbaceous Wetlands	224	0.02
Evergreen Forest	15,627	1.58
High Intensity Commercial/Industrial/ Transportation	5,091	0.51
High Intensity Residential	809	0.08
Low Intensity Residential	5,751	0.58
Mixed Forest	61,224	6.18
Open Water	6,784	0.69
Other Grasses (Urban/recreational)	2,749	0.28
Pasture/Hay	190,343	19.23
Quarries/Strip Mines/ Gravel Pits	810	0.08
Row Crops	73,860	7.46
Transitional	5,333	0.54
Woody Wetlands	6,853	0.69
Total	**989,948**	**100.00**

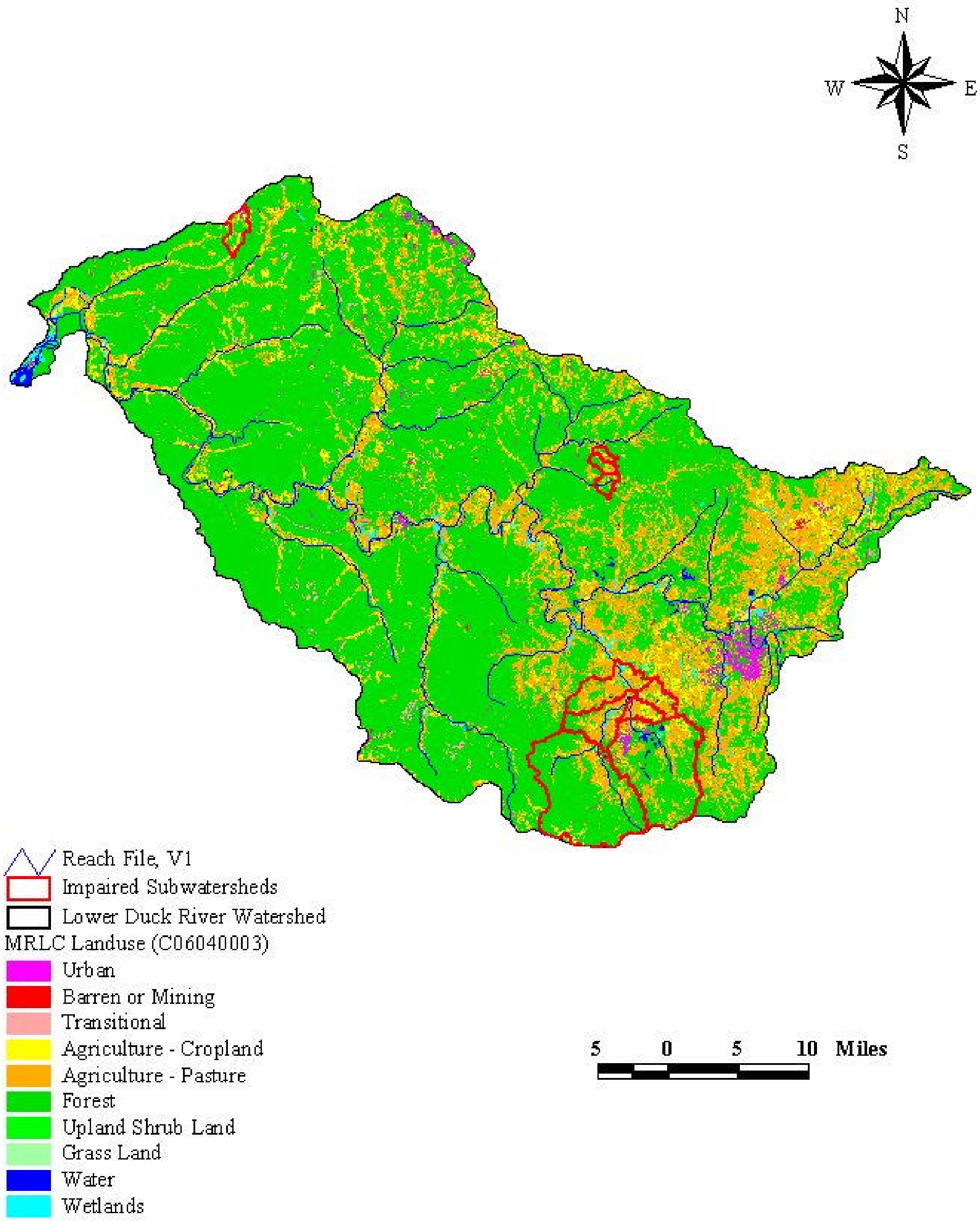

Figure 3. Land Use Characteristics of the Lower Duck River Watershed.

Table 2. 2002 303(d) List for Pathogens – Lower Duck River Watershed

Waterbody ID	Impacted Waterbody	RM Partially Supporting	RM Not Supporting	CAUSE (Pollutant)	Pollutant Source
BIG BIGBY CREEK	TN06040003019 – 2000	4.6		Nitrate Pathogens	Major Municipal Point Source
SUGAR FORK	TN06040003023 – 1000		2.0	Suspended Solids Organic Enrichment/Low DO Pathogens	Major Municipal Point Source
POTTS BRANCH	TN06040003041 – 0800	2.9		Organic Enrichment/Low DO Pathogens Suspended Solids	Confined Animal Feeding Operation (nonpoint)
LUNNS BRANCH	TN06040003041 – 0950		2.4	Organic Enrichment/Low DO Pathogens	Confined Animal Feeding Operation (permitted point)
DOG CREEK	TN06040003041 – 1150		2.0	Organic Enrichment/Low DO Pathogens	Confined Animal Feeding Operation (permitted point)
BLUE CREEK	TN06040003062 – 3000		5.1	Organic Enrichment/Low DO Pathogens	Minor Municipal Point Source

Table 3. Water Quality Assessment of Waterbodies Impaired Due to Pathogens - Lower Duck River Watershed

Waterbody ID	Segment Name	Cause	Sources	Comments
TN06040003019 – 2000	BIG BIGBY CREEK	Escherichia coli	Municipal Point Source Discharges	TDEC ambient station at Canaan Road. E. coli elevated. Elevated nitrate-nitrite levels. 2000 TDEC biological survey at mile 8.5 (Canaan Road). 8 EPT families, 22 total families. Habitat score = 128.
TN06040003023 – 1000	SUGAR FORK	Escherichia coli	Municipal Point Source Discharges	1999 TDEC biological survey at mile 2.2 (below Mt. Pleasant SPT). O EPT families, 3 total families below STP. Habitat score = 103.
TN06040003041 – 0800	POTTS BRANCH	Total Fecal Coliform	Animal Feeding Operations (NPS)	1999 TDEC biological survey at mile 0.1 (Old Lick Creek Road). 9 EPT families, 29 total families. Habitat score = 141. However, manure discharge from AFO has recently occurred (January, 2000).
TN06040003041 – 0950	LUNNS BRANCH	Total Fecal Coliform	Permitted Runoff from Confined Animal Feeding Operations (CAFOs)	Impacted by animal wastes from Blackjack Dairy.
TN06040003041 – 1150	DOG CREEK	Total Fecal Coliform	Permitted Runoff from Confined Animal Feeding Operations (CAFOs)	Impacted by animal wastes from Blackjack Dairy.
TN06040003062 – 3000	BLUE CREEK	Total Fecal Coliform	Municipal Point Source Discharges	1999 TDEC biological survey at mile 16.1 (Bold Spring Road). Floating sewage, sludge banks below McEwen STP. Creek not entered by biologists.

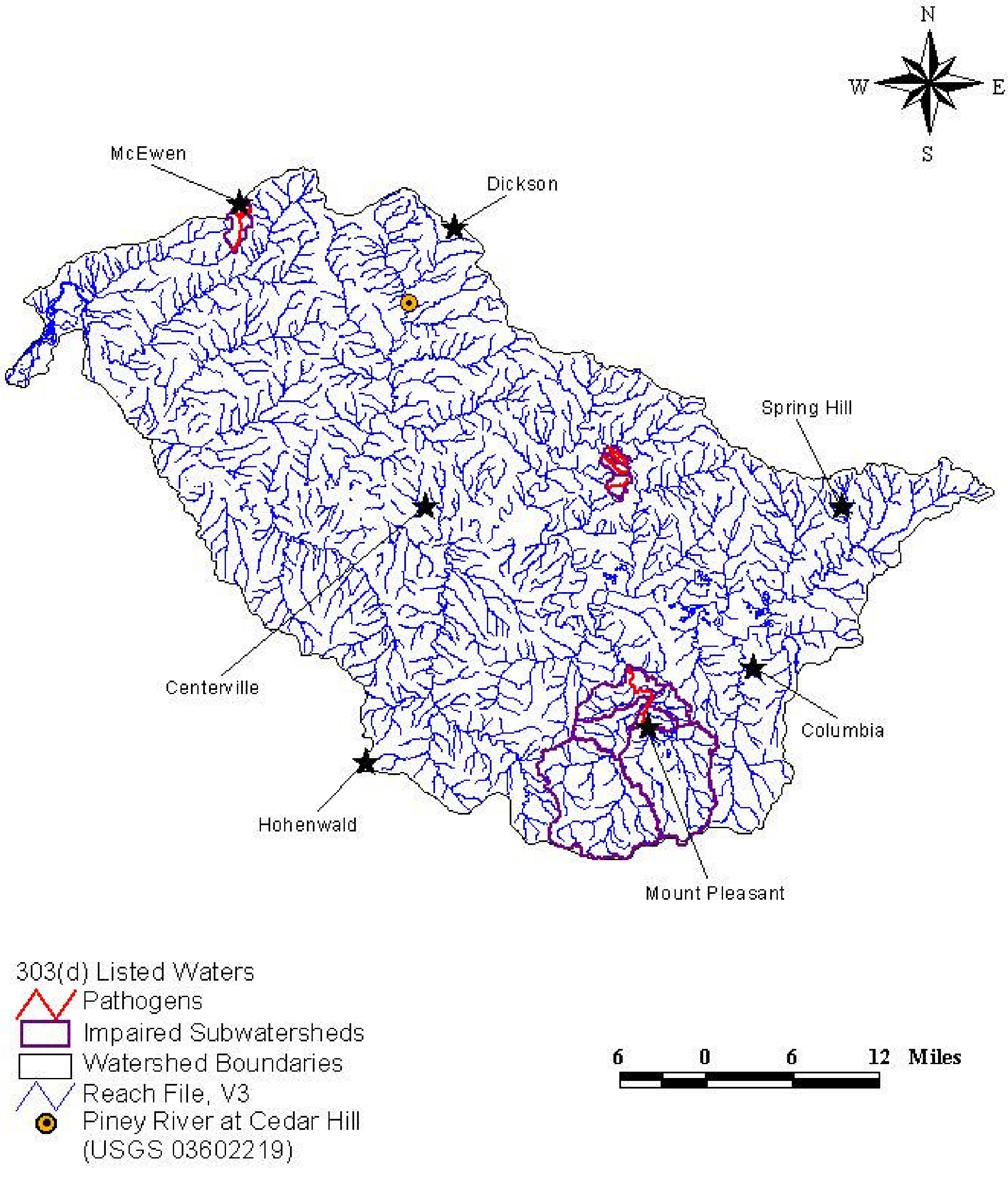

Figure 4. Waterbodies on the 303(d) List - Pathogens.

5.0 WATER QUALITY GOAL

As previously stated, the designated use classifications for the Lower Duck River waterbodies include fish & aquatic life, recreation, irrigation, livestock watering & wildlife, industrial water supply, and domestic 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.

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) stated:

> 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 the state of Tennessee, E. coli and fecal coliform are well correlated (R = 0.902) when evaluating all available ecoregion data (623 observations). Furthermore, as described in Section 3.0, the impaired waterbodies of the Lower Duck River watershed (HUC 06040003) lie within level IV ecoregions 71f and 71h. The correlation between E. coli and fecal coliform in level III ecoregion 71 is fair (R = 0.669); however, the correlations between E. coli and fecal coliform in level IV ecoregions 71f (R = 0.983) and 71h (R = 0.960) are excellent.

For consistency with current TMDL methodology, since the dynamic loading model method is only applicable to fecal coliform, and to comply with current water quality standards for pathogens, the primary instream goals selected for TMDL development are threefold: 1) the geometric mean standard for fecal coliform of 200 counts/100 mL, 2) the fecal coliform sample maximum of 1,000 counts/100 mL, and 3) the E. coli sample maximum of 941 counts/100 mL. The most protective (or highest percent of load reduction) of the three methodologies will determine the percent reduction(s) required for impaired waterbodies.

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.

6.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM GOAL

There are three primary water quality monitoring stations that provide data for waterbodies identified as impaired for pathogens in the Lower Duck River watershed:

- BBIGB008.5MY – Big Bigby Creek downstream from the confluence with Sugar Creek (˜ RM 8.5).
- BLUE015.8HU – Blue Creek at Bold Springs Road, d/s McEwen STP outfall (˜ RM 15.8).
- SUGAR001.8MY – Sugar Fork below Mt. Pleasant STP outfall (˜ RM 1.8).

The location of these monitoring stations is shown in Figure 5. Water quality monitoring results for these stations are tabulated in Appendix B and summarized in Table 4. Examination of the data shows multiple violations of the 1,000 counts/100 mL maximum fecal coliform standard and the 941 counts/100 mL maximum E. coli standard at each monitoring station. There were not enough data to determine compliance with the geometric mean standard for fecal coliform or E. coli.

Table 4. Summary of Water Quality Monitoring Data

Monitoring Station	Fecal Coliform					E. Coli				
	Data Pts.	[Counts/100 mL]			No. Viol. WQ Std.	Data Pts.	[Counts/100 mL]			No. Viol. WQ Std.
		Min.	Avg.	Max.			Min.	Avg.	Max.	
BBIGB008.5MY	37	56	1659	16,000	10	20	31	>634	>2400	5
BLUE015.8HU	9	73	3446	15,000	4	10	39	>1199	>2400	5
SUGAR001.8MY	11	110	>4611	>20,000	6	11	100	>1503	>2400	6

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

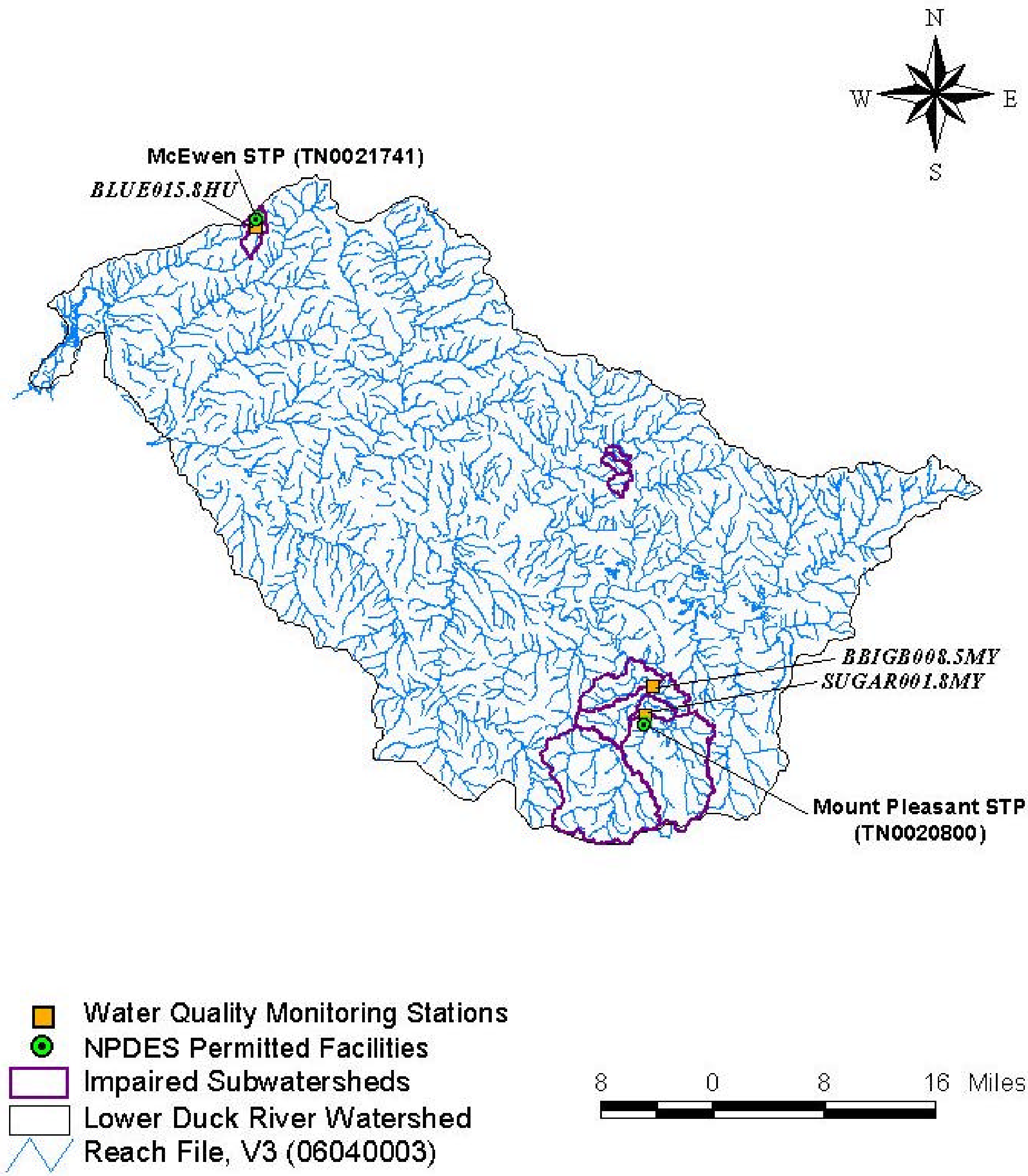

Figure 5. Selected Water Quality Monitoring Stations and Point Source Dischargers in the Lower Duck River Watershed.

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 two (2) NPDES permitted WWTFs in the impaired subwatersheds of the Lower Duck River watershed that are authorized to discharge treated sanitary wastewater. These facilities are tabulated in Table 5 and the locations shown in Figure 5. The fecal coliform and E. coli permit limits for discharges from these two 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).

The Mount Pleasant Sewage Treatment Plant (STP) (TN0020800) serves the Mount Pleasant municipality and discharges to Sugar Fork at mile 1.9. The McEwen Sewage Treatment Plant (TN0021741) serves the McEwen municipality and discharges to Blue Creek at mile 16.2. The sanitary sewage collection systems for each, with documented long-term wet-weather overflow problems, have historically been significant contributors to coliform impairment in the Sugar Fork/Big Bigby Creek and Blue Creek watersheds, respectively.

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 Duck River watershed. As of March 2003, small MS4s serving urbanized areas, or having the potential to exceed instream water quality standards, are required to obtain a permit under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2002b). 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. Columbia is covered under Phase II of the NPDES Storm Water Program. 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/. For the purposes of Lower Duck River Pathogen TMDL development, there are no portions of impaired subwatersheds that are covered by an MS4 permit.

Table 5. WWTFs Permitted to Discharge Treated Sanitary Wastewater in the Impaired Subwatersheds of the Lower Duck River Watershed

NPDES Permit No.	Facility	Design Flow [MGD]	Receiving Stream
TN0020800	Mount Pleasant STP	0.71	Sugar Fork at mile 1.9
TN0021741	McEwen STP	0.45	Blue Creek at mile 16.2

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, 2002). 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. Requirements of both the general and individual CAFO permits include:

- Development of a Nutrient Management Plan (NMP), and approval of the NMP by the Tennessee Department of Agriculture (TDA).
- Liquid waste handling systems, if utilized, shall be designed, constructed, and operated to contain all process generated waste waters plus the runoff from a 25-year, 24-hour rainfall event. A discharge from a liquid waste handling facility to waters of the state during a chronic or catastrophic rainfall event, or as a result of an unpermitted discharge, upset, or bypass of the system, shall not cause or contribute to an exceedance of Tennessee water quality standards.
- Other Best Management Practices (BMPs).

As of May 5, 2004, there is only one Class II CAFO in the Lower Duck River watershed with coverage under the general NPDES permit. The location of this facility, the Blackjack Ridge Dairy, is shown in Figure 6. There are no CAFOs with individual permits located in the watershed. The Blackjack Ridge Dairy has been identified as the source of pollution for Potts Branch, Lunns Branch, and Dog Branch on the 2002 303(d) list. Over a period of several years, a number of complaints regarding manure discharges from this facility have been investigated by personnel from the Division of Water Pollution Control (DWPC) and the Tennessee Wildlife Resources Agency (TWRA). These investigations indicated that discharges from the Blackjack Ridge Dairy and runoff from improper land application of animal waste have resulted in a condition of pollution in Potts Branch, Lunns Branch, Dog Branch, two springs, and several unnamed tributaries. Copies of Notices of Violation (NOVs) sent to this facility and related sampling result summaries are included as Appendix C. Further enforcement action is under consideration.

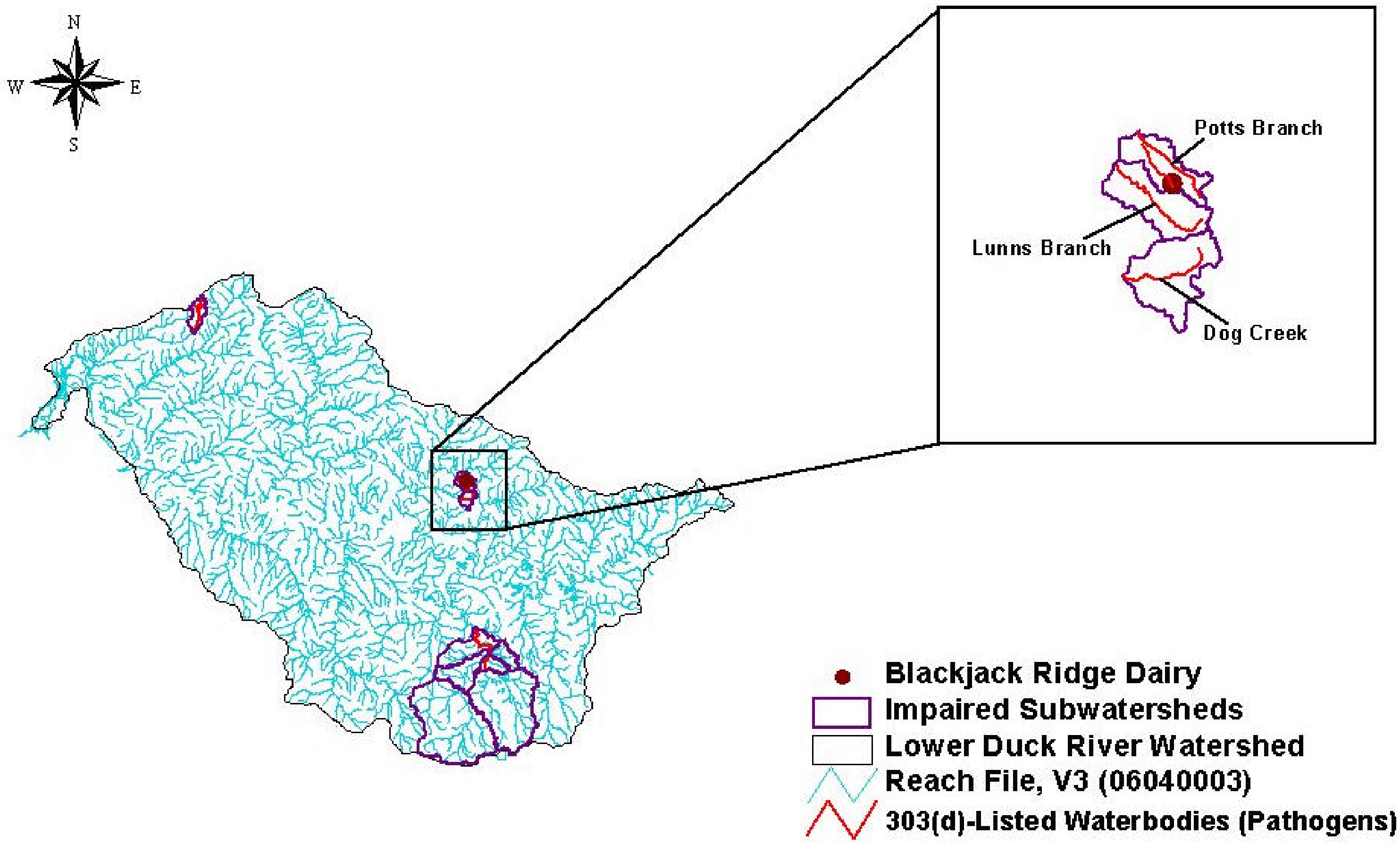

Figure 6. Location of CAFOs in the Lower Duck River Watershed.

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 approved 2002 303(d) list as impaired due to pathogens 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 (i.e., deer and other wildlife) often have direct access to waterbodies and can provide a concentrated source of coliform bacteria loading directly to a stream.

Livestock data for pathogen-impaired subwatersheds were compiled from the 1997 Census of Agriculture utilizing the Watershed Characterization System (WCS) and summarized in Table 6. WCS is an Arcview geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development.

Table 6. Livestock Distribution in the Lower Duck River Watershed

Subwatershed	Livestock Population (WCS)				
	Beef Cow	Milk Cow	Poultry	Hogs	Sheep
Big Bigby Creek	4961	472	0	425	57
Sugar Fork[1]	1815	178	0	139	21
Potts Branch	51	485[2]	0	2	0
Lunns Branch	70	7	0	3	0
Dog Creek	86	8	0	3	0
Blue Creek	9	0	0	1	0

[1] Sugar Fork is a tributary to Big Bigby Creek
[2] Milk Cow population in Potts Branch derived from DWPC personnel estimates.

7.2.3 Failing Septic Systems

Some coliform loading in the Lower Duck River watershed can be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates from 1997 county census data of people in subwatersheds of the Lower Duck River watershed utilizing septic systems were compiled using the WCS and are summarized in Table 7. In middle 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 Duck River Watershed

Subwatershed	Population on Septic Systems
Big Bigby Creek	4266
Sugar Fork[1]	1910
Potts Branch	39
Lunns Branch	54
Dog Creek	67
Blue Creek	50

[1] Sugar Fork is a tributary to Big Bigby Creek

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. Blue Creek and Sugar Fork have the highest percentages of urban land area for impaired waterbodies in the Lower Duck River watershed, with 6.4% and 2.7%, respectively. Land use for the Lower Duck River impaired drainage areas is summarized in Figures 7-9 and tabulated in Appendix A.

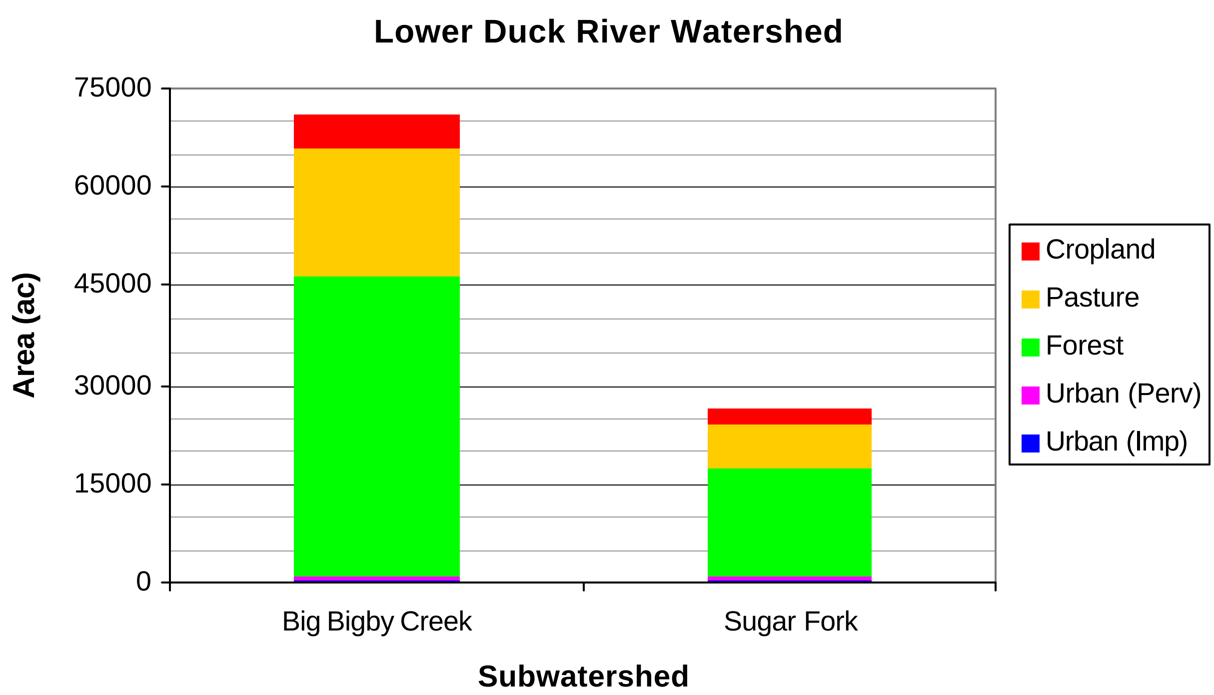

Figure 7. Land Use Area of Big Bigby Creek and Sugar Fork Subwatersheds, Lower Duck River Watershed.

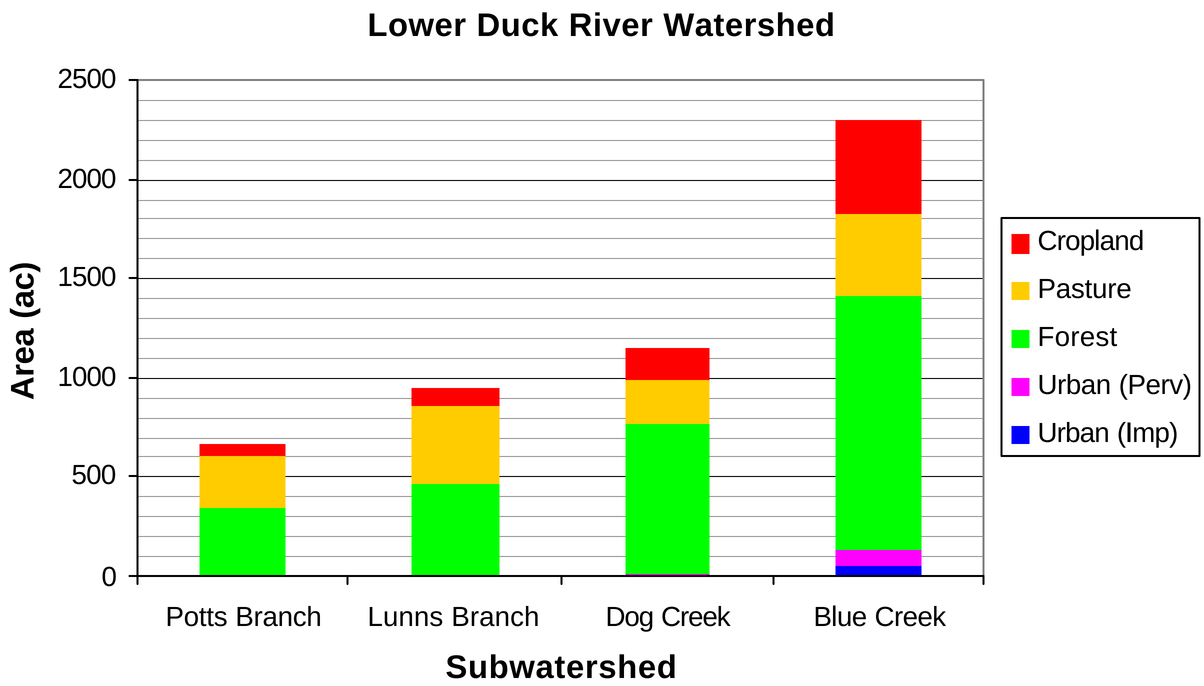

Figure 8. **Land Use Area of Potts Branch, Lunns Branch, Dog Creek, and Blue Creek Subwatersheds, Lower Duck River Watershed.**

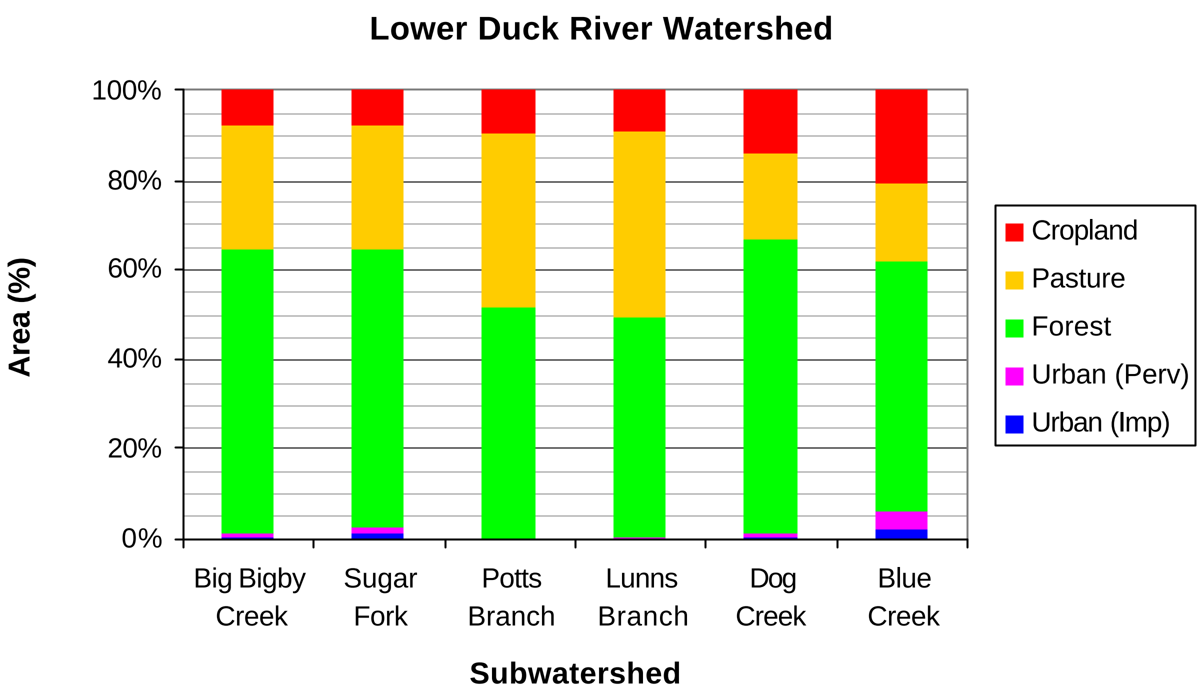

Figure 9. **Land Use Percent of the Lower Duck River Pathogen-Impaired Subwatersheds.**

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:

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

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

8.1 Scope of TMDL Development

This document describes pathogen TMDL, Waste Load Allocation (WLA), and Load Allocation (LA) development for waterbodies identified as impaired due to pathogens on the 2002 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 pathogens on the 2002 303(d) list. In cases where impaired streams are located in the upstream portion of a subwatershed, TMDLs are developed for the impaired drainage area only (as is the case in the Lower Duck River watershed). The Lower Duck River subwatersheds are shown in Figures 1-5.

8.2 Critical Conditions

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 each TMDL analysis method.

8.2.1 Dynamic Loading Model Method

The ten-year period from October 1, 1991 to September 30, 2001 was used to simulate continuous 30-day geometric mean concentrations to compare to the target. This 10-year period contained a range of hydrologic conditions that included both low and high streamflows from which critical conditions were identified and used to derive the TMDL value.

The 30-day critical period is the period preceding the highest simulated violation of the geometric mean standard (USEPA, 1991). Meeting water quality standards during the critical period ensures that water quality standards can be achieved throughout the ten-year period. For Big Bigby Creek and Sugar Fork, the highest violations of the 30-day geometric mean occurred during the 30-day periods 2/8/98 – 3/9/98 and 8/31/99 – 9/29/99, respectively.

8.2.2 Load Duration Curve Method

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 Lower Duck River impaired waterbodies. Water quality data have been collected during all flow ranges. Based on the location of the majority of water quality exceedances on the load duration curves (between the 0% and 40% duration intervals), runoff during wet weather events is the probable dominant delivery mode for pathogens (see Section 9.3). However, Sugar Fork exhibits some exceedances during dry flow conditions (between the 60% and 90% duration intervals), suggesting significant contribution from direct sources.

8.3 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. The TMDLs for the Lower Duck River watershed were developed using two different methodologies to assure compliance with both the 200 counts/100 mL geometric mean standard and the dual maximum standards (ref.: Section 5.0) of 1,000 counts/100 mL for fecal coliform and 941 counts/100 mL for E. coli.

8.3.1 Dynamic Loading Model Method

In order to demonstrate compliance with the 200 counts/100 mL geometric mean standard, a dynamic loading model was utilized to: a) continuously simulate fecal coliform bacteria deposition on land surfaces and pollutant transport to receiving waters in response to storm events; b) incorporate seasonal effects on the production and fate of fecal coliform bacteria; and c) simulate continuous fecal coliform concentration in surface waters.

The Loading Simulation Program C++ (LSPC) is a dynamic watershed model based on the Hydrologic Simulation Program - Fortran (HSPF) and was selected for TMDL analysis of pathogen impaired waters in the Lower Duck River watershed. LSPC was used to simulate the deposition and transport of fecal coliform bacteria from land surfaces, incorporate point source loading, and compute the resulting water quality response. From model output, instream 30-day geometric mean concentrations were computed, critical conditions identified, existing loads determined, and reductions required to meet the target concentrations (standard - MOS) calculated. Details of model development, calibration and TMDL analysis are presented in Appendix D.

8.3.2 Load Duration Curve Method

A load duration curve 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 and determination of the load reductions required to meet the target maximum concentration (standard - MOS). Details of load duration curve development for Lower Duck River impaired waterbodies are presented in Appendix E.

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 to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In these TMDLs, both explicit and implicit MOS were utilized.

Dynamic Loading Model Analysis
An explicit MOS, equal to 10% of the geometric mean fecal coliform standard (200 counts/100 mL), was utilized for TMDL modeling analysis. Application of this explicit MOS of 20 counts/100 mL results in an effective 30-day geometric mean target concentration of 180 counts/100 mL.

Implicit MOS includes the use of conservative modeling assumptions and a 10-year continuous simulation that incorporates a range of meteorological events. Conservative modeling assumptions used include: septic systems discharging directly into the streams; development of the TMDL using loads based on the design flow and fecal coliform permit limits of NPDES facilities; and all land uses connected directly to streams.

Load Duration Curve Analysis
An explicit MOS, equal to 10% of the maximum coliform standard, was utilized for TMDL analysis. Application of the explicit MOS of 100 counts/100 mL to the fecal coliform maximum standard of 1000 counts/100 mL results in an effective maximum target concentration of 900 counts/100 mL. Application of the explicit MOS of 94 counts/100 mL to the E. coli maximum standard of 941 counts/100 mL results in an effective maximum target concentration of 847 counts/100 mL.

8.5 Expression of TMDLs, WLAs, & LAs

In this document, the pathogen TMDL is expressed as the percent reduction in instream loading required to decrease: a) the existing 30-day geometric mean concentration of fecal coliform to the target of 180 counts/100 mL, b) the existing maximum concentration of fecal coliform to the target of 900 counts/100 mL, and c) the existing maximum concentration of E. coli to the target of 847 counts/100 mL. 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, WLAs for CAFOs, and LAs for “other direct sources”) are expressed as counts per day.

8.5.1 Determination of TMDLs

Load reductions for Big Bigby Creek and Sugar Fork were developed using the Dynamic Loading Model to achieve compliance with the 30-day geometric mean target concentration (Appendix D). Load reductions were also developed for these two waterbodies using Load Duration Curves to achieve compliance with the maximum target concentrations (Appendix E), both fecal coliform and E coli for Big Bigby Creek and fecal coliform only for Sugar Fork. The instream load reductions determined by these two methodologies (dynamic loading model and load duration curves) were compared and the largest required load reduction was selected as the TMDL. The Load Duration Curve methodology was used to determine load reduction for Blue Creek. The largest required load reduction (to achieve compliance with the dual maximum target concentrations) was selected as the TMDL. TMDL load reductions for Lower Duck River are shown in Table 8. Detailed TMDL analyses were not performed on Potts Branch, Lunns Branch, and Dog Creek. It is assumed that water quality standards for pathogens will be attained in these waterbodies when the outstanding enforcement action(s) against Blackjack Ridge Dairy are implemented and Blackjack Ridge Dairy complies with the terms of its CAFO permit.

Table 8. Determination of TMDLs for Impaired Waterbodies, Lower Duck River Watershed

Impaired Waterbody Name	Impaired Waterbody ID	Required Load Reduction			
		Dynamic Loading Model [%] (Fecal Coliform)	Load Duration Curve [%]		TMDL [%]
			Fecal Coliform	E. Coli	
Big Bigby Creek	TN06040003019 – 2000	**86.5**	**57.2**	**53.7**	**86.5**
Sugar Fork	TN06040003023 – 1000	**89.5**	**86.9**	**NA**	**89.5**
Potts Branch	TN06040003041 – 0800	**NA**	**NA**	**NA**	*
Lunns Branch	TN06040003041 – 0950	**NA**	**NA**	**NA**	*
Dog Creek	TN06040003041 – 1150	**NA**	**NA**	**NA**	*
Blue Creek	TN06040003062 – 3000	**NA**	**79.5**	**46.3**	**79.5**

* Detailed TMDL analyses were not performed on Potts Branch, Lunns Branch, and Dog Creek. It is assumed that water quality standards for pathogens will be attained in these waterbodies when the outstanding enforcement action(s) against Blackjack Ridge Dairy are implemented and Blackjack Ridge Dairy complies with the terms of its CAFO permit.

8.5.2 Determination of WLAs & LAs

WLAs & LAs are developed in Appendix F for point sources and nonpoint sources respectively. TMDLs, WLAs, & LAs for Lower Duck River watershed impaired waterbodies are summarized in Table 9.

8.6 Seasonal Variation

Seasonal variation was incorporated in the continuous simulation water quality model by using varying monthly loading rates and daily meteorological data over a ten-year period. 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 collected during all seasons.

Table 9. WLAs & LAs for Lower Duck River, Tennessee

Impaired Waterbody Name	Impaired Waterbody ID	WLAs					LAs	
		WWTFs[a] (Monthly Avg.)		Leaking Collection Systems[b]	CAFOs	MS4s[c]	Precipitation Induced Nonpoint Sources	Other Direct Sources[d]
		Fecal Coliform	E. Coli					
		[cts./day]	[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
Big Bigby Creek	TN06040003019 – 2000	**5.376×10^9**	**3.387×10^9**	**0**	**NA**	**NA**	**86.5**	**0**
Sugar Fork	TN06040003023 – 1000	**5.376×10^9**	**3.387×10^9**	**0**	**NA**	**NA**	**89.5**	**0**
Potts Branch	TN06040003041 – 0800	**0**	**0**	**NA**	**0**	**NA**	*[e]	**0**
Lunns Branch	TN06040003041 – 0950	**0**	**0**	**NA**	**0**	**NA**	*[e]	**0**
Dog Creek	TN06040003041 – 1150	**0**	**0**	**NA**	**0**	**NA**	*[e]	**0**
Blue Creek	TN06040003062 – 3000	**3.407×10^9**	**2.147×10^9**	**0**	**NA**	**NA**	**79.5**	**0**

Note: NA = Not Applicable.

a. WLAs for WWTFs expressed as fecal coliform and 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 pathogens.

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 pathogens.

e. Detailed TMDL analyses were not performed on Potts Branch, Lunns Branch, and Dog Creek. It is assumed that water quality standards for pathogens will be attained in these waterbodies when the outstanding enforcement action(s) against Blackjack Ridge Dairy are implemented and Blackjack Ridge Dairy complies with the terms of its CAFO permit.

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 Duck River 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 fecal coliform and E. coli limits.

Six (6) Notices of Violation (NOVs) were issued against the Mount Pleasant STP (TN0020800) by the State of Tennessee for discharge of sewage into waters of the State, causing pollution to waters of the State, at least 12 bypass/overflow events, an exceedance of the daily maximum concentration for fecal coliform on August 27, 2003 (confirmed by split sampling with DWPC personnel), and for having no certified operator since 2001. Furthermore, a total of 269 bypass/overflow events were reported by the Mount Pleasant STP from May 1994 through July 2003.

A Commissioner's Order was issued against the City of Mount Pleasant on 1/15/04 for discharging wastewater effluent from the Mount Pleasant STP contrary to the NPDES permit, causing a condition of pollution to waters of the State, and failure to submit reports as required by the NPDES permit. Violations include fecal coliform effluent limit exceedances and multiple bypass/overflow events. The City of Mount Pleasant is required, in part, to submit and implement a sewer overflow response plan, submit a sanitary sewer overflow evaluation report, and submit a corrective action plan to address the elimination of recurring overflows. In addition, a moratorium has been placed on further connections, line extensions, or increased flows to the sanitary sewer collection system.

In order to meet water quality criteria for Sugar Fork and Big Bigby Creek, the Mount Pleasant STP must meet the provisions of its NPDES permit, including elimination of bypasses and overflows.

Nine (9) NOVs were issued against the McEwen STP (TN0021741) by the State of Tennessee for 50 bypass/overflow events during the period June 2002 through May 2004. A total of 105 bypass/overflow events and 7 fecal coliform effluent limit violations were reported by the McEwen STP from January 1998 through March 2004. An NOV issued on May 2, 2002, detailing findings of a Compliance Evaluation Inspection conducted by DWPC personnel on March 27, 2002, stated, "There is a severe inflow and infiltration (I/I) problem in the collection system" and "The plant is operationally challenged by the I/I problems in the collection system". In order to meet water quality criteria for Blue Creek, the McEwen STP must meet the provisions of its NPDES permit, including elimination of bypasses and overflows.

9.1.2 NPDES Regulated Concentrated Animal Feeding Operations (CAFOs)

Existing or future CAFOs that are located in impaired subwatersheds will be required to comply with WLAs consistent with their permits. These WLAs will be implemented through the Nutrient Management Plan (NMP), liquid waste handling system, and Best Management Practices (BMP) provisions of NPDES Permit No. TNA000000, *Class II Concentrated Animal Feeding Operation General Permit* or the individual NPDES permit for Class I CAFOs. All discharges, except during a catastrophic or chronic rainfall event, are not authorized by this permit. Any discharge shall not cause an exceedance of Tennessee water quality standards.

In the case of the Blackjack Ridge Dairy, compliance with the Class II Concentrated Animal Feeding Operation General Permit will be ensured through appropriate, pending enforcement action.

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 Duck River watershed to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. These BMPs (e.g., stream stabilization, fencing, heavy use area treatment, livestock exclusion, etc.) may have contributed to reductions in in-stream concentrations of coliform bacteria in the Big Bigby Creek/Sugar Fork subwatersheds during the TMDL evaluation period. The TDA keeps a database of BMPs implemented in Tennessee. Those listed in the Lower Duck River 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 Stage 2 implementation. Coliform bacteria 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.

9.3 Example Application of Load Duration Curves for Implementation Planning

The Load Duration Curve methodology (Appendix E) 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 fecal coliform load duration analysis was utilized for implementation planning because the data are more abundant than E. coli and cover a longer period of record. The fecal coliform load duration curve for Big Bigby Creek at mile 8.5 (Figure 10) was analyzed to determine the frequency with which water quality monitoring data exceed the fecal coliform target maximum concentration of 900 counts/100 mL (standard – MOS) under five flow conditions (low, dry, mid-range, moist, and high). Observation of the plot suggests the Big Bigby Creek watershed is impacted primarily by non-point sources.

Table 10 presents Load Duration analysis statistics for fecal coliform in Big Bigby Creek 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 Big Bigby Creek implementation strategy will require BMPs targeting primarily non-point sources (dominant under high flow/runoff conditions). The implementation strategies listed in Table 10 are a subset of the categories of BMPs and implementation strategies available for application to the Lower Duck River watershed for reduction of pathogen loading and mitigation of water quality impairment.

See Appendix E for a detailed discussion of the Load Duration Curve Methodology applied to the Lower Duck River watershed.

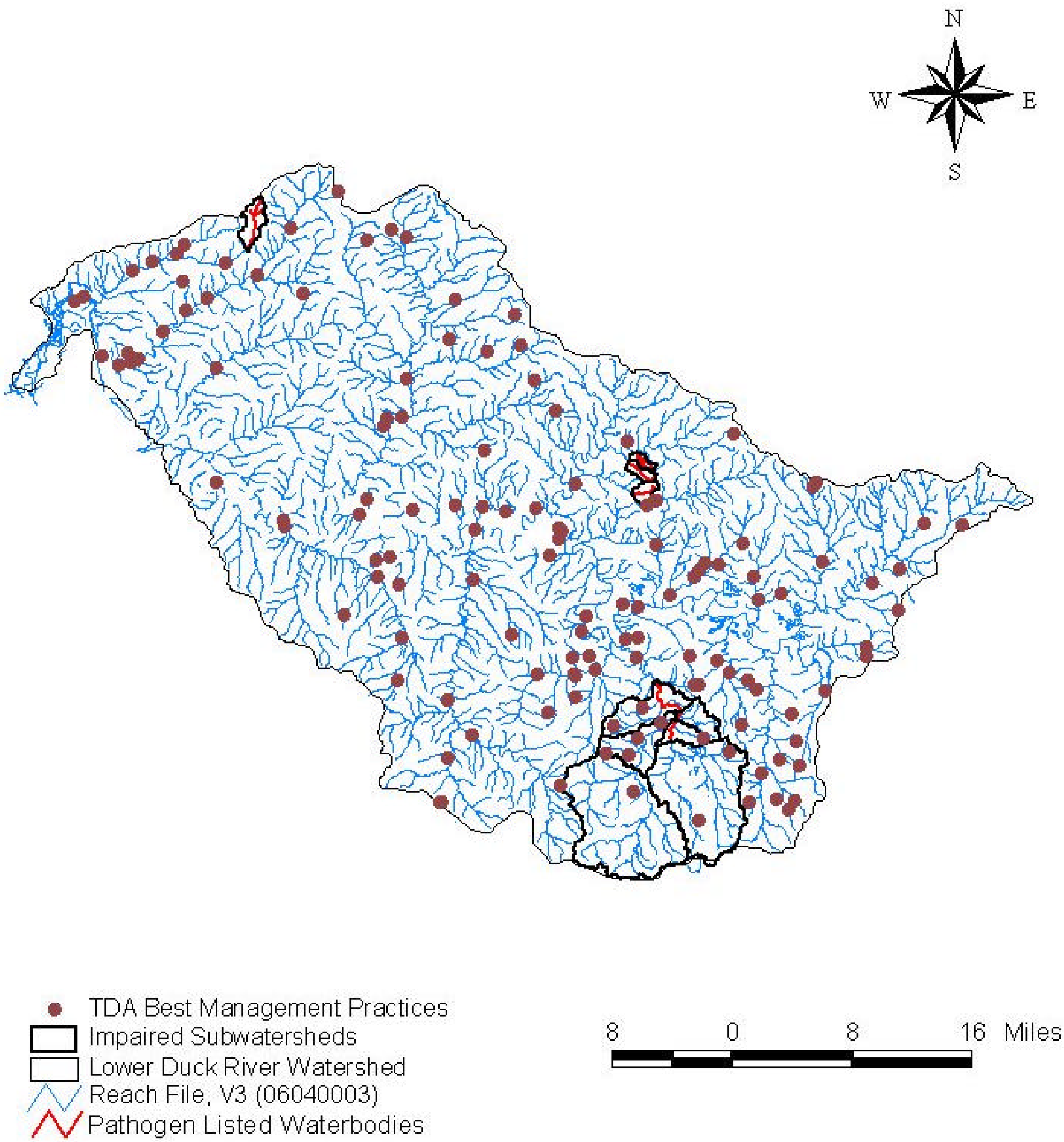

Figure 10. Tennessee Department of Agriculture Best Management Practices located in the Lower Duck River Watershed.

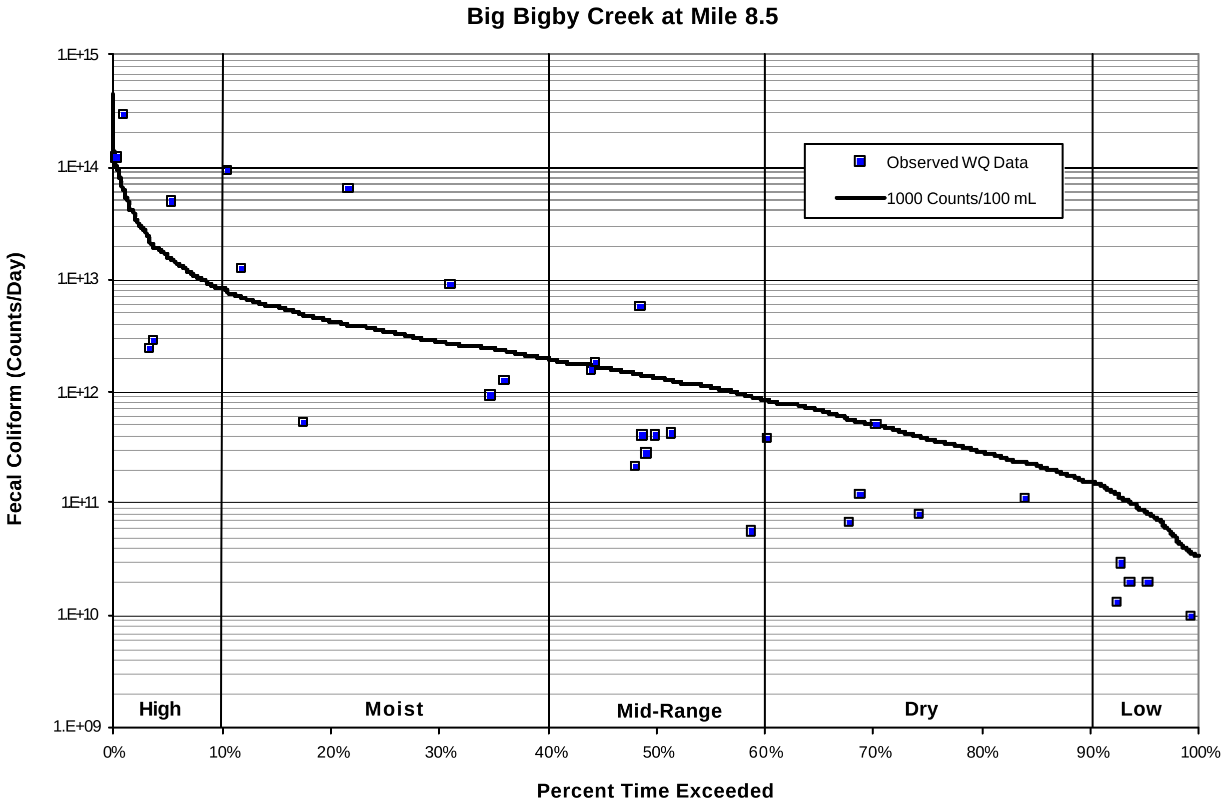

Figure 11. Load Duration Curve for Big Bigby Creek Implementation.

Table 10. Load Duration Curve Summary for Implementation Strategies

Flow Condition		High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded		0-10	10-40	40-60	60-90	90-100
Big Bigby Creek at Mile 8.5	% Samples > 900 Counts/100 mL[1]	60	57.1	22.2	0.0	0.0
	Reduction[2]	52.8%	74.9%	37.7%	0.0%	0.0%
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[3]				M	H	H
Pasture Management/Land Application of Manure[3]		H	H	M	L	
Riparian Buffers[3]			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 fecal coliform (1000 Counts/100 mL) minus 10% MOS (100 Counts/100 mL).
[2] Reductions based on analyses of observed values in each range (see Appendix E).
[3] Example Best Management Practices (BMPs) for Agricultural Source reduction. Actual BMPs applied to Lower Duck River may vary.

9.4 Additional Monitoring

Documenting progress in reducing the quantity of pathogens entering the Lower Duck River 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 standards for pathogens.

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 monitoring and assessment activities are recommended for the Sugar Fork Creek, Big Bigby Creek, and Blue Creek watersheds to verify the assessment status of the stream reaches identified on the 2002 303(d) list as impaired due to pathogens. If it is determined that these stream reaches are still not fully supporting designated uses, then sufficient data to enable development of a TMDL must be acquired. In addition, collection of pathogen data at sufficient frequency to support calculation of the geometric mean, as described in Tennessee's General Water Quality Criteria (TDEC, 2004b), is encouraged.

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, utilization of Bacteria Source Tracking (BST) technologies are recommended.

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.

10.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed pathogen TMDLs for the Lower Duck River watershed were 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 TMDL 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 TMDL (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings which was sent to approximately 90 interested persons or groups who have requested this information.

3) Letters were sent to WWTFs located in pathogen-impaired subwatersheds in the Lower Duck River 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. Letters were sent to the following facilities:

   Mount Pleasant STP (TN0020800)
   McEwen STP (TN0021741)

No written comments were received during the proposed TMDL public comment period. No requests to hold public meetings were received regarding the proposed TMDLs as of close of business on December 27, 2004.

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:

Dennis M. Borders, P.E., Watershed Management Section
e-mail: Dennis.Borders@state.tn.us

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

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APPENDIX A

Land Use Distribution in the Lower Duck River Watershed

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

Land Use	Lower Duck River Subwatersheds											
	Big Bigby Creek		Sugar Fork[1]		Potts Branch		Lunns Branch		Dog Creek		Blue Creek	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	1	0.0	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	32811	46.1	8727	33.0	320	47.6	428	45.4	658	57.4	1138	49.6
Emergent Herbaceous Wetlands	12	0.0	4	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	2366	3.3	1349	5.1	13	1.9	13	1.3	61	5.3	32	1.4
High Intensity Commercial/Industrial/Transp.	325	0.5	191	0.7	0	0.0	3	0.3	8	0.7	29	1.3
High Intensity Residential	56	0.1	52	0.2	0	0.0	0	0.0	0	0.0	20	0.9
Low Intensity Residential	568	0.8	468	1.8	0	0.0	0	0.0	2	0.2	96	4.2
Mixed Forest	8035	11.3	5121	19.4	14	2.0	21	2.3	38	3.3	61	2.6
Open Water	611	0.9	574	2.2	0	0.0	0	0.0	0	0.0	0	0.0
Other Grasses (Urban/recreation; e.g. parks)	400	0.6	364	1.4	0	0.0	0	0.0	0	0.0	44	1.9
Pasture/Hay	19593	27.5	7150	27.1	260	38.8	393	41.7	215	18.8	394	17.1
Quarries/Strip Mines/Gravel Pits	163	0.2	14	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	5438	7.6	2131	8.1	64	9.6	85	9.0	163	14.2	481	21.0
Transitional	98	0.1	47	0.2	0	0.0	0	0.0	0	0.0	0	0.0
Woody Wetlands	758	1.1	218	0.8	0	0.0	0	0.0	0	0.0	0	0.0
Total	71233	100.0	26411	100.1	671	100.0	943	100.0	1146	100.0	2296	100.0

[1] Sugar Fork is a tributary to Big Bigby Creek

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 Duck River watershed. The location of these monitoring stations is shown in Figure 5. Monitoring data recorded at these stations for Fecal Coliform and Escherichia Coli (E. Coli) are tabulated in Table B-1.

Table B-1. Water Quality Monitoring Data – Lower Duck River Watershed

Monitoring Station	Date	Fecal Coliform	E. Coli
		[cts./100 mL]	[cts./100 mL]
BBIGB008.5MY	11/12/91	200	NA
	3/31/92	1100	NA
	6/3/92	390	NA
	9/21/92	1000	NA
	11/30/93	150	NA
	1/27/94	5000	NA
	1/27/94	5000	NA
	5/25/94	490	NA
	9/1/94	200	NA
	11/2/94	300	NA
	3/20/95	63	NA
	6/14/95	930	NA
	12/18/95	140	NA
	12/3/96	1800	NA
	2/27/97	12220	NA
	6/26/97	4100	NA
	12/17/97	290	NA
	2/26/98	110	NA
	6/23/98	820	NA
	6/23/98	56	NA
	9/22/98	NA	220
	12/10/98	3200	1700
	3/17/99	110	460
	6/17/99	240	260
	9/14/99	270	120
	11/22/99	120	130
	1/20/00	NA	66
	2/16/00	1200	NA
	3/9/00	220	210
	4/13/00	3200	>2400
	5/23/00	16000	>2400

Table B-1. Water Quality Monitoring Data – Lower Duck River Watershed (Cont.)

Monitoring Station	Date	Fecal Coliform [cts./100 mL]	E. Coli [cts./100 mL]
BBIGB008.5MY	6/14/00	200	31
	7/25/00	250	300
	11/2/00	110	110
	12/16/00	NA	1400
	3/28/01	330	650
	7/11/01	530	440
	10/24/01	260	NA
	7/15/03	620	NA
	12/22/03	150	NA
BLUE015.8HU	8/12/03	510	610
	9/24/03	15000J	>2400
	10/22/03	80	120
	11/20/03	7000J	>2000
	12/9/03	550	980
	1/7/04	500	920
	2/24/04	2200	>2400
	3/23/04	73	120
	4/29/04	NA	39
	5/18/04	5100	2400
SUGAR001.8MY	2/10/00	8700J	>2400
	3/16/00	270	820
	4/12/00	8400J	>2400
	5/11/00	5000	>2400
	6/7/00	330	260
	8/13/03	110	100
	9/16/03	110	120
	10/21/03	>20000	>2400
	12/2/03	5500	>2400
	12/17/03	700	830
	1/13/04	1600	>2400

[1] NA = Not Applicable (no data collected).
[2] J = estimated.

APPENDIX C

Blackjack Ridge Dairy Enforcement Documents

Notice of Violation Dated June 9, 2000 (3 pages)

ENVIRONMENTAL ASSISTANCE CENTER
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
537 BRICK CHURCH PARK DRIVE
NASHVILLE, TENNESSEE 37243-1550
PHONE (615) 226-6918 STATEWIDE 1-888-891-8332 FAX (615) 650-7301

June 9, 2000

JUN 1 3 2000

CERTIFIED MAIL # Z 308 826 525

Mr. Milton Beard
Blackjack Ridge Dairy
6233 Beard Road
Santa Fe, TN 38482-3401

Re: Notice of Violation
Compliant investigation # 4193
Blackjack Ridge Dairy
Maury County, unnamed tributary & Potts Branch

Dear Mr. Beard:

On January 26, 27 and February 10, 2000, I investigated a report that overflow had occurred from the animal waste handling system at your dairy farm and that animal waste had entered an unnamed tributary to Pott's Branch. The investigation confirmed that animal waste had exited the system at your farm and flowed down the hillside entering a drainageway which conveyed the material into the stream. Deposits of manure solids were still visible on the lagoon spillway, down the slope on the hillside, in the drainageway and in the tributary. At the time of my investigation on January 26, you had just completed pumping and land application of wastewater and solids to lower the level in the lagoons.

On July 10, 1997, personnel from Division of Water Pollution Control issued a Notice of Violation and Compliance Review Meeting because of previous discharges from the dairy. The Compliance Review Meeting, which you attended, was conducted on July 25, 1997. It was decided that further enforcement action would not be taken at that time contingent upon the following conditions:

(1) A written reply be provided to this office stating what steps you would take to prevent this type of discharge from occurring in the future.
(2) After completion of all preventive measures, no further animal waste/water pollution problems are found leading to Blackjack Ridge Dairy as a source.

June 9, 2000
Mr. Milton Beard
Page 2

You were notified of that decision by letter dated August 7, 1997. Some time following that date, the planned upgrade of the waste handling system was completed and put into service. The upgrade should have made the system of adequate capacity for the manure and milking parlor wastes so that with proper management no discharge would occur.

The unnamed tributary and Pott's Branch downstream of the tributary's confluence were observed to contain deposits of manure solids. Both streams have been listed as failing to support or partially supporting the designated uses for fish and aquatic life during the past several years. The adverse water quality impact is the result of nutrient enrichment due to animal waste entering the streams. Discharges from your facility have been a contributing factor resulting in this water quality degradation.

It is my understanding that the dairy milks approximately 400 head of cattle. Any facility with 201 to 700 dairy cattle and using a liquid manure management system is defined by the Environmental Protection Agency and by the Tennessee Water Quality Control Act as a concentrated animal feeding operation (CAFO). Existing facilities meeting these conditions were required to file a Notice of Intent (NOI) by August 1, 1999, for coverage under the General NPDES Permit for Class II Concentrated Animal Feeding Operations. Our records indicate that no Notice-of Intent has been filed for coverage under the CAFO Permit. Another criteria that necessitates permit coverage is for existing facilities located in watersheds of 303(d) listed streams identified as being impacted due to livestock operations.

The discharge from the animal waste handling system at your dairy constitutes a violation of the Tennessee Water Quality Control Act (T.C.A 69-3-108 et. seq.). Failure to timely file Notice of Intent for permit coverage also constitutes a violation of the Act. This letter will serve as a formal Notice of Violation and by copy will inform our Enforcement and Compliance Section of the violations. Corrective action must be taken to eliminate the violations and to prevent any future discharges. Because of the recurrent violations at the dairy and the continued impact to water quality, the Division will be considering further enforcement action.

We are requesting a written reply be provided to this office within fifteen (15) days of receipt of this letter stating what measures have been or will be taken to prevent future discharges from the dairy. A timetable for completion of each item should be included. We are also requesting that you submit the following documents and information along with your plans for corrective action.

1. A completed Notice of Intent form for coverage under the Class II Permit for Concentrated Animal Feeding Operations submitted to Department of Agriculture. A copy of the Notice of Intent form with application information is enclosed.

2. A copy of the animal waste handling system and nutrient management plan prepared for your dairy by the Natural Resource Conservation Service (NRCS).
3. The number of milked and dry cows at the dairy farm.
4. The design capacity (number of cows and system volume) of the current waste handling system, the date the system was completed and date it was placed into service.
5. Copies of pumping and disposal/land application records for the current waste handling system since it went into service. This should include dates and volume pumped, as well as disposal/land application methods.

Should you need assistance with developing corrective measures, agricultural best management practices or waste handling system design/operation, you may contact the USDA Natural Resource Conservation Service (NRCS), the University of Tennessee Agricultural Extension Service, or the Tennessee Department of Agriculture, Agricultural Resources Division.

If you have any questions about this correspondence or the investigation, please contact me at this office, (615) 650-7251.

Sincerely,

Ann E. Rochelle

Ann E. Rochelle, Assistant Manager
Division of Water Pollution Control

Enclosures
Cc: Garland Wiggins, WPC Deputy Director
Chris Moran, WPC Enforcement & Compliance Section
Phil Simmons, WPC Permits Section
John McClurkan, Department of Agriculture
Jim Nance, Department of Agriculture, Agricultural Resources Programs
Clark Hollis, Department of Agriculture, Agricultural Resources
Paul Fulks, NRCS Asst. State Conservationist
Jeff Bowie, NRCS District Conservationist, Maury County

Notice of Violation Dated April 11, 2001 (4 pages)

ENVIRONMENTAL ASSISTANCE CENTER
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
711 R. S. GASS BOULEVARD
NASHVILLE, TENNESSEE 37243
PHONE (615) 687-7000 STATEWIDE 1-888-891-8332 FAX (615) 687-7078

April 11, 2001

CERTIFIED MAIL #7000 0520 0021 7204 3470

Mr. Milton Beard
Blackjack Ridge Dairy
7500 Gordon Lawrence Road
Sante Fe, TN 38482

Re: Second Notice of Violation
Investigation of Complaints # 4522, # 4523, & # 4524
Blackjack Ridge Dairy, CAFO Permit # TNA000068
Maury County

Dear Mr. Beard:

On November 29, 2000, David Sims of the Tennessee Wildlife Resources Agency (TWRA) and I investigated a report that animal waste from a lagoon had overflowed into a stream near your farm. Our investigation revealed that the livestock waste handling system at your dairy had been allowed to discharge and that this flow of wastewater had entered an unnamed tributary to Potts Branch. The stream was found to be brown in color and heavily laden with manure solids downstream of the entry of the wastewater from the lagoon. The wastewater flow was traced directly back to the lagoon, which was still overflowing at the time of the investigation.

Near the headwaters of the unnamed tributary, two springs were also found to have been contaminated with the wastewater. Laboratory analysis results from samples collected of the lagoon overflow, the stream and the springs confirmed that the stream and springs were contaminated with animal waste characteristic of the lagoon discharge. Low dissolved oxygen levels, and high levels of ammonia, biochemical oxygen demand and suspended solids were found. Dissolved oxygen and ammonia levels found in the stream would prevent the stream from supporting fish and aquatic life. Bacteria counts exceeded safe standards set by water quality criteria for human contact. As a result of the continued discharges, this stream and Potts Branch must remain on the 303(d) list as streams severely impacted by pollutants.

Mr. Milton Beard
April 11, 2001
Page 2

When we spoke with you on the date of the investigation, you stated that the lagoon had been overflowing for a month and that Tuckasee Irrigation Company, where you had previously leased a pump, had been unable to supply the necessary equipment when you requested it. In a voice mail message left at my office on December 2, 2000, you stated that you had obtained a pump on November 30, that you began pumping wastewater from the lagoons on that date, and that the lagoon overflow had ceased.

On 12/14/2000, David Sims of TWRA and I investigated a second complaint involving a report of livestock waste discharged into Lunns Branch. Despite heavy rains the previous day and several days time lapse since the occurrence, evidence of manure discharge was traced upstream in Lunns Branch and an unnamed tributary to Lunns Branch at the Blackjack Ridge Dairy property. At the time of our investigation milk waste was also found to be entering this unnamed tributary to Lunns Branch. A pipe on your property across the county road from the dairy barns was observed to be discharging milk and wastewater from the milking parlor. The milk wastes and wastewater had not been routed into the livestock waste handling system for proper containment and disposal by land application. Analysis results from water samples collected from that discharge revealed high levels of bacteria, biochemical oxygen demand, solids and ammonia. Results from water samples collected from the streams also revealed adverse impact to water quality that would prevent these streams from supporting fish and aquatic life. All of the samples revealed fecal coliform and E. coli levels which would be unsafe for body contact.

On 2/27/2001, David Sims of TWRA investigated a report of animal waste entering Dog Creek. The source of the discharge was spray irrigation of wastewater from the animal waste handling system at the dairy. Application of the wastewater was still occurring despite saturated conditions that allowed the wastewater to flow off the field and into Dog Creek. Samples collected from Dog Creek downstream of the application site revealed high levels of bacteria, biochemical oxygen demand, ammonia and solids resulting from the discharge. Bacteria concentrations found in the stream exceeded water quality criteria for safe body contact levels.

On 2/28/2001, David Sims and I conducted further investigations related to the land application of the wastewater from the animal waste handling system. At that time the spray irrigation equipment had been moved to another field, and application was still occurring despite saturated ground conditions. The field in use is in the headwaters area of Lunns Branch. Samples collected in Lunns Branch downstream of the application site revealed high levels of bacteria caused by runoff from the irrigation site. E. coli levels in the stream exceeded water quality criteria for safe body contact.

Runoff of wastewater was still occurring from the field surrounding the headwaters of Dog Creek, and samples collected downstream of that application site revealed that bacteria, biochemical oxygen demand, ammonia and solids levels were still high. The resulting impact to water quality would prevent the stream from supporting fish and aquatic life. Concentrations of fecal coliform and E. coli exceeded water quality criteria for safe body contact.

Mr. Milton Beard
April 11, 2001
Page 3

When we talked with you during the investigation on 2/28/2001, you stated that it was the wrong time of year to land apply the wastewater, but that land spreading was needed to keep down the lagoon levels. You further stated that the discharge pipe from the milking parlor tank room had been there since 1978. The current operation methods employed at the dairy facility and waste handling system will result in a continued threat to public health, as well as fish and aquatic life in areas downstream of the dairy and the land application sites. Water quality in the Potts Branch, Lunns Branch, and Dog Creek watersheds are all affected at locations on and downstream of your property.

On 3/20/2001, the discharge pipe carrying wastewater from the milking parlor tank room was found to have been re-routed into the lagoon. However, another discharge pipe from the milking parlor was discovered. Wastewater from floor drains and alleyways at the milking parlor was not directed into the animal waste handling system, but was piped to a discharge point located on the slope to the northeast side of the buildings. Wastewater discharged to this point would flow into an unnamed tributary to Potts Branch. Analysis results from samples collected of this discharge showed high levels of biochemical oxygen demand, ammonia, solids and bacteria.

The discharge of animal waste from the livestock waste handling system, the discharges of milk and wastewater from the milking parlor, and improper land application of animal waste resulting in runoff into streams all constitute point source discharges. These discharges have caused a condition of pollution in two springs, two unnamed tributaries to Potts Branch, an unnamed tributary to Lunns Branch and Lunns Branch, as well as Dog Creek. Each incident of discharge and each incident causing a condition of pollution constitutes a violation of the Tennessee Water Quality Control Act (T.C.A. 69-3-101 et. seq.).

Blackjack Ridge Dairy currently has coverage under the conditions of the Class II Concentrated Animal Feeding Operation NPDES General Permit. This general permit prohibits any discharge of wastewater from the facility, unless such discharge results from a catastrophic or chronic storm event. Samples must be collected from any discharges that occur, and results of analyses submitted to the Division. Immediate notification to the Division is required by telephone when any discharge occurs, and must be followed with a written report within 5 days of any discharge occurrence. Failure to meet these requirements constitutes a violation of the general permit and of the Act.

Action must be taken to ensure that all point source discharges are eliminated and that the dairy and waste handling system are properly managed to prevent entry of animal waste or wastewater into streams, springs or other waterways. This letter will serve as a Second Notice of Violation and by copy will inform our Enforcement and Compliance Section of the recurring violations. Because of the repeated discharges and the continuing pollution of streams, it is our intention to recommend this case for further enforcement action.

Mr. Milton Beard
April 11, 2001
Page 4

Corrective measures provided in your response (dated July 11, 2000) to the Notice of Violation issued June 9, 2000, were either not properly carried out and/or were inadequate to prevent discharge of animal waste and to prevent wastewater from entering streams. We are requesting that you provide a written response within fifteen (15) days of receipt of this letter stating what circumstances at the dairy caused these discharges to occur. Your response should also state what action you have taken or will take to correct each of these factors in order to prevent any future discharge, and a schedule for completion of each item. Copies of any records related to maintenance and operation of the animal waste handling system should also be provided. This should include: number of cows milked on a daily/weekly/monthly basis; pumping records; dates and locations of land application; pump rates and duration of application; total volume pumped to each field; the dates, nature, and location of any discharges; results of any sampling or analysis of any discharges; records of "freeboard" in the lagoon on any given dates; and water usage records for the dairy.

As you are aware technical assistance, information and methods to properly maintain and operate the animal waste handling system are available through the USDA Natural Resources Conservation Service, U. T. Agricultural Extension Service, and the Tennessee Department of Agriculture.

If you have any questions regarding this correspondence or the complaint investigations, please contact me at (615) 687-7123.

Sincerely,

Ann E. Rochelle

Ann E. Rochelle, Assistant Manager
Division of Water Pollution Control

Cc: Garland Wiggins, Deputy Director, WPC
Chris Moran, Enforcement Manager, WPC
Phil Simmons, Permit Section, WPC
Tim Wilder, Columbia EAC, WPC
John McClurkan, Water Resource Administrator, Dept. of Agriculture
Jim Nance, Ag. Resources Div., Dept. of Agriculture
Clark Hollis, Ag Resources Div., Dept. of Agriculture
David Sims, Aquatic Habitat Protection Biologist, TWRA
Jeff Bowie, District Conservationist, Maury County

Monitoring Data Summaries Referred to in April 11, 2001 NOV (4 pages)

BLACKJACK RIDGE DAIRY, MILTON BEARD
MAURY COUNTY
SUMMARY OF LABORATORY ANALYSIS RESULTS
SAMPLES COLLECTED NOVEMBER 29, 2000, SAMPLING DATE A

	FIRST SPRING # 01	SPRING, CLAY PIPE # 02	UNNAMED TRIBUTARY # 03	LAGOON OVERFLOW # 04
Biochemical Oxygen Demand, mg/L	420	400	500	520
Total Suspended Solids, mg/L	300	210	940	1,860
Settleable Solids, ml/L	0.2	0.1	0.5	0.5
Ammonia as Nitrogen, mg/L	106	76	304	715
* Total Coliform, colonies/100 ml	730,000	730,000	>240,000	>240,000
* Fecal Coliform, colonies/100 ml	160,000	180,000	480,000	540,000
* E. Coli, colonies/100 ml	180,000	140,000	580,000	610,000
FIELD ANALYSIS				
Dissolved Oxygen, mg/L	0.8	1.1	0.2	0.0

Additional dissolved oxygen field analysis in the unnamed tributary to Potts Branch just upstream of the First Spring was 0.9 mg/L.
* All bacteria samples exceeded holding times, which would result in lower bacteria counts.

Streams are posted with warnings against body contact recreation at fecal coliform levels of greater than 1,000 colonies per 100 ml, and at E. coli levels of greater than 126 colonies per 100 ml.

BLACKJACK RIDGE DAIRY, MILTON BEARD
MAURY COUNTY
SUMMARY OF LABORATORY ANALYSIS RESULTS
SAMPLES COLLECTED DECEMBER 14, 2000, SAMPLING DATE B

	LUNNS BR. D/S SLAUGHTER RD #01	TRIBUTARY TO LUNNS BR. # 02	MILK FLOW, DISCHARGE # 03	LUNNS BR. D/S OF TRIBUTARY # 04	LUNNS BR. U/S OF TRIBUTARY # 05
Biochemical Oxygen Demand, mg/L	10.5	315	380	57	10.8
Total Suspended Solids, mg/L	undetected	276	610	40	40
Settleable Solids, ml/L	0.1	0.2	0.2	0.1	undetected
Ammonia as Nitrogen, mg/L	0.73	10.1	63	8.4	1.68
Total Coliform colonies/100 ml	370,000	>2,400,000	>2,400,000	770,000	62,000
Fecal Coliform, colonies/100 ml	19,000	160,000	*73,000	34,000	32,000
E. Coli, colonies/100 ml	19,000	260,000	63,000	49,000	30,000
FIELD ANALYSIS					
Dissolved Oxygen, mg/L	10.2	8.6	6.1	6.4	6.8

* Estimated value, result is less than sample quantitation limit but greater than zero.

Streams are posted with warnings against body contact recreation at fecal coliform levels of greater than 1,000 colonies per 100 ml, and at E. coli levels of greater than 126 colonies per 100 ml.

BLACKJACK RIDGE DAIRY, MILTON BEARD
DOG CREEK, MAURY/HICKMAN COUNTIES
SUMMARY OF LABORATORY ANALYSIS RESULTS
SAMPLES COLLECTED FEBRUARY 27, 2001 BY TWRA, SAMPLING DATE C

	AT EXIT POINT FROM FIELD # 01	BRIDGE D/S OF MCCOY BRANCH # 02	FIRST BRIDGE D/S CALVIN POTTS RD. # 03	BRIDGE, CALVIN POTTS RD. # 04
Biochemical Oxygen Demand, mg/L	4,350	undetected	undetected	3.1
Total Suspended Solids, mg/L	4,230	undetected	undetected	13
Settleable Solids, ml/L	†	undetected	undetected	undetected
Ammonia as Nitrogen, mg/l	230	undetected	undetected	0.38
* Total Coliform, colonies/100 ml	>2,400,000	150	50	1300
* Fecal Coliform, colonies/100ml	3,000,000	190	80	320
* E. Coli, colonies/100 ml	>2,400,000	30	10	160

† Solids in sample would not settle, unable to obtain numerical reading.
* All bacteria samples exceeded holding times, which would result in lower bacteria counts.

Streams are posted with warnings against body contact recreation at fecal coliform levels of greater than 1,000 colonies per 100 ml, and At E. coli levels of greater than 126 colonies per 100 ml.

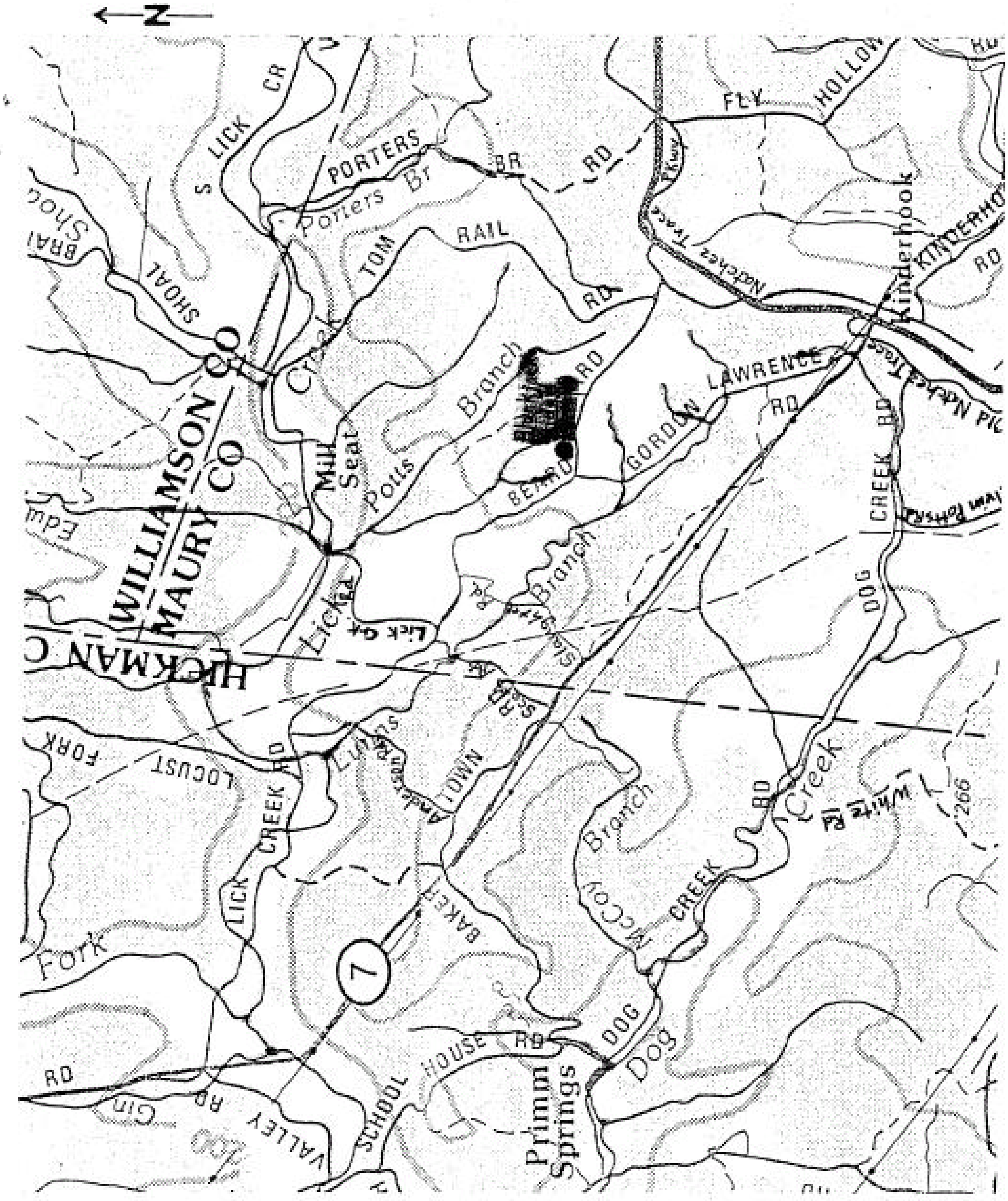
BLACKJACK RIDGE DAIRY, MILTON BEARD
MAURY COUNTY
SUMMARY OF LABORATORY ANALYSIS RESULTS
SAMPLES COLLECTED FEBRUARY 28, 2001, SAMPLING DATE D

	DOG CREEK D/S OF LAKE # 01	DOG CREEK D/S IRRIGA. SITE @ CULVERT # 02	LUNNS BRANCH U/S G. LAWRENCE RD # 03	TRIBUTARY TO LUNNS BRANCH # 04
Biochemical Oxygen Demand, mg/L	14.5	1,090	4.2	*ED*
Total Suspended Solids, mg/L	24	1,400	11	192
Settleable Solids, ml/L	undetected	†	undetected	0.1
Ammonia as Nitrogen, mg/L	1.70	126	0.17	1.51
* Total Coliform, colonies/100 ml	6,000	>2.400,000	4,000	610,000
* Fecal Coliform, colonies/100 ml	4,500	1,900,000	800	5,400
* E. Coli, colonies/100 ml	2,000	2,000,000	2,000	11,000

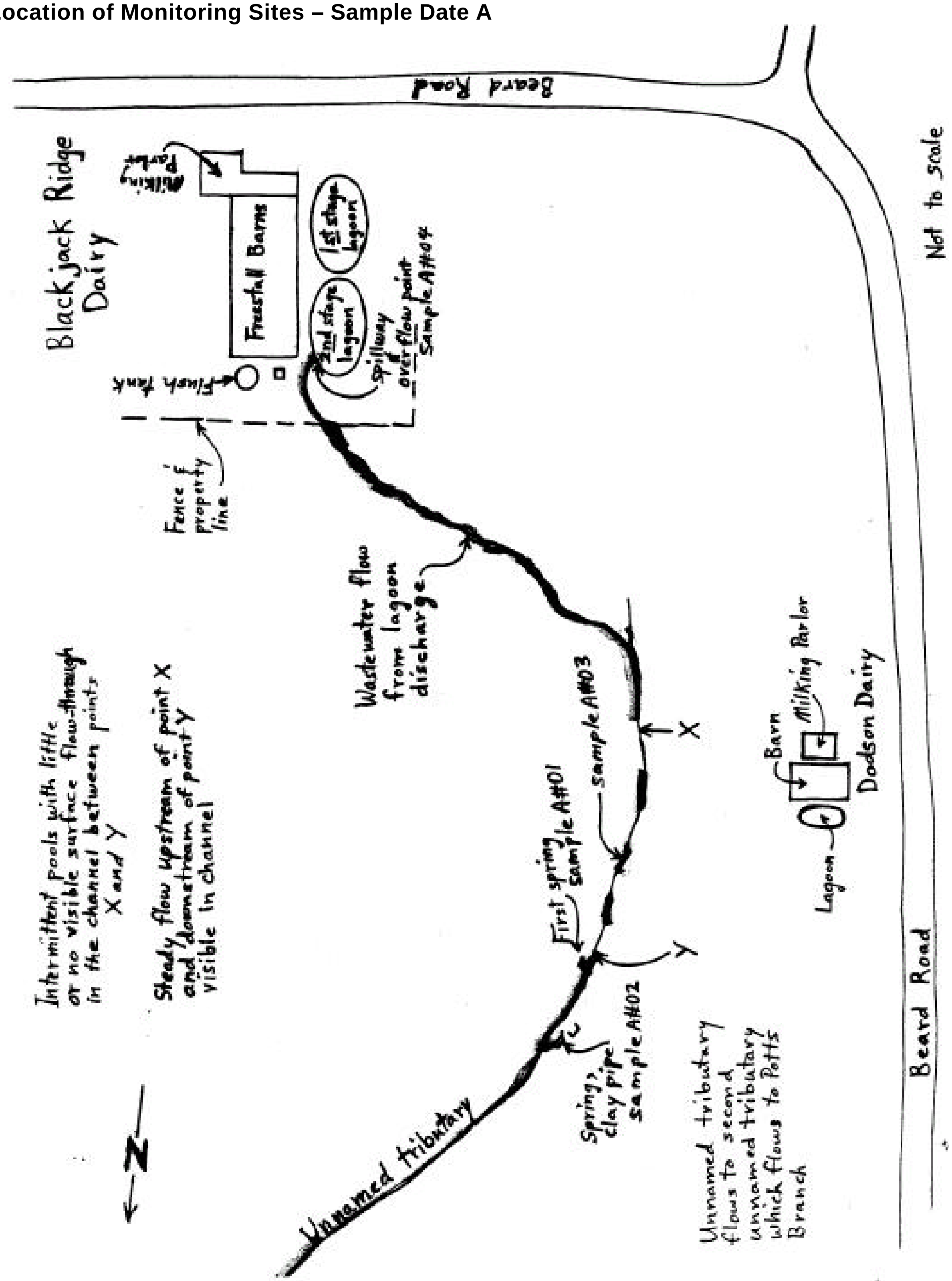
ED Excessive depletion, actual result for BOD is undetermined due to total depletion of the sample. Estimated BOD is > 100 mg/L.
* All bacteria samples exceeded holding times, which would result in lower bacteria counts.
† Solids in sample would not settle, could not obtain a numerical reading.

Streams are posted with warnings against body contact recreation at fecal coliform levels of greater than 1,000 colonies per 100 ml, and at E. coli levels of greater than 126 colonies per 100 ml.

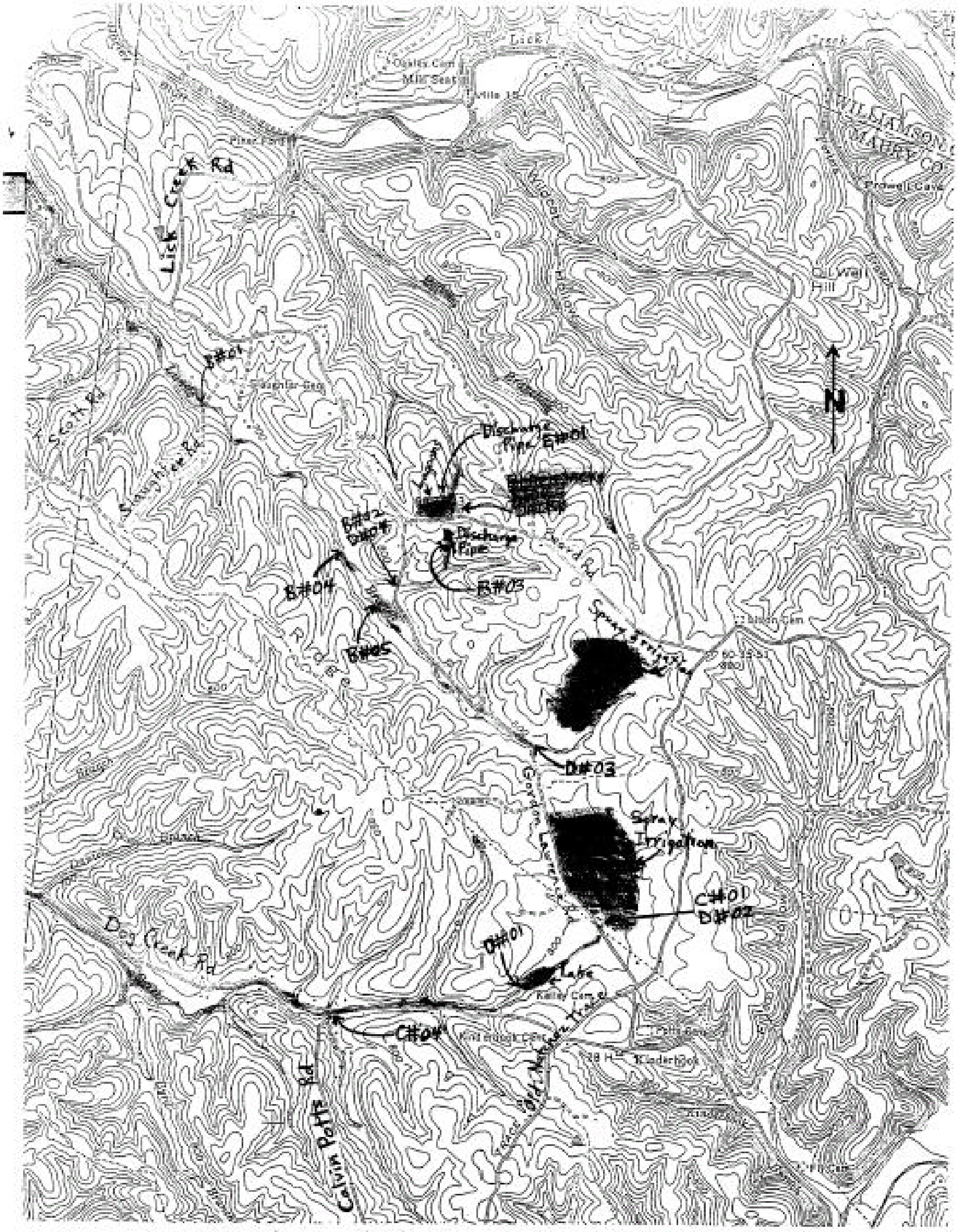
Location of Blackjack Ridge Dairy



Location of Monitoring Sites – Sample Date A



Location of Monitoring Sites – Sample Dates B, C (partial), D, & E



Primm Springs Quad 56SW

Location of Monitoring Sites – Sample Date C (partial)

Littlelot Quad 49SE

Notice of Violation Dated December 31, 2002 (4 pages)

ENVIRONMENTAL ASSISTANCE CENTER
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
711 R. S. GASS BOULEVARD
NASHVILLE, TENNESSEE 37243
PHONE (615) 687-7000 STATEWIDE 1-888-891-8332 FAX (615) 687-7078

December 31, 2002

CERTIFIED MAIL RECEIPT
 # 7002 0860 0001 4109 8868

Mr. Milton Beard
Blackjack Ridge Dairy
7500 Gordon Lawrence Road
Stante Fe, TN 38482

JAN - 8 2003

Re: **Notice of Violation**
Complaint Investigations
Blackjack Ridge Dairy, CAFO Permit # TNA000068
Maury County

Dear Mr. Beard:

On April 11, 2001, a Second Notice of Violation (NOV) was issued to you citing violations of the Tennessee Water Quality Control Act and of the Class II Concentrated Animal Feeding Operation General Permit. To date no response has been received by our division addressing those violations and permit compliance issues cited in that NOV. However, you have stated during a telephone conversation that one of the violations cited, a discharge pipe from the milking parlor floor drains and ramps, has been connected to the livestock waste handling system lagoons. The other violations, permit compliance issues, information submittal requirements, and changes in management of the livestock waste handling system needed to prevent future discharges have not been addressed to meet the requirements of the NOV.

On March 13, 2002, Joe Holland and I conducted a follow-up visit to Blackjack Ridge Dairy to determine whether the discharge pipe from floor drains and ramps at the milking parlor had been re-routed to the livestock waste handling system. Based on our observations and your statements made on that date, it appeared that the discharge had been eliminated and that this wastewater flow was now connected to the lagoons. On that date we observed that the wastewater level in the second stage lagoon had reached the spillway, but had not yet overflowed. You stated that without pumping of the lagoon (for land application) any significant rain event would result in overflow and discharge from that lagoon.

Mr. Milton Beard
December 31, 2002
Page 2

Since that date, the division has received two other complaints. The first caller stated that manure from your dairy was pumped out onto Gordon Lawrence Road. On June 3, 2002, I investigated this complaint. On the previous day, June 2, 2002, David Sims of the Tennessee Wildlife Resources Agency had also investigated this same complaint. Both investigations confirmed that livestock wastes and wastewater had been discharged from the spray irrigation system at your dairy onto the county road adjacent to the land application site. You were advised of the complaint investigation by telephone call with a message left requesting a return call to discuss the situation.

These investigations also documented that livestock wastes and wastewater had entered the headwaters channel of Dog Creek and had flowed for some distance downstream of the spray irrigation application site. The source of this discharge was found to be the spray irrigation system used to apply wastewater from the livestock waste handling system for Blackjack Ridge Dairy. This is the same field where spray irrigation application from the livestock waste handling system resulted in discharge of livestock wastes and wastewater into Dog Creek during February of 2001. The NOV dated April 11, 2001, cited those violations, required corrective measures to prevent recurrence of the discharge, and a response to this office stating what corrective measures were taken.

Laboratory analysis of samples collected in the stream channel during the June 3, 2002, investigation revealed that the discharged material contained high concentrations of biochemical oxygen demand, settleable solids, suspended solids, ammonia as nitrogen, fecal coliform bacteria and E. coli bacteria. These levels are in excess of acceptable water quality standards.

Since that complaint investigation, it has been discovered that the impacted section of Dog Creek just downstream of the land application site and the immediate surrounding property at Highway 7 and Gordon Lawrence Road are part of the Natchez Trace Parkway, owned and operated by the U.S. Department of Interior, National Parks System. The discharge of livestock wastes and wastewater onto the county road, onto adjoining property, and into the stream channel constitutes a hazard to both public health and the environment.

On September 19, 2002, the Division received another complaint stating that Dog Creek was being polluted again. Donald Ey and I investigated that complaint and found that there did not appear to be any discharge into Dog Creek on that date. However, a discharge of leachate liquid from the trench silo was found to be flowing down the roadside ditch and into the channel of an unnamed tributary to Lunns Branch. We discussed the violation with you on that date and requested that you correct the problem. I also contacted the Tennessee Department of Agriculture, Agricultural Resources Division and requested that they offer technical assistance to help find a solution to the problem.

Mr. Milton Beard
December 31, 2002
Page 3

Laboratory analysis results from samples collected of the silage leachate revealed that the discharge contained high concentrations of ammonia as nitrogen, biochemical oxygen demand and suspended solids.

The discharge of livestock waste and/or wastewater from the spray irrigation system, and the discharge of silage leachate liquid into stream channels both constitute point source discharges.

To date, no notification of the discharges has been provided to the Division by either telephone or written report.

The following acts constitute violations of the Class II Concentrated Animal Feeding Operation General Permit (General Permit) and of the Tennessee Water Quality Control Act, T.C.A. 69-3-108 et. seq. (the Act):

- The discharge of livestock wastes and/or wastewater to waters of the state, or a point where it will likely reach waters of the state.
- Discharge to waters of the state that causes or contributes to an exceedance of Tennessee's water quality standards.
- Failure to notify the Division by telephone and in writing that a discharge has occurred.
- Failure to collect samples of the discharge, conduct required analysis, and report analysis results to the Division.
- The discharge of livestock wastes or wastewater that threaten to cause a fish kill or that otherwise threaten public health.

Causing pollution and refusing to furnish information are also violations of the Act.

A thorough review of the permit requirements should be conducted to make sure that the dairy and livestock waste handling system is operated in compliance with all the conditions of the General Permit.

This letter will serve as a formal Notice of Violation and by copy will inform the Division's Enforcement and Compliance Section of the continued violations. Action must be taken to prevent any future discharges from the dairy, livestock waste handling system, or the spray irrigation system. Violations of permits and of the Act may be subject to civil penalties of up to $10,000 per day, per violation, for each day that the violations occur.

We are requiring that a written reply be provided to this office within 15 days of receipt of this letter. The following information is to be provided in that reply:

Mr. Milton Beard
December 31, 2002
Page 4

1. Detailed information about and dates of any discharges that have occurred from the milking parlor, livestock waste handling system, spray irrigation system, or trench silo.

2. Any corrective measures taken by you or changes made in operating procedures to prevent future discharges of livestock waste, wastewater, silage leachate, or other pollutants.

3. Copies of any spray irrigation and land application records since March 20, 2002.

If you have any questions regarding this correspondence or the complaint investigation, you may contact me at this office at (615) 687-7123.

Sincerely,

Ann E. Rochelle

Ann E. Rochelle, Assistant Manager
Division of Water Pollution Control

Cc: Garland Wiggins, Deputy Director, WPC
Chris Moran, Manager, Enforcement Section, WPC
Phil Simmons, Permits Section, WPC
Tim Wilder, WPC, Columbia EAC
John McClurkan, Water Resources Administrator, Dept. of Agriculture
Jim Nance, Ag. Resources Division, Dept. of Agriculture
Clark Hollis, Ag. Resources Division, Dept. of Agriculture
David Sims, Aquatic Habitat Protection Biologist, TWRA
Jeff Bowie, District Conservationist, NRCS, Maury County
Bill Whitworth, US Park Service, Natchez Trace Parkway

Monitoring Data Summary Referred to in December 31, 2002 NOV (1 page)

BLACKJACK RIDGE DAIRY, MILTON BEARD
MAURY COUNTY
SUMMARY OF LABORATORY ANALYSIS RESULTS
SAMPLES COLLECTED JUNE 3, 2002, FROM CHANNEL OF DOG CREEK

	# 01, Just upstream of Hwy 7 box culvert	# 02, Just downstream of Beard property fence, upstream of culvert	# 03, downstream of culvert in woods
Biochemical Oxygen Demand, mg/L	670	240	100
Total Suspended Solids, mg/L	48,200	145,000	41,800
Settleable Solids, ml/L	165	110	13
Ammonia as Nitrogen, mg/L	172	43	112
*Fecal Coliform, colonies/100 ml	48,000	150,000	10,000
*E. coli, colonies/100 ml	43,000	170,000	9,800
*Total Coliform, colonies/100 ml	>2,400,000	>2,400,000	1,100,000

* All bacteria samples exceeded holding times, which would result in lower bacteria counts.

Streams are posted with warnings against body contact recreation at fecal coliform levels of 1,000 colonies per 100 ml, and at E. coli levels of 126 colonies per 100 ml.

APPENDIX D

Dynamic Loading Model Methodology

DYNAMIC LOADING MODEL METHOD

D.1 Model Selection

The Loading Simulation Program C++ (LSPC) was selected for TMDL analysis of pathogen-impaired waters in the Big Bigby Creek and Sugar Fork subwatersheds of the Lower Duck River watershed. LSPC is a dynamic watershed model based on the Hydrologic Simulation Program - Fortran (HSPF) and is well suited to demonstrate compliance with the 200 counts/100 mL geometric mean standard. LSPC was used to simulate the buildup and washoff of fecal coliform bacteria from land surfaces in response to storm events, loading from point sources, and compute the resulting water quality response. From model output, instream 30-day geometric mean concentrations were computed, critical conditions identified, existing loads determined, and reductions required to meet target concentrations (standard - MOS) were calculated.

D.2 Model Set Up

The Big Bigby Creek/Sugar Fork watershed was delineated into subwatersheds in order to facilitate model hydrologic and water quality calibration; and to characterize relative fecal coliform contributions from significant contributing drainage areas. Boundaries were constructed so that subwatershed "pour points" coincided with HUC-12 delineations and water quality monitoring stations located at mile 8.5 of Big Bigby Creek and mile 1.8 of Sugar Fork. Watershed delineation was based on the Rf3 stream coverage and Digital Elevation Model (DEM) data. This discretization allows management and load reduction alternatives to be varied by subwatershed.

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 water quality 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. Results of the WCS characterization was input into the Fecal Coliform Loading Estimation Spreadsheet (FCLES), developed by Tetra Tech, Inc., to estimate LSPC input parameters associated with fecal coliform buildup (loading rates) and subsequent washoff from land surfaces. In addition, FCLES was used to estimate direct sources of fecal coliform loading to water bodies from leaking septic systems and animals having access to streams. Information from the WCS and FCLES utilities were used as initial input for variables in the LSPC model.

An important factor influencing model results is the precipitation data contained in the meteorological data files used in these simulations. The pattern and intensity of rainfall affects the buildup and washoff of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Weather data from multiple meteorological stations were available for the time period from January 1970 through December 2001. 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 (10/1/91 – 9/30/01) used for TMDL analysis.

D.3 Model Calibration

The calibration of the LSPC watershed model involves both hydrology and water quality components. The model must first be calibrated to appropriately represent hydrologic response to meteorological conditions before water quality calibration and subsequent simulations can be performed. Due to the lack of continuous flow data at the mouths of the listed waterbodies, data collected at the nearest appropriate location was used to calibrate the subwatershed models.

D.3.1 Hydrologic 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 Upper Elk River 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 Cane Creek near Howell, USGS Station 035825882, are shown in Table D-1 and Figure D-1.

D.3.2 Water Quality Calibration

After hydrologic calibration, the watershed model was calibrated for water quality through comparison of simulated fecal coliform concentrations to instream monitoring data at a specified location. Watershed data, produced with WCS, were processed through the FCLES spreadsheet to generate fecal coliform loading data for use as <u>initial</u> input to the LSPC model. In the model, in-stream decay of fecal coliform bacteria was estimated using the values reported in Lombardo (1972). For freshwater streams, decay ranges from 0.008 hr^{-1} to 0.13 hr^{-1}, with a median value of 0.048 hr^{-1}. The value of 0.083 hr^{-1} was used as initial input to model simulations.

D.3.2.1 Point Sources

For existing conditions, NPDES facilities located in modeled watersheds are represented as point sources of average (constant) flow and concentration based on the facility’s flow and effluent fecal coliform concentration as reported on Discharge Monitoring Reports (DMRs).

D.3.2.2 Nonpoint Sources

A number of nonpoint source categories are not associated with land loading processes and are represented as direct, instream source contributions in the model. These may include, but are not limited to, failing septic systems, leaking sewer lines, animals in streams, illicit connections, direct discharge of raw sewage, and undefined sources. All other nonpoint sources involve land loading of fecal coliform bacteria and washoff as a result of storm events. Only a portion of the load from these sources is actually delivered to streams due to the mechanisms of washoff (efficiency), decay, and incorporation into soil (adsorption, absorption, filtering) before being transported to the stream. Therefore, land loading nonpoint sources are represented as indirect contributions to the stream. Buildup, washoff, and die-off rates are dependent on seasonal and hydrologic processes.

D.3.2.2.1 Wildlife

Wildlife deposit fecal 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. The resulting fecal coliform loading on a unit area basis is 3.52×10^{7} counts/acre/day and is considered background.

D.3.2.2.2 Land Application of Agricultural Manure

In the water quality model, livestock populations are distributed to subwatersheds based on information derived from WCS. Fecal coliform loading rates were calculated from livestock populations based on manure application rates, literature values for bacteria concentrations in livestock manure, and the following assumptions:

- Fecal content in manure was adjusted to account for die-off due to known treatment/storage methods.
- Manure application rates from the various animal sources are applied according to application practices throughout the year.
- The fraction of manure available for runoff is dependent on the method of manure application. In the water quality model, the fraction available is estimated based on incorporation into the soil.

Fecal coliform production rates used in the model for beef cattle, dairy cattle, hogs, and chicken are 1.06×10^{11} counts/day/beef cow, 1.04×10^{11} counts/day/dairy cow, 1.24×10^{10} counts/day/hog, and 1.38×10^{8} counts/day/chicken (NCSU, 1994).

D.3.2.2.3 Grazing Animals

Cattle spend time grazing on pastureland and deposit feces onto the land. During storm events, a portion of this material containing fecal coliform bacteria is transported to streams. Beef cattle are assumed to spend all their time in pasture. The percentage of feces deposited during grazing time is used to estimate fecal coliform loading rates from pastureland. Because there is no assumed monthly variation in animal access to pastures in east Tennessee, the fecal loading rate does not vary significantly throughout the year. Therefore, the loading rate to pastureland is assumed to be relatively constant within each subwatershed. However, this rate varies across subwatersheds depending on livestock population. The approximate loads from grazing cattle vary from 3.495×10^{10} to 1.165×10^{11} counts/acre-day. Contributions of fecal coliform from wildlife (as noted in Section D.3.2.2.1) are also included in these rates.

D.3.2.2.4 Urban Development

Urban land use represented in the MRLC database includes areas classified as: high intensity commercial, industrial, transportation; high intensity residential; and low density residential. Associated with each of these classifications is a percent of the land area that is impervious. A single, area-weighted loading rate from urban areas is used for each subwatershed in the model and is based on the percentage of each urban land use type in the watershed and buildup and accumulation rates referenced in Horner (Horner, 1992). In the water quality calibrated model, this rate is 1.5 x 10^9 counts/acre-day and is assumed constant within each subwatershed throughout the year.

D.3.2.2.5 Other Direct Sources

As previously stated, there are a number of nonpoint sources of fecal coliform bacteria that are not associated with land loading and washoff processes. These include animal access to streams, failing septic systems, illicit discharges, and other undefined sources. In each subwatershed, these miscellaneous sources have been modeled as point sources of constant flow and fecal coliform concentration and are referred to as "other direct sources" in this document. The <u>initial</u> baseline values of flow and concentration were estimated using the FCLES spreadsheets and the following assumptions:

- The load attributed to animals having access to streams is initially based on the beef cow population in the watershed. The percentage of animals having access to streams is derived from assumptions on animals in operations that are adjacent to streams and seasonal and behavioral assumptions. Literature values were used to estimate the fecal coliform bacteria concentration in beef cow manure.

- The initial baseline loads attributable to leaking septic systems is based on an assumed failure rate of 20 percent.

Flow and concentration variables were adjusted during water quality calibration to best-fit simulated in-stream fecal coliform concentrations during dry weather conditions.

D.3.2.3 Water Quality Calibration Results

During water quality calibration, model parameters were adjusted within reasonable limits until acceptable agreement between simulation output and instream observed data was achieved. Model variables adjusted include:

- Rate of fecal coliform bacteria accumulation
- Maximum storage of fecal coliform bacteria
- Rate of surface runoff that will remove 90% of stored fecal coliform bacteria
- Concentration of fecal coliform bacteria in interflow
- Concentration of fecal coliform bacteria in groundwater
- Concentration of fecal coliform bacteria and rate of flow of "other direct sources".
- In-stream fecal coliform decay (die-off) rate

At times, a high observed value may not have been simulated in the model due to the absence of rainfall at the meteorological station as compared to localized rainfall occurring in the watershed, or as the result of an unknown source that is not included in the model.

Water quality calibration for the Big Bigby Creek and Sugar Fork watersheds was performed at mile 8.5 and mile 1.8, respectively. Sugar Fork is a tributary to Big Bigby Creek; therefore, Sugar Fork was water quality calibrated prior to completion of Big Bigby Creek calibration. The results of the Big Bigby Creek and Sugar Fork water quality calibrations are shown in Figures D-2 and D3, respectively. Results show that the model adequately simulates peaks in fecal coliform bacteria in response to rainfall events and pollutant loading dynamics.

D.4 Margin of Safety

There are two methods for incorporating an MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For TMDL analyses using LSPC, both an explicit and implicit MOS were used. The explicit MOS is 20 counts/100 mL, equal to 10% of the 200 counts/100 mL geometric standard. This results in a target fecal coliform concentration of 180 counts/100 mL. The implicit MOS includes the use of conservative modeling assumptions and a 10-year continuous simulation that incorporates a wide range of meteorological events. Conservative modeling assumptions used include: septic systems discharging directly into the streams; development of the TMDL using loads based on the design flow and fecal coliform permit limits of NPDES facilities; and all land uses connected directly to streams.

Note: In this document, the water quality standard is the instream goal. The term "target concentration" reflects the application of an explicit Margin of Safety (MOS) to the water quality standard. See Section 5.0.

D.5 Determination of Existing Loading

The critical condition for nonpoint source fecal coliform loading is typically 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 simulated in the water quality model.

For each modeled subwatershed, the 10-year simulation period was used to generate daily mean instream concentrations. These were used to calculate continuous 30-day geometric mean concentrations that were then compared to the target concentration. The 10-year simulation period contained a range of hydrologic conditions that included both low and high streamflows. The 30-day critical period for each subwatershed is the period preceding the highest simulated violation of the geometric mean standard. The magnitude of the highest peak, together with the corresponding simulated flow, represents the existing fecal coliform loading to the waterbody.

The drainage areas of the waterbody segments (Big Bigby Creek and Sugar Fork) coincided with HUC-12 subwatersheds, water quality monitoring stations, and the outlets (endpoints) of 303(d)-Listed segments. The waterbody segments were at the "pour points" of these subwatersheds. In addition, the pour points coinciding with water quality monitoring stations had sufficient fecal coliform data for water quality calibration. Existing loads and required load reductions were determined on a subwatershed basis for the Big Bigby Creek and Sugar Fork waterbodies.

The results of the 10-year simulation used to determine existing conditions for Big Bigby Creek and Sugar Fork are shown in Figures D-4 and D-5, respectively.

D.6 Determination of TMDL

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 the purposes of these analyses, fecal coliform TMDLs are expressed as the percent reduction in instream loading required to decrease the existing instream 30-day geometric mean concentration (as defined in Section E.5) to the target of 180 counts/100 mL. The required reduction can be determined directly using the following equation:

$$\text{TMDL} = \text{RILR} = \frac{[(C)\ (Q)\ (\text{Const})]_{\text{Existing}} - [(C)\ (Q)\ (\text{Const})]_{\text{Target}}}{[(C)\ (Q)\ (\text{Const})]_{\text{Existing}}} \times 100$$

where: RILR = Required Instream Load Reduction [%]
C = Instream Concentration [counts/100 mL]
Q = Daily Mean Flow [cfs]
Const = Unit Conversion Constant

Since the streamflow for the existing condition is equal to the streamflow for the target condition:

$$\text{TMDL} = \text{RILR} = \cancel{\frac{(Q)\ (\text{Const})}{(Q)\ (\text{Const})}} \times \frac{[C]_{\text{Existing}} - [C]_{\text{Target}}}{[C]_{\text{Existing}}} \times 100$$

therefore:

$$\text{TMDL} = \text{RILR} = \frac{[C]_{\text{Existing}} - [C]_{\text{Target}}}{[C]_{\text{Existing}}} \times 100$$

As an example, for the subwatershed at the pour point of the 303(d)-Listed segment of Big Bigby Creek, the simulated 30-day geometric mean concentration for the existing loading condition (ref.: Section D.5) is 1331 counts/100 mL. The required instream load reduction is calculated by:

$$\text{TMDL} = \text{RILR} = \frac{(1331 \text{ cts/100 mL}) - (180 \text{ cts/100 mL})}{(1331 \text{ cts/100 mL})} \times 100$$

TMDL = RILR = 86.5%

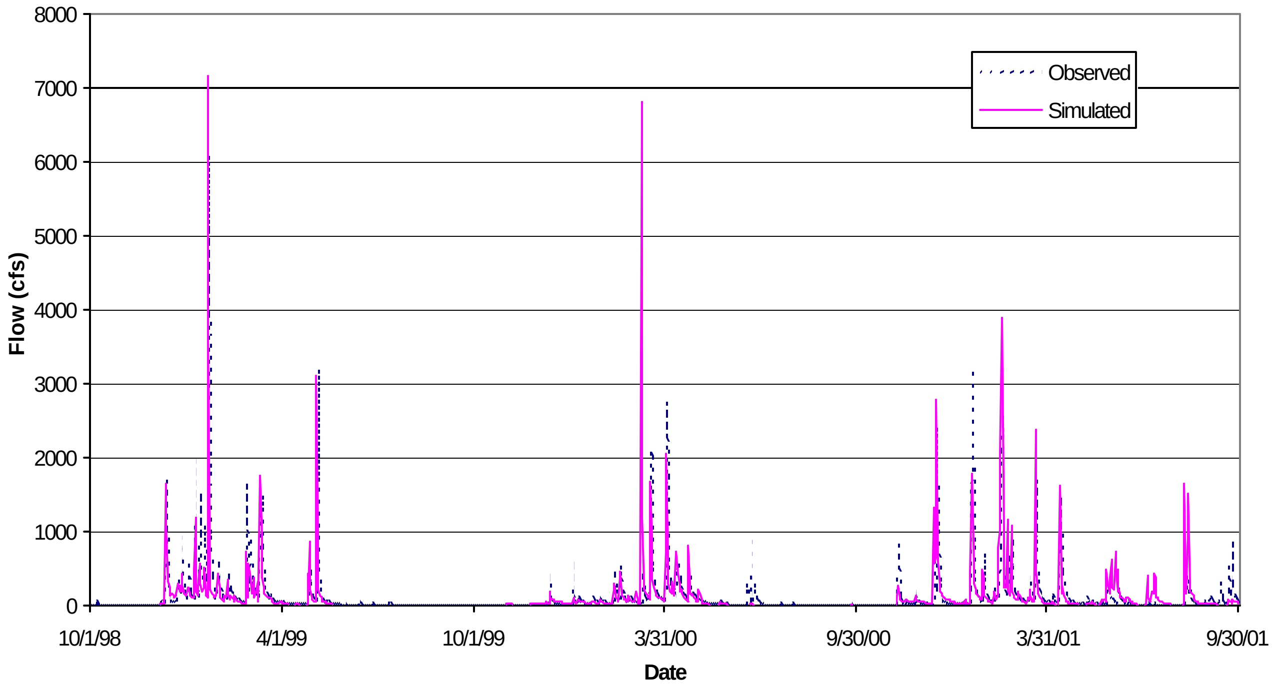
Required load reductions are summarized in Table D-2.

Table D-1. Hydrologic Calibration Summary: Cane Creek near Howell (USGS 035825882)

Simulation Name:	Cane Creek	**Simulation Period:**	
	USGS 035825882	**Watershed Area (ac):**	67650
Period for Flow Analysis			
Begin Date:	**10/01/98**		
End Date:	**09/30/01**		
Total Simulated In-stream Flow:	**44.94**	Total Observed In-stream Flow:	**45.47**
Total of highest 10% flows:	**32.07**	Total of Observed highest 10% flows:	**31.94**
Total of lowest 50% flows:	**0.95**	Total of Observed Lowest 50% flows:	**0.92**
Simulated Summer Flow Volume (months 7-9):	**3.31**	Observed Summer Flow Volume (7-9):	**2.30**
Simulated Fall Flow Volume (months 10-12):	**6.38**	Observed Fall Flow Volume (10-12):	**5.33**
Simulated Winter Flow Volume (months 1-3):	**25.33**	Observed Winter Flow Volume (1-3):	**27.35**
Simulated Spring Flow Volume (months 4-6):	**9.92**	Observed Spring Flow Volume (4-6):	**10.49**
Total Simulated Storm Volume:	**44.94**	Total Observed Storm Volume:	**45.47**
Simulated Summer Storm Volume (7-9):	**3.31**	Observed Summer Storm Volume (7-9):	**2.30**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**-1.17**	10	
Error in 50% lowest flows:	**3.11**	10	
Error in 10% highest flows:	**0.41**	15	
Seasonal volume error - Summer:	**44.21**	30	
Seasonal volume error - Fall:	**19.72**	30	
Seasonal volume error - Winter:	**-7.40**	30	
Seasonal volume error - Spring:	**-5.48**	30	
Error in storm volumes:	**-1.17**	20	
Error in summer storm volumes:	**44.21**	50	

Table D-2. TMDLs for Lower Duck River Waterbodies – 30-Day Geometric Mean Target

Impaired Waterbody Name	Waterbody ID	Existing Conditions		TMDL - Required Load Reduction
		Date(s) of Max. 30-Day Geom. Mean Concen.	Max. 30-Day Geom. Mean Concentration [cts./100 mL]	[%]
Big Bigby Creek	TN06040003019 – 2000	**3/9/98**	**1331**	**86.5**
Sugar Fork	TN06040003023 – 1000	**9/29/99**	**1710**	**89.5**



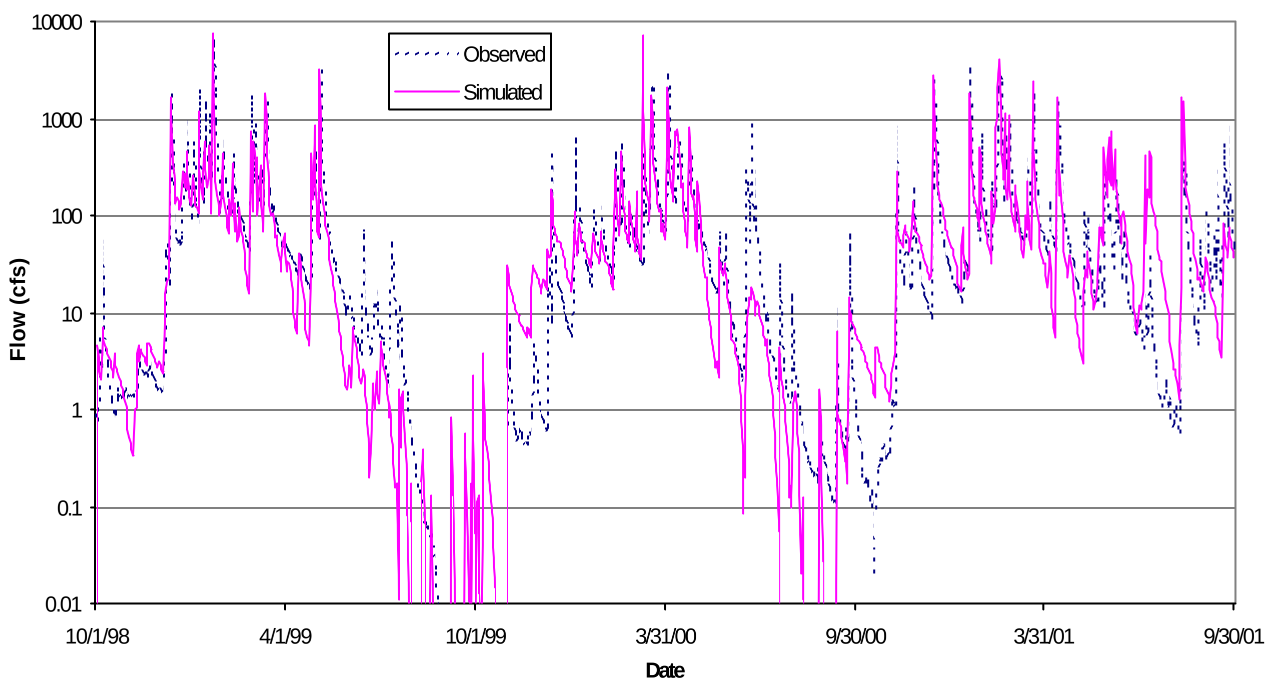
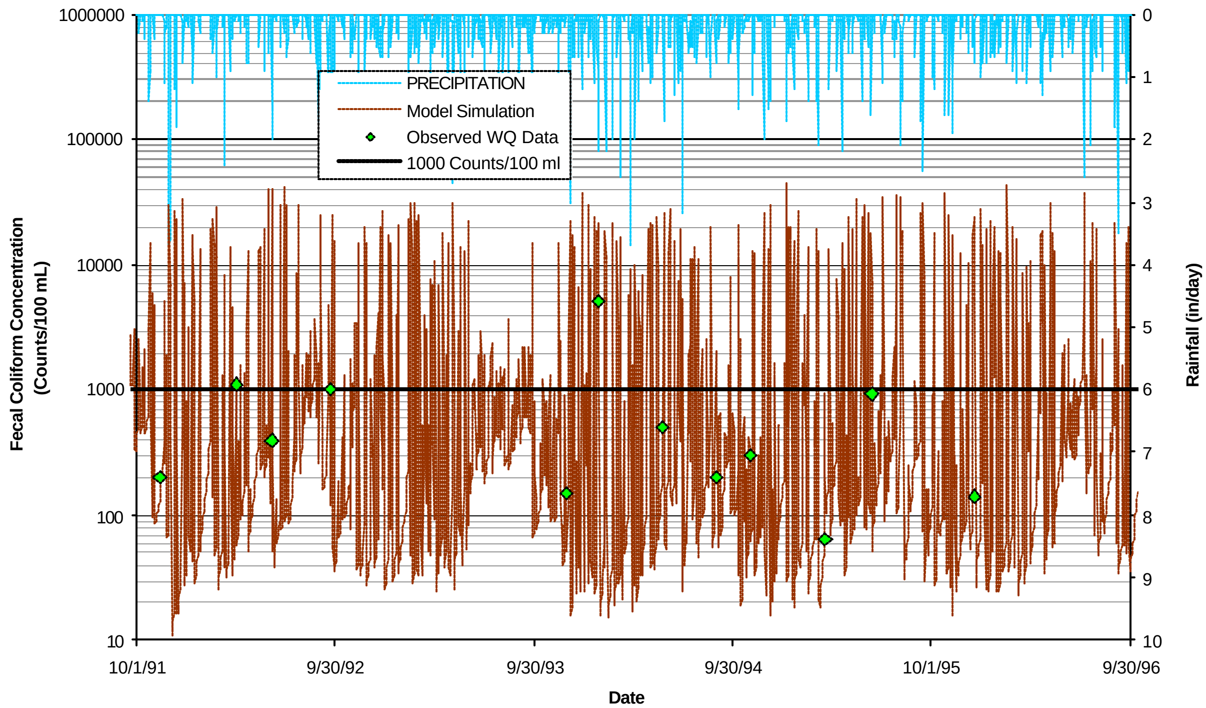


Figure D-1. Hydrologic Calibration: Cane Creek nr Howell, USGS 035825882 (WYs 1998-2001)



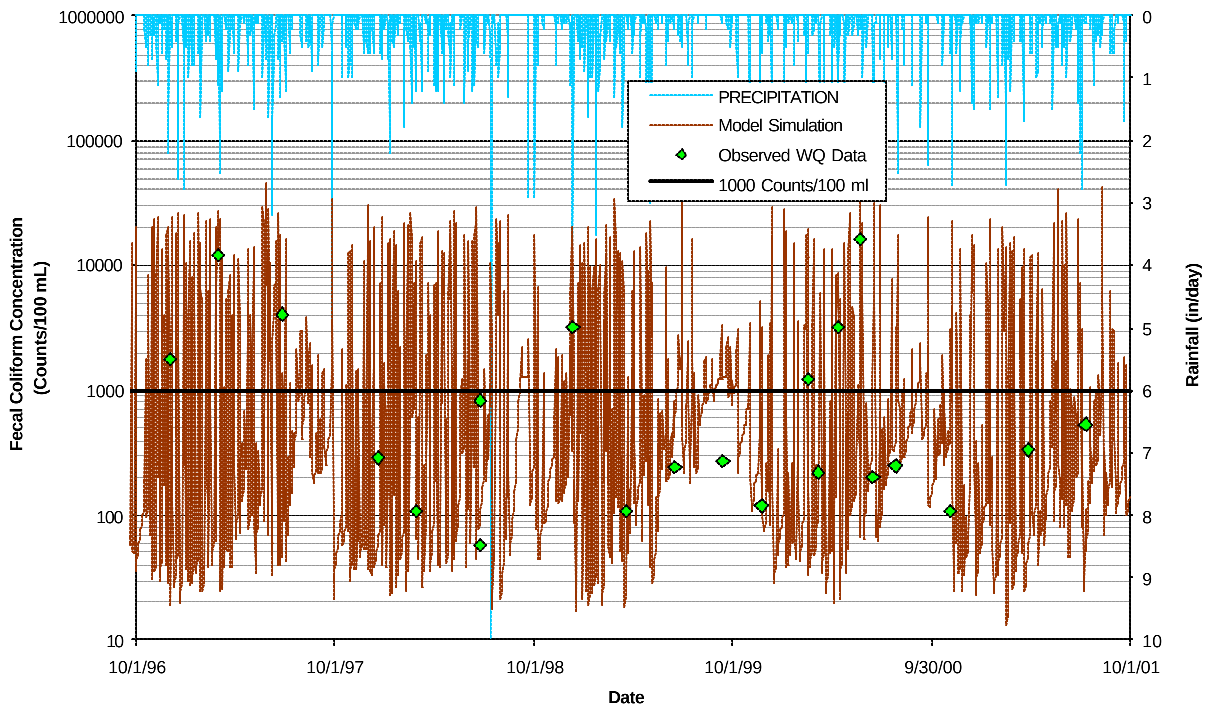


Figure D-2. Water Quality Calibration of Big Bigby Creek at Mile 8.5 (BBIGB008.5MY)

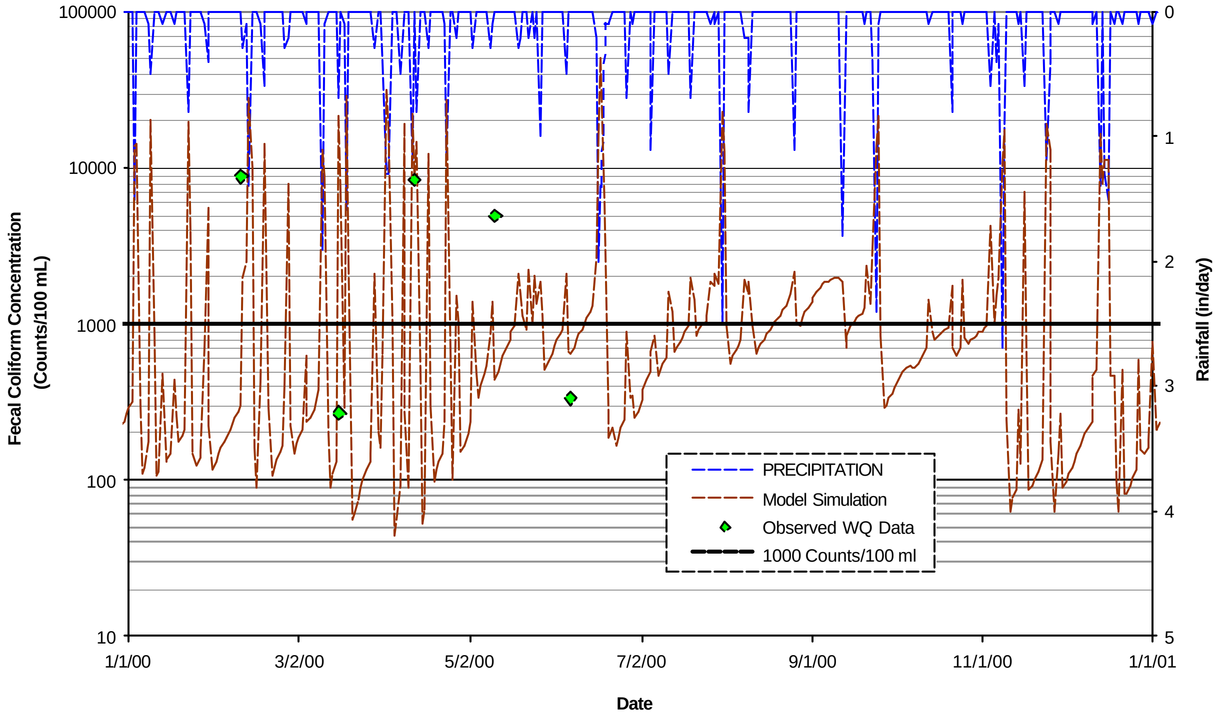


Figure D-3. Water Quality Calibration of Sugar Fork at Mile 1.8 (SUGAR001.8MY)

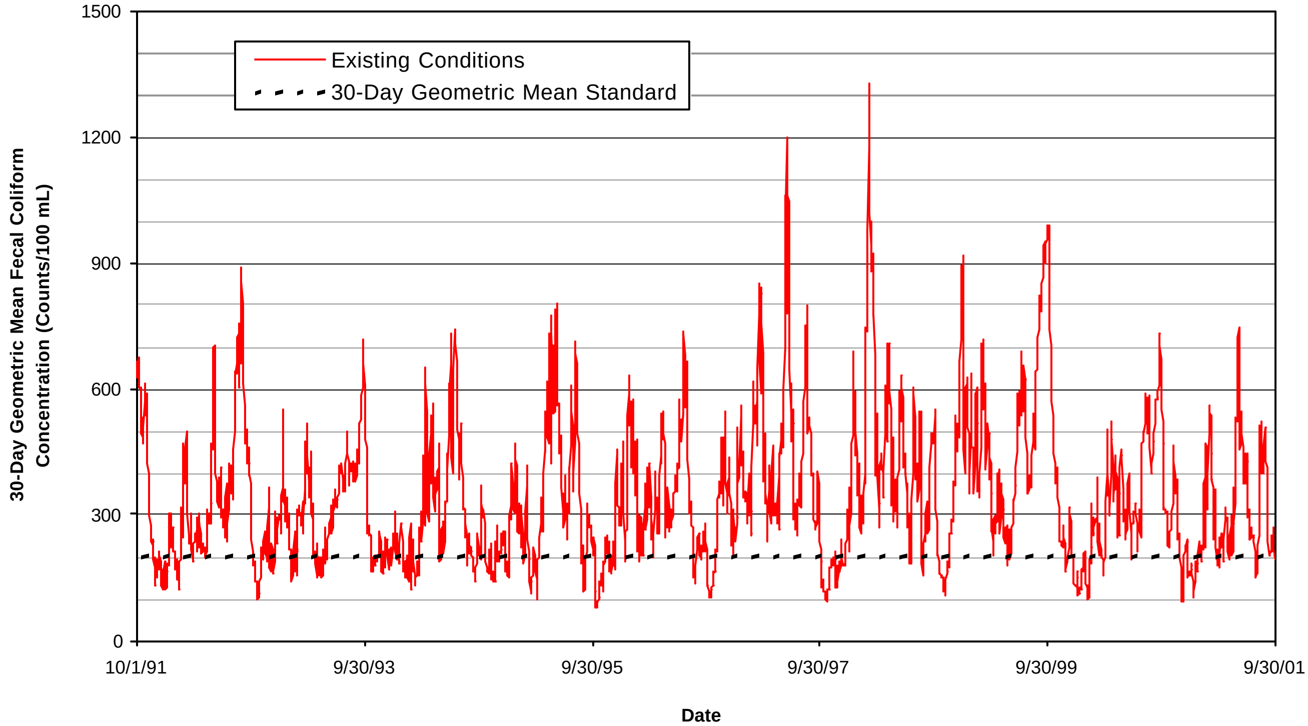


Figure D-4. Simulated 30-Day Geometric Mean Fecal Coliform Concentrations for Big Bigby Creek at the confluence with Beard Branch for Existing Conditions.

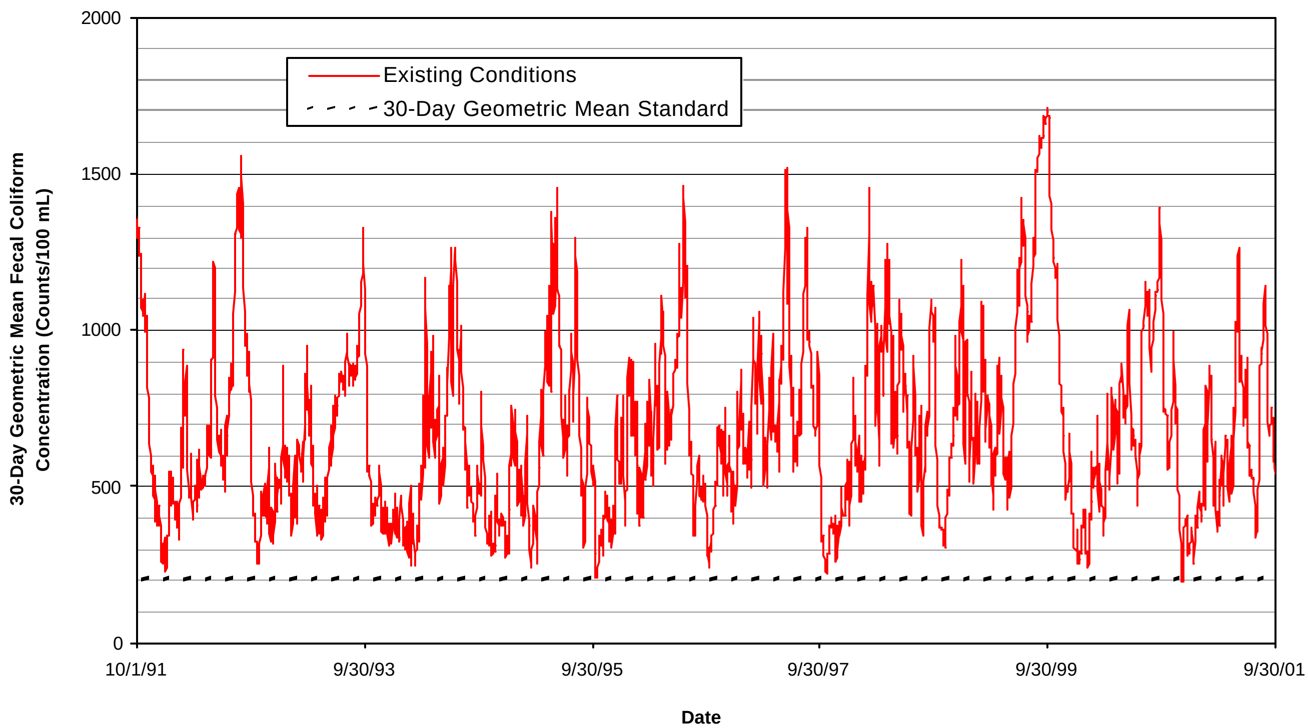


Figure D-5. Simulated 30-Day Geometric Mean Fecal Coliform Concentrations for Sugar Fork at the Mouth for Existing Conditions.

APPENDIX E

Load Duration Curve Methodology

LOAD DURATION CURVE METHOD

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 are useful for TMDL analysis:

Note: The following was based on information from Nevada Division of Environmental Protection, Bureau of Water Quality Planning website (Nevada, 2003):

- Load duration curves can serve as TMDL targets, thereby establishing allowable loading to waterbodies over the entire range of flow.

- Pollutant monitoring data, plotted on a load duration curve, provide a visual depiction of stream water quality with respect to allowable loads. The frequency and magnitude of exceedances are also illustrated.

- Load duration curves can be used to characterize the flow conditions under which exceedances occur. For example, exceedances that occur in the 0% to 10% area of the curve may be considered to represent extreme high flow problems that may be beyond feasible management solutions. Exceedances in the 99% to 100% area reflect extreme drought conditions.

- Different loading mechanisms can dominate at different flow regimes. Exceedances of the load duration curve during high flow conditions may indicate excessive nonpoint source loading associated with rain events, while exceedances at the lower flows can indicate point source problems.

E.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) drainage area extrapolation of data from a nearby continuous-record station of similar size and topography; and 2) calculation of daily mean flow using a dynamic computer model, such as LSPC.

Flow duration curves for Big Bigby Creek and Sugar Fork were derived from hydrologic simulations based on parameters derived from calibration at USGS Station No. 035825882, located on Cane Creek near Howell, in the Upper Elk River watershed. The flow duration curve for Blue Creek was derived from a drainage area relationship to nearby Piney River at Cedar Hill. The data used, in each case, included the period of record from 10/1/91 – 9/31/01. The flow duration curves for Big Bigby Creek at mile 8.5, Sugar Fork at mile 1.8, and Blue Creek at mile 15.8 are shown in Figures E-1 through E-3.

E.2 Development of Load Duration Curves

Fecal coliform and E. coli load duration curves for Big Bigby Creek and Blue Creek and a fecal coliform load duration curve for Sugar Fork were developed from the flow duration curves developed in Section E.1 and available water quality monitoring data. Load duration curves were developed using the following procedure:

1. A load-duration curve was generated for Big Bigby Creek at mile 8.5 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 E.1) and plotting the results. The fecal coliform target load corresponding to each ranked daily mean flow is:

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

   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 the monitoring station (ref.: Table B-1) by multiplying the sample concentration by the derived daily mean flow for the sampling date and the required unit conversion factor.

   Note: 1) 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 Step 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 2 according to the PDFE. The resulting fecal coliform and E. coli load duration curves for Big Bigby Creek at mile 8.5, Sugar Fork at mile 1.8 (fecal coliform only), and Blue Creek at mile 15.8 are shown in Figures E-4 through E-8.

4. For cases where the existing load exceeded the water quality standard, the reduction corresponding to each sample load was determined through comparison with the target load corresponding to the PDFE. The geometric means of the calculated reductions of existing fecal coliform load and E. coli load, respectively, required to meet the TMDL targets were considered to be the required load reductions for the Big Bigby Creek, Sugar Fork, and Blue Creek subwatersheds (see Tables E-1 through E-5).

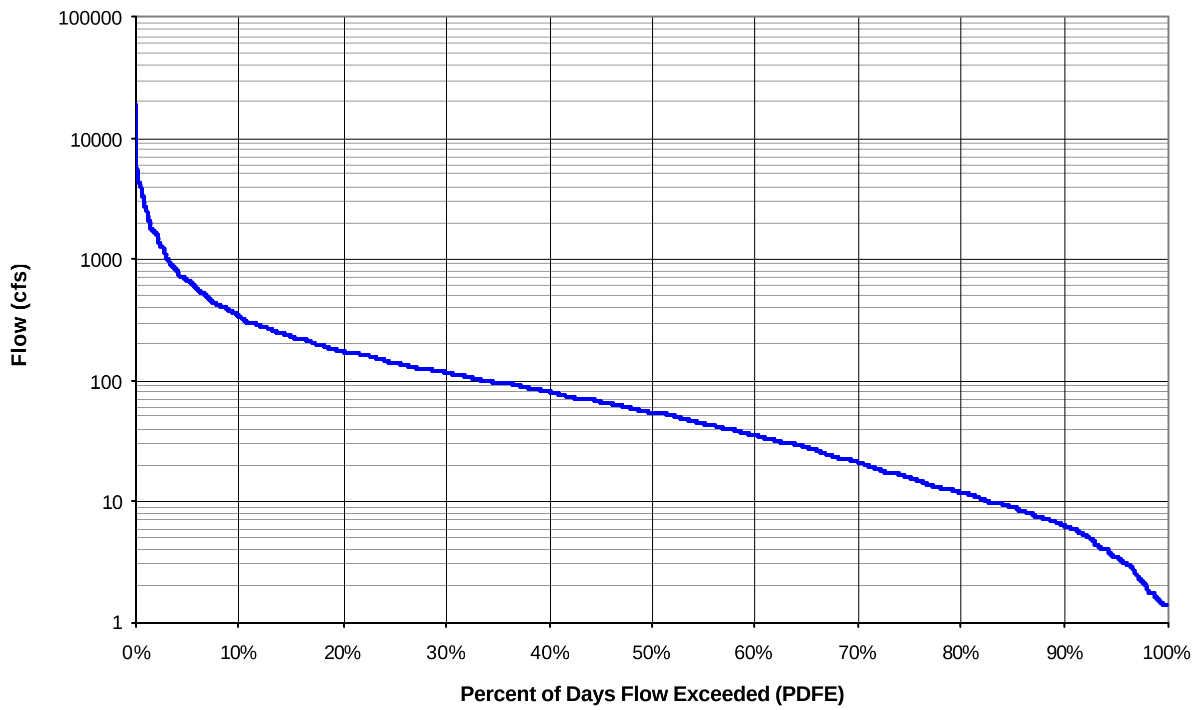


Figure E-1. Flow Duration Curve for Big Bigby Creek at Mile 8.5

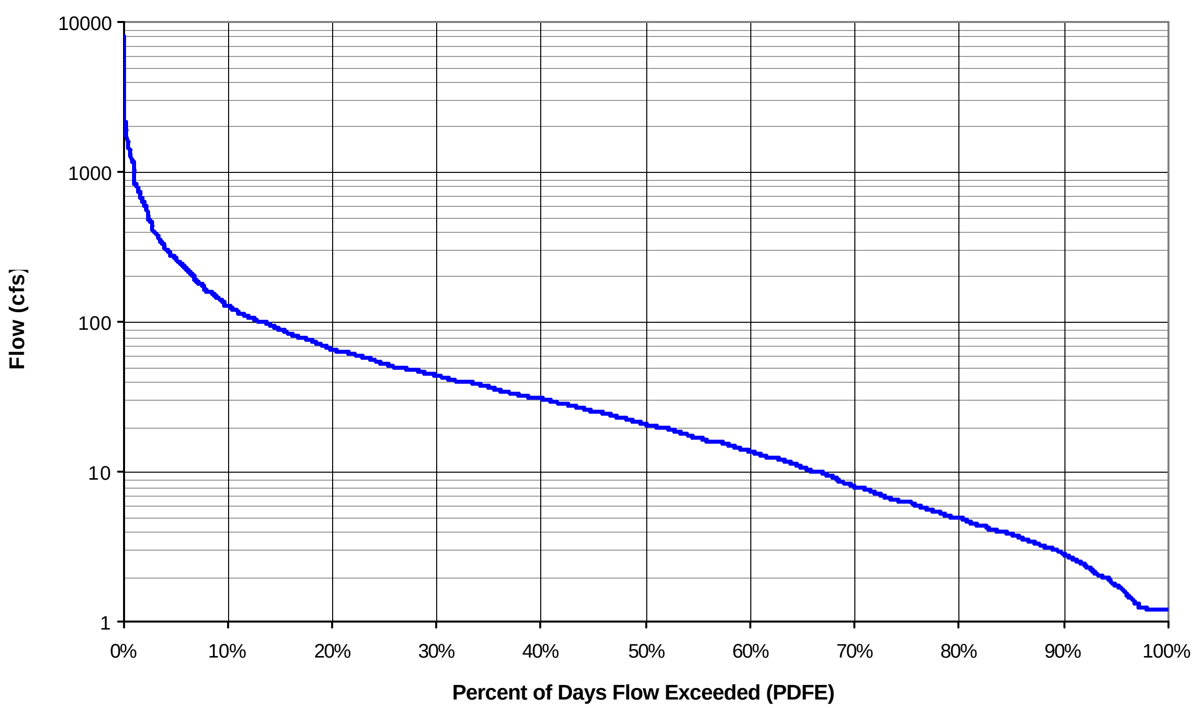


Figure E-2. Flow Duration Curve for Sugar Fork at Mile 1.8

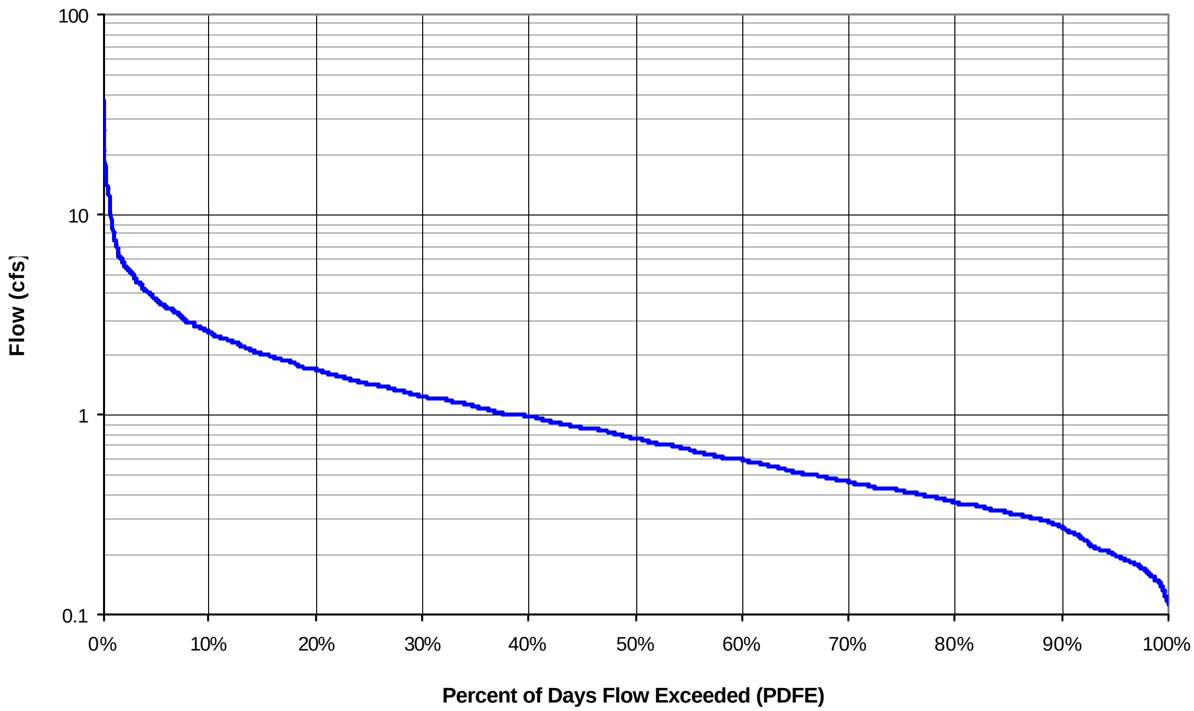


Figure E-3. Flow Duration Curve for Blue Creek at Mile 15.8

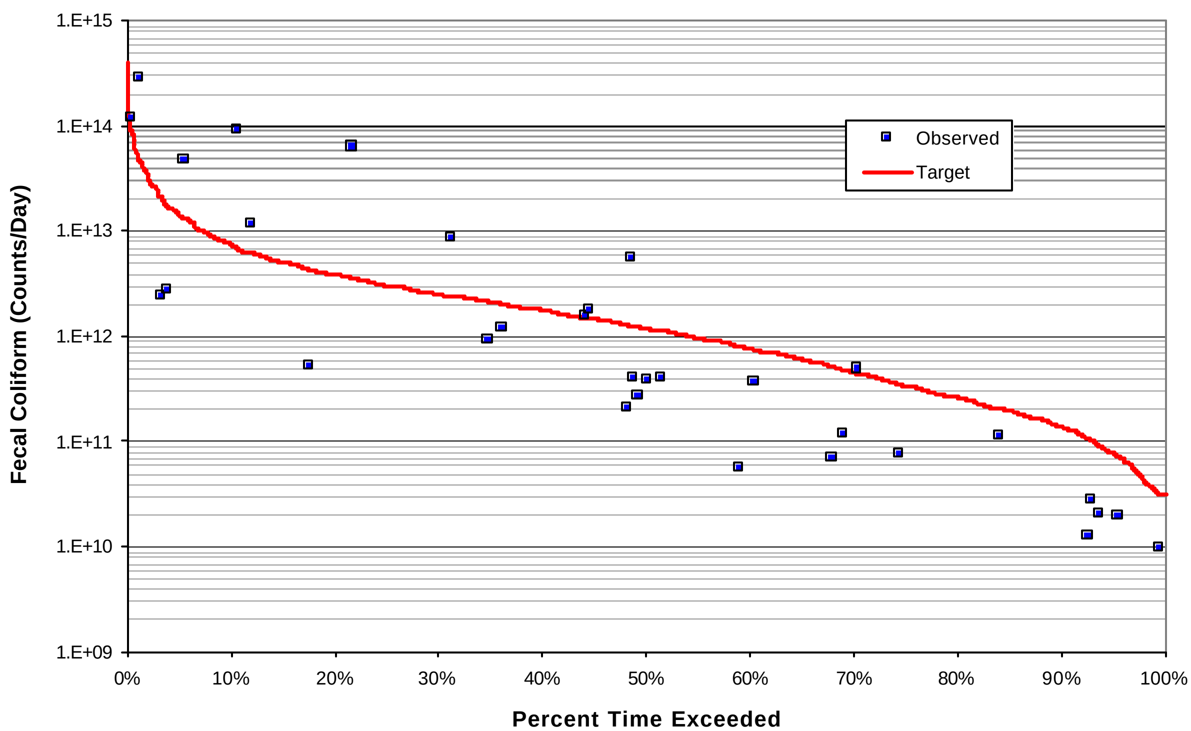


Figure E-4. Fecal Coliform Load Duration Curve for Big Bigby Creek at Mile 8.5

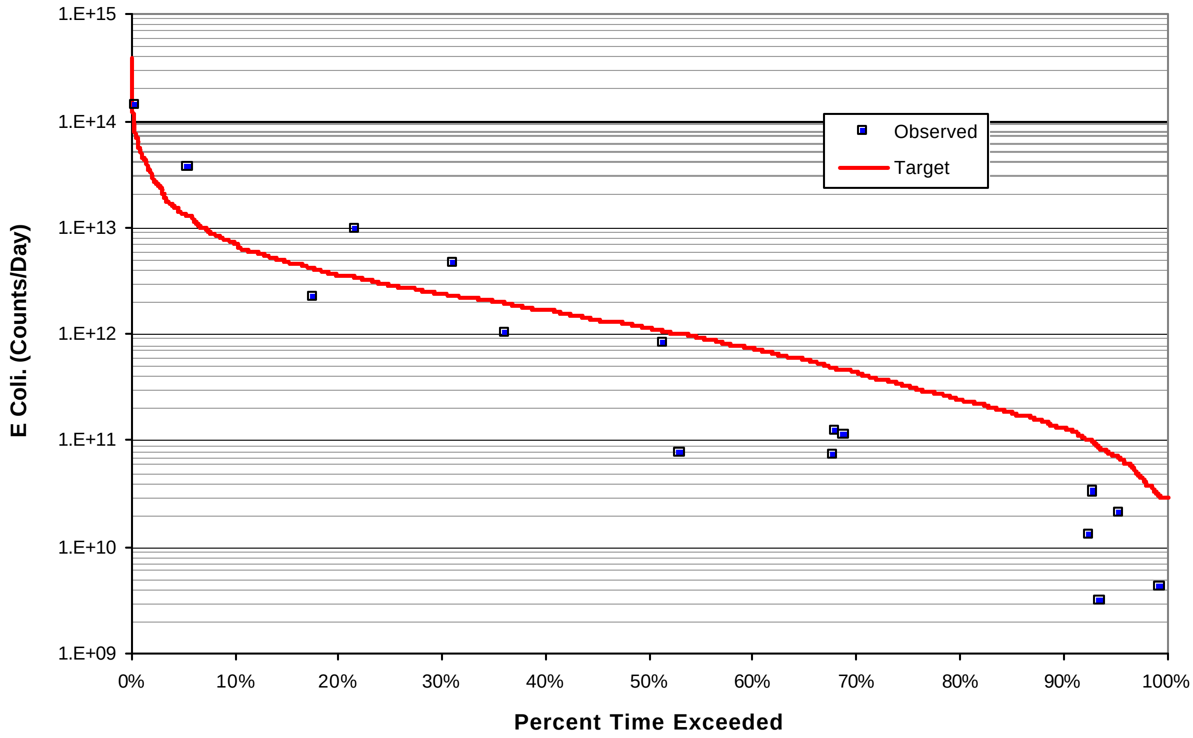


Figure E-5. E. Coli Load Duration Curve for Big Bigby Creek at Mile 8.5

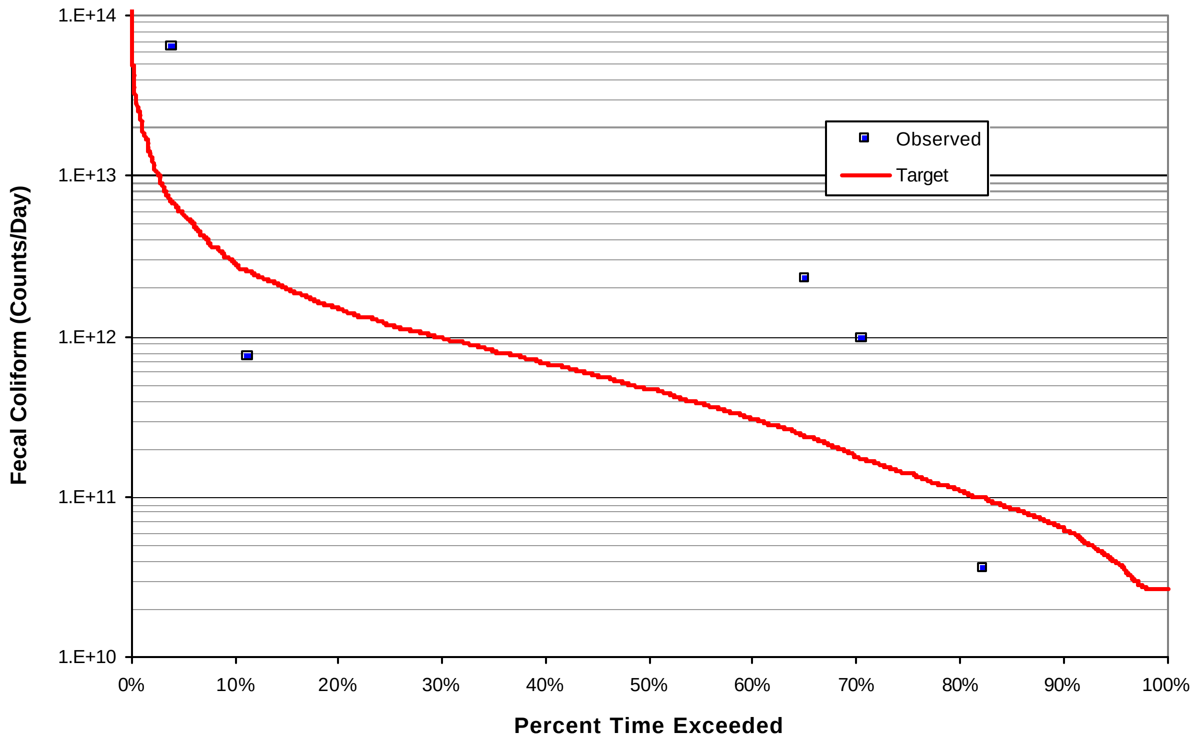


Figure E-6. Fecal Coliform Load Duration Curve for Sugar Fork at Mile 1.8

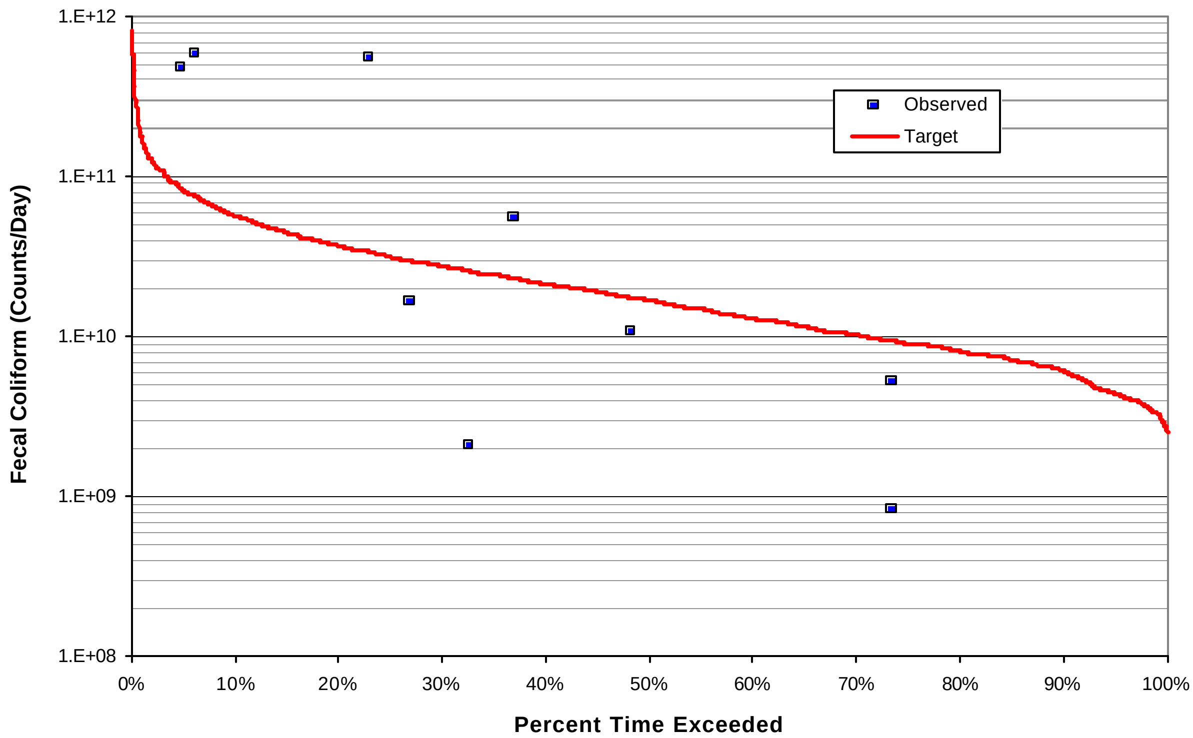


Figure E-7. Fecal Coliform Load Duration Curve for Blue Creek at Mile 15.8

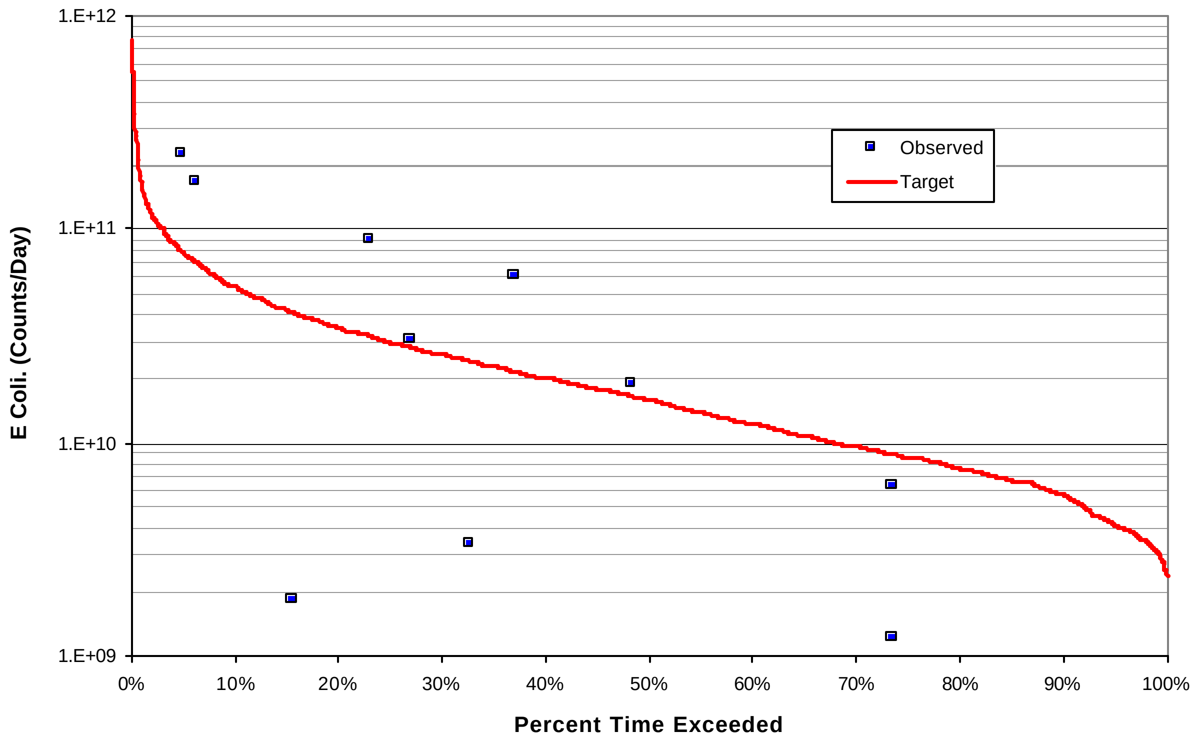


Figure E-8. E. Coli Load Duration Curve for Blue Creek at Mile 15.8

Table E-1. Required Load Reduction for Big Bigby Creek at Mile 8.5 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Conc.	Fecal Coliform Sample Load	Fecal Coliform Target Load	Fecal Coliform Required Load Reduction
	[cfs]	[%]	[cts/100 ml]	[cts/day]	[cts/day]	[%]
11/12/91	16.0229	74.350%	200	7.841E+10	3.529E+11	**NR**
3/31/92	66.9942	44.402%	**1100**	1.803E+12	1.475E+12	18.2
6/3/92	97.0079	34.739%	390	9.257E+11	2.136E+12	**NR**
9/21/92	20.2999	70.298%	1000	4.967E+11	4.470E+11	**NR**
11/30/93	58.2617	48.152%	150	2.138E+11	1.283E+12	**NR**
1/27/94	2382.39	0.958%	**5000**	2.915E+14	5.247E+13	82.0
5/25/94	9.24747	83.986%	490	1.109E+11	2.036E+11	**NR**
9/1/94	56.2034	49.083%	200	2.750E+11	1.238E+12	**NR**
11/2/94	54.4097	49.932%	300	3.994E+11	1.198E+12	**NR**
3/20/95	36.619	58.801%	63	5.645E+10	8.064E+11	**NR**
6/14/95	68.3056	44.046%	930	1.554E+12	1.504E+12	**NR**
12/18/95	820.487	3.668%	140	2.811E+12	1.807E+13	**NR**
12/3/96	277.651	11.908%	**1800**	1.223E+13	6.114E+12	50.0
2/27/97	310.661	10.539%	**12220**	9.289E+13	6.841E+12	92.6
6/26/97	57.3289	48.508%	**4100**	5.751E+12	1.263E+12	78.0
12/17/97	57.0374	48.700%	290	4.047E+11	1.256E+12	**NR**
2/26/98	901.429	3.258%	110	2.426E+12	1.985E+13	**NR**
6/23/98	34.2712	60.307%	438	3.673E+11	7.547E+11	**NR**
12/10/98	110.739	31.043%	**3200**	8.671E+12	2.439E+12	71.9
3/17/99	195.277	17.575%	110	5.256E+11	4.300E+12	**NR**
6/17/99	3.29606	95.346%	240	1.936E+10	7.259E+10	**NR**
9/14/99	1.45076	99.370%	270	9.585E+09	3.195E+10	**NR**
11/22/99	23.2089	67.862%	120	6.815E+10	5.111E+11	**NR**
3/9/00	21.9805	68.820%	220	1.183E+11	4.841E+11	**NR**
4/13/00	617.094	5.393%	**3200**	4.832E+13	1.359E+13	71.9
5/23/00	161.718	21.626%	**16000**	6.331E+13	3.561E+12	94.4
6/14/00	4.08776	93.594%	200	2.000E+10	9.002E+10	**NR**
7/25/00	4.58247	92.855%	250	2.803E+10	1.009E+11	**NR**
11/2/00	4.90639	92.445%	110	1.321E+10	1.080E+11	**NR**
12/16/00	4076.52	0.328%	**1200**	1.197E+14	8.977E+13	25.0
3/28/01	51.563	51.355%	330	4.164E+11	1.136E+12	**NR**
7/11/01	92.9078	36.135%	530	1.205E+12	2.046E+12	**NR**
					Geometric Mean	**57.2**

NR = Not Required

Table E-2. Required Load Reduction for Big Bigby Creek at Mile 8.5 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Conc.	Sample Load	Target Load	Required Load Reduction
	[cfs]	[%]	[cts/100 ml]	[cts/day]	[cts/day]	[%]
9/22/98	23.1618	67.917%	220	1.247E+11	4.800E+11	**NR**
12/10/98	110.739	31.043%	**1700**	4.606E+12	2.295E+12	50.2
3/17/99	195.277	17.575%	460	2.198E+12	4.047E+12	**NR**
6/17/99	3.29606	95.346%	260	2.097E+10	6.831E+10	**NR**
9/14/99	1.45076	99.370%	120	4.260E+09	3.007E+10	**NR**
11/22/99	23.2089	67.862%	130	7.383E+10	4.810E+11	**NR**
1/20/00	47.5437	52.998%	66	7.678E+10	9.854E+11	**NR**
3/9/00	21.9805	68.820%	210	1.129E+11	4.556E+11	**NR**
4/13/00	617.094	5.393%	**>2400**	3.624E+13	1.279E+13	>64.7
5/23/00	161.718	21.626%	**>2400**	9.497E+12	3.352E+12	>64.7
6/14/00	4.08776	93.594%	31	3.101E+09	8.472E+10	**NR**
7/25/00	4.58247	92.855%	300	3.364E+10	9.497E+10	**NR**
11/2/00	4.90639	92.445%	110	1.321E+10	1.017E+11	**NR**
12/16/00	4076.52	0.328%	**1400**	1.396E+14	8.449E+13	39.5
3/28/01	51.563	51.355%	650	8.201E+11	1.069E+12	**NR**
7/11/01	92.9078	36.135%	440	1.000E+12	1.926E+12	**NR**
NR = Not Required				**Geometric Mean**		**>53.7**

Table E-3. Required Load Reduction for Sugar Fork at Mile 1.8 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform			
			Sample Conc.	Sample Load	Target Load	Required Load Reduction
	[cfs]	[%]	[cts/100 ml]	[cts/day]	[cts/day]	[%]
2/10/00	10.8273	65.042%	**8700**	2.305E+12	2.384E+11	89.7
3/16/00	114.456	11.224%	270	7.562E+11	2.521E+12	**NR**
4/12/00	309.912	3.915%	**8400**	6.370E+13	6.825E+12	89.3
5/11/00	7.81941	70.600%	**5000**	9.567E+11	1.722E+11	82.0
6/7/00	4.45511	82.234%	330	3.597E+10	9.811E+10	**NR**
NR = Not Required				**Geometric Mean**		**86.9**

Table E-4. Required Load Reduction for Blue Creek at Mile 15.8 – Fecal Coliform Analysis

Sample Date	Flow	PDFE	Fecal Coliform Sample Conc.	Sample Load	Target Load	Required Load Reduction
	[cfs]	[%]	[cts/100 ml]	[cts/day]	[cts/day]	[%]
8/12/03	0.428	73.39%	510	5.335E+09	9.415E+09	**NR**
9/24/03	1.52	23.02%	**15000**	5.594E+11	3.357E+10	94.0
10/22/03	0.428	73.50%	80	8.369E+08	9.415E+09	**NR**
11/20/03	3.44	6.10%	**7000**	5.890E+11	7.573E+10	87.1
12/9/03	0.799	48.29%	550	1.076E+10	1.760E+10	**NR**
1/7/04	1.36	26.85%	500	1.660E+10	2.988E+10	**NR**
1/10/04	1.17	32.49%	73	2.092E+09	2.579E+10	**NR**
1/22/04	1.04	37.01%	**2200**	5.603E+10	2.292E+10	59.1
5/18/04	3.83	4.79%	**5100**	4.778E+11	8.432E+10	82.4
NR = Not Required				**Geometric Mean**		**79.5**

Table E-5. Required Load Reduction for Blue Creek at Mile 15.8 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli Sample Conc.	Sample Load	Target Load	Required Load Reduction
	[cfs]	[%]	[cts/100 ml]	[cts/day]	[cts/day]	[%]
8/12/03	0.428	73.39%	610	6.381E+09	8.860E+09	**NR**
9/24/03	1.52	23.02%	**>2400**	8.951E+10	3.159E+10	64.7
10/22/03	0.428	73.50%	120	1.255E+09	8.860E+09	**NR**
11/20/03	3.44	6.10%	**>2000**	1.683E+11	7.127E+10	57.7
12/9/03	0.799	48.29%	**980**	1.917E+10	1.656E+10	13.6
1/7/04	1.36	26.85%	920	3.055E+10	2.812E+10	**NR**
1/10/04	1.17	32.49%	120	3.438E+09	2.427E+10	**NR**
1/22/04	1.04	37.01%	**>2400**	6.113E+10	2.157E+10	64.7
4/29/04	1.97	15.49%	39	1.880E+09	4.083E+10	**NR**
5/18/04	3.83	4.79%	**2400**	2.249E+11	7.936E+10	64.7
NR = Not Required				**Geometric Mean**		**>46.3**

APPENDIX F

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:

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

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

For fecal coliform TMDLs in each impaired subwatershed, WLA terms include:

- $[\sum WLAs]_{WWTF}$ 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.

- $[\sum WLAs]_{CAFO}$ is the allowable load for all CAFOs in an impaired subwatershed. Since discharges from a CAFO liquid waste handling facility to waters of the state during a chronic or catastrophic rainfall event (in excess of a 25-year, 24-hour rainfall event), or as a result of an unpermitted discharge, upset, or bypass of the system, are not to cause or contribute to an exceedance of Tennessee water quality standards, the WLA = 0.

- $[\sum WLAs]_{MS4}$ is the required load reduction for discharges from MS4s. Fecal coliform 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:

- $[\sum LAs]_{DS}$ is the allowable fecal coliform 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).

- $[\sum LAs]_{SW}$ represents the required reduction in fecal coliform 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 D and Appendix E. TMDLs, WLAs, & LAs are applied to the entire subwatershed. WLAs & LAs for Lower Duck River waterbodies are summarized in Table F-1.

Table F-1. WLAs & LAs for Lower Duck River, Tennessee

Impaired Waterbody Name	Impaired Waterbody ID	WLAs					LAs	
		WWTFs [a] (Monthly Avg.)		Leaking Collection Systems[b]	CAFOs	MS4s[c]	Precipitation Induced Nonpoint Sources	Other Direct Sources[d]
		Fecal Coliform	E. Coli					
		[cts./day]	[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
Big Bigby Creek	TN06040003019 – 2000	**5.376×10^9**	**3.387×10^9**	**0**	**NA**	**NA**	**86.5**	**0**
Sugar Fork	TN06040003023 – 1000	**5.376×10^9**	**3.387×10^9**	**0**	**NA**	**NA**	**89.5**	**0**
Potts Branch[e]	TN06040003041 – 0800	**0**	**0**	**NA**	**0**	**NA**	***[e]**	**0**
Lunns Branch[e]	TN06040003041 – 0950	**0**	**0**	**NA**	**0**	**NA**	***[e]**	**0**
Dog Creek[e]	TN06040003041 – 1150	**0**	**0**	**NA**	**0**	**NA**	***[e]**	**0**
Blue Creek	TN06040003062 – 3000	**3.407×10^9**	**2.147×10^9**	**0**	**NA**	**NA**	**79.5**	**0**

Note: NA = Not applicable.

a. WLAs for WWTFs expressed as fecal coliform and 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 pathogens.

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 pathogens.

e. Detailed TMDL analyses were not performed on Potts Branch, Lunns Branch, and Dog Creek. It is assumed that water quality standards for pathogens will be attained in these waterbodies when the outstanding enforcement action(s) against Blackjack Ridge Dairy are implemented and Blackjack Ridge Dairy complies with the terms of its CAFO permit.

APPENDIX G

Public Notice of Proposed Total Maximum Daily Loads (TMDLs) for Pathogens in the Lower Duck River Watershed (HUC 06040003)

DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR PATHOGENS IN THE LOWER DUCK RIVER WATERSHED (HUC 06040003), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed total maximum daily load (TMDL) for pathogens in the Lower Duck River watershed, located in western middle 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.

Big Bigby Creek, Sugar Fork, Potts Branch, Lunns Branch, Dog Branch, and Blue Creek are listed on Tennessee's Final 2002 303(d) list as not supporting designated use classifications due, in part, to discharge of pathogens from municipal point sources and a confined animal feeding operation. The TMDL utilizes Tennessee's general water quality criteria, recently collected site specific water quality data, continuous flow data from a USGS discharge monitoring station located in proximity to the watershed, and a calibrated dynamic water quality model to establish allowable loadings of pathogens which will result in reduced in-stream concentrations and attainment of water quality standards. The TMDL requires reductions on the order of 80% - 90% for the impaired waterbodies.

The proposed Lower Duck River pathogen TMDL document can be downloaded from the following 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:

Dennis M. Borders, P.E., Watershed Management Section
Telephone: 615-532-0706

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

Persons wishing to comment on the proposed TMDL are invited to submit their comments in writing no later than December 27, 2004 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, 7th 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.