STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
William R. Snodgrass - Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1102

March 20, 2023

EPA Region 4 – Water Protection Division
Ms. Elizabeth Belk
61 Forsyth Street SW, 9T25
Atlanta, GA
30303

Subject: **TMDL for Waterbodies Impaired Due to E. coli**
In the Hiwassee River Watershed (HUC 06020002)

As required by Section 303(d) of the Clean Water Act, the Tennessee Department of Environment and Conservation Division of Water Resources hereby formally submits the subject TMDLs to the U.S. Environmental Protection Agency, Region 4, for approval.

If you have questions concerning this correspondence, please contact Ms. Vicki S. Steed by telephone at (615) 532-0707 or by e-mail at Vicki.Steed@tn.gov.

Sincerely,

Richard Cochran

Richard Cochran., Manager
Watershed Planning Unit
Division of Water Resources
Richard.Cochran@tn.gov
615-532-0997

Enclosures

cc: File

TOTAL MAXIMUM DAILY LOAD (TMDL)

for

Escherichia coli (E. coli)

in the

Hiwassee River Watershed

(HUC 06020002)

Bradley, Hamilton, McMinn, Meigs, Monroe, and Polk Counties, Tennessee

Proposed Final

Prepared by:

Tennessee Department of Environment and Conservation
Division of Water Resources
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, TN 37243

March 20, 2023

TN Department of Environment & Conservation

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LIST OF ABBREVIATIONS

AFO	Animal Feeding Operation
ARA	Antibiotic Resistance Analysis
ATTAINS	Assessment and TMDL Tracking Implementation System
BMP	Best Management Practices
BST	Bacteria Source Tracking
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CFU	Colony Forming Units
CSA	Critical Source Area
CSO	Combined Sewer Overflow
CUP	Carbon Utilization Profile
d/s	Downstream
DA	Drainage Area
DEM	Digital Elevation Model
DS	Direct Sources
DWR	Division of Water Resources
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
ES	Elementary School
exc	Exceedance(s)
Geomean	Geometric Mean
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - Fortran
HUC	Hydrologic Unit Code
H/W	Headwaters
LA	Load Allocation
LDC	Load Duration Curve
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
NHD	National Hydrography Dataset
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NR	No reduction required
NRCS	Natural Resources Conservation Service
ONRW	Outstanding National Resource Water
PCR	Polymerase Chain Reaction
PDFE	Percent of Days Flow Exceeded
PFGE	Pulsed Field Gel Electrophoresis
PLRG	Percent Load Reduction Goal
q_m	Mean daily facility (WWTP) flow (cfs)
q_d	Facility design flow (cfs)
Q	Mean daily in-stream flow (cfs)
qPCR	Quantitative Polymerase Chain Reaction
RM	River Mile

SF	Storm Flow
SOP	State Operating Permit
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
SW	Storm Water
SWMP	Storm Water Management Plan
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
u/s	Upstream
UCF	Unit Conversion Factor
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UT	Unnamed Tributary
UTK	University of Tennessee, Knoxville
WLA	Waste Load Allocation
WQ	Water Quality
WWTP	Wastewater Treatment Plant
WY	Water Year

SUMMARY SHEET

Total Maximum Daily Load for *E. coli* in Hiwassee River Watershed (HUC 06020002)

Impaired Waterbody Information (Based on TDEC's Final 2022 List of Impaired and Threatened Waters)

State: Tennessee
Counties: Bradley, Hamilton, McMinn, Meigs, Monroe, and Polk
Constituents of Concern: *E. coli*

Impaired Waterbodies Addressed in This Document:

Waterbody ID	Waterbody	Miles Impaired
TN06020002001_0100 [a]	Agency Creek	18.46
TN06020002001_0200	Gunstocker Creek	25
TN06020002005_0100	Black Fox Creek	19.55
TN06020002005_1000	Candies Creek (from Hiwassee River to Greasy Creek)	9.65
TN06020002005_1100	Beaverdam Branch	3.07
TN06020002005_3000	Candies Creek (from Brymer Creek to hw)	9.51
TN06020002008_0100	Bacon Branch	3.36
TN06020002008_1000 [a]	Hiwassee River Embayment of Chickamauga Reservoir (from Rogers Creek to South Mouse Creek)	1050 acres
TN06020002009_0200 [a]	Fillauer Creek	7.4
TN06020002009_0300 [a]	Woolen Mill Branch	3.92
TN06020002009_1000	South Mouse Creek (from Hiwassee River Embayment to Fillauer Branch)	12.1
TN06020002009_2000 [a]	South Mouse Creek (from Fillauer Branch to hw)	6.5
TN06020002012_0200 [a]	Little Chatata Creek	14.3
TN06020002012_0300	Rattlesnake Branch	2.98
TN06020002012_1000 [a]	Chatata Creek	19.62
TN06020002014_1000	South Chestuee Creek (from Hiwassee River to Benton Pike)	8.77
TN06020002014_2000	South Chestuee Creek (from Benton Pike to hw)	9.81
TN06020002018_0200 [a]	Dairy Branch	1.78
TN06020002018_0300	*Siccowee Branch*	*3.23*
TN06020002081_0100	Cane Creek (from Hiwassee River to UT near north city limit of Etowah)	13.7
TN06020002082_0300	Middle Creek	15.5
TN06020002082_0900 [a]	Little Chestuee Creek	13.3

Waterbody ID	Waterbody	Miles Impaired
TN06020002082_1200	Tom Foeman Creek	13.1
TN06020002082_1300	Big Foot Branch	16.0
TN06020002082_2000 [a]	Chestuee Creek (from Middle Creek to hw)	17.9
TN06020002083_0500	Black Branch	1.98
TN06020002083_0510	Walker Branch	1.8
TN06020002083_1000 [a]	Oostanaula Creek (from mouth to Sanford Rd.)	5.7
TN06020002083_2000 [a]	Oostanaula Creek (from Sanford Rd. to Cedar Springs)	21.1
TN06020002083_3000 [a]	Oostanaula Creek (from Cedar Springs Br to Inglewood Spring)	7.4
TN06020002083_4000 [a]	Oostanaula Creek (from Inglewood Spring to CR 307)	8.5
TN06020002083_5000 [a]	Oostanaula Creek (from CR 307 to hw)	6.2
TN06020002084_0200	Latham Spring Branch	9.0
TN06020002084_0400	Little North Mouse Creek	8.5
TN06020002084_0500	Dry Valley Creek	13.3
TN06020002084_1000 [a]	North Mouse Creek (from Dry Valley Creek to Athens NMouse Ck STP outfall)	15.56
TN06020002084_2000 [a]	North Mouse Creek (from NMouse Ck STP outfall to hw)	15.61
TN06020002085_1000 [a]	Spring Creek	31.58
TN06020002087_0200	Brush Creek	11.8
TN06020002087_0600	Unnamed Trib to Rogers Creek	1.1
TN06020002087_1000 [a]	Rogers Creek	21.6
TN06020002088_1000 [a]	Price Creek	6.9

* Maximum water quality target is 487 CFU/100 mL for lakes, reservoirs, State Scenic Rivers, or Exceptional Tennessee Waters waterbodies and 941 CFU/100 mL for other waterbodies. Waterbodies utilizing the 487 CFU/100 mL target are italicized.

[a] Waterbodies covered by TMDLs approved by EPA in 2006. The TMDLs included in this document supersede the TMDLs approved by EPA in 2006.

Waterbodies that are located within impaired HUC-12s or drainage areas, but are not currently listed as impaired for *E. coli*, were evaluated for protection. Unimpaired (fully supporting) and unassessed waterbodies addressed for protection in this document include:

Waterbody ID	Waterbody	Assessment Status for *E. coli*
TN06020002005_0200	Taylor Branch	Not Assessed
TN06020002005_0300	Dry Creek	Not Assessed
TN06020002005_0400	Brymer Creek	Fully Supporting
TN06020002005_1200	*UT to Candies Creek*	*Not Assessed*
TN06020002005_1300	UT to Candies Creek	Fully Supporting
TN06020002005_1400	UT to Candies Creek	Not Assessed
TN06020002012_0100	Five Mile Branch	Not Assessed
TN06020002014_0100	Little South Chestuee Creek	Not Assessed
TN06020002014_0110	Carson Creek	Not Assessed
TN06020002014_0111	UT to Carson Creek	Not Assessed
TN06020002014_0200	London Branch	Not Assessed
TN06020002081_0150	Cane Creek (from UT near north city limit of Etowah to hw)	Not Assessed
TN06020002082_0310	Rocky Branch	Not Assessed
TN06020002082_0400	UT to Chestuee Creek	Not Assessed
TN06020002082_0500	Cave Springs Branch	Not Assessed
TN06020002082_0700	UT to Chestuee Creek	Not Assessed
TN06020002082_0800	Carson Branch	Not Assessed
TN06020002082_1100	Burger Branch	Not Assessed
TN06020002083_0100	UT to Oostanaula Creek	Not Assessed
TN06020002083_0200	UT to Oostanaula Creek	Not Assessed
TN06020002083_0300	Cedar Springs Branch	Fully Supporting
TN06020002083_0400	Sokey Branch	Not Assessed
TN06020002083_0600	Meadow Fork Creek	Not Assessed
TN06020002083_0610	Acre Spring Branch	Not Assessed
TN06020002084_0100	Blue Spring Branch	Not Assessed
TN06020002084_0300	East Fork North Mouse Creek	Not Assessed
TN06020002085_0100	Meadow Branch	Not Assessed
TN06020002085_0110	UT to Meadow Branch	Not Assessed
TN06020002087_0100	Short Creek	Not Assessed
TN06020002087_0300	Shoal Creek	Not Assessed
TN06020002087_0400	Rock Creek	Not Assessed
TN06020002087_0500	Possum Creek	Not Assessed

* Maximum water quality target is 941 CFU/100 mL for all protection waterbodies except UT to Candies Creek (005_1200), which is 487 CFU/100 mL.

Designated Uses:

The designated use classifications for all waterbodies in the Hiwassee River Watershed include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Additional designated use classifications for specific impaired waterbodies are listed in the following table:

Waterbody ID	Waterbody Name	Portion	Designated Use
TN06020002082_0300	Middle Creek	RM 1.9 to origin	Domestic Water Supply
TN06020002083_1000 & TN06020002083_2000	Oostanaula Creek	RM 0.0 to 26.0	Domestic Water Supply Industrial Water Supply
TN06020002083_2000 & TN06020002083_3000	Oostanaula Creek	RM 26.0 to 33.8	Industrial Water Supply
TN06020002083_3000 & TN06020002083_4000	Oostanaula Creek	RM 33.8 to 37.5	Domestic Water Supply Industrial Water Supply
TN06020002084_1000	North Mouse Creek	RM 0 to 10.0	Domestic Water Supply Industrial Water Supply
TN06020002084_1000 & TN06020002084_2000	North Mouse Creek	RM 10.0 to 30.1	Industrial Water Supply
TN06020002085_1000	Spring Creek	RM 0.0 to 18.7	Industrial Water Supply

There is only one impaired waterbody in the Hiwassee River Watershed that has been classified as Exceptional Tennessee Waters. A portion of Siccowee Branch is located in the Cherokee National Forest. There is also one protection waterbody in the Hiwassee River Watershed that has been classified as Exceptional Tennessee Waters. One of the Unnamed Tributaries to Candies Creek (005_1200) has been identified as having exceptional biological diversity above Eureka Road.

Water Quality Targets:

Derived from *State of Tennessee Water Quality Standards, Chapter 0400-40-03, General Water Quality Criteria, 2019 Version* (TDEC, 2019) 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, Exceptional Tennessee Water or Outstanding Natural Resource Water (ONRW) (0400-40-03-.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.

Further information on Tennessee's general water quality criteria are available on TDEC's website.

40 CFR 131.10 (b) provides that "In designating uses of a water body and the appropriate criteria for those uses, the State shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters." For Tennessee waterbodies that flow into neighboring states, the most stringent criteria are used.

None of the impaired waterbodies in the Tennessee portion of the Hiwassee River Watershed flow from Tennessee into North Carolina. Therefore, Tennessee water quality criteria will be applied and only the Tennessee portion of the Hiwassee River Watershed will be covered in this TMDL.

TMDL Scope:

The waterbodies addressed by this TMDL are those in the Hiwassee River Watershed (HUC 06020002) identified, in the Tennessee Department of Environment and Conservation's (TDEC) Final 2022 List of Impaired and Threatened Waters, as impaired due to *E. coli*.

TMDLs were developed for impaired waterbodies on a HUC-12 subwatershed or waterbody drainage area basis. Other waterbodies that are located within the impaired HUC-12s or drainage areas, but are not currently listed as impaired, were evaluated for protection. TMDLs and allocations were developed for these unimpaired (fully supporting) and unassessed waterbodies in order to maintain good water quality and to maximize the likelihood of each protection waterbody meeting water quality standards in the future.

Under Tennessee's watershed management approach, each HUC-8 watershed is examined (or re-examined) on a rotating basis. TMDLs were developed for portions of the Hiwassee River Watershed in 2006. Since that time, (1) additional monitoring data have been collected; and (2) twenty-two additional waterbodies have been assessed as impaired due to *E. coli*. For these reasons, existing TMDLs have been revisited (and re-developed) and TMDLs developed for newly assessed impairments for the Hiwassee River Watershed (HUC 06020002). The *E. coli* TMDLs developed in this document supersede the *E. coli* TMDLs approved by the U.S. Environmental Protection Agency (EPA) on January 23, 2006 for selected waterbodies in the Hiwassee River Watershed.

Analysis/Methodology:

The TMDLs for the impaired waterbodies in the Hiwassee River Watershed were developed using a load duration curve methodology to ensure compliance with the *E. coli* 126 Colony Forming Units (CFU)/100 mL geometric mean and the 487 CFU/100 mL maximum water quality criteria for lakes, reservoirs, State Scenic Rivers, or Exceptional Tennessee Waters and 941 CFU/100 mL maximum water quality criterion for all other waterbodies. 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 region of the waterbody flow zone represented by these existing loads. Load duration curves were also used to determine percent load reduction goals (PLRG) to meet the target maximum loading for *E. coli*.

Critical Conditions:

Water quality data collected over a period of 5 to 10 years for load duration curve analysis were used to assess the water quality standards representing a range of hydrologic and meteorological conditions.

For each impaired waterbody, critical conditions were determined by evaluating the percent load reduction goals and the percent of samples exceeding TMDL target concentrations (percent exceedance), for each hydrologic flow zone, to meet the target (TMDL) loading for *E. coli*. The percent load reduction goal and/or the percent exceedance of the greatest magnitude corresponds with the critical flow zone(s).

When available, water quality data collected over a period of up to 15 years were evaluated for determination of relative change (trend analysis).

Seasonal Variation:

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

Margin of Safety (MOS):

Explicit MOS = 10% of the *E. coli* water quality criteria for each impaired subwatershed or drainage area.

Summary of TMDLs, WLAs, & LAs expressed as daily loads for the Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
0802	Cane Creek [d,e]	TN06020002081_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(2.595 \times 10^{6} \times Q) - (2.88 \times 10^{6} \times q_d)$	$(2.595 \times 10^{6} \times Q) - (2.88 \times 10^{6} \times q_d)$
0909	Dairy Branch [d,e]	TN06020002018_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(4.278 \times 10^{7} \times Q) - (4.75 \times 10^{7} \times q_d)$	$(4.278 \times 10^{7} \times Q) - (4.75 \times 10^{7} \times q_d)$
	Siccowee Branch [d,e]	TN06020002018_0300	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2\times10^{10} \times q_m)$	NA	$(1.841 \times 10^{7} \times Q) - (2.05 \times 10^{7} \times q_d)$	$(1.841 \times 10^{7} \times Q) - (2.05 \times 10^{7} \times q_d)$
1001	Middle Creek [e]	TN06020002082_0300	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(9.913 \times 10^{5} \times Q) - (1.10 \times 10^{6} \times q_d)$	$(9.913 \times 10^{5} \times Q) - (1.10 \times 10^{6} \times q_d)$
1002	Little Chestuee Creek [d,e]	TN06020002082_0900	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(3.668 \times 10^{6} \times Q) - (4.08 \times 10^{6} \times q_d)$	$(3.668 \times 10^{6} \times Q) - (4.08 \times 10^{6} \times q_d)$
	Chestuee Creek	TN06020002082_2000					$(8.371 \times 10^{5} \times Q) - (9.30 \times 10^{5} \times q_d)$	$(8.371 \times 10^{5} \times Q) - (9.30 \times 10^{5} \times q_d)$
1003	Tom Foeman Creek [d,e]	TN06020002082_1200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(4.302 \times 10^{6} \times Q) - (4.78 \times 10^{6} \times q_d)$	$(4.302 \times 10^{6} \times Q) - (4.78 \times 10^{6} \times q_d)$
	Big Foot Branch [d,e]	TN06020002082_1300					$(3.912 \times 10^{6} \times Q) - (4.35 \times 10^{6} \times q_d)$	$(3.912 \times 10^{6} \times Q) - (4.35 \times 10^{6} \times q_d)$
1101	Oostanaula Creek [e]	TN06020002083_4000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(1.858 \times 10^{6} \times Q) - (2.07 \times 10^{6} \times q_d)$	$(1.858 \times 10^{6} \times Q) - (2.07 \times 10^{6} \times q_d)$
		TN06020002083_5000					$(1.095 \times 10^{7} \times Q) - (1.22 \times 10^{7} \times q_d)$	$(1.095 \times 10^{7} \times Q) - (1.22 \times 10^{7} \times q_d)$
1102	Black Branch [d,e]	TN06020002083_0500	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(1.700 \times 10^{7} \times Q) - (1.89 \times 10^{7} \times q_d)$	$(1.700 \times 10^{7} \times Q) - (1.89 \times 10^{7} \times q_d)$
	Walker Branch [d,e]	TN06020002083_0510					$(3.354 \times 10^{7} \times Q) - (3.73 \times 10^{7} \times q_d)$	$(3.354 \times 10^{7} \times Q) - (3.73 \times 10^{7} \times q_d)$
	Oostanaula Creek	TN06020002083_1000					$(4.734 \times 10^{5} \times Q) - (5.26 \times 10^{5} \times q_d)$	$(4.734 \times 10^{5} \times Q) - (5.26 \times 10^{5} \times q_d)$
	Oostanaula Creek [d]	TN06020002083_2000					$(6.403 \times 10^{5} \times Q) - (7.11 \times 10^{5} \times q_d)$	$(6.403 \times 10^{5} \times Q) - (7.11 \times 10^{5} \times q_d)$
	Oostanaula Creek [d]	TN06020002083_3000					$(1.062 \times 10^{6} \times Q) - (1.18 \times 10^{6} \times q_d)$	$(1.062 \times 10^{6} \times Q) - (1.18 \times 10^{6} \times q_d)$
1201	Latham Springs Branch [d,e]	TN06020002084_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(6.453 \times 10^{6} \times Q) - (7.17 \times 10^{6} \times q_d)$	$(6.453 \times 10^{6} \times Q) - (7.17 \times 10^{6} \times q_d)$
	Little North Mouse Creek [d]	TN06020002084_0400					$(4.040 \times 10^{6} \times Q) - (4.49 \times 10^{6} \times q_d)$	$(4.040 \times 10^{6} \times Q) - (4.49 \times 10^{6} \times q_d)$
	North Mouse Creek [,e]	TN06020002084_2000					$(8.184 \times 10^{5} \times Q) - (9.09 \times 10^{5} \times q_d)$	$(8.184 \times 10^{5} \times Q) - (9.09 \times 10^{5} \times q_d)$
1202	Spring Creek [,d,e]	TN06020002085_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(1.965 \times 10^{6} \times Q) - (2.18 \times 10^{6} \times q_d)$	$(1.965 \times 10^{6} \times Q) - (2.18 \times 10^{6} \times q_d)$
1203	Dry Valley Creek [d,e]	TN06020002084_0500	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(2.642 \times 10^{6} \times Q) - (2.94 \times 10^{6} \times q_d)$	$(2.642 \times 10^{6} \times Q) - (2.94 \times 10^{6} \times q_d)$
	North Mouse Creek	TN06020002084_1000					$(4.388 \times 10^{5} \times Q) - (4.88 \times 10^{5} \times q_d)$	$(4.388 \times 10^{5} \times Q) - (4.88 \times 10^{5} \times q_d)$

Summary of TMDLs, WLAs, & LAs expressed as daily loads for the Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
1301	Candies Creek [e]	TN06020002005_3000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(2.043 \times 10^6 \times Q) - (2.27 \times 10^6 \times q_d)$	$(2.043 \times 10^6 \times Q) - (2.27 \times 10^6 \times q_d)$
1302	Black Fox Creek [d,e]	TN06020002005_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(3.278 \times 10^6 \times Q) - (3.64 \times 10^6 \times q_d)$	$(3.278 \times 10^6 \times Q) - (3.64 \times 10^6 \times q_d)$
1303	Candies Creek [e]	TN06020002005_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(3.120 \times 10^5 \times Q) - (3.47 \times 10^5 \times q_d)$	$(3.120 \times 10^5 \times Q) - (3.47 \times 10^5 \times q_d)$
	Beaverdam Creek [d,e]	TN06020002005_1100					$(1.468 \times 10^7 \times Q) - (1.63 \times 10^7 \times q_d)$	$(1.468 \times 10^7 \times Q) - (1.63 \times 10^7 \times q_d)$
1401	South Chestuee Creek [e]	TN06020002014_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(8.348 \times 10^5 \times Q) - (9.28 \times 10^5 \times q_d)$	$(8.348 \times 10^5 \times Q) - (9.28 \times 10^5 \times q_d)$
	South Chestuee Creek [d,e]	TN06020002014_2000					$(3.746 \times 10^6 \times Q) - (4.16 \times 10^6 \times q_d)$	$(3.746 \times 10^6 \times Q) - (4.16 \times 10^6 \times q_d)$
1402	Little Chatata Creek [d,e]	TN06020002012_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(3.212 \times 10^6 \times Q) - (3.57 \times 10^6 \times q_d)$	$(3.212 \times 10^6 \times Q) - (3.57 \times 10^6 \times q_d)$
	Rattlesnake Branch [d,e]	TN06020002012_0300					$(1.051 \times 10^7 \times Q) - (1.17 \times 10^7 \times q_d)$	$(1.051 \times 10^7 \times Q) - (1.17 \times 10^7 \times q_d)$
	Chatata Creek [e]	TN06020002012_1000					$(1.015 \times 10^6 \times Q) - (1.13 \times 10^6 \times q_d)$	$(1.015 \times 10^6 \times Q) - (1.13 \times 10^6 \times q_d)$
1403	Bacon Branch [d,e]	TN06020002008_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.660 \times 10^7 \times Q) - (1.85 \times 10^7 \times q_d)$	$(1.660 \times 10^7 \times Q) - (1.85 \times 10^7 \times q_d)$
1404	Fillauer Branch [d,e]	TN06020002009_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(7.930 \times 10^6 \times Q) - (8.81 \times 10^6 \times q_d)$	$(7.930 \times 10^6 \times Q) - (8.81 \times 10^6 \times q_d)$
	Woolen Mill Branch [d,e]	TN06020002009_0300					$(1.347 \times 10^7 \times Q) - (1.50 \times 10^7 \times q_d)$	$(1.347 \times 10^7 \times Q) - (1.50 \times 10^7 \times q_d)$
	South Mouse Creek [e]	TN06020002009_1000					$(8.873 \times 10^5 \times Q) - (9.86 \times 10^5 \times q_d)$	$(8.873 \times 10^5 \times Q) - (9.86 \times 10^5 \times q_d)$
	South Mouse Creek [d,e]	TN06020002009_2000					$(2.936 \times 10^6 \times Q) - (3.26 \times 10^6 \times q_d)$	$(2.936 \times 10^6 \times Q) - (3.26 \times 10^6 \times q_d)$
1405	Brush Creek [d,e]	TN06020002087_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(6.005 \times 10^6 \times Q) - (6.67 \times 10^6 \times q_d)$	$(6.005 \times 10^6 \times Q) - (6.67 \times 10^6 \times q_d)$
	UT to Rogers Creek [d,e]	TN06020002087_0600				$(2.3 \times 10^{10} \times q_2)$	$(1.011 \times 10^8 \times Q) - (1.12 \times 10^8 \times q_d)$	$(1.011 \times 10^8 \times Q) - (1.12 \times 10^8 \times q_d)$
	Rogers Creek	TN06020002087_1000				NA	$(6.473 \times 10^5 \times Q) - (7.19 \times 10^5 \times q_d)$	$(6.473 \times 10^5 \times Q) - (7.19 \times 10^5 \times q_d)$
1406	Hiwassee River Embayment [d]	TN06020002008_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.330 \times 10^4 \times Q) - (1.48 \times 10^4 \times q_d)$	$(1.330 \times 10^4 \times Q) - (1.48 \times 10^4 \times q_d)$

Summary of TMDLs, WLAs, & LAs expressed as daily loads for the Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
1407	Agency Creek [d,e]	TN06020002001_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(1.997 \times 10^6 \times Q) - (2.22 \times 10^6 \times q_d)$	$(1.997 \times 10^6 \times Q) - (2.22 \times 10^6 \times q_d)$
	Price Creek [d,e]	TN06020002088_1000					$(5.777 \times 10^6 \times Q) - (6.42 \times 10^6 \times q_d)$	$(5.777 \times 10^6 \times Q) - (6.42 \times 10^6 \times q_d)$
1408	Gunstocker Creek [d,e]	TN06020002001_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(1.953 \times 10^6 \times Q) - (2.17 \times 10^6 \times q_d)$	$(1.953 \times 10^6 \times Q) - (2.17 \times 10^6 \times q_d)$

Notes: Q = Mean Daily In-stream Flow (cfs).

q_m = Mean Daily WWTP Flow (cfs)

q_d = Facility (WWTP) Design Flow (cfs)

q_2 = Estimated stormwater flow from permitted industrial point source (cfs)

a. WLAs for WWTPs are expressed as *E. coli* loads (CFU/day). All current and future WWTPs must meet water quality standards as specified in their NPDES permit.

b. Applies to any Municipal Separate Storm Sewer System (MS4) discharge loading in the subwatershed. Future MS4s will be assigned waste load allocations (WLAs) consistent with load allocations (LAs) assigned to precipitation induced nonpoint sources (NPS). See Section 9.2.2 for implementation details.

c. WLAs and LAs expressed as a "per acre" load are calculated based on the drainage area at the pour point of the HUC-12 subwatershed or drainage area (see Table A-1). As regulated MS4 area increases (due to future growth and/or new MS4 designation), unregulated LA area decreases by an equivalent amount. The sum will continue to equal total subwatershed area.

d. Waterbody Drainage Area (DA) is not coincident with HUC-12(s).

e. No WWTPs currently discharging into or upstream of the waterbody. (WLA[WWTPs] Expression is future growth term for new WWTPs.)

f. When there are no MS4s currently located in a subwatershed drainage area, the expression is a future growth term for expanding or newly designated MS4s.

PROPOSED *E. COLI* TOTAL MAXIMUM DAILY LOAD (TMDL)
Hiwassee River Watershed (HUC 06020002)

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 Hiwassee River Watershed, identified in TDEC's Final 2022 List of Impaired and Threatened Waters as not supporting designated uses due to *E. coli*. The presence of *E. coli* bacteria in a waterbody indicates the likelihood that the waterbody contains pathogens, or disease-causing agents, associated with contamination from human or animal wastes. TMDL analyses were performed primarily on a 12-digit hydrologic unit code area (HUC-12) basis. In some cases, where appropriate, TMDLs were developed for an impaired waterbody drainage area. Other waterbodies that are located within the impaired HUC-12s or drainage areas, but are not currently listed as impaired, were evaluated for protection. TMDLs and allocations were developed for these unimpaired (fully supporting) and unassessed waterbodies in order to maintain good water quality and to maximize the likelihood of each protection waterbody meeting water quality standards in the future.

Portions of the Hiwassee River Watershed are located in North Carolina and Georgia. The Hiwassee River flows in a northwesterly direction from the north slope of Rocky Mountain, Georgia, through North Carolina into Tennessee. None of the impaired waterbodies in the Tennessee portion of the Hiwassee River Watershed flow into North Carolina. Therefore, the Tennessee water quality criteria will be used to assess impaired waterbodies and this TMDL will only address the portion of the Hiwassee River Watershed located in Tennessee.

Under Tennessee's watershed management approach, each HUC-8 watershed is examined on a rotating basis. TMDLs were developed for portions of the Hiwassee River Watershed in 2006. Since that time, (1) additional monitoring data have been collected; and (2) twenty-two additional waterbodies have been assessed as impaired due to *E. coli*. For these reasons, existing TMDLs have been revisited (and re-developed) and TMDLs developed for newly assessed impairments for the Hiwassee River Watershed (HUC 06020002). The *E. coli* TMDLs developed in this document supersede the *E. coli* TMDLs approved by the U.S. Environmental Protection Agency (EPA) on January 23, 2006 for selected waterbodies in the Hiwassee River Watershed.

3.0 WATERSHED DESCRIPTION

A watershed is an area of land that drains all of the streams and rainfall to a common outlet or pour point. Watersheds vary in size and shape. A standardized system for organizing and collecting hydrologic data was developed in the mid-1970s by the United States Geological Survey (USGS). The system divided and subdivided the United States into successively smaller hydrologic units based on surface features (Seaber, et al, 1987). The hierarchical Hydrologic Unit Code (HUC) consists of two-digit numbers for each of the nested hydrologic unit levels. The hydrologic unit code hierarchy for the Hiwassee River Watershed is as follows:

Region	06	Tennessee	
Subregion	0602	Middle TN-Hiwassee	5,160 mi^2
Accounting Unit	060200	Middle TN-Hiwassee	5,160 mi^2
Cataloging Unit	06020002	Hiwassee 2,060 mi^2 (Tennessee portion is 1,017 mi^2)	

The Hiwassee River HUC-8 watershed (HUC 06020002) is located in Bradley, Hamilton, McMinn, Meigs, Monroe, and Polk Counties, in southeastern Tennessee (Figure 1). The Hiwassee River HUC-8 has a drainage area of approximately 2,060 square miles (mi^2), approximately 49% of which are in Tennessee. The Tennessee portion of the Hiwassee River HUC-8 has approximately 1,666 miles of streams (based on the National Hydrography Dataset [NHD] Medium Resolution [1:100,000]) and no reservoir acres. There are no dams located along the Tennessee portion of the Hiwassee River. The section of the river from the NC state line to Delano, TN is designated as a State Scenic River and is a popular paddling destination featuring flat water and whitewater class I, II, and III rapids.

Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from 2016. Although changes in the land use of the Hiwassee River Watershed have occurred since 2016 as a result of development, this is the most current land use data available. Land use for the Hiwassee River Watershed is summarized in Table 1 and shown in Figure 2. Predominant land use in the Tennessee portion of the Hiwassee River Watershed is forest or other types of natural land covers (61.1%) followed by agriculture (26.7%) and urban (12.2%). Details of land use distribution of impaired subwatersheds in the Hiwassee River Watershed are presented in Appendix A. The land use distribution in Table 1 includes all watersheds, both impaired and unimpaired.

The Hiwassee River Watershed lies within two Level III ecoregions (Blue Ridge Mountains, Ridge and Valley) and contains nine Level IV subecoregions as shown in Figure 3 (USEPA, 1997):

- **Southern Igneous Ridges and Mountains (66d)** occur in Tennessee's northeastern Blue Ridge near the North Carolina border, primarily on Precambrian-age igneous and high-grade metamorphic rocks. The typical crystalline rock types include granite, gneiss, schist, and metavolcanics, covered by well-drained, acidic brown loamy soils. Elevations of this rough, dissected region range from 2000-6400 feet, with Roan Mountain reaching 6286 feet. Although there are a few small areas of pasture and apple orchards, the region is mostly forested; Appalachian oak and northern hardwood forests predominate.
- **The Southern Sedimentary Ridges (66e)** in Tennessee include some of the westernmost foothill areas of the Blue Ridge Mountains ecoregion, such as the Bean, Starr, Chilhowee, English, Stone, Bald, and Iron Mountain areas. Slopes are steep, and

elevations are generally 1000-4500 feet. The rocks are primarily Cambrian-age sedimentary (shale, sandstone, siltstone, quartzite, conglomerate), although some lower stream reaches occur on limestone. Soils are predominantly friable loams and fine sandy loams with variable amounts of sandstone rock fragments, and support mostly mixed oak and oak-pine forests.

- **The Southern Metasedimentary Mountains (66g)** are steep, dissected, biologically-diverse mountains that include Clingmans Dome (6643 feet), the highest point in Tennessee. The Precambrian-age metamorphic and sedimentary geologic materials are generally older and more metamorphosed than the Southern Sedimentary Ridges (66e) to the west and north. The Appalachian oak forests and, at higher elevations, the northern hardwoods forests include a variety of oaks and pines, as well as silverbell, hemlock, yellow poplar, basswood, buckeye, yellow birch, and beech. Spruce-fir forests, found generally above 5500 feet, have been affected greatly over the past twenty-five years by the balsam woolly aphid. The Copper Basin, in the southeast corner of Tennessee, was the site of copper mining and smelting from the 1850's to 1987, and once left more than fifty square miles of eroded earth.

- **The High Mountains (66i)** include three separate high-elevation areas in Tennessee above 4500 feet along the North Carolina line including portions of the Cherokee National Forest in Monroe County, Great Smoky Mountains National Park in Blount, Sevier, and Cocke counties, and Roan Mountain in Carter County. The region has a more severe, boreal-like climate than surrounding regions, with wind and ice affecting vegetation. It has frigid soils rather than mesic soils.

- **The Broad Plains (66j)** is the Copper Basin area of Polk County and was originally included in subregion 66g, the Southern Metasedimentary Mountains. Subsequent ecoregion delineation work conducted in North Carolina and Georgia indicated there were several disjunct large basin areas of the Blue Ridge. The Broad Basins ecoregion is drier, has lower elevations and less relief than the other, more mountainous Blue Ridge subregions as well as different soil and vegetation types. Copper mining and related operations occurred in this region from the 1850's until 1987.

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

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

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

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

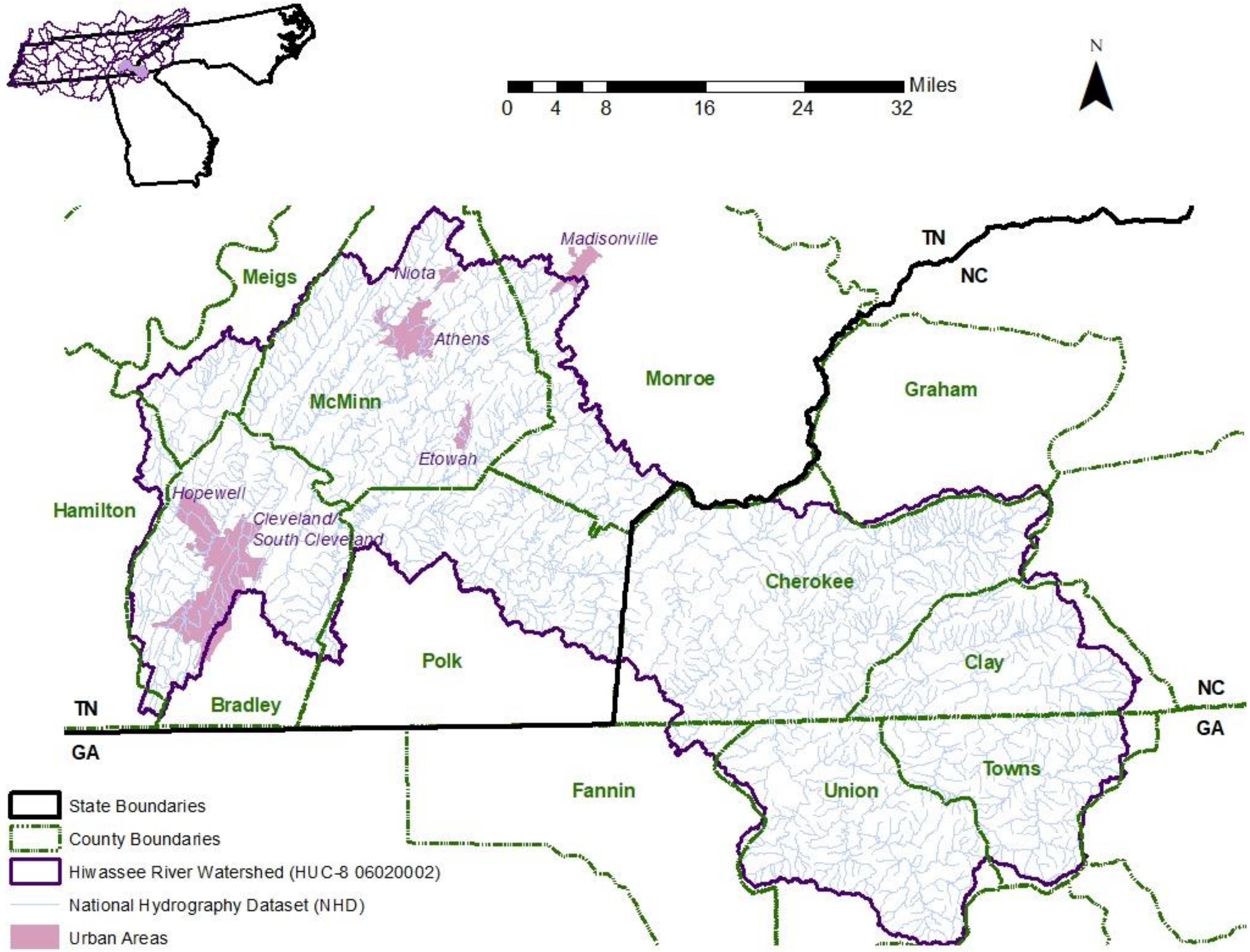

Figure 1. Location of the Hiwassee River Watershed

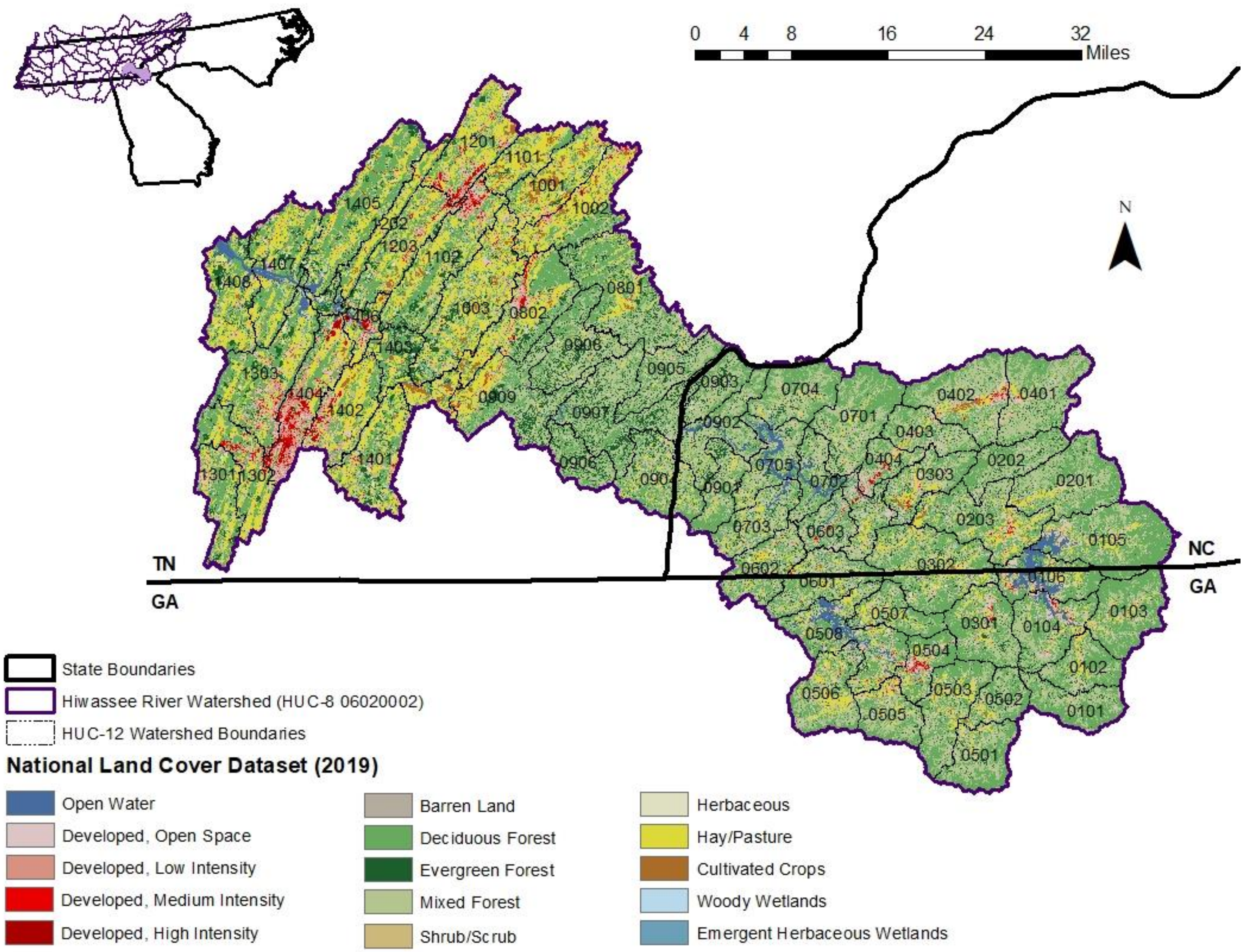

Figure 2. Land Use Characteristics of the Hiwassee River Watershed

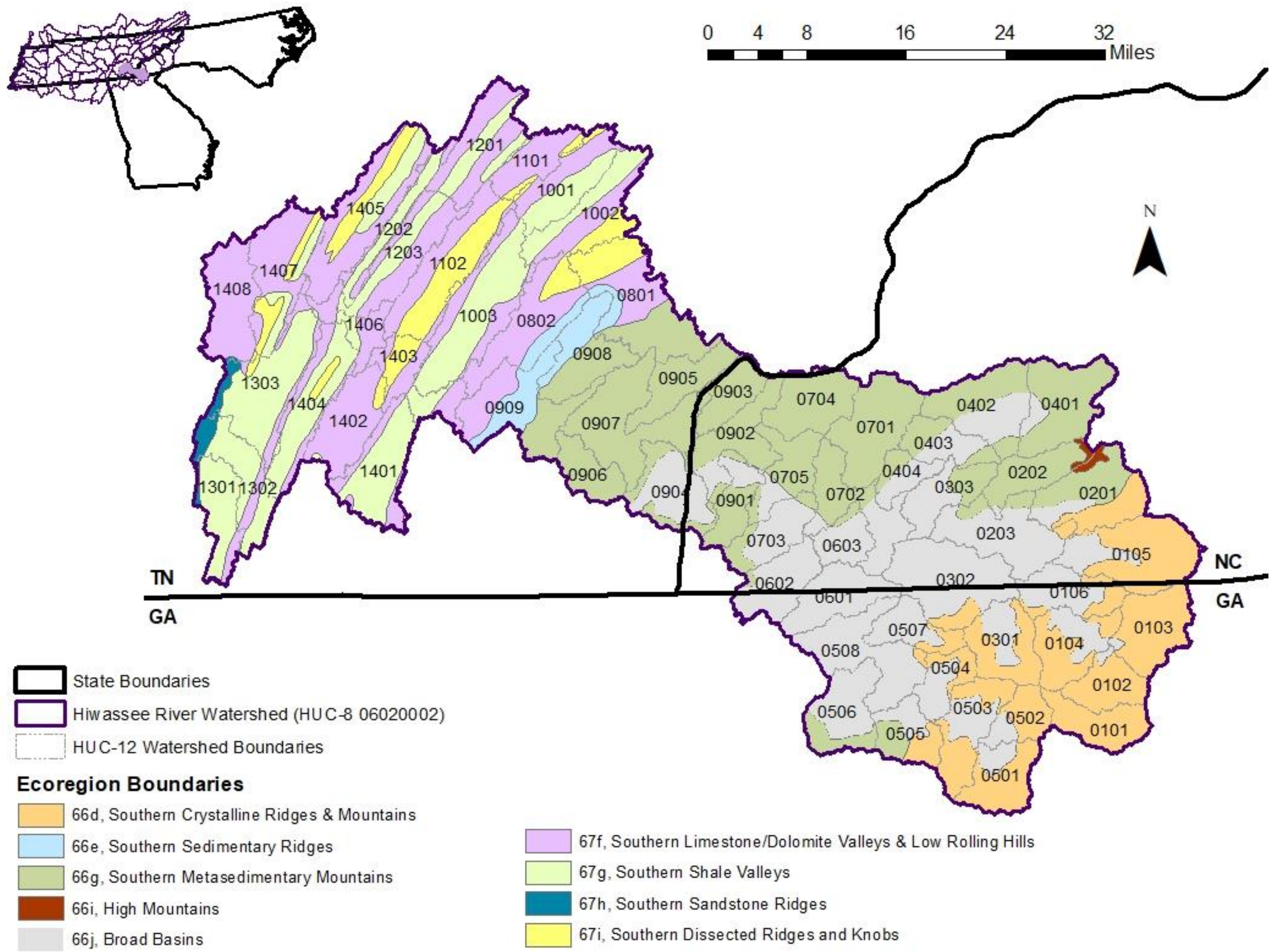

Figure 3. Level IV Ecoregions in the Hiwassee River Watershed

Table 1. MRLC Land Use Distribution – Hiwassee River Watershed

Land use		Entire Watershed		Tennessee Portion Only	
Code	Description	[acres]	[%]	[acres]	[%]
11	Open Water	24,150	1.83%	7,485	1.15%
21	Developed Open Spaces	97,128	7.36%	42,372	6.51%
22	Low Intensity Residential	29,033	2.20%	23,302	3.58%
23	Medium Intensity Residential	12,141	0.92%	9,633	1.48%
24	High Intensity Residential	4,883	0.37%	4,166	0.64%
31	Bare Rock/Sand/Clay	1,584	0.12%	456	0.07%
41	Deciduous Forest	484,323	36.7%	196,696	30.2%
42	Evergreen Forest	95,941	7.27%	61,703	9.48%
43	Mixed Forest	307,485	23.3%	101,082	15.5%
52	Shrub/Scrub	17,156	1.30%	11,976	1.84%
71	Grassland/Herbaceous	22,171	1.68%	15,231	2.34%
81	Pasture/Hay	205,606	15.6%	161,158	24.8%
82	Cultivated Crops	14,253	1.08%	12,302	1.89%
90	Woody Wetlands	2,771	0.21%	2,473	0.38%
95	Emergent Herbaceous Wetlands	1,056	0.08%	846	0.13%
	Total	1,319,680	100%	650,880	100%

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

4.0 PROBLEM DEFINITION

TDEC's Final 2022 List of Impaired and Threatened Waters (TDEC, 2022a), was approved by EPA, Region 4 on April 25, 2022. This list identified a number of waterbodies in the Hiwassee River Watershed as not fully supporting designated use classifications due, in part, to *E. coli* (see Table 3 & Figures 4 through 6). The designated use classifications for these waterbodies include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Additional designated use classifications for specific impaired waterbodies are listed in Table 2.

Table 2. Waterbody-Specific Designated Use Classifications

Waterbody ID	Waterbody Name	Portion	Designated Use
TN06020002082_0300	Middle Creek	RM 1.9 to origin	Domestic Water Supply
TN06020002083_1000 & TN06020002083_2000	Oostanaula Creek	RM 0.0 to 26.0	Domestic Water Supply Industrial Water Supply
TN06020002083_2000 & TN06020002083_3000	Oostanaula Creek	RM 26.0 to 33.8	Industrial Water Supply
TN06020002083_3000 & TN06020002083_4000	Oostanaula Creek	RM 33.8 to 37.5	Domestic Water Supply Industrial Water Supply
TN06020002084_1000	North Mouse Creek	RM 0 to 10.0	Domestic Water Supply Industrial Water Supply
TN06020002084_1000 & TN06020002084_2000	North Mouse Creek	RM 10.0 to 30.1	Industrial Water Supply
TN06020002085_1000	Spring Creek	RM 0.0 to 18.7	Industrial Water Supply

5.0 WATER QUALITY CRITERIA & TMDL TARGET

As previously stated, the designated use classifications for the Hiwassee River waterbodies include fish & aquatic life, recreation, irrigation, and livestock watering & wildlife. Of the use classifications with numeric criteria for *E. coli*, 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 0400-40-03, General Water Quality Criteria* (TDEC, 2019). Coliform is a certain type of bacteria and *E.coli* is a sub-group of fecal coliform bacteria. Not all *E. coli* bacteria are pathogenic (i.e. meaning causing disease). *E. coli* is considered a good indicator of fecal contamination from warm-blooded animals because *E. coli* generally don't grow and reproduce in the environment (unlike fecal coliforms) and have a better correlation with gastrointestinal illness in humans than do fecal coliforms.

There is only one impaired waterbody in the Hiwassee River Watershed that has been classified as Exceptional Tennessee Waters. A portion of Siccowee Branch is located in the Cherokee National Forest. There is also one protection waterbody in the Hiwassee River Watershed that has been classified as Exceptional Tennessee Waters. One of the Unnamed Tributaries to Candies Creek (005_1200) has been identified as having exceptional biological diversity above Eureka Road.

As of September 1, 2022, none of the other impaired or protection waterbodies in the Hiwassee River Watershed are classified as a lake, reservoir, State Scenic River, Exceptional Tennessee Water or Outstanding Natural Resource Water (ONRW) (0400-40-03-.06).

Further information concerning Tennessee's general water quality criteria and Tennessee's Antidegradation Statement, including the definition of Exceptional Tennessee Water, are available on TDEC's website.

The geometric mean standard for the *E. coli* group of 126 colony forming units per 100 ml (CFU/100 ml) and the sample maximum of 487 CFU/100 ml have been selected as the appropriate numerical targets for TMDL development for Exceptional Tennessee Waters (Table 3). The geometric mean standard for the *E. coli* group of 126 colony forming units per 100 ml (CFU/100 ml) and the sample maximum of 941 CFU/100 ml have been selected as the appropriate numerical targets for TMDL development for the other impaired and protection waterbodies.

40 CFR 131.10 (b) provides that "In designating uses of a water body and the appropriate criteria for those uses, the State shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters."

The Hiwassee River flows in a northwesterly direction from Georgia and North Carolina into Tennessee and none of the impaired waterbodies in the Tennessee portion of the Hiwassee River Watershed flow into North Carolina. Therefore, the Tennessee water quality criteria will be used to assess impaired waterbodies and this TMDL will only address the portion of the Hiwassee River Watershed located in Tennessee.

Table 3. Extract from TDEC's Final 2022 List of Impaired and Threatened Waterbodies – Hiwassee River Watershed

Waterbody ID	Impacted Waterbody	Miles Impaired	Cause (Pollutant)	Pollutant Source
TN06020002001_0100 [a]	Agency Creek	18.46	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002001_0200	Gunstocker Creek	25	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002005_0100	Black Fox Creek	19.55	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002005_1000	Candies Creek (from Hiwassee River to Greasy Creek)	9.65	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002005_1100	Beaverdam Branch	3.07	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002005_3000	Candies Creek (from Brymer Creek to hw)	9.51	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002008_0100	Bacon Branch	3.36	Escherichia coli	Animal Feeding Operations (NPS)
TN06020002008_1000 [a]	Hiwassee River Embayment of Chickamauga Reservoir (from Rogers Creek to South Mouse Creek)	1050 ac	Escherichia coli	Source Unknown
TN06020002009_0200 [a]	Fillauer Creek	7.4	Escherichia coli	Sanitary Sewer Overflows (Collection System Failures) Municipal (Urbanized High Density Area)
TN06020002009_0300 [a]	Woolen Mill Branch	3.92	Escherichia coli	Sanitary Sewer Overflows (Collection System Failures) Municipal (Urbanized High Density Area)
TN06020002009_1000	South Mouse Creek (from Hiwassee River Embayment to Fillauer Branch)	12.1	Escherichia coli	Sanitary Sewer Overflows (Collection System Failures) Grazing in Riparian or Shoreline Zones
TN06020002009_2000 [a]	South Mouse Creek (from Fillauer Branch to hw)	6.5	Escherichia coli	Sanitary Sewer Overflows (Collection System Failures) Grazing in Riparian or Shoreline Zones
TN06020002012_0200 [a]	Little Chatata Creek	14.3	Escherichia coli	Sanitary Sewer Overflows (Collection System Failures) Animal Feeding Operations (NPS) Municipal (Urbanized High Density Area)

Table 3 (cont'd). Extract from TDEC's Final 2022 List of Impaired and Threatened Waterbodies – Hiwassee River Watershed

Waterbody ID	Impacted Waterbody	Miles Impaired	Cause (Pollutant)	Pollutant Source
TN06020002012_0300	Rattlesnake Branch	2.98	Escherichia coli	Animal Feeding Operations (NPS) Grazing in Riparian or Shoreline Zones
TN06020002012_1000 [a]	Chatata Creek	19.62	Escherichia coli	Animal Feeding Operations (NPS) Grazing in Riparian or Shoreline Zones Municipal (Urbanized High Density Area)
TN06020002014_1000	South Chestuee Creek (from Hiwassee River to Benton Pike)	8.77	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002014_2000	South Chestuee Creek (from Benton Pike to hw)	9.81	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002018_0200 [a]	Dairy Branch	1.78	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002018_0300	Siccowee Branch	3.23	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002081_0100	Cane Creek (from Hiwassee River to UT near north city limit of Etowah)	13.7	Escherichia coli	Grazing in Riparian or Shoreline Zones Municipal (Urbanized High Density Area)
TN06020002082_0300	Middle Creek	15.5	Escherichia coli	Sanitary Sewer Overflows (Collection System Failures) Grazing in Riparian or Shoreline Zones
TN06020002082_0900 [a]	Little Chestuee Creek	13.3	Escherichia coli	Grazing in Riparian or Shoreline Zones Confined Animal Feeding Operations – CAFOS (Point Sources)
TN06020002082_1200	Tom Foeman Creek	13.1	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002082_1300	Big Foot Branch	16.0	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002082_2000 [a]	Chestuee Creek (from Middle Creek to hw)	17.9	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002083_0500	Black Branch	1.98	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002083_0510	Walker Branch	1.8	Escherichia coli	Grazing in Riparian or Shoreline Zones Municipal (Urbanized High Density Area)

Table 3 (cont'd). Extract from TDEC's Final 2022 List of Impaired and Threatened Waterbodies – Hiwassee River Watershed

Waterbody ID	Impacted Waterbody	Miles Impaired	Cause (Pollutant)	Pollutant Source
TN06020002083_1000 [a]	Oostanaula Creek (from mouth to Sanford Rd.)	5.7	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002083_2000 [a]	Oostanaula Creek (from Sanford Rd. to Cedar Springs)	21.1	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002083_3000 [a]	Oostanaula Creek (from Cedar Springs Br to Inglewood Spring)	7.4	Escherichia coli	Sanitary Sewer Overflows (Collection System Failures) Municipal (Urbanized High Density Area)
TN06020002083_4000 [a]	Oostanaula Creek (from Inglewood Spring to CR 307)	8.5	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002083_5000 [a]	Oostanaula Creek (from CR 307 to hw)	6.2	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002084_0200	Latham Spring Branch	9.0	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002084_0400	Little North Mouse Creek	8.5	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002084_0500	Dry Valley Creek	13.3	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002084_1000 [a]	North Mouse Creek (from Dry Valley Creek to Athens NMouse Ck STP outfall)	15.56	Escherichia coli	Grazing in Riparian or Shoreline Zones Municipal (Urbanized High Density Area)
TN06020002084_2000 [a]	North Mouse Creek (from NMouse Ck STP outfall to hw)	15.61	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002085_1000 [a]	Spring Creek	31.58	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002087_0200	Brush Creek	11.8	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002087_0600	Unnamed Trib to Rogers Creek	1.1	Escherichia coli	Source Unknown
TN06020002087_1000 [a]	Rogers Creek	21.6	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN06020002088_1000 [a]	Price Creek	6.9	Escherichia coli	Grazing in Riparian or Shoreline Zones

[a] Waterbodies covered by TMDLs approved by EPA in 2006. The TMDLs included in this document supersede the TMDLs approved by EPA in 2006.

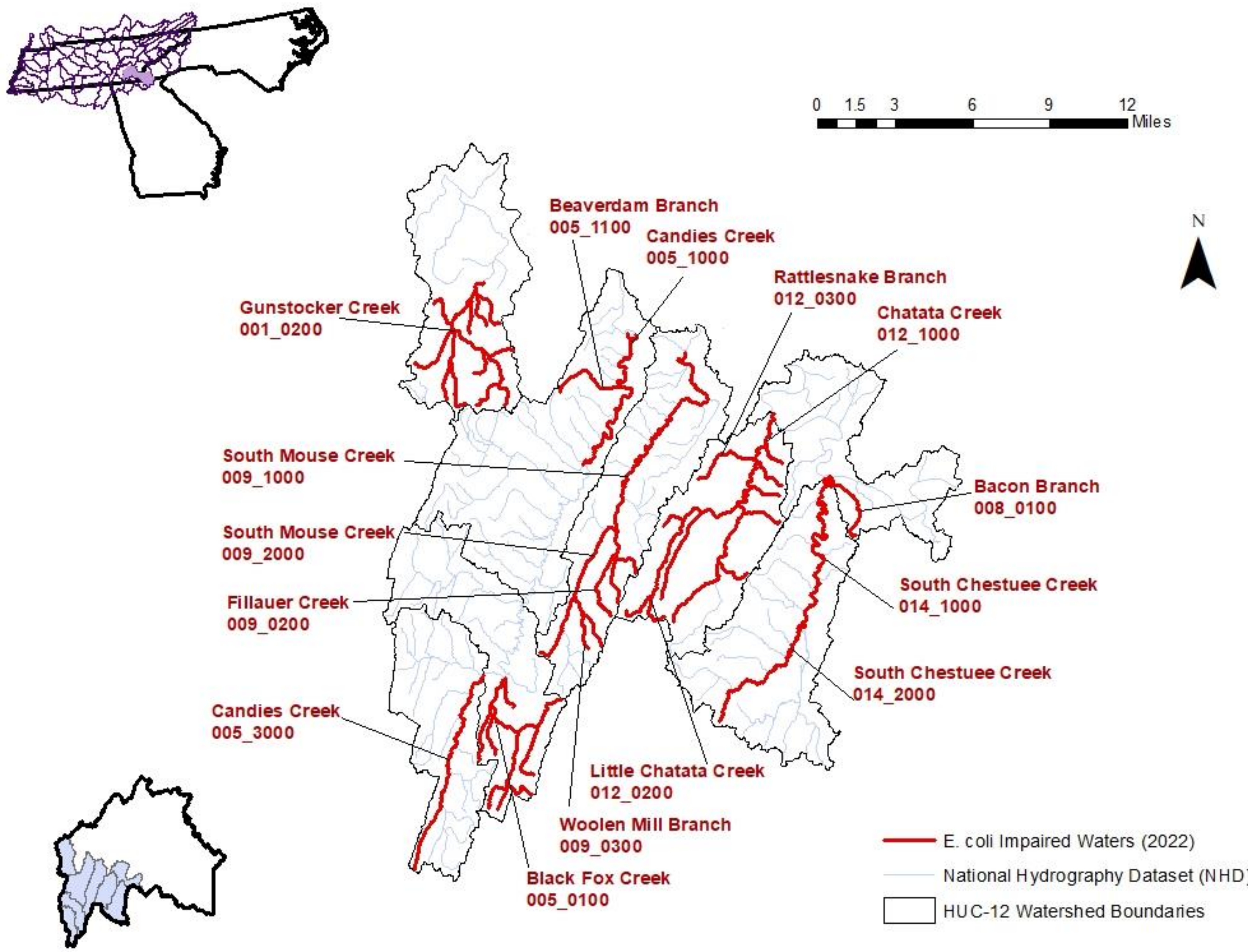

Figure 4. Waterbodies Impaired by *E. coli* (as Documented on TDEC's Final 2022 List of Impaired and Threatened Waterbodies) – Part 1

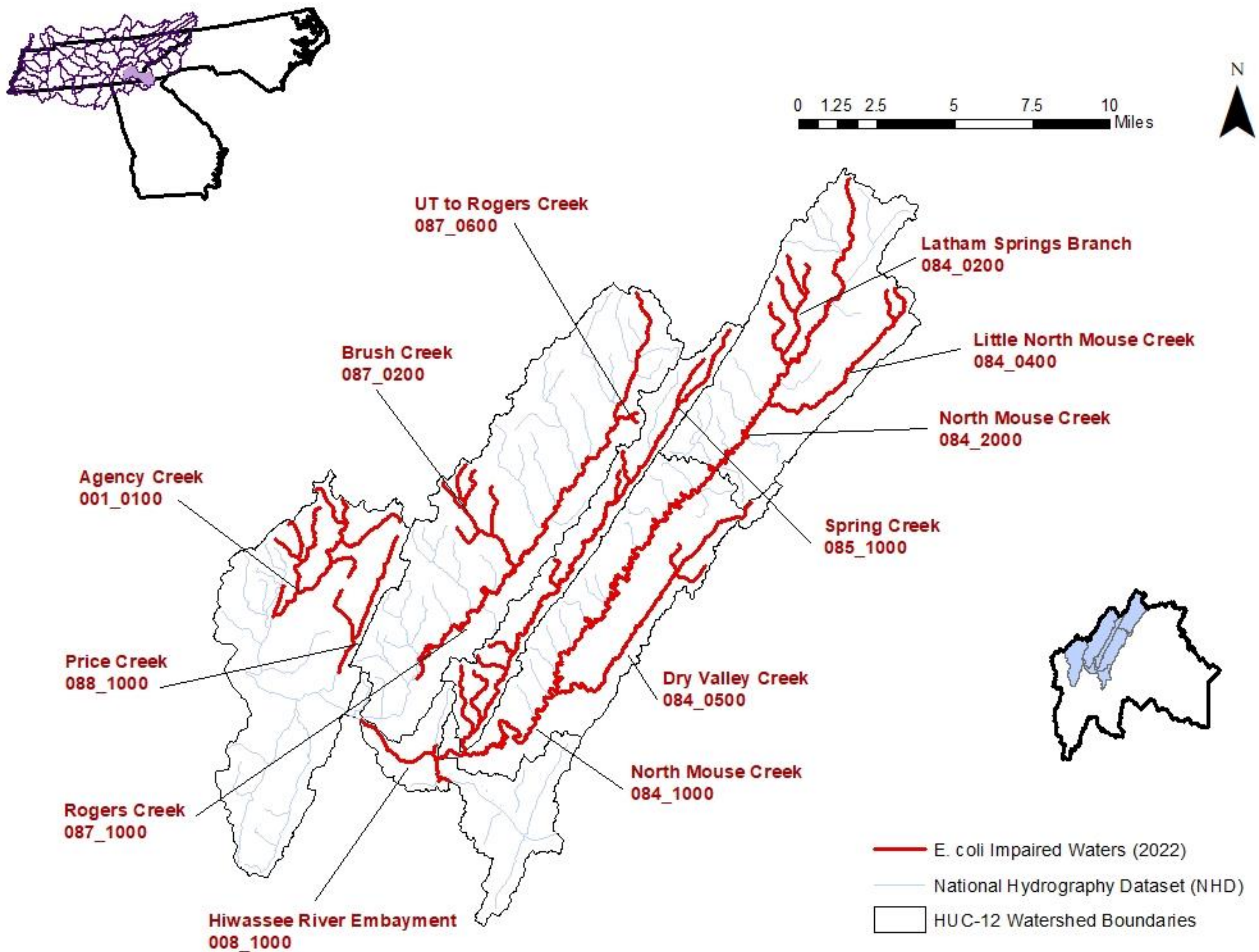

Figure 5. Waterbodies Impaired by *E. coli* (as Documented on TDEC's Final 2022 List of Impaired and Threatened Waterbodies) – Part 2

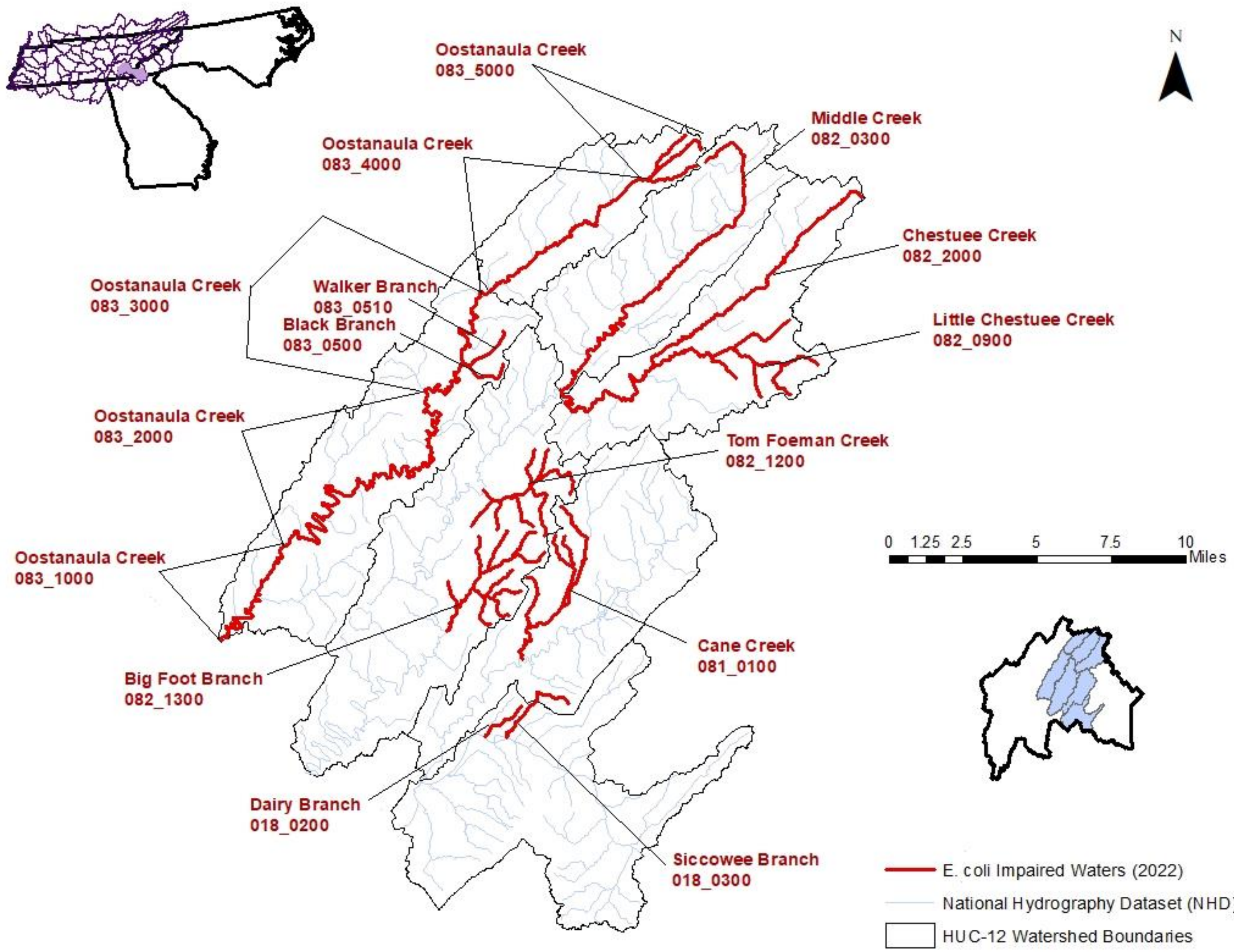

Figure 6. Waterbodies Impaired by *E. coli* (as Documented on TDEC's Final 2022 List of Impaired and Threatened Waterbodies) – Part 3

6.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

The following water quality monitoring stations provided data for waterbodies identified as impaired for *E. coli* in the Hiwassee River Watershed:

- HUC-12 06020002-0802:
    - CANE001.5MM – Cane Creek, at Carlock Road
- HUC-12 06020002-0909:
    - DAIRY001.2PO – Dairy Branch, at Old Patty Road (Delano Road) of Hwy 411 at Delano
    - SICCO000.3PO – Siccowee Branch, on Forest Service tree farm along entry road
    - SICCO000.7PO – Siccowee Branch, at Old Patty Road (Delano Road), off Hwy 411 at Delano
- HUC-12 06020002-1001:
    - MIDDL004.6MM – Middle Creek, off Niota Road
- HUC-12 06020002-1002:
    - CHEST041.4MM – Chestuee Creek, at County Road 500 bridge crossing
    - CHEST042.5MM – Chestuee Creek, 0.1 mi u/s Englewood STP outfall
    - LCHES001.6MM – Little Chestuee Creek, at Hwy 460
- HUC-12 06020002-1003:
    - BFOOT000.5MM – Big Foot Branch, at Big Foot Road and Little Foot Road
    - TFOEM001.8MM – Tom Foeman Creek, off of State Road 30
- HUC-12 06020002-1101:
    - OOSTA037.1MM – Oostanaula Creek, at Mayfield Farms
    - OOSTA041.0MM – Oostanaula Creek, at County Road 364 bridge crossing
- HUC-12 06020002-1102:
    - BLACK000.3MM – Black Branch, d/s of Union Hill Road crossing
    - BLACK000.5MM – Black Branch, at Highway 30 crossing
    - OOSTA005.8MM – Oostanaula Creek, at Sanford Road bridge (Matlock Road)
    - OOSTA011.6MM – Oostanaula Creek, at Cedar Springs Road
    - OOSTA018.0MM – Oostanaula Creek, at Clayhill Road bridge crossing
    - OOSTA028.4MM – Oostanaula Creek, at Long Mill Road bridge
    - OOSTA031.8MM – Oostanaula Creek, off Sunset Dr. in Athens Veteran Park
    - WALKE000.6MM – Walker Branch, adjacent to Heritage Park in Athens

- HUC-12 06020002-1201:
  - LNMOU000.1MM – Little North Mouse Creek, County Hwy 253 crossing near intersection with County Road 249
  - LNMOU002.4MM – Little North Mouse Creek, at Hwy 260 Br on Old Kingston Road
  - LSPRI000.4MM – Latham Spring Branch, u/s Shoemaker Road
  - NMOUS025.4MM – North Mouse Creek, near Athens City Park soccer fields
- HUC-12 06020002-1202:
  - SPRIN003.8MM – Spring Creek, d/s Sanford Road/Hillsview Road (Co Road 50)
- HUC-12 06020002-1203:
  - DVALL000.2MM – Dry Valley Creek, at County Route 50
  - NMOUS004.2MM – North Mouse Creek, at County Highway 28 bridge
  - NMOUS007.3MM – North Mouse Creek, at County Hwy 29
  - NMOUS024.3MM – North Mouse Creek, Rocky Mount Union Chapel Road bridge, d/s of the Athens STP outfall
- HUC-12 06020002-1301:
  - CANDI033.1BR – Candies Creek, 0.2 mi u/s Kelly Lane
- HUC-12 06020002-1302:
  - BFOX000.5BR – Black Fox Creek, at Chattanooga Pike Road
- HUC-12 06020002-1303:
  - BEAVE000.1BR – Beaverdam Branch, near Jessie Lane
  - BEAVE000.5BR – Beaverdam Branch, at Eureka Road NW bridge crossing
  - CANDI008.1BR – Candies Creek, at Mcpherson Road crossing
- HUC-12 06020002-1401:
  - SCHES001.8BR – South Chestuee Creek, off of Upper River Road
  - SCHES013.9BR – South Chestuee Creek, off of Old Parksville Road
- HUC-12 06020002-1402:
  - CHATA002.0BR – Chatata Creek, Chatata Valley Road NE Bridge north of Council Road NE
  - LCHAT000.3BR – Little Chatata Creek, at Tasso Road
  - RATTL001.3BR – Rattlesnake Branch, d/s Dry Valley Road crossing near Henry Cemetery
- HUC-12 06020002-1403:
  - BACON001.8PO – Bacon Branch, at stream crossing on Upper River Road Farm Road

- HUC-12 06020002-1404:
  - FILLA000.1BR – Fillauer Branch, at South Mouse Road (Mouse Creek Road)
  - FILLA000.3BR – Fillauer Branch, at entrance to Tinsley Park
  - SMOUS003.5BR – South Mouse Creek, at Highway 308
  - SMOUS012.7BR – South Mouse Creek, at Raider Drive
  - WMILL000.8BR – Woolen Mill Branch, at 2nd and Worth Streets in Cleveland, d/s Maytag
- HUC-12 06020002-1405:
  - BRUSH000.5MM – Brush Creek, County Road 59 near intersection with Brush Creek Road
  - ROGER005.1MM – Rogers Creek, d/s Sanford Hwy 50
  - ROGER18.3T0.3MM – UT to Rogers Creek, d/s County Road 164
- HUC-12 06020002-1406:
  - HIWAS013.4MM – Hiwassee River Embayment, below Olin & Bowaters Southeast of B&B Marina North of Lower River Road (Hwy 308)
- HUC-12 06020002-1407:
  - AGENC002.1ME – Agency Creek, at Big Springs Road/Calhoun Road; station influenced by Hiwassee Reservoir
  - AGENC002.3ME – Agency Creek, 0.2 mi u/s Big Spring Road, above bedrock shelf and u/s embayment influence
  - PRICE004.4MM – Price Creek, at Shiloh Road
- HUC-12 06020002-1408:
  - GUNST003.0ME – Gunstocker Creek, off Clayton Road (Posey Road/Gunstocker Road)

The locations of these monitoring stations are shown in Figures 7 through 9. The water quality monitoring results for these stations are tabulated in Appendix B. Examination of the data shows exceedances of the maximum *E. coli* standard at monitoring stations on all of the impaired waterbodies. Water quality monitoring results for those stations are summarized in Table 4.

When a minimum of 5 samples was collected at a given monitoring station over a period of not more than 30 consecutive days, the geometric mean (geomean) was calculated.

Thirty of the 53 water quality monitoring stations (Table 4 and Appendix B) have at least one *E. coli* sample value reported as ">2419" or ">2420". For the purpose of calculating summary data statistics and required pollutant reductions, these data values are treated as (equal to) 2419 or 2420, respectively. Therefore, the calculated results are considered to be estimates of the existing load and current conditions. In order to obtain an accurate number for future calculations, *E. coli* sample analyses at these sites should follow established protocol for high values (see Section 9.4.).

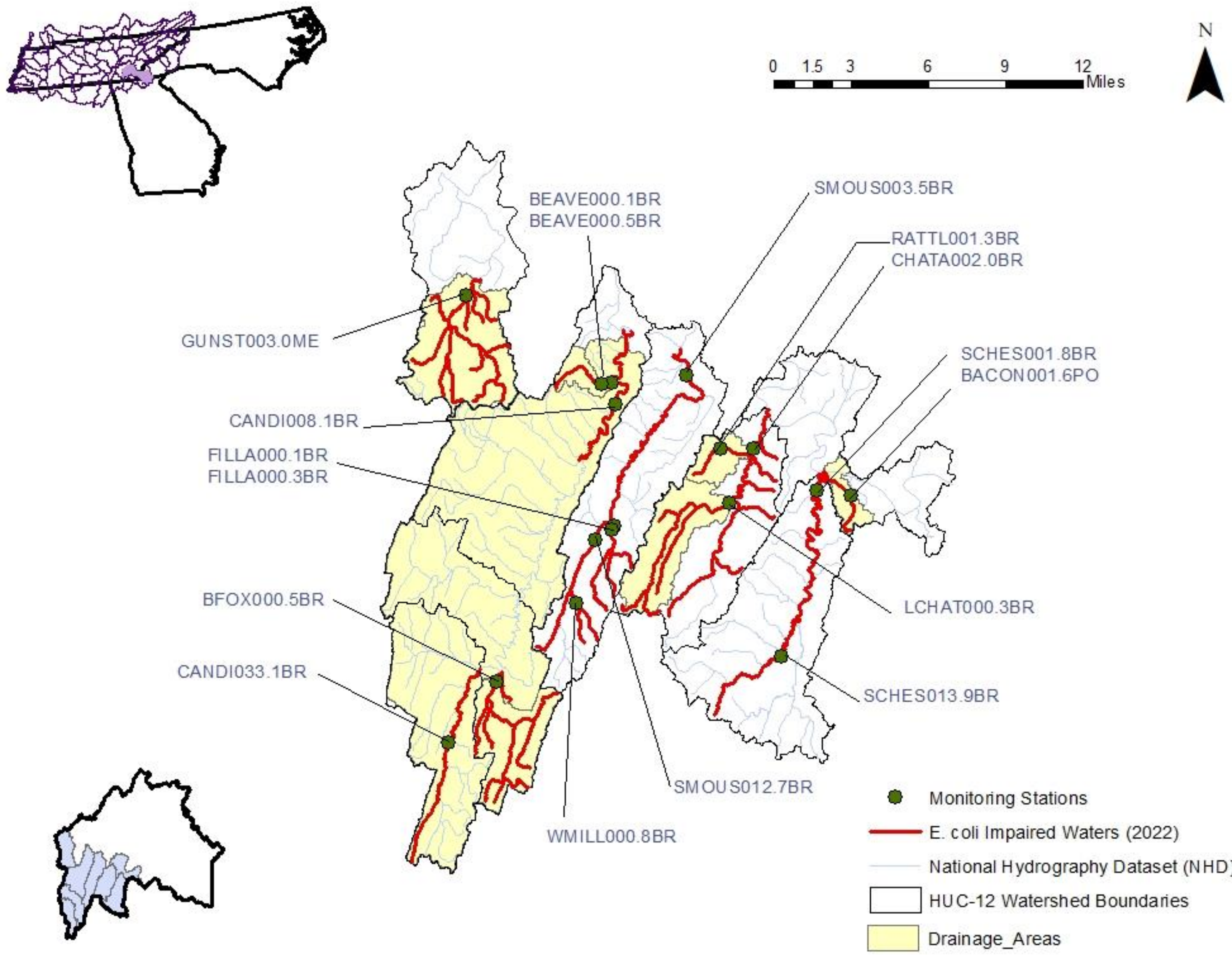

Figure 7. Water Quality Monitoring Stations in the Tennessee portion of the Hiwassee River Watershed – Part 1

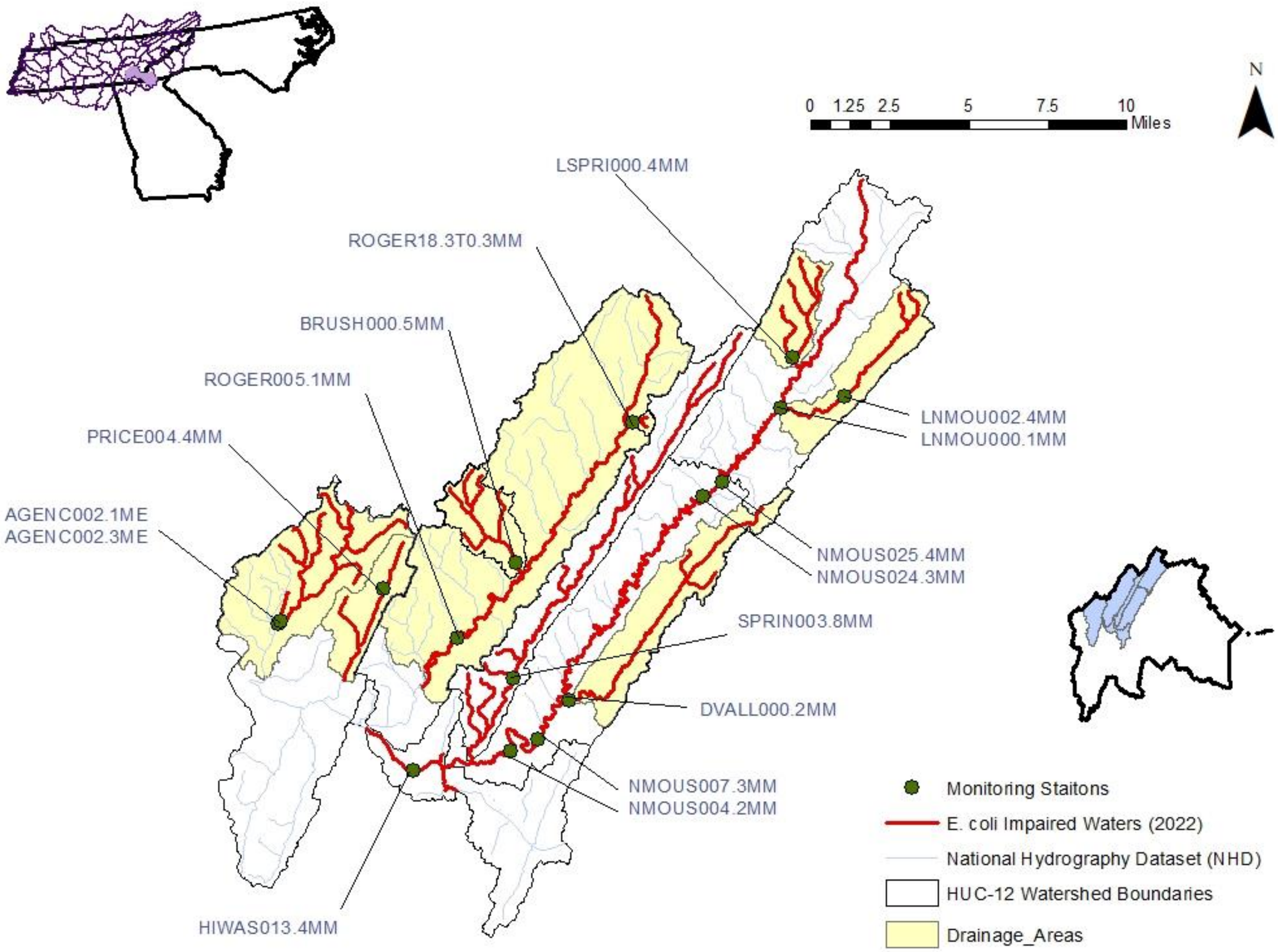

Figure 8. Water Quality Monitoring Stations in the Tennessee portion of the Hiwassee River Watershed – Part 2

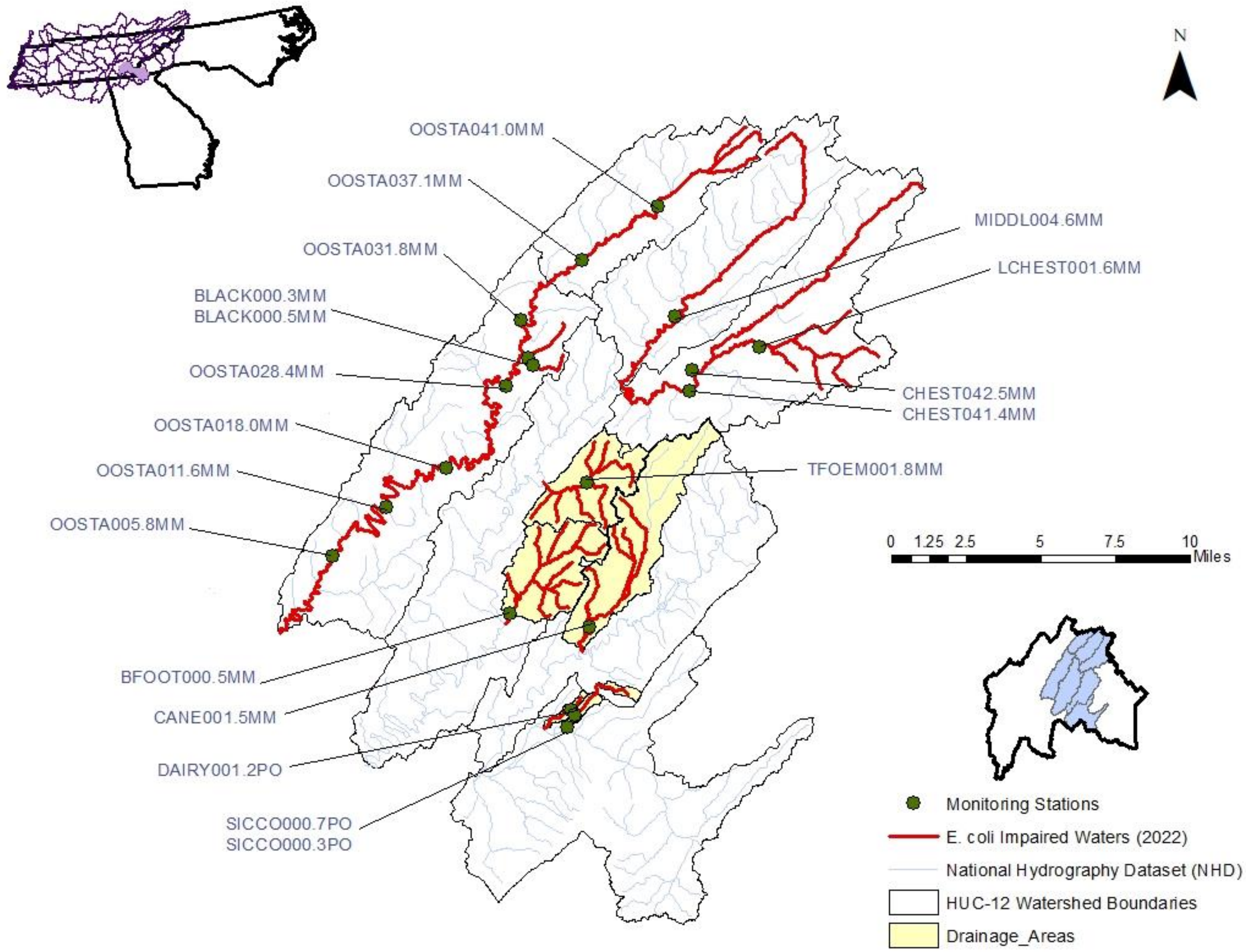

Figure 9. Water Quality Monitoring Stations in the Tennessee portion of the Hiwassee River Watershed – Part 3

Table 4. Summary of Water Quality Monitoring Data

Monitoring Station	Date Range [a]	*E. coli* (Max. WQ Target = 941 cfu/100 mL *) (Geomean WQ Target = 126 cfu/100 mL)					
		# of Data Points	Min. [CFU/100mL]	Avg. [CFU/100mL]	Max. [CFU/100mL]	Geomean** [CFU/100mL]	No. Exceedances WQ Max. Target
AGENC002.1ME	2007-2012	10	15.6	121.4	547.5	89.9	0
AGENC002.3ME	2013-2018	17	69.7	463.5	1413.6	475	1
	2017-2018	12	69.7	452.6	1413.6	Ngd	1
BACON001.6PO	2008-2018	27	123.6	>109,957	1,413,600	>2419.2	24
	2017-2018	12	2,920	>244,930	1,413,600	Ngd	12
BEAVE000.1BR	2007-2017	26	129.1	>730.3	>2,420	941	6
	2017	1	2,420	2,420	2,420	Ngd	1
BEAVE000.5BR	2017-2018	11	172.5	>1,448.9	>2,420	Ngd	7
BFOOT000.5MM	2007-2018	25	59.2	439.8	1,986	750.3	5
	2017-2018	12	59.2	307.7	1,986	Ngd	1
BFOX000.5BR	2007-2018	25	75.9	>724.9	>2,419.6	>578.9	5
	2017-2018	12	155.3	565.3	1,986.3	Ngd	2
BLACK000.3MM	2017-2018	11	51.2	474.1	1,413.6	Ngd	2
BLACK000.5MM	2012	5	235.9	>1,233.5	>2,419.6	874.3	3
BRUSH000.5MM	2012-2018	20	27.2	>799.1	>2,419.6	1,007.3	5
	2017-2018	12	101.9	463.3	1,733	Ngd	1
CANDI008.1BR	2012-2018	16	79.4	>459.5	>2,419.6	>558.7	1
	2017-2018	11	79.4	297.9	410.6	Ngd	0
CANDI033.1BR	2007-2018	17	178.9	>953.4	>2,419	Ngd	8
	2017-2018	12	178.9	771.7	1,986.3	Ngd	4

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Table 4 (cont'd). Summary of Water Quality Monitoring Data

Monitoring Station	Date Range [a]	*E. coli* (Max. WQ Target = 941 cfu/100 mL *) (Geomean WQ Target = 126 cfu/100 mL)					
		# of Data Points	Min. [CFU/100mL]	Avg. [CFU/100mL]	Max. [CFU/100mL]	Geomean** [CFU/100mL]	No. Exceedances WQ Max. Target
CANE001.5MM	2004-2022	69	1	>457.7	>2,419.6	405.5	9
	2017-2022	21	81.6	217.2	866.4	Ngd	0
CHATA002.0BR	2004-2018	29	248.1	>1,111.3	>2,419.6	1,129.6	13
	2017-2018	12	248.1	>1,084.2	>2,420	Ngd	6
CHEST041.4MM	2017-2018	12	127.4	>981.6	>2,420	Ngd	3
CHEST042.5MM	2005-2012	31	249.5	>1,280.9	>2,419.6	>1,112.7	16
DAIRY001.2PO	2004-2008	6	166.9	1,822.1	4,430	757.8	4
DVALL000.2MM	2007-2018	26	68.3	293.6	920.8	293.5	0
	2017-2018	12	68.3	274.3	920.8	Ngd	0
FILLA000.1BR	2008-2017	15	143.9	619.4	2,419.6	663.8	2
	2017	1	548	548	548	Ngd	0
FILLA000.3BR	2012-2018	12	133.4	321.9	770.1	Ngd	0
	2017-2018	11	133.4	338.1	770.1	Ngd	0
GUNST003.0ME	2007-2018	27	90.8	356.5	1,300	431.0	1
	2017-2018	12	166	389.4	1,300	Ngd	1
HIWAS013.4MM	2004-2021	69	1	>378.9	>2,419.6	Ngd	11
	2017-2021	19	6.3	>310.4	>2,419.6	Ngd	3
LCHAT000.3BR	2008-2018	26	139.6	>1,146.3	>2,419.6	1,889.7	14
	2017-2018	12	139.6	>830.8	>2,419.6	Ngd	4
LCHES001.6MM	2007-2018	33	298.7	>1,648.0	>2,419.6	>2,419.6	25
	2017-2018	12	461.1	>1,195.8	>2,420	Ngd	6

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Table 4 (cont'd). Summary of Water Quality Monitoring Data

Monitoring Station	Date Range [a]	*E. coli* (Max. WQ Target = 941 cfu/100 mL *) (Geomean WQ Target = 126 cfu/100 mL)					
		# of Data Points	Min. [CFU/100mL]	Avg. [CFU/100mL]	Max. [CFU/100mL]	Geomean** [CFU/100mL]	No. Exceedances WQ Max. Target
LNMOU001.0MM	2004-2013	13	40	111.8	290.9	Ngd	0
LNMOU002.4MM	2017-2018	12	151.5	576.5	2,419.6	Ngd	2
LSPRI000.4MM	2012-2018	21	12.1	411.0	2,420	369.6	2
	2017-2018	12	12.1	364.2	2,420	Ngd	1
MIDDL004.6MM	2007-2018	22	40	>1,701.1	>2,420	2,032.2	17
	2017-2018	12	40	>1,838.4	>2,420	Ngd	10
NMOUS004.2MM	2004-2012	32	88.4	>355.9	>2,419.2	246.7	2
NMOUS007.3MM	2017-2018	12	62	326.8	1,553.1	Ngd	1
NMOUS024.3MM	2004-2018	43	35.5	>373.6	>2,419.2	376.7	2
	2017-2018	12	35.5	198.0	461	Ngd	0
NMOUS025.4MM	2017-2018	12	18.3	160.0	285.1	Ngd	0
OOSTA005.8MM	2004-2018	42	29.2	>520.7	>2,419.6	620.8	5
	2017-2018	12	101	>672.4	>2,419.6	Ngd	2
OOSTA011.6MM	2012-2013	15	23.1	>385.1	>2,419.6	212.3	1
OOSTA018.0MM	2017-2018	12	62.4	325.9	1,046.2	Ngd	1
OOSTA028.4MM	1999-2022	105	1	>437.5	>2,419.6	408.7	13
	2017-2022	29	29.4	292.7	1,732.9	Ngd	2
OOSTA031.8MM	2017-2018	12	13.4	156.8	980	Ngd	1
OOSTA037.1MM	2012-2018	25	118.7	>480.5	>2,419.6	679.1	2
	2017-2018	12	151.5	387.6	461	Ngd	0
OOSTA041.0MM	2017-2018	12	166.4	>591.1	>2,419.6	Ngd	1

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Table 4 (cont'd). Summary of Water Quality Monitoring Data

Monitoring Station	Date Range [a]	*E. coli* (Max. WQ Target = 941 cfu/100 mL *) (Geomean WQ Target = 126 cfu/100 mL)					
		# of Data Points	Min. [CFU/100mL]	Avg. [CFU/100mL]	Max. [CFU/100mL]	Geomean** [CFU/100mL]	No. Exceedances WQ Max. Target
PRICE004.4ME	2007-2018	33	129.1	>874.0	>2,419.6	750.0	8
	2017-2018	12	129.1	>870.4	>2,419.6	Ngd	3
RATTL001.3BR	2012-2018	19	70.3	>1,977.1	>2,420	>1,146.2	18
	2017-2018	12	1,046	>2,034.7	>2,420	Ngd	12
ROGER005.1MM	2005-2018	30	1	319.5	1,733	157.2	2
	2017-2018	12	93.4	479.9	1,733	Ngd	2
ROGER18.3T0.3MM	2013-2018	15	85.7	>884.9	2,420	Ngd	4
	2017-2018	12	85.7	>1,048.1	>2,420	Ngd	2
SCHES001.8BR	2007-2018	26	83.9	>661.8	>2,420	405.8	6
	2017-2018	12	128.1	>861.0	>2,420	Ngd	4
SCHES013.9BR	2007-2018	23	36.9	>744.8	>2,419.6	930.3	6
	2017-2018	12	36.9	>466.4	>2,419.6	Ngd	2
SICCO000.3PO	*2008-2012*	*11*	*209.8*	*535.2*	*980.4*	*516.7*	*6*
SICCO000.7PO	*2004-2018*	*13*	*11*	*580.9*	*2,419.6*	*Ngd*	*6*
SMOUS003.5BR	2007-2018	26	65.7	416.1	1,413.6	778.6	2
	2017-2018	12	65.7	264.3	770.1	Ngd	0
SMOUS012.7BR	2012-2018	17	275.5	796.2	1,986	564.5	4
	2017-2018	12	290.9	828.0	1553.1	Ngd	3
SPRIN003.8MM	2007-2018	34	58.1	>566.5	>2,419.2	389.0	3
	2017-2018	12	291	690.5	1,733	Ngd	1

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Table 4 (cont'd). Summary of Water Quality Monitoring Data

Monitoring Station	Date Range [a]	*E. coli* (Max. WQ Target = 941 cfu/100 mL *) (Geomean WQ Target = 126 cfu/100 mL)					
		# of Data Points	Min. [CFU/100mL]	Avg. [CFU/100mL]	Max. [CFU/100mL]	Geomean** [CFU/100mL]	No. Exceedances WQ Max. Target
TFOEM001.8MM	2007-2018	25	161.6	>1,172.8	>2,420	693.7	13
	2017-2018	12	488	>1,649.1	>2,420	Ngd	10
WALKE000.6MM	2012-2018	17	13.4	316.4	980.4	499.9	1
	2017-2018	12	13.4	224.1	579	Ngd	0
WMILL000.8BR	2004-2018	33	41	410.2	2,419	428.3	3
	2017-2018	12	66.3	285.3	770.1	Ngd	0

* Maximum water quality target is 487 CFU/100 mL for lakes, reservoirs, State Scenic Rivers, or Exceptional Tennessee Waters waterbodies and 941 CFU/100 mL for other waterbodies. Waterbodies utilizing the 487 CFU/100 mL target are italicized.

** If multiple geomean sampling periods are available, the maximum calculated geomean value is recorded.

[a] When two date ranges are presented, the first is the period of record and the second is the most recent five year period.

Ngd = no geomean data

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 have the potential to affect *E. coli* loading and the amount of loading contributed by each of these sources. Since a portion of the Hiwassee River Watershed is located in North Carolina and Georgia, many point and nonpoint sources may also be located in North Carolina or Georgia.

Under the Clean Water Act, sources are classified as either point or nonpoint sources. Under Title 40 Code of Federal Regulations (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 plants (WWTPs); 2) NPDES regulated industrial and municipal stormwater discharges; and 3) NPDES regulated Concentrated Animal Feeding Operations (CAFOs). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES regulated point sources. Nonpoint sources (NPS) 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 NPS. The TMDL must provide a Load Allocation (LA) for these sources.

7.1 Point Sources

7.1.1 NPDES Regulated Municipal Wastewater Treatment Facilities

Both treated and untreated sanitary wastewaters contain coliform bacteria. Certain process wastewaters can also contain coliform bacteria. There are eight facilities located in or upstream of impaired subwatersheds or drainage areas within the Tennessee portion of the Hiwassee River Watershed that have NPDES permits authorizing the discharge of treated sanitary or process wastewater. (Figure 10 and Table 5). Four of the eight facilities are wastewater treatment plants (WWTPs) serving municipalities with design capacities equal to or greater than 1.0 million gallons per day (MGD). All NPDES-permitted facilities, both major and minor, currently have permit limits equal to the appliable single-sample maximum and geomean E. coli criteria. There are also several minor facilities within the North Carolina and Georgia portion of the Hiwassee River Watershed.

Non-permitted point sources of (potential) *E. coli* contamination of surface waters associated with WWTP collection systems include leaking collection systems and sanitary sewer overflows (SSOs).

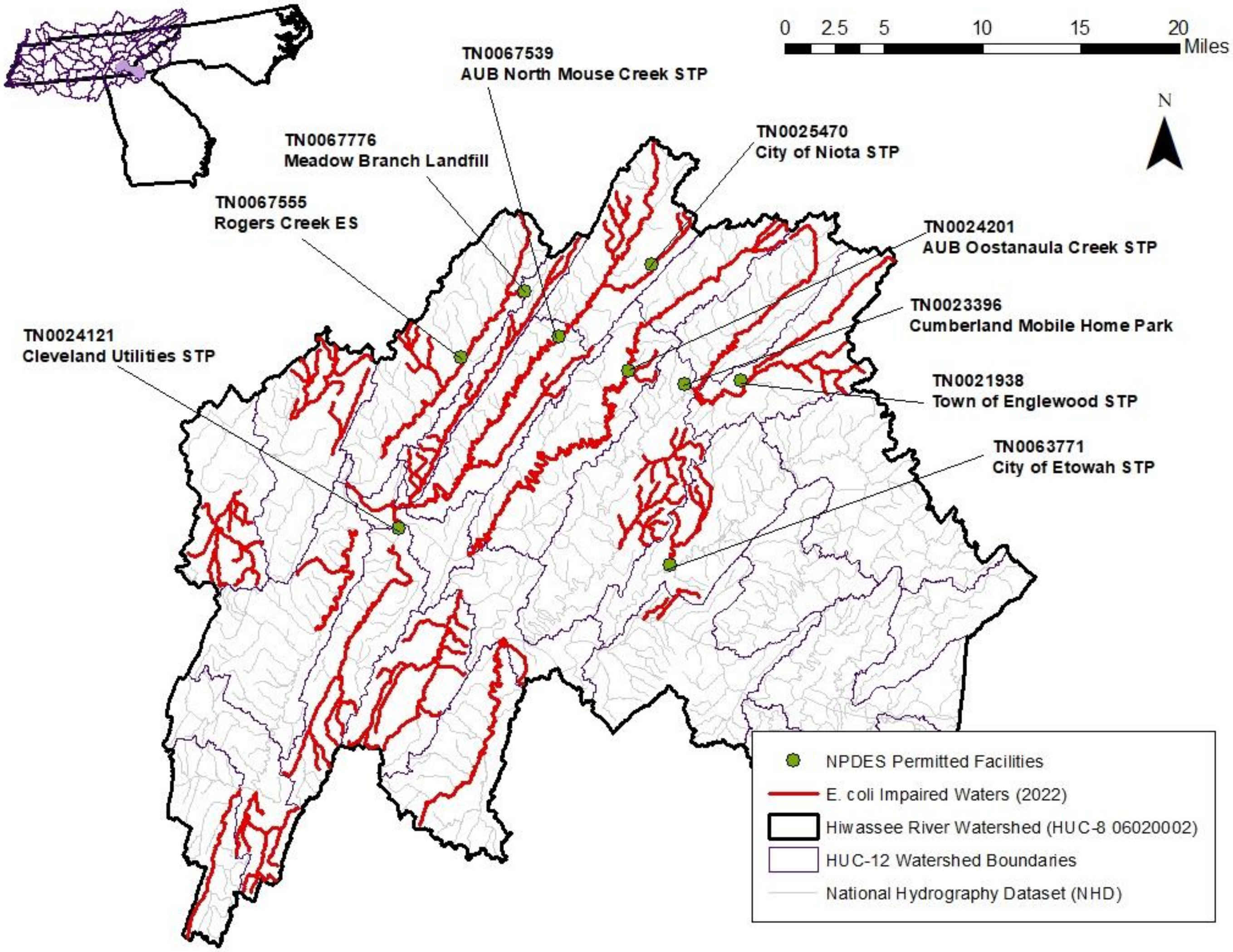

Figure 10. Facilities with NPDES Permits to Discharge Sanitary Wastewater To Impaired Subwatersheds and Drainage Areas of the Tennessee portion of the Hiwassee River Watershed

Table 5. Facilities with NPDES Permits to Discharge Sanitary Wastewater Located in Impaired Subwatersheds and Drainage Areas of the Tennessee portion of the Hiwassee River Watershed

NPDES Permit No.	Facility	Design Flow [MGD*]	Receiving Stream (Waterbody ID)
TN0021938	Town of Englewood STP	0.25	Chestuee Creek Mile 42.4 (TN06020002082_2000)
TN0023396	Cumberland Mobile Home Park	0.006	UT to Chestuee Creek Mile 0.8 (TN06020002082_0999)
TN0024121	Cleveland Utilities STP	21.6	Hiwassee River Mile 15.4 (TN06020002008_1000)
TN0024201	AUB Oostanaula STP	6.0	Oostanaula Creek Mile 30.1 (TN06020002083_3000)
TN0025470	City of Niota STP	0.4	Little North Mouse Creek Mile 3.5 (TN06020002084_0400)
TN0063771	City of Etowah STP	1.2	Conasauga Creek Mile 8.0 (TN06020002081_1000)
TN0067539	AUB North Mouse Creek STP	1.2	North Mouse Creek Mile 24.7 (TN06020002084_1000)
TN0067555	McMinn County Board of Education (Rogers Creek ES)	0.0025	Rogers Creek Mile 12.5 (TN06020002087_1000)

* Million Gallons/Day (MGD)

7.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

MS4s are considered to be potential point sources of *E. coli*. Discharges from MS4s occur in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. Phase I of the EPA stormwater program requires large and medium MS4s to obtain individual NPDES stormwater permits. Large and medium MS4s are those located in incorporated places or counties serving populations greater than 100,000 people. At present, except for the individual MS4 permit issued to TDOT, there are no large or medium (Phase 1) MS4s located in the Hiwassee River Watershed.

Regulated small MS4s in Tennessee must also obtain NPDES permits in accordance with the Phase II stormwater program. A small MS4 is designated as *regulated* if: a) it is located within the boundaries of a defined urbanized area that has a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile; b) it is located outside of an urbanized area but within a jurisdiction with a population of at least 10,000 people, a population density of 1,000 people per square mile, and has the potential to cause an adverse impact on water quality; or c) it is located outside of an urbanized area but contributes substantially to the pollutant loadings of a physically interconnected MS4 regulated by the NPDES stormwater program. Most regulated small MS4s in Tennessee obtain coverage under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2022b). Table 6 lists the entities covered under Phase II of the NPDES Stormwater Program.

Table 6. Phase II MS4 Permits

MS4 Permit No.	Permitted Entity
TNS077771	Bradley County
TNS075566	Hamilton County
TNS075141	City of Athens
TNS075213	City of Cleveland

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

For information about TDOT's stormwater management program, see the TDOT website:

https://www.tn.gov/tdot/environmental-home/transportation-environmental-compliance-office/environmental-compliance-office-ms4-permit-facility-compliance-program.html

For information regarding stormwater permitting in Tennessee, see the TDEC website:

https://www.tn.gov/environment/permit-permits/water-permits1/npdes-permits1/npdes-stormwater-permitting-program.html

7.1.3 NPDES Regulated Industrial Stormwater

Industrial facilities can also be point sources of *E. coli*. Most stormwater discharges from industrial facilities are covered under the Tennessee Stormwater Multi-Sector General Permit (TMSP). However, there is one facility in the Hiwassee River watershed covered under an individual permit and discharging to an impaired waterbody. (See Figure 10).

Meadow Branch Landfill, operated by Environmental Trust Company (TN0067776) is located in McMinn County near Athens, Tennessee, and discharges to unnamed tributaries to Meadow Branch and Roger's Creek. According to the 2018 Remaining Life survey of Sanitary Landfills in Tennessee conducted by the TDEC Division of Solid Waste Management, Meadow Branch Landfill is the second largest landfill based on the tons/day received at the facility. Additionally, the facility is under construction in order to expand the landfill to meet the waste disposal needs of the region.

Water quality in the receiving streams (unnamed tributaries to Meadow Branch and Roger's Creek) is heavily defined by the landfill stormwater quality. In dry weather of July to October, the minimum flow of these tributaries is typically zero. During these periods, the entire flow in the stream is composed of stormwater from the site, thus, stormwater quality is especially important. While not an obvious source of *E. coli*, annual stormwater sampling for *E. coli* is included in the most recent permit to confirm.

7.1.4 Concentrated Animal Feeding Operations (CAFOs)

Animal feeding operations (AFOs) are agricultural enterprises where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland (USEPA, 2002a). Concentrated Animal Feeding Operations (CAFOs) are AFOs that meet certain criteria with respect to animal type, number of animals, and type of manure management system. CAFOs are considered to be potential sources of *E. coli* loading.

Due to legislation passed in 2018, changes to the CAFO program in Tennessee have been implemented. Only large CAFOs that have the outdoor storage of liquid manure are required to obtain a State Operating Permit. However, any CAFO may voluntarily request coverage under a State Operating Permit or an NPDES permit. There are currently no CAFOs in the Hiwassee River Watershed with coverage under either a State Operating Permit or an NPDES permit.

7.2 Nonpoint Sources (NPS)

NPS 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. NPS of *E. coli* loading are primarily associated with agricultural and urban land uses. The majority of waterbodies identified on TDEC's Final 2022 List of Impaired and Threatened Waters as impaired due to *E. coli* are attributed to nonpoint agricultural or urban sources.

7.2.1 Wildlife

Wildlife feces contain coliform bacteria which can be deposited onto land surfaces where it can be transported during storm events to nearby streams. Wildlife is included in the allocation for the LA_{SW} term in the TMDL.

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:

- CAFOs, which by definition involve a certain quantity of animals, are considered point sources and are covered under the State Operating Permit (SOP) or NPDES permit (see Section 7.1.3 above). Smaller AFOs, if they exist, are unregulated. This includes some AFOs that were previously covered under an SOP or NPDES permit. AFOs are considered potential sources if not properly controlled/managed.
- Agricultural livestock grazing in pastures deposit manure containing coliform bacteria onto land surfaces. This material accumulates during periods of dry weather and is available for washoff and transport to surface waters during storm events. The number of animals in pasture and the time spent grazing are important factors in determining the loading contribution.
- Processed agricultural manure from confined feeding operations is often applied to land surfaces and can provide a significant source of coliform bacteria loading. Guidance for issues relating to manure application is available through the University of Tennessee Agricultural Extension Service and the Natural Resources Conservation Service (NRCS).
- Agricultural livestock and other unconfined animals often have direct access to waterbodies and can provide a concentrated source of coliform bacteria loading directly to a stream.

Data sources related to livestock operations include the 2017 Census of Agriculture. Livestock data for counties located within the Hiwassee River Watershed are summarized in Table 7. Note that, due to confidentiality issues, any tabulated item that identifies data reported by a respondent or allows a respondent's data to be accurately estimated or derived is suppressed and coded with a 'D' (USDA, 2019). Agricultural animals are included in the allocation for the LA_{SW} term in the TMDL. (See Section C.2.)

7.2.3 Failing Septic Systems

Some of the coliform loading in the Hiwassee River Watershed can be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates of population utilizing septic systems for counties in the Hiwassee River Watershed were derived from 2020 county census data and the percent of population on septic systems in 1990 (the last year the data are available), and are summarized in Table 8. In Tennessee, it is estimated that there are approximately 2.47 people per household on septic systems, some of which can be reasonably assumed to be failing. As with livestock in streams, failing septic systems have the potential to provide a concentrated source of coliform bacteria directly to waterbodies. Failing septic systems must be repaired or upgraded. Therefore, failing septic systems receive an allocation of zero. (See Section C.2.)

7.2.4 Urban Development

NPS 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. Urban land use area in impaired subwatersheds in the Hiwassee River Watershed ranges from 2.38% to 38.3%. Land use for the Hiwassee drainage areas is summarized in Figures 11-22, and tabulated in Appendix A. If a bar in the figure or a column in the table is labeled with "HUC-12", that indicates that the land use presented is for the entire Subwatershed area(s), including all impaired waterbodies in the HUC-12. Urban development not covered by MS4 permits is included in the allocation for the LA_{SW} term in the TMDL.

Table 7. Livestock Distribution for Counties in the Hiwassee River Watershed

County	Livestock Population (2017 Census of Agriculture)							
	Beef Cow	Milk Cow	Poultry		Hogs	Sheep	Goats	Horse
			Layers	Broilers				
Bradley	11,469	1,062	175,124	4,148,659	180	487	469	649
Hamilton	5,232	22	24,330	1,032,280	140	251	752	1,262
McMinn	12,810	3,163	19,764	581,630	351	262	1,052	1,241
Meigs	5,825	400	729	(D)	47	450	646	382
Monroe	11,135	3,420	2,283	55	70	1,091	560	1,049
Polk	2,353	1,923	711	1,635,514	179	291	390	349

* In keeping with the provisions of Title 7 of the United States Code, no data are published in the 2017 Census of Agriculture that would disclose information about the operations of an individual farm or ranch. Any tabulated item that identifies data reported by a respondent or allows a respondent's data to be accurately estimated or derived is suppressed and coded with a 'D' (USDA, 2019).

Table 8. Estimated Population on Septic Systems for Counties in the Hiwassee River Watershed

County	% of Population on Septic Systems (1990)	Total Population (2020 Census)	Estimated Population on Septic (2020)*
Bradley	52.0	108,620	56,489
Hamilton	33.7	366,207	123,468
McMinn	53.6	53,276	28,574
Meigs	84.1	12,758	10,731
Monroe	71.8	46,250	33,216
Polk	87.5	17,544	15,352

* Estimate based on 2020 census and 1990 percent of population on septic.

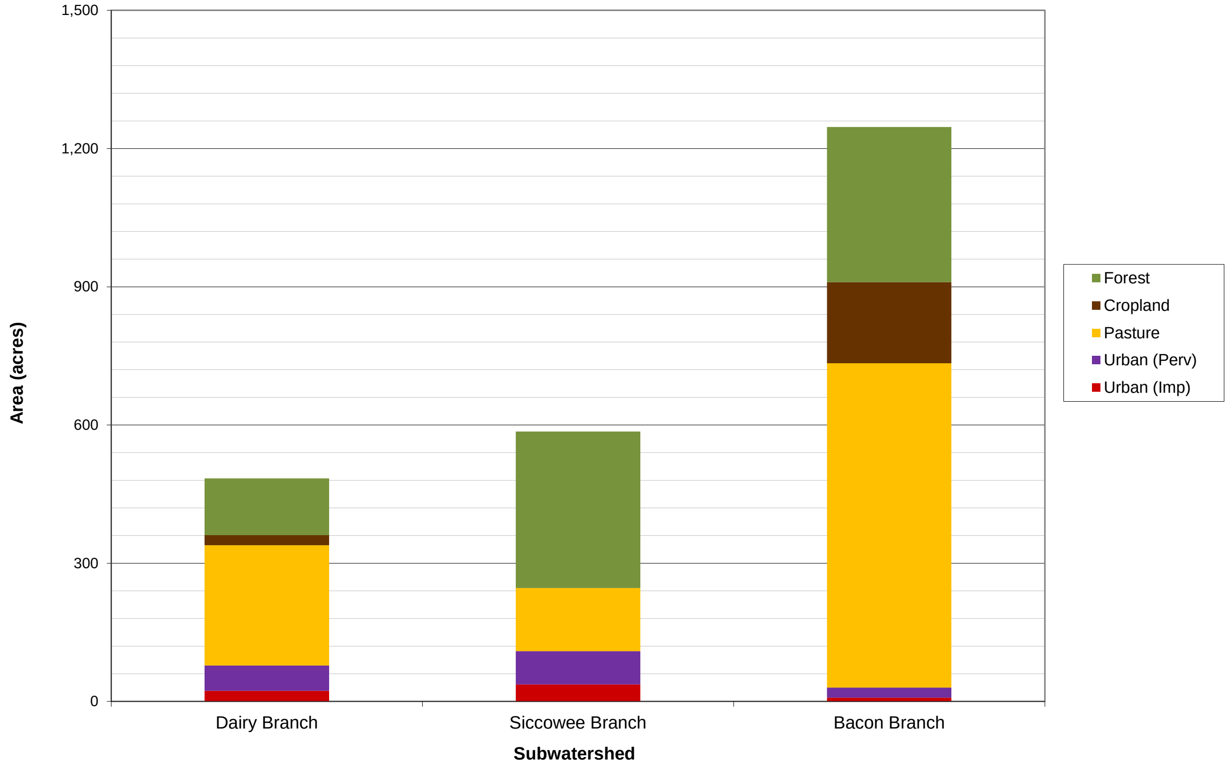

Figure 11. Land Use Area of Hiwassee River *E. coli*-Impaired Subwatersheds (less than 2,000 acres)

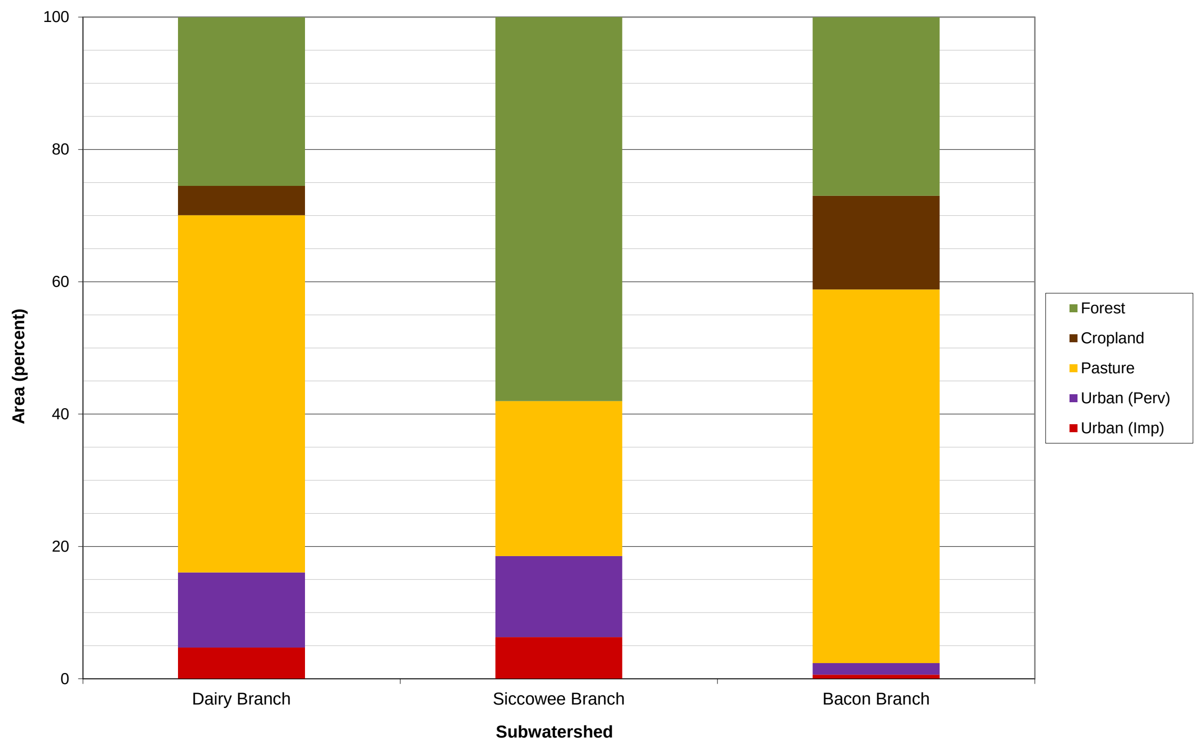

Figure 12. Land Use Percent of Hiwassee River *E. coli*-Impaired Subwatersheds (less than 2,000 acres)

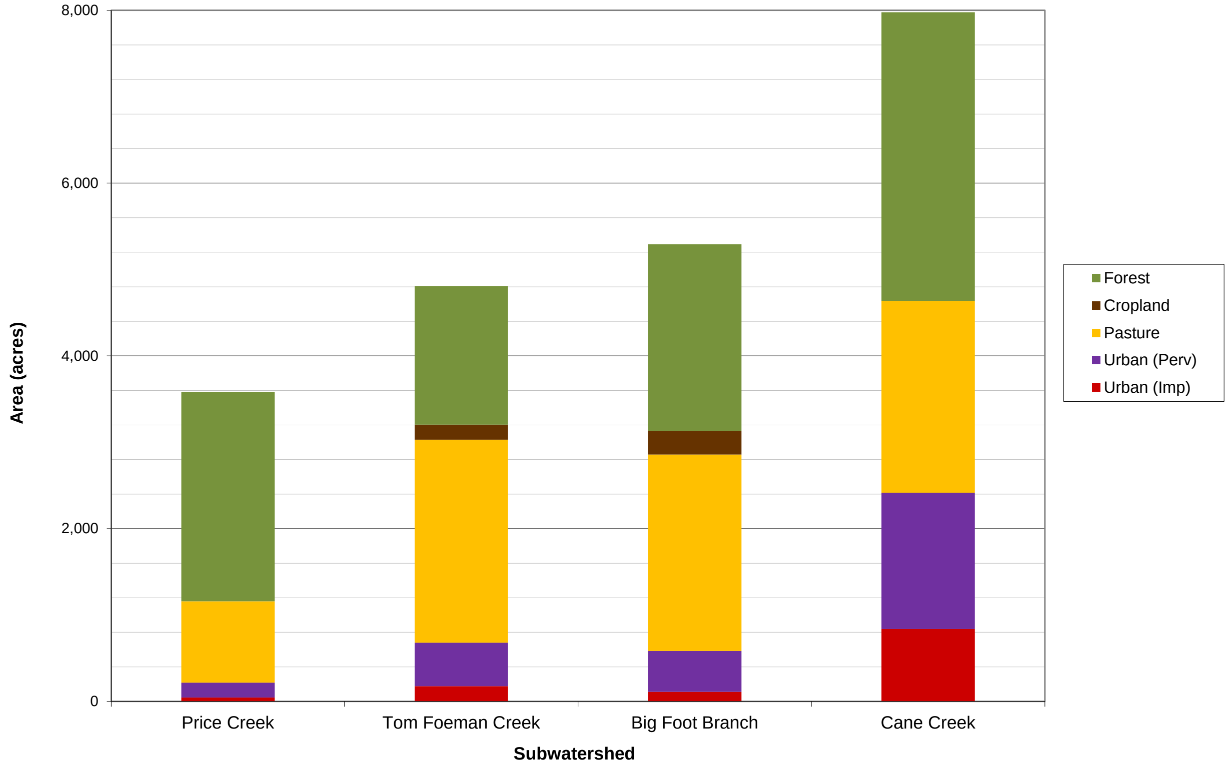

Figure 13. Land Use Area of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 2,000 and less than 8,000 acres)

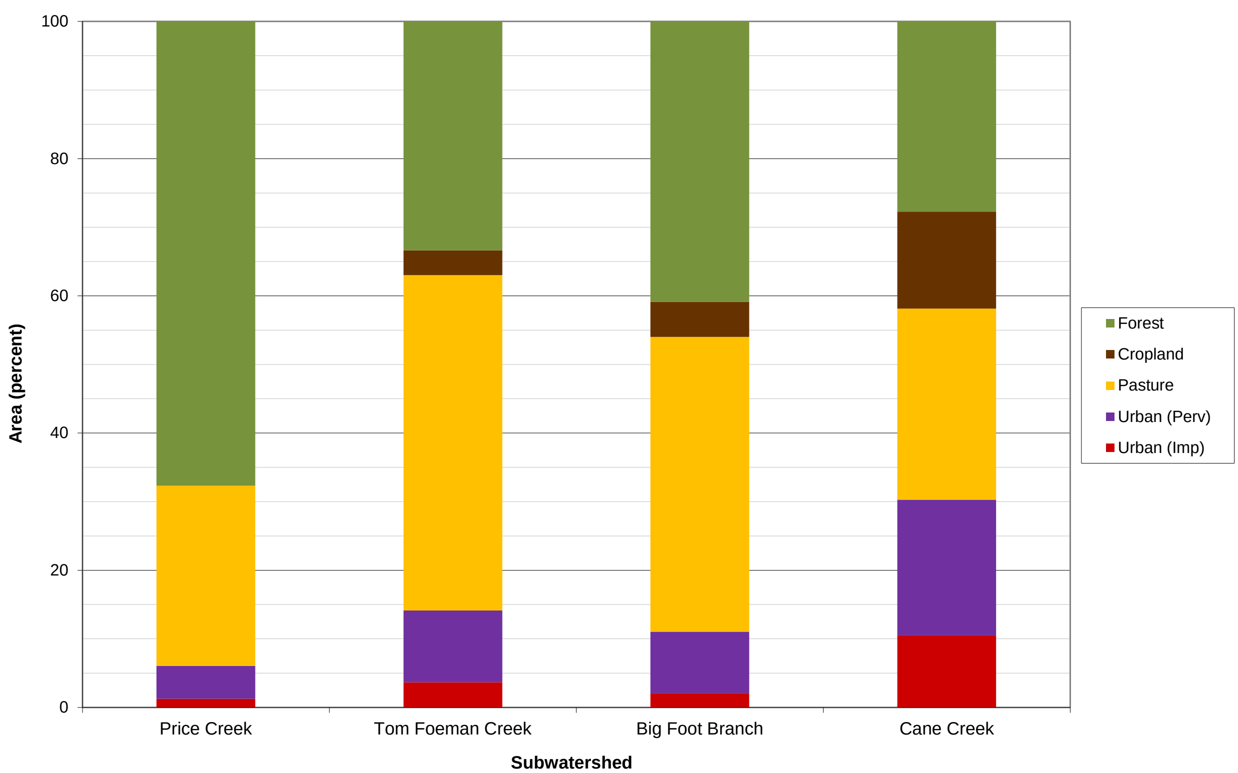

Figure 14. Land Use Percent of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 2,000 and less than 8,000 acres)

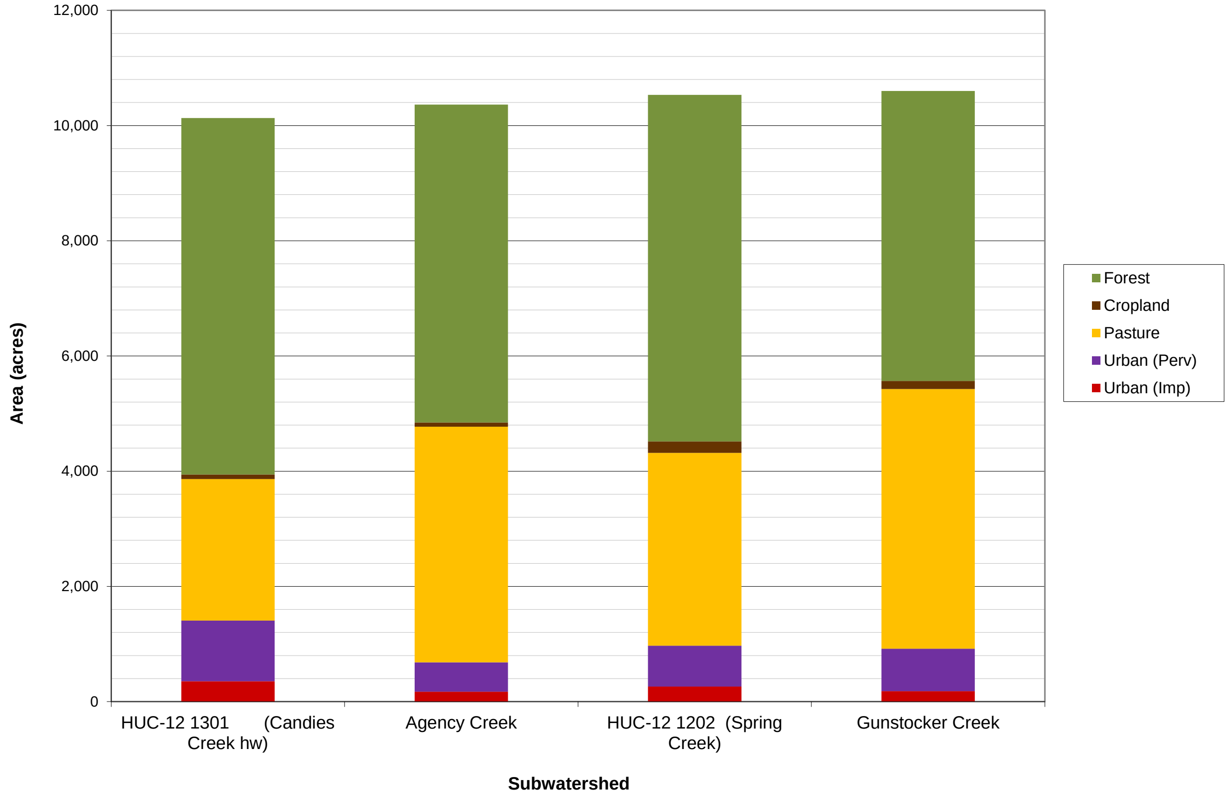

Figure 15. Land Use Area of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 8,000 and less than 12,000 acres)

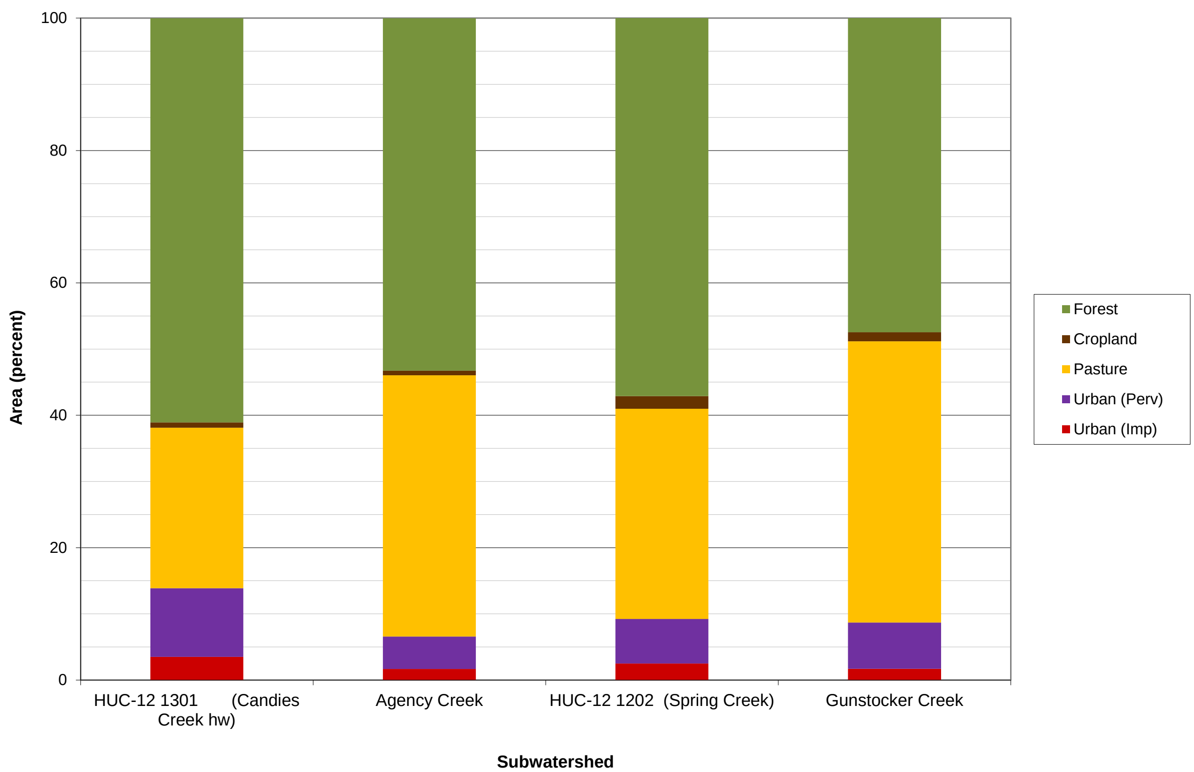

Figure 16. Land Use Percent of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 8,000 and less than 12,000 acres)

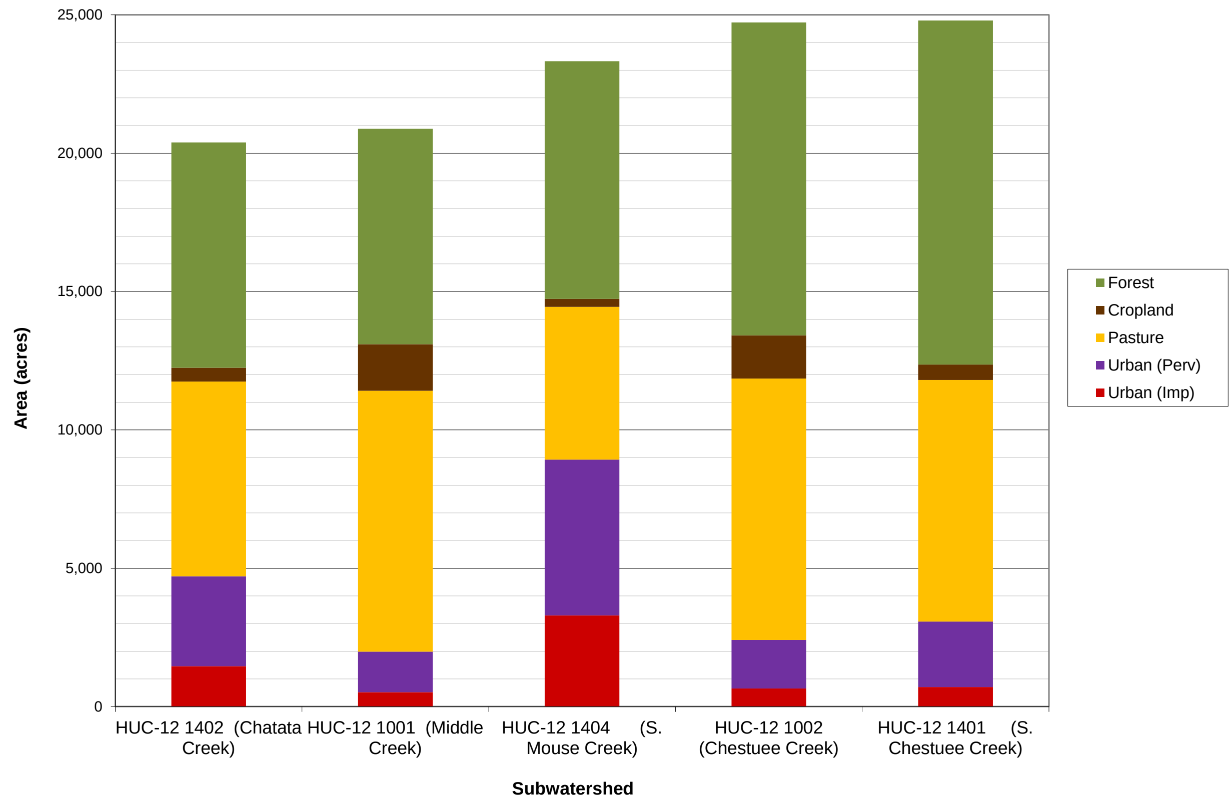

Figure 17. Land Use Area of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 12,000 and less than 25,000 acres)

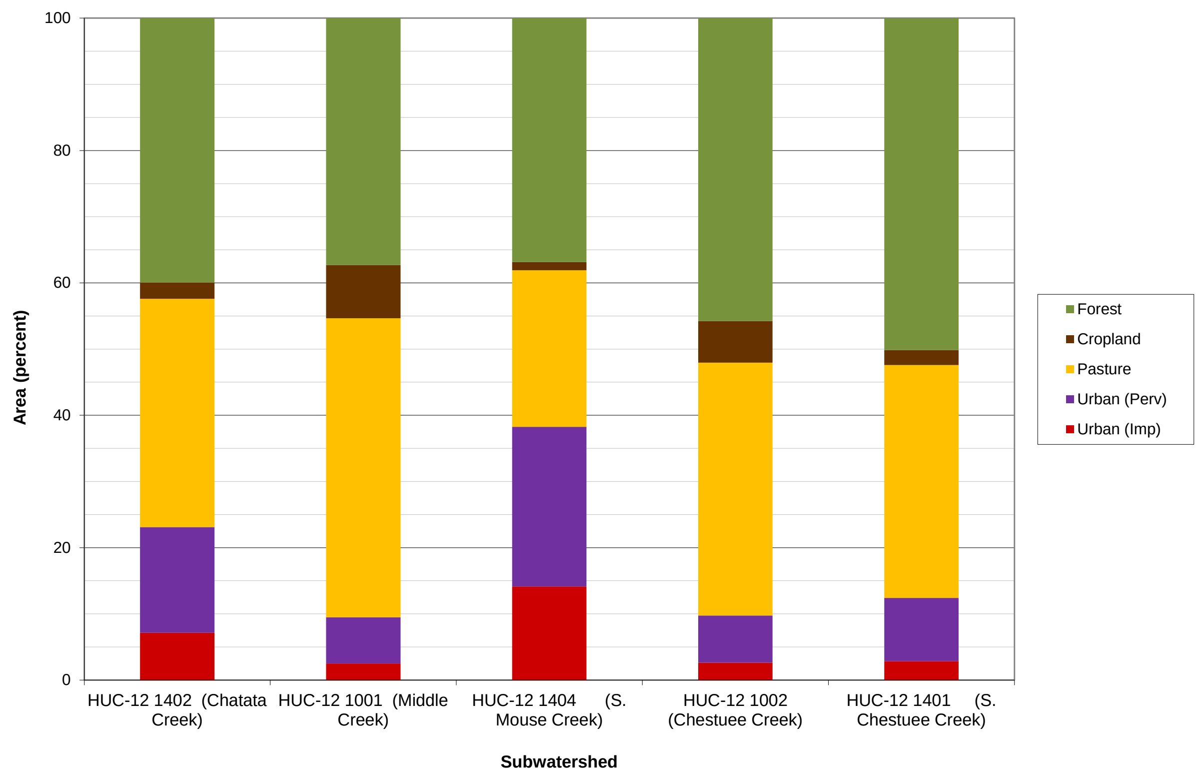

Figure 18. Land Use Percent of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than128,000 and less than 25,000 acres)

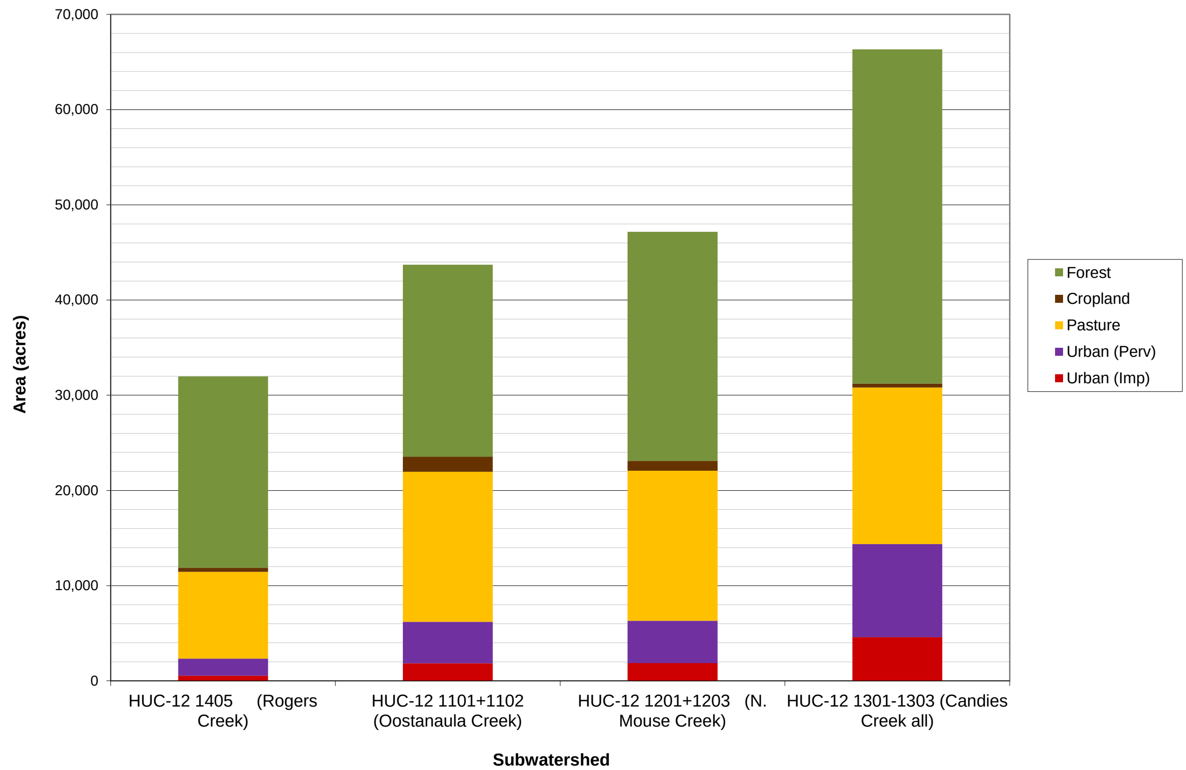

Figure 19. Land Use Area of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 25,000 and less than 1,000,000 acres)

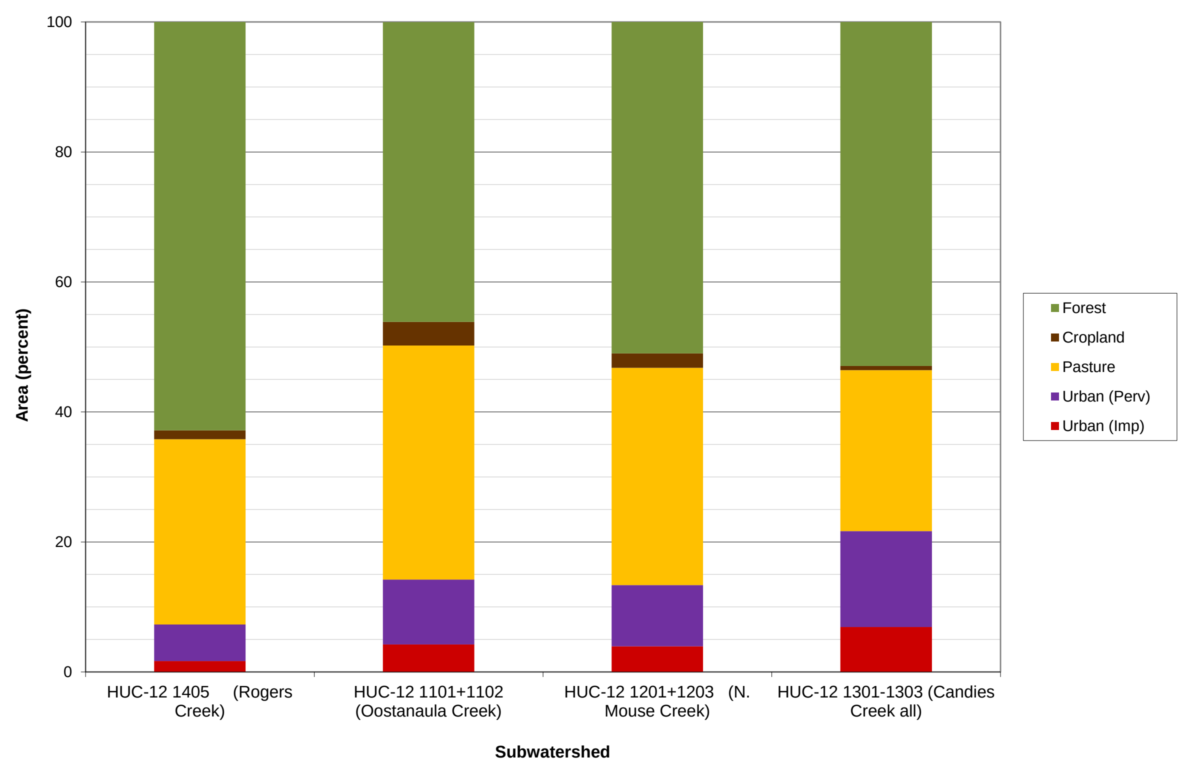

Figure 20. Land Use Percent of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 25,000 and less than 1,000,000 acres)

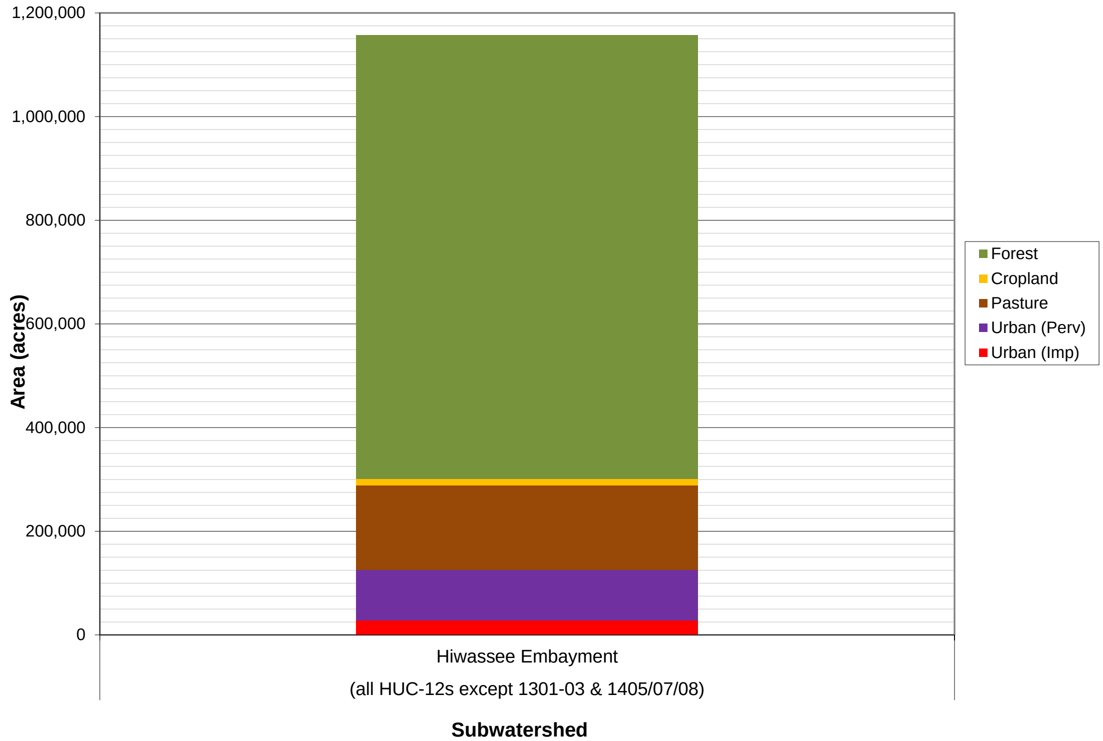

Figure 21. Land Use Area of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 1,000,000 acres)

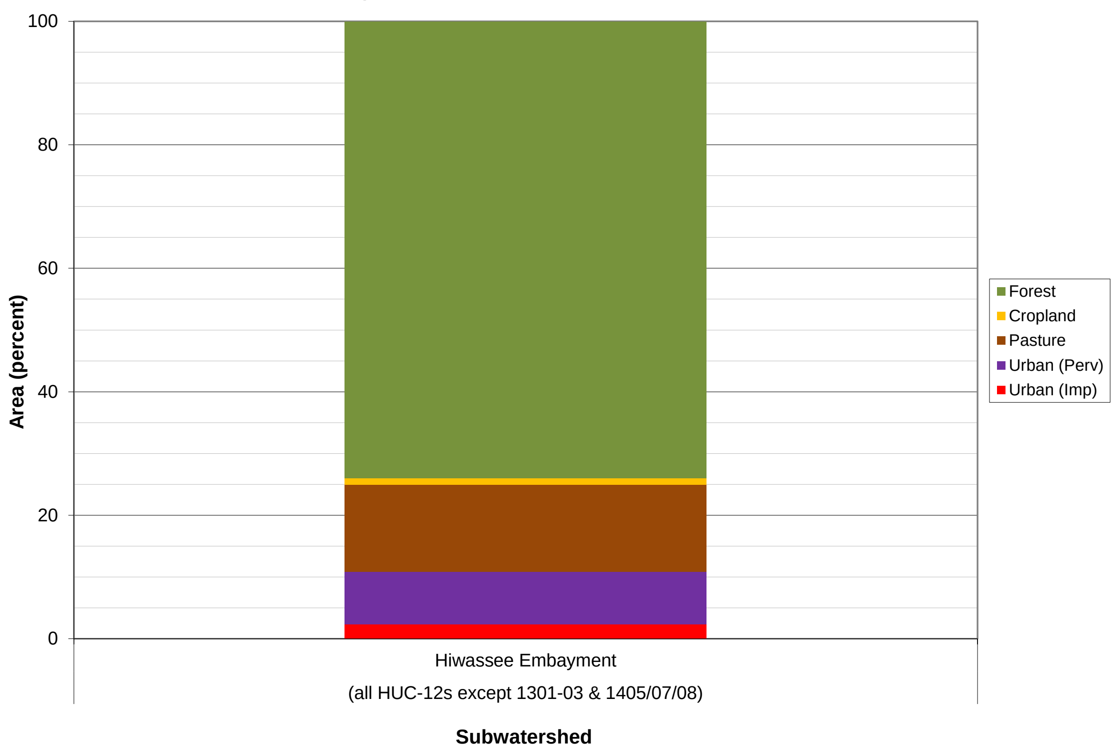

Figure 22. Land Use Percent of Hiwassee River *E. coli*-Impaired Subwatersheds (greater than 1,000,000 acres)

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

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), NPS 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 other appropriate measure.

This document describes TMDL, Waste Load Allocation (WLA), Load Allocation (LA), and Margin of Safety (MOS) development for waterbodies identified as impaired due to *E. coli* on TDEC's Final 2022 List of Impaired and Threatened Waters.

8.1 Expression of TMDLs, WLAs, & LAs

In this document, the *E. coli* TMDL is a daily load expressed as a function of mean daily flow (daily loading function). For implementation purposes, corresponding percent load reduction goals (PLRGs) to decrease *E. coli* loads to TMDL target levels, within each respective flow zone, are also expressed. (See Appendix E.) WLAs & LAs for precipitation-induced loading sources are also expressed as daily loading functions in CFU/day/acre. Allocations for loading that is independent of precipitation (WLAs for WWTPs and LAs for "other direct sources") are expressed as CFU/day.

8.2 Area Basis for TMDL Analysis

The primary area unit of analysis for TMDL development is normally a HUC-12 subwatershed containing one or more waterbodies assessed as impaired due to *E. coli* (as documented in TDEC's Final 2022 List of Impaired and Threatened Waterbodies). In some cases, however, TMDLs may be developed for an impaired waterbody drainage area only. Determination of the appropriate area to use for analysis (see Table 9) was based on a careful consideration of a number of relevant factors, including: 1) location of impaired waterbodies in the HUC-12 subwatershed; 2) land use type and distribution; 3) water quality monitoring data; and 4) the assessment status of other waterbodies in the HUC-12 subwatershed.

Table 9. Determination of Analysis Areas for TMDL Development

Subwatershed (06020002____)	Impaired Waterbody	Area *
0802	Cane Creek	DA
0909	Dairy Branch	DA
	Siccowee Branch	DA
1001	Middle Creek	HUC-12
1002	Chestuee Creek	HUC-12
	Little Chestuee Creek	
1003	Tom Foeman Creek	DA
	Big Foot Branch	DA
1101	Oostanaula Creek (083-4000)	HUC-12
	Oostanaula Creek (083-5000)	
1102	Oostanaula Creek (083_1000)	HUC-12
	Oostanaula Creek (083_2000)	
	Oostanaula Creek (083_3000)	
	Black Branch	
	Walker Branch	
1201	Latham Springs Branch	DA
	Little North Mouse Creek	DA
	North Mouse Creek (084_2000)	DA
1202	Spring Creek	HUC-12
1203	North Mouse Creek (084_1000)	HUC-12
	Dry Valley Creek	
1301	Candies Creek (005_3000)	HUC-12
1302	Black Fox Creek	DA
1303	Beaverdam Creek	DA
	Candies Creek (005_1000)	DA
1401	South Chestuee Creek (014_1000)	HUC-12
	South Chestuee Creek (014_2000)	
1402	Little Chatata Creek	DA
	Rattlesnake Branch	DA
	Chatata Creek	DA
1403	Bacon Branch	DA
1404	South Mouse Creek (009_1000)	HUC-12
	South Mouse Creek (009_2000)	
	Fillauer Branch	
	Woolen Mill Branch	
1405	Brush Creek	DA
	UT to Rogers Creek	DA
	Rogers Creek	DA
1406	Hiwassee Embayment (008_1000)	DA
1407	Agency Creek	DA
	Price Creek	DA
1408	Gunstocker Creek	DA

Note: HUC-12 = HUC-12 Subwatershed
DA = Waterbody Drainage Area

* Drainage Areas are provided in Table E-3

8.3 TMDL Analysis Methodology

TMDLs for the Hiwassee River Watershed were developed using load duration curves for analysis of impaired HUC-12 subwatersheds or specific waterbody drainage areas. A load duration curve (LDC) is a cumulative frequency graph that illustrates allowable and/or existing pollutant loads at different flow frequencies for a given location on a stream. An advantage of LDCs is that they help visualize the flow conditions – high flow vs. low flow vs. entire range of flows – 1) during which existing data were collected, and 2) under which exceedances of the target are most likely to occur. Load duration curves are considered to be well suited for analysis of periodic monitoring data collected by grab sample. LDCs were developed at most monitoring site locations in impaired waterbodies and daily loading functions were expressed for TMDLs, WLAs, LAs, and MOS. In addition, load reductions (PLRGs) for each flow zone were calculated for prioritization of implementation measures according to the methods described in Appendix E.

For the Hiwassee River mainstem waterbody (008_1000), flows were not simulated due to unsuitable conditions for modeling, therefore, LDCs could not be developed and load reductions could not be determined using the dynamic loading model. The waterbody segment, on the lower section of the Hiwassee River, is influenced by backwater from Chickamauga Lake, having the hydrodynamic characteristics of a reservoir rather than a free-flowing river. Load reductions for this waterbody were calculated based on simple 90th percentiles of water quality samples.

Waterbodies that are located within an impaired HUC-12 or drainage area, but are not currently listed as impaired, were evaluated for protection. TMDLs and allocations were developed for these unimpaired (fully supporting) and unassessed waterbodies in order to maintain good water quality and to maximize the likelihood of each protection waterbody meeting water quality standards in the future.

8.4 Critical Conditions and Seasonal Variation

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

A ten- to fifteen-year period between January 1, 2002 and December 31, 2021 was used to simulate flow (the length of the simulation period varied depending on the period of record of the monitoring data for the selected waterbody). This period contained a range of hydrologic conditions that included both low and high streamflows. Critical conditions are accounted for in the load duration curve analyses by using the entire period of flow and water quality data available for the impaired waterbodies.

Water quality data have been collected during most flow ranges. For each subwatershed, the critical flow zone has been identified based on the incremental levels of impairment relative to the target loads. Based on the location of the water quality exceedances on the load duration curves and the distribution of critical flow zones, no one delivery mode for *E. coli* appears to be dominant for waterbodies in the Hiwassee River Watershed (see Section 9.1.2 and 9.1.3).

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. Some water quality data were collected during all seasons, but most water quality data were collected during the summer recreational period.

8.5 Margin of Safety

There are two methods for incorporating MOS in TMDL analyses: a) implicitly incorporate the MOS using conservative model assumptions; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For development of *E. coli* TMDLs in the Hiwassee River Watershed, an explicit MOS, equal to 10% of the *E. coli* water quality targets (ref.: Section 5.0), was utilized for determination of WLAs and LAs:

Instantaneous Maximum (lakes, reservoirs, State Scenic Rivers, or Exceptional Tennessee Waters waterbodies):	MOS = 49 CFU/100 ml
Instantaneous Maximum (all other waterbodies):	MOS = 94 CFU/100 ml
30-Day Geometric Mean:	MOS = 13 CFU/100 ml

8.6 Determination of TMDLs

E. coli daily loading functions were calculated for impaired segments in the Hiwassee River Watershed using LDCs to evaluate compliance with the single sample maximum target concentrations according to the procedure in Appendix C. These TMDL loading functions for impaired segments and subwatersheds are shown in Table 10. TMDLs were also developed for waterbodies located within the drainage area of an impaired waterbody but not currently assessed as impaired. These protection TMDLs are shown in Appendix G.

For the Hiwassee River mainstem waterbody, flows were not simulated due to unsuitable conditions for modeling, therefore, LDCs could not be developed and load reductions could not be determined using the dynamic loading model. The waterbody segment, on the lower section of the Hiwassee River, is influenced by backwater from Chickamauga Lake, having the hydrodynamic characteristics of a reservoir rather than a free-flowing river. Load reductions for this waterbody were calculated based on simple 90th percentiles of water quality samples.

8.7 Determination of WLAs & LAs

WLAs for MS4s and LAs for precipitation induced sources of *E. coli* loading were determined according to the procedures in Appendix C. These allocations represent the available loading after application of the explicit MOS. WLAs for existing WWTPs are equal to their existing NPDES permit limits. Since WWTP permit limits require that *E. coli* concentrations must comply with water quality criteria (TMDL targets) (both single sample maximum and geomean) at the point of discharge and recognition that loading from these facilities are generally small in comparison to other loading sources, further reductions were not considered to be warranted. All waterbody IDs have a WLA term for WWTPs. The "q_m" term in the WLA_{WWTP} expression will be equal to the sum of the mean daily discharge for all WWTPs discharging to that waterbody ID. When there is no WWTP currently discharging to a waterbody ID (indicated by superscript e), the "q_m" term in the WLA_{WWTP} expression will be zero. The "q_m" term provides a future growth allowance to the WLA_{WWTP} expression when there is not an active WWTP, and when a WWTP goes online. WLAs for CAFOs and LAs for "other direct sources" (non-precipitation induced) are equal to zero. WLAs, & LAs are summarized in Table 10.

Table 10. TMDLs, WLAs, & LAs expressed as daily loads for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
0802	Cane Creek [d,e]	TN06020002081_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(2.595 \times 10^6 \times Q) – (2.88 \times 10^6 \times q_d)$	$(2.595 \times 10^6 \times Q) – (2.88 \times 10^6 \times q_d)$
0909	Dairy Branch [d,e]	TN06020002018_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(4.278 \times 10^7 \times Q) – (4.75 \times 10^7 \times q_d)$	$(4.278 \times 10^7 \times Q) – (4.75 \times 10^7 \times q_d)$
	Siccowee Branch [d,e]	TN06020002018_0300	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2\times10^{10} \times q_m)$	NA	$(1.841 \times 10^7 \times Q) – (2.05 \times 10^7 \times q_d)$	$(1.841 \times 10^7 \times Q) – (2.05 \times 10^7 \times q_d)$
1001	Middle Creek [e]	TN06020002082_0300	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(9.913 \times 10^5 \times Q) – (1.10 \times 10^6 \times q_d)$	$(9.913 \times 10^5 \times Q) – (1.10 \times 10^6 \times q_d)$
1002	Little Chestuee Creek [d,e]	TN06020002082_0900	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(3.668 \times 10^6 \times Q) – (4.08 \times 10^6 \times q_d)$	$(3.668 \times 10^6 \times Q) – (4.08 \times 10^6 \times q_d)$
	Chestuee Creek	TN06020002082_2000					$(8.371 \times 10^5 \times Q) – (9.30 \times 10^5 \times q_d)$	$(8.371 \times 10^5 \times Q) – (9.30 \times 10^5 \times q_d)$
1003	Tom Foeman Creek [d,e]	TN06020002082_1200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(4.302 \times 10^6 \times Q) – (4.78 \times 10^6 \times q_d)$	$(4.302 \times 10^6 \times Q) – (4.78 \times 10^6 \times q_d)$
	Big Foot Branch [d,e]	TN06020002082_1300					$(3.912 \times 10^6 \times Q) – (4.35 \times 10^6 \times q_d)$	$(3.912 \times 10^6 \times Q) – (4.35 \times 10^6 \times q_d)$
1101	Oostanaula Creek [e]	TN06020002083_4000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(1.858 \times 10^6 \times Q) – (2.07 \times 10^6 \times q_d)$	$(1.858 \times 10^6 \times Q) – (2.07 \times 10^6 \times q_d)$
		TN06020002083_5000					$(1.095 \times 10^7 \times Q) – (1.22 \times 10^7 \times q_d)$	$(1.095 \times 10^7 \times Q) – (1.22 \times 10^7 \times q_d)$
1102	Black Branch [d,e]	TN06020002083_0500	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(1.700 \times 10^7 \times Q) – (1.89 \times 10^7 \times q_d)$	$(1.700 \times 10^7 \times Q) – (1.89 \times 10^7 \times q_d)$
	Walker Branch [d,e]	TN06020002083_0510					$(3.354 \times 10^7 \times Q) – (3.73 \times 10^7 \times q_d)$	$(3.354 \times 10^7 \times Q) – (3.73 \times 10^7 \times q_d)$
	Oostanaula Creek	TN06020002083_1000					$(4.734 \times 10^5 \times Q) – (5.26 \times 10^5 \times q_d)$	$(4.734 \times 10^5 \times Q) – (5.26 \times 10^5 \times q_d)$
	Oostanaula Creek [d]	TN06020002083_2000					$(6.403 \times 10^5 \times Q) – (7.11 \times 10^5 \times q_d)$	$(6.403 \times 10^5 \times Q) – (7.11 \times 10^5 \times q_d)$
	Oostanaula Creek [d]	TN06020002083_3000					$(1.062 \times 10^6 \times Q) – (1.18 \times 10^6 \times q_d)$	$(1.062 \times 10^6 \times Q) – (1.18 \times 10^6 \times q_d)$
1201	Latham Springs Branch [d,e]	TN06020002084_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(6.453 \times 10^6 \times Q) – (7.17 \times 10^6 \times q_d)$	$(6.453 \times 10^6 \times Q) – (7.17 \times 10^6 \times q_d)$
	Little North Mouse Creek [d]	TN06020002084_0400					$(4.040 \times 10^6 \times Q) – (4.49 \times 10^6 \times q_d)$	$(4.040 \times 10^6 \times Q) – (4.49 \times 10^6 \times q_d)$
	North Mouse Creek [,e]	TN06020002084_2000					$(8.184 \times 10^5 \times Q) – (9.09 \times 10^5 \times q_d)$	$(8.184 \times 10^5 \times Q) – (9.09 \times 10^5 \times q_d)$
1202	Spring Creek [,d,e]	TN06020002085_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	NA	$(1.965 \times 10^6 \times Q) – (2.18 \times 10^6 \times q_d)$	$(1.965 \times 10^6 \times Q) – (2.18 \times 10^6 \times q_d)$

Table 10 (cont'd). TMDLs, WLAs, & LAs expressed as daily loads for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
1203	Dry Valley Creek [d,e]	TN06020002084_0500	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(2.642 \times 10^6 \times Q) - (2.94 \times 10^6 \times q_d)$	$(2.642 \times 10^6 \times Q) - (2.94 \times 10^6 \times q_d)$
	North Mouse Creek	TN06020002084_1000					$(4.388 \times 10^5 \times Q) - (4.88 \times 10^5 \times q_d)$	$(4.388 \times 10^5 \times Q) - (4.88 \times 10^5 \times q_d)$
1301	Candies Creek [e]	TN06020002005_3000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(2.043 \times 10^6 \times Q) - (2.27 \times 10^6 \times q_d)$	$(2.043 \times 10^6 \times Q) - (2.27 \times 10^6 \times q_d)$
1302	Black Fox Creek [d,e]	TN06020002005_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(3.278 \times 10^6 \times Q) - (3.64 \times 10^6 \times q_d)$	$(3.278 \times 10^6 \times Q) - (3.64 \times 10^6 \times q_d)$
1303	Candies Creek [e]	TN06020002005_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(3.120 \times 10^5 \times Q) - (3.47 \times 10^5 \times q_d)$	$(3.120 \times 10^5 \times Q) - (3.47 \times 10^5 \times q_d)$
	Beaverdam Creek [d,e]	TN06020002005_1100					$(1.468 \times 10^7 \times Q) - (1.63 \times 10^7 \times q_d)$	$(1.468 \times 10^7 \times Q) - (1.63 \times 10^7 \times q_d)$
1401	South Chestuee Creek [e]	TN06020002014_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(8.348 \times 10^5 \times Q) - (9.28 \times 10^5 \times q_d)$	$(8.348 \times 10^5 \times Q) - (9.28 \times 10^5 \times q_d)$
	South Chestuee Creek [d,e]	TN06020002014_2000					$(3.746 \times 10^6 \times Q) - (4.16 \times 10^6 \times q_d)$	$(3.746 \times 10^6 \times Q) - (4.16 \times 10^6 \times q_d)$
1402	Little Chatata Creek [d,e]	TN06020002012_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(3.212 \times 10^6 \times Q) - (3.57 \times 10^6 \times q_d)$	$(3.212 \times 10^6 \times Q) - (3.57 \times 10^6 \times q_d)$
	Rattlesnake Branch [d,e]	TN06020002012_0300					$(1.051 \times 10^7 \times Q) - (1.17 \times 10^7 \times q_d)$	$(1.051 \times 10^7 \times Q) - (1.17 \times 10^7 \times q_d)$
	Chatata Creek [e]	TN06020002012_1000					$(1.015 \times 10^6 \times Q) - (1.13 \times 10^6 \times q_d)$	$(1.015 \times 10^6 \times Q) - (1.13 \times 10^6 \times q_d)$
1403	Bacon Branch [d,e]	TN06020002008_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.660 \times 10^7 \times Q) - (1.85 \times 10^7 \times q_d)$	$(1.660 \times 10^7 \times Q) - (1.85 \times 10^7 \times q_d)$
1404	Fillauer Branch [d,e]	TN06020002009_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(7.930 \times 10^6 \times Q) - (8.81 \times 10^6 \times q_d)$	$(7.930 \times 10^6 \times Q) - (8.81 \times 10^6 \times q_d)$
	Woolen Mill Branch [d,e]	TN06020002009_0300					$(1.347 \times 10^7 \times Q) - (1.50 \times 10^7 \times q_d)$	$(1.347 \times 10^7 \times Q) - (1.50 \times 10^7 \times q_d)$
	South Mouse Creek [e]	TN06020002009_1000					$(8.873 \times 10^5 \times Q) - (9.86 \times 10^5 \times q_d)$	$(8.873 \times 10^5 \times Q) - (9.86 \times 10^5 \times q_d)$
	South Mouse Creek [d,e]	TN06020002009_2000					$(2.936 \times 10^6 \times Q) - (3.26 \times 10^6 \times q_d)$	$(2.936 \times 10^6 \times Q) - (3.26 \times 10^6 \times q_d)$
1405	Brush Creek [d,e]	TN06020002087_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(6.005 \times 10^6 \times Q) - (6.67 \times 10^6 \times q_d)$	$(6.005 \times 10^6 \times Q) - (6.67 \times 10^6 \times q_d)$
	UT to Rogers Creek [d,e]	TN06020002087_0600				$(2.3 \times 10^{10} \times q_2)$	$(1.011 \times 10^8 \times Q) - (1.12 \times 10^8 \times q_d)$	$(1.011 \times 10^8 \times Q) - (1.12 \times 10^8 \times q_d)$
	Rogers Creek	TN06020002087_1000				NA	$(6.473 \times 10^5 \times Q) - (7.19 \times 10^5 \times q_d)$	$(6.473 \times 10^5 \times Q) - (7.19 \times 10^5 \times q_d)$

Table 10 (cont'd). TMDLs, WLAs, & LAs expressed as daily loads for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
1406	Hiwassee River Embayment [d]	TN06020002008_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.330 \times 10^4 \times Q) - (1.48 \times 10^4 \times q_d)$	$(1.330 \times 10^4 \times Q) - (1.48 \times 10^4 \times q_d)$
1407	Agency Creek [d,e]	TN06020002001_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.997 \times 10^6 \times Q) - (2.22 \times 10^6 \times q_d)$	$(1.997 \times 10^6 \times Q) - (2.22 \times 10^6 \times q_d)$
	Price Creek [d,e]	TN06020002088_1000					$(5.777 \times 10^6 \times Q) - (6.42 \times 10^6 \times q_d)$	$(5.777 \times 10^6 \times Q) - (6.42 \times 10^6 \times q_d)$
1408	Gunstocker Creek [d,e]	TN06020002001_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.953 \times 10^6 \times Q) - (2.17 \times 10^6 \times q_d)$	$(1.953 \times 10^6 \times Q) - (2.17 \times 10^6 \times q_d)$

Notes: Q = Mean Daily In-stream Flow (cfs).
q_m = Mean Daily WWTP Flow (cfs)
q_d = Facility (WWTP) Design Flow (cfs)
q_2 = Estimated stormwater flow from permitted industrial point source (cfs)

a. WLAs for WWTPs are expressed as *E. coli* loads (CFU/day). All current and future WWTPs must meet water quality standards as specified in their NPDES permit.
b. Applies to any MS4 discharge loading in the subwatershed. Future MS4s will be assigned waste load allocations (WLAs) consistent with load allocations (LAs) assigned to precipitation induced NPS. See Section 9.2.2 for implementation details.
c. WLAs and LAs expressed as a "per acre" load are calculated based on the drainage area at the pour point of the HUC-12 subwatershed or drainage area (see Table A-1). As regulated MS4 area increases (due to future growth and/or new MS4 designation), unregulated LA area decreases by an equivalent amount. The sum will continue to equal total subwatershed area.
d. Waterbody Drainage Area (DA) is not coincident with HUC-12(s).
e. No WWTPs currently discharging into or upstream of the waterbody. (WLA[WWTPs] Expression is future growth term for new WWTPs.)
f. When there are no MS4s currently located in a subwatershed drainage area, the expression is a future growth term for expanding or newly designated MS4s.

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 Hiwassee River Watershed through reduction of excessive *E. coli* 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.

TMDL implementation activities will be accomplished within the framework of Tennessee's Watershed Approach . 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 non-governmental levels to be successful.

9.1 Application of Load Duration Curves for Implementation Planning

The Load Duration Curve (LDC) methodology (Appendix C) is a form of water quality analysis and presentation of data that aids in guiding implementation by targeting management strategies for appropriate flow conditions. One of the strengths of this method is that it can be used to interpret possible delivery mechanisms of *E. coli* by differentiating between point and nonpoint source problems. The load duration curve analysis can be utilized for implementation planning. See Cleland (2003) for further information on duration curves and TMDL development.

9.1.1 Flow Zone Analysis for Implementation Planning

A major advantage of the duration curve framework in TMDL development is the ability to provide meaningful connections between allocations and implementation efforts (USEPA, 2006). Because the flow duration interval serves as a general indicator of hydrologic condition (i.e., wet versus dry and to what degree), allocations and reduction goals can be linked to source areas, delivery mechanisms, and the appropriate set of management practices. The use of duration curve zones (e.g., high flow, moist, mid-range, dry, and low flow) allows the development of allocation tables (USEPA, 2006) (Appendix E), which can be used to guide potential implementation actions to most effectively address water quality concerns.

For the purposes of implementation strategy development, available *E. coli* data are grouped according to flow zones, with the number of flow zones determined by the HUC-12 subwatershed or drainage area size, the total contributing area (for non-headwater HUC-12s), and/or the baseflow characteristics of the waterbody. In general, for drainage areas greater than 40 square miles, the duration curves will be divided into five zones (Figure 23): high flows (exceeded 0-10% of the time), moist conditions (10-40%), median or mid-range flows (40-60%), dry conditions (60-90%), and low flows (90-100%). For smaller drainage areas, flows occurring in the low flow zone (baseflow conditions) are often extremely low and difficult to measure accurately. In many small drainage areas, extreme dry conditions are characterized by zero flow for a significant percentage of time. For this reason, the low flow zone may be characterized as a broader range of conditions (or percent time) with subsequently fewer flow zones. Therefore, for some HUC-12 subwatershed drainage areas less than 40 square miles, the duration curves will be divided into four zones: high flows (exceeded 0-10% of the time), moist conditions (10-40%), median or mid-range flows (40-70%), and low flows (70-100%). Some small (<40 mi^2) waterbody drainage areas have sustained baseflow (no zero flows) throughout their period of record. For these waterbodies, the duration curves will be divided into five zones.

Given adequate data, results (allocations and percent load reduction goals) will be calculated for all flow zones; however, less emphasis is placed on the upper 10% flow range for *E. coli* TMDLs and implementation plans. The highest 10 percent flows, representing flood conditions, are considered non-recreational conditions: unsafe for wading and swimming. Humans are not expected to enter the water due to the inherent hazard from high depths and velocities during these flow conditions. As a rule of thumb, the United States Geological Survey (USGS) *National Field Manual for the Collection of Water Quality Data* (Lane, 1997) advises its personnel not to attempt to wade a stream for which values of depth (ft) multiplied by velocity (ft/s) equal or exceed 10 ft^2/s to collect a water sample. Few observations are typically available to estimate loads under these adverse conditions due to the difficulty and danger of sample collection.

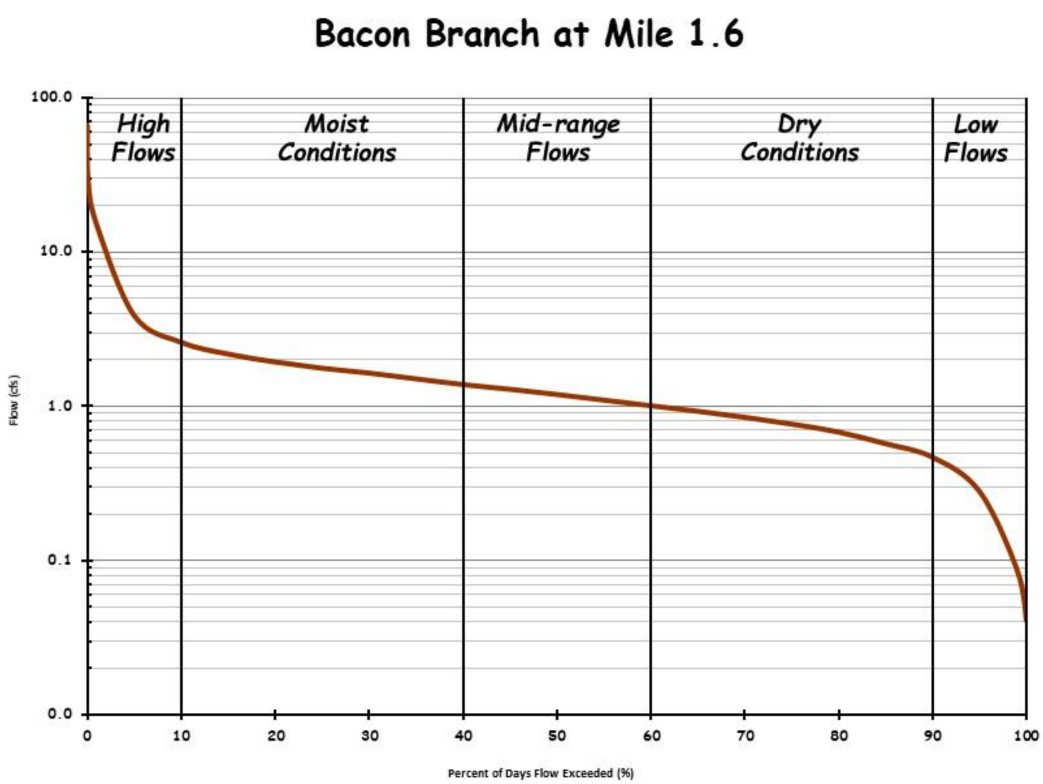

Figure 23. Five-Zone Flow Duration Curve for Bacon Branch at RM 1.6

9.1.2 Existing Loads and Percent Load Reductions

Each impaired waterbody has a characteristic set of pollutant sources and existing loading conditions that vary according to flow conditions. In addition, maximum allowable loading (assimilative capacity) of a waterbody varies with flow. Therefore, existing loading, allowable loading, and percent load reduction expressed at a single location on the LDC (for a single flow condition) do not appropriately represent the TMDL in order to address all sources under all flow conditions (i.e., at all times) to satisfy implementation objectives. The LDC approach provides a methodology for determination of assimilative capacity and existing loading conditions of a waterbody for each flow zone. Subsequently, each flow zone, and the sources contributing to impairment under the corresponding flow conditions, can be evaluated independently. Lastly, the critical flow zone (with the highest percent load reduction goal and/or the highest percent of samples exceeding the TMDL target) can be identified for prioritization of implementation actions.

Existing loading is calculated for each individual water quality sample as the product of the sample flow (cfs) times the single sample *E. coli* concentration (times a conversion factor). A percent load reduction is calculated for each water quality sample exceeding the single sample maximum water quality criterion as that required to reduce the existing loading to the product of the sample flow (cfs) times the single sample maximum water quality standard (times a conversion factor). Samples with negative percent load reductions (non-exceedance: concentration below the single sample maximum water quality criterion) are not factored into the calculation of the percent load reduction goals (PLRGs). The PLRG for a given flow zone is calculated as the mean of all the percent load reductions for a given flow zone. (See Appendix E.)

9.1.3 Critical Conditions

The critical condition for each impaired waterbody is defined as the flow zone with the largest PLRG and/or percent exceedance, excluding the “high flow” zone because these extremely high flows are not representative of recreational flow conditions, as described in Section 9.1.1. If the PLRG and/or percent exceedance in the high flow zone is greater than all the other zones, the zone with the second highest PLRG and/or percent exceedance will be considered the critical flow zone. The critical conditions are such that if water quality standards were met under those conditions, they would likely be met overall.

9.2 Point Sources

9.2.1 NPDES Regulated Municipal 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, including elimination of bypasses and overflows. With few exceptions, 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 WWTPs are derived from mean daily facility flows and permitted *E. coli* limits and are expressed as daily loads in CFU per day.

9.2.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

For discharges from current and future regulated MS4s, WLAs are and will be implemented through the appropriate MS4 permit. These permits typically require the development and implementation of a Storm Water Management Plan (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of state water quality standards. A monitoring component to assess the effectiveness of Best Management Practices (BMPs) is also typically included in the SWMP. Regulated MS4s that maintain compliance with the provisions of their NPDES permits are considered to be consistent with the assumptions and requirements of the WLAs of this TMDL.

For guidance on the six minimum control measures for MS4s regulated under Phase I or Phase II and a menu of BMPs representative of the types of practices that can successfully achieve them, a series of fact sheets are available at: http://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater.

For further information on Tennessee's MS4 permitting program (including links to individual MS4 programs and the Division of Water Resources (DWR)'s Permits Dataviewer) see:

https://www.tn.gov/content/tn/environment/permit-permits/water-permits1/npdes-permits1/npdes-stormwater-permitting-program/npdes-municipal-separate-storm-sewer-system--ms4--program.html

9.2.3 NPDES Regulated Industrial Stormwater

For present and future regulated stormwater discharges from industrial facilities, WLAs are and will be implemented through their NPDES permits. WLAs are derived from estimated stormwater flows and permitted *E. coli* limits and are expressed as average loads in CFU per day.

9.2.4 Regulated Concentrated Animal Feeding Operations (CAFOs)

There are currently no CAFOs present in the Hiwassee River Watershed with coverage under either a State Operating Permit (SOP) or an NPDES permit. Future CAFOs will be addressed through the appropriate CAFO SOP or NPDES permit. For further information, see: https://www.tn.gov/environment/permit-permits/water-permits1/concentrated-animal-feeding-operation--cafo--general-state-operating-permit.html.

9.3 Nonpoint Sources (NPS)

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most NPS discharges. Reductions of *E. coli* loading from 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. There are links to a number of publications and information resources on EPA's NPS web page relating to the implementation and evaluation of NPS pollution control measures.

EPA has recently published the CWSRF Best Practices Guide for Financing Nonpoint Source Solutions (December 2021). This guide is designed to help the state-level Clean Water State Revolving Fund programs apply best practices to address the challenge of NPS pollution. The guide suggests strategies and provides helpful case studies of successful and innovative partnerships underway across the country.

Effective application of agricultural, urban, and other NPS BMPs requires that these measures are properly planned, sited, and sized for implementation. An important aspect of the planning process is the identification of critical source areas (CSAs). EPA has recently published Critical Source Area Identification and BMP Selection: Supplement to Watershed Planning Handbook (USEPA, 2018b) to assist watershed project teams in determining where appropriate BMPs and BMP systems should be implemented to achieve water quality goals in the most efficient manner possible.

Local citizen-led and implemented management measures have the potential to provide the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. The Hiwassee River Watershed Coalition was a private-nonprofit organization dedicated to sustaining good water quality in creeks, lakes and rivers that flow into the Hiwassee River. The Coalition worked with local landowners, governments, schools, and businesses to understand and address threats to our water resources. In 2019, the Hiwassee River Watershed Coalition merged with Mountain True to become its Western Regional Office. Mountain True's Western Regional Office partners with and services communities in Western North Carolina's Cherokee, Clay, Graham, Haywood, Jackson, Macon, and Swain countries, as well as Towns and Union counties in North Georgia. Mountain True champions resilient forests, clean waters, and healthy communities in Western North Carolina and the Hiwassee watershed in North Georgia. They are committed to keeping the mountain region a beautiful place to live, work, and play. Members protect forests, clean up rivers, plan vibrant and livable communities, and advocate for a sound and sustainable future. Unfortunately, Mountain True is not currently active in Tennessee. Additional information about the Mountain True is available at: http://mountaintrue.org.

9.3.1 Urban NPS

Management measures to reduce *E. coli* loading from urban NPS are similar to those recommended for MS4s (Sect. 9.2.2). Specific categories of urban NPS include stormwater, illicit discharges, septic systems, pet waste, and wildlife.

Stormwater: Most mitigation measures for stormwater are not designed specifically to reduce bacteria concentrations (ENSR, 2005, p. 3-6). Instead, BMPs are typically designed to remove sediment and other pollutants. Bacteria in stormwater runoff are, however, often attached to particulate matter. Therefore, treatment systems that remove sediment may also provide reductions in bacteria concentrations.

Illicit discharges: Removal of illicit discharges to storm sewer systems, particularly of sanitary wastes, is an effective means of reducing *E. coli* loading to receiving waters (ENSR, 2005). These include intentional illegal connections from commercial or residential buildings, failing septic systems, and improper disposal of sewage from campers and boats.

Septic systems: When properly installed, operated, and maintained, septic systems effectively reduce *E. coli* concentrations in sewage. To reduce the release of *E. coli*, practices can be employed to maximize the life of existing systems, identify failed systems, and replace or remove failed systems (USEPA, 2005a). Alternatively, the installation of public sewers may be appropriate.

Pet waste: If the waste is not properly disposed of, these bacteria can wash into storm drains or directly into waterbodies and contribute to *E. coli* impairment. Encouraging pet owners to properly collect and dispose of pet waste is the primary means for reducing the impact of pet waste (USEPA, 2002b; USEPA, 2001).

Wildlife: Reducing the impact of wildlife on *E. coli* concentrations in waterbodies generally requires either reducing the concentration of wildlife in an area or reducing their proximity to the waterbody (ENSR, 2005). The primary means for doing this is to eliminate human inducements for wildlife congregation. In addition, in some instances wildlife population control measures may be appropriate.

Three additional urban NPS resource documents provided by EPA are:

National Management Measures to Control Nonpoint Source Pollution from Urban Areas helps citizens and municipalities in urban areas protect bodies of water from polluted runoff that can result from everyday activities. The scientifically sound techniques it presents are among the best practices known today. The guidance will also help states to implement their NPS control programs and municipalities to implement their Phase II Storm Water Permit Programs (Publication Number EPA 841-B-05-004, November 2005).

The Use of Best Management Practices (BMPs) in Urban Watersheds is a comprehensive literature review on commonly used urban watershed BMPs that heretofore was not consolidated. The purpose of this document is to serve as an information source to individuals and agencies/municipalities/watershed management groups/etc. on the existing state of BMPs in urban stormwater management (Publication Number EPA/600/R-04/184, September 2004).

The *National Menu of Stormwater Best Management Practices* website is based on the Stormwater Phase II Rule's six minimum control measures and was first released in October 2000. As recently as October, 2021, EPA has renamed, reorganized, updated, and enhanced the features of the website, including addition of new fact sheets and revisions of existing fact sheets. Fact sheets can be obtained by following the directions on the above website.

9.3.2 Agricultural NPS

BMPs have been implemented in the Hiwassee River Watershed to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. These BMPs (e.g., watering facilities, fencing, heavy use area treatment, livestock exclusion, etc.) may have contributed to reductions in in-stream concentrations of coliform bacteria in one or more Hiwassee River Watershed *E. coli*-impaired subwatersheds during the TMDL evaluation period. The Tennessee Department of Agriculture (TDA) keeps a database of TDA-administered BMPs implemented in Tennessee. Those listed in the Hiwassee River Watershed are shown in Figure 24. The NRCS has also implemented BMPs in the Hiwassee River Watershed. Identification and quantification of agricultural sources of coliform bacteria (e.g., livestock access to streams, manure application practices, etc.) would be necessary to increase success of future remediation efforts.

Implementation and monitoring of BMPs are essential to document performance in reducing coliform bacteria loading to surface waters from agricultural sources. Demonstration sites for various types of BMPs should be established and maintained, and their performance (in source reduction) evaluated prior to recommendations for utilization for subsequent implementation. *E. coli* sampling and monitoring during low-flow (baseflow) and storm periods at sites with and without BMPs and/or before and after implementation of BMPs are necessary to document appropriate BMP operation.

For additional information on agricultural BMPs in Tennessee, see the Tennessee Department of Agriculture Nonpoint Source Program Management Program Document.

An additional agricultural NPS resource is *National Management Measures to Control Nonpoint Source Pollution from Agriculture*, a technical guidance and reference document for use by state, local, and tribal managers in the implementation of NPS pollution management programs. It contains information on the best available, economically achievable means of reducing pollution of surface and groundwater from agriculture (EPA 841-B-03-004, July 2003). Information about specific BMPs can be obtained at the following website:

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/

9.3.3 Other NPS

Additional NPS references (not specifically addressing urban and/or agricultural sources) provided by EPA include:

National Management Measures to Control Nonpoint Source Pollution from Forestry helps forest owners protect lakes and streams from polluted runoff that can result from forestry activities. These scientifically sound techniques are the best practices known today. The report will also help states to implement their NPS control programs (EPA 841-B-05-001, May 2005).

9.4 Additional Monitoring

Additional monitoring and assessment activities will determine whether implementation of TMDLs, WLAs, & LAs has resulted in achievement of in-stream water quality targets for *E. coli*.

9.4.1 TMDL Monitoring

Future activities recommended for the Hiwassee River Watershed:

- Evaluate the effectiveness of implementation measures (see Sect. 9.6) and include BMP performance analysis and monitoring by permittees and stakeholders.
- Provide additional data to clarify status of ambiguous sites for potential listing as an impaired water.
- Continue ambient (long-term) monitoring at appropriate sites and key locations.

Comprehensive water quality monitoring activities include sampling during all seasons and a broad range of flow and meteorological conditions. This should be accomplished by monthly collection of *E. coli* data for a period of not less than one year. In addition, for individual monitoring locations, where historical *E. coli* data are greater than 2419 colonies/100 mL (or future samples are anticipated to be), a 1:10 (or 1:100) dilution should be performed as described in Protocol A of the *Quality System Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water* (TDEC, 2018).

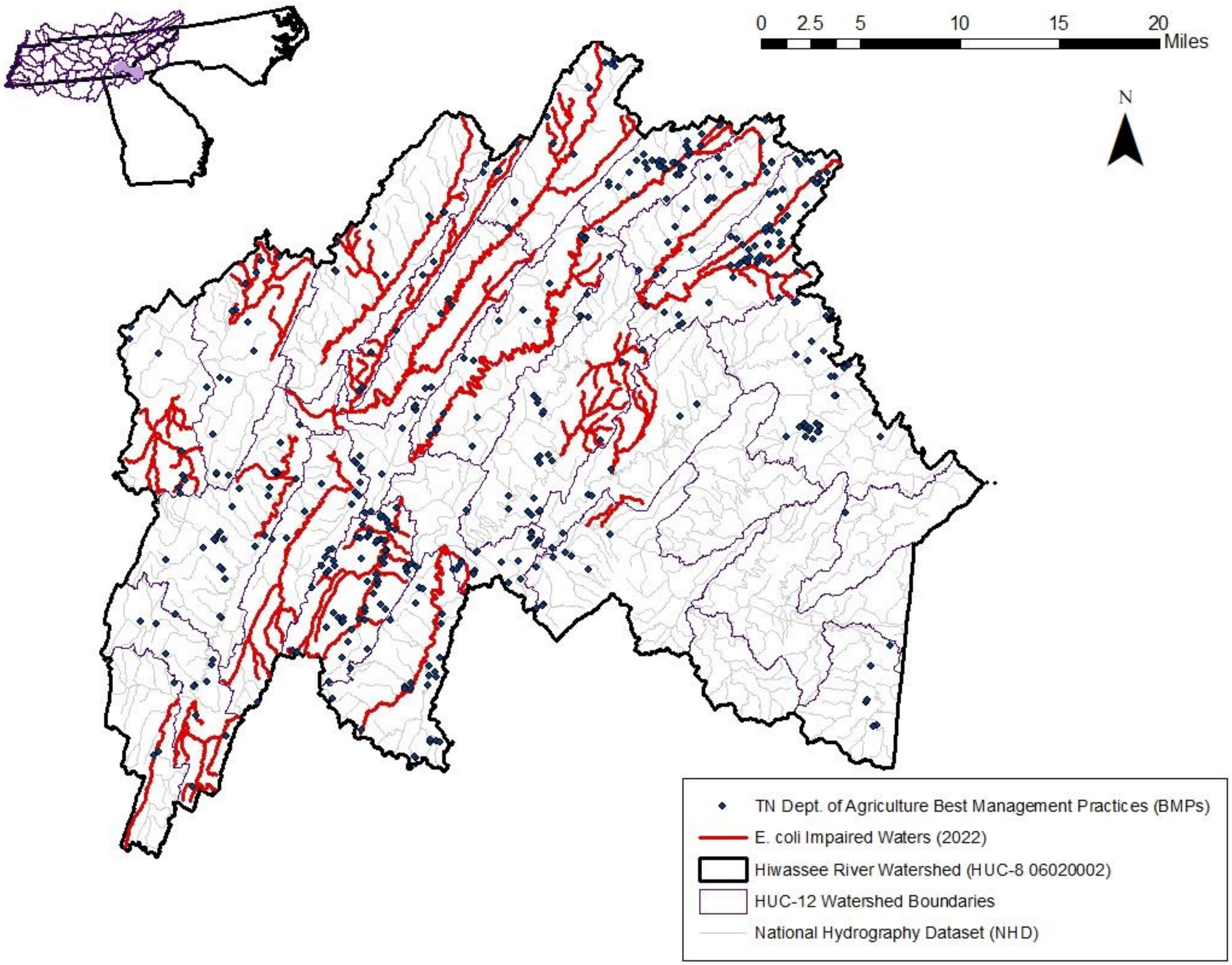

Figure 24. TDA-Administered Best Management Practices located in the Hiwassee River Watershed

9.4.2 Source Identification

An important aspect of *E. coli* load reduction activities is the accurate identification of the actual sources of pollution. In cases where the sources of *E. coli* impairment are not readily apparent, Microbial Source Tracking (MST) is one approach to determining the sources of fecal pollution and *E. coli* affecting a waterbody. Those methods that use bacteria as target organisms are also known as Bacterial Source Tracking (BST) methods. This technology is recommended for source identification in *E. coli* impaired waterbodies and can aid in determining implementation activities. However, regardless of the actual source of pollution (human vs other), any waterbody with enough exceedances of water quality standards will be considered impaired.

BST is a collective term used for various biochemical, chemical, and molecular methods that have been developed to distinguish sources of human and non-human fecal pollution in environmental samples (Shah, 2004). In general, these methods rely on genotypic (also known as "genetic fingerprinting"), or phenotypic (relating to the physical characteristics of an organism) distinctions between the bacteria of different sources. Three primary genotypic techniques are available for BST: ribotyping, pulsed field gel electrophoresis (PFGE), and polymerase chain reaction (PCR). Two prominent phenotypic techniques are available for BST: antibiotic resistance analysis (ARA) and carbon utilization profile (CUP). (Powell, 2014).

The USEPA has published a fact sheet that discusses BST methods and presents examples of BST application to TMDL development and implementation (USEPA, 2002b). Various BST projects and descriptions of the application of BST techniques used to guide implementation of effective BMPs to remove or reduce fecal contamination are presented. The fact sheet can be found on the following EPA website: http://www3.epa.gov/npdes/pubs/bacsortk.pdf.

"Advancements in Bacterial Source Tracking" is an article that provides information about: (1) general types of BST methods, and comparison of the advantages and disadvantages of several of these methodologies, (2) the value of adopting BST techniques in an effort to focus system improvements in a way that reduces costs by placing an emphasis on the right source(s) of bacteria (i.e., human versus non-human), and (3) advances in BST technology, including a list of reading sources to study this topic in greater detail.

A multi-disciplinary group of researchers at the University of Tennessee, Knoxville (UTK) developed and tested a series of different microbial assay methods based on real-time PCR to detect fecal bacterial concentrations and host sources in water samples (Layton, 2006). The assays have been used to study fecal contamination and have proven useful in identification of areas where livestock represent a significant fecal input and in development of BMPs. These types of assays have broad applications in monitoring fecal impacts from Animal Feeding Operations, as well as from wildlife and human sources. The value of these assays is in identifying the host, so that the BMPs can be tailored to address human or animal sources.

The EPA has recently completed a five-year review of its 2012 Recreational Water Quality Criteria as required by the BEACH Act amendments to the Clean Water Act (CWA). Since 2012, there has been significant progress toward the implementation of human source identification technologies. Research has shown that quantitative polymerase chain reaction (qPCR) methodologies are highly reproducible, but only with standardized protocols. Currently, draft EPA Methods for human fecal source identification are under internal review. The EPA has also entered into an Interagency Agreement with the National Institute of Standards and Technology to develop national DNA reference material. With continuing advances and broader application of these technologies, MST has great potential to improve water quality management and help protect public health. (USEPA, 2018a).

There are several projects in progress in various EPA regions. A project was presented at the 2019 Aquatic Sciences Meeting of ASLO which reported on Seasonality of Fecal Indicator Bacteria, Microbial Source Tracking Markers, and Pathogen Occurrence in an Urbanized Stream. A fact sheet has been published by the Southeast New England Program relating to Using Phylogenetics for Fecal Source Tracking in the SNEP Region. The full report is available here.

9.5 Source Area Implementation Strategy

Implementation strategies are organized according to the dominant landuse type and the sources associated with each (Table 11 and Appendix E). Additional considerations for classification of source area type include waterbody assessment information from EPA's Assessment and TMDL Tracking Implementation System (ATTAINS) and TDEC's WaterLog and subsequent Pollutant Source designation on TDEC's Water Quality Assessment. Each HUC-12 subwatershed and waterbody drainage area is grouped and targeted for implementation based on this source area classification. Three primary categories are identified: predominantly urban, predominantly agricultural, and mixed urban/agricultural. See Appendix A for information regarding landuse distribution of impaired subwatersheds. For the purpose of implementation evaluation, urban is defined as residential, commercial, and industrial landuse areas (landuse classifications: low, medium, and high intensity development) with predominant source categories such as point sources (WWTPs), collection systems/septic systems (including SSOs and Combined Sewer Overflows (CSOs)), and urban stormwater runoff associated with MS4s. Agricultural is defined as cropland and pasture, with predominant source categories associated with livestock and manure management activities. An assessment Pollutant Source designation of *Undetermined Source* warrants classification as mixed source area unless landuse is overwhelmingly dominated by urban or agricultural. A fourth category (infrequent) is associated with forested (including non-agricultural undeveloped and unaltered [by humans]) landuse areas with the predominant source category being wildlife.

All impaired waterbodies and corresponding HUC-12 subwatersheds or drainage areas have been classified according to their respective source area types in Table 11. The implementation for each area will be prioritized according to the guidance provided in Sections 9.5.1 and 9.5.2, below. For all impaired waterbodies, the determination of source area types serves to identify the predominant sources contributing to impairment (i.e., those that should be targeted initially for implementation). However, it is not intended to imply that sources in other landuse areas are not contributors to impairment and/or to grant an exemption from addressing other source area contributions with implementation strategies and corresponding load reduction. For mixed use areas, implementation will follow the guidance established for both urban and agricultural areas, at a minimum.

Appendix E provides source area implementation examples for urban and agricultural subwatersheds, development of percent load reduction goals, and determination of critical flow zones (for implementation prioritization) for *E. coli* impaired waterbodies. Load duration curve analyses (TMDLs, WLAs, LAs, and MOS) and percent load reduction goals for all flow zones for all *E. coli* impaired waterbodies in the Hiwassee River Watershed are summarized in Table E-36.

9.5.1 Urban Source Areas

For impaired waterbodies and corresponding HUC-12 subwatersheds or drainage areas classified as predominantly urban, implementation strategies for *E. coli* load reduction will initially and primarily target source categories similar to those listed in Table 12 (USEPA, 2006). Table 12 presents example urban area management practices and the corresponding potential relative effectiveness under each of the hydrologic flow zones. Each implementation strategy addresses a range of flow conditions and targets point sources, NPS, or a combination of each. For each waterbody, the existing loads and corresponding PLRG for each flow zone are calculated according to the method described in Section E.1. The resulting determination of the critical flow zone further focuses the types of urban management practices appropriate for development of an effective load reduction strategy for a particular waterbody.

9.5.2 Agricultural Source Areas

For impaired waterbodies and corresponding HUC-12 subwatersheds or drainage areas classified as predominantly agricultural, implementation strategies for *E. coli* load reduction will initially and primarily target source categories similar to those listed in Table 13 (USDA, 1988). Table 13 presents example agricultural area management practices and the corresponding potential relative effectiveness under each of the hydrologic flow zones. Each implementation strategy addresses a range of flow conditions and targets point sources, NPS, or a combination of each. For each waterbody, the existing loads and corresponding PLRG for each flow zone are calculated according to the method described in Section E.2. The resulting determination of the critical flow zone further focuses the types of agricultural management practices appropriate for development of an effective load reduction strategy for a particular waterbody.

Table 11. Source area types for waterbody drainage area analyses

HUC-12 / Waterbody	Source Area Type*			
	Urban	Agriculture	Mixed	Forested
Agency Creek (001_0100) DA		✓		
Bacon Branch (008_0100) DA		✓		
Beaverdam Creek (005_1100) DA			✓	
Big Foot Branch (082_1300) DA		✓		
Black Fox Creek (005_0100) DA			✓	
Brush Creek (087_0200) DA			✓	
Candies Creek (005_1000) DA			✓	
Candies Creek (HUC-12 1301)	✓			
Cane Creek (081_0100) DA	✓			
Chatata Creek (012_1000) DA	✓			
Chestuee Creek (HUC-12 1002)			✓	
Dairy Branch (018_0200) DA		✓		
Gunstocker Creek (001_0200) DA		✓		
Latham Springs Branch (084_0200) DA			✓	
Little Chatata Creek (012_0200) DA			✓	
Little North Mouse Creek (084_0400) DA			✓	

Table 11 (cont'd). Source area types for waterbody drainage area analyses

HUC-12 / Waterbody	Source Area Type*			
	Urban	Agriculture	Mixed	Forested
Middle Creek (HUC-12 1001)		✓		
North Mouse Creek (HUC-12 1203)			✓	
North Mouse Creek (084_2000) DA			✓	
Oostanaula Creek (HUC-12 1101)			✓	
Oostanaula Creek (HUC-12 1102)			✓	
Price Creek (088_1000) DA			✓	
Rattlesnake Branch (012_0300) DA			✓	
Rogers Creek (087_1000) DA			✓	
Siccowee Branch (018_0300) DA			✓	
South Chestuee Creek (HUC-12 1401)			✓	
South Mouse Creek (HUC-12 1404)	✓			
Spring Creek (HUC-12 1202)			✓	
Tom Foeman Branch (082_1200) DA		✓		
UT to Rogers Creek (087_0600) DA			✓	

* All waterbodies potentially have significant source contributions from other source type/landuse areas.

Table 12. Example Urban Area Management Practice/Hydrologic Flow Zone Considerations

Management Practice	Duration Curve Zone (Flow Zone)				
	High	**Moist**	**Mid-Range**	**Dry**	**Low**
Bacteria source reduction					
Remove illicit discharges			L	M	H
Address pet & wildlife waste		H	M	M	L
Combined sewer overflow management					
Combined sewer separation		H	M	L	
CSO prevention practices		H	M	L	
Sanitary sewer system					
Infiltration/Inflow mitigation	H	M	L	L	
Inspection, maintenance, and repair		L	M	H	H
SSO repair/abatement	H	M	L		
Illegal cross-connections					
Septic system management					
Managing private systems		L	M	H	M
Replacing failed systems		L	M	H	M
Installing public sewers		L	M	H	M
Storm water infiltration/retention					
Infiltration basin		L	M	H	
Infiltration trench		L	M	H	
Infiltration/Biofilter swale		L	M	H	
Storm Water detention					
Created wetland		H	M	L	
Low impact development					
Disconnecting impervious areas		L	M	H	
Bioretention	L	M	H	H	
Pervious pavement		L	M	H	
Green Roof		L	M	H	
Buffers		H	H	H	
New/existing on-site wastewater treatment systems					
Permitting & installation programs		L	M	H	M
Operation & maintenance programs		L	M	H	M
Other					
Point source controls		L	M	H	H
Landfill control		L	M	H	
Riparian buffers		H	H	H	
Pet waste education & ordinances		M	H	H	L
Wildlife management		M	H	H	L
Inspection & maintenance of BMPs	L	M	H	H	L

Note: Potential relative importance of management practice effectiveness under given hydrologic condition (*H: High, M: Medium, L: Low*)

Table 13. Example Agricultural Area Management Practice/Hydrologic Flow Zone Considerations

Flow Condition	High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded	0-10	10-40	40-60	60-90	90-100
Grazing Management					
Prescribed Grazing (528A)	H	H	M	L	
Pasture & Hayland Mgmt (510)	H	H	M	L	
Deferred Grazing (352)	H	H	M	L	
Planned Grazing System (556)	H	H	M	L	
Proper Grazing Use (528)	H	H	M	L	
Proper Woodland Grazing (530)	H	H	M	L	
Livestock Access Limitation					
Livestock Exclusion (472)			M	H	H
Fencing (382)			M	H	H
Stream Crossing			M	H	H
Alternate Water Supply					
Pipeline (516)			M	H	H
Pond (378)			M	H	H
Trough or Tank (614)			M	H	H
Well (642)			M	H	H
Spring Development (574)			M	H	H
Manure Management					
Managing Barnyards	H	H	M	L	
Manure Transfer (634)	H	H	M	L	
Land Application of Manure	H	H	M	L	
Composting Facility (317)	H	H	M	L	
Vegetative Stabilization					
Pasture & Hayland Planting (512)	H	H	M	L	
Range Seeding (550)	H	H	M	L	
Channel Vegetation (322)	H	H	M	L	
Brush (& Weed) Mgmt (314)	H	H	M	L	
Conservation Cover (327)		H	H	H	
Riparian Buffers (391)		H	H	H	
Critical Area Planting (342)		H	H	H	
Wetland restoration (657)		H	H	H	

Table 13(cont'd). Example Agricultural Area Management Practice/Hydrologic Flow Zone Considerations

Flow Condition	High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded	0-10	10-40	40-60	60-90	90-100
CAFO Management					
Waste Management System (312)	H	H	M		
Waste Storage Structure (313)	H	H	M		
Waste Storage Pond (425)	H	H	M		
Waste Treatment Lagoon (359)	H	H	M		
Mulching (484)	H	H	M		
Waste Utilization (633)	H	H	M		
Water & Sediment Control Basin (638)	H	H	M		
Filter Strip (393)	H	H	M		
Sediment Basin (350)	H	H	M		
Grassed Waterway (412)	H	H	M		
Diversion (362)	H	H	M		
Heavy Use Area Protection (561)					
Constructed Wetland (656)					
Dikes (356)	H	H	M		
Lined Waterway or Outlet (468)	H	H	M		
Roof Runoff Mgmt (558)	H	H	M		
Floodwater Diversion (400)	H	H	M		
Terrace (600)	H	H	M		
Potential for source area contribution under given hydrologic condition (H: High; M: Medium; L: Low)					

Note: Numbers in parentheses are the U.S. Soil Conservation Service practice number.

9.5.3 Forestry Source Areas

Many of the impaired watersheds in the Hiwassee River Watershed have a <u>land use</u> that is predominantly forested. However, none of these impaired watersheds have a <u>source area type</u> that is predominantly forested, with the predominant source category being wildlife.

9.6 Evaluation of TMDL Implementation Effectiveness

Evaluation of the effectiveness of TMDL implementation strategies should be conducted on multiple levels, as appropriate:

- HUC-12 or waterbody drainage area (i.e., TMDL analysis location)
- Subwatersheds or intermediate sampling locations
- Specific landuse areas (urban, pasture, etc.)
- Specific facilities (WWTP, CAFO, uniquely identified portion of MS4, etc.)
- Individual BMPs

In order to conduct an implementation effectiveness analysis on measures to reduce *E. coli* source loading, monitoring results should be evaluated in at least one of several ways. Sampling results can be compared to water quality standards (e.g., load duration curve analysis) for determination of impairment status, results can be compared on a before and after basis (temporal), or results can be evaluated both upstream and downstream of source reduction measures or source input (spatial). Considerations include period of record, data collection frequency, representativeness of data, and sampling locations.

In general, periods of record greater than 5 years (given adequate sampling frequency) can be evaluated for determination of relative change (trend analysis). For watersheds in second or successive TMDL cycles, data collected from multiple cycles can be compared. If implementation efforts have been initiated to reduce loading, evaluation of routine monitoring data may indicate improving or worsening conditions over time and corresponding effectiveness of implementation efforts.

Water quality data for implementation effectiveness analysis can be presented in multiple ways. The following examples are taken from the Hiwassee River watershed because the monitoring site (Oostanaula Creek at mile 28.4) has a large quantity of monitoring data available and the data demonstrate clear improvement between 1999 and 2008. Since 2008 the condition of Oostanaula Creek has remained relatively unchanged. There were no other monitoring sites in the Hiwassee River Watershed with a similar quantity of monitoring data available and showing a definite trend.

Figure 25 shows best fit curve analyses (regressions) of flow (percent time exceeded) versus *E. coli* loading, for a historical (1999-2004) period versus a more recent post-implementation period of sampling data (2005-2013). The LDCs of the single sample maximum and geometric mean water quality standards are also plotted to illustrate the relative degree of impairment for each period. Figure 26 shows an LDC analysis of *E. coli* loading statistics for Oostanaula Creek for the same two periods. In addition, the 90th percentiles for each flow zone are plotted for comparison. Lastly, Figure 27 shows *E. coli* concentration data statistics for recent versus historical data. The individual flow zone analyses are presented in a box and whisker plot of recent [2] versus historical [1] data. Note that Figures 25-27 present the same data, each clearly illustrating improving conditions between historical and recent periods.

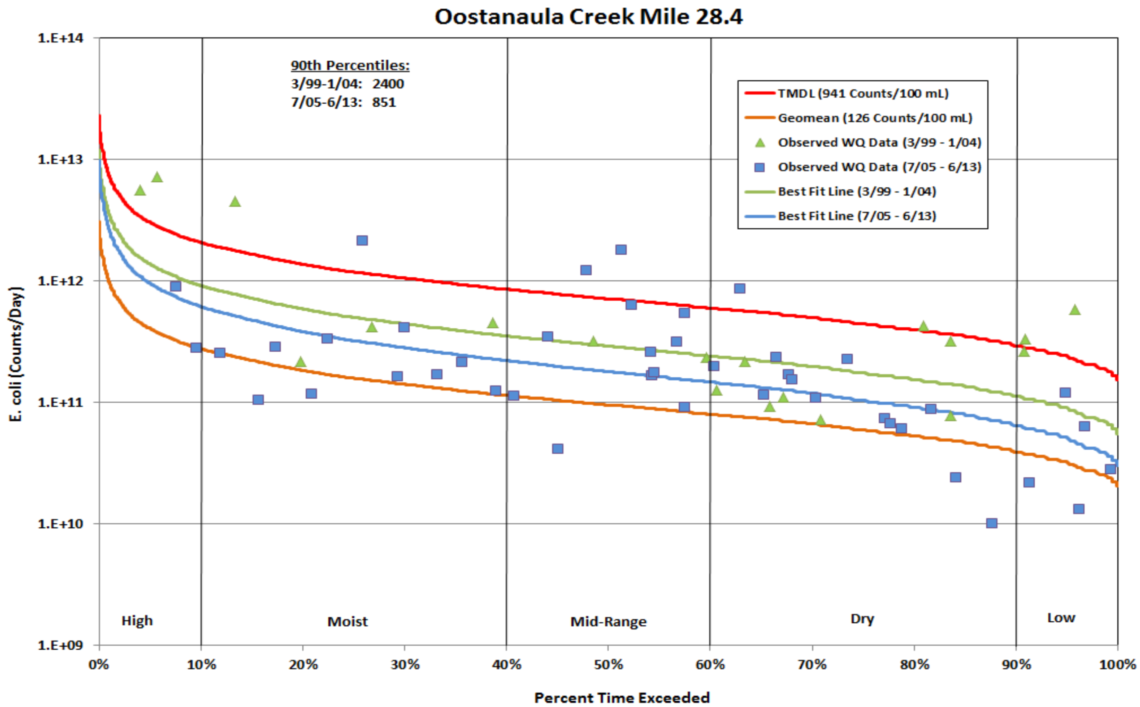

Figure 25. Example Graph of TMDL implementation effectiveness (LDC regression analysis)

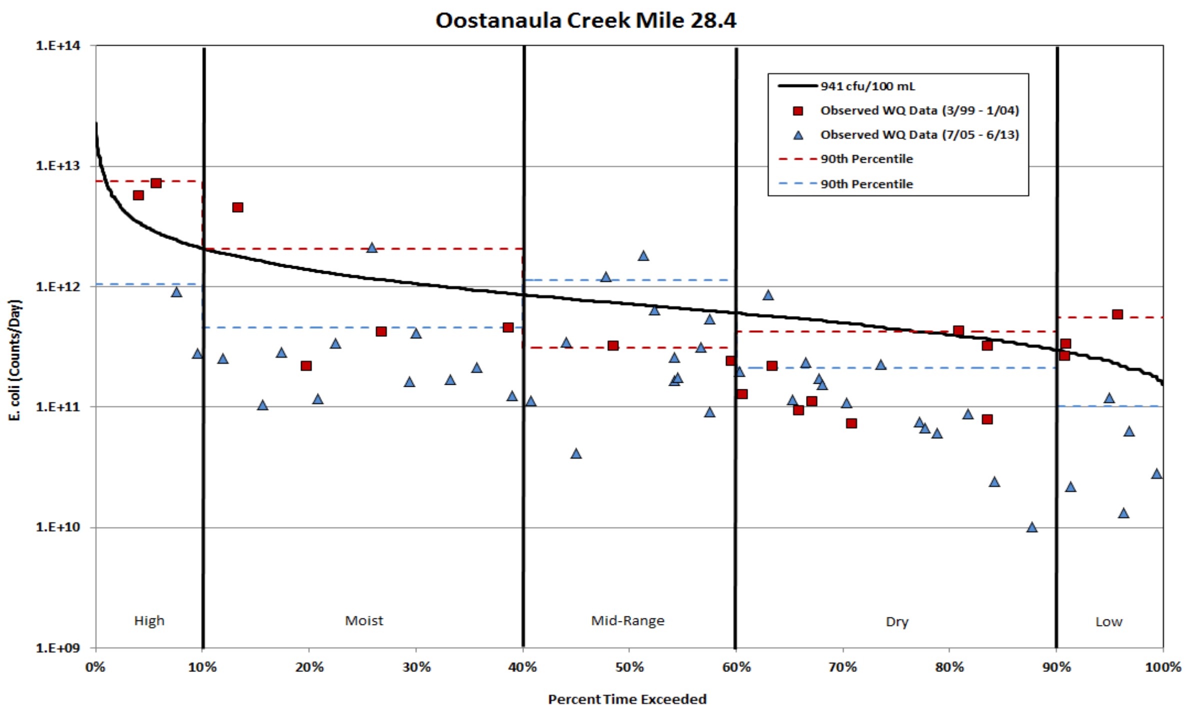

Figure 26. Example Graph of TMDL implementation effectiveness (LDC analysis)

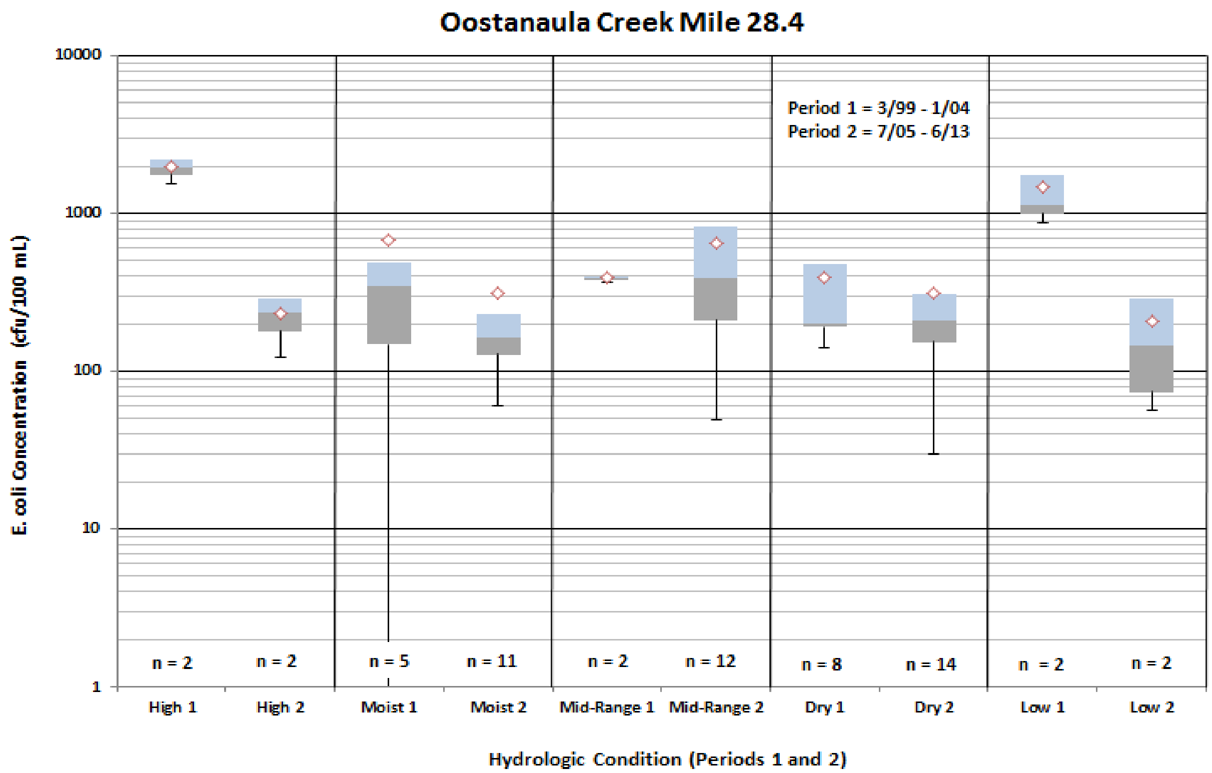

Figure 27. Example Graph of TMDL implementation effectiveness (box and whisker plot)

10.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed *E. coli* TMDLs for the Hiwassee River Watershed was placed on Public Notice for a 35-day period to solicit public review and comments. The public notice process included:

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

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice e-mail distributions which is sent to over 190 interested persons or groups who have requested this information.

3) Letters were sent via e-mail to WWTPs and other facilities located in *E. coli*-impaired subwatersheds or drainage areas in the Hiwassee River Watershed that are permitted to discharge treated effluent containing *E. coli*. The letters advised them of the availability of the proposed TMDLs, provided them a link to a downloadable version of the TMDL document, and notified them that a copy of the draft TMDL document would be provided on request. Letters were sent to the following facilities:

   Town of Englewood STP (TN0021938)
   Cumberland Mobile Home Park (TN0023396)
   Cleveland Utilities STP (TN0024121)
   AUB Oostanaula STP (TN0024201)
   City of Niota STP (TN0025470)
   City of Etowah STP (TN0063771)
   AUB North Mouse Creek STP (TN0067539)
   McMinn County Board of Education (Rogers Creek ES) (TN0067555)
   Meadow Branch Landfill (TN0067776)

4) Letters were sent via e-mail to those MS4s that are wholly or partially located in *E. coli*-impaired subwatersheds. The letters advised them of the availability of the proposed TMDLs, provided them a link to a downloadable version of the TMDL document, and notified them that a copy of the draft TMDL document would be provided on request. Letters were sent to the following MS4s:

   Bradley County, Tennessee (TNS077771)
   Hamilton County, Tennessee (TNS075566)
   City of Athens, Tennessee (TNS075141)
   City of Cleveland, Tennessee (TNS075213)
   Tennessee Dept. of Transportation (TNS077585)

5) Letters were sent via e-mail to local interagency and stakeholder groups in the Hiwassee River Watershed advising them of the availability of the proposed *E. coli* TMDLs, providing a link to a downloadable version of the TMDL document, and notifying them that a copy of the draft TMDL document would be provided upon request. Letters were sent to the following partners:

Georgia Dept. of Natural Resources,
    Environmental Protection Division
Mountain True (formerly Hiwassee River Watershed Coalition)
Natural Resources Conservation Service
North Carolina Dept. of Environmental Quality,
    Division of Water Resources
Southeast TN RC&D
Tennessee Department of Agriculture
Tennessee Valley Authority
Tennessee Wildlife Federation
Tennessee Wildlife Resources Agency
The Nature Conservancy

11.0 FURTHER INFORMATION

Further information can be found on the [TDEC TMDL Program web page].

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

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REFERENCES

California Dept. of Transportation (CalTrans). November 2003. *Discharge Characterization Study Report. CTSW-RT-03-065.51.42*. Available at the following website: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-03-065.pdf.

Center for Watershed Protection, 1999. *Watershed Protection Techniques*. Vol. 3. No. 1. Center for Watershed Protection. Ellicott City, MD. April 1999.

Cleland, Bruce, 2003. *TMDL Development from the "Bottom Up" – Part III: Duration Curves and Wet-Weather Assessments*. America's Clean Water Foundation. Washington, DC. September 2003. This document can be found at TMDLs.net, a joint effort of America's Clean Water Foundation, the Association of State and Interstate Water Resources Administrators, and EPA: https://www.researchgate.net/publication/228822472_TMDL_Development_from_the_Bottom_Up-_PART_III_Durations_Curves_and_Wet-Weather_Assessments

ENSR. 2005. *Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Manual for Massachusetts*. Prepared by ENSR International for U.S. Environmental Protection Agency, Region 1. July 2005.

Hyer, Kenneth E., and Douglas L. Moyer, 2004. *Enhancing Fecal Coliform Total Maximum Daily Load Models Through Bacterial Source Tracking*. Journal of the American Water Resources Association (JAWRA) 40(6):1511-1526. Paper No. 03180.

Lane, S. L., and R. G. Fay, 1997. *National Field Manual for the Collection of Water-Quality Data, Chapter A9. Safety in Field Activities: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. 9*. October 1997. This document is available on the USGS website: http://water.usgs.gov/owq/FieldManual/Chap9/content.html.

Layton, Alice, Gentry, Randy, and McKay, Larry, 2004. *Calculation of Stock Creek E. coli loads and partitioning of E. coli loads into that attributable to bovine using Bruce Cleland's Flow Duration Curve Models*. Personal note.

Layton, Alice, McKay, Larry, Williams, Dan, Garrett, Victoria, Gentry, Randall, and Sayler, Gary, 2006. *Development of Bacteriodes 16S rRNA Gene TaqMan-Based Real-Time PCR Assays for Estimation of Total Human, and Bovine Fecal Pollution in Water*. Applied and Environmental Microbiology (AEM), June 2006, p. 4214-4224.

Powell, Mike. 2014. *Advancements in Bacterial Source Tracking*. StormH2O, May 2014, p. 20-27. This document is available at the following website: https://www.foresternetwork.com/stormwater/stormwater-management/article/13010673/advancements-in-bacterial-source-tracking

Seaber, P. R., F. P. Kapinos, G.L. Knapp. 1987. Hydrologic Unit Maps: U.S. Geological Survey Water-Supply Paper 2294. http://pubs.usgs.gov/wsp/wsp2294/

Shah, Vikas G., Hugh Dunstan, and Phillip M. Geary, 2004. *Application of Emerging Bacterial Source Tracking (BST) Methods to Detect and Distinguish Sources of Fecal Pollution in Waters.* School of Environmental and Life Sciences, The University of Newcastle, Callaghan, NSW 2308 Australia.

Stiles, T., and B. Cleland, 2003, Using Duration Curves in TMDL Development & Implementation Planning. ASIWPCA "States Helping States" Conference Call, July 1, 2003. This document is available on the Indiana Office of Water Quality website: http://www.in.gov/idem/nps/files/monitoring_loads_duration_about_using.pdf.

TDEC. 2018. *Quality System Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water.* State of Tennessee, Department of Environment and Conservation, Division of Water Resources. August 2018.

TDEC. 2019. *State of Tennessee Water Quality Standards, Chapter 0400-40-03 General Water Quality Criteria.* State of Tennessee, Department of Environment and Conservation, Division of Water Resources. September 2019.

TDEC, 2022a. *List of Impaired and Threatened Waters*. State of Tennessee, Department of Environment and Conservation, Division of Water Resources, April 2022. This document is available on the TDEC website: https://www.tn.gov/environment/program-areas/wr-water-resources/water-quality/water-quality-reports---publications.html

TDEC, 2022b. *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems*. State of Tennessee, Department of Environment and Conservation, Division of Water Resources. This document is available on the TDEC website: https://dataviewers.tdec.tn.gov/dataviewers/f?p=2005:34051:9706895507031:::34051:P34051_PERMIT_NUMBER:TNS000000

USDA, 1988. *1-4 Effects of Conservation Practices on Water Quantity and Quality*. In *Water Quality Workshop, Integrating Water Quality and Quantity into Conservation Planning*. U.S. Department of Agriculture, Soil Conservation Service. Washington, D.C.

USDA, 2016. National Conservation Practice Standards. Available from USDA website URL: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/

USDA, 2019. 2017 Census of Agriculture, Tennessee State and County Data, Volume 1, Geographic Area Series, Part 42 (AC-12-A-42). USDA website URL: http://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Tennessee/tnv1.pdf. April 2019.

USEPA. 1991. *Guidance for Water Quality –based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

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

USEPA, 2001. *Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-916-F-01-027, July 2001.

USEPA, 2002a. *Animal Feeding Operations Frequently Asked Questions*. USEPA website URL: https://www.epa.gov/npdes/animal-feeding-operations-afos . September 12, 2002.

USEPA, 2002b. *Wastewater Technology Fact Sheet, Bacterial Source Tracking*. U.S. Environmental Protection Agency, Office of Water. Washington, D.C. EPA 832-F-02-010, May 2002. This document is available on the EPA website: http://www3.epa.gov/npdes/pubs/bacsortk.pdf

USEPA. 2003a. *National Management Measures to Control Nonpoint Source Pollution from Agriculture*. EPA 841-B-03-004. U.S. Environmental Protection Agency. Washington, DC. This document is available on the EPA website: (http://www.epa.gov/polluted-runoff-nonpoint-source-pollution/national-management-measures-control-nonpoint-source-0

USEPA. 2003b. Title 40. Protection of Environment; Chapter I. Environmental Protection Agency; Subchapter N. Effluent Guidelines and Standards; Part 412. Concentrated Animal Feeding Operations (CAFO) Point Source Category; Subpart C. Dairy Cows and Cattle Other Than Veal Calves; Section 412.31. Effluent limitations attainable by the application of the best practicable control technology current available (BPT). February 12, 2003. https://www.law.cornell.edu/cfr/text/40/412.31

USEPA. 2004. *The Use of Best Management Practices (BMPs) in Urban Watersheds*. U.S. Environmental Protection Agency, Office of Research and Development. Washington, D.C. EPA/600/R-04/184, September 2004.

USEPA. 2005a. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*. U.S. Environmental Protection Agency, Office of Water. Washington, D.C. EPA 841-B-05-004, November 2005. This document is available on the EPA website: (http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P10004FY.txt)

USEPA. 2005b. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. U.S. Environmental Protection Agency, Office of Water. Washington, D.C. EPA 841-B-05-001, May 2005. This document is available on the EPA website: (http://www.epa.gov/sites/production/files/2015-10/documents/2005_05_09_nps_forestrymgmt_guidance.pdf

USEPA, 2006. *An Approach for Using Load Duration Curves in Developing TMDLs.* U.S. Environmental Protection Agency, Office of Wetlands, Oceans, & Watersheds. Washington, D.C. Draft, December 2006.

USEPA, 2014. *Protection of Downstream Waters in Water Quality Standards: Frequently Asked Questions.* U.S. Environmental Protection Agency, Office of Water. Washington, D.C. EPA/820-F-14-001. June 2014.

USEPA, 2018a. *2017 Five-Year Review of the 2012 Recreational Water Quality Criteria*. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology. Washington, D.C. EPA/823-R-18-001. May 2018.

USEPA, 2018b. *Critical Source Area Identification and BMP Selection: Supplement to Watershed Planning Handbook.* U.S. Environmental Protection Agency, Office of Water, Nonpoint Source Management Branch, Washington, D.C. EPA/841-K-18-001. July 2018. This document is available on the EPA website: Critical Source Area Identification and BMP Selection: Supplement to Watershed Planning Handbook

USEPA, 2021. CWSRF Best Practices Guide for Financing Nonpoint Source Solutions: Building Successful Project Funding Partnerships. U.S. Environmental Protection Agency, Office of Water, Nonpoint Source Management Branch, Washington, D.C. EPA/841-B-21-012. December 2021. This document is available on the EPA website: CWSRF Best Practices Guide for Financing Nonpoint Source Solutions.

APPENDIX A

Land Use Distribution in the Hiwassee River Watershed

Table A-1. 2016 MRLC Land Use Distribution of Impaired HUC-12s & Drainage Areas

Landuse		Impaired Watershed (06020002____) or Waterbody Drainage Area (DA)					
		HUC-12 1001 (Middle Creek)		HUC-12 1002 (Chestuee Creek)		HUC-12 1101+1102 (Oostanaula Creek)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	31	0.15	27	0.11	57	0.13
21	Developed, Open Space	1,107	5.30	1,318	5.33	3,109	7.11
22	Developed, Low Intensity	589	2.82	695	2.81	1,863	4.26
23	Developed, Medium Intensity	223	1.07	314	1.27	901	2.06
24	Developed, High Intensity	65	0.31	82	0.33	337	0.77
31	Barren Land (Rock/Sand/Clay)	19	0.09	17	0.07	61	0.14
41	Deciduous Forest	4,857	23.3	6,956	28.1	12,054	27.6
42	Evergreen Forest	697	3.34	1,177	4.76	2,588	5.92
43	Mixed Forest	1,501	7.19	2,186	8.84	3,423	7.83
52	Shrub/Scrub	251	1.20	398	1.61	774	1.77
71	Grassland/Herbaceous	380	1.82	495	2.00	1,006	2.30
81	Pasture/Hay	9,432	45.2	9,448	38.2	15,749	36.0
82	Cultivated Crops	1,679	8.04	1,560	6.31	1,587	3.63
90	Woody Wetlands	40	0.19	45	0.18	162	0.37
95	Emergent Herbaceous Wetlands	10	0.05	10	0.04	48	0.11
21-24	Subtotal – Urban	1,984	9.50	2,408	9.74	6,209	14.2
81-82	Subtotal – Agriculture	11,111	53.2	11,008	44.5	17,336	39.7
All other	Subtotal - Forest	7,787	37.3	11,310	45.7	20,173	46.1
	Total	20,882	100.0	24,757	100.0	43,718	100.0

Table A-1 (cont'd). 2016 MRLC Land Use Distribution of Impaired HUC-12s & Drainage Areas

Landuse		Impaired Watershed (06020002____) or Waterbody Drainage Area (DA)					
		HUC-12 1201+1203 (North Mouse Creek)		HUC-12 1202 (Spring Creek)		HUC-12 1301 (Candies Creek - hw)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	127	0.27	16	0.15	38	0.38
21	Developed, Open Space	3,166	6.71	530	5.03	847	8.36
22	Developed, Low Intensity	1,915	4.06	281	2.67	354	3.49
23	Developed, Medium Intensity	901	1.91	133	1.26	155	1.53
24	Developed, High Intensity	321	0.68	28	0.27	51	0.50
31	Barren Land (Rock/Sand/Clay)	71	0.15	21	0.20	7	0.07
41	Deciduous Forest	15,436	32.72	4,376	41.54	3,619	35.72
42	Evergreen Forest	2,925	6.20	618	5.87	723	7.14
43	Mixed Forest	3,288	6.97	564	5.35	1,077	10.63
52	Shrub/Scrub	788	1.67	137	1.30	440	4.34
71	Grassland/Herbaceous	1,161	2.46	247	2.34	279	2.75
81	Pasture/Hay	15,766	33.42	3,347	31.77	2,457	24.25
82	Cultivated Crops	1,047	2.22	200	1.90	81	0.80
90	Woody Wetlands	198	0.42	27	0.26	1	0.01
95	Emergent Herbaceous Wetlands	66	0.14	9	0.09	2	0.02
21-24	Subtotal – Urban	6,303	13.36	972	9.23	1,406	13.88
81-82	Subtotal – Agriculture	16,814	35.64	3,547	33.67	2,538	25.05
All other	Subtotal - Forest	24,060	51.00	6,015	57.10	6,186	61.06
	Total	47,176	100.0	10,535	100.0	10,130	100

Table A-1 (cont'd). 2016 MRLC Land Use Distribution of Impaired HUC-12s & Drainage Areas

Landuse		Impaired Watershed (06020002____) or Waterbody Drainage Area (DA)					
		HUC-12 1301-1303 (Candies Creek - all)		HUC-12 1401 (South Chestuee Creek)		HUC-12 1402 (Chatata Creek)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	876	1.32	64	0.26	49	0.24
21	Developed, Open Space	6,216	9.37	1,912	7.71	2,145	10.5
22	Developed, Low Intensity	5,234	7.89	860	3.47	1,662	8.15
23	Developed, Medium Intensity	1,983	2.99	228	0.92	608	2.98
24	Developed, High Intensity	935	1.41	74	0.30	296	1.45
31	Barren Land (Rock/Sand/Clay)	20	0.03	20	0.08	10	0.05
41	Deciduous Forest	22,143	33.4	6,757	27.3	5,623	27.6
42	Evergreen Forest	4,597	6.93	1,902	7.67	718	3.52
43	Mixed Forest	4,418	6.66	1,892	7.63	820	4.02
52	Shrub/Scrub	1,088	1.64	687	2.77	247	1.21
71	Grassland/Herbaceous	1,532	2.31	1,009	4.07	638	3.13
81	Pasture/Hay	16,438	24.8	8,729	35.2	7,036	34.5
82	Cultivated Crops	418	0.63	560	2.26	504	2.47
90	Woody Wetlands	352	0.53	69	0.28	24	0.12
95	Emergent Herbaceous Wetlands	86	0.13	30	0.12	10	0.05
21-24	Subtotal – Urban	14,368	21.7	3,075	12.4	4,709	23.1
81-82	Subtotal – Agriculture	16,856	25.4	9,289	37.5	7,539	37.0
All other	Subtotal - Forest	35,112	52.9	12,431	50.1	8,138	39.9
	Total	66,336	100.0	24,795	100.0	20,387	100

Table A-1 (cont'd). 2016 MRLC Land Use Distribution of Impaired HUC-12s & Drainage Areas

Landuse		Impaired Watershed (06020002____) or Waterbody Drainage Area (DA)					
		HUC-12 1404 (South Mouse Creek)		HUC-12 1405 (RogersCreek)		Agency Creek DA (in HUC-12 1407)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	201	0.86	361	1.13	5	0.05
21	Developed, Open Space	3,075	13.2	1,452	4.54	351	3.39
22	Developed, Low Intensity	3,469	14.9	617	1.93	259	2.50
23	Developed, Medium Intensity	1,467	6.29	237	0.74	65	0.63
24	Developed, High Intensity	914	3.92	26	0.08	6	0.06
31	Barren Land (Rock/Sand/Clay)	30	0.13	35	0.11	0	0.00
41	Deciduous Forest	5,562	23.8	13,796	43.1	3,187	30.7
42	Evergreen Forest	1,024	4.39	2,399	7.50	675	6.51
43	Mixed Forest	833	3.57	1,884	5.89	602	5.81
52	Shrub/Scrub	180	0.77	518	1.62	553	5.33
71	Grassland/Herbaceous	560	2.40	873	2.73	423	4.08
81	Pasture/Hay	5,520	23.7	9,117	28.5	4,092	39.5
82	Cultivated Crops	287	1.23	438	1.37	73	0.70
90	Woody Wetlands	170	0.73	182	0.57	72	0.69
95	Emergent Herbaceous Wetlands	37	0.16	45	0.14	3	0.03
21-24	Subtotal – Urban	8,926	38.3	2,331	7.29	682	6.58
81-82	Subtotal – Agriculture	5,807	24.9	9,556	29.9	4,164	40.2
All other	Subtotal - Forest	8,597	36.9	20,093	62.8	5,519	53.2
	Total	23,329	100.0	31,980	100.0	10,366	100

Table A-1 (cont'd). 2016 MRLC Land Use Distribution of Impaired HUC-12s & Drainage Areas

Landuse		Impaired Watershed (06020002____) or Waterbody Drainage Area (DA)					
		Bacon Branch DA (in HUC-12 1403)		Big Foot Branch DA (in HUC-12 1003)		Cane Creek DA (in HUC-12 0802)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	8	0.68	15	0.28	12	0.15
21	Developed, Open Space	20	1.61	417	7.88	1,016	12.7
22	Developed, Low Intensity	4	0.30	135	2.55	749	9.39
23	Developed, Medium Intensity	3	0.27	29	0.54	445	5.58
24	Developed, High Intensity	2	0.20	4	0.07	205	2.57
31	Barren Land (Rock/Sand/Clay)	0	0.00	1	0.01	2	0.03
41	Deciduous Forest	183	14.7	929	17.6	1,815	22.8
42	Evergreen Forest	15	1.20	304	5.74	349	4.37
43	Mixed Forest	47	3.77	482	9.11	741	9.29
52	Shrub/Scrub	4	0.35	247	4.66	193	2.42
71	Grassland/Herbaceous	75	6.05	159	3.00	215	2.69
81	Pasture/Hay	704	56.5	2,274	43.0	2,221	27.9
82	Cultivated Crops	176	14.2	271	5.12	0	0.00
90	Woody Wetlands	3	0.24	20	0.38	6	0.08
95	Emergent Herbaceous Wetlands	1	0.06	8	0.15	8	0.10
21-24	Subtotal – Urban	30	2.38	584	11.0	2,415	30.3
81-82	Subtotal – Agriculture	880	70.6	2,545	48.1	2,221	27.9
All other	Subtotal - Forest	337	27.0	2,163	40.9	3,341	41.9
	Total	1,247	100	5,292	100	7,977	100.0

Table A-1 (cont'd). 2016 MRLC Land Use Distribution of Impaired HUC-12s & Drainage Areas

Landuse		Impaired Watershed (06020002____) or Waterbody Drainage Area (DA)					
		Dairy Branch DA (in HUC-12 0909)		Gunstocker Creek DA (in HUC-12 1408)		Hiwassee Embayment DA (all HUC-12s except 1301/02/03 & 1405/07/08)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	5	1.04	21	0.20	18,876	1.63
21	Developed, Open Space	38	7.95	624	5.89	86,969	7.51
22	Developed, Low Intensity	22	4.63	250	2.36	23,740	2.05
23	Developed, Medium Intensity	16	3.39	37	0.35	10,422	0.90
24	Developed, High Intensity	0	0.10	8	0.08	4,516	0.39
31	Barren Land (Rock/Sand/Clay)	0	0.03	3	0.03	1,505	0.13
41	Deciduous Forest	79	16.3	2,915	27.5	422,456	36.5
42	Evergreen Forest	3	0.70	877	8.27	81,990	7.08
43	Mixed Forest	29	6.00	854	8.06	297,387	25.7
52	Shrub/Scrub	3	0.60	88	0.83	14,128	1.22
71	Grassland/Herbaceous	4	0.81	271	2.56	17,255	1.49
81	Pasture/Hay	261	54.0	4,506	42.5	162,706	14.1
82	Cultivated Crops	22	4.46	143	1.35	13,202	1.14
90	Woody Wetlands	0	0.00	0	0.00	1,969	0.17
95	Emergent Herbaceous Wetlands	0	0.00	1	0.01	811	0.07
21-24	Subtotal – Urban	78	16.1	920	8.68	125,648	10.9
81-82	Subtotal – Agriculture	283	58.4	4,649	43.9	175,908	15.2
All other	Subtotal - Forest	123	25.5	5,031	47.5	856,377	74.0
	Total	484	100	10,600	100	1,158,049	100

Table A-1 (cont'd). 2016 MRLC Land Use Distribution of Impaired HUC-12s & Drainage Areas

Landuse		Impaired Watershed (06020002____) or Waterbody Drainage Area (DA)					
		Price Creek DA (in HUC-12 1407)		Siccowee Branch DA (in HUC-12 0909)		Tom Foeman Creek DA (in HUC-12 1003)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	2	0.05	1	0.22	4	0.09
21	Developed, Open Space	141	3.94	56	9.55	387	8.05
22	Developed, Low Intensity	61	1.69	29	5.01	196	4.07
23	Developed, Medium Intensity	15	0.42	0	0.00	74	1.54
24	Developed, High Intensity	0	0.00	23	3.99	23	0.48
31	Barren Land (Rock/Sand/Clay)	3	0.09	0	0.08	2	0.05
41	Deciduous Forest	1,705	47.6	161	27.5	872	18.1
42	Evergreen Forest	260	7.25	59	10.1	249	5.17
43	Mixed Forest	212	5.93	113	19.3	319	6.64
52	Shrub/Scrub	75	2.10	1	0.14	53	1.10
71	Grassland/Herbaceous	157	4.39	4	0.72	74	1.53
81	Pasture/Hay	942	26.3	137	23.4	2,351	48.9
82	Cultivated Crops	0	0.00	0	0.00	174	3.62
90	Woody Wetlands	9	0.24	0	0.00	30	0.62
95	Emergent Herbaceous Wetlands	1	0.03	0	0.00	1	0.03
21-24	Subtotal – Urban	217	6.05	109	18.6	680	14.1
81-82	Subtotal – Agriculture	942	26.3	137	23.4	2,526	52.5
All other	Subtotal - Forest	2,424	67.7	340	58.0	1,605	33.4
	Total	3,583	100.0	587	100	4,811	100

APPENDIX B

Water Quality Monitoring Data
for the Hiwassee River Watershed

The location of monitoring stations in the Hiwassee River watershed are shown in Figures 7 through 9. Exceedances of the appropriate *E. coli* standard are shown in red.

Table B-1. Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
AGENC002.1ME	7/24/07	15.6
	8/1/07	48.1
	8/6/07	23.1
	8/7/07	48.9
	8/13/07	44.7
	8/5/12	547.5
	8/21/12	123.6
	8/23/12	110.6
	9/5/12	58.3
	9/6/12	193.5
AGENC002.3ME	8/6/13	360.9
	8/8/13	365.4
	8/15/13	648.8
	8/20/13	461.1
	8/27/13	613.1
	7/10/17	488
	8/7/17	687
	9/26/17	206.4
	10/2/17	69.7
	11/13/17	185
	12/4/17	275.5
	1/9/18	272.3
	2/6/18	461.1
	3/21/18	1413.6
	4/9/18	548
	5/8/18	548
	6/5/18	276
BACON001.6PO	5/14/08	>2419.2
	5/20/08	>2419.2
	5/22/08	>2419.2
	5/27/08	>2419.2
	5/29/08	>2419.2

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
BACON001.6PO (cont'd)	8/9/12	>2419.6
	8/13/12	>2419.6
	8/21/12	>2419.6
	8/23/12	>2419.6
	8/28/12	>2419.6
	9/10/12	2419.6
	9/13/12	123.6
	10/4/12	156.5
	12/13/12	2419.6
	1/22/13	365.4
	7/18/17	>241960
	8/10/17	1413600
	9/20/17	249500
	10/3/17	185000
	11/2/17	48200
	12/11/17	198630
	1/16/18	24950
	2/1/18	4200
	3/8/18	2920
	4/26/18	120330
	5/3/18	14670
	6/11/18	435200
BEAVE000.1BR	7/10/07	365.4
	7/12/07	387.5
	7/16/07	129.1
	7/23/07	275.5
	7/30/07	178.2
	9/12/07	>2419.2
	10/31/07	648.8
	11/6/07	1986.28
	12/5/07	198.9
	12/11/07	261.3
	2/5/08	272.3
	3/12/08	139.6

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
BEAVE000.1BR (cont'd)	4/2/08	201.4
	5/7/08	920.8
	5/14/08	435.2
	5/20/08	387.3
	5/22/08	1986.3
	5/27/08	1732.9
	5/29/08	1299.7
	6/3/08	686.7
	8/14/12	290.9
	8/15/12	209.8
	8/20/12	517.2
	8/21/12	325.5
	8/23/12	313
	7/11/17	2420
BEAVE000.5BR	8/15/17	2420
	9/7/17	579.4
	10/3/17	2419.6
	11/6/17	>2419.6
	12/12/17	1986.3
	1/10/18	1413.6
	2/22/18	770.1
	3/7/18	172.5
	4/11/18	291
	5/9/18	1046
	6/6/18	>2420
BFOOT000.5MM	7/17/07	980.4
	12/17/07	1119.85
	4/7/08	228.2
	5/21/08	686.7
	5/28/08	980.4
	6/3/08	478.6
	6/4/08	1203.3
	6/16/08	613.1

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
BFOOT000.5MM (cont'd)	8/9/12	191.8
	8/13/12	166.4
	8/21/12	248.1
	8/23/12	228.2
	8/28/12	178.5
	7/18/17	59.2
	8/10/17	1986
	9/20/17	142.1
	10/3/17	65.7
	11/2/17	128.1
	12/11/17	114.5
	1/16/18	275.5
	2/1/18	238.2
	3/8/18	142.1
	4/26/18	261
	5/3/18	160
	6/11/18	120
BFOX000.5BR	7/11/07	>2419.2
	2/25/08	103.9
	3/31/08	>2419.2
	5/21/08	816.4
	5/28/08	75.9
	6/3/08	298.7
	6/4/08	920.8
	6/16/08	167
	8/14/12	579.4
	8/15/12	>2419.6
	8/20/12	275.5
	8/21/12	325.5
	8/23/12	517.2
	7/13/17	1986.3
	8/22/17	387
	9/19/17	218.7
	10/4/17	214.2
	11/15/17	275.5

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
BFOX000.5BR (cont'd)	12/6/17	1553.1
	1/11/18	155.3
	2/20/18	410.6
	3/8/18	866.4
	4/12/18	214
	5/10/18	194
	6/7/18	308
BLACK000.3MM	7/12/17	308
	8/8/17	411
	9/21/17	107.1
	10/18/17	387.3
	11/2/17	125.9
	12/12/17	435.2
	1/24/18	1413.6
	3/15/18	51.2
	4/12/18	225
	5/17/18	770
	6/20/18	980.4
BLACK000.5MM	8/7/12	365.4
	8/9/12	1413.6
	8/14/12	235.9
	8/15/12	1732.9
	8/21/12	>2419.6
BRUSH000.5MM	8/23/12	1986.3
	10/1/12	>2419.6
	2/21/13	27.2
	8/6/13	1553.1
	8/8/13	547.5
	8/13/13	547.5
	8/15/13	2419.6
	8/27/13	920.8
	7/10/17	249
	8/7/17	649

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
BRUSH000.5MM (cont'd)	9/26/17	517.2
	10/2/17	686.7
	11/13/17	461.1
	12/4/17	150
	1/9/18	122.3
	2/6/18	101.9
	3/21/18	131.4
	4/9/18	179
	5/8/18	1733
	6/5/18	579
CANDI008.1BR	8/2/12	>2419.6
	8/14/12	686.7
	8/15/12	387.3
	8/20/12	290.9
	8/21/12	290.9
	8/15/17	313
	9/7/17	302.6
	10/3/17	79.4
	11/6/17	261.3
	12/12/17	166.4
	1/10/18	218.7
	2/22/18	155.3
	3/7/18	410.6
	4/11/18	326
	5/9/18	228
	6/6/18	816
CANDI033.1BR	9/18/07	727
	9/25/07	>2419
	10/3/07	1553
	10/10/07	1203
	10/15/07	1046
	7/13/17	1119.9
	8/22/17	770
	9/19/17	816.4
	10/4/17	461.1
	11/15/17	727

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
CANDI033.1BR (cont'd)	12/6/17	1986.3
	1/11/18	980.4
	2/20/18	178.9
	3/8/18	461.1
	4/12/18	291
	5/10/18	980
	6/7/18	488
CANE001.5MM	1/14/04	249
	7/20/05	190
	10/31/05	140
	1/17/06	410.6
	5/22/06	>2419.2
	8/2/06	1046.24
	12/5/06	47.2
	2/27/07	272.3
	4/24/07	224.7
	8/7/07	1046.24
	10/9/07	178.5
	2/13/08	>2419.2
	4/16/08	64.4
	7/15/08	166.4
	11/12/08	178.5
	1/28/09	488.4
	8/31/09	1732.9
	3/10/10	165
	6/23/10	461.1
	10/13/10	866.4
	2/1/11	186
	4/26/11	228.2
	7/19/11	816.4
	10/4/11	116.2
	11/7/11	1
	2/27/12	119.8
	5/14/12	461.1
	7/25/12	613.1

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
CANE001.5MM (cont'd)	8/9/12	686.7
	8/13/12	387.3
	8/21/12	248.9
	8/23/12	270
	10/3/12	155.3
	1/8/13	166.4
	4/8/13	344.8
	10/2/13	1119.9
	1/8/14	187.2
	5/7/14	178.2
	8/25/14	579.4
	10/20/14	104.6
	3/17/15	187.2
	6/9/15	>2419.6
	8/26/15	547.5
	10/13/15	1986.3
	3/3/16	686.7
	6/7/16	387.3
	8/9/16	980.4
	10/12/16	91
	1/18/17	866.4
	5/3/17	214.3
	7/18/17	166.4
	10/2/17	214.2
	1/23/18	151.5
	4/4/18	387
	8/7/18	224.7
	10/15/18	228.2
	1/7/19	179.3
	5/7/19	307.6
	8/19/19	112.6
	10/10/19	90.9
	1/22/20	83.6
	6/17/20	98.7

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
CANE001.5MM (cont'd)	8/10/20	201.4
	10/13/20	222.4
	2/24/21	81.6
	4/13/21	261.3
	8/25/21	130
	11/16/21	115
	2/22/22	224.7
CHATA002.0BR	1/13/04	261
	5/11/04	1733
	3/5/08	>2419.6
	4/7/08	579.4
	5/12/08	770.1
	5/14/08	1413.6
	5/20/08	1732.87
	5/22/08	866.4
	5/27/08	816.4
	5/29/08	727
	6/10/08	>2419.6
	8/9/12	1553.1
	8/13/12	686.7
	8/21/12	517.2
	8/23/12	1413.6
	8/28/12	920.8
	3/14/13	387.3
	7/13/17	1553.1
	8/22/17	387
	9/19/17	488.4
	10/4/17	387.3
	11/15/17	980.4
	12/6/17	>2419.6
	1/11/18	248.1
	2/20/18	1413.6
	3/8/18	866.4
	4/12/18	>2420
	5/10/18	980
	6/7/18	866

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
CHEST041.1MM	7/12/17	1986
	8/8/17	>2420
	9/21/17	365.4
	10/18/17	866.4
	11/2/17	920.8
	12/12/17	816.4
	1/24/18	127.4
	2/1/18	325.5
	3/15/18	435.2
	4/12/18	548
	5/17/18	2420
	6/20/18	547.5
CHEST042.5MM	8/8/05	1300
	10/4/05	250
	1/4/06	547.5
	4/4/06	>2400
	7/10/06	>2419.2
	10/18/06	>2419.2
	1/17/07	727
	7/25/07	435.2
	8/1/07	613.1
	8/6/07	249.5
	8/8/07	2419.2
	8/13/07	770.1
	8/22/07	2419.17
	9/17/07	727
	10/31/07	>2419.2
	11/14/07	>2419.2
	12/11/07	1046.24
	12/17/07	613.1
	1/4/08	1732.87
	1/14/08	1732.87
	2/12/08	365.4
	2/13/08	>2419.2
	3/26/08	648.8
	4/15/08	866.4

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
CHEST042.5MM (cont'd)	5/27/08	461.1
	6/4/08	1119.9
	8/7/12	770.1
	8/9/12	>2419.6
	8/14/12	1046.2
	8/15/12	1203.3
	8/21/12	727
DAIRY001.2PO	2/11/04	4430
	5/14/08	196.8
	5/20/08	166.9
	5/22/08	1299.7
	5/27/08	2419.6
	5/29/08	2419.6
DVALL000.2MM	7/11/07	81.3
	9/24/07	209.8
	2/25/08	128.1
	3/31/08	488.4
	5/21/08	307.6
	5/28/08	178.5
	6/3/08	161.6
	6/4/08	920.8
	6/16/08	137.4
	8/15/12	461.1
	8/21/12	155.3
	8/23/12	186
	9/5/12	238.2
	9/6/12	686.7
	7/10/17	579
	8/7/17	272
	9/26/17	90.8
	10/2/17	68.3
	11/13/17	95.9
	12/4/17	80.9
	1/9/18	214.2
	2/6/18	238.2
	3/21/18	920.8

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
DVALL000.2MM (cont'd)	4/9/18	308
	5/8/18	238
	6/5/18	186
FILLA000.1BR	5/14/08	517.2
	5/20/08	435.2
	5/22/08	325.5
	5/27/08	727
	5/29/08	2419.6
	8/14/12	547.5
	8/15/12	1046.2
	8/20/12	410.6
	8/21/12	410.6
	8/23/12	488.4
	9/13/12	143.9
	9/17/12	770.1
	9/20/12	210.5
	9/26/12	290.9
	8/22/17	548
FILLA000.3BR	10/3/12	143.9
	7/13/17	770.1
	9/19/17	387.3
	10/4/17	228.2
	11/15/17	133.4
	12/6/17	410.6
	1/11/18	387.3
	2/20/18	140.8
	3/8/18	167
	4/12/18	387
	5/10/18	272
	6/7/18	435
GUNST003.0ME	7/11/07	275.5
	9/24/07	410.6
	2/25/08	95.9
	3/31/08	133.4
	5/21/08	116.2
	5/28/08	201.4

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
GUNST003.0ME (cont'd)	6/3/08	90.8
	6/4/08	249.5
	6/16/08	547.5
	8/2/12	344.8
	8/15/12	365.4
	8/21/12	167
	8/23/12	816.4
	9/5/12	410.6
	9/6/12	727
	7/11/17	365
	8/15/17	166
	9/7/17	435.2
	10/3/17	248.1
	11/6/17	290.9
	12/12/17	387.3
	1/10/18	365.4
	2/22/18	410.6
	3/7/18	214.3
	4/11/18	214
	5/9/18	276
	6/6/18	1300
HIWAS013.4MM	3/9/04	1200
	7/7/04	180
	12/1/04	820
	2/23/05	870
	5/11/05	6
	7/26/05	1
	11/9/05	2
	2/1/06	172.3
	5/9/06	83.5
	7/25/06	7.4
	11/14/06	24.6
	3/14/07	12.2
	5/29/07	6.3
	8/14/07	13.5
	11/27/07	>2419.2

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
HIWAS013.4MM (cont'd)	3/18/08	1986.28
	5/28/08	9.8
	9/30/08	5.2
	12/30/08	195.6
	4/22/09	1413.6
	6/15/09	90.8
	8/26/09	40.4
	3/31/10	235.9
	7/27/10	15.5
	10/19/10	19.9
	3/16/11	1203.3
	5/17/11	83.6
	7/26/11	12.1
	10/12/11	55.6
	3/13/12	124.6
	5/9/12	15.8
	8/1/12	7.4
	12/12/12	>2419.6
	2/27/13	488.4
	5/13/13	83.6
	8/20/13	1553.1
	10/9/13	37.9
	3/12/14	28.7
	5/13/14	30.7
	8/21/14	816.4
	10/20/14	27.5
	3/18/15	64.4
	6/11/15	579.4
	9/10/15	88.2
	10/12/15	115.3
	3/10/16	34.1
	6/7/16	78
	8/11/16	26.6
	10/19/16	>2419.6
	10/25/16	20.6
	5/8/17	1046.2

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
HIWAS013.4MM (cont'd)	9/26/17	9.6
	11/15/17	43.5
	3/22/18	104.6
	5/23/18	1203
	7/18/18	70.8
	10/23/18	25.6
	3/13/19	79.4
	6/10/19	159.7
	9/3/19	10.8
	11/19/19	30.9
	3/4/20	>2419.6
	6/10/20	73.8
	8/12/20	22.6
	12/7/20	488
	2/9/21	16.1
	6/16/21	6.3
	9/16/21	35
	10/20/21	53
LCHAT000.3BR	2/12/08	517.2
	3/5/08	980.4
	4/7/08	579.4
	5/12/08	686.7
	5/14/08	1553.07
	5/20/08	1119.85
	5/22/08	547.5
	5/27/08	1553.1
	6/10/08	2419.6
	8/9/12	>2419.6
	8/13/12	1203.3
	8/21/12	2419.6
	8/23/12	1413.6
	8/28/12	>2419.6
	7/13/17	517.2
	8/22/17	411
	9/19/17	1413.6
	10/4/17	866.4

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
LCHAT000.3BR (cont'd)	11/15/17	1046.2
	12/6/17	>2419.6
	1/11/18	209.8
	2/20/18	1413.6
	3/8/18	139.6
	4/12/18	435
	5/10/18	687
	6/7/18	411
LCHES001.6MM	7/25/07	2419.17
	8/1/07	1986.28
	8/6/07	2419.2
	8/8/07	2419.2
	8/13/07	2419.17
	8/22/07	1986.28
	9/17/07	1203.31
	10/31/07	1119.85
	11/14/07	1299.65
	12/11/07	648.8
	12/17/07	298.7
	1/14/08	1413.6
	2/13/08	>2419.2
	3/26/08	1046.24
	4/15/08	2419.17
	6/4/08	>2419.6
	8/7/12	>2419.6
	8/9/12	>2419.6
	8/14/12	>2419.6
	8/15/12	>2419.6
	8/21/12	>2419.6
	7/12/17	727
	8/8/17	>2420
	9/21/17	686.7
	10/18/17	980.4
	11/2/17	1299.7
	12/12/17	461.1
	1/24/18	727

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
LCHES001.6MM (cont'd)	2/1/18	1203.3
	3/15/18	517.2
	4/12/18	488
	5/17/18	>2420
	6/20/18	>2419.6
LNMOU000.1MM	1/13/04	100
	5/11/04	200
	1/4/05	68.3
	8/8/05	210
	10/4/05	75
	4/4/06	40
	7/10/06	69.7
	10/18/06	290.9
	1/17/07	53.6
	9/12/12	129.6
	10/9/12	107.1
	2/20/13	68.2
	4/10/13	41.4
LNMOU002.4MM	7/11/17	308
	8/7/17	345
	9/11/17	151.5
	10/26/17	325.5
	11/14/17	1299.7
	12/7/17	613.1
	1/25/18	344.8
	2/20/18	2419.6
	3/13/18	517.2
	4/5/18	248
	5/15/18	179
	6/14/18	166
LSPRI000.4MM	9/12/12	648.8
	10/9/12	1046.2
	2/20/13	157.6
	4/10/13	120.1
	8/6/13	648.8
	8/8/13	110.6

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
LSPRI000.4MM (cont'd)	8/13/13	686.7
	8/15/13	613.1
	8/27/13	228.2
	7/11/17	308
	8/7/17	84
	9/11/17	78.9
	10/26/17	55.7
	11/14/17	105
	12/7/17	78.5
	1/25/18	12.1
	2/20/18	435.2
	3/13/18	325.5
	4/5/18	326
	5/15/18	2420
	6/14/18	142
MIDDL004.6MM	7/17/07	816.4
	10/3/07	1119.85
	12/17/07	1203.31
	1/14/08	920.8
	4/7/08	613.1
	5/21/08	2419.6
	5/28/08	2419.6
	6/3/08	1011.2
	6/4/08	2419.6
	6/16/08	2419.6
	7/12/17	40
	8/8/17	2420
	9/21/17	>2419.6
	10/18/17	>2419.6
	11/2/17	1732.9
	12/12/17	>2419.6
	1/24/18	2419.6
	2/1/18	1553.1
	3/15/18	816.4
	4/12/18	1414

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
MIDDL004.6MM (cont'd)	5/17/18	>2420
	6/20/18	1986.3
NMOUS004.2MM	1/13/04	410
	5/11/04	310
	8/1/05	160
	1/3/06	290.9
	4/4/06	1100
	7/10/06	613.1
	10/2/06	155.3
	1/16/07	209.8
	5/8/07	127.4
	7/24/07	209.8
	8/1/07	186
	8/6/07	123.6
	8/8/07	365.4
	8/13/07	90.6
	8/21/07	90.6
	9/10/07	98.8
	10/8/07	261.3
	12/10/07	>2419.2
	12/17/07	88.4
	1/16/08	272.3
	2/4/08	344.8
	3/10/08	866.4
	3/31/08	152.9
	5/13/08	248.9
	6/16/08	118.7
	7/23/12	416
	8/15/12	365.4
	8/15/12	250
	8/21/12	214.2
	8/23/12	290.9
	9/5/12	151.5
	9/6/12	387.3
NMOUS007.3MM	7/10/17	579
	8/7/17	112

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
NMOUS007.3MM (cont'd)	9/26/17	129.1
	10/2/17	86
	11/13/17	387.3
	12/4/17	62
	1/9/18	159.7
	2/6/18	260.3
	3/21/18	1553.1
	4/9/18	249
	5/8/18	214
	6/5/18	130
NMOUS024.3MM	1/13/04	100
	5/11/04	100
	8/8/05	>2400
	10/4/05	180
	1/4/06	344.8
	4/4/06	330
	7/10/06	325.5
	10/18/06	>2419.2
	1/17/07	344.8
	7/25/07	365.4
	8/1/07	517.2
	8/6/07	344.8
	8/8/07	238.2
	8/13/07	488.4
	8/22/07	148.3
	9/17/07	224.7
	10/31/07	111.2
	11/14/07	48.2
	12/11/07	488.4
	12/17/07	248.1
	1/14/08	228.2
	2/13/08	686.7
	3/26/08	238.2
	4/15/08	435.2
	5/27/08	248.1
	6/4/08	325.5

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
NMOUS024.3MM (cont'd)	7/25/12	365.4
	8/7/12	488.4
	8/9/12	160.7
	8/14/12	435.2
	8/15/12	307.6
	7/11/17	461
	8/7/17	201
	9/11/17	90.6
	10/26/17	77.1
	11/14/17	365.4
	12/7/17	83.6
	1/25/18	35.5
	2/20/18	88.6
	3/13/18	307.6
	4/5/18	70
	5/15/18	411
	6/14/18	185
NMOUS025.4MM	7/11/17	261
	8/7/17	248
	9/11/17	77.6
	10/26/17	79.4
	11/14/17	191.8
	12/7/17	121
	1/25/18	18.3
	2/20/18	151.5
	3/13/18	285.1
	4/5/18	65
	5/15/18	236
	6/14/18	185
OOSTA005.8MM	1/14/04	236
	7/9/07	108.1
	8/1/07	613.1
	8/6/07	866.4
	8/8/07	517.2
	8/13/07	547.5
	8/15/07	613.1

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
OOSTA005.8MM (cont'd)	9/11/07	307.6
	11/13/07	103.6
	12/4/07	488.4
	1/29/08	435.2
	3/5/08	>2419.2
	4/7/08	228.2
	5/12/08	980.4
	6/10/08	290.9
	7/25/12	228.2
	8/15/12	68.9
	8/21/12	178.5
	8/23/12	307.6
	9/5/12	93.3
	9/6/12	125
	10/3/12	81.6
	11/7/12	328.2
	12/18/12	>2419.6
	1/8/13	117.8
	2/12/13	123.6
	3/4/13	29.2
	4/8/13	103.9
	5/13/13	325.5
	6/27/13	517.2
	7/10/17	816
	8/7/17	166
	9/26/17	172.3
	10/2/17	172.5
	11/13/17	488.4
	12/4/17	>2419.6
	1/9/18	>2419.6
	2/6/18	224.7
	3/21/18	613.1
	4/9/18	225
	5/8/18	101
	6/5/18	250

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
OOSTA011.6MM	7/25/12	313
	8/15/12	325.5
	8/21/12	184.2
	8/23/12	285.1
	9/5/12	101.7
	9/6/12	248.1
	10/3/12	261.3
	11/7/12	387.3
	12/18/12	>2419.6
	1/8/13	218.7
	2/12/13	107.1
	3/4/13	23.1
	4/8/13	77.1
	5/13/13	517.2
	6/27/13	307.6
OOSTA018.0MM	7/10/17	770
	8/7/17	345
	9/26/17	166.4
	10/2/17	108.1
	11/13/17	325.5
	12/4/17	325.5
	1/9/18	62.4
	2/6/18	67
	3/21/18	1046.2
	4/9/18	199
	5/8/18	205
	6/5/18	291
OOSTA028.4MM	3/9/99	>2400
	6/8/99	200
	9/13/99	>2400
	12/7/99	820
	3/7/00	370
	6/12/00	140
	9/19/00	870
	12/11/00	160
	3/13/01	>2400

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
OOSTA028.4MM (cont'd)	9/11/01	200
	3/25/02	1
	8/7/02	1120
	9/25/02	1046
	10/22/02	200
	1/14/03	488
	2/19/03	1553
	3/5/03	148
	8/20/03	411
	11/5/03	365
	1/14/04	345
	7/20/05	410
	10/31/05	30
	1/17/06	135.4
	5/22/06	1553.7
	8/2/06	63.7
	12/5/06	137.6
	2/27/07	816.4
	4/24/07	198.9
	8/15/07	290.9
	11/13/07	146.7
	12/4/07	73.8
	1/29/08	166.4
	3/26/08	142.1
	4/15/08	365.4
	5/27/08	214.2
	6/4/08	139.6
	7/15/08	235.9
	11/12/08	57.1
	1/28/09	126.7
	8/31/09	307.6
	3/10/10	214.3
	6/23/10	410.6
	10/13/10	461.1

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
OOSTA028.4MM (cont'd)	2/1/11	49.6
	4/26/11	178.9
	7/19/11	461.1
	10/4/11	866.4
	2/27/12	83
	5/14/12	>2419.6
	7/25/12	1413.6
	8/7/12	206.4
	8/9/12	275.5
	8/14/12	461.1
	8/15/12	307.6
	10/3/12	248.9
	11/7/12	149.7
	12/18/12	1732.9
	1/8/13	365.4
	2/12/13	127.4
	3/4/13	60.2
	4/8/13	123.6
	5/13/13	344.8
	6/27/13	248.1
	10/2/13	155.3
	1/8/14	86.7
	5/7/14	547.5
	8/25/14	275.5
	10/20/14	95.9
	3/17/15	90.9
	6/9/15	686.7
	8/26/15	218.7
	10/13/15	261.3
	3/3/16	248.1
	6/7/16	1986.3
	8/9/16	143.9
	10/12/16	193.5
	1/18/17	101.7
	5/3/17	186

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
OOSTA028.4MM (cont'd)	7/12/17	249
	8/8/17	147
	9/21/17	110.6
	10/18/17	90.9
	11/2/17	110
	12/12/17	29.4
	1/23/18	96
	2/1/18	59.4
	3/15/18	1732.9
	4/4/18	1046
	5/17/18	225
	6/20/18	209.8
	8/7/18	313
	10/15/18	238.2
	1/7/19	90.4
	5/7/19	365.4
	8/19/19	1299.7
	10/10/19	178.9
	1/22/20	108.1
	6/17/20	142.1
	8/10/20	167
	10/13/20	235.9
	2/24/21	73.3
	4/13/21	107.6
	8/25/21	387
	11/16/21	162
	2/22/22	224.7
OOSTA031.8MM	7/12/17	980
	8/8/17	179
	9/21/17	70.5
	10/18/17	65.7
	11/2/17	108.6
	12/12/17	28.8
	1/24/18	13.4
	2/1/18	36.9

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
OOSTA031.8MM (cont'd)	3/15/18	65.7
	4/12/18	61
	5/17/18	157
	6/20/18	114.5
OOSTA037.1MM	7/25/12	410.6
	8/7/12	>2419.6
	8/9/12	648.8
	8/14/12	613.1
	8/15/12	365.4
	10/3/12	325.5
	11/7/12	1046.2
	1/8/13	118.7
	2/12/13	128.1
	3/4/13	129.1
	4/8/13	172.2
	5/13/13	547.5
	6/27/13	435.2
	7/11/17	313
	8/7/17	219
	9/11/17	172.2
	10/26/17	387.3
	11/14/17	727
	12/7/17	410.6
	1/25/18	178.5
	2/20/18	151.5
	3/13/18	325.5
	4/5/18	727
	5/15/18	579
	6/14/18	461
OOSTA041.0MM	7/11/17	345
	8/7/17	378
	9/11/17	>2419.6
	10/26/17	579.4
	11/14/17	648.8
	12/7/17	435.2
	1/25/18	285.1

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
OOSTA041.0MM (cont'd)	2/20/18	214.3
	3/13/18	166.4
	4/5/18	866
	5/15/18	411
	6/14/18	344
PRICE004.4ME	7/24/07	2419.17
	8/1/07	488.4
	8/6/07	193.5
	8/8/07	307.6
	8/13/07	1046.24
	8/21/07	>2419.2
	9/10/07	1732.87
	10/8/07	1553.7
	11/5/07	286.3
	12/10/07	2419.17
	12/17/07	920.8
	1/16/08	770.1
	3/10/08	488.4
	3/31/08	488.4
	5/13/08	435.2
	6/16/08	172.3
	8/15/12	727
	8/21/12	313
	8/23/12	248.1
	9/5/12	387.3
	9/6/12	579.4
	7/10/17	1120
	8/7/17	>2420
	9/26/17	866.4
	10/2/17	307.6
	11/13/17	1203.3
	12/4/17	129.1
	1/9/18	980.4
	2/6/18	344.8
	3/21/18	920.8

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
PRICE004.4ME (cont'd)	4/9/18	1203
	5/8/18	488
	6/5/18	461
RATTL001.3BR	9/10/12	1413.6
	11/28/12	>2419.6
	8/6/13	70.3
	8/8/13	>2419.6
	8/15/13	1986.3
	8/20/13	>2419.6
	8/27/13	>2419.6
	7/13/17	>2419.6
	8/22/17	1046
	9/19/17	1413.6
	10/4/17	>2419.6
	11/15/17	1732.9
	12/6/17	>2419.6
	1/11/18	>2419.6
	2/20/18	>2419.6
	3/8/18	1986.3
	4/12/18	>2420
	5/10/18	1300
	6/7/18	>2420
ROGER005.1MM	8/1/05	200
	1/3/06	420.8
	4/4/06	820
	7/10/06	727
	7/24/06	13.1
	9/13/06	25.9
	10/2/06	206.3
	11/6/06	1
	1/10/07	1
	1/16/07	135.4
	3/7/07	1
	5/1/07	11
	5/8/07	387.3

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
ROGER005.1MM (cont'd)	8/15/12	365.4
	8/21/12	123.6
	8/23/12	122.3
	9/5/12	139.6
	9/6/12	124.6
	7/10/17	980
	8/7/17	1733
	9/26/17	770.1
	10/2/17	93.4
	11/13/17	686.7
	12/4/17	107.6
	1/9/18	95.9
	2/6/18	238.2
	3/21/18	435.2
	4/9/18	236
	5/8/18	135
	6/5/18	248
ROGER18.3T0.3MM	3/19/13	325.5
	5/1/13	110.6
	6/26/13	261.3
	7/11/17	219
	8/7/17	2420
	9/11/17	>2419.6
	10/26/17	85.7
	11/14/17	727
	12/7/17	290.9
	1/25/18	866.4
	2/20/18	488.4
	3/13/18	613.1
	4/5/18	1414
	5/15/18	613
	6/14/18	>2419.6
SCHES001.8BR	7/17/07	83.9
	12/17/07	328.2
	1/14/08	1413.6
	4/7/08	228.2

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
SCHES001.8BR (cont'd)	5/21/08	178.9
	5/28/08	1299.7
	6/3/08	328.2
	6/4/08	866.4
	6/16/08	166.4
	8/9/12	517.2
	8/13/12	307.6
	8/21/12	193.5
	8/23/12	275.5
	8/28/12	686.7
	7/18/17	2419.6
	8/10/17	1203
	9/20/17	248.9
	10/3/17	275.5
	11/2/17	920.8
	12/11/17	160.7
	1/16/18	129.6
	2/1/18	128.1
	3/8/18	214.3
	4/26/18	1986
	5/3/18	>2420
	6/11/18	225
SCHES013.9BR	7/31/07	344.8
	11/5/07	>2419.2
	1/8/08	2419.2
	4/15/08	436
	7/23/12	1732.9
	8/9/12	686.7
	8/13/12	648.8
	8/15/12	920.8
	8/21/12	980.4
	8/23/12	727
	8/28/12	218.7
	7/18/17	365.4
	8/10/17	488
	9/20/17	185

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
SCHES013.9BR (cont'd)	10/3/17	325.5
	11/2/17	>2419.6
	12/11/17	128.1
	1/16/18	73.8
	2/1/18	36.9
	3/8/18	159.7
	4/26/18	1046
	5/3/18	147
	6/11/18	222
SICCO000.3PO	*5/14/08*	*980.4*
	5/20/08	*365.4*
	5/22/08	*218.7*
	5/27/08	*613.1*
	5/29/08	*209.8*
	8/9/12	*435.2*
	8/13/12	*488.4*
	8/21/12	*727*
	8/23/12	*435.2*
	8/28/12	*547.5*
	12/13/12	*866.4*
SICCO000.7PO	*2/11/04*	*24*
	7/17/17	*11*
	8/22/17	*921*
	9/7/17	*517.2*
	10/18/17	*325.5*
	11/8/17	*980.4*
	12/5/17	*2419.6*
	1/10/18	*1119.9*
	2/14/18	*196.8*
	3/12/18	*547.5*
	4/2/18	*173*
	5/1/18	*225*
	6/11/18	*91*
SMOUS003.5BR	7/11/07	547.5
	9/24/07	307.6
	2/25/08	76.3

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
SMOUS003.5BR (cont'd)	3/31/08	574.8
	5/21/08	579.4
	5/28/08	980.4
	6/3/08	549.3
	6/4/08	1413.6
	6/16/08	648.8
	8/14/12	387.3
	8/15/12	435.2
	8/20/12	206.4
	8/21/12	648.8
	8/23/12	290.9
	7/18/17	770.1
	8/10/17	261
	9/20/17	307.6
	10/3/17	129.6
	11/2/17	151.5
	12/11/17	128.1
	1/16/18	69.7
	2/1/18	65.7
	3/8/18	172.3
	4/26/18	488
	5/3/18	140
	6/11/18	488
SMOUS012.7BR	8/14/12	727
	8/15/12	1732.9
	8/20/12	285.1
	8/21/12	275.5
	8/23/12	579.4
	7/13/17	920.8
	8/22/17	579
	9/19/17	517.2
	10/4/17	461.1
	11/15/17	579.4
	12/6/17	1553.1
	1/11/18	1413.6
	2/20/18	290.9

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
SMOUS012.7BR (cont'd)	3/8/18	461.1
	4/12/18	308
	5/10/18	866
	6/7/18	1986
SPRIN003.8MM	7/24/07	307.6
	8/1/07	2419.2
	8/6/07	275.5
	8/8/07	209.8
	8/13/07	58.1
	8/21/07	111.9
	9/10/07	90.7
	10/8/07	285.1
	11/5/07	135.4
	12/10/07	>2419.2
	12/17/07	209.8
	1/16/08	307.6
	2/4/08	461.1
	3/10/08	488.4
	3/31/08	613.1
	5/13/08	290.9
	6/16/08	248.1
	8/15/12	488.4
	8/21/12	222.4
	8/23/12	365.4
	9/5/12	579.4
	9/6/12	387.3
	7/10/17	548
	8/7/17	291
	9/26/17	579.4
	10/2/17	285.1
	11/13/17	727
	12/4/17	686.7
	1/9/18	435.2
	2/6/18	816.4
	3/21/18	770.1

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
SPRIN003.8MM (cont'd)	4/9/18	1733
	5/8/18	687
	6/5/18	727
TFOEM001.8MM	7/17/07	686.7
	12/17/07	161.6
	1/14/08	461.1
	5/21/08	648.8
	5/28/08	816.4
	6/3/08	549.3
	6/4/08	2419.6
	6/16/08	228.2
	8/7/12	980.4
	8/9/12	1203.3
	8/14/12	248.1
	8/15/12	866.4
	8/21/12	260.3
	7/12/17	1414
	8/8/17	1986
	9/21/17	1732.9
	10/18/17	1046.2
	11/2/17	2419.6
	12/12/17	2419.6
	1/24/18	>2419.6
	2/1/18	770.1
	3/15/18	1119.9
	4/12/18	488
	5/17/18	>2420
	6/20/18	1553.1
WALKE000.6MM	8/7/12	365.4
	8/9/12	365.4
	8/14/12	461.1
	8/15/12	517.2
	8/21/12	980.4
	7/12/17	186
	8/8/17	411
	9/21/17	218.7

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
WALKE000.6MM (cont'd)	10/18/17	178.5
	11/2/17	120.1
	12/12/17	325.5
	1/24/18	13.4
	2/1/18	135.4
	3/15/18	53.7
	4/12/18	206
	5/17/18	579
	6/20/18	261.3
WMILL000.8BR	3/4/04	2419
	7/9/07	198.9
	8/15/07	155.3
	10/9/07	435.2
	11/13/07	101.2
	1/29/08	58.1
	3/5/08	307.6
	4/7/08	116
	5/5/08	238.2
	5/12/08	686.7
	6/10/08	1553.1
	7/23/12	461.1
	8/14/12	410.6
	8/15/12	1299.7
	8/20/12	290.9
	8/21/12	201.4
	9/4/13	320
	9/9/13	470
	9/11/13	41
	9/16/13	180
	9/18/13	170
	7/13/17	770.1
	8/22/17	228
	9/19/17	195.6
	10/4/17	145
	11/15/17	108.6
	12/6/17	260.3

Table B-1 (cont'd). Water Quality Monitoring Data

Monitoring Station	Date	*E. coli* [CFU/100mL]
WMILL000.8BR (cont'd)	1/11/18	547.5
	2/20/18	66.3
	3/8/18	161.6
	4/12/18	172
	5/10/18	155
	6/7/18	613

* Maximum water quality target is 487 CFU/100 mL for lakes, reservoirs, State Scenic Rivers, or Exceptional Tennessee Waters waterbodies and 941 CFU/100 mL for other waterbodies. Waterbodies utilizing the 487 CFU/100 mL target are italicized.

APPENDIX C

Load Duration Curve Development
and
Determination of Daily Loading

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 other appropriate measure.

C.1 Development of TMDLs

E. coli TMDLs, WLAs, and LAs were developed for impaired subwatersheds and drainage areas in the Hiwassee River watershed using Load Duration Curves (LDCs). Daily loads for TMDLs, WLAs, and LAs are expressed as a function of daily mean in-stream flow (daily loading function).

C.1.1 Development of Flow Duration Curves

A flow duration curve is a cumulative frequency graph, constructed from historic flow data at a particular location, which represents the percentage of time a particular flow is equaled or exceeded. Flow duration curves are developed for a waterbody from daily discharges of flow over an extended period of record. In general, there is a higher level of confidence that curves derived from data over a long period of record accurately represent the entire range of flow. The preferred method of flow duration curve computation uses daily mean data from USGS continuous-record stations located on the waterbody of interest. For ungaged streams, alternative methods must be used to estimate daily mean flow. These include: 1) regression equations (using drainage area as the independent variable) developed from continuous record stations in the same ecoregion; 2) drainage area extrapolation of data from a nearby continuous-record station of similar size and topography; and 3) calculation of daily mean flow using a dynamic computer model, such as the Windows version of Hydrologic Simulation Program - Fortran (WinHSPF).

Flow duration curves for impaired waterbodies in the Hiwassee River watershed were derived from WinHSPF hydrologic simulations based on parameters derived from calibrations at USGS gaging stations in or near the Hiwassee River watershed (see Appendix D for details of calibration). For example, a flow duration curve for Bacon Branch at mile 1.6 was constructed using simulated daily mean flow for the period from 1/1/08 through 12/31/20 (RM 1.6 corresponds to the location of monitoring station BACON001.6PO). This flow duration curve is shown in Figure C-1 and represents the cumulative distribution of daily discharges arranged to show percentage of time specific flows were exceeded during the period of record (the highest daily mean flow during this period is exceeded 0% of the time and the lowest daily mean flow is equaled or exceeded 100% of the time). Flow duration curves for other impaired waterbodies were derived using a similar procedure.

C.1.2 Development of Load Duration Curves and TMDLs

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

E. coli load duration curves for impaired waterbodies in the Hiwassee River watershed were developed from the flow duration curves described in Section C.1.1, *E. coli* target concentrations, and available water quality monitoring data. Load duration curves and required load reductions were developed using the following procedure (Bacon Branch at RM 1.6 is shown as an example):

1. A target load duration curve (LDC) was generated for Bacon Branch by applying the *E. coli* target concentration of 941 CFU/100 mL to each of the ranked flows used to generate the flow duration curve (ref.: Section D.1) and plotting the results. The *E. coli* target maximum load corresponding to each ranked daily mean flow is:

   $(\text{Target Load})_{\text{Bacon Branch}}$ = (941 CFU/100 mL) x (Q) x (UCF)

   where: Target Load = TMDL (CFU/day)
   Q = daily instream mean flow (cfs)
   UCF = the required unit conversion factor (2.44×10^{7} mL-s/ft^3-day)

   TMDL = (2.30×10^{10}) x (Q) CFU/day

2. Daily loads were calculated for each of the water quality samples collected at monitoring station BACON001.6PO (ref.: Table B-1) by multiplying the sample concentration by the daily mean flow for the sampling date and the required unit conversion factor. BACON001.6PO was selected for LDC analysis because it has a longer period of record and multiple exceedances of the target concentration.

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

Example – 1/16/18 sampling event
Modeled Flow = 0.829 cfs
Concentration = 24,950 CFU/100 mL
Daily Load = 5.06 x10^{11} CFU/day

3. Using the flow duration curves described in C.1.1, the "percent of days the flow was exceeded" (PDFE) was determined for each sampling event. Each sample load was then plotted on the load duration curves developed in Step 1 according to the PDFE. Sample events occurring during the recreation season (April – October) and when greater than 50% of the flow is storm flow are designated. Also, the mean of the exceedances in each flow zone (or the exceedance itself, if there is only one) is indicated. The resulting *E. coli* load duration curve for Bacon Branch is shown in Figure C-2.

LDCs of other impaired waterbodies were derived in a similar manner and are shown in Appendix E.

C.2 Development of WLAs & LAs

As previously discussed, a TMDL can be expressed as the sum of all point source loads (WLAs), nonpoint source loads (LAs), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

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

Expanding the terms:

$$\text{TMDL} = [\Sigma\text{WLAs}]_{\text{WWTP}} + [\Sigma\text{WLAs}]_{\text{IndSW}} + [\Sigma\text{WLAs}]_{\text{MS4}} + [\Sigma\text{WLAs}]_{\text{CAFO}} + [\Sigma\text{LAs}]_{\text{DS}} + [\Sigma\text{LAs}]_{\text{SW}} + \text{MOS}$$

For *E. coli* TMDLs in each impaired subwatershed or drainage area, WLA terms include:

- $[\Sigma\text{WLAs}]_{\text{WWTP}}$ is the allowable load associated with discharges of NPDES permitted WWTPs located in impaired subwatersheds or drainage areas. Since NPDES permits for these facilities specify that treated wastewater must meet in-stream water quality standards at the point of discharge, no additional load reduction is required. WLAs for WWTPs are calculated from the mean daily facility flow (expressed as "q_m") and the Daily Maximum permit limit. A future growth term for potential new WWTPs is included.
- [$[\Sigma\text{WLAs}]_{\text{IndSW}}$ is the allowable load associated with loading from industrial point sources directly going to surface waters as a result of the buildup/wash-off processes associated with storm events (i.e., precipitation induced). Since NPDES permits for these facilities specify that stormwater must meet in-stream water quality standards at the point of discharge, no additional load reduction is required. WLAs for Industrial Stormwater are calculated from the estimated stormwater flow (expressed as "q_2") and the permit limit.
- $[\Sigma\text{WLAs}]_{\text{CAFO}}$ is the allowable load for all permitted CAFOs in an impaired subwatershed or drainage area. All wastewater discharges from a CAFO to waters of the state of Tennessee are prohibited, except when either chronic or catastrophic

rainfall events cause an overflow of process wastewater from a facility properly designed, constructed, maintained, and operated to contain:

- All process wastewater resulting from the operation of the CAFO (such as wash water, parlor water, watering system overflow, etc.); plus,
- All runoff from a 25-year, 24-hour rainfall event. (USEPA, 2003b)

Therefore, a WLA of zero has been assigned to this class of facilities.

- $[\sum WLAs]_{MS4}$ is the allowable *E. coli* load for discharges from MS4s. *E. coli* loading from MS4s is the result of buildup/wash-off processes associated with storm events.

LA terms include:

- $[\sum LAs]_{DS}$ is the allowable *E. coli* load from "other direct sources". These sources include leaking septic systems, illicit discharges, and animals access to streams. The LA specified for all sources of this type is zero CFU/day (or to the maximum extent feasible).
- $[\sum LAs]_{SW}$ represents the allowable *E. coli* loading from nonpoint sources indirectly going to surface waters from all land use areas (except areas covered by a MS4 permit) as a result of the buildup/wash-off processes associated with storm events (i.e., precipitation induced).

Since $[\sum WLAs]_{CAFO} = 0$ and $[\sum LAs]_{DS} = 0$, the expression relating TMDLs to non-precipitation-based point sources and precipitation-based point and nonpoint sources may be simplified to:

$$\text{TMDL} - \text{MOS} = [\text{WLAs}]_{WWTP} + [\sum \text{WLAs}]_{IndSW} + [\sum \text{WLAs}]_{MS4} + [\sum \text{LAs}]_{SW}$$

As stated in Section 8.5, an explicit MOS, equal to 10% of the *E. coli* water quality targets (ref.: Section 5.0), was utilized for determination of the percent load reductions necessary to achieve WLAs and LAs:

Instantaneous Maximum (lake, reservoir, State Scenic River, Exceptional Tennessee Waters):

Target – MOS = (487 CFU/100 ml) – 0.1(487 CFU/100 ml)

Target – MOS = 438 CFU/100 ml

Instantaneous Maximum (other):

Target – MOS = (941 CFU/100 ml) – 0.1(941 CFU/100 ml)

Target – MOS = 847 CFU/100 ml

30-Day Geometric Mean: Target – MOS = (126 CFU/100 ml) – 0.1(126 CFU/100 ml)

Target – MOS = 113 CFU/100 ml

C.2.1 Daily Load Calculation

Since WWTPs discharge must comply with instream water quality criteria (TMDL target) at the point of discharge, WLAs for WWTPs are expressed as a function of the mean daily facility flow (“q_m”) and the Daily Maximum permit limit. In addition, WLAs for MS4s and LAs for precipitation-based nonpoint sources are equal on a per unit area basis and may be expressed as the daily allowable load per unit area (acre) resulting from a decrease in in-stream *E. coli* concentrations to TMDL target values minus MOS:

WLA[MS4] = LA = {TMDL – MOS – WLA[WWTPs] – WLA[IndSW]} / DA

where: DA = waterbody drainage area (acres)

Using Bacon Branch as an example:

$\text{TMDL}_{\text{Bacon Branch}}$ = (941 CFU/100 mL) x (Q) x (UCF)

TMDL = ($2.30\text{x}10^{10}$) x (Q) CFU/day

$\text{MOS}_{\text{Bacon Branch}}$ = TMDL x 0.10 = $2.30\text{x}10^9$ x Q

MOS = ($2.30\text{x}10^9$) x (Q) CFU/day

$\text{WLA[WWTPs]}_{\text{Bacon Branch}}$ = q_m (cfs) x 941 (CFU/100 mL) x UCF

$\text{WLA[WWTPs]}_{\text{Bacon Branch}}$ = ($2.30\text{x}10^{10}$) x (q_m) CFU/day

For cases in which there is a WWTP currently discharging to the waterbody, the design flow (q_d) will be used in the equation because the mean daily facility flow can be as high as design flow (q_d):

$\text{WLA[MS4]}_{\text{Bacon Branch}}$ = $\text{LA}_{\text{Bacon Branch}}$

= {TMDL – MOS – WLA[WWTPs]_d} / DA

= {($2.30\text{x}10^{10}$ x Q) – ($2.30\text{x}10^9$ x Q) – ($2.30\text{x}10^{10}$ x q_d)} / (666)

$\text{WLA[MS4]}_{\text{Bacon Branch}}$ = $\text{LA}_{\text{Bacon Branch}}$

= [$3.107\text{x}10^7$ x Q] – [$3.45\text{x}10^7$ x q_d]

For cases in which there is no WWTP currently discharging to the waterbody, the variable q_d will be retained in the equation as a placeholder for any future WWTPs.

TMDLs, WLAs, & LAs for other impaired subwatersheds and drainage areas were derived in a similar manner and are summarized in Table C-1.

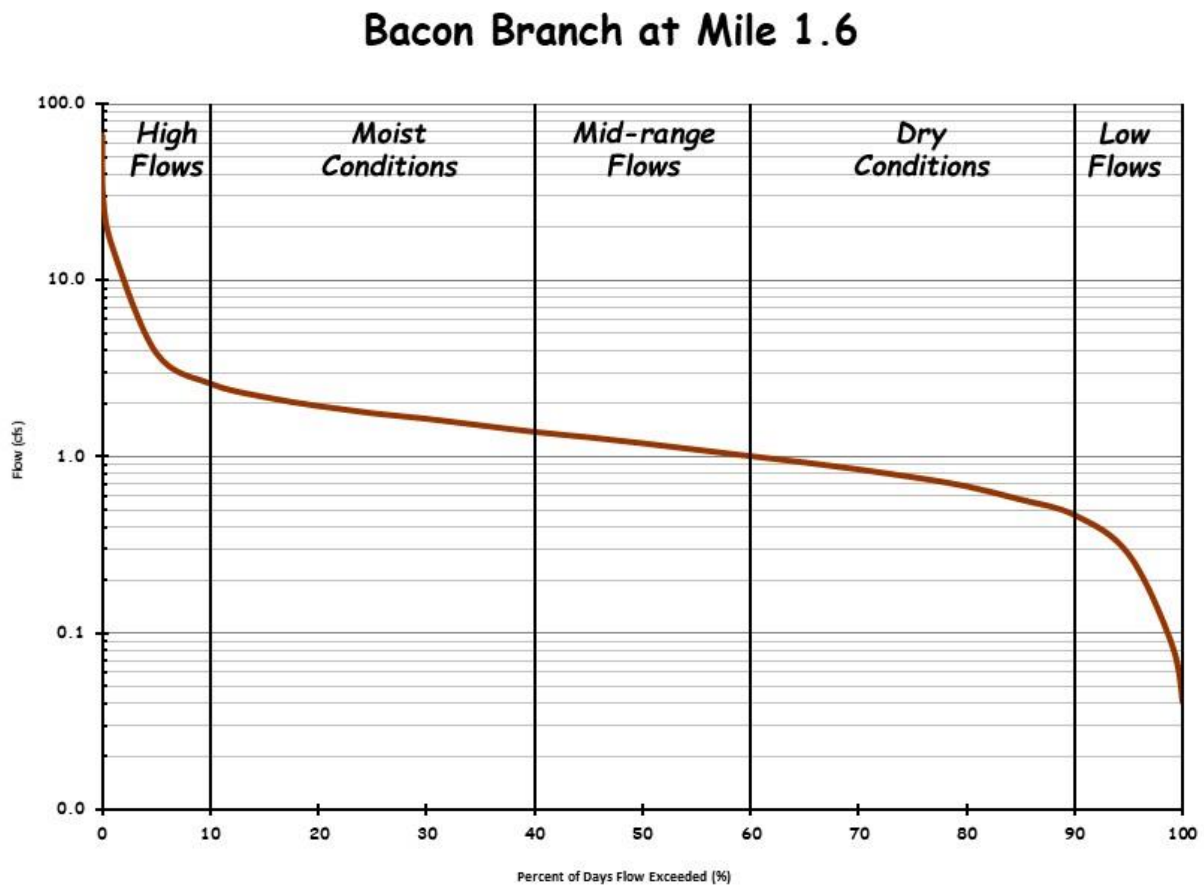

Figure C-1. Flow Duration Curve for Bacon Branch at RM 1.6

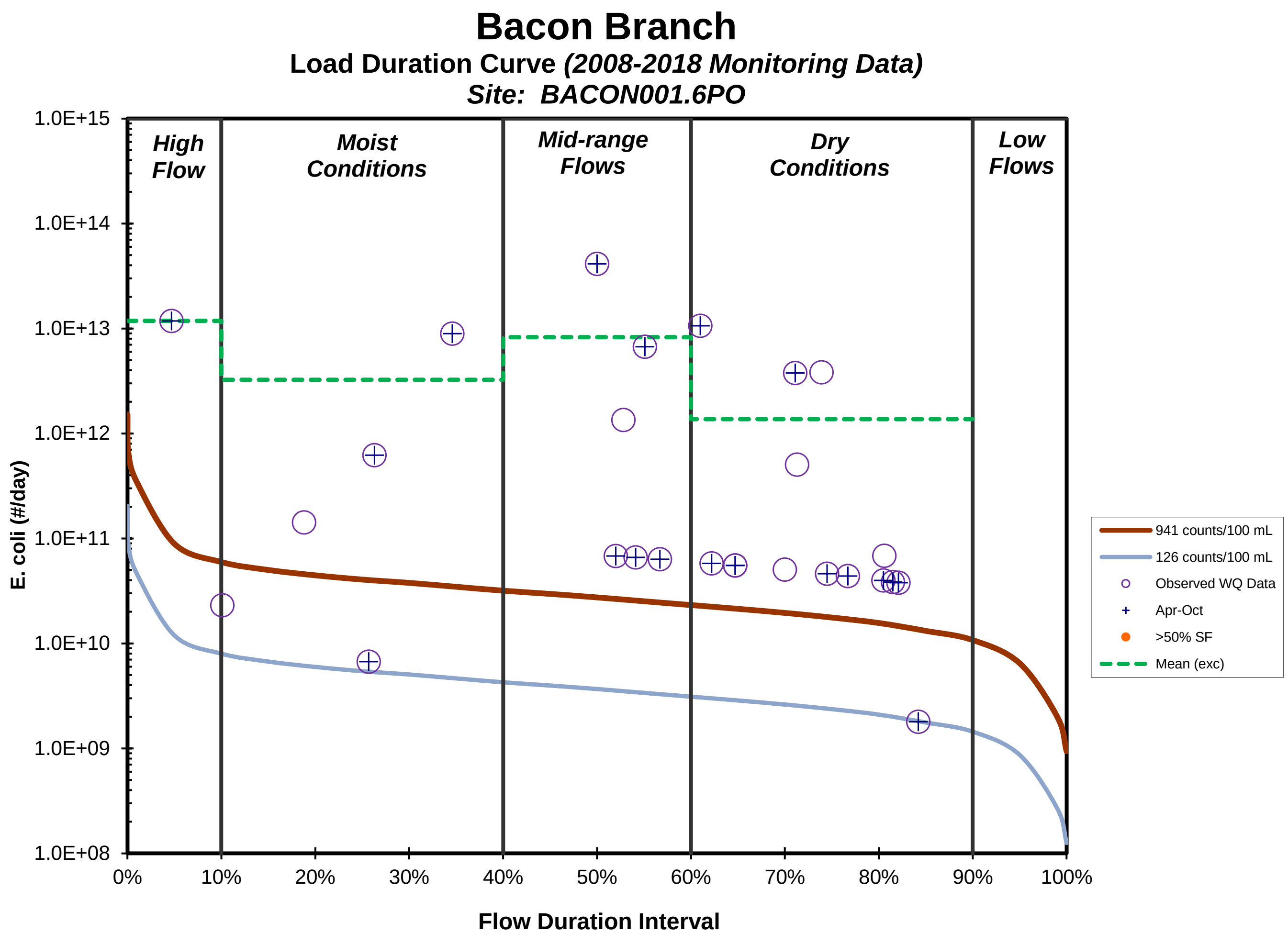

Figure C-2. ***E. coli*** **Load Duration Curve for Bacon Branch at RM 1.6**

Table C-1. TMDLs, WLAs, & LAs for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
0802	Cane Creek [d,e]	TN06020002081_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(2.595 \times 10^6 \times Q) - (2.88 \times 10^6 \times q_d)$	$(2.595 \times 10^6 \times Q) - (2.88 \times 10^6 \times q_d)$
0909	Dairy Branch [d,e]	TN06020002018_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(4.278 \times 10^7 \times Q) - (4.75 \times 10^7 \times q_d)$	$(4.278 \times 10^7 \times Q) - (4.75 \times 10^7 \times q_d)$
	Siccowee Branch [d,e]	TN06020002018_0300	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	NA	$(1.841 \times 10^7 \times Q) - (2.05 \times 10^7 \times q_d)$	$(1.841 \times 10^7 \times Q) - (2.05 \times 10^7 \times q_d)$
1001	Middle Creek [e]	TN06020002082_0300	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(9.913 \times 10^5 \times Q) - (1.10 \times 10^6 \times q_d)$	$(9.913 \times 10^5 \times Q) - (1.10 \times 10^6 \times q_d)$
1002	Little Chestuee Creek [d,e]	TN06020002082_0900	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(3.668 \times 10^6 \times Q) - (4.08 \times 10^6 \times q_d)$	$(3.668 \times 10^6 \times Q) - (4.08 \times 10^6 \times q_d)$
	Chestuee Creek	TN06020002082_2000					$(8.371 \times 10^5 \times Q) - (9.30 \times 10^5 \times q_d)$	$(8.371 \times 10^5 \times Q) - (9.30 \times 10^5 \times q_d)$
1003	Tom Foeman Creek [d,e]	TN06020002082_1200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(4.302 \times 10^6 \times Q) - (4.78 \times 10^6 \times q_d)$	$(4.302 \times 10^6 \times Q) - (4.78 \times 10^6 \times q_d)$
	Big Foot Branch [d,e]	TN06020002082_1300					$(3.912 \times 10^6 \times Q) - (4.35 \times 10^6 \times q_d)$	$(3.912 \times 10^6 \times Q) - (4.35 \times 10^6 \times q_d)$
1101	Oostanaula Creek [e]	TN06020002083_4000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.858 \times 10^6 \times Q) - (2.07 \times 10^6 \times q_d)$	$(1.858 \times 10^6 \times Q) - (2.07 \times 10^6 \times q_d)$
		TN06020002083_5000					$(1.095 \times 10^7 \times Q) - (1.22 \times 10^7 \times q_d)$	$(1.095 \times 10^7 \times Q) - (1.22 \times 10^7 \times q_d)$
1102	Black Branch [d,e]	TN06020002083_0500	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.700 \times 10^7 \times Q) - (1.89 \times 10^7 \times q_d)$	$(1.700 \times 10^7 \times Q) - (1.89 \times 10^7 \times q_d)$
	Walker Branch [d,e]	TN06020002083_0510					$(3.354 \times 10^7 \times Q) - (3.73 \times 10^7 \times q_d)$	$(3.354 \times 10^7 \times Q) - (3.73 \times 10^7 \times q_d)$
	Oostanaula Creek	TN06020002083_1000					$(4.734 \times 10^5 \times Q) - (5.26 \times 10^5 \times q_d)$	$(4.734 \times 10^5 \times Q) - (5.26 \times 10^5 \times q_d)$
	Oostanaula Creek [d]	TN06020002083_2000					$(6.403 \times 10^5 \times Q) - (7.11 \times 10^5 \times q_d)$	$(6.403 \times 10^5 \times Q) - (7.11 \times 10^5 \times q_d)$
	Oostanaula Creek [d]	TN06020002083_3000					$(1.062 \times 10^6 \times Q) - (1.18 \times 10^6 \times q_d)$	$(1.062 \times 10^6 \times Q) - (1.18 \times 10^6 \times q_d)$
1201	Latham Springs Branch [d,e]	TN06020002084_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(6.453 \times 10^6 \times Q) - (7.17 \times 10^6 \times q_d)$	$(6.453 \times 10^6 \times Q) - (7.17 \times 10^6 \times q_d)$
	Little North Mouse Creek [d]	TN06020002084_0400					$(4.040 \times 10^6 \times Q) - (4.49 \times 10^6 \times q_d)$	$(4.040 \times 10^6 \times Q) - (4.49 \times 10^6 \times q_d)$
	North Mouse Creek [,e]	TN06020002084_2000					$(8.184 \times 10^5 \times Q) - (9.09 \times 10^5 \times q_d)$	$(8.184 \times 10^5 \times Q) - (9.09 \times 10^5 \times q_d)$
1202	Spring Creek [,d,e]	TN06020002085_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.965 \times 10^6 \times Q) - (2.18 \times 10^6 \times q_d)$	$(1.965 \times 10^6 \times Q) - (2.18 \times 10^6 \times q_d)$

Table C-1 (cont'd). TMDLs, WLAs, & LAs for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
1203	Dry Valley Creek [d,e]	TN06020002084_0500	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(2.642 x 10^6 x Q) – (2.94 x 10^6 x q_d)	(2.642 x 10^6 x Q) – (2.94 x 10^6 x q_d)
	North Mouse Creek	TN06020002084_1000					(4.388 x 10^5 x Q) – (4.88 x 10^5 x q_d)	(4.388 x 10^5 x Q) – (4.88 x 10^5 x q_d)
1301	Candies Creek [e]	TN06020002005_3000	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(2.043 x 10^6 x Q) – (2.27 x 10^6 x q_d)	(2.043 x 10^6 x Q) – (2.27 x 10^6 x q_d)
1302	Black Fox Creek [d,e]	TN06020002005_0100	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(3.278 x 10^6 x Q) – (3.64 x 10^6 x q_d)	(3.278 x 10^6 x Q) – (3.64 x 10^6 x q_d)
1303	Candies Creek [e]	TN06020002005_1000	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(3.120 x 10^5 x Q) – (3.47 x 10^5 x q_d)	(3.120 x 10^5 x Q) – (3.47 x 10^5 x q_d)
	Beaverdam Creek [d,e]	TN06020002005_1100					(1.468 x 10^7 x Q) – (1.63 x 10^7 x q_d)	(1.468 x 10^7 x Q) – (1.63 x 10^7 x q_d)
1401	South Chestuee Creek [e]	TN06020002014_1000	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(8.348 x 10^5 x Q) – (9.28 x 10^5 x q_d)	(8.348 x 10^5 x Q) – (9.28 x 10^5 x q_d)
	South Chestuee Creek [d,e]	TN06020002014_2000					(3.746 x 10^6 x Q) – (4.16 x 10^6 x q_d)	(3.746 x 10^6 x Q) – (4.16 x 10^6 x q_d)
1402	Little Chatata Creek [d,e]	TN06020002012_0200	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(3.212 x 10^6 x Q) – (3.57 x 10^6 x q_d)	(3.212 x 10^6 x Q) – (3.57 x 10^6 x q_d)
	Rattlesnake Branch [d,e]	TN06020002012_0300					(1.051 x 10^7 x Q) – (1.17 x 10^7 x q_d)	(1.051 x 10^7 x Q) – (1.17 x 10^7 x q_d)
	Chatata Creek [e]	TN06020002012_1000					(1.015 x 10^6 x Q) – (1.13 x 10^6 x q_d)	(1.015 x 10^6 x Q) – (1.13 x 10^6 x q_d)
1403	Bacon Branch [d,e]	TN06020002008_0100	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(1.660 x 10^7 x Q) – (1.85 x 10^7 x q_d)	(1.660 x 10^7 x Q) – (1.85 x 10^7 x q_d)
1404	Fillauer Branch [d,e]	TN06020002009_0200	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(7.930 x 10^6 x Q) – (8.81 x 10^6 x q_d)	(7.930 x 10^6 x Q) – (8.81 x 10^6 x q_d)
	Woolen Mill Branch [d,e]	TN06020002009_0300					(1.347 x 10^7 x Q) – (1.50 x 10^7 x q_d)	(1.347 x 10^7 x Q) – (1.50 x 10^7 x q_d)
	South Mouse Creek [e]	TN06020002009_1000					(8.873 x 10^5 x Q) – (9.86 x 10^5 x q_d)	(8.873 x 10^5 x Q) – (9.86 x 10^5 x q_d)
	South Mouse Creek [d,e]	TN06020002009_2000					(2.936 x 10^6 x Q) – (3.26 x 10^6 x q_d)	(2.936 x 10^6 x Q) – (3.26 x 10^6 x q_d)
1405	Brush Creek [d,e]	TN06020002087_0200	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	NA	(6.005 x 10^6 x Q) – (6.67 x 10^6 x q_d)	(6.005 x 10^6 x Q) – (6.67 x 10^6 x q_d)
	UT to Rogers Creek [d,e]	TN06020002087_0600				(2.3x10^{10} x q_2)	(1.011 x 10^8 x Q) – (1.12 x 10^8 x q_d)	(1.011 x 10^8 x Q) – (1.12 x 10^8 x q_d)
	Rogers Creek	TN06020002087_1000				NA	(6.473 x 10^5 x Q) – (7.19 x 10^5 x q_d)	(6.473 x 10^5 x Q) – (7.19 x 10^5 x q_d)

Table C-1 (cont'd). TMDLs, WLAs, & LAs for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	MOS	WLAs			LAs [c]
					WWTPs [a]	Ind'l Stormwater	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
1406	Hiwassee River Embayment [d]	TN06020002008_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.330 \times 10^4 \times Q) - (1.48 \times 10^4 \times q_d)$	$(1.330 \times 10^4 \times Q) - (1.48 \times 10^4 \times q_d)$
1407	Agency Creek [d,e]	TN06020002001_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.997 \times 10^6 \times Q) - (2.22 \times 10^6 \times q_d)$	$(1.997 \times 10^6 \times Q) - (2.22 \times 10^6 \times q_d)$
	Price Creek [d,e]	TN06020002088_1000					$(5.777 \times 10^6 \times Q) - (6.42 \times 10^6 \times q_d)$	$(5.777 \times 10^6 \times Q) - (6.42 \times 10^6 \times q_d)$
1408	Gunstocker Creek [d,e]	TN06020002001_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	NA	$(1.953 \times 10^6 \times Q) - (2.17 \times 10^6 \times q_d)$	$(1.953 \times 10^6 \times Q) - (2.17 \times 10^6 \times q_d)$

Notes: Q = Mean Daily In-stream Flow (cfs).
q_m = Mean Daily WWTP Flow (cfs)
q_d = Facility (WWTP) Design Flow (cfs)
q_2 = Estimated stormwater flow from permitted industrial point source (cfs)

a. WLAs for WWTPs are expressed as *E. coli* loads (CFU/day). All current and future WWTPs must meet water quality standards as specified in their NPDES permit.
b. Applies to any MS4 discharge loading in the subwatershed. Future MS4s will be assigned waste load allocations (WLAs) consistent with load allocations (LAs) assigned to precipitation induced nonpoint sources. See Section 9.2.2 for implementation details.
c. WLAs and LAs expressed as a "per acre" load are calculated based on the drainage area at the pour point of the HUC-12 subwatershed or drainage area (see Table A-1). As regulated MS4 area increases (due to future growth and/or new MS4 designation), unregulated LA area decreases by an equivalent amount. The sum will continue to equal total subwatershed area.
d. Waterbody Drainage Area (DA) is not coincident with HUC-12(s).
e. No WWTPs currently discharging into or upstream of the waterbody. (WLA[WWTPs] Expression is future growth term for new WWTPs.)
f. When there are no MS4s currently located in a subwatershed drainage area, the expression is a future growth term for expanding or newly designated MS4s.

APPENDIX D

Hydrodynamic Modeling Methodology

D.1 Model Selection

The Windows version of Hydrologic Simulation Program - Fortran (HSPF) was selected for flow simulation of pathogen-impaired waters in the subwatersheds of the Hiwassee River watershed. HSPF is a watershed model capable of performing flow routing through stream reaches.

D.2 Model Set Up

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

Several computer-based tools were utilized to generate input data for the WinHSPF model. ArcMap and BASINS, Geographic Information System (GIS) tools, were used to display, analyze, and compile available information to support hydrology model simulations for selected subwatersheds. This information includes land use categories, point source dischargers, soil types and characteristics, presence or absence of dams and karst geology, population data (human and livestock), and stream characteristics.

Weather data from multiple meteorological stations were available for the time period from January 1970 through December 2021. Meteorological data for a selected 11- to 21-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- to 20-year period used for TMDL analysis. The length of the simulation varied depending on the period of record of the monitoring data for the selected waterbody. Occasionally, a period of less than 10 years was used for calibration because either (1) the gage did not have a full 10-year period of continuous record; or, (2) unusual weather events (e.g. drought or flood) precluded calibration for a 10-year period.

D.3 Model Calibration

Hydrologic calibration of the watershed model involves comparison of simulated streamflow to historic streamflow data from USGS stream gaging stations for the same period of time. One USGS continuous record station located near the Hiwassee River watershed was selected as the basis of the hydrology calibration. Station 03565500 is located on Oostanaula Creek near Sanford, TN, within Level IV ecoregions 67f and 67g and has a drainage area of 57 square miles. Meteorological data from the station at Chattanooga Airport was used for calibration.

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 Oostanaula Creek near Sanford, TN, (USGS Station 03565500) are shown in Table D-1 and Figures D-1 and D-2.

Table D-1. Hydrologic Calibration Summary: Oostanaula Creek near Sanford, TN (USGS 03565500)

Simulation Name:	USGS03565500	**Simulation Period:**	
		Watershed Area (ac):	36116.00
		Watershed Area (mi^2):	56.43
Period for Flow Analysis			
Begin Date:	**01/01/08**	**Baseflow PERCENTILE:**	2.5
End Date:	**12/31/17**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**235.84**	Total Observed In-stream Flow:	**237.03**
Total of highest 10% flows:	**88.04**	Total of Observed highest 10% flows:	**86.08**
Total of lowest 50% flows:	**51.05**	Total of Observed Lowest 50% flows:	**48.40**
Simulated Summer Flow Volume (months 7-9):	**39.62**	Observed Summer Flow Volume (7-9):	**36.01**
Simulated Fall Flow Volume (months 10-12):	**52.25**	Observed Fall Flow Volume (10-12):	**53.23**
Simulated Winter Flow Volume (months 1-3):	**80.42**	Observed Winter Flow Volume (1-3):	**84.73**
Simulated Spring Flow Volume (months 4-6):	**63.55**	Observed Spring Flow Volume (4-6):	**63.07**
Total Simulated Storm Volume:	**208.19**	Total Observed Storm Volume:	**190.70**
Simulated Summer Storm Volume (7-9):	**32.63**	Observed Summer Storm Volume (7-9):	**24.33**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**-0.50**	10	
Error in 50% lowest flows:	**5.47**	10	
Error in 10% highest flows:	**2.27**	15	
Seasonal volume error - Summer:	**10.01**	30	
Seasonal volume error - Fall:	**-1.85**	30	
Seasonal volume error - Winter:	**-5.08**	30	
Seasonal volume error - Spring:	**0.77**	30	
Error in storm volumes:	**9.17**	20	
Error in summer storm volumes:	**34.12**	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	**0.4335**	Model accuracy increases as E or R^2 approaches 1.0	
Coefficient of Determination, R^2	**0.5405**		

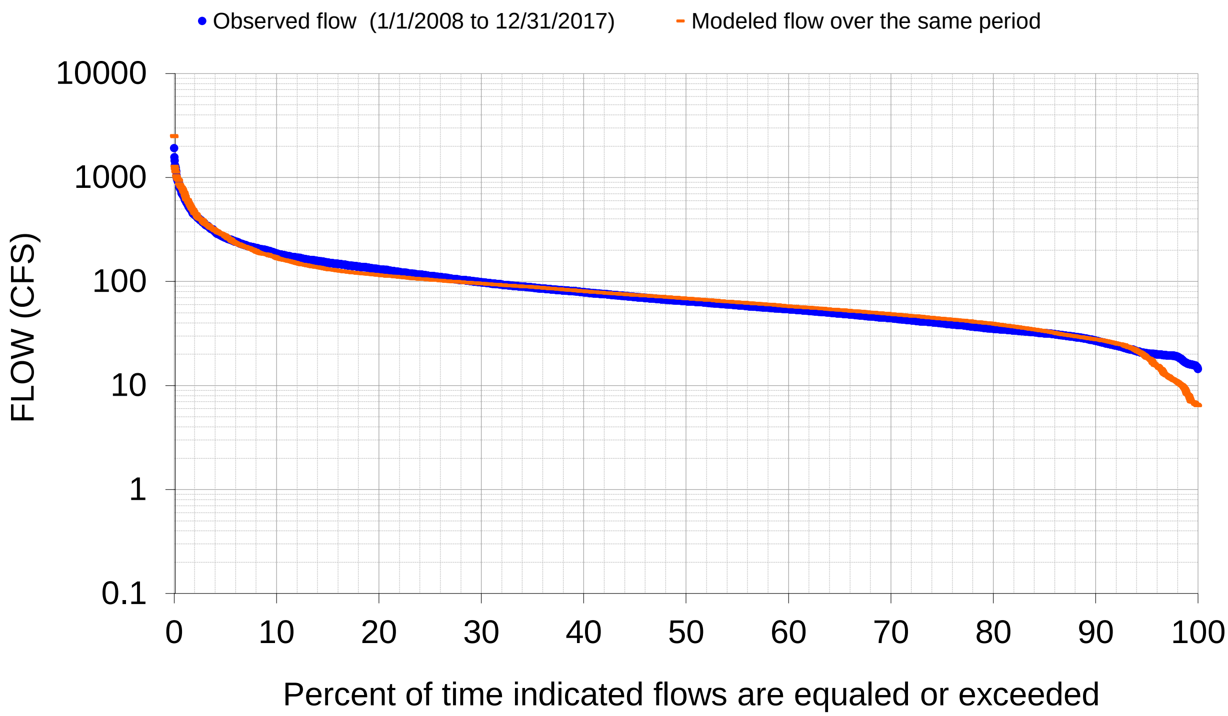

Figure D-1. Hydrologic Calibration: Oostanaula Creek, USGS 03565500 (Calendar Years 2008-2018)

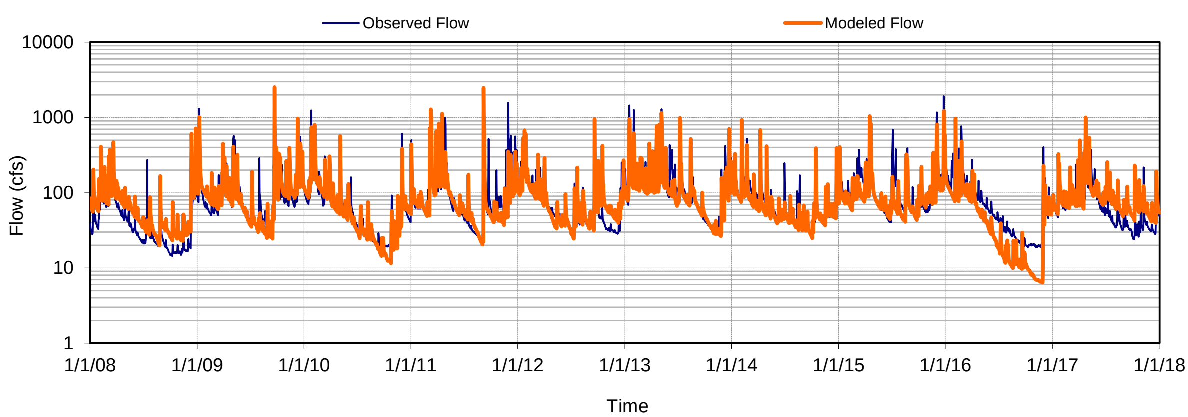

Figure D-2. 10-Year Hydrologic Comparison: Oostanaula Creek, USGS 03565500

APPENDIX E

Source Area Implementation Strategy

All impaired waterbodies and corresponding HUC-12 subwatersheds or drainage areas have been classified according to their respective source area types in Section 9.5, Table 11. The implementation for each will be prioritized according to the source area classifications and the information provided in Sections 9.5.1 and 9.5.2, with examples provided in Sections E.1 and E.2, below. For all impaired waterbodies, the determination of source area types serves to identify the predominant sources contributing to impairment (i.e., those that should be targeted initially for implementation). It is not intended to imply that sources in other landuse areas are not contributors to impairment and/or to grant an exemption from addressing other source area contributions with implementation strategies and corresponding load reduction. For mixed use areas, implementation will address both urban and agricultural areas, at a minimum.

E.1 Urban Source Areas

For impaired waterbodies and corresponding HUC-12 subwatersheds or drainage areas identified as predominantly urban source area types, Chatata Creek provides an example for implementation analysis. Chatata Creek was selected because of its high proportion (22.8 percent) of urban area. The Chatata Creek subwatershed lies in HUC-12 060200021402 and includes portions of South Cleveland. The drainage area for Chatata Creek at mile 2.0 is approximately 18,923 acres (29.6 mi^2). Five flow zones were used for the duration curve analysis (see Sect. 9.1.1).

The flow duration curve for Chatata Creek at mile 2.0 was constructed using simulated daily mean flow for the period from 1/1/04 through 12/31/20 (mile 2.0 corresponds to the location of monitoring station CHATA002.0BR). This flow duration curve is shown in Figure E-1 and represents the cumulative distribution of daily discharges arranged to show percentage of time specific flows were exceeded during the period of record.

The *E. coli* LDC for Chatata Creek (Figure E-2) was analyzed to determine the frequency with which observed daily water quality loads exceed the *E. coli* target maximum daily loading (941 CFU/100 mL x flow [cfs] x conversion factor) under five flow conditions (low, dry, mid-range, moist, and high). Observation of the plot illustrates that monitoring over the entire period of record occurred in all flow zones, with exceedances also occurring during most flow conditions (Table E-3, Section E.4), indicating that the Chatata Creek subwatershed is impacted by both point and nonpoint sources.

Results indicate the implementation strategy for the Chatata Creek subwatershed will require BMPs targeting point and nonpoint sources. Table E-1 presents an allocation table of LDC analysis statistics for Chatata Creek *E. coli* and implementation strategies for each source category covering the entire range of flow and entire period of record (Stiles, 2003). The implementation strategies listed in Table E-1 are a subset of the categories of BMPs and implementation strategies available for application to the Hiwassee River watershed for reduction of *E. coli* loading and mitigation of water quality impairment from urban sources. Targeted implementation strategies and LDC analysis statistics for other impaired waterbodies and corresponding HUC-12 subwatersheds and drainage areas identified as predominantly urban source area types can be derived from the information and results available in Tables 12 and E-3.

LDCs for other impaired waterbodies were developed using a similar procedure (Appendix C) and are shown in Figures E-5 through E-35. The LDCs shown in Figures E-5 through E-35 (and the associated Tables E-4 through E-35) are based on the most recent sampling period (2016-2020), unless there are no monitoring data available for that time period at that monitoring station. Table E-36 presents LDC analyses (TMDLs, WLAs, LAs, and MOS) and PLRGs for all flow zones for all *E. coli* impaired waterbodies in the Hiwassee River watershed.

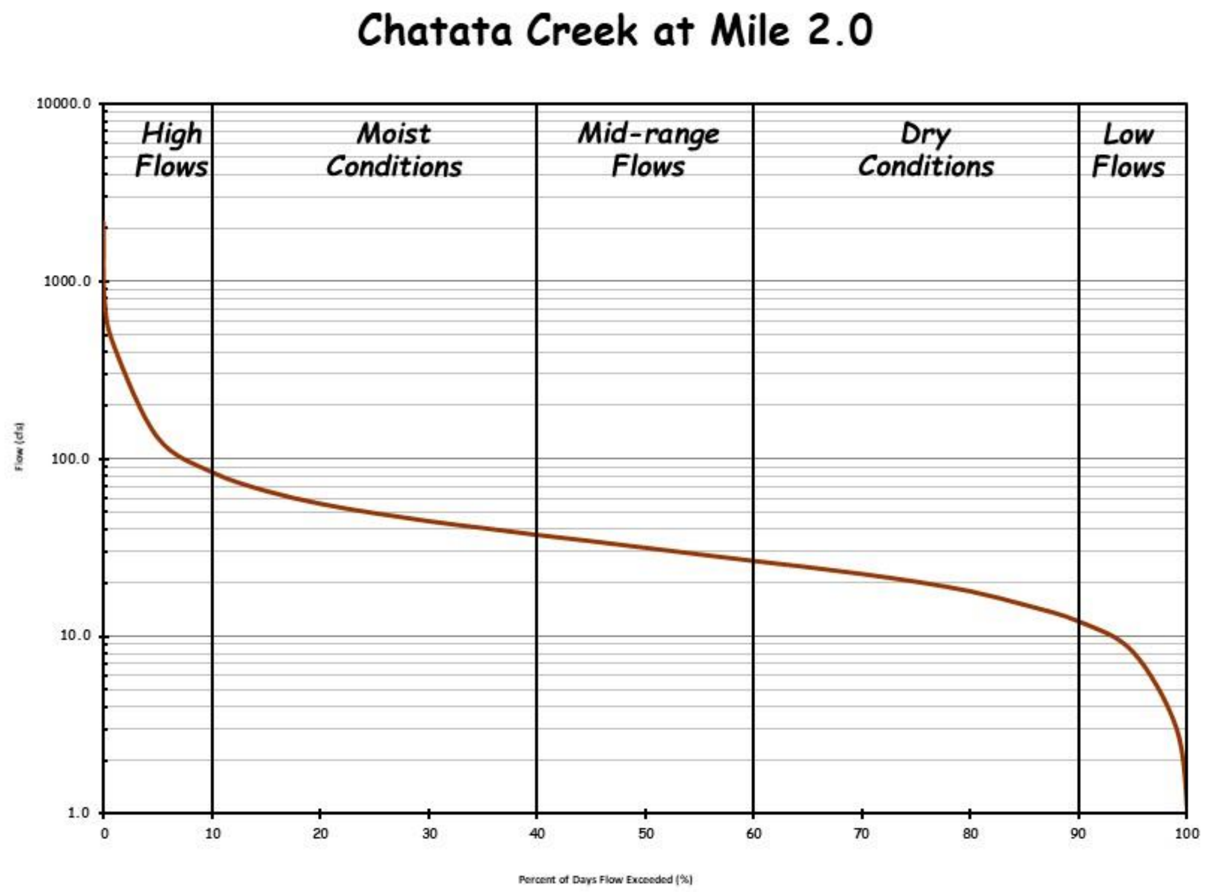

Figure E-1. Flow Duration Curve for Chatata Creek – RM 2.0

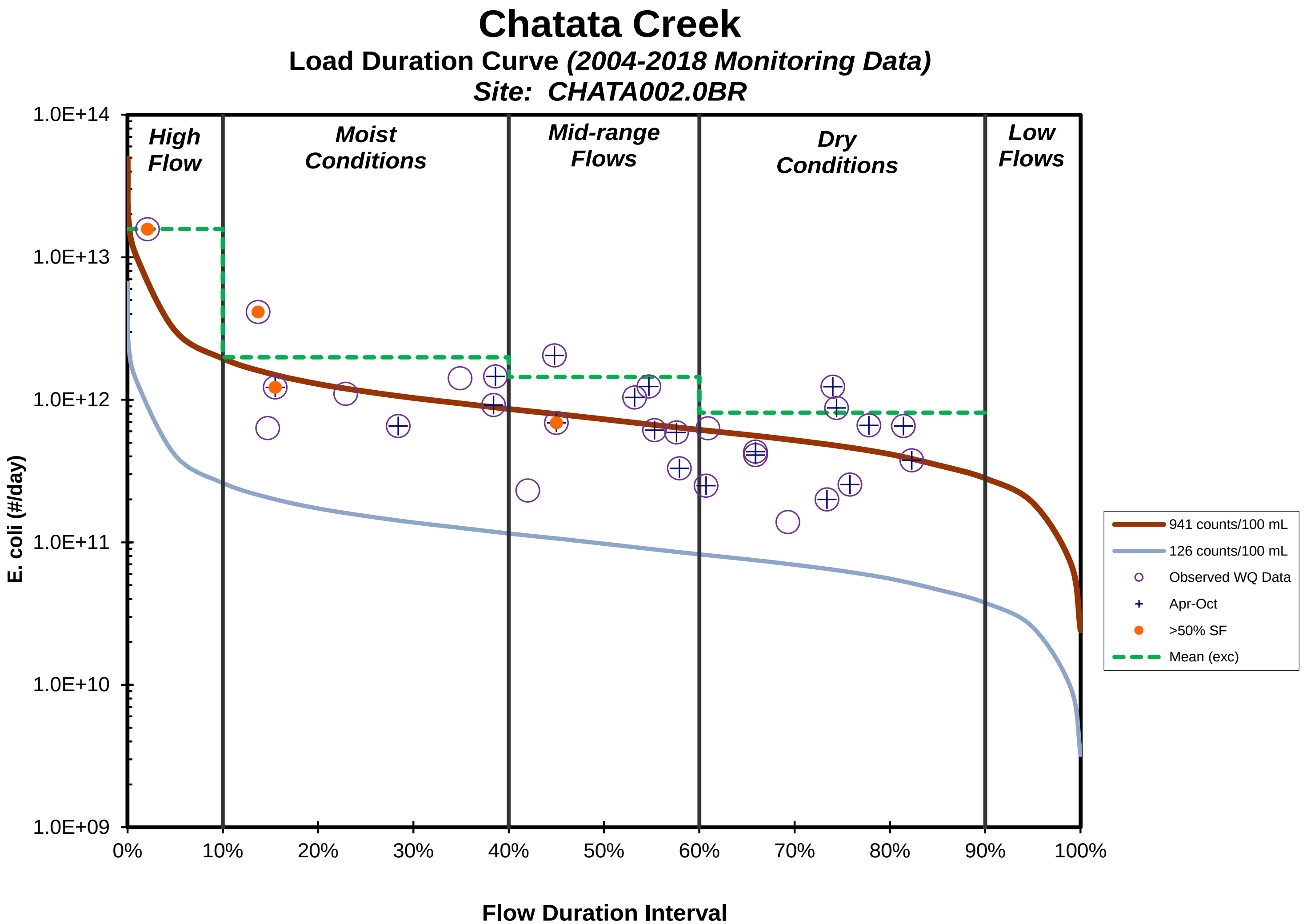

Figure E-2. ***E. coli*** **Load Duration Curve for Chatata Creek – RM 2.0**

Table E-1. Load Duration Curve Summary for Urban Area Implementation Strategies (Example: Chatata Creek subwatershed, part of HUC-12 060200021402) (5 Flow Zones).

Hydrologic Condition		High	Moist	Mid-range*	Dry	Low
% Time Flow Exceeded		0-10	10-40	40-60	60-90	90-100
Chatata Creek (060200021402) RM 2.0	Number of Samples	1	8	8	12	0
	% > 941 CFU/100 mL[1]	100	50.0	37.5	41.7	0
	Load Reduction[2]	61.1%	34.5%	46.7%	36.7%	NA
TMDL (CFU/day)		3.039E+12	1.140E+12	7.286E+11	4.692E+11	1.886E+11
Margin of Safety (CFU/day)		3.039E+11	1.140E+11	7.286E+10	4.692E+10	1.886E+10
WLA (WWTPs) (CFU/day)		2.30E+10 x q_m	2.30E+10 x q_m	2.30E+10 x q_m	2.30E+10 x q_m	2.30E+10 x q_m
WLAs (MS4s) (CFU/day/acre)[3]		(1.445E+08) - (1.22E+06 x q_d)	(5.421E+07) - (1.22+06 x q_d)	(3.465E+07) - (1.22E+06 x q_d)	(2.232E+07) - (1.22E+06 x q_d)	(8.970E+06) - (1.22E+06 x q_d)
LA (CFU/day/acre)[3]		(1.445E+08) - (1.22E+06 x q_d)	(5.421E+07) - (1.22+06 x q_d)	(3.465E+07) - (1.22E+06 x q_d)	(2.232E+07) - (1.22E+06 x q_d)	(8.970E+06) - (1.22E+06 x q_d)
Implementation Strategies[4]						
Municipal NPDES			L	M	H	H
Stormwater Management			H	H		
SSO Mitigation		H	M	L		
Collection System Repair			H	M		
Septic System Repair			L	M	M	M
Potential for source area contribution under given flow condition (H: High; M: Medium; L: Low)						

q_m = Mean Daily WWTP Discharge (cfs)
q_d = Facility (WWTP) Design Flow (cfs)
* The Mid-Range Flow Conditions represents the critical condition for *E. coli* loading in the Chatata Creek subwatershed.
[1] Tennessee Maximum daily water quality criterion for *E. coli*.
[2] Reductions (percent) based on mean of observed percent load reductions in range.
[3] LAs and MS4s are expressed as daily load per unit area in order to provide for future changes in the distribution of LAs and MS4s (WLAs).
[4] Example Best Management Practices for Urban Source reduction. Actual BMPs applied may vary and should not be limited according to this grouping.

E.2 Agricultural Source Areas

For impaired waterbodies and corresponding HUC-12 subwatersheds or drainage areas identified as predominantly agricultural source area types, Bacon Branch provides an example for implementation analysis.

The Bacon Branch drainage area, part of HUC-12 060200021403, lies in a rural area of Polk county. The drainage area for Bacon Branch is approximately 666 acres (1.0 mi^2). Five flow zones were used for the duration curve analysis (see Sect. 9.1.1). The landuse for Bacon Branch is approximately 70.6% agricultural, with the remainder split between forest (27.0%) and urban (2.38%).

The flow duration curve for Bacon Branch at mile 1.6 was constructed using simulated daily mean flow for the period from 1/1/08 through 12/31/20 (mile 1.6 corresponds to the location of monitoring station BACON001.6PO). This flow duration curve is shown in Figure E-3 and represents the cumulative distribution of daily discharges arranged to show percentage of time specific flows were exceeded during the period of record.

The *E. coli* LDC for Bacon Branch (Figure E-4) was analyzed to determine the frequency with which observed daily water quality loads exceed the *E. coli* target maximum daily loading (941 CFU/100 mL x flow [cfs] x conversion factor) under five flow conditions (low, dry, mid-range, moist, and high). Observation of the plot illustrates that monitoring over the entire period of record occurred in most flow zones, with exceedances also occurring during most flow conditions (see Table E-3, Section E.4) indicating that the Bacon Branch subwatershed is impacted by both point and nonpoint sources.

Results indicate the implementation strategy for the Bacon Branch drainage area will require BMPs targeting both point sources and non-point sources. Table E-2 presents an allocation table of LDC analysis statistics for Bacon Branch *E. coli* and targeted implementation strategies for each source category covering the entire range of flow and entire period of record (Stiles, 2003). The implementation strategies listed in Table E-2 are a subset of the categories of BMPs and implementation strategies available for application to the Hiwassee River watershed for reduction of *E. coli* loading and mitigation of water quality impairment from agricultural sources. Targeted implementation strategies and LDC analysis statistics for other impaired waterbodies and corresponding HUC-12 subwatersheds and drainage areas identified as predominantly agricultural source area types can be derived from the information and results available in Tables 12 and E-3.

LDCs for other impaired waterbodies were developed using a similar procedure (Appendix C) and are shown in Figures E-5 through E-35. The LDCs shown in Figures E-5 through E-35 (and the associated Tables E-4 through E-35) are based on the most recent sampling period (2016-2020), unless there are no monitoring data available for that time period at that monitoring station. Table E-36 presents LDC analyses (TMDLs, WLAs, LAs, and MOS) and PLRGs for all flow zones for all *E. coli* impaired waterbodies in the Hiwassee River watershed.

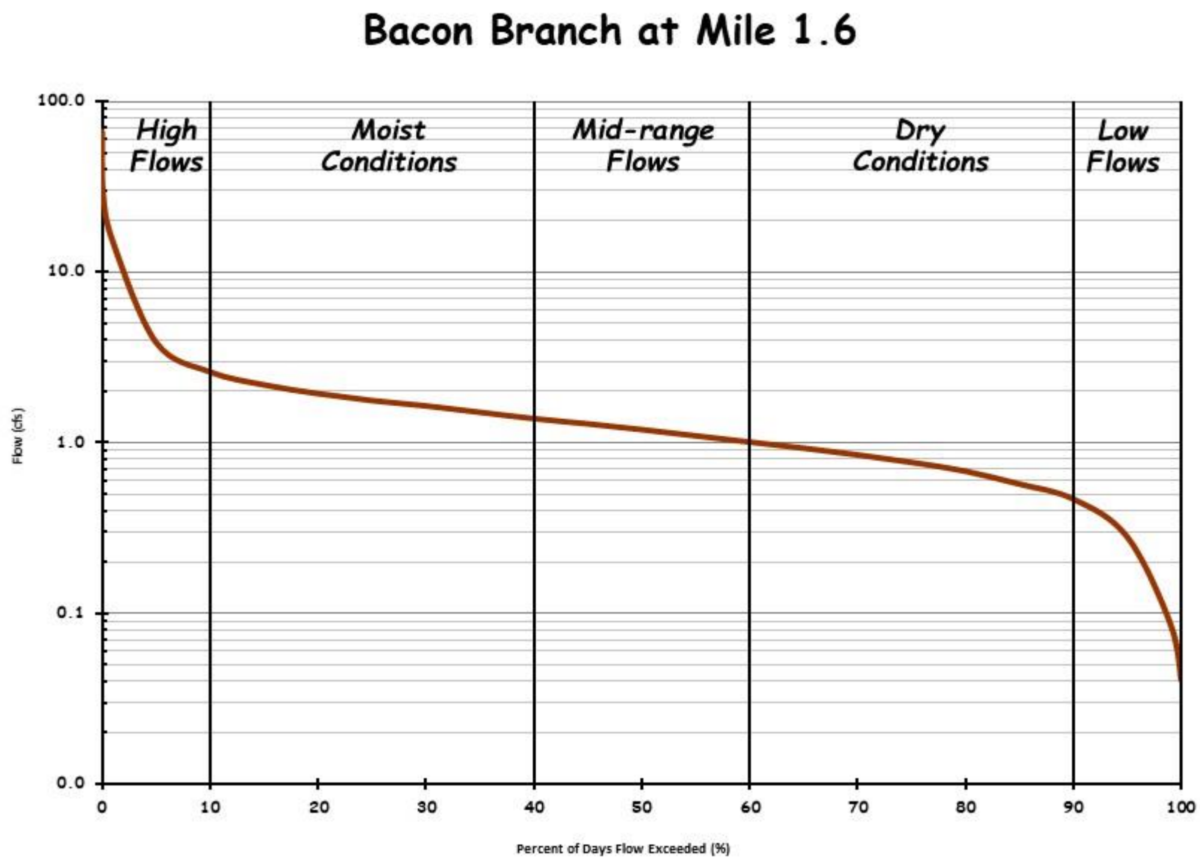

Figure E-3. Flow Duration Curve for Bacon Branch – RM 1.6

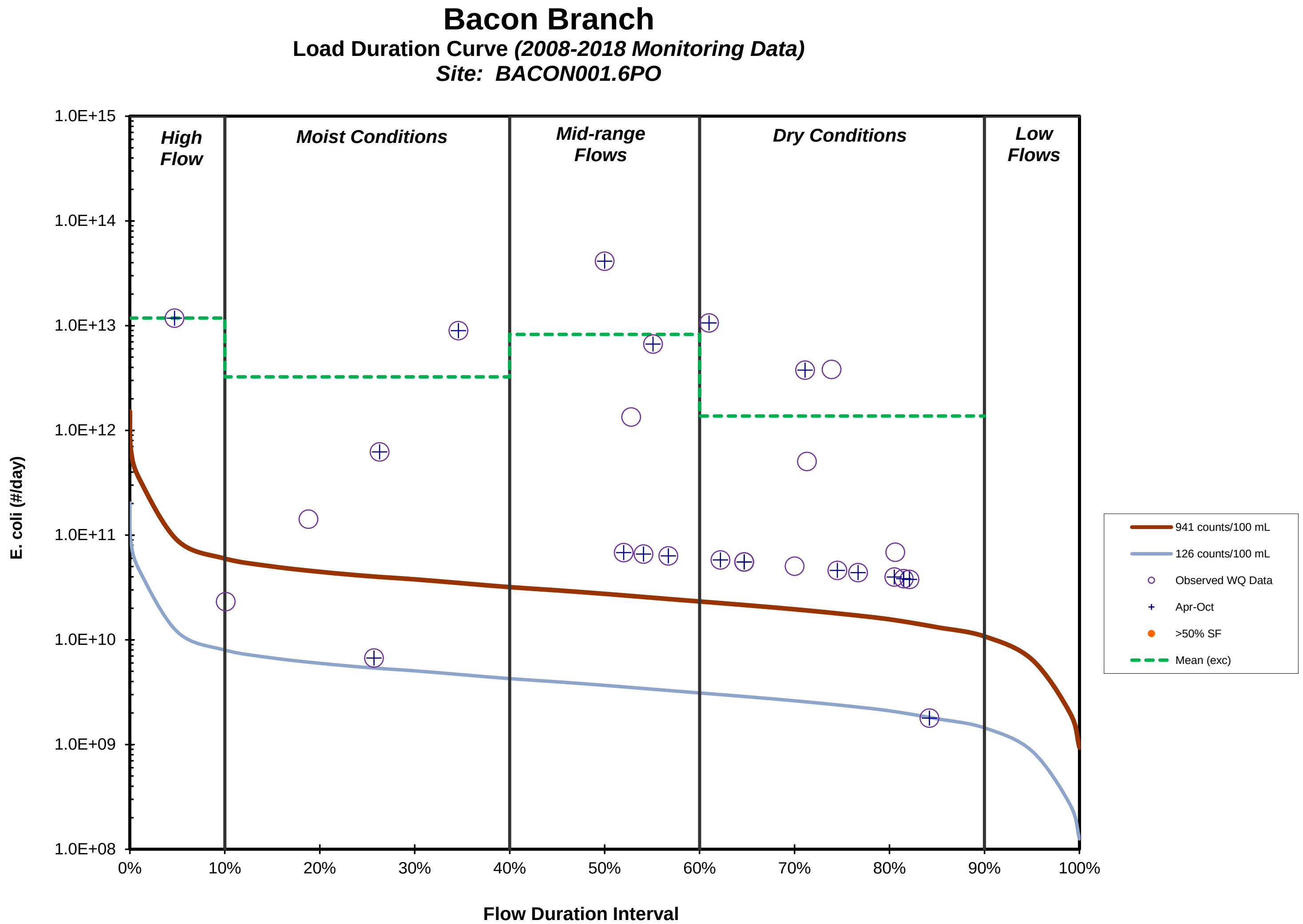

Figure E-4. ***E. coli*** **Load Duration Curve for Bacon Branch – RM 1.6**

Table E-2. Load Duration Curve Summary for Agricultural Area Implementation Strategies (Example: Bacon Branch subwatershed, in HUC-12 060200021403) (5 Flow Zones)

Hydrologic Condition		High	Moist*	Mid-range*	Dry	Low
% Time Flow Exceeded		0-10	10-40	40-60	60-90	90-100
Bacon Branch (060200021403) RM 1.6	Number of Samples	1	5	6	15	0
	% > 941 CFU/100 mL[1]	100.0	60.0	100.0	93.3	NA
	Load Reduction[2]	99.2	87.0	80.2	73.0	NA
TMDL (CFU/day)		8.901E+10	4.048E+10	2.737E+10	1.771E+10	6.440E+09
Margin of Safety (CFU/day)		8.901E+09	4.048E+09	2.737E+09	1.771E+09	6.440E+08
WLA (WWTPs) (CFU/day)		2.30E+10 x q_m	2.30E+10 x q_m	2.30E+10 x q_m	2.30E+10 x q_m	2.30E+10 x q_m
WLAs (MS4s) (CFU/day/acre)[3]		(1.202E+08) - (3.45E+07 x q_d)	(5.469E+07) - (3.45E+07 x q_d)	(3.698E+07) - (3.45E+07 x q_d)	(2.393E+07) - (3.45E+07 x q_d)	(8.700E+06) - (3.45E+07 x q_d)
LA (CFU/day/acre)[3]		(1.202E+08) - (3.45E+07 x q_d)	(5.469E+07) - (3.45E+07 x q_d)	(3.698E+07) - (3.45E+07 x q_d)	(2.393E+07) - (3.45E+07 x q_d)	(8.700E+06) - (3.45E+07 x q_d)
Implementation Strategies[4]						
Pasture and Hayland Management		H	H	M	L	L
Livestock Exclusion				M	H	H
Fencing				M	H	H
Manure Management		H	H	M	L	L
Riparian Buffers		L	M	H	M	M
Potential for source area contribution under given flow condition (H: High; M: Medium; L: Low)						

q_m = Mean Daily WWTP Discharge (cfs)
q_d = Facility (WWTP) Design Flow (cfs)
* The Moist Conditions (entire period of record) and Mid-Range (most recent cycle) flow zones represent the critical conditions for *E. coli* loading in the Bacon Branch drainage area.
[1] Tennessee Maximum daily water quality criterion for *E. coli*.
[2] Reductions (percent) based on mean of observed percent load reductions in range.
[3] LAs and MS4s are expressed as daily load per unit area in order to provide for future changes in the distribution of LAs and MS4s (WLAs).
[4] Example Best Management Practices for Agricultural Source reduction. Actual BMPs applied may vary and should not be limited according to this grouping.

E.3 Forestry Source Areas

There are no impaired waterbodies with a corresponding HUC-12 subwatershed or drainage area classified as source area type predominantly forested, with the predominant source category being wildlife, in the Hiwassee River watershed.

E.4 Calculation of Percent Load Reduction Goals and Determination of Critical Flow Zones

In order to facilitate implementation, corresponding percent reductions in loading required to decrease existing, in-stream *E. coli* loads to TMDL target levels (percent load reduction goals) were calculated. As a result, critical flow zones were determined and subsequently verified by secondary analyses. The following example is from Bacon Branch at mile 1.6 (Figure E-2).

For each individual sampling date, the percent load reduction required to reduce each exceedance to its respective target maximum load is calculated. For each flow zone, the mean of the percent load reductions was calculated. Individual loads with no required load reduction are not included in the mean calculation. The following illustrates the calculation of the PLRG for the moist conditions flow zone for the period of record (2008-2018):

Date	Sample Conc. (CFU/100 mL)	Flow (cfs)	Existing Load (CFU/Day)	Target (TMDL) Load (CFU/Day)	Percent Reduction
1/22/13	365.4	2.59	2.31E+10	5.96E+10	
3/8/18	2,920	1.99	1.42E+11	4.58E+10	67.8
10/4/12	156.5	1.75	6.70E+09	4.03E+10	
5/3/18	14,670	1.74	6.23E+11	3.99E+10	93.6
7/18/17	241,960	1.51	8.95E+12	3.48E+10	99.6
Percent Load Reduction Goal (PLRG) for Moist Conditions (Mean)					**87.0**

1. The first step in determining the critical flow zone requires examination of data for the most recent sampling cycle. The PLRGs calculated for each of the flow zones, not including the high flow zone (see Section 9.1.1), were compared and the PLRG of the greatest magnitude indicates the critical flow zone for prioritizing implementation actions for Bacon Branch at mile 1.6.

   Example – *High Flow Zone Percent Load Reduction Goal = 99.2*
   Moist Conditions Flow Zone Percent Load Reduction Goal = 87.0
   Mid-Range Flow Zone Percent Load Reduction Goal = 99.2
   Dry Conditions Flow Zone Percent Load Reduction Goal = 98.8
   Low Flow Zone Percent Load Reduction Goal =NA

   Therefore, based on the most recent sampling cycle, the critical flow zone for prioritization of Bacon Branch implementation activities is the Mid-Range Flow Zone (and subsequently actions targeting both point sources and nonpoint sources).

2. Due to the frequently limited availability of sampling data and subsequent randomness of distribution of samples by flow zone, the determination of the critical flow zone by PLRG calculation often has a high degree of uncertainty. Therefore, the second step in determining the critical flow zone requires examination of the same data as step 1, but focusing on the percent of samples that exceed the *E. coli* TMDL target levels in each flow zone rather than the PLRGs in each flow zone. The percent of samples that exceed the *E. coli* TMDL target levels during the most recent sampling cycle, for each flow zone, was calculated for Bacon Branch at mile 1.6:

Flow Zone	Total # of Samples	# of Samples > 941 CFU/100 mL	% Samples > 941 CFU/100 mL
High	1	1	100
Moist	3	3	100
Mid-Range	3	3	100
Dry	4	4	100
Low	0	0	0

Based on the number of exceedances in each flow zone, the critical flow zone for prioritization of Bacon Branch implementation activities could not be determined because all flow zones had 100% exceedance. When the two methods of determining critical flow zone produce different results, both flow zones should be targeted for implementation activities.

3. Lastly, emphasis (priority) should be placed on recent data versus historical data. Therefore, the third step in determining the critical flow zone requires comparison of the results of the methods described in steps 1 and 2 as applied both to recent data (current cycle) and to the entire period of record, or previous cycles:

Zone	Past 3 Cycles (2008-20)			Most Recent Cycle (2016-2020)		
	# of samples	% Red.	% Exceed.	# of samples	% Red.	% Exceed.
High	1	99.2	100	1	99.2	100
Moist	**5**	**87.0**	**60.0**	3	87.0	100
Mid-Range	6	80.2	100	**3**	**99.2**	**100**
Dry	15	73.0	93.3	4	98.8	100
Low	0	NA	0	0	NA	0

Step 1 already identified the Mid-Range flow zone as the critical flow zone. When a different flow zone, or zones, is identified, the flow zone(s) from analysis of recent data would have primary emphasis for implementation prioritization.

PLRGs and critical flow zones of the other impaired waterbodies were derived in a similar manner and are shown in Tables E-3 and E-36. For the Hiwassee River mainstem impaired waterbody (008_1000), where flows were not simulated due to unsuitable conditions for modeling (ref.: Section 8.6), load duration curves could not be developed. However, required load reductions were derived based on the 90th percentile of monitoring data for the most recent monitoring cycle and are shown in Tables E-17 and E-36.

Geometric Mean Data

For cases where five or more samples were collected over a period of not more than 30 consecutive days, the geometric mean *E. coli* concentration was determined and compared to the target geometric mean *E. coli* concentration of 126 CFU/100 mL. If the sample geometric mean exceeded the target geometric mean concentration, the reduction required to reduce the sample geometric mean value to the target geometric mean concentration was calculated.

Example: *Monitoring Location = Dairy Branch Mile 1.2*
Sampling Period = 5/14/08 – 5/29/08
Geometric Mean Concentration = 757.8 CFU/100 mL
Target Concentration = 126 CFU/100 mL
Reduction to Target = 83.4%

For impaired waterbodies where monitoring data are limited to geometric mean data only, results can be utilized for general indication of relative impairment and, when plotted on a load duration curve, may indicate areas for prioritization of implementation efforts. For impaired waterbodies where both types of data are available, geometric mean data may be utilized to supplement the results of the individual flow zone calculations.

Table E-3. Summary of Critical Conditions for Analysis of Impaired Waterbodies In the Hiwassee River Watershed

Waterbody Name	Analysis Area [a]	Moist	Mid-Range	Dry	Low	Monitoring Station	Drainage Area (ac)
Cane Creek	DA in 0802	X				CANE001.5MM	7,481
Dairy Branch	DAs in 0909	✓				DAIRY001.2PO	288
Siccowee Branch				✓		SICCO000.7PO	587
Middle Creek	HUC-12 1001		✓	X		MIDDL004.6ME	13,164
Chestuee Creek	HUC-12 1002						
Little Chestuee Creek			✓			CHEST041.4MM	20,612
Big Foot Branch	DAs in 1003		✓			BFOOT000.5MM	5,292
Tom Foeman Branch		✓	X			TFOEM001.8MM	2,685
Oostanaula Creek (083_4000)	HUC-12 1101			X		OOSTA037.1MM	11,140
Oostanaula Creek (083_1000)	HUC-12 1102						
Oostanaula Creek (083_2000)							
Oostanaula Creek (083_3000)							
Black Branch							
Walker Branch		✓				OOSTA028.4MM	19,494
Latham Springs Branch	DAs in 1201		✓			LSPRI000.4MM	3,156
Little N. Mouse Creek		✓				LNMOU002.4MM	3,418
North Mouse Creek (084_2000) [b]						NMOUS025.4MM	25,292
Spring Creek	HUC-12 1202	✓		X		SPRIN003.8MM	8,330

Table E-3 (cont'd). Summary of Critical Conditions for Analysis of Impaired Waterbodies In the Hiwassee River Watershed

Waterbody Name	Analysis Area [a]	Moist	Mid-Range	Dry	Low	Monitoring Station	Drainage Area (ac)
North Mouse Creek (084_1000 [b]	HUC-12 1203					NMOUS007.3MM	44,923
Dry Valley Creek [b]							
Candies Creek (005_3000)	HUC-12 1301		✓			CANDI033.1BR	5,529
Black Fox Creek	HUC-12 1302	✓	X		X	BFOX000.5BR	6,315
Beaverdam Creek	DAs in 1303		✓			BEAVE000.5BR	1,410
Candies Creek (005_1000)				X		CANDI008.1BR	62,417
South Chestuee Creek	HUC-12 1401	✓				SCHES001.8BR	24,335
Little Chatata Creek	DAs in 1402	✓	✓	X		LCHAT000.3xx	6,444
Rattlesnake Branch			✓			RATTL001.3xx	906
Chatata Creek			✓			CHATA002.0BR	18,923
Bacon Branch	DA in 1403	X	✓			BACON001.6PO	666
South Mouse Creek	HUC-12 1404		✓			SMOUS012.7BR	7,050
South Mouse Creek							
Fillauer Branch							
Woolen Mill Branch							
Brush Creek	DAs in 1405	✓		X		BRUSH000.5MM	3,447
UT to Rogers Creek			✓	✓		ROGER18.3T0.3MM	205
Rogers Creek			✓			ROGER005.1MM	24,200
Hiwassee Embayment (008_1000)	90th Percentile					HIWAS013.4MM	1,555,981
Agency Creek	DAs in 1407	✓				AGENC002.3ME	6,298
Gunstocker Creek			✓			GUNST003.0ME	9,135
Price Creek			✓		X	PRICE004.4ME	1,158

*Critical condition determined based on current (✓) sampling cycle and entire period of record (X).
[a] Analysis Area as identified in Table 8.
[b] For some waterbodies, critical flow zone could not be determined. Either the waterbody had no exceedances, or exceedances only in the high flow zone.

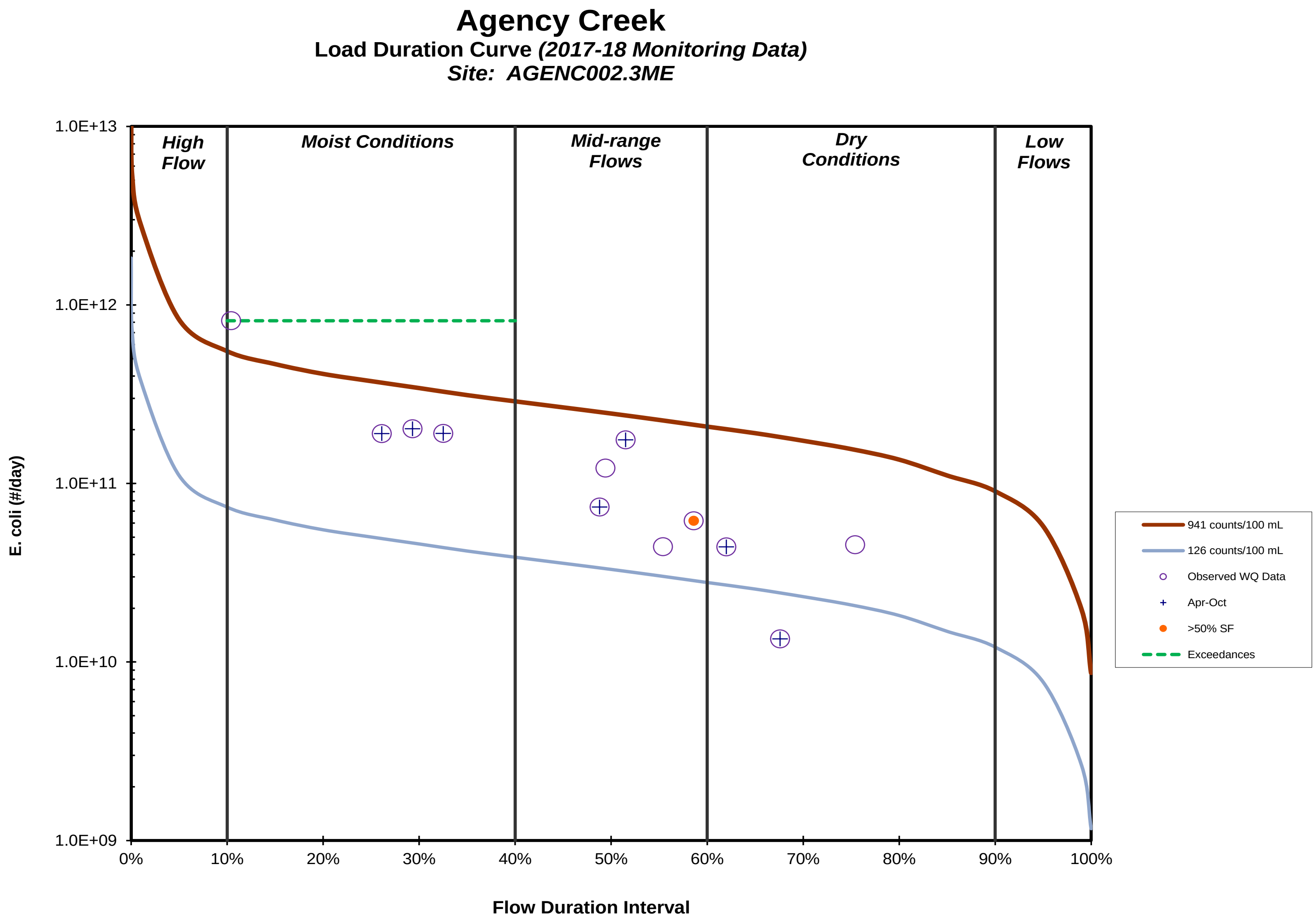

Figure E-5. ***E. coli* Load Duration Curve for Agency Creek – RM 2.3**

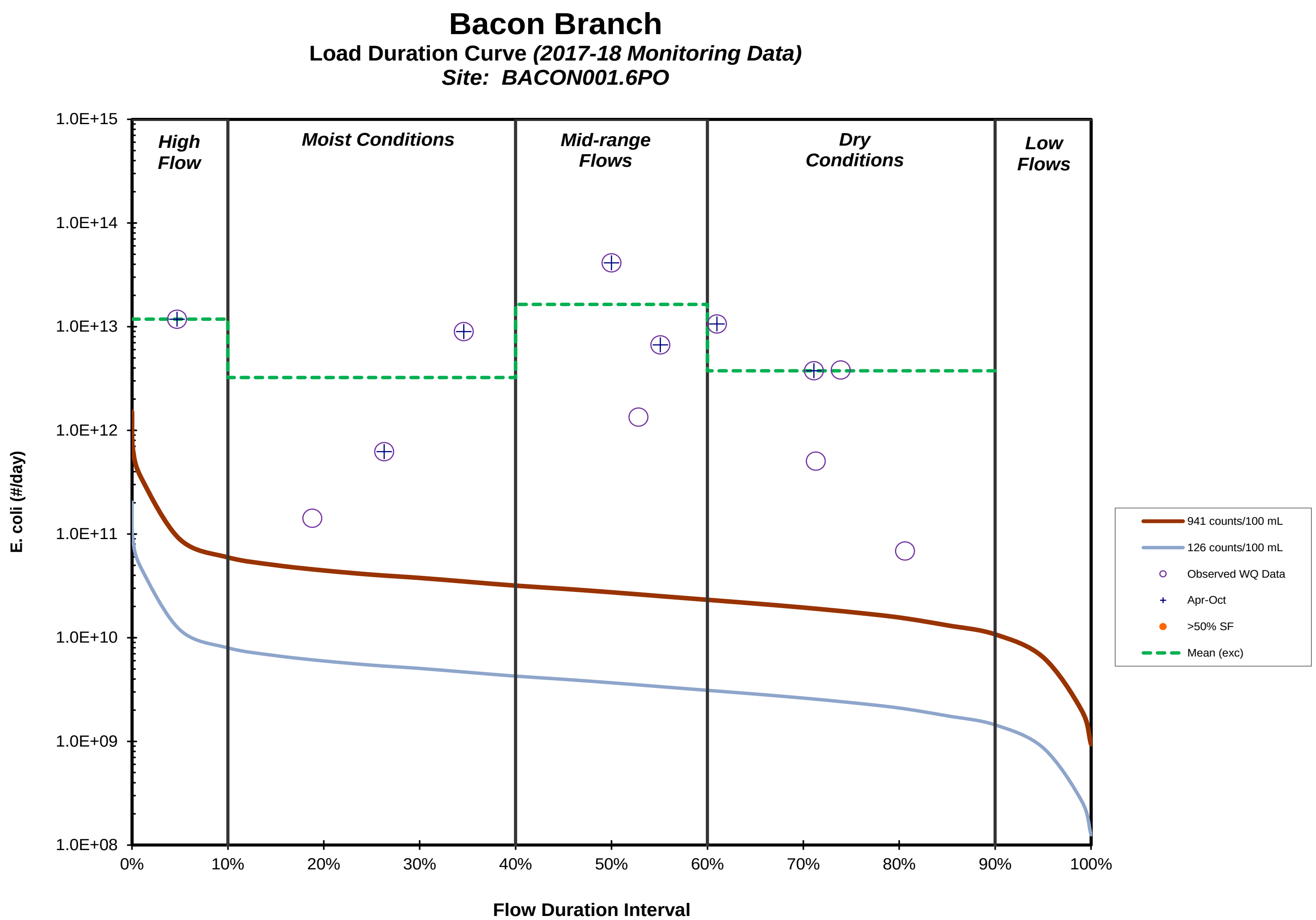

Figure E-6. ***E. coli*** **Load Duration Curve for Bacon Branch – RM 1.6**

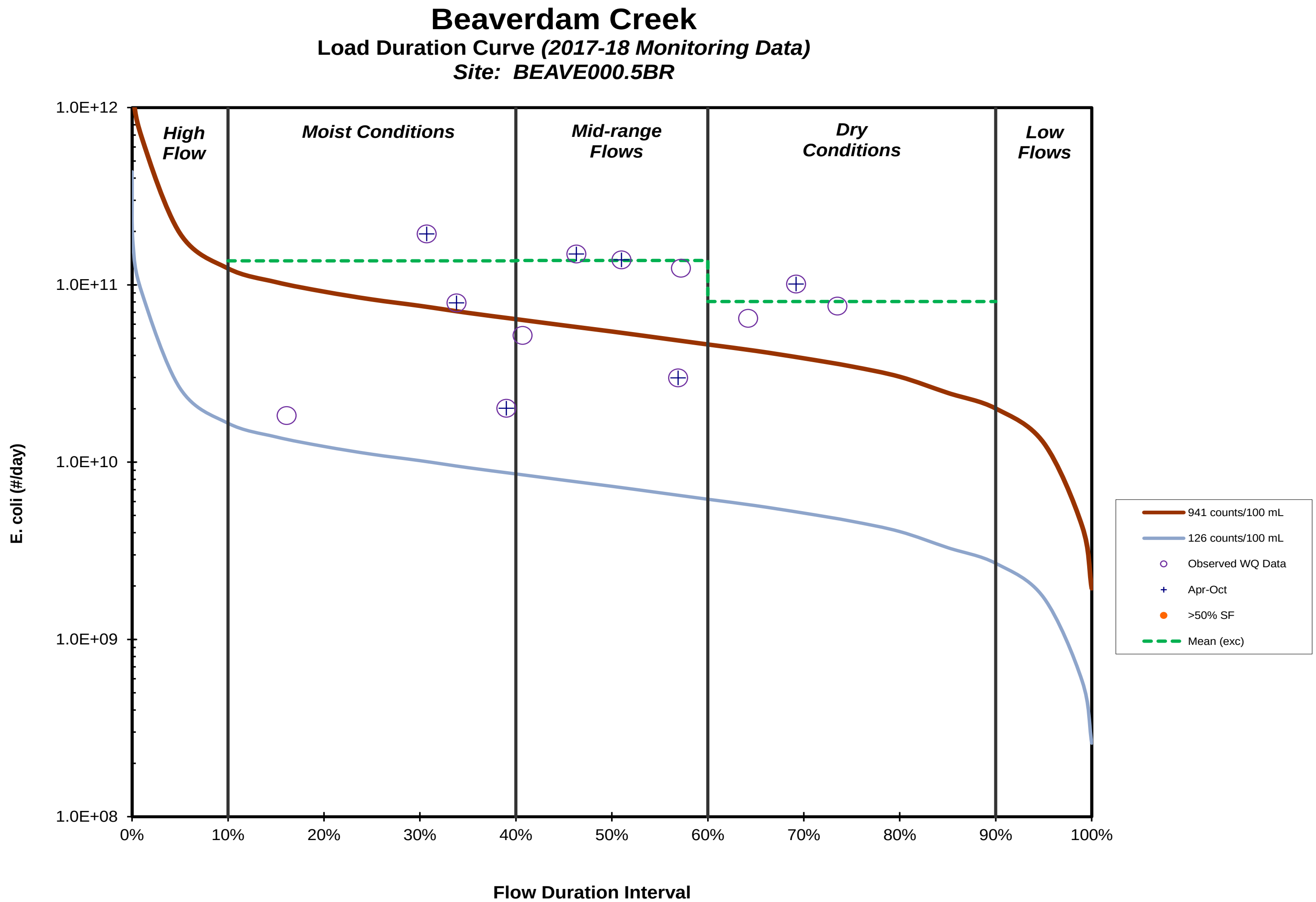

Figure E-7. *E. coli* Load Duration Curve for Beaverdam Creek – RM 0.5

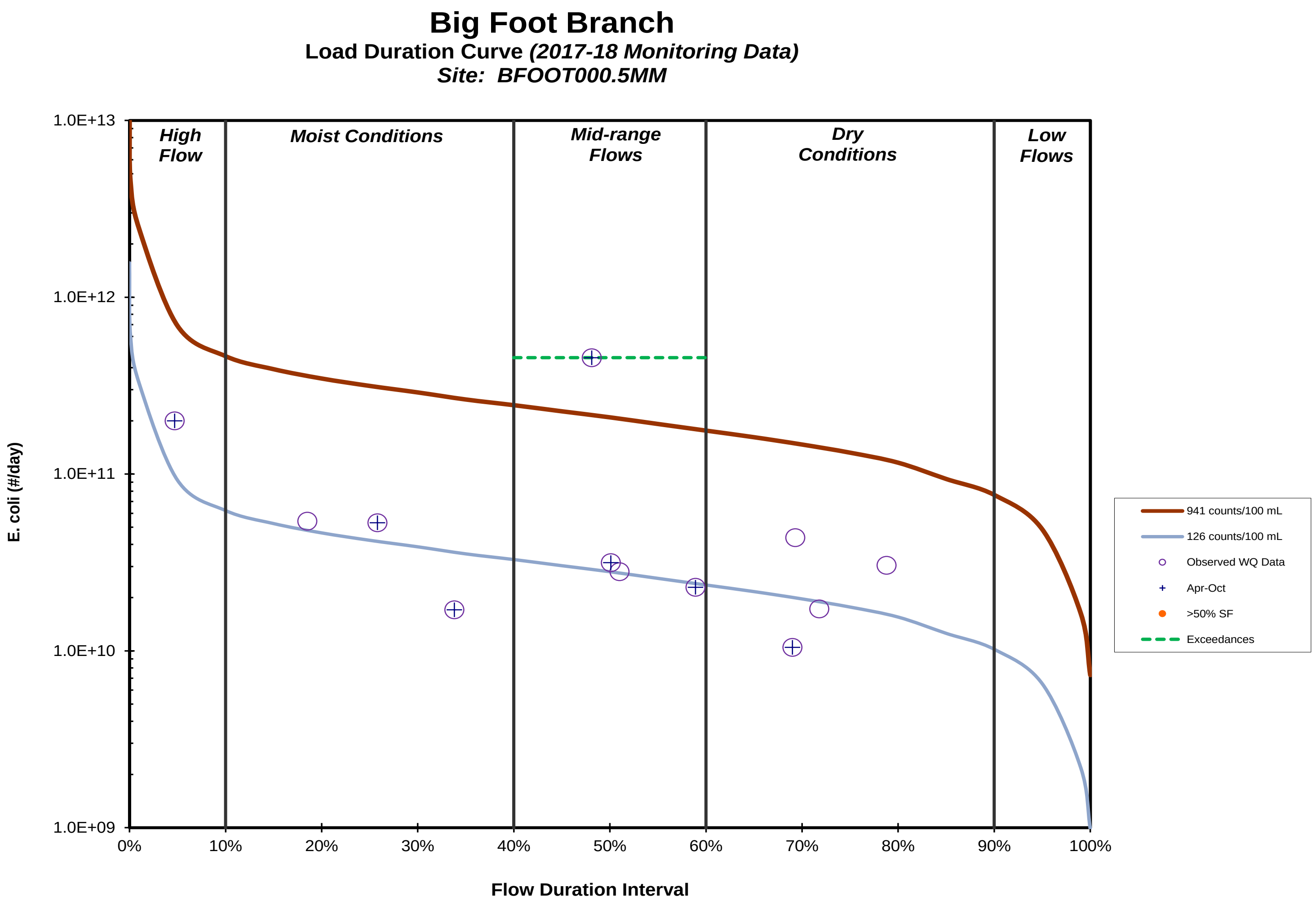

Figure E-8. ***E. coli*** **Load Duration Curve for Big Foot Branch – RM 0.5**

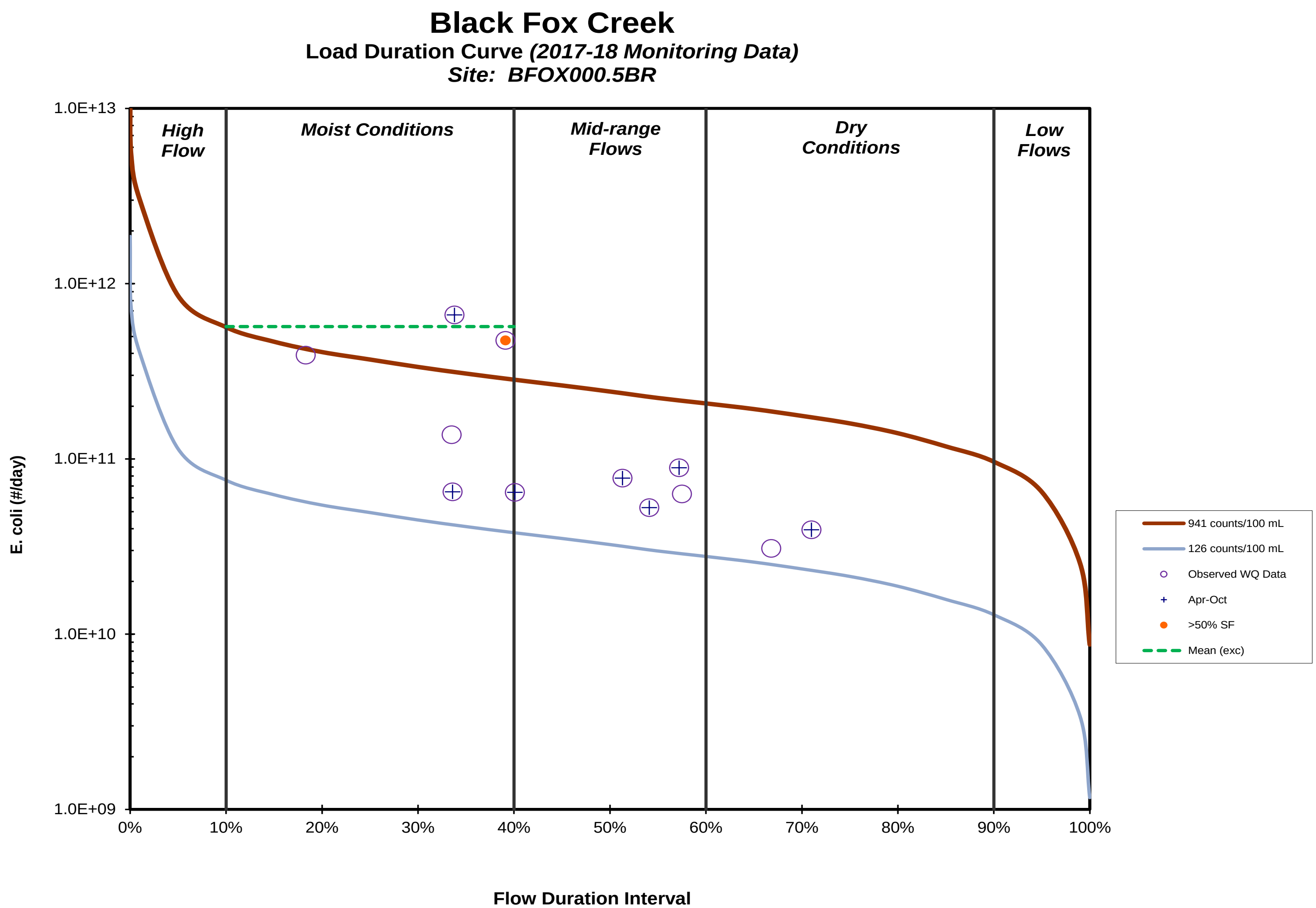

Figure E-9. ***E. coli*** **Load Duration Curve for Black Fox Creek – RM 0.5**

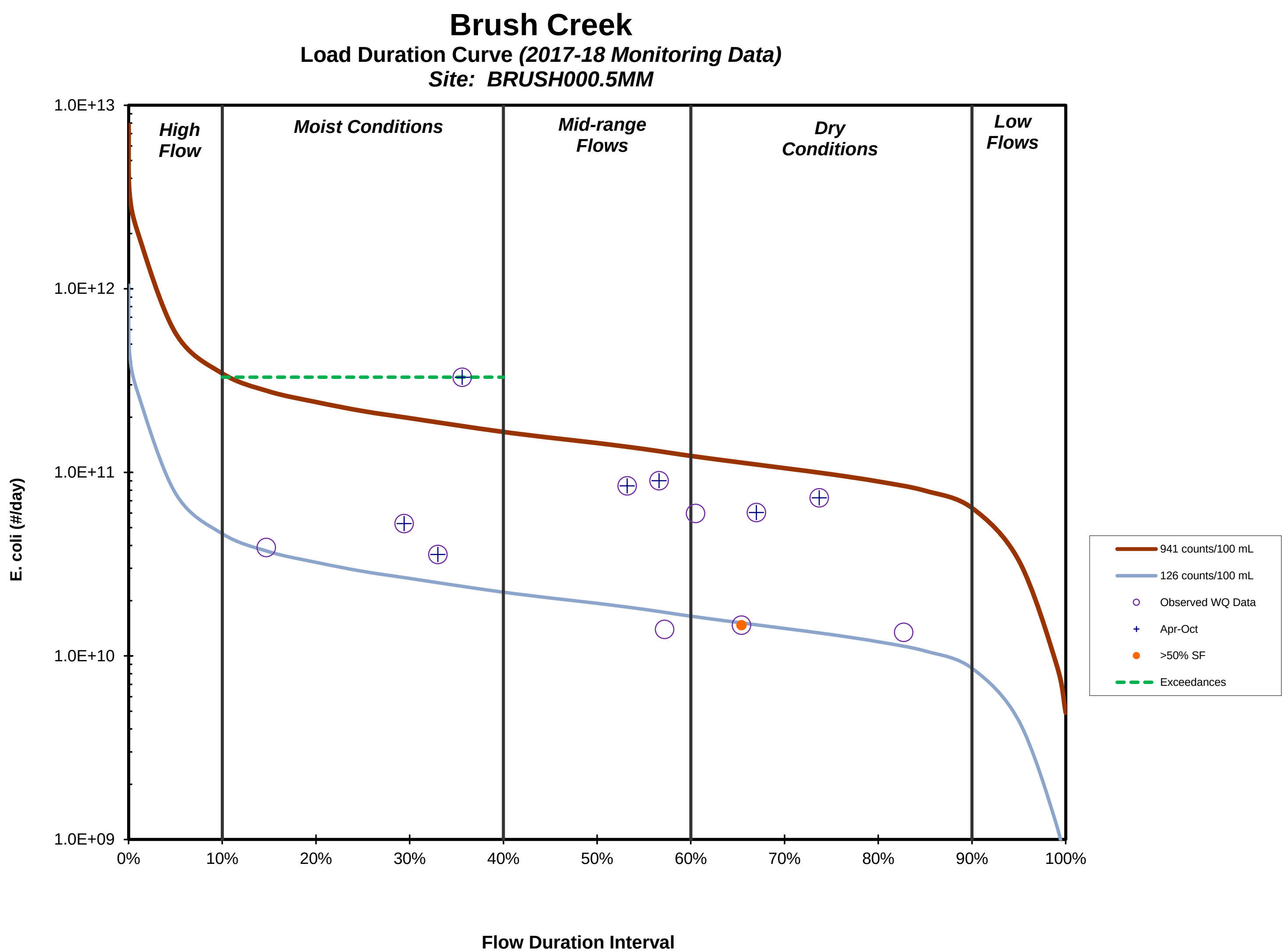

Figure E-10. *E. coli* Load Duration Curve for Brush Creek – RM 0.5

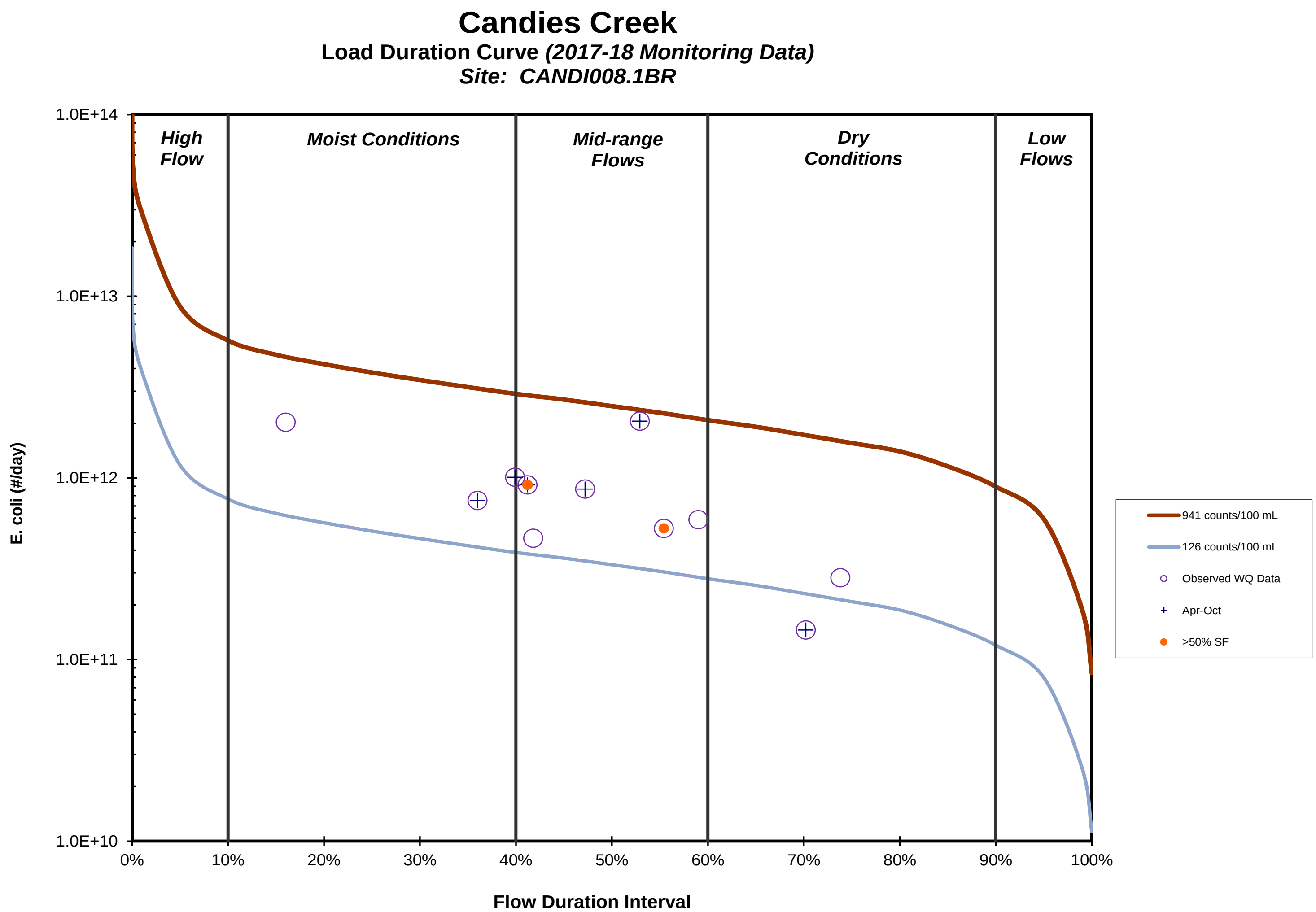

Figure E-11. *E. coli* Load Duration Curve for Candies Creek – RM 8.1

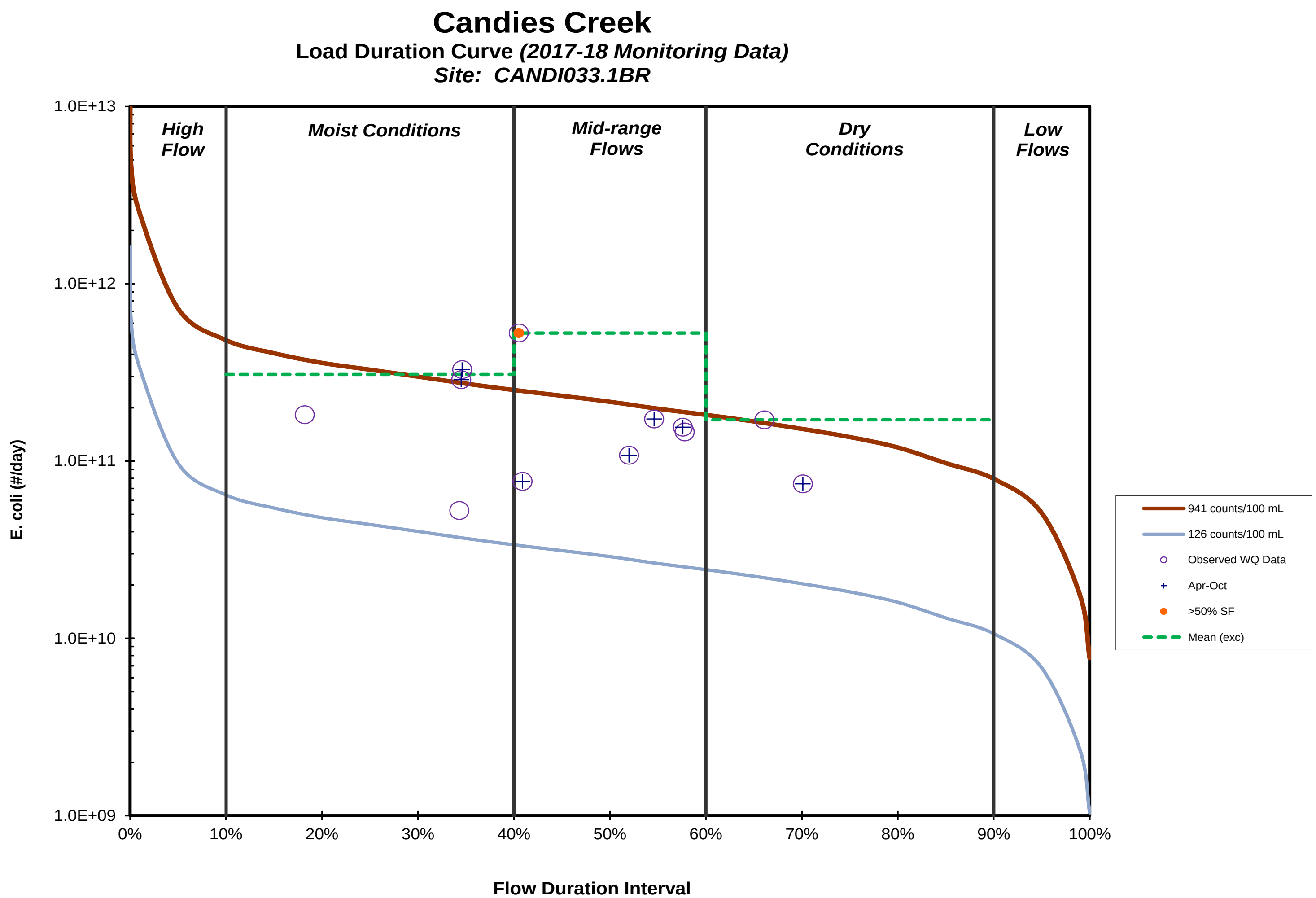

Figure E-12. *E. coli* Load Duration Curve for Candies Creek – RM 33.1

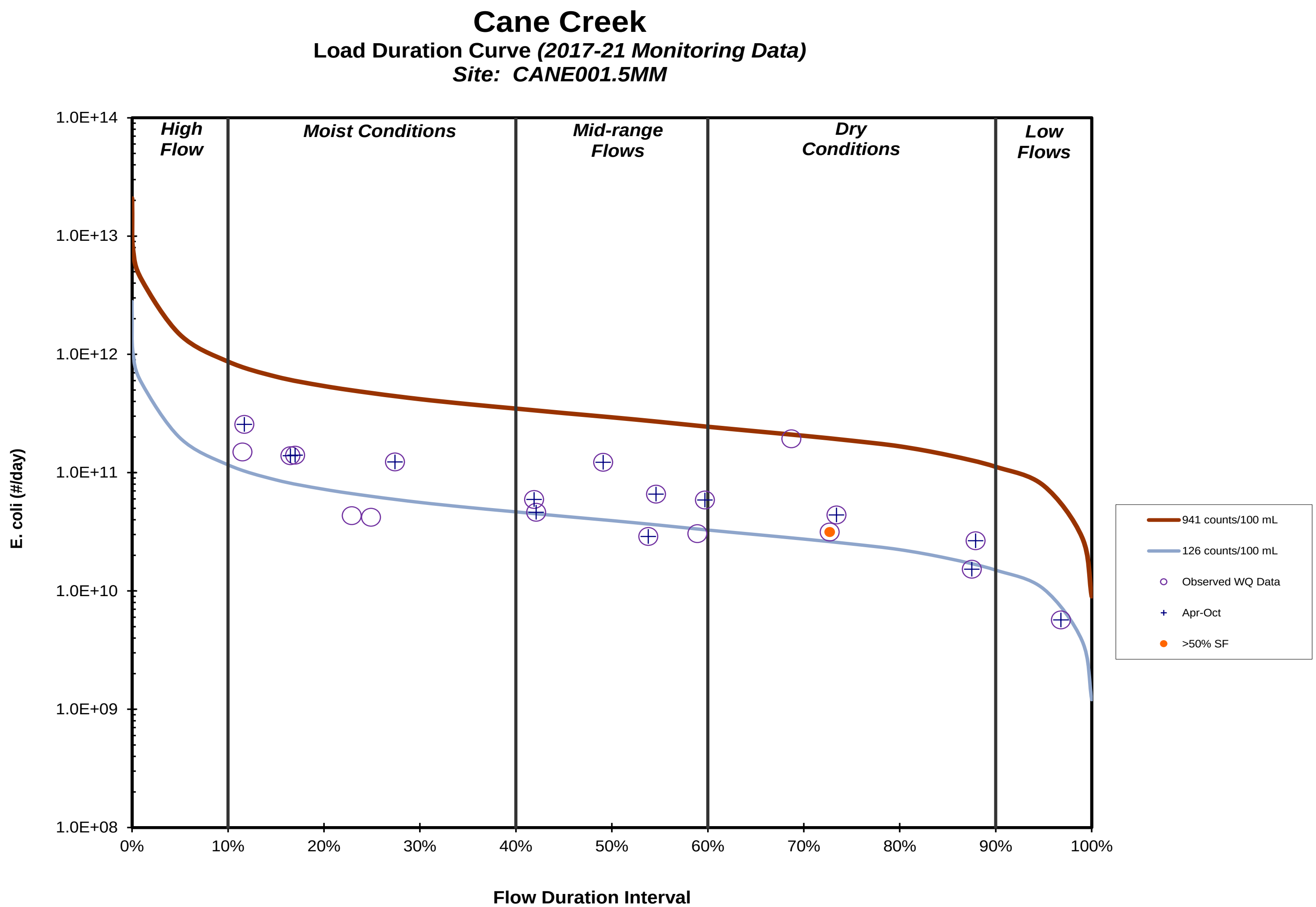

Figure E-13. *E. coli* Load Duration Curve for Cane Creek – RM 1.5

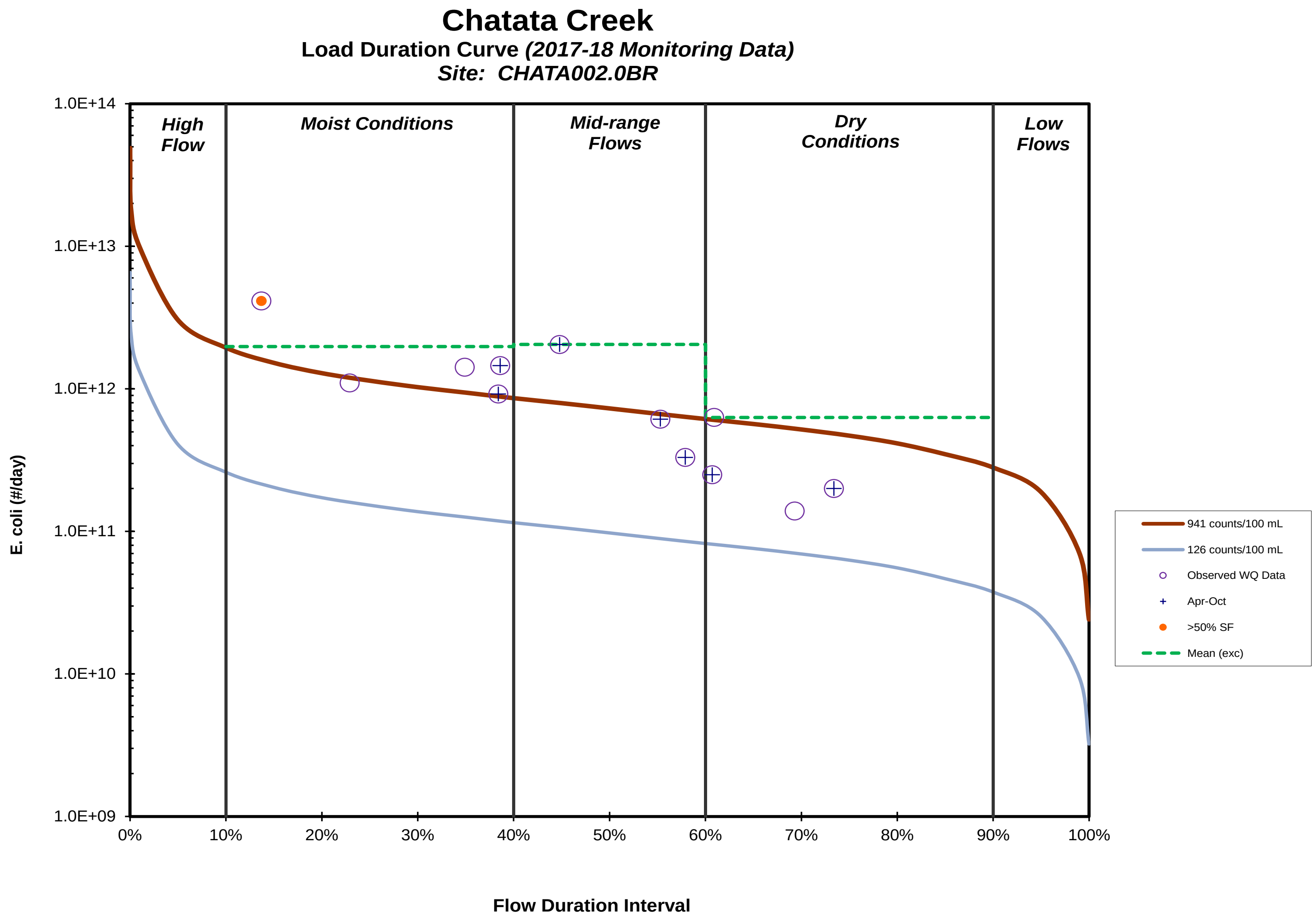

Figure E-14. *E. coli* Load Duration Curve for Chatata Creek – RM 2.0

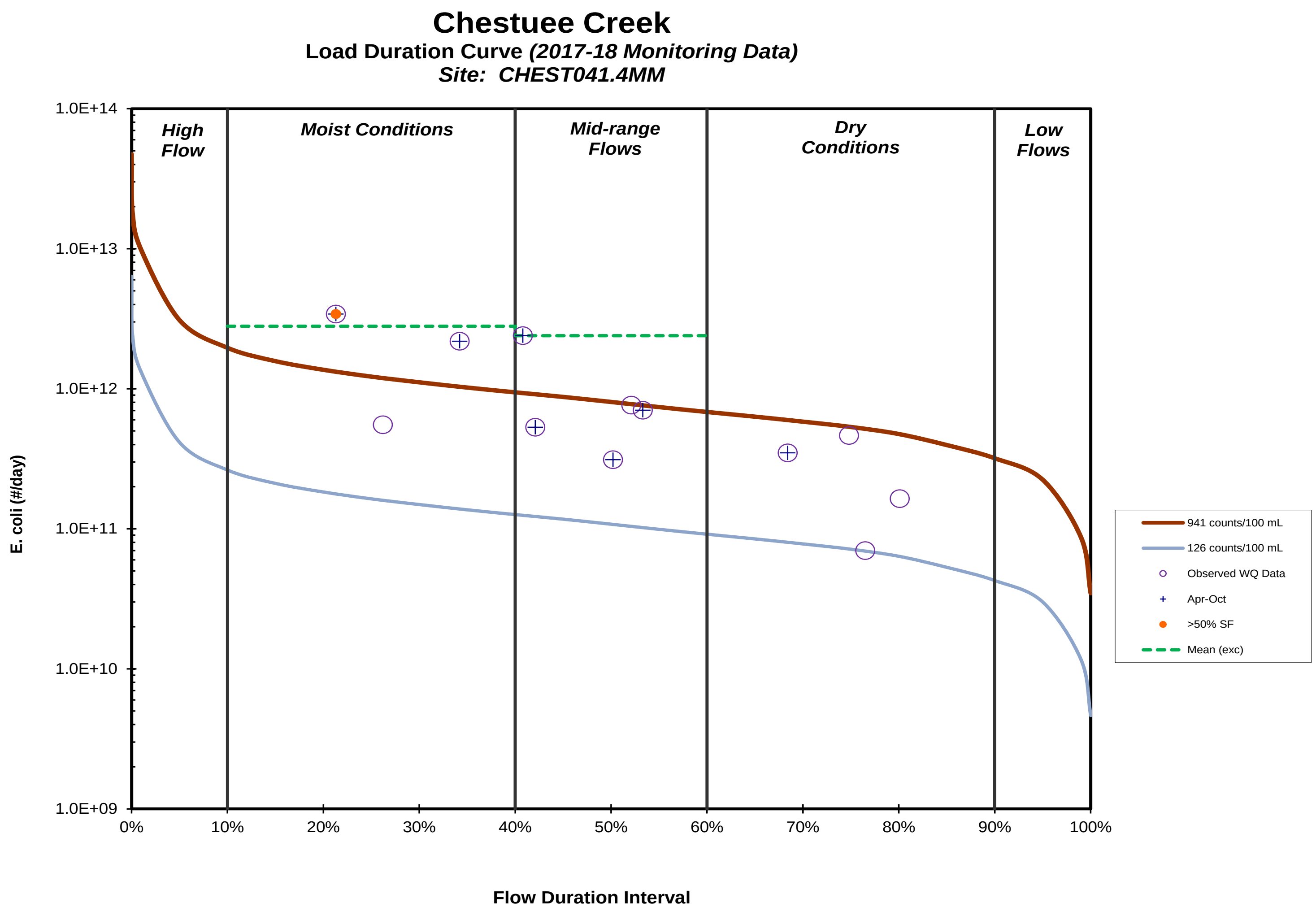

Figure E-15. ***E. coli*** **Load Duration Curve for Chestuee Creek – RM 41.4**

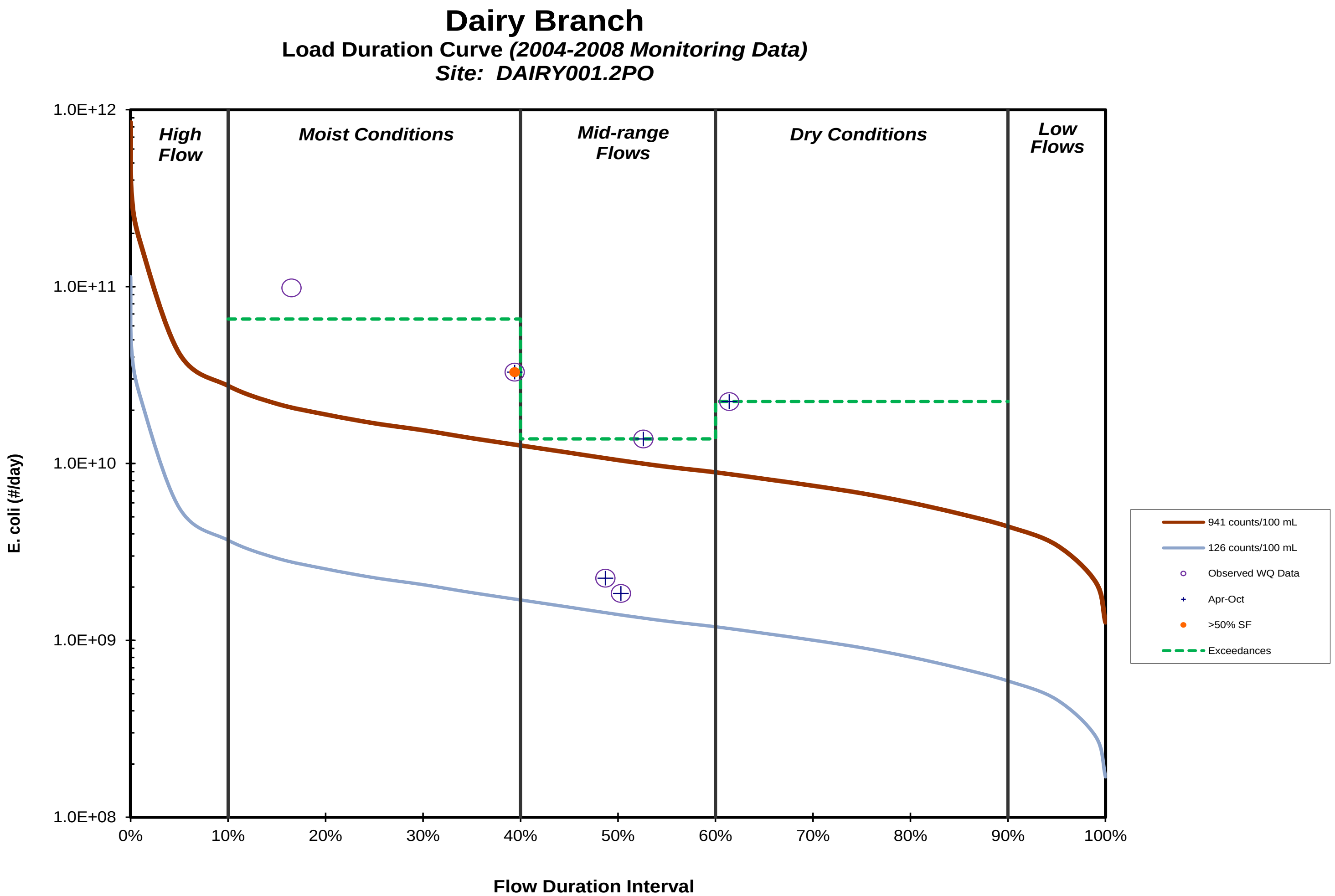

Figure E-16. *E. coli* Load Duration Curve for Dairy Branch – RM 1.2

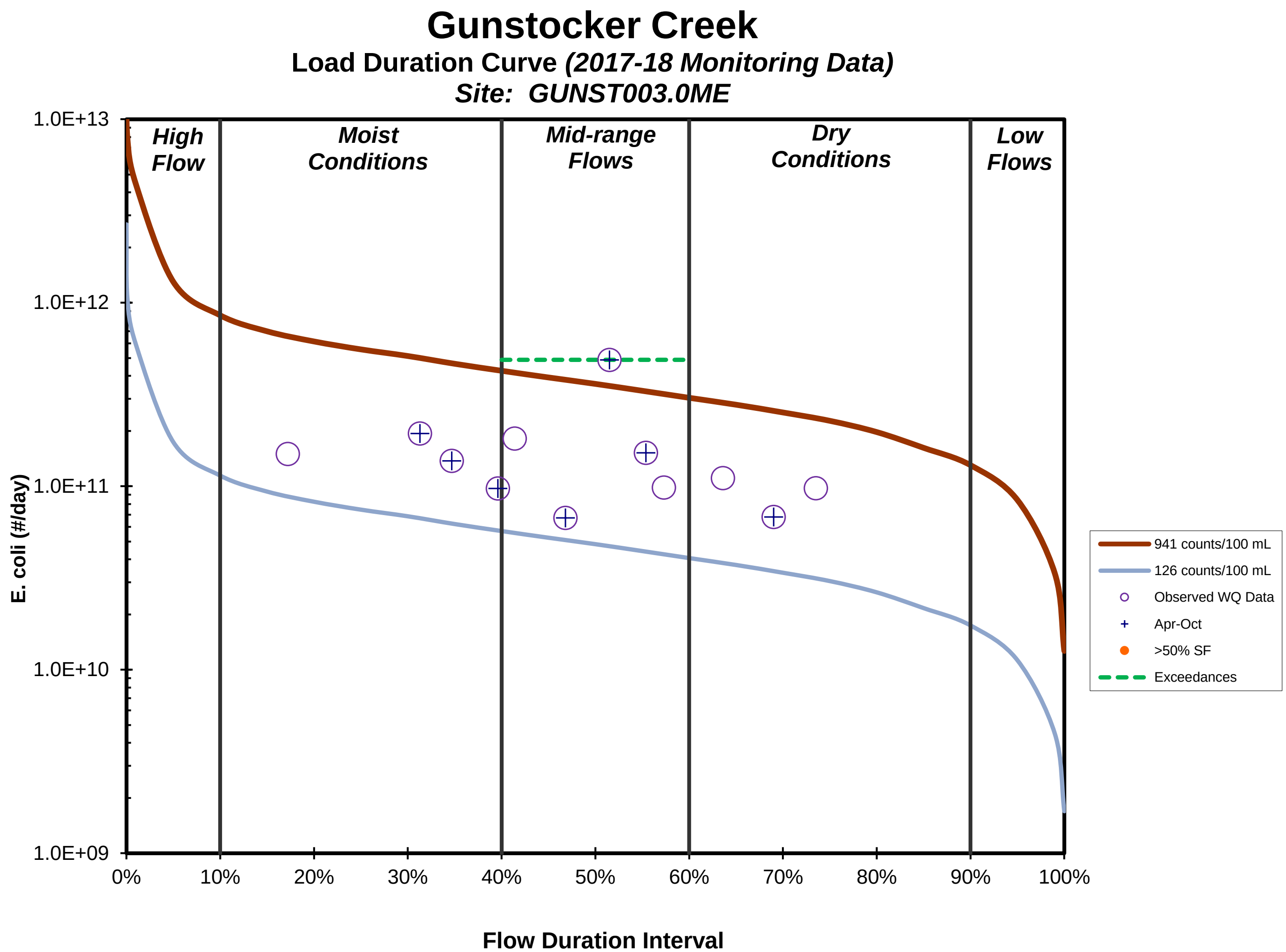

Figure E-17. *E. coli* Load Duration Curve for Gunstocker Creek – RM 3.0

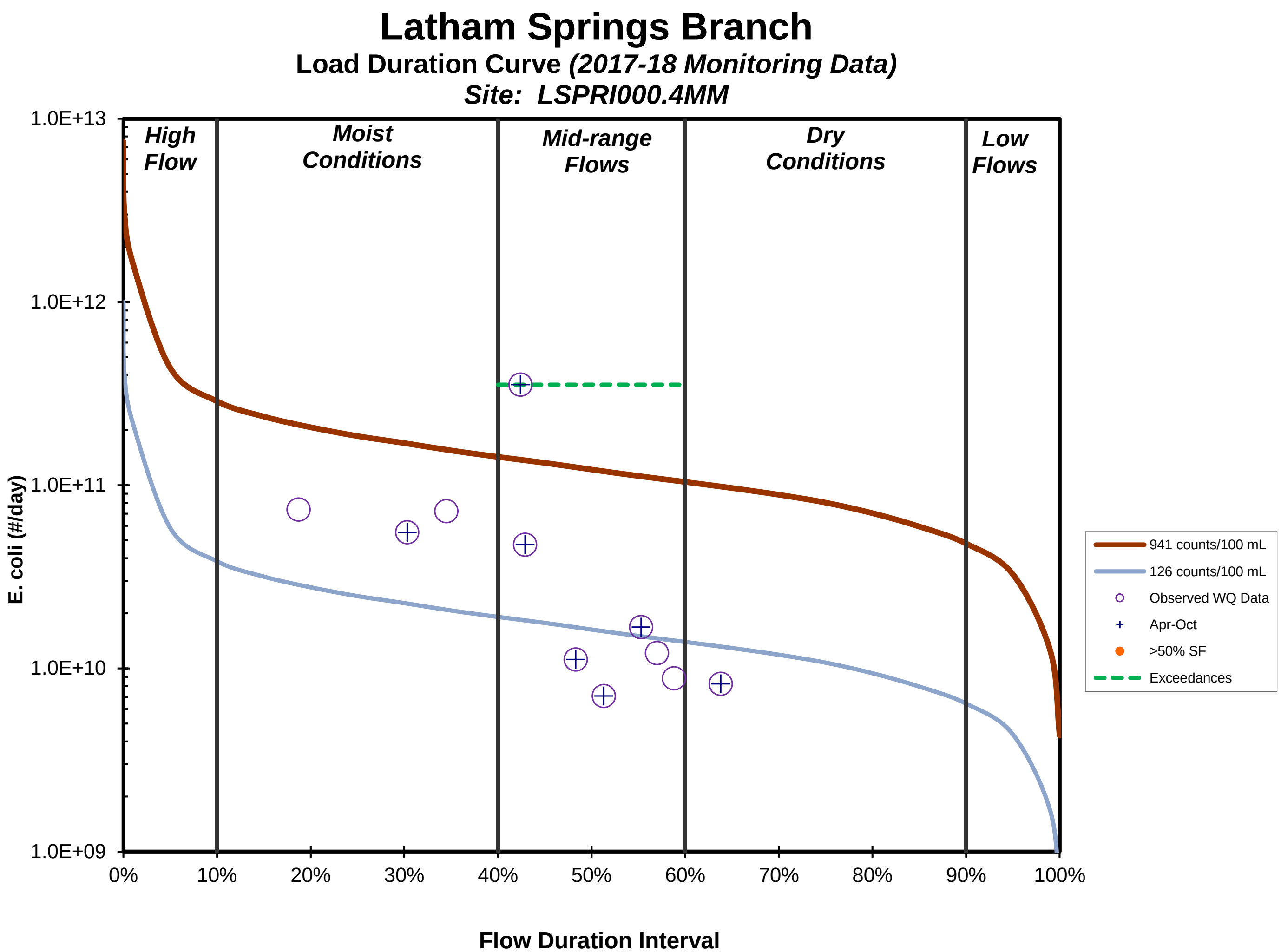

Figure E-18. ***E. coli*** **Load Duration Curve for Latham Springs Branch – RM 0.4**

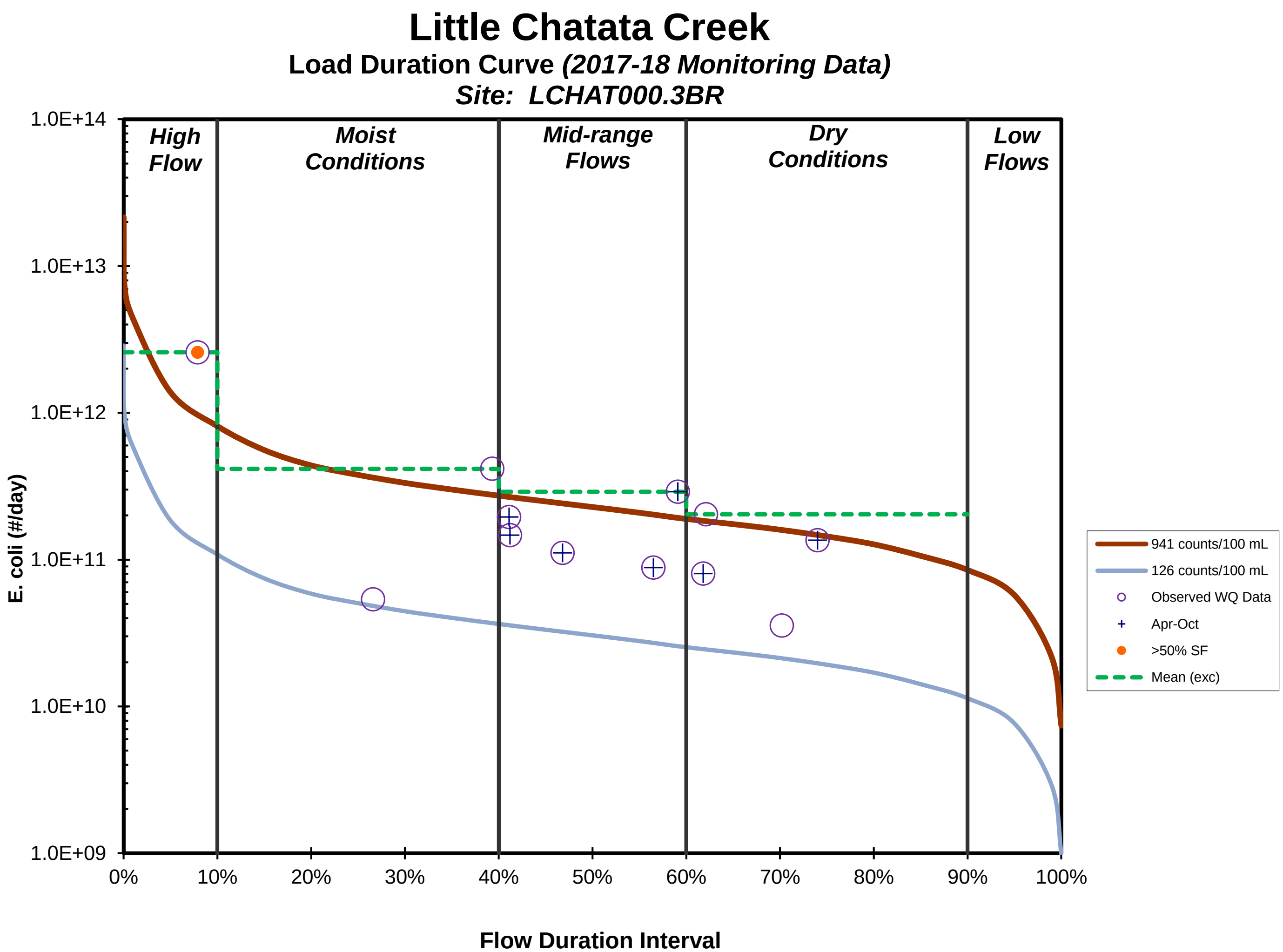

Figure E-19. *E. coli* Load Duration Curve for Little Chatata Creek – RM 0.3

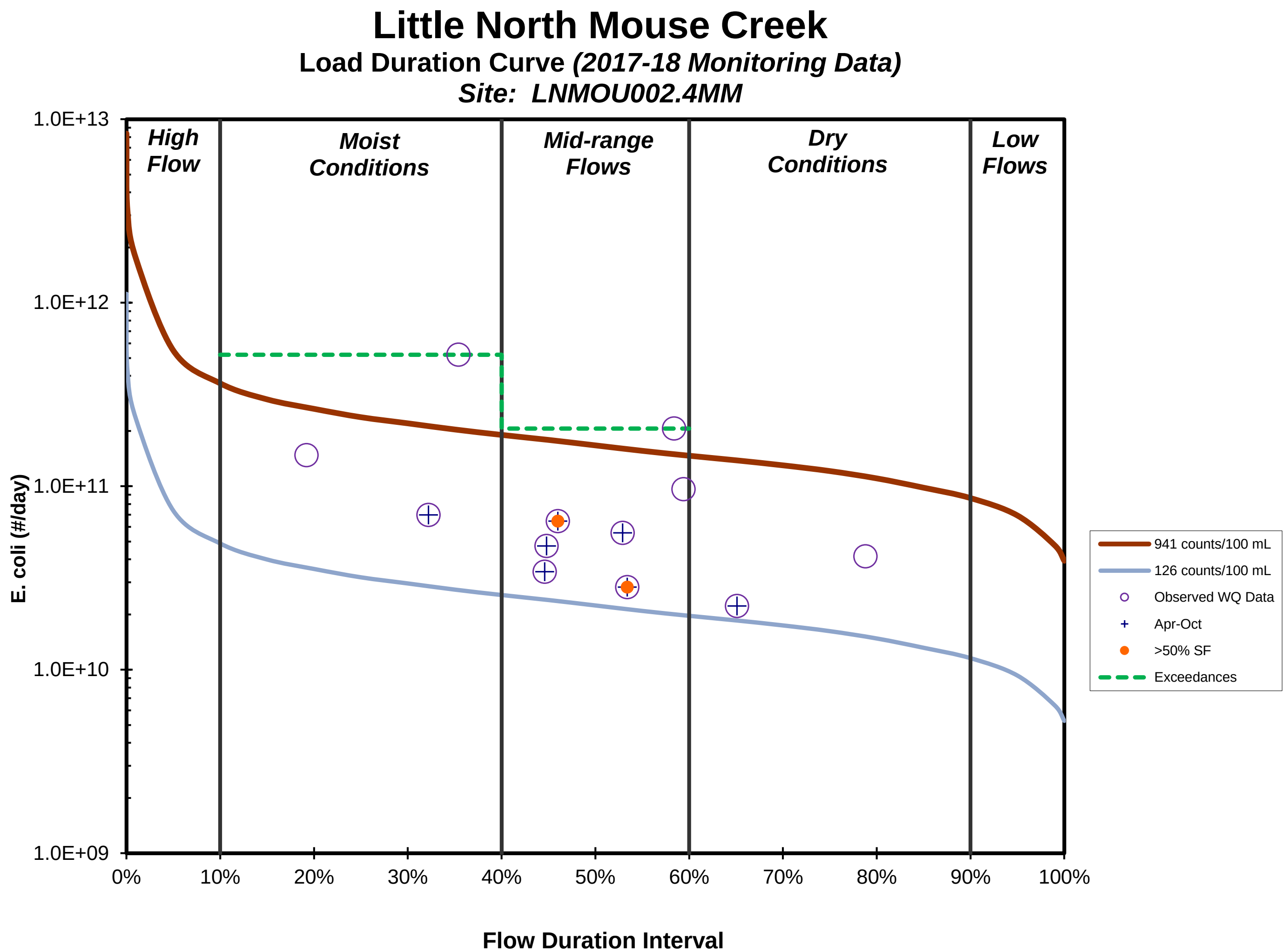

Figure E-20. *E. coli* Load Duration Curve for Little North Mouse Creek – RM 2.4

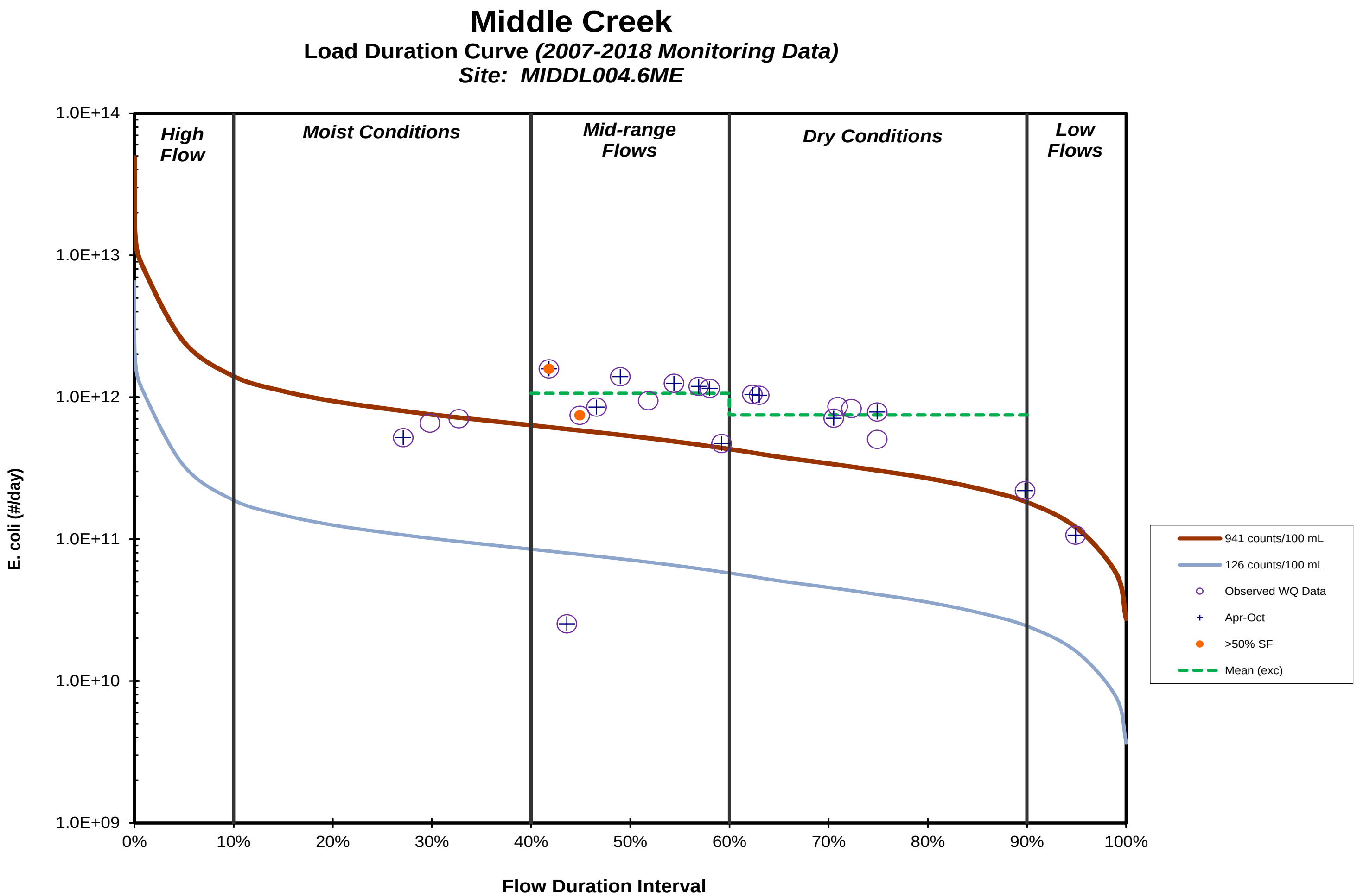

Figure E-21. *E. coli* Load Duration Curve for Middle Creek – RM 4.6

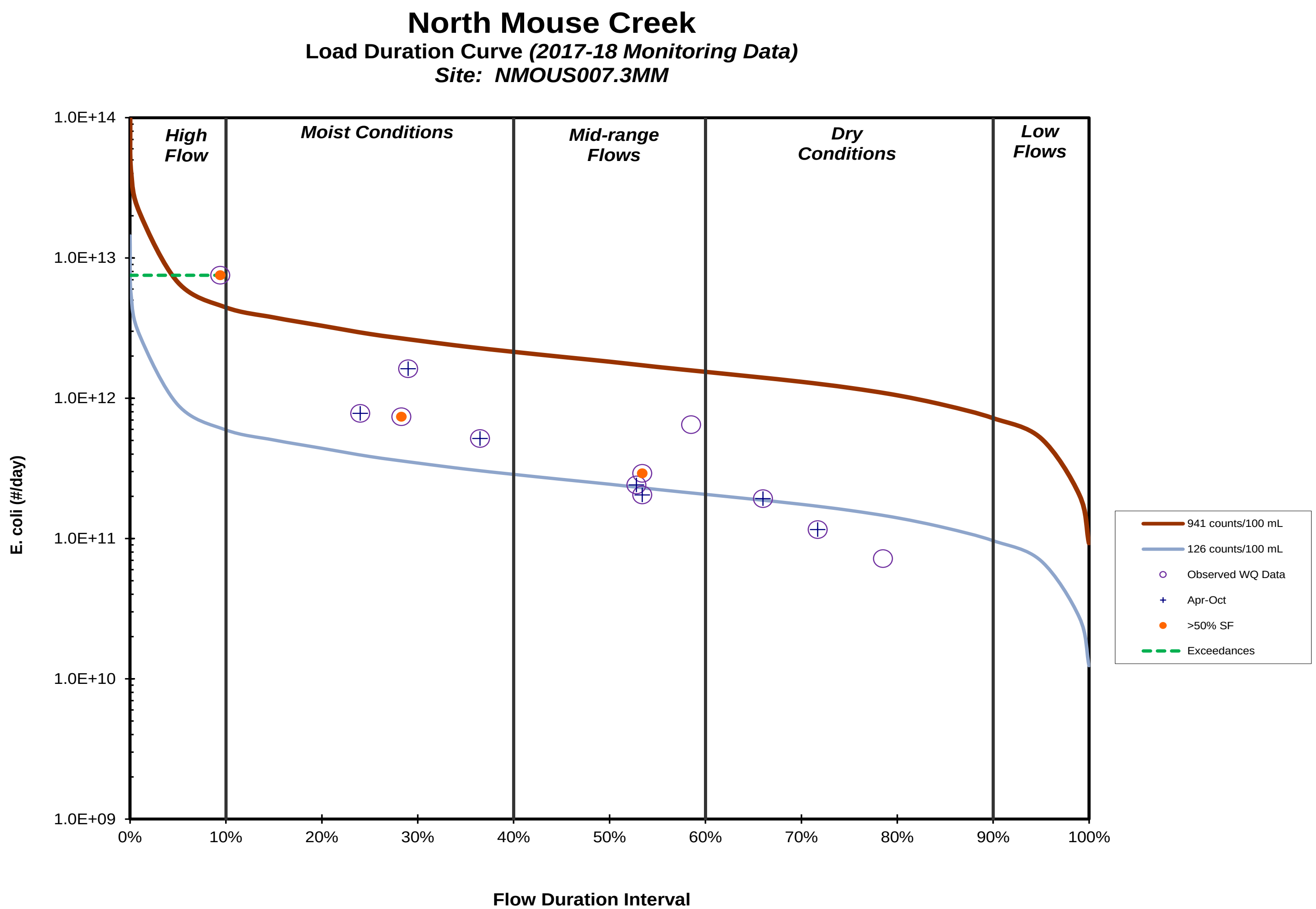

Figure E-22. *E. coli* Load Duration Curve for North Mouse Creek – RM 7.3

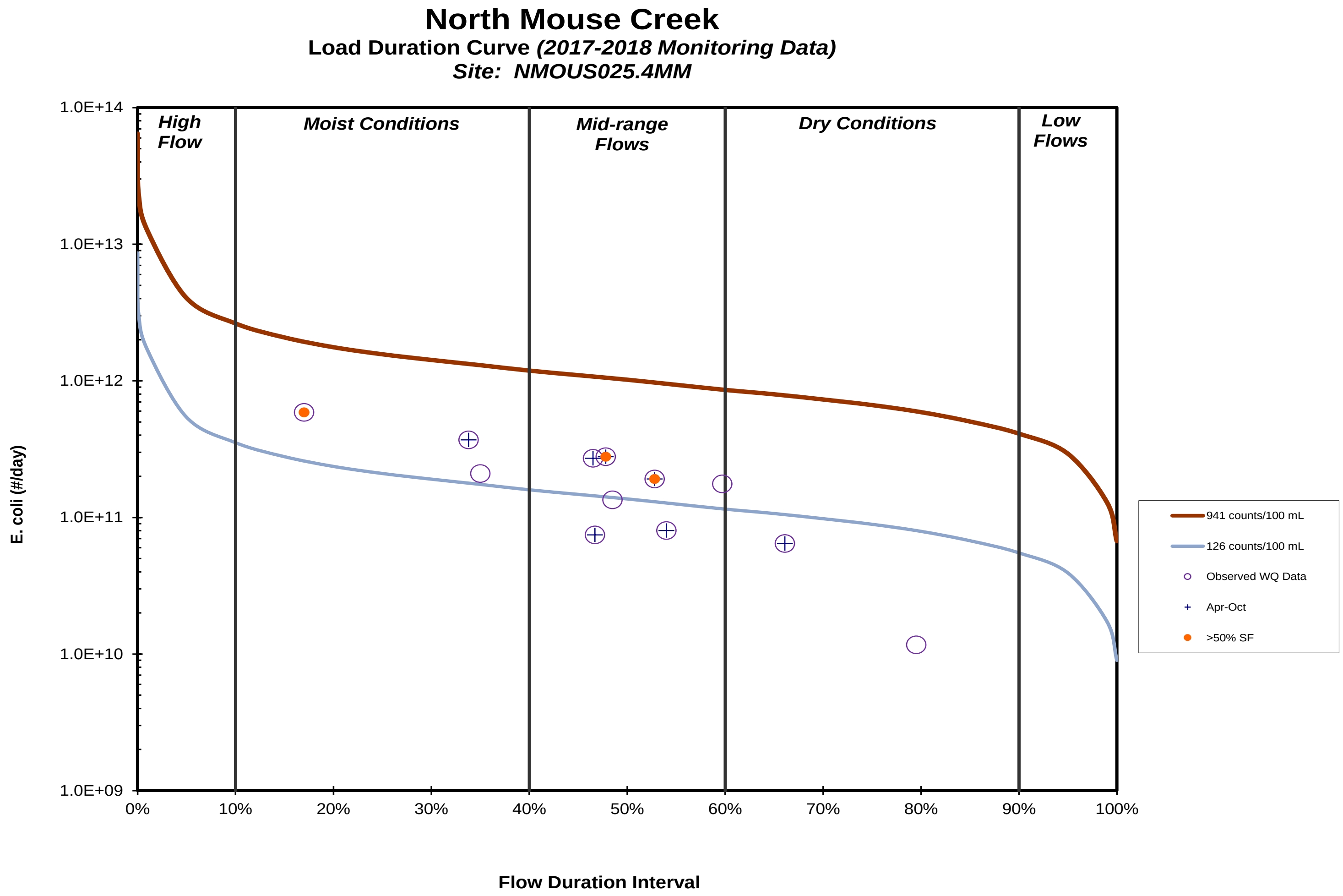

Figure E-23. *E. coli* Load Duration Curve for North Mouse Creek – RM 25.4

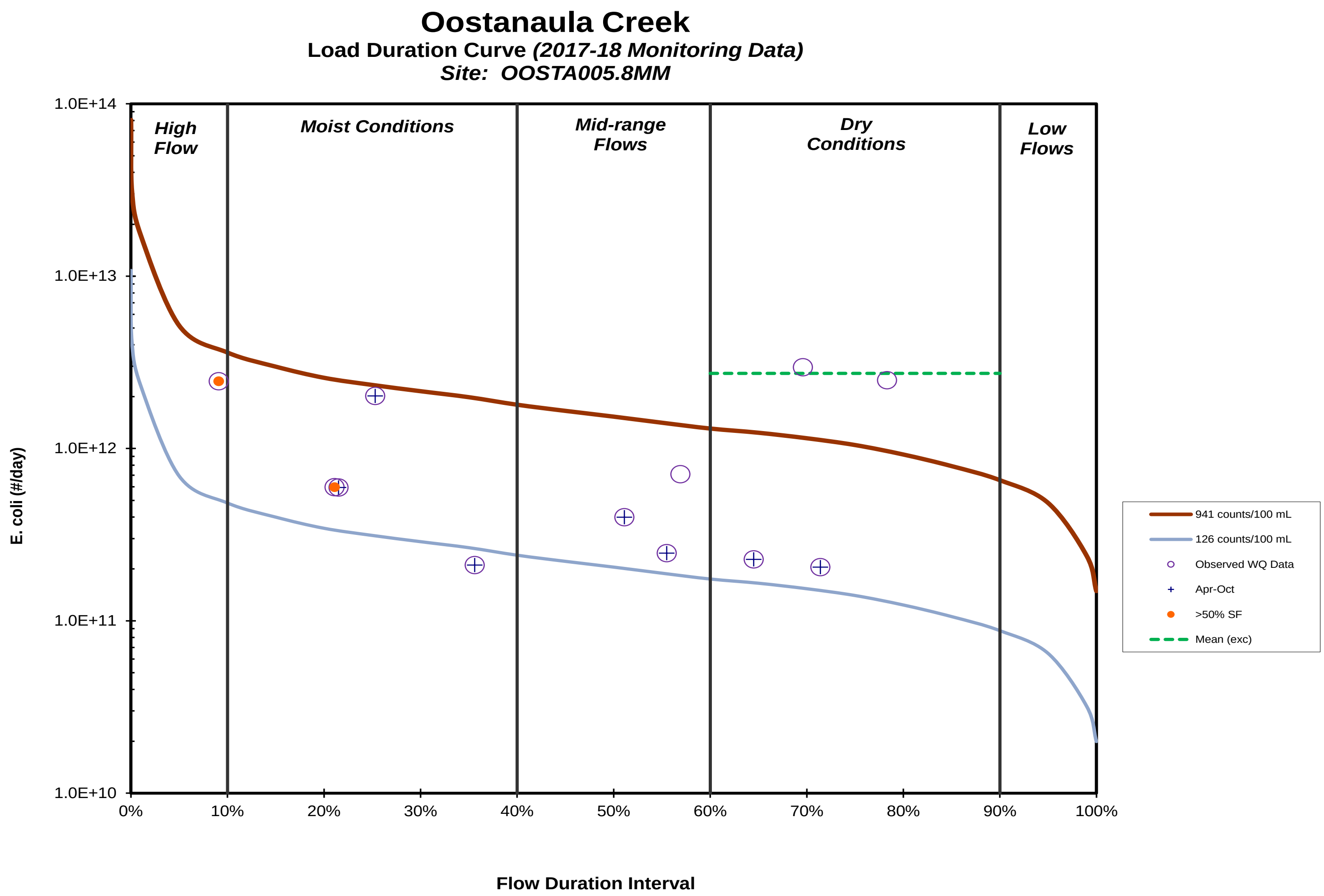

Figure E-24. *E. coli* Load Duration Curve for Oostanaula Creek – RM 5.8

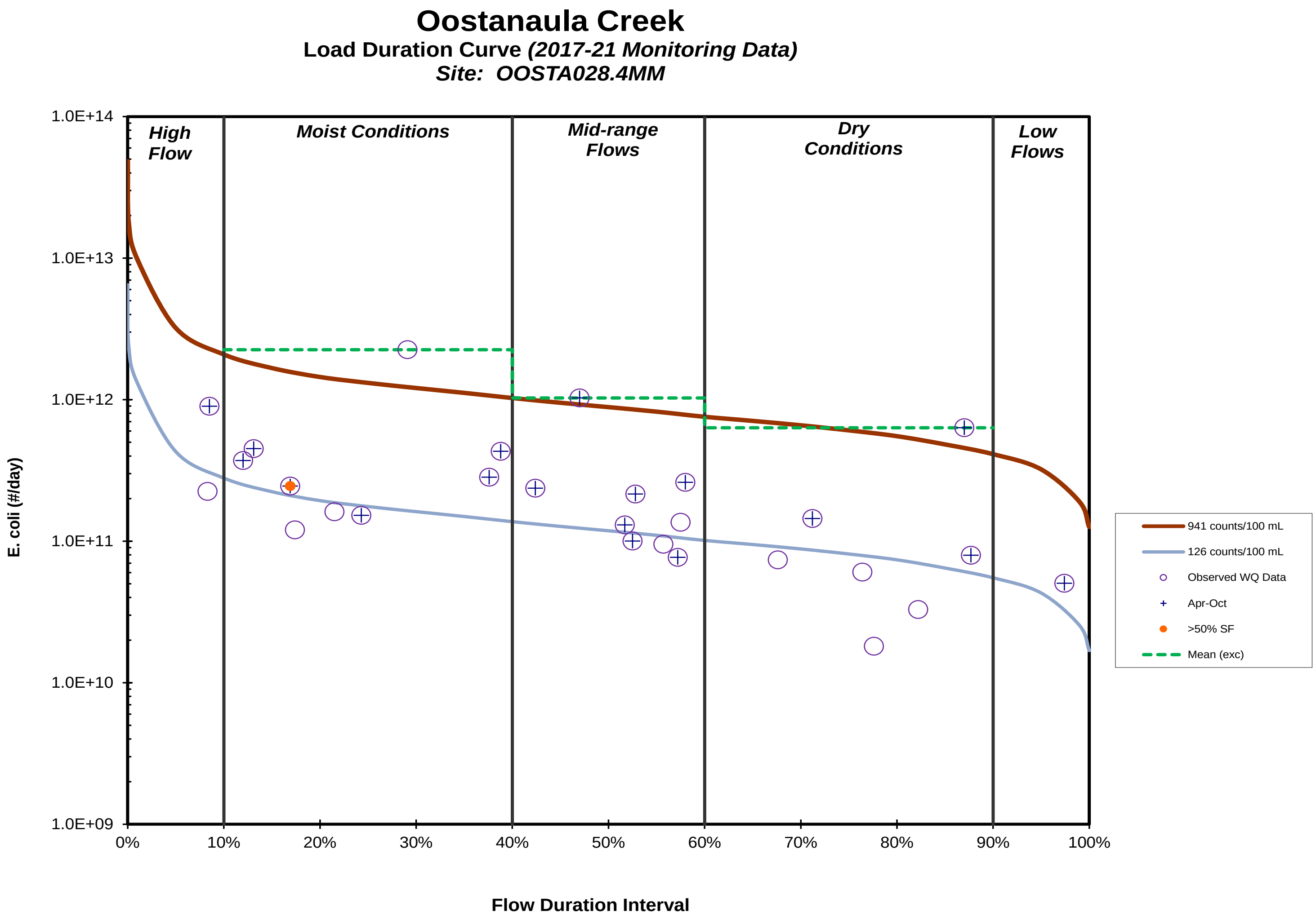

Figure E-25. *E. coli* Load Duration Curve for Oostanaula Creek – RM 28.4

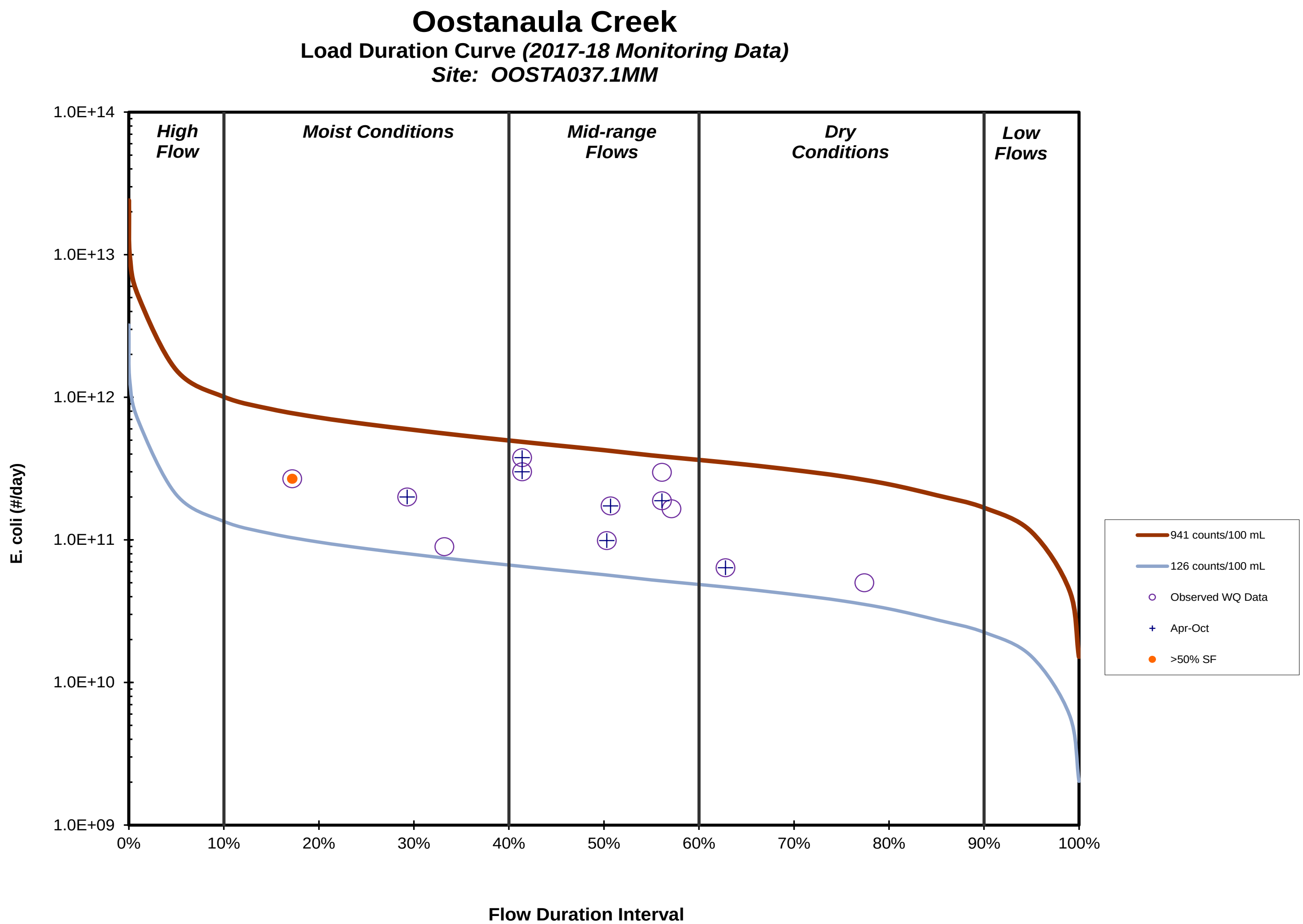

Figure E-26. *E. coli* Load Duration Curve for Oostanaula Creek – RM 37.1

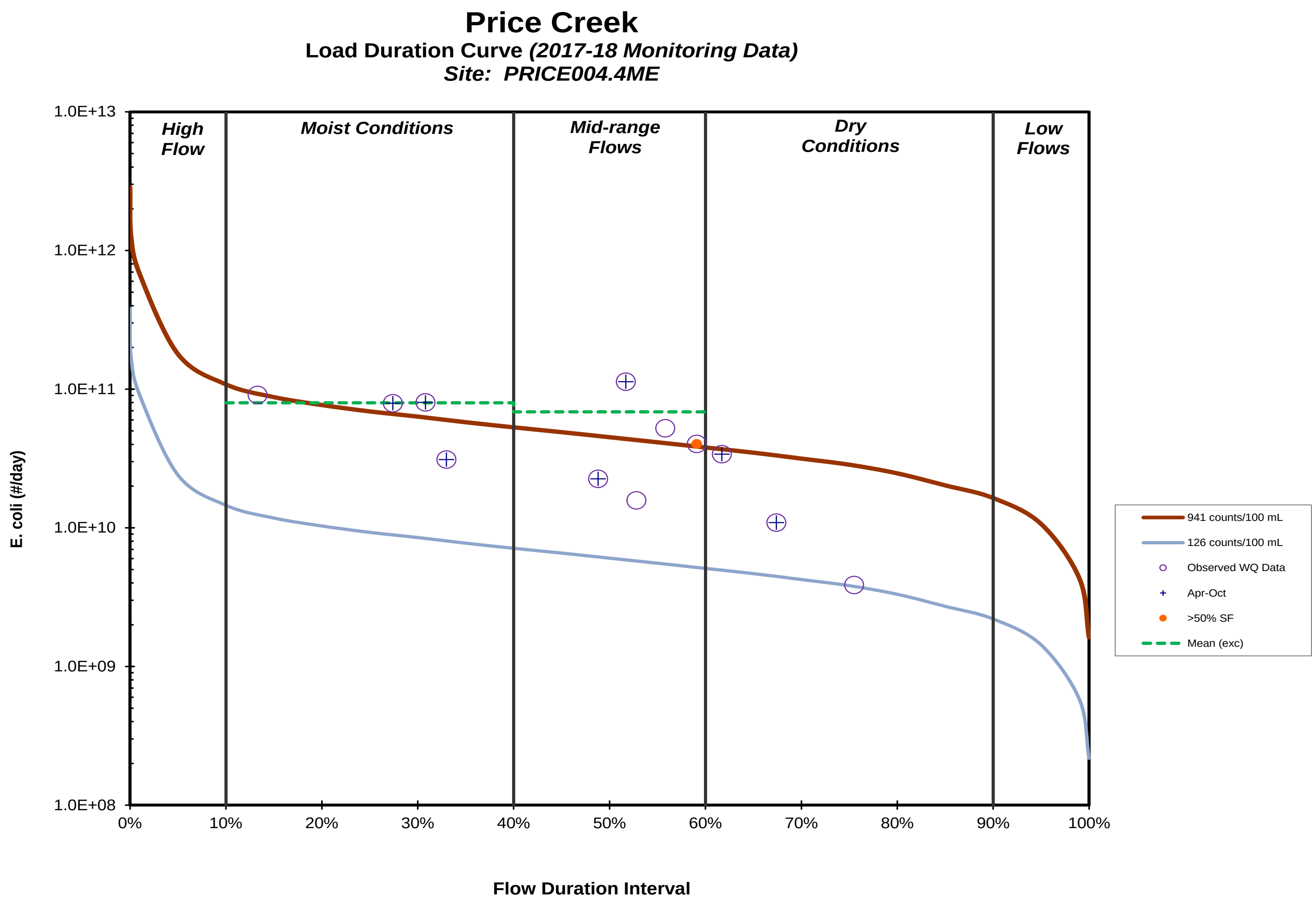

Figure E-27. ***E. coli*** **Load Duration Curve for Price Creek – RM 4.4**

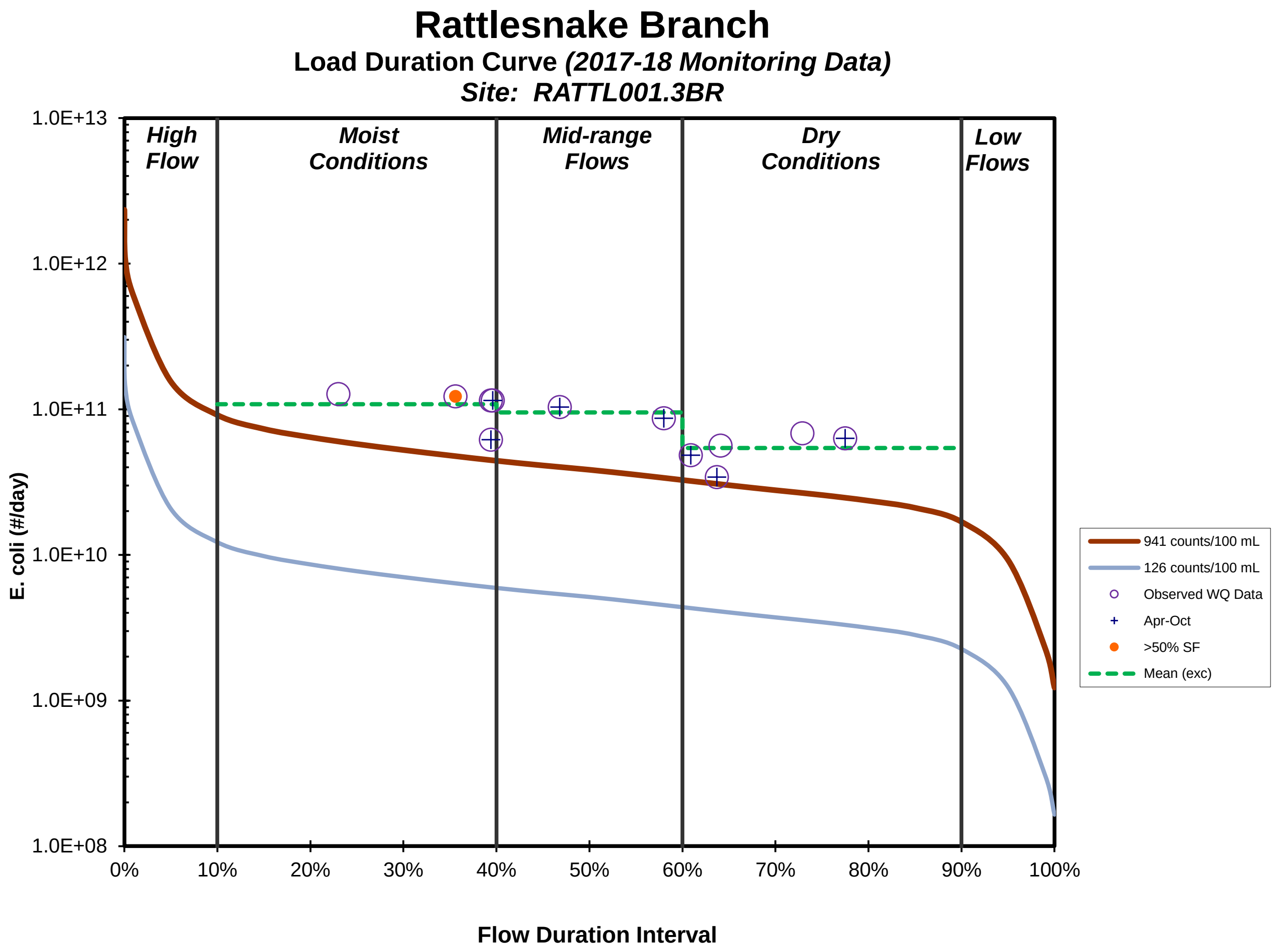

Figure E-28. *E. coli* Load Duration Curve for Rattlesnake Branch – RM 1.3

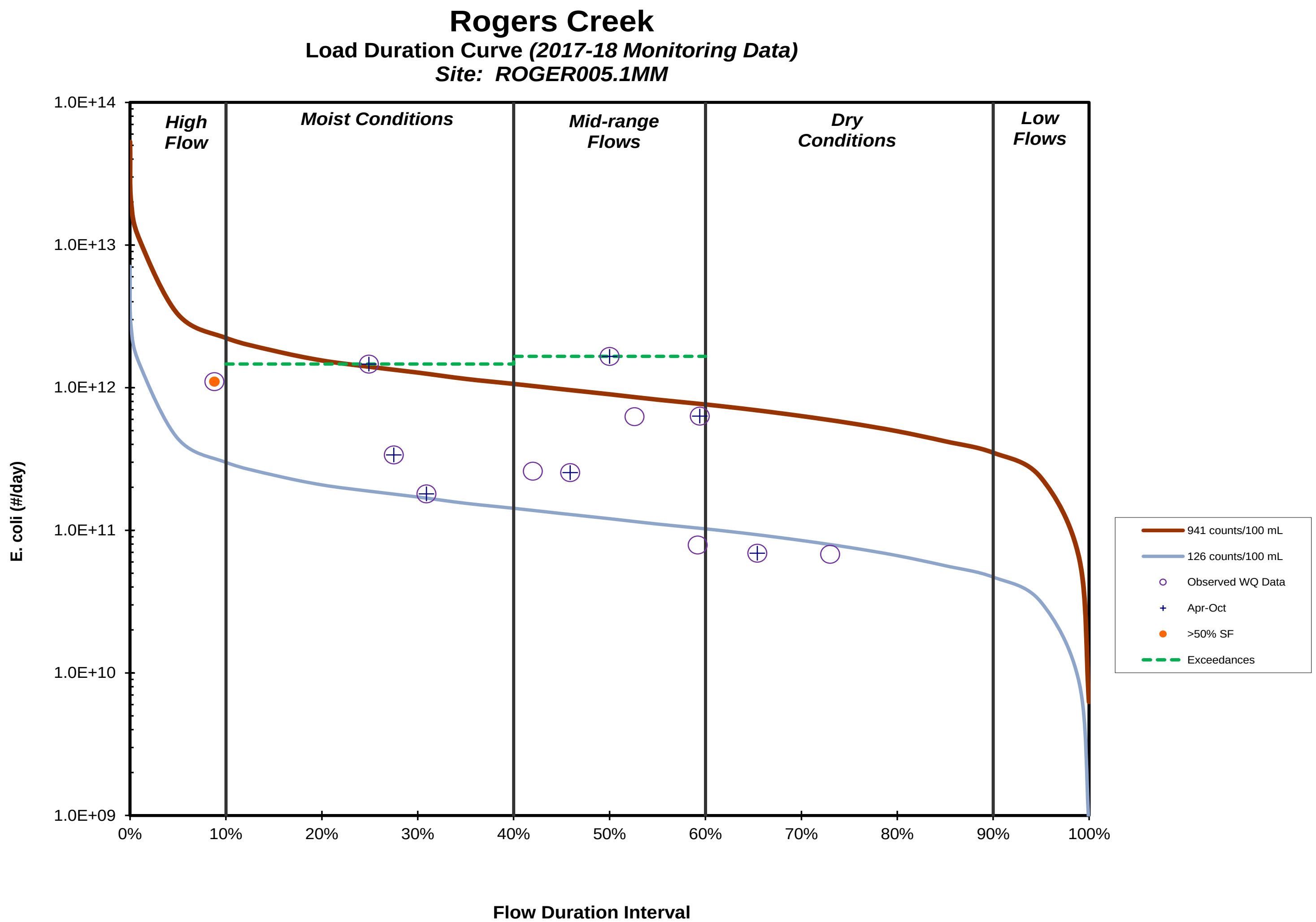

Figure E-29. ***E. coli*** **Load Duration Curve for Rogers Creek – RM 5.1**

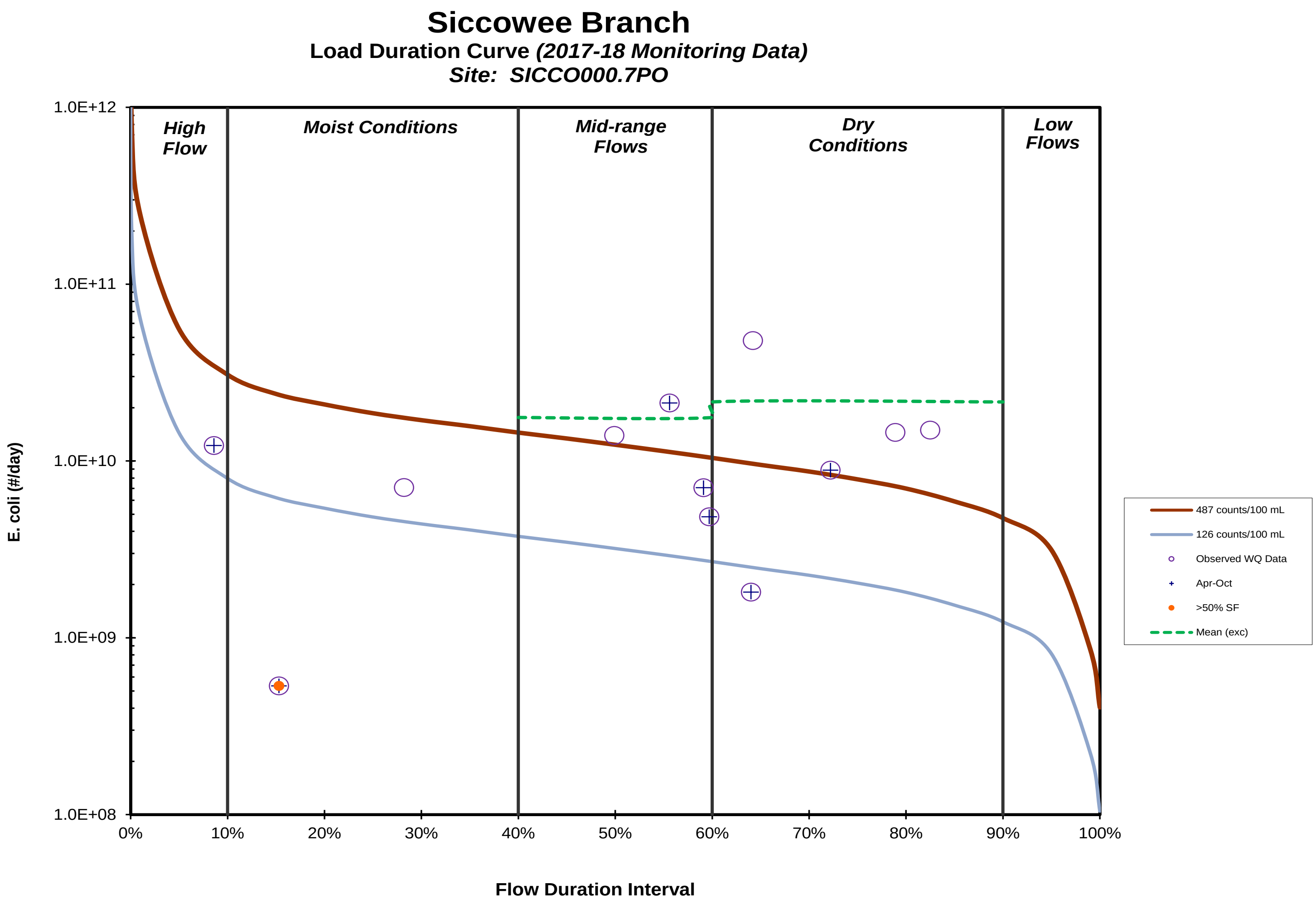

Figure E-30. *E. coli* Load Duration Curve for Siccowee Branch – RM 0.7

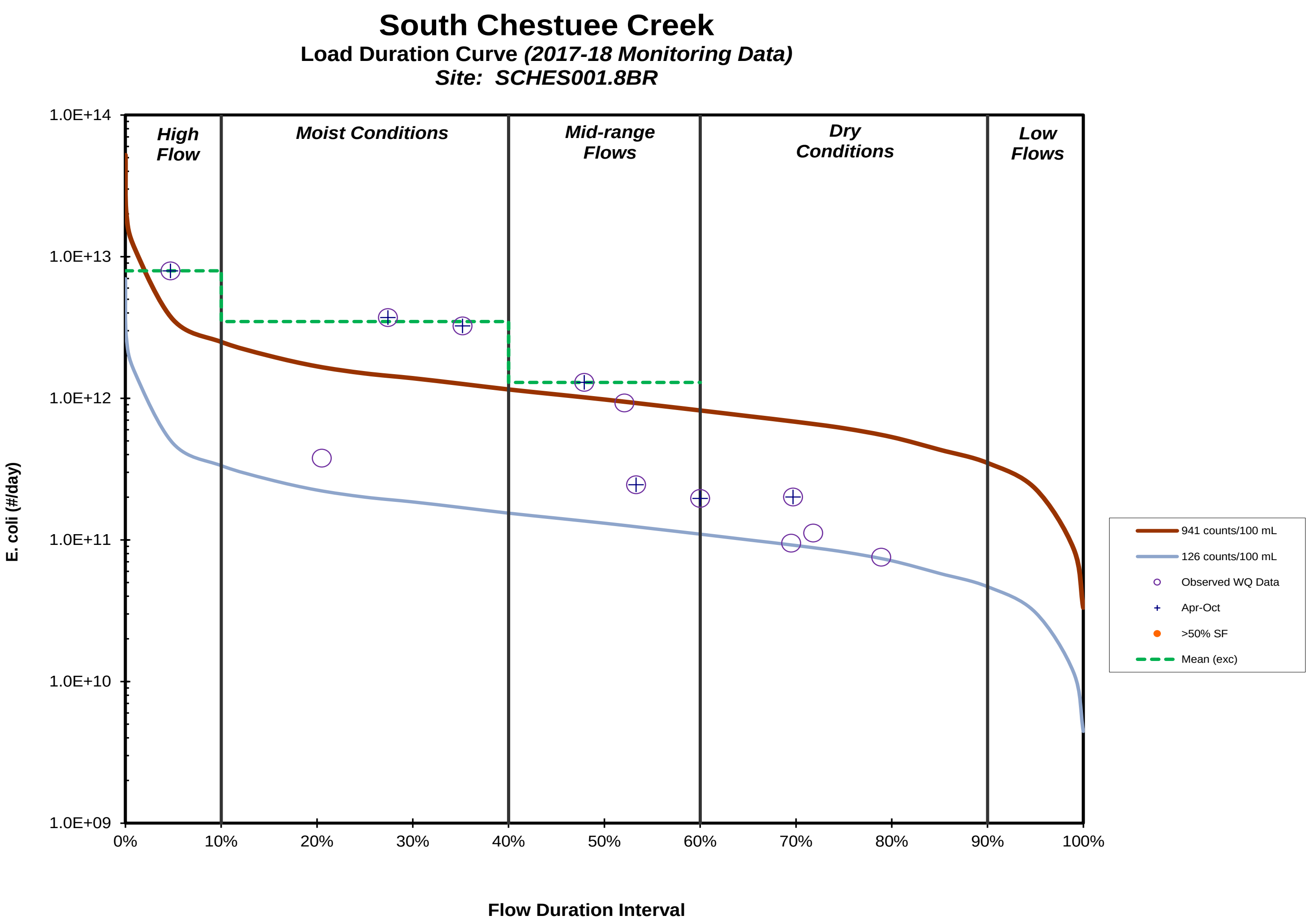

Figure E-31. ***E. coli*** **Load Duration Curve for South Chestuee Creek – RM 1.8**

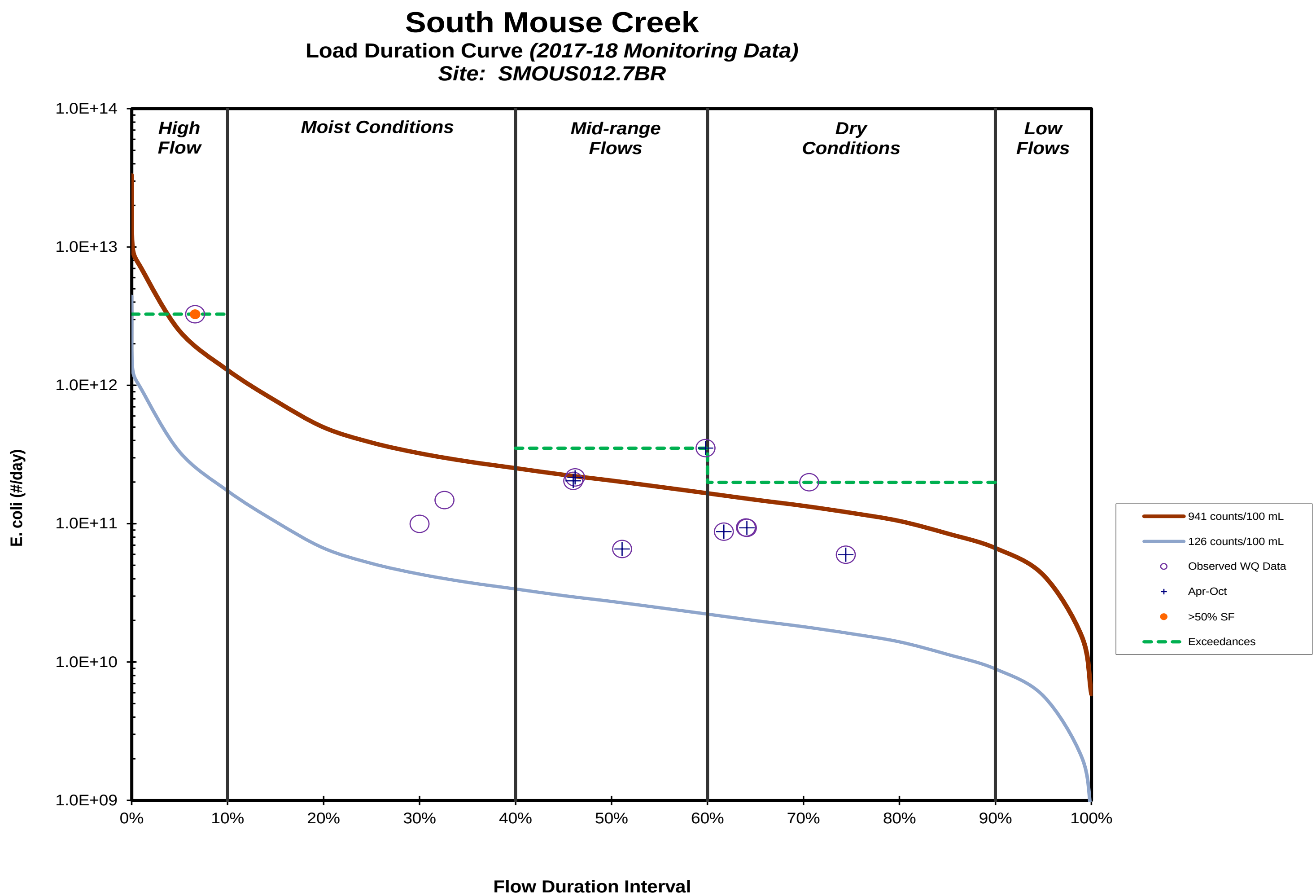

Figure E-32. ***E. coli*** **Load Duration Curve for South Mouse Creek – RM 12.7**

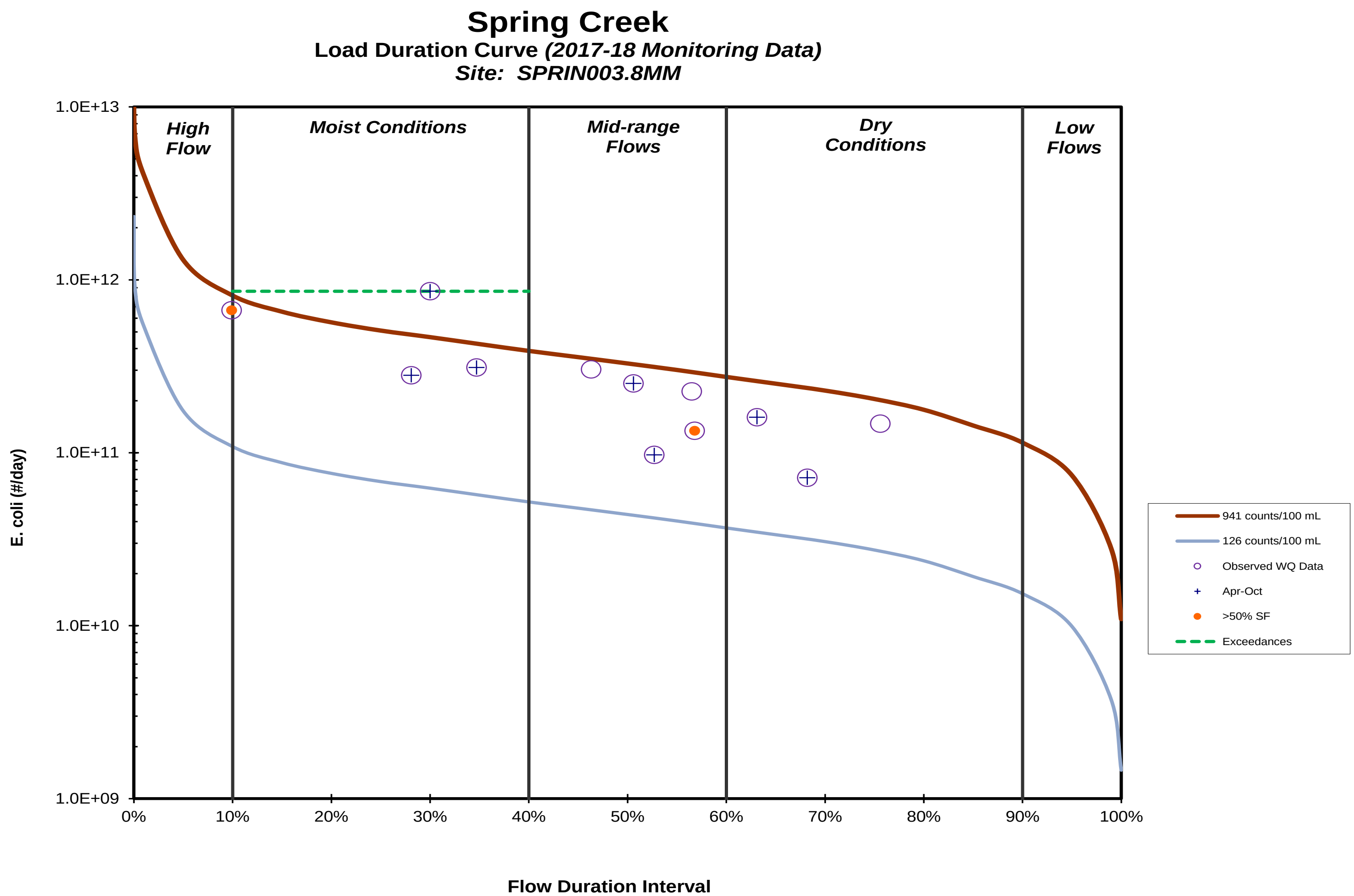

Figure E-33. *E. coli* Load Duration Curve for Spring Creek – RM 3.8

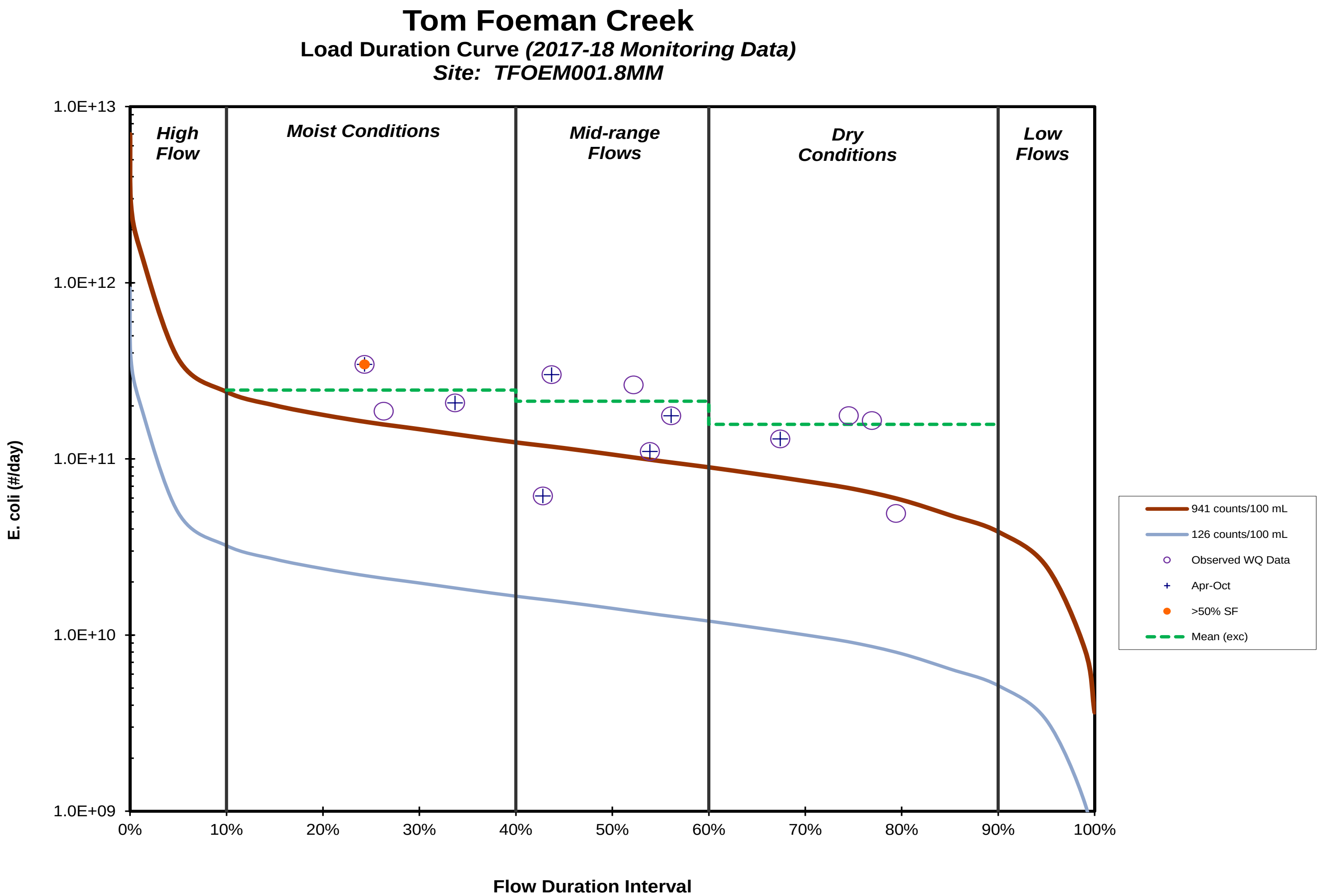

Figure E-34. *E. coli* Load Duration Curve for Tom Foeman Creek – RM 3.8

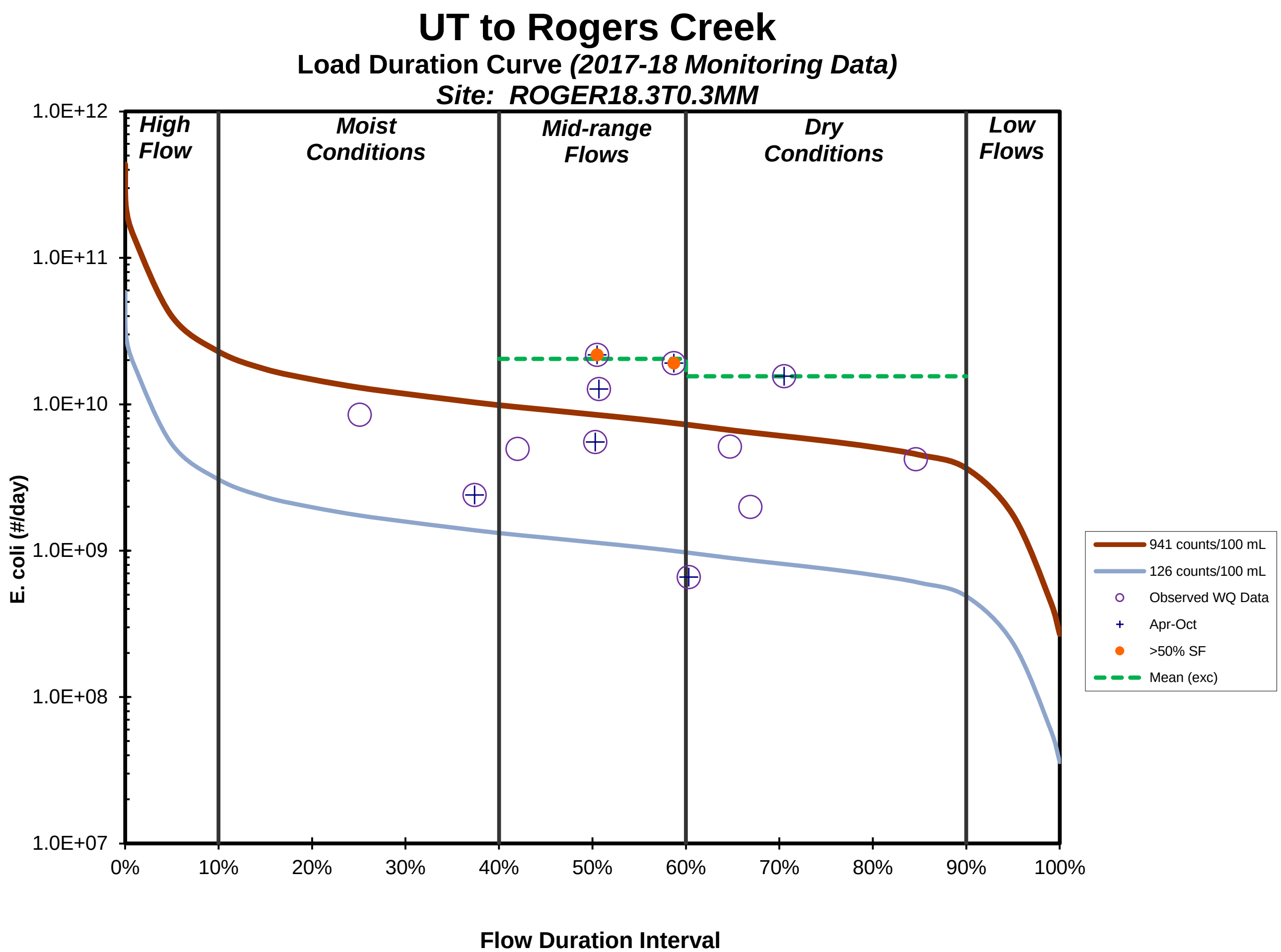

Figure E-35. ***E. coli*** **Load Duration Curve for UT to Rogers Creek – RM 0.3**

Table E-4. Calculated Load Reduction Based on Daily Loading – Agency Creek – RM 2.3

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/21/18	Moist Conditions	23.6	10.4%	1413.6	8.16E+11	**33.4**	**40.1**	**33.4**	**40.1**
7/10/17		15.9	26.1%	488	1.90E+11	NR	NR		
4/9/18		15.1	29.3%	548	2.03E+11	NR	NR		
5/8/18		14.2	32.5%	548	1.91E+11	NR	NR		
6/5/18	Mid-Range Flows	10.9	48.8%	276	7.38E+10	NR	NR	**NR**	**NR**
2/6/18		10.8	49.4%	461.1	1.22E+11	NR	NR		
8/7/17		10.5	51.5%	687	1.76E+11	NR	NR		
11/13/17		9.78	55.4%	185	4.42E+10	NR	NR		
1/9/18		9.28	58.6%	272.3	6.18E+10	NR	NR		
9/26/17	Dry Conditions	8.75	62.0%	206.4	4.42E+10	NR	NR	**NR**	**NR**
10/2/17		7.91	67.6%	69.7	1.35E+10	NR	NR		
12/4/17		6.74	75.4%	275.5	4.54E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-5. Calculated Load Reduction Based on Daily Loading – Bacon Branch – RM 1.6

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
4/26/18	High Flows	4.01	4.7%	120,330	1.18E+13	**99.2**	**99.3**	**99.2**	**99.3**
3/8/18	Moist Conditions	1.99	18.8%	2,920	1.42E+11	**67.8**	**71.0**		
5/3/18		1.74	26.3%	14,670	6.23E+11	**93.6**	**94.2**		
7/18/17		1.51	34.6%	241,960	8.95E+12	**99.6**	**99.6**	**87.0**	**88.3**
8/10/17	Mid-Range Flows	1.19	50.0%	1,413,600	4.13E+13	**99.9**	**99.9**		
11/2/17		1.14	52.8%	48,200	1.34E+12	**98.0**	**98.2**		
9/20/17		1.10	55.1%	249,500	6.69E+12	**99.6**	**99.7**	**99.2**	**99.3**
6/11/18	Dry Conditions	0.997	61.0%	435,200	1.06E+13	**99.8**	**99.8**		
10/3/17		0.833	71.1%	185,000	3.77E+12	**99.5**	**99.5**		
1/16/18		0.829	71.3%	24,950	5.06E+11	**96.2**	**96.6**		
12/11/17		0.787	73.9%	198,630	3.83E+12	**99.5**	**99.6**	**98.8**	**98.9**

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-6. Calculated Load Reduction Based on Daily Loading – Beaverdam Creek – RM 0.5

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]		[%]	[%]
3/7/18	Moist Conditions	4.34	16.1%	172.5	1.83E+10	NR	NR	**35.6**	**42.0**
7/11/17		3.27	30.7%	2420	1.94E+11	**61.1**	**65.0**		
5/9/18		3.09	33.8%	1046	7.92E+10	**10.0**	**19.0**		
4/11/18		2.83	39.0%	291	2.01E+10	NR	NR		
2/22/18	Mid-Range Flows	2.75	40.7%	770.1	5.19E+10	NR	NR	**61.1**	**65.0**
8/15/17		2.52	46.3%	2420	1.49E+11	**61.1**	**65.0**		
6/6/18		2.34	51.0%	2420	1.39E+11	**61.1**	**65.0**		
9/7/17		2.11	56.9%	579.4	2.99E+10	NR	NR		
11/6/17		2.10	57.2%	2419.6	1.24E+11	**61.1**	**65.0**		
1/10/18	Dry Conditions	1.87	64.2%	1413.6	6.47E+10	**33.4**	**40.1**	**49.1**	**54.1**
10/3/17		1.71	69.2%	2419.6	1.01E+11	**61.1**	**65.0**		
12/12/17		1.56	73.5%	1986.3	7.60E+10	**52.6**	**57.4**		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (487 CFU/100 mL)

Table E-7. Calculated Load Reduction Based on Daily Loading – Big Foot Branch – RM 0.5

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
4/26/18	High Flows	31.3	4.7%	261	2.00E+11	NR	NR	**NR**	**NR**
3/8/18	Moist Conditions	15.6	18.5%	142.1	5.42E+10	NR	NR	**NR**	**NR**
5/3/18		13.6	25.8%	160	5.30E+10	NR	NR		
7/18/17		11.8	33.8%	59.2	1.71E+10	NR	NR		
8/10/17	Mid-Range Flows	9.37	48.1%	1986	4.55E+11	**52.6**	**57.4**	**52.6**	**57.4**
9/20/17		9.08	50.1%	142.1	3.16E+10	NR	NR		
11/2/17		8.95	51.0%	128.1	2.80E+10	NR	NR		
6/11/18		7.80	58.9%	120	2.29E+10	NR	NR		
10/3/17	Dry Conditions	6.51	69.0%	65.7	1.05E+10	NR	NR	**NR**	**NR**
1/16/18		6.48	69.3%	275.5	4.37E+10	NR	NR		
12/11/17		6.16	71.8%	114.5	1.73E+10	NR	NR		
2/1/18		5.22	78.8%	238.2	3.04E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-8. Calculated Load Reduction Based on Daily Loading – Black Fox Creek – RM 0.5

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	B[CFU/day]	[%]		[%]	[%]
3/8/18	Moist Conditions	18.5	18.3%	866.4	3.91E+11	NR	**2.2**		
2/20/18		13.7	33.5%	410.6	1.38E+11	NR	NR		
5/10/18		13.7	33.6%	194	6.49E+10	NR	NR		
7/13/17		13.6	33.8%	1986.3	6.63E+11	**52.6**	**57.4**		
12/6/17		12.5	39.1%	1553.1	4.75E+11	**39.4**	**45.5**	**46.0**	**35.0**
4/12/18	Mid-Range Flows	12.3	40.1%	214	6.44E+10	NR	NR		
6/7/18		10.3	51.3%	308	7.77E+10	NR	NR		
9/19/17		9.86	54.1%	218.7	5.28E+10	NR	NR		
8/22/17		9.40	57.2%	387	8.90E+10	NR	NR		
11/15/17		9.36	57.5%	275.5	6.31E+10	NR	NR	**NR**	**NR**
1/11/18	Dry Conditions	8.13	66.8%	155.3	3.09E+10	NR	NR		
10/4/17		7.52	71.0%	214.2	3.94E+10	NR	NR	**NR**	**NR**

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-9. Calculated Load Reduction Based on Daily Loading – Brush Creek – RM 0.5

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	B[CFU/day]	[%]		[%]	[%]
3/21/18	Moist Conditions	12.1	14.7%	131.4	3.90E+10	NR	NR	45.7	51.1
7/10/17		8.64	29.4%	249	5.26E+10	NR	NR		
4/9/18		8.16	33.0%	179	3.57E+10	NR	NR		
5/8/18		7.78	35.6%	1733	3.30E+11	**45.7**	**51.1**		
6/5/18	Mid-Range Flows	5.97	53.2%	579	8.46E+10	NR	NR	**NR**	**NR**
8/7/17		5.67	56.6%	649	9.00E+10	NR	NR		
2/6/18		5.60	57.2%	101.9	1.40E+10	NR	NR		
11/13/17	Dry Conditions	5.29	60.5%	461.1	5.97E+10	NR	NR	**NR**	**NR**
1/9/18		4.91	65.4%	122.3	1.47E+10	NR	NR		
9/26/17		4.78	67.0%	517.2	6.05E+10	NR	NR		
10/2/17		4.33	73.7%	686.7	7.27E+10	NR	NR		
12/4/17		3.66	82.7%	150	1.34E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-10. Calculated Load Reduction Based on Daily Loading – Candies Creek – RM 8.1

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	B[CFU/day]	[%]		[%]	[%]
3/7/18	Moist Conditions	202	16.0%	410.6	2.03E+12	NR	NR	**NR**	**NR**
5/9/18		135	36.0%	228	7.51E+11	NR	NR		
4/11/18		126	39.9%	326	1.01E+12	NR	NR		
9/7/17	Mid-Range Flows	124	41.2%	302.6	9.17E+11	NR	NR	**NR**	**NR**
2/22/18		123	41.8%	155.3	4.66E+11	NR	NR		
8/15/17		113	47.2%	313	8.69E+11	NR	NR		
6/6/18		103	52.9%	816	2.05E+12	NR	NR		
1/10/18		98.5	55.4%	218.7	5.27E+11	NR	NR		
11/6/17		92.2	59.0%	261.3	5.90E+11	NR	NR		
10/3/17	Dry Conditions	74.8	70.2%	79.4	1.45E+11	NR	NR	**NR**	**NR**
12/12/17		69.3	73.8%	166.4	2.82E+11	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-11. Calculated Load Reduction Based on Daily Loading – Candies Creek – RM 33.1

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]		[%]	[%]
3/8/18	Moist Conditions	16.2	18.2%	461.1	1.83E+11	NR	NR	**10.0**	**19.0**
2/20/18		12.0	34.3%	178.9	5.27E+10	NR	NR		
5/10/18		12.0	34.5%	980	2.88E+11	**4.0**	**13.6**		
7/13/17		12.0	34.6%	1119.9	3.28E+11	**16.0**	**24.4**		
12/6/17	Mid-Range Flows	10.9	40.5%	1986.3	5.28E+11	**52.6**	**57.4**	**52.6**	**57.4**
4/12/18		10.8	40.9%	291	7.68E+10	NR	NR		
6/7/18		9.05	52.0%	488	1.08E+11	NR	NR		
9/19/17		8.65	54.6%	816.4	1.73E+11	NR	NR		
8/22/17		8.25	57.6%	770	1.55E+11	NR	NR		
11/15/17		8.21	57.8%	727	1.46E+11	NR	NR		
1/11/18	Dry Conditions	7.13	66.1%	980.4	1.71E+11	**4.0**	**13.6**	**4.0**	**13.6**
10/4/17		6.60	70.1%	461.1	7.44E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-12. Calculated Load Reduction Based on Daily Loading – Chatata Creek – RM 2.0

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]		[%]	[%]
12/6/17	Moist Conditions	69.9	13.7%	2419.6	4.14E+12	**61.1**	**65.0**	**34.5**	**33.3**
3/8/18		52.0	22.9%	866.4	1.10E+12	NR	**2.2**		
2/20/18		41.0	34.9%	1413.6	1.42E+12	**33.4**	**40.1**		
5/10/18		38.4	38.4%	980	9.21E+11	**4.0**	**13.6**		
7/13/17		38.3	38.6%	1553.1	1.46E+12	**39.4**	**45.5**		
4/12/18	Mid-Range Flows	34.6	44.8%	2420	2.05E+12	**61.1**	**65.0**	**61.1**	**33.6**
6/7/18		28.9	55.3%	866	6.13E+11	NR	**2.2**		
9/19/17		27.7	57.9%	488.4	3.31E+11	NR	NR		
8/22/17	Dry Conditions	26.4	60.7%	387	2.50E+11	NR	NR	**4.0**	**13.6**
11/15/17		26.3	60.9%	980.4	6.31E+11	**4.0**	**13.6**		
1/11/18		22.9	69.3%	248.1	1.39E+11	NR	NR		
10/4/17		21.1	73.4%	387.3	2.00E+11	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-13. Calculated Load Reduction Based on Daily Loading – Chestuee Creek – RM 41.4

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]		[%]	[%]
8/8/17	Moist Conditions	57.7	21.3%	2420	3.42E+12	**61.1**	**65.0**	**56.9**	**61.2**
3/15/18		52.0	26.2%	435.2	5.54E+11	NR	NR		
7/12/17		45.0	34.2%	1986	2.19E+12	**52.6**	**57.4**		
5/17/18	Mid-Range Flows	40.5	40.8%	2420	2.40E+12	**61.1**	**65.0**	**61.1**	**25.1**
4/12/18		39.6	42.1%	548	5.31E+11	NR	NR		
9/21/17		34.9	50.2%	365.4	3.12E+11	NR	NR		
11/2/17		33.9	52.1%	920.8	7.65E+11	NR	**8.0**		
10/18/17		33.1	53.3%	866.4	7.03E+11	NR	**2.2**		
6/20/18	Dry Conditions	26.0	68.4%	547.5	3.48E+11	NR	NR	**NR**	**NR**
12/12/17		23.3	74.8%	816.4	4.65E+11	NR	NR		
1/24/18		22.4	76.5%	127.4	6.99E+10	NR	NR		
2/1/18		20.6	80.1%	325.5	1.64E+11	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-14. Calculated Load Reduction Based on Daily Loading – Dairy Branch – RM 1.2

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]		[%]	[%]
2/11/04	Moist Conditions	0.908	16.5%	4430	9.84E+10	**78.8**	**80.9**	**69.9**	**72.9**
5/27/08		0.555	39.4%	2419.6	3.28E+10	**61.1**	**65.0**		
5/14/08	Mid-Range Flows	0.466	48.7%	196.8	2.25E+09	NR	NR	**27.6**	**34.8**
5/20/08		0.452	50.3%	166.9	1.84E+09	NR	NR		
5/22/08		0.433	52.6%	1299.7	1.38E+10	**27.6**	**34.8**		
5/29/08	Dry Conditions	0.378	61.4%	2419.6	2.24E+10	**61.1**	**65.0**	**61.1**	**65.0**

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-15. Calculated Load Reduction Based on Geomean Data – Dairy Branch – RM 1.2

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction to Target GM (126 CFU/100 mL)	Calculated Reduction to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
5/14/08	0.466	48.7%	196.8			
5/20/08	0.452	50.3%	166.9			
5/22/08	0.433	52.6%	1299.7			
5/27/08	0.555	39.4%	2419.6			
5/29/08	0.378	61.4%	2419.6	**757.8**	**83.4**	**85.1**

Note: Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table E-16. Calculated Load Reduction Based on Daily Loading – Gunstocker Creek – RM 3.0

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]		[%]	[%]
3/7/18	Moist Conditions	28.6	17.2%	214.3	1.50E+11	NR	NR	**NR**	**NR**
7/11/17		21.7	31.3%	365	1.94E+11	NR	NR		
5/9/18		20.4	34.7%	276	1.38E+11	NR	NR		
4/11/18		18.6	39.6%	214	9.72E+10	NR	NR		
2/22/18	Mid-Range Flows	18.1	41.4%	410.6	1.82E+11	NR	NR	**27.6**	**34.8**
8/15/17		16.6	46.8%	166	6.73E+10	NR	NR		
6/6/18		15.4	51.5%	1300	4.89E+11	**27.6**	**34.8**		
9/7/17		14.3	55.4%	435.2	1.52E+11	NR	NR		
11/6/17		13.8	57.3%	290.9	9.83E+10	NR	NR		
1/10/18	Dry Conditions	12.4	63.6%	365.4	1.11E+11	NR	NR	**NR**	**NR**
10/3/17		11.2	69.0%	248.1	6.80E+10	NR	NR		
12/12/17		10.3	73.5%	387.3	9.74E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-17. Required Load Reduction for Hiwassee River at Mile 13.4 – E. Coli Analysis

Sample Date	E. Coli	
	Sample Conc.	Required Load Reduction
	[cts/100 ml]	[%]
5/8/17	1046.2	**10.1**
9/26/17	9.6	NR
11/15/17	43.5	NR
3/22/18	104.6	NR
5/23/18	1203	**21.8**
7/18/18	70.8	NR
10/23/18	25.6	NR
3/13/19	79.4	NR
6/10/19	159.7	NR
9/3/19	10.8	NR
11/19/19	30.9	NR
3/4/20	2419.6	**61.1**
6/10/20	73.8	NR
8/12/20	22.6	NR
12/7/20	488	NR
2/9/21	16.1	NR
6/16/21	6.3	NR
9/16/21	35	NR
10/20/21	53	NR
90th Percentile (all)	**1077.6**	**12.7**

Table E-18. Calculated Load Reduction Based on Daily Loading – Latham Springs Branch – RM 0.4

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/13/18	Moist Conditions	9.26	18.7%	325.5	7.37E+10	NR	NR	**NR**	**NR**
7/11/17		7.34	30.3%	308	5.53E+10	NR	NR		
2/20/18		6.78	34.5%	435.2	7.22E+10	NR	NR		
5/15/18	Mid-Range Flows	5.98	42.4%	2420	3.54E+11	**61.1**	**65.0**	**61.1**	**65.0**
4/5/18		5.94	42.9%	326	4.74E+10	NR	NR		
8/7/17		5.45	48.3%	84	1.12E+10	NR	NR		
10/26/17		5.19	51.3%	55.7	7.07E+09	NR	NR		
6/14/18		4.85	55.3%	142	1.68E+10	NR	NR		
11/14/17		4.72	57.0%	105	1.21E+10	NR	NR		
12/7/17		4.60	58.8%	78.5	8.83E+09	NR	NR		
9/11/17	Dry Conditions	4.27	63.8%	78.9	8.24E+09	NR	NR	**NR**	**NR**
1/25/18		3.23	78.3%	12.1	9.56E+08	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-19. Calculated Load Reduction Based on Daily Loading – Little Chatata Creek – RM 0.3

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
12/6/17	High Flows	43.7	7.9%	2419.6	2.59E+12	**61.1**	**65.0**	**61.1**	**65.0**
3/8/18	Moist Conditions	15.7	26.6%	139.6	5.37E+10	NR	NR	**33.4**	**40.1**
2/20/18		12.0	39.3%	1413.6	4.16E+11	**33.4**	**40.1**		
5/10/18	Mid-Range Flows	11.6	41.1%	687	1.96E+11	NR	NR	**33.4**	**40.1**
7/13/17		11.6	41.2%	517.2	1.47E+11	NR	NR		
4/12/18		10.5	46.8%	435	1.11E+11	NR	NR		
6/7/18		8.78	56.5%	411	8.83E+10	NR	NR		
9/19/17		8.39	59.1%	1413.6	2.90E+11	**33.4**	**40.1**		
8/22/17	Dry Conditions	8.00	61.8%	411	8.05E+10	NR	NR	**10.1**	**19.0**
11/15/17		7.97	62.1%	1046.2	2.04E+11	**10.1**	**19.0**		
1/11/18		6.92	70.2%	209.8	3.55E+10	NR	NR		
10/4/17		6.40	74.0%	866.4	1.36E+11	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-20. Calculated Load Reduction Based on Daily Loading – Little North Mouse Creek – RM 2.4

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/13/18	Moist Conditions	11.7	19.2%	517.2	1.48E+11	NR	NR	61.1	65.0
7/11/17		9.25	32.2%	308	6.97E+10	NR	NR		
2/20/18		8.81	35.4%	2419.6	5.22E+11	**61.1**	**65.0**		
5/15/18	Mid-Range Flows	7.80	44.6%	179	3.42E+10	NR	NR	27.6	34.8
4/5/18		7.79	44.8%	248	4.73E+10	NR	NR		
8/7/17		7.65	46.0%	345	6.46E+10	NR	NR		
10/26/17		6.99	52.9%	325.5	5.57E+10	NR	NR		
6/14/18		6.94	53.4%	166	2.82E+10	NR	NR		
11/14/17		6.49	58.4%	1299.7	2.07E+11	**27.6**	**34.8**		
12/7/17		6.42	59.4%	613.1	9.64E+10	NR	NR		
9/11/17	Dry Conditions	6.01	65.1%	151.5	2.23E+10	NR	NR	NR	NR
1/25/18		4.92	78.8%	344.8	4.15E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-21. Calculated Load Reduction Based on Daily Loading – Middle Creek – RM 4.6

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/15/18	Moist Conditions	32.9	29.8%	816.4	6.57E+11	NR	NR	**NR**	**NR**
8/8/17	Mid-Range Flows	26.7	41.8%	2420	1.58E+12	**61.1**	**65.0**	**53.9**	**58.5**
7/12/17		25.8	43.6%	40	2.53E+10	NR	NR		
4/12/18		24.6	46.6%	1414	8.51E+11	**33.5**	**40.1**		
5/17/18		23.6	49.0%	2420	1.39E+12	**61.1**	**65.0**		
11/2/17		22.3	51.8%	1732.9	9.44E+11	**45.7**	**51.1**		
10/18/17		21.2	54.4%	2419.6	1.25E+12	**61.1**	**65.0**		
9/21/17		20.1	56.9%	2419.6	1.19E+12	**61.1**	**65.0**		
6/20/18	Dry Conditions	14.6	70.5%	1986.3	7.10E+11	**52.6**	**57.4**	**53.6**	**58.2**
12/12/17		14.5	70.9%	2419.6	8.58E+11	**61.1**	**65.0**		
1/24/18		14.0	72.3%	2419.6	8.31E+11	**61.1**	**65.0**		
2/1/18		13.3	74.9%	1553.1	5.04E+11	**39.4**	**45.5**		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-22. Calculated Load Reduction Based on Daily Loading – North Mouse Creek – RM 7.3

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/21/18	High Flows	198	9.4%	1553.1	7.53E+12	**39.4**	**45.5**	**39.4**	**45.5**
4/9/18	Moist Conditions	128	24.0%	249	7.81E+11	NR	NR	**NR**	**NR**
2/6/18		116	28.3%	260.3	7.38E+11	NR	NR		
7/10/17		115	29.0%	579	1.62E+12	NR	NR		
5/8/18		98.6	36.5%	214	5.16E+11	NR	NR		
6/5/18	Mid-Range Flows	75.7	52.8%	130	2.41E+11	NR	NR	**NR**	**NR**
8/7/17		74.6	53.4%	112	2.05E+11	NR	NR		
1/9/18		74.7	53.4%	159.7	2.92E+11	NR	NR		
11/13/17		68.5	58.5%	387.3	6.49E+11	NR	NR		
9/26/17	Dry Conditions	61.0	66.0%	129.1	1.93E+11	NR	NR	**NR**	**NR**
10/2/17		55.0	71.7%	86	1.16E+11	NR	NR		
12/4/17		47.4	78.5%	62	7.19E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-23. Calculated Load Reduction Based on Daily Loading – North Mouse Creek – RM 25.4

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/13/18	Moist Conditions	84.4	17.0%	285.1	5.89E+11	NR	NR	**NR**	**NR**
7/11/17		57.8	33.8%	261	3.69E+11	NR	NR		
2/20/18		56.6	35.0%	151.5	2.10E+11	NR	NR		
5/15/18	Mid-Range Flows	47.0	46.5%	236	2.71E+11	NR	NR	**NR**	**NR**
4/5/18		46.9	46.7%	65	7.45E+10	NR	NR		
8/7/17		45.9	47.8%	248	2.79E+11	NR	NR		
12/7/17		45.4	48.5%	121	1.35E+11	NR	NR		
6/14/18		42.3	52.8%	185	1.91E+11	NR	NR		
10/26/17		41.3	54.0%	79.4	8.03E+10	NR	NR		
11/14/17		37.5	59.7%	191.8	1.76E+11	NR	NR		
9/11/17	Dry Conditions	34.0	66.1%	77.6	6.46E+10	NR	NR	**NR**	**NR**
1/25/18		26.1	79.5%	18.3	1.17E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-24. Calculated Load Reduction Based on Daily Loading – Oostanaula Creek – RM 5.8

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/21/18	High Flows	164	9.1%	613.1	2.46E+12	NR	NR	**NR**	**NR**
2/6/18	Moist Conditions	109	21.1%	224.7	5.97E+11	NR	NR	**NR**	**NR**
4/9/18		108	21.5%	225	5.94E+11	NR	NR		
7/10/17		101	25.3%	816	2.02E+12	NR	NR		
5/8/18		85.2	35.6%	101	2.10E+11	NR	NR		
6/5/18	Mid-Range Flows	65.3	51.1%	250	4.00E+11	NR	NR	**NR**	**NR**
8/7/17		60.8	55.5%	166	2.47E+11	NR	NR		
11/13/17		59.3	56.9%	488.4	7.09E+11	NR	NR		
9/26/17	Dry Conditions	53.9	64.5%	172.3	2.27E+11	NR	NR	**61.1**	**65.0**
1/9/18		50.1	69.6%	2419.6	2.96E+12	**61.1**	**65.0**		
10/2/17		48.5	71.4%	172.5	2.05E+11	NR	NR		
12/4/17		42.1	78.3%	2419.6	2.49E+12	**61.1**	**65.0**		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-25. Calculated Load Reduction Based on Daily Loading – Oostanaula Creek – RM 28.4

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
1/7/19	High Flows	101.8	8.30%	90.4	2.25E+11	NR	NR	**NR**	**NR**
5/7/19		100.5	8.50%	365.4	8.99E+11	NR	NR		
5/3/17	Moist Conditions	81.6	12.0%	186	3.71E+11	NR	NR	**45.7**	**51.1**
10/13/20		78.1	13.1%	235.9	4.51E+11	NR	NR		
8/8/17		68.2	16.9%	147	2.45E+11	NR	NR		
2/24/21		67.1	17.4%	73.3	1.20E+11	NR	NR		
1/22/20		61.0	21.5%	108.1	1.61E+11	NR	NR		
4/13/21		57.8	24.3%	107.6	1.52E+11	NR	NR		
3/15/18		53.2	29.1%	1732.9	2.25E+12	**45.7**	**51.1**		
7/12/17		46.5	37.6%	249	2.84E+11	NR	NR		
8/25/21		45.6	38.8%	387	4.32E+11	NR	NR		
5/17/18	Mid-Range Flows	43.0	42.4%	225	2.37E+11	NR	NR	**10.0**	**19.0**
4/4/18		40.2	47.0%	1046	1.03E+12	**10.0**	**19.0**		
6/17/20		37.5	51.7%	142.1	1.30E+11	NR	NR		
9/21/17		37.1	52.5%	110.6	1.00E+11	NR	NR		
10/15/18		36.9	52.8%	238.2	2.15E+11	NR	NR		
11/2/17		35.4	55.7%	110	9.53E+10	NR	NR		
10/18/17		34.6	57.2%	90.9	7.69E+10	NR	NR		
11/16/21		34.3	57.5%	162	1.36E+11	NR	NR		
8/7/18		34.0	58.0%	313	2.61E+11	NR	NR		
1/18/17	Dry Conditions	29.7	67.6%	*101.7*	7.38E+10	NR	NR		
6/20/18		28.2	71.2%	209.8	1.45E+11	NR	NR		
1/23/18		25.8	76.4%	96	6.05E+10	NR	NR		
12/12/17		25.2	77.6%	29.4	1.81E+10	NR	NR		

Table E-25 (cont'd). Calculated Load Reduction Based on Daily Loading – Oostanaula Creek – RM 28.4

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
2/1/18	Dry Conditions (cont'd)	22.7	82.2%	59.4	3.29E+10	NR	NR		
8/19/19		19.9	87.0%	1299.7	6.33E+11	**27.6**	**34.8**		
8/10/20		19.5	87.7%	167	7.97E+10	NR	NR	**27.6**	**34.8**
10/10/19	Low Flows	11.5	97.4%	178.9	5.05E+10	NR	NR	**NR**	**NR**

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-26. Calculated Load Reduction Based on Daily Loading – Oostanaula Creek – RM 37.1

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/13/18	Moist Conditions	34.1	17.0%	325.5	2.72E+11	NR	NR		
7/11/17		26.4	29.1%	313	2.02E+11	NR	NR		
2/20/18		24.5	33.1%	151.5	9.06E+10	NR	NR	**NR**	**NR**
5/15/18	Mid-Range Flows	21.4	41.3%	579	3.03E+11	NR	NR		
4/5/18		21.3	41.6%	727	3.79E+11	NR	NR		
10/26/17		18.6	50.1%	387.3	1.76E+11	NR	NR		
8/7/17		18.5	50.3%	219	9.93E+10	NR	NR		
11/14/17		16.9	55.9%	727	3.01E+11	NR	NR		
12/7/17		16.8	56.2%	410.6	1.69E+11	NR	NR		
6/14/18		16.8	56.6%	461	1.89E+11	NR	NR	**NR**	**NR**
9/11/17	Dry Conditions	15.3	63.0%	172.2	6.44E+10	NR	NR		
1/25/18		11.6	77.4%	178.5	5.05E+10	NR	NR	**NR**	**NR**

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-27. Calculated Load Reduction Based on Daily Loading – Price Creek – RM 4.4

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/21/18	Moist Conditions	4.04	13.3%	920.8	9.10E+10	NR	**8.0**	**18.9**	**20.7**
7/10/17		2.89	27.4%	1120	7.92E+10	**16.0**	**24.4**		
4/9/18		2.73	30.8%	1203	8.03E+10	**21.8**	**29.6**		
5/8/18		2.61	33.0%	488	3.11E+10	NR	NR		
6/5/18	Mid-Range Flows	2.00	48.8%	461	2.26E+10	NR	NR	**29.0**	**36.1**
8/7/17		1.91	51.7%	2420	1.13E+11	**61.1**	**65.0**		
2/6/18		1.87	52.8%	344.8	1.58E+10	NR	NR		
11/13/17		1.77	55.8%	1203.3	5.22E+10	**21.8**	**29.6**		
1/9/18		1.68	59.1%	980.4	4.03E+10	**4.0**	**13.6**		
9/26/17	Dry Conditions	1.60	61.7%	866.4	3.40E+10	NR	**2.2**	**NR**	**2.2**
10/2/17		1.45	67.4%	307.6	1.09E+10	NR	NR		
12/4/17		1.23	75.5%	129.1	3.87E+09	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-28. Calculated Load Reduction Based on Daily Loading – Rattlesnake Branch – RM 1.3

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/8/18	Moist Conditions	2.62	23.0%	1986.3	1.27E+11	**52.6**	**57.4**	**52.7**	**57.4**
12/6/17		2.07	35.6%	2419.6	1.23E+11	**61.1**	**65.0**		
2/20/18		1.95	39.4%	2419.6	1.15E+11	**61.1**	**65.0**		
5/10/18		1.95	39.4%	1300	6.19E+10	**27.6**	**34.8**		
7/13/17		1.94	39.6%	2419.6	1.15E+11	**61.1**	**65.0**		
4/12/18	Mid-Range Flows	1.75	46.8%	2420	1.04E+11	**61.1**	**65.0**	**61.1**	**65.0**
6/7/18		1.47	58.0%	2420	8.69E+10	**61.1**	**65.0**		
9/19/17	Dry Conditions	1.40	60.9%	1413.6	4.85E+10	**33.4**	**40.1**	**42.3**	**48.0**
8/22/17		1.34	63.7%	1046	3.43E+10	**10.0**	**19.0**		
11/15/17		1.33	64.1%	1732.9	5.64E+10	**45.7**	**51.1**		
1/11/18		1.16	72.9%	2419.6	6.84E+10	**61.1**	**65.0**		
10/4/17		1.07	77.5%	2419.6	6.33E+10	**61.1**	**65.0**		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-29. Calculated Load Reduction Based on Daily Loading – Rogers Creek – RM 5.1

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/21/18	High Flows	103	8.8%	435.2	1.10E+12	NR	NR	**NR**	**NR**
7/10/17	Moist Conditions	61.0	24.9%	980	1.46E+12	**4.0**	**13.6**	**4.0**	**13.6**
4/9/18		58.4	27.5%	236	3.37E+11	NR	NR		
5/8/18		54.5	30.9%	135	1.80E+11	NR	NR		
2/6/18	Mid-Range Flows	44.6	42.0%	238.2	2.60E+11	NR	NR	**45.7**	**51.1**
6/5/18		41.8	45.9%	248	2.54E+11	NR	NR		
8/7/17		39.1	50.0%	1733	1.66E+12	**45.7**	**51.1**		
11/13/17		37.3	52.6%	686.7	6.26E+11	NR	NR		
1/9/18		33.6	59.2%	95.9	7.89E+10	NR	NR		
9/26/17		33.5	59.4%	770.1	6.31E+11	NR	NR		
10/2/17	Dry Conditions	30.2	65.4%	93.4	6.91E+10	NR	NR	**NR**	**NR**
12/4/17		25.8	73.0%	107.6	6.79E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-30. Calculated Load Reduction Based on Daily Loading – Siccowee Branch – RM 0.7

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
4/2/18	High Flows	2.89	8.6%	173	1.22E+10	NR	NR	**NR**	**NR**
7/17/17	Moist Conditions	1.99	15.3%	11	5.34E+08	NR	NR	**NR**	**NR**
2/14/18		1.47	28.2%	196.8	7.09E+09	NR	NR		
3/12/18	Mid-Range Flows	1.04	49.9%	547.5	1.39E+10	**11.1**	**20.5**	**29.1**	**36.7**
8/22/17		0.944	55.6%	921	2.13E+10	**47.1**	**52.8**		
10/18/17		0.888	59.1%	325.5	7.07E+09	NR	NR		
5/1/18		0.879	59.7%	225	4.84E+09	NR	NR		
6/11/18	Dry Conditions	0.814	64.0%	91	1.81E+09	NR	NR	**48.1**	**53.7**
12/5/17		0.810	64.2%	2419.6	4.80E+10	**79.9**	**82.0**		
9/7/17		0.702	72.2%	517.2	8.88E+09	**5.8**	**15.9**		
11/8/17		0.605	78.9%	980.4	1.45E+10	**50.3**	**55.6**		
1/10/18		0.545	82.5%	1119.9	1.49E+10	**56.5**	**61.2**		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (487 CFU/100 mL)

Table E-31. Calculated Load Reduction Based on Daily Loading – South Chestuee Creek – RM 1.8

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
4/26/18	High Flows	163	4.7%	1986	7.93E+12	**52.6**	**57.4**	**52.6**	**57.4**
3/8/18	Moist Conditions	72.2	20.5%	214.3	3.78E+11	NR	NR	**61.1**	**65.0**
5/3/18		62.7	27.4%	2420	3.71E+12	**61.1**	**65.0**		
7/18/17		54.8	35.2%	2419.6	3.24E+12	**61.1**	**65.0**		
8/10/17	Mid-Range Flows	44.0	47.9%	1203	1.30E+12	**21.8**	**29.6**	**21.8**	**18.8**
11/2/17		41.2	52.1%	920.8	9.28E+11	NR	**8.0**		
9/20/17		40.2	53.3%	248.9	2.45E+11	NR	NR		
6/11/18	Dry Conditions	35.6	60.0%	225	1.96E+11	NR	NR	**NR**	**NR**
1/16/18		29.9	69.5%	129.6	9.48E+10	NR	NR		
10/3/17		29.8	69.7%	275.5	2.01E+11	NR	NR		
12/11/17		28.5	71.8%	160.7	1.12E+11	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-32. Calculated Load Reduction Based on Daily Loading – South Mouse Creek – RM 12.7

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
12/6/17	High Flows	86.1	6.6%	1553.1	3.27E+12	**39.4**	**45.5**	**39.4**	**45.5**
2/20/18	Moist Conditions	14.0	30.0%	290.9	9.98E+10	NR	NR		
3/8/18		13.1	32.6%	461.1	1.48E+11	NR	NR	**NR**	**NR**
5/10/18	Mid-Range Flows	9.63	46.0%	866	2.04E+11	NR	NR		
7/13/17		9.59	46.2%	920.8	2.16E+11	NR	**8.0**		
4/12/18		8.71	51.1%	308	6.56E+10	NR	NR		
6/7/18		7.24	59.8%	1986	3.52E+11	**52.6**	**57.4**	**52.6**	**32.7**
9/19/17	Dry Conditions	6.93	61.7%	517.2	8.78E+10	NR	NR		
11/15/17		6.62	64.0%	579.4	9.38E+10	NR	NR		
8/22/17		6.60	64.1%	579	9.34E+10	NR	NR		
1/11/18		5.76	70.6%	1413.6	1.99E+11	**33.4**	**40.1**		
10/4/17		5.29	74.4%	461.1	5.97E+10	NR	NR	**33.4**	**40.1**

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-33. Calculated Load Reduction Based on Daily Loading – Spring Creek – RM 7.3

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/21/18	High Flows	35.4	9.9%	770.1	6.67E+11	NR	NR	**NR**	**NR**
7/10/17	Moist Conditions	20.9	28.1%	548	2.80E+11	NR	NR	**45.7**	**51.1**
4/9/18		20.3	30.0%	1733	8.60E+11	**45.7**	**51.1**		
5/8/18		18.5	34.7%	687	3.12E+11	NR	NR		
2/6/18	Mid-Range Flows	15.2	46.3%	816.4	3.04E+11	NR	NR	**NR**	**NR**
6/5/18		14.1	50.6%	727	2.52E+11	NR	NR		
8/7/17		13.7	52.7%	291	9.73E+10	NR	NR		
11/13/17		12.7	56.5%	727	2.26E+11	NR	NR		
1/9/18		12.6	56.8%	435.2	1.34E+11	NR	NR		
9/26/17	Dry Conditions	11.3	63.1%	579.4	1.61E+11	NR	NR	**NR**	**NR**
10/2/17		10.3	68.2%	285.1	7.17E+10	NR	NR		
12/4/17		8.76	75.6%	686.7	1.47E+11	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-34. Calculated Load Reduction Based on Daily Loading – Tom Foeman Creek – RM 1.8

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
8/8/17	Moist Conditions	7.08	24.3%	1986	3.44E+11	**52.6**	**57.4**	**34.0**	**40.6**
3/15/18		6.82	26.3%	1119.9	1.87E+11	**16.0**	**24.4**		
7/12/17		6.01	33.7%	1414	2.08E+11	**33.5**	**40.1**		
4/12/18	Mid-Range Flows	5.16	42.8%	488	6.16E+10	NR	NR	**44.5**	**50.0**
5/17/18		5.08	43.7%	2420	3.01E+11	**61.1**	**650**		
11/2/17		4.44	52.2%	2419.6	2.63E+11	**61.1**	**65.0**		
10/18/17		4.31	53.9%	1046.2	1.10E+11	**10.1**	**19.0**		
9/21/17		4.15	56.1%	1732.9	1.76E+11	**45.7**	**51.1**		
6/20/18	Dry Conditions	3.41	67.4%	1553.1	1.30E+11	**39.4**	**45.5**	**53.9**	**58.5**
12/12/17		2.98	74.5%	2419.6	1.76E+11	**61.1**	**65.0**		
1/24/18		2.79	76.9%	2419.6	1.65E+11	**61.1**	**65.0**		
2/1/18		2.60	79.4%	770.1	4.90E+10	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-35. Calculated Load Reduction Based on Daily Loading – UT to Rogers Creek – RM 0.3

Sample Date	Flow Regime	Flow	PDFE	Concentration	Load	% Reduction to Achieve TMDL *	% Reduction to Achieve TMDL -- MOS	Average of Reductions to TMDL	Average of Reduction to TMDL – MOS
		[cfs]	[%]	[CFU/100 ml]	[CFU/day]	[%]	[%]	[%]	[%]
3/13/18	Moist Conditions	0.565	25.1%	613.1	8.48E+09	NR	NR	**NR**	**NR**
7/11/17		0.449	37.4%	219	2.40E+09	NR	NR		
2/20/18	Mid-Range Flows	0.416	42.0%	488.4	4.96E+09	NR	NR	**61.1**	**65.0**
5/15/18		0.368	50.3%	613	5.52E+09	NR	NR		
8/7/17		0.368	50.5%	2420	2.18E+10	**61.1**	**65.0**		
4/5/18		0.367	50.7%	1414	1.27E+10	NR	NR		
6/14/18		0.323	58.7%	2419.6	1.91E+10	**61.1**	**65.0**		
10/26/17	Dry Conditions	0.314	60.3%	85.7	6.59E+08	NR	NR	**61.1**	**65.0**
11/14/17		0.289	64.7%	727	5.15E+09	NR	NR		
12/7/17		0.280	66.9%	290.9	1.99E+09	NR	NR		
9/11/17		0.263	70.5%	2419.6	1.56E+10	**61.1**	**65.0**		
1/25/18		0.199	84.6%	866.4	4.21E+09	NR	NR		

Note: NR = No reduction required
* % Reduction based on Single Sample Maximum Criterion (941 CFU/100 mL)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002)

Waterbody Description (06020002____)	Hydrologic Condition			Flow [a]	PLRG	TMDL	MOS	WLAs		LAs [d]
	Flow Regime	PDFE Range	Flow Range					WWTPs[c]	MS4s[d,f]	
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
Cane Creek [e]	High Flows	0-10	37.8 – 672	63.8	NA	1.467E+12	1.467E+11	2.3E+10 x q_m	(1.765E+08) - (3.07E+6 x q_d)	(1.765E+08) - (3.07E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	15.1 – 37.8	20.4	NR	4.701E+11	4.701E+10		(5.656E+07) - (3.07E+6 x q_d)	(5.656E+07) - (3.07E+6 x q_d)
081_0100	Mid-Range	40-60	10.6 – 15.1	12.8	NR	2.935E+11	2.935E+10		(3.531E+07) - (3.07E+6 x q_d)	(3.531E+07) - (3.07E+6 x q_d)
	Dry Conditions	60-90	4.87 – 10.6	8.10	NR	1.863E+11	1.863E+10		(2.241E+07) - (3.07E+6 x q_d)	(2.241E+07) - (3.07E+6 x q_d)
HUC-12: 0802	Low Flows	90-100	0.390 – 4.87	3.37	NR	7.751E+10	7.751E+09		(9.325E+06) - (3.07E+6 x q_d)	(9.325E+06) - (3.07E+6 x q_d)
Dairy Branch [e]	High Flows	0-10	1.19 – 32.3	1.82	83.4 [b]	4.186E+10	4.186E+09	2.3E+10 x q_m	(1.307E+08) - (7.98E+7 x q_d)	(1.307E+08) - (7.98E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	0.550 – 1.19	0.730		1.679E+10	1.679E+09		(5.243E+07) - (7.98E+7 x q_d)	(5.243E+07) - (7.98E+7 x q_d)
018_0200	Mid-Range	40-60	0.390 – 0.550	0.450		1.035E+10	1.035E+09		(3.232E+07) - (7.98E+7 x q_d)	(3.232E+07) - (7.98E+7 x q_d)
	Dry Conditions	60-90	0.190 – 0.390	0.290		6.670E+09	6.670E+08		(2.083E+07) - (7.98E+7 x q_d)	(2.083E+07) - (7.98E+7 x q_d)
HUC-12: 0909	Low Flows	90-100	0.050 – 0.190	0.150		3.450E+09	3.450E+08		(1.077E+07) - (7.98E+7 x q_d)	(1.077E+07) - (7.98E+7 x q_d)
Siccowee Branch [e]	High Flows	0-10	2.58 – 911	4.67	NR	5.604E+10	5.604E+09	1.2E+10 x q_m	(8.599E+07) - (2.05E+7 x q_d)	(8.599E+07) - (2.05E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	1.21 – 2.58	1.56	NR	1.872E+10	1.872E+09		(2.873E+07) - (2.05E+7 x q_d)	(2.873E+07) - (2.05E+7 x q_d)
018_0300	Mid-Range	40-60	0.870 – 1.21	1.04	29.1	1.248E+10	1.248E+09		(1.915E+07) - (2.05E+7 x q_d)	(1.915E+07) - (2.05E+7 x q_d)
	Dry Conditions	60-90	0.400 – 0.870	0.660	48.1	7.920E+09	7.920E+08		(1.215E+07) - (2.05E+7 x q_d)	(1.215E+07) - (2.05E+7 x q_d)
HUC-12: 0909	Low Flows	90-100	0.030 – 0.400	0.260	NA	3.120E+09	3.120E+08		(4.788E+06) - (2.05E+7 x q_d)	(4.788E+06) - (2.05E+7 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description (06020002____)	Hydrologic Condition			Flow[a]	PLRG	TMDL	MOS	WLAs		LAs [d]
	Flow Regime	PDFE Range	Flow Range					WWTPs[c]	MS4s[d,f]	
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
Middle Creek [e]	High Flows	0-10	60.9 – 1,627	106	NA	2.443E+12	2.443E+11	2.3E+10 x q_m	(1.670E+08) - (1.75E+6 x q_d)	(1.670E+08) - (1.75E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	27.5 – 60.9	36.3	NR	8.344E+11	8.344E+10		(5.705E+07) - (1.75E+6 x q_d)	(5.705E+07) - (1.75E+6 x q_d)
082_0300	Mid-Range	40-60	18.7 – 27.5	23.1	53.9	5.315E+11	5.315E+10		(3.634E+07) - (1.75E+6 x q_d)	(3.634E+07) - (1.75E+6 x q_d)
	Dry Conditions	60-90	7.90 – 18.7	13.2	53.6	3.034E+11	3.034E+10		(2.074E+07) - (1.75E+6 x q_d)	(2.074E+07) - (1.75E+6 x q_d)
HUC-12: 1001	Low Flows	90-100	1.19 – 7.90	5.21	NA	1.198E+11	1.198E+10		(8.193E+06) - (1.75E+6 x q_d)	(8.193E+06) - (1.75E+6 x q_d)
Chestuee Creek	High Flows	0-10	85.3 – 1,714	134	NA	3.093E+12	3.093E+11	2.3E+10 x q_m	(1.350E+08) - (1.12E+6 x q_d)	(1.350E+08) - (1.12E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	41.0 – 85.3	53.1	56.9	1.220E+12	1.220E+11		(5.329E+07) - (1.12E+6 x q_d)	(5.329E+07) - (1.12E+6 x q_d)
082_2000	Mid-Range	40-60	29.7 – 41.0	35.0	61.1	8.045E+11	8.045E+10		(3.513E+07) - (1.12E+6 x q_d)	(3.513E+07) - (1.12E+6 x q_d)
	Dry Conditions	60-90	13.9 – 29.7	23.2	NR	5.331E+11	5.331E+10		(2.328E+07) - (1.12E+6 x q_d)	(2.328E+07) - (1.12E+6 x q_d)
HUC-12: 1002	Low Flows	90-100	1.51 – 13.9	9.73	NA	2.238E+11	2.238E+10		(9.772E+06) - (1.12E+6 x q_d)	(9.772E+06) - (1.12E+6 x q_d)
Tom Foeman Creek [e]	High Flows	0-10	10.4 – 274	16.1	NA	3.692E+11	3.692E+10	2.3E+10 x q_m	(1.237E+08) - (8.57E+6 x q_d)	(1.237E+08) - (8.57E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	5.39 – 10.4	6.97	34.0	1.603E+11	1.603E+10		(5.373E+07) - (8.57E+6 x q_d)	(5.373E+07) - (8.57E+6 x q_d)
082_1200	Mid-Range	40-60	3.89 – 5.39	4.60	44.5	1.058E+11	1.058E+10		(3.546E+07) - (8.57E+6 x q_d)	(3.546E+07) - (8.57E+6 x q_d)
	Dry Conditions	60-90	1.67 – 3.89	2.93	53.9	6.739E+10	6.739E+09		(2.259E+07) - (8.57E+6 x q_d)	(2.259E+07) - (8.57E+6 x q_d)
HUC-12: 1003	Low Flows	90-100	0.160 – 1.67	1.06	NA	2.438E+10	2.438E+09		(8.171E+06) - (8.57E+6 x q_d)	(8.171E+06) - (8.57E+6 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description (06020002____)	Hydrologic Condition: Flow Regime	PDFE Range [%]	Flow Range [cfs]	Flow[a] [cfs]	PLRG [%]	TMDL [CFU/d]	MOS [CFU/d]	WLAs: WWTPs[c] [CFU/d]	WLAs: MS4s[d,f] [CFU/d/ac]	LAs[d] [CFU/d/ac]
Big Foot Branch[e]	High Flows	0-10	20.2 – 433	30.0	NR	6.891E+11	6.891E+10	2.3E+10 x q_m	(1.172E+08) - (4.35E+6 x q_d)	(1.172E+08) - (4.35E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	10.7 – 20.2	13.7	NR	3.151E+11	3.151E+10		(5.359E+07) - (4.35E+6 x q_d)	(5.359E+07) - (4.35E+6 x q_d)
082_1300	Mid-Range	40-60	7.65 – 10.7	9.10	52.6	2.093E+11	2.093E+10		(3.560E+07) - (4.35E+6 x q_d)	(3.560E+07) - (4.35E+6 x q_d)
	Dry Conditions	60-90	3.31 – 7.65	5.74	NR	1.320E+11	1.320E+10		(2.245E+07) - (4.35E+6 x q_d)	(2.245E+07) - (4.35E+6 x q_d)
HUC-12: 1003	Low Flows	90-100	0.320 – 3.31	2.11	NA	4.853E+10	4.853E+09		(8.254E+06) - (4.35E+6 x q_d)	(8.254E+06) - (4.35E+6 x q_d)
Oostanaula Creek[e]	High Flows	0-10	43.4 – 839	66.4	NA	1.527E+12	1.527E+11	2.3E+10 x q_m	(1.233E+08) - (2.07E+6 x q_d)	(1.233E+08) - (2.07E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	21.8– 43.4	28.3	NR	6.518E+11	6.518E+10		(5.266E+07) - (2.07E+6 x q_d)	(5.266E+07) - (2.07E+6 x q_d)
083_4000 &	Mid-Range	40-60	15.9 – 21.8	18.7	NR	4.290E+11	4.290E+10		(3.465E+07) - (2.07E+6 x q_d)	(3.465E+07) - (2.07E+6 x q_d)
083_5000	Dry Conditions	60-90	7.38 – 15.9	12.2	NR	2.813E+11	2.813E+10		(2.273E+07) - (2.07E+6 x q_d)	(2.273E+07) - (2.07E+6 x q_d)
HUC-12: 1101	Low Flows	90-100	0.660 – 7.38	4.99	NA	1.148E+11	1.148E+10		(9.272E+06) - (2.07E+6 x q_d)	(9.272E+06) - (2.07E+6 x q_d)
Oostanaula Creek	High Flows	0-10	90.6 – 1,812	139	NR	3.206E+12	3.206E+11	2.3E+10 x q_m	(1.480E+08) - (1.18E+6 x q_d)	(1.480E+08) - (1.18E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	44.6 – 90.6	57.0	45.7	1.312E+12	1.312E+11		(6.057E+07) - (1.18E+6 x q_d)	(6.057E+07) - (1.18E+6 x q_d)
083_3000	Mid-Range	40-60	32.9 – 44.6	38.5	10.0	8.846E+11	8.846E+10		(4.084E+07) - (1.18E+6 x q_d)	(4.084E+07) - (1.18E+6 x q_d)
	Dry Conditions	60-90	17.9 – 32.9	26.4	27.6	6.063E+11	6.063E+10		(2.799E+07) - (1.18E+6 x q_d)	(2.799E+07) - (1.18E+6 x q_d)
HUC-12: 1102	Low Flows	90-100	5.48 – 17.9	14.0	NR	3.215E+11	3.215E+10		(1.484E+07) - (1.18E+6 x q_d)	(1.484E+07) - (1.18E+6 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description **(06020002____)**	Hydrologic Condition			Flow[a]	PLRG	TMDL	MOS	WLAs		LAs [d]
	Flow Regime	PDFE Range	Flow Range					WWTPs[c]	MS4s[d,f]	
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
Latham Springs Branch [e]	High Flows	0-10	12.5 – 274	19.0	NA	4.359E+11	4.359E+10	2.3E+10 x q_m	(1.243E+08) - (7.29E+6 x q_d)	(1.243E+08) - (7.29E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	6.20 – 12.5	8.05	NR	1.852E+11	1.852E+10		(5.281E+07) - (7.29E+6 x q_d)	(5.281E+07) - (7.29E+6 x q_d)
084_0200	Mid-Range	40-60	4.52 – 6.20	5.29	61.1	1.217E+11	1.217E+10		(3.470E+07) - (7.29E+6 x q_d)	(3.470E+07) - (7.29E+6 x q_d)
	Dry Conditions	60-90	2.09 – 4.52	3.49	NR	8.027E+10	8.027E+09		(2.289E+07) - (7.29E+6 x q_d)	(2.289E+07) - (7.29E+6 x q_d)
HUC-12: 1201	Low Flows	90-100	0.190 – 2.09	1.42	NA	3.266E+10	3.266E+09		(9.315E+06) - (7.29E+6 x q_d)	(9.315E+06) - (7.29E+6 x q_d)
Little N. Mouse Creek	High Flows	0-10	15.8 – 293	23.8	NA	5.483E+11	5.483E+10	2.3E+10 x q_m	(1.444E+08) - (6.73E+6 x q_d)	(1.444E+08) - (6.73E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	8.28 – 15.8	10.3	61.1	2.378E+11	2.378E+10		(6.261E+07) - (6.73E+6 x q_d)	(6.261E+07) - (6.73E+6 x q_d)
084_0400	Mid-Range	40-60	6.37 – 8.28	7.26	27.6	1.670E+11	1.670E+10		(4.396E+07) - (6.73E+6 x q_d)	(4.396E+07) - (6.73E+6 x q_d)
	Dry Conditions	60-90	3.75 – 6.37	5.26	NR	1.210E+11	1.210E+10		(3.185E+07) - (6.73E+6 x q_d)	(3.185E+07) - (6.73E+6 x q_d)
HUC-12: 1201	Low Flows	90-100	1.71 – 3.75	3.01	NA	6.923E+10	6.923E+09		(1.823E+07) - (6.73E+6 x q_d)	(1.823E+07) - (6.73E+6 x q_d)
North Mouse Creek	High Flows	0-10	114 – 2,183	175	NA	4.035E+12	4.035E+11	2.3E+10 x q_m	(1.436E+08) - (9.09E+5 x q_d)	(1.436E+08) - (9.09E+5 x q_d)
Waterbody ID:	Moist Conditions	10-40	51.6 – 114	68.0	NR	1.564E+12	1.564E+11		(5.565E+07) - (9.09E+5 x q_d)	(5.565E+07) - (9.09E+5 x q_d)
084_2000	Mid-Range	40-60	37.3 – 51.6	44.3	NR	1.018E+12	1.018E+11		(3.624E+07) - (9.09E+5 x q_d)	(3.624E+07) - (9.09E+5 x q_d)
	Dry Conditions	60-90	17.8 – 37.3	28.9	NR	6.640E+11	6.640E+10		(2.363E+07) - (9.09E+5 x q_d)	(2.363E+07) - (9.09E+5 x q_d)
HUC-12: 1201	Low Flows	90-100	2.92 – 17.8	12.7	NA	2.923E+11	2.923E+10		(1.040E+07) - (9.09E+5 x q_d)	(1.040E+07) - (9.09E+5 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description (06020002____)	Hydrologic Condition			Flow[a]	PLRG	TMDL	MOS	WLAs		LAs[d]
	Flow Regime	PDFE Range	Flow Range					WWTPs[c]	MS4s[d,f]	
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
Spring Creek[e]	High Flows	0-10	35.2 – 678	56.6	NR	1.302E+12	1.302E+11	2.3E+10 x q_m	(1.407E+08) - (2.76E+6 x q_d)	(1.407E+08) - (2.76E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	16.9 – 35.2	22.1	45.7	5.083E+11	5.083E+10		(5.492E+07) - (2.76E+6 x q_d)	(5.492E+07) - (2.76E+6 x q_d)
085_1000	Mid-Range	40-60	11.9 – 16.9	14.3	NR	3.280E+11	3.280E+10		(3.544E+07) - (2.76E+6 x q_d)	(3.544E+07) - (2.76E+6 x q_d)
	Dry Conditions	60-90	4.97 – 11.9	8.89	NR	2.045E+11	2.045E+10		(2.209E+07) - (2.76E+6 x q_d)	(2.209E+07) - (2.76E+6 x q_d)
HUC-12: 1202	Low Flows	90-100	0.470 – 4.97	3.22	NA	7.406E+10	7.406E+09		(8.002E+06) - (2.76E+6 x q_d)	(8.002E+06) - (2.76E+6 x q_d)
North Mouse Creek	High Flows	0-10	193 – 3,883	290	39.4	6.678E+12	6.678E+11	2.3E+10 x q_m	(1.338E+08) - (5.12E+5 x q_d)	(1.338E+08) - (5.12E+5 x q_d)
Waterbody ID:	Moist Conditions	10-40	92.9 – 193	125	NR	2.867E+12	2.867E+11		(5.744E+07) - (5.12E+5 x q_d)	(5.744E+07) - (5.12E+5 x q_d)
084_1000	Mid-Range	40-60	67.0 – 92.9	79.1	NR	1.819E+12	1.819E+11		(3.620E+07) - (5.12E+5 x q_d)	(3.620E+07) - (5.12E+5 x q_d)
	Dry Conditions	60-90	31.3 – 67.0	51.5	NR	1.185E+12	1.185E+11		(2.373E+07) - (5.12E+5 x q_d)	(2.373E+07) - (5.12E+5 x q_d)
HUC-12: 1203	Low Flows	90-100	4.02 – 31.3	22.5	NA	5.164E+11	5.164E+10		(1.034E+07) - (5.12E+5 x q_d)	(1.034E+07) - (5.12E+5 x q_d)
Dry Valley Creek[e]	High Flows	0-10	35.2 – 704	56.7	NA	1.304E+12	1.304E+11	2.3E+10 x q_m	(1.659E+08) - (3.25E+6 x q_d)	(1.659E+08) - (3.25E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	15.4 – 35.2	20.5	NR	4.724E+11	4.724E+10		(6.009E+07) - (3.25E+6 x q_d)	(6.009E+07) - (3.25E+6 x q_d)
084_0500	Mid-Range	40-60	10.9 – 15.4	13.0	NR	2.997E+11	2.997E+10		(3.812E+07) - (3.25E+6 x q_d)	(3.812E+07) - (3.25E+6 x q_d)
	Dry Conditions	60-90	4.94 – 10.9	8.38	NR	1.927E+11	1.927E+10		(2.452E+07) - (3.25E+6 x q_d)	(2.452E+07) - (3.25E+6 x q_d)
HUC-12: 1203	Low Flows	90-100	0.420 – 4.94	3.31	NA	7.613E+10	7.613E+09		(9.684E+06) - (3.25E+6 x q_d)	(9.684E+06) - (3.25E+6 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description **(06020002____)**	Hydrologic Condition			Flow[a]	PLRG	TMDL	MOS	WLAs		LAs[d]
	Flow Regime	PDFE Range	Flow Range					WWTPs[c]	MS4s[d,f]	
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
Candies Creek[e]	High Flows	0-10	20.9 – 453	31.5	NA	7.247E+11	7.247E+10	2.3E+10 x q_m	(1.180E+08) - (4.16E+6 x q_d)	(1.180E+08) - (4.16E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	10.9 – 20.9	14.2	10.0	3.273E+11	3.273E+10		(5.327E+07) - (4.16E+6 x q_d)	(5.327E+07) - (4.16E+6 x q_d)
005_3000	Mid-Range	40-60	7.92 – 10.9	9.38	52.6	2.157E+11	2.157E+10		(3.512E+07) - (4.16E+6 x q_d)	(3.512E+07) - (4.16E+6 x q_d)
	Dry Conditions	60-90	3.45 – 7.92	5.93	4.0	1.364E+11	1.364E+10		(2.220E+07) - (4.16E+6 x q_d)	(2.220E+07) - (4.16E+6 x q_d)
HUC-12: 1301	Low Flows	90-100	0.340 – 3.45	2.21	NA	5.083E+10	5.083E+09		(8.274E+06) - (4.16E+6 x q_d)	(8.274E+06) - (4.16E+6 x q_d)
Black Fox Creek[e]	High Flows	0-10	24.5 – 508	37.1	NA	8.524E+11	8.524E+10	2.3E+10 x q_m	(1.215E+08) - (3.64E+6 x q_d)	(1.215E+08) - (3.64E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	12.3 – 24.5	16.1	46.0	3.692E+11	3.692E+10		(5.261E+07) - (3.64E+6 x q_d)	(5.261E+07) - (3.64E+6 x q_d)
005_0100	Mid-Range	40-60	9.02 – 12.3	10.5	NR	2.424E+11	2.424E+10		(3.455E+07) - (3.64E+6 x q_d)	(3.455E+07) - (3.64E+6 x q_d)
	Dry Conditions	60-90	4.19 – 9.02	6.94	NR	1.596E+11	1.596E+10		(2.275E+07) - (3.64E+6 x q_d)	(2.275E+07) - (3.64E+6 x q_d)
HUC-12: 1302	Low Flows	90-100	0.380 – 4.19	2.82	NA	6.486E+10	6.486E+09		(9.244E+06) - (3.64E+6 x q_d)	(9.244E+06) - (3.64E+6 x q_d)
Beaverdam Creek[e]	High Flows	0-10	5.38 – 120	8.48	NA	1.950E+11	1.950E+10	2.3E+10 x q_m	(1.245E+08) - (1.63E+7 x q_d)	(1.245E+08) - (1.63E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	2.78 – 5.38	3.60	35.6	8.280E+10	8.280E+09		(5.284E+07) - (1.63E+7 x q_d)	(5.284E+07) - (1.63E+7 x q_d)
005_1100	Mid-Range	40-60	2.00 – 2.78	2.37	61.1	5.451E+10	5.451E+09		(3.479E+07) - (1.63E+7 x q_d)	(3.479E+07) - (1.63E+7 x q_d)
	Dry Conditions	60-90	0.870 – 2.00	1.51	49.1	3.473E+10	3.473E+09		(2.216E+07) - (1.63E+7 x q_d)	(2.216E+07) - (1.63E+7 x q_d)
HUC-12: 1303	Low Flows	90-100	0.080 – 0.870	0.560	NA	1.288E+10	1.288E+09		(8.220E+06) - (1.63E+7 x q_d)	(8.220E+06) - (1.63E+7 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description (06020002____)	Hydrologic Condition: Flow Regime	PDFE Range	Flow Range	Flow[a]	PLRG	TMDL	MOS	WLAs: WWTPs[c]	WLAs: MS4s[d,f]	LAs[d]
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
Candies Creek[e]	High Flows	0-10	248 – 5,459	382	NA	8.780E+12	8.780E+11	2.3E+10 x q_m	(1.266E+08) - (3.69E+5 x q_d)	(1.266E+08) - (3.69E+5 x q_d)
Waterbody ID:	Moist Conditions	10-40	126 – 248	165	NR	3.801E+12	3.801E+11		(5.480E+07) - (3.69E+5 x q_d)	(5.480E+07) - (3.69E+5 x q_d)
005_1000	Mid-Range	40-60	90.3 – 126	108	NR	2.481E+12	2.481E+11		(3.577E+07) - (3.69E+5 x q_d)	(3.577E+07) - (3.69E+5 x q_d)
	Dry Conditions	60-90	38.9 – 90.3	67.6	NR	1.554E+12	1.554E+11		(2.240E+07) - (3.69E+5 x q_d)	(2.240E+07) - (3.69E+5 x q_d)
HUC-12: 1303	Low Flows	90-100	3.66 – 38.9	25.8	NA	5.925E+11	5.925E+10		(8.543E+06) - (3.69E+5 x q_d)	(8.543E+06) - (3.69E+5 x q_d)
South Chestuee Creek[e]	High Flows	0-10	109 – 1,966	155	52.6	3.569E+12	3.569E+11	2.3E+10 x q_m	(1.320E+08) - (9.45E+5 x q_d)	(1.320E+08) - (9.45E+5 x q_d)
Waterbody ID:	Moist Conditions	10-40	50.1 – 109	65.0	61.1	1.496E+12	1.496E+11		(5.532E+07) - (9.45E+5 x q_d)	(5.532E+07) - (9.45E+5 x q_d)
014_1000	Mid-Range	40-60	35.6 – 50.1	42.6	21.8	9.789E+11	9.789E+10		(3.620E+07) - (9.45E+5 x q_d)	(3.620E+07) - (9.45E+5 x q_d)
	Dry Conditions	60-90	15.2 – 35.6	26.7	NR	6.134E+11	6.134E+10		(2.269E+07) - (9.45E+5 x q_d)	(2.269E+07) - (9.45E+5 x q_d)
HUC-12: 1401	Low Flows	90-100	1.44 – 15.2	9.97	NA	2.293E+11	2.293E+10		(8.481E+06) - (9.45E+5 x q_d)	(8.481E+06) - (9.45E+5 x q_d)
Little Chatata Creek[e]	High Flows	0-10	35.2 – 737	60.0	61.1	1.380E+12	1.380E+11	2.3E+10 x q_m	(1.928E+08) - (3.57E+6 x q_d)	(1.928E+08) - (3.57E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	11.9 – 35.2	16.4	33.4	3.774E+11	3.774E+10		(5.272E+07) - (3.57E+6 x q_d)	(5.272E+07) - (3.57E+6 x q_d)
012_0200	Mid-Range	40-60	8.22 – 11.9	9.91	33.4	2.279E+11	2.279E+10		(3.184E+07) - (3.57E+6 x q_d)	(3.184E+07) - (3.57E+6 x q_d)
	Dry Conditions	60-90	3.69 – 8.22	6.25	10.1	1.438E+11	1.438E+10		(2.008E+07) - (3.57E+6 x q_d)	(2.008E+07) - (3.57E+6 x q_d)
HUC-12: 1402	Low Flows	90-100	0.320 – 3.69	2.49	NA	5.727E+10	5.727E+09		(7.999E+06) - (3.57E+6 x q_d)	(7.999E+06) - (3.57E+6 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description (06020002____)	Hydrologic Condition: Flow Regime	PDFE Range [%]	Flow Range [cfs]	Flow[a] [cfs]	PLRG [%]	TMDL [CFU/d]	MOS [CFU/d]	WLAs: WWTPs[c] [CFU/d]	WLAs: MS4s[d,f] [CFU/d/ac]	LAs [d] [CFU/d/ac]
Rattlesnake Branch [e]	High Flows	0-10	3.97 – 94.9	6.73	NA	1.548E+11	1.548E+10	2.3E+10 x q_m	(1.537E+08) - (2.54E+7 x q_d)	(1.537E+08) - (2.54E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	1.93 – 3.97	2.51	52.7	5.773E+10	5.773E+09		(5.734E+07) - (2.54E+7 x q_d)	(5.734E+07) - (2.54E+7 x q_d)
012_0300	Mid-Range	40-60	1.42 – 1.93	1.67	61.1	3.841E+10	3.841E+09		(3.815E+07) - (2.54E+7 x q_d)	(3.815E+07) - (2.54E+7 x q_d)
	Dry Conditions	60-90	0.730 – 1.42	1.12	42.3	2.576E+10	2.576E+09		(2.558E+07) - (2.54E+7 x q_d)	(2.558E+07) - (2.54E+7 x q_d)
HUC-12: 1402	Low Flows	90-100	0.050 – 0.730	0.400	NA	9.200E+09	9.200E+08		(9.137E+06) - (2.54E+7 x q_d)	(9.137E+06) - (2.54E+7 x q_d)
Chatata Creek [e]	High Flows	0-10	84.4 – 1,692	132	NA	3.039E+12	3.039E+11	2.3E+10 x q_m	(1.445E+08) - (1.22E+6 x q_d)	(1.445E+08) - (1.22E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	37.4 – 84.4	49.6	34.5	1.140E+12	1.140E+11		(5.421E+07) - (1.22E+6 x q_d)	(5.421E+07) - (1.22E+6 x q_d)
012_1000	Mid-Range	40-60	26.7 – 37.4	31.7	61.1	7.286E+11	7.286E+10		(3.465E+07) - (1.22E+6 x q_d)	(3.465E+07) - (1.22E+6 x q_d)
	Dry Conditions	60-90	12.2 – 26.7	20.4	4.0	4.692E+11	4.692E+10		(2.232E+07) - (1.22E+6 x q_d)	(2.232E+07) - (1.22E+6 x q_d)
HUC-12: 1402	Low Flows	90-100	1.05 – 12.2	8.20	NA	1.886E+11	1.886E+10		(8.970E+06) - (1.22E+6 x q_d)	(8.970E+06) - (1.22E+6 x q_d)
Bacon Branch [e]	High Flows	0-10	2.59 – 59.8	3.87	99.2	3.039E+12	3.039E+11	2.3E+10 x q_m	(1.202E+08) - (3.45E+7 x q_d)	(1.202E+08) - (3.45E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	1.38 – 2.59	1.76	87.0	1.140E+12	1.140E+11		(5.469E+07) - (3.45E+7 x q_d)	(5.469E+07) - (3.45E+7 x q_d)
008_0100	Mid-Range	40-60	1.01 – 1.38	1.19	99.2	7.286E+11	7.286E+10		(3.698E+07) - 3.45E+7 x q_d)	(3.698E+07) - 3.45E+7 x q_d)
	Dry Conditions	60-90	0.470 – 1.01	0.770	98.8	4.692E+11	4.692E+10		(2.393E+07) - (3.45E+7 x q_d)	(2.393E+07) - (3.45E+7 x q_d)
HUC-12: 1403	Low Flows	90-100	0.040 – 0.470	0.280	NA	1.886E+11	1.886E+10		(8.700E+06) - (3.45E+7 x q_d)	(8.700E+06) - (3.45E+7 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description (06020002____)	Hydrologic Condition			Flow[a]	PLRG	TMDL	MOS	WLAs		LAs [d]
	Flow Regime	PDFE Range	Flow Range					WWTPs[c]	MS4s[d,f]	
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
South Mouse Creek [e]	High Flows	0-10	56.0 – 1,091	107	39.4	2.466E+12	2.466E+11	2.3E+10 x q_m	(3.148E+08) - (3.26E+6 x q_d)	(3.148E+08) - (3.26E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	11.0 – 56.0	16.8	NR	3.855E+11	3.855E+10		(4.921E+07) - (3.26E+6 x q_d)	(4.921E+07) - (3.26E+6 x q_d)
009_2000	Mid-Range	40-60	7.21 – 11.0	8.90	52.6	2.047E+11	2.047E+10		(2.613E+07) - (3.26E+6 x q_d)	(2.613E+07) - (3.26E+6 x q_d)
	Dry Conditions	60-90	2.89 – 7.21	5.20	33.4	1.196E+11	1.196E+10		(1.527E+07) - (3.26E+6 x q_d)	(1.527E+07) - (3.26E+6 x q_d)
HUC-12: 1404	Low Flows	90-100	0.250 – 2.89	1.84	NA	4.232E+10	4.232E+09		(5.402E+06) - (3.26E+6 x q_d)	(5.402E+06) - (3.26E+6 x q_d)
Brush Creek [e]	High Flows	0-10	15.0 – 312	25.0	NA	5.755E+11	5.755E+10	2.3E+10 x q_m	(1.502E+08) - (6.67E+6 x q_d)	(1.502E+08) - (6.67E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	7.22 – 15.0	9.38	45.7	2.157E+11	2.157E+10		(5.632E+07) - (6.67E+6 x q_d)	(5.632E+07) - (6.67E+6 x q_d)
087_0200	Mid-Range	40-60	5.34 – 7.22	6.28	NR	1.444E+11	1.444E+10		(3.771E+07) - 6.67E+6 x q_d)	(3.771E+07) - 6.67E+6 x q_d)
	Dry Conditions	60-90	2.78 – 5.34	4.24	NR	9.752E+10	9.752E+09		(2.546E+07) - (6.67E+6 x q_d)	(2.546E+07) - (6.67E+6 x q_d)
HUC-12: 1405	Low Flows	90-100	0.210 – 2.78	1.43	NA	3.289E+10	3.289E+09		(8.586E+06) - (6.67E+6 x q_d)	(8.586E+06) - (6.67E+6 x q_d)
UT to Rogers Creek [e]	High Flows	0-10	0.990 – 18.4	1.73	NA	3.979E+10	3.979E+09	2.3E+10 x q_m	(1.749E+08) - (1.12E+8 x q_d)	(1.749E+08) - (1.12E+8 x q_d)
Waterbody ID:	Moist Conditions	10-40	0.430 – 0.990	0.570	NR	1.311E+10	1.311E+09		(5.764E+07) - (1.12E+8 x q_d)	(5.764E+07) - (1.12E+8 x q_d)
087_0600	Mid-Range	40-60	0.320 – 0.430	0.370	61.1	8.510E+09	8.510E+08		(3.742E+07) - (1.12E+8 x q_d)	(3.742E+07) - (1.12E+8 x q_d)
	Dry Conditions	60-90	0.160 – 0.320	0.240	61.1	5.520E+09	5.520E+08		(2.427E+07) - (1.12E+8 x q_d)	(2.427E+07) - (1.12E+8 x q_d)
HUC-12: 1405	Low Flows	90-100	0.010 – 0.160	0.080	NA	1.840E+09	1.840E+08		(8.090E+06) - (1.12E+8 x q_d)	(8.090E+06) - (1.12E+8 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description (06020002____)	Hydrologic Condition: Flow Regime	PDFE Range	Flow Range	Flow[a]	PLRG	TMDL	MOS	WLAs: WWTPs[c]	WLAs: MS4s[d,f]	LAs [d]
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
Rogers Creek	High Flows	0-10	97.0 – 1,894	142	NR	3.264E+12	3.264E+11	2.3E+10 x q_m	(1.214E+08) - (9.50E+5 x q_d)	(1.214E+08) - (9.50E+5 x q_d)
Waterbody ID:	Moist Conditions	10-40	46.2 – 97.0	60.8	4.0	1.399E+12	1.399E+11		(5.204E+07) - (9.50E+5 x q_d)	(5.204E+07) - (9.50E+5 x q_d)
087_1000	Mid-Range	40-60	33.2 – 46.2	39.1	45.7	8.984E+11	8.984E+10		(3.341E+07) - (9.50E+5 x q_d)	(3.341E+07) - (9.50E+5 x q_d)
	Dry Conditions	60-90	15.2 – 33.2	24.6	NR	5.649E+11	5.649E+10		(2.101E+07) - (9.50E+5 x q_d)	(2.101E+07) - (9.50E+5 x q_d)
HUC-12: 1405	Low Flows	90-100	0.270 – 15.2	10.1	NA	2.332E+11	2.332E+10		(8.673E+06) - (9.50E+5 x q_d)	(8.673E+06) - (9.50E+5 x q_d)
Hiwassee Embayment	High Flows	0-10			12.7			2.3E+10 x q_m		
Waterbody ID:	Moist Conditions	10-40								
008_1000	Mid-Range	40-60								
	Dry Conditions	60-90								
HUC-12: 1406	Low Flows	90-100								
Agency Creek [e]	High Flows	0-10	23.9 – 508	35.9	NA	8.262E+11	8.262E+10	2.3E+10 x q_m	(1.181E+08) - (3.65E+6x q_d)	(1.181E+08) - (3.65E+6x q_d)
Waterbody ID:	Moist Conditions	10-40	12.5 – 23.9	16.3	33.4	3.740E+11	3.740E+10		(5.345E+07) - (3.65E+6 x q_d)	(5.345E+07) - (3.65E+6 x q_d)
001_0100	Mid-Range	40-60	9.04 – 12.5	10.7	NR	2.463E+11	2.463E+10		(3.520E+07) - (3.65E+6 x q_d)	(3.520E+07) - (3.65E+6 x q_d)
	Dry Conditions	60-90	3.93 – 9.04	6.77	NR	1.557E+11	1.557E+10		(2.225E+07) - (3.65E+6 x q_d)	(2.225E+07) - (3.65E+6 x q_d)
HUC-12: 1407	Low Flows	90-100	0.380 – 3.93	2.50	NA	5.750E+10	5.750E+09		(8.218E+06) - (3.65E+6 x q_d)	(8.218E+06) - (3.65E+6 x q_d)

Table E-36. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Hiwassee River Watershed (HUC 06020002) (cont'd)

Waterbody Description (06020002____)	Hydrologic Condition			Flow[a]	PLRG	TMDL	MOS	WLAs		LAs [d]
	Flow Regime	PDFE Range	Flow Range					WWTPs[c]	MS4s[d,f]	
		[%]	[cfs]	[cfs]	[%]	[CFU/d]	[CFU/d]	[CFU/d]	[CFU/d/ac]	[CFU/d/ac]
Price Creek [e]	High Flows	0-10	4.71 – 111	7.78	NA	1.789E+11	1.789E+10	2.3E+10 x q_m	(1.390E+08) - (1.99E+7 x q_d)	(1.390E+08) - (1.99E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	2.31 – 4.71	3.00	18.9	6.900E+10	6.900E+09		(5.361E+07) - (1.99E+7 x q_d)	(5.361E+07) - (1.99E+7 x q_d)
088_0100	Mid-Range	40-60	1.65 – 2.31	1.96	29.0	4.508E+10	4.508E+09		(3.503E+07) - 1.99E+7 x q_d)	(3.503E+07) - 1.99E+7 x q_d)
	Dry Conditions	60-90	0.710 – 1.65	1.24	NR	2.852E+10	2.852E+09		(2.216E+07) - (1.99E+7 x q_d)	(2.216E+07) - (1.99E+7 x q_d)
HUC-12: 1407	Low Flows	90-100	0.070 – 0.710	0.460	NA	1.058E+10	1.058E+09		(8.221E+06) - (1.99E+7 x q_d)	(8.221E+06) - (1.99E+7 x q_d)
Gunstocker Creek [e]	High Flows	0-10	37.1 – 730	56.4	NA	1.298E+12	1.298E+11	2.3E+10 x q_m	(1.279E+08) - (2.52E+6 x q_d)	(1.279E+08) - (2.52E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	18.5 – 37.1	24.2	NR	5.564E+11	5.564E+10		(5.481E+07) - (0.52E+6 x q_d)	(5.481E+07) - (0.52E+6 x q_d)
001_0200	Mid-Range	40-60	13.2 – 18.5	15.7	27.6	3.609E+11	3.609E+10		(3.555E+07) - (2.52E+6 x q_d)	(3.555E+07) - (2.52E+6 x q_d)
	Dry Conditions	60-90	5.66 – 13.2	9.87	NR	2.270E+11	2.270E+10		(2.237E+07) - (2.52E+6 x q_d)	(2.237E+07) - (2.52E+6 x q_d)
HUC-12: 1408	Low Flows	90-100	0.550 – 5.66	3.66	NA	8.418E+10	8.418E+09		(8.293E+06) - (2.52E+6 x q_d)	(8.293E+06) - (2.52E+6 x q_d)

Notes: NA = Not Applicable. No monitoring data in flow zone.
NR = No Reduction Required.
PLRG = Percent Load Reduction Goal to achieve TMDL.
q_m = Mean Daily WWTP Discharge (cfs)
q_d = Facility (WWTP) Design Flow (cfs)
Shaded Flow Zone for each waterbody represents the critical flow zone(s). For some waterbodies, critical flow zone could not be determined. Either the waterbody had no exceedances, or exceedances only in the high flow zone. When there was no critical flow zone for the most recent cycle, the critical flow zone was determined based on the entire period of record.

a. Flow applied to TMDL, MOS, and allocation (WLA[MS4] and LA) calculations. Flows represent the midpoint value in the respective hydrologic flow regime.
b. PLRG based on geomean data.
c. WLAs for WWTPs are expressed as *E. coli* loads (CFU/day). All current and future WWTPs must meet water quality standards as specified in their NPDES permit.
d. WLAs and LAs expressed on a "per acre" basis are calculated based on the drainage area at the specific monitoring point (see Table E-3). As regulated MS4 area increases (due to future growth and/or new MS4 designation), unregulated LA area decreases by an equivalent amount. The sum will continue to equal total subwatershed area.
e. No WWTPs currently discharging into or upstream of the waterbody. (WLA[WWTPs] Expression is future growth term for new WWTPs.)
f. When there are no MS4s currently located in a subwatershed drainage area, the expression is future growth term for expanding or newly designated MS4s.

APPENDIX F

Trend Analysis for Waterbodies Impaired by *E. coli* in the Hiwassee River Watershed

In the Hiwassee River watershed, periods of record greater than 5 years (given adequate sampling frequency) were evaluated for trend analysis. For watersheds in second or successive TMDL cycles, data collected from multiple cycles were compared. If implementation efforts have been initiated to reduce loading, evaluation of routine monitoring data may indicate improving or worsening conditions over time and corresponding effectiveness of implementation efforts.

Water quality data for implementation effectiveness analysis can be presented in multiple ways. Several examples are shown in Section 9.6. Load duration curve methodology is most appropriate when monthly monitoring data, representative of all flow regimes, have been collected. However, in cases where not all flow regimes are represented, box and whisker plots may be a more appropriate method of presenting the monitoring data than a load duration curve.

Data intended for geomean analysis are grouped together for each specific 30-day period and the maximum geomean within that 30-day period is represented by a red dot. Geomean sampling can only be used to determine the condition of a given waterbody during a 30-day period and, by itself, is inadequate to determine an overall trend. Data covering a period greater than 30 days are grouped together by sampling cycle, a 12-month period usually not coincident with the calendar year. In this case, the mean of the data is represented by a white diamond. As stated in section 9.4.1, "comprehensive water quality monitoring activities include sampling during all seasons and a broad range of flow and meteorological conditions."

Twenty-seven of the impaired waterbodies had occurrences of ">2419" or ">2420". As stated in Section 9.4.1, for individual monitoring locations, where historical *E. coli* data are greater than 2419 colonies/100 mL, dilutions should be performed in order to accurately assess the magnitude of the impairment.

Only minimal monitoring data was available for Dairy Branch. However, all of the other waterbodies in the Hiwassee River watershed listed as impaired by *E. coli* had sufficient monitoring data to perform trend analysis. In most cases, the condition of the waterbody appears to be unchanged. All values are in the same general range. Improvement will be necessary before the waterbodies can re-attain water quality standards. Therefore, data for those waterbodies will not be displayed or plotted.

The conditions of the following waterbodies in the Hiwassee River watershed appear to be changing. One appears to be deteriorating while the others show slight worsening or slight improvement.

Based on analysis of data from 2007 through 2018, the condition of **Agency Creek (TN06020002001_0100)** appears to be worsening (Figures F-1 and F-2). There was only one exceedance of the single sample maximum criterion during the most recent sampling cycle, but there were no exceedances in any of the previous sampling cycles. Additional monitoring and improvement will be necessary to determine whether Agency Creek has re-attained water quality standards.

Based on analysis of data from 2008 through 2018, the condition of **Bacon Branch (TN06020002008_0100)** appears to be deteriorating over time (Figures F-3 and F-4). Over the entire period of record, only three of the 27 samples did <u>not</u> exceed the single sample maximum criterion. It is possible that the condition of Bacon Branch is not deteriorating as significantly as it appears, but that it was always poor. Samples prior to 2013 were reported as ">2419.6", but were not diluted to obtain an accurate measurement. Additional monitoring and improvement will be necessary before Bacon Branch can re-attain water quality standards.

Based on analysis of data from 2004 through 2022, the condition of **Cane Creek (TN06020002081_0100)** appears to be improving (Figures F-5 and F-6). There were no exceedances of the single sample maximum criterion during the most recent sampling cycle, but there were numerous exceedances in each of the previous sampling cycles. Additional monitoring will be necessary to determine whether Cane Creek has re-attained water quality standards.

Based on analysis of data from 2008 through 2018, the condition of **Fillauer Branch (TN06020002009_0200)** appears to be improving (Figures F-7 and F-8). There were no exceedances of the single sample maximum criterion during the most recent sampling cycle, but there were exceedances in each of the previous sampling cycles. Additional monitoring will be necessary to determine whether Fillauer Branch has re-attained water quality standards.

Based on analysis of data from 2004 through 2018, the condition of **Little North Mouse Creek (TN06020002084_0400)** appears to be worsening (Figures F-9 and F-10). There were two exceedances of the single sample maximum criterion during the most recent sampling cycle, but there were no exceedances in any of the previous sampling cycles. Additional monitoring and improvement will be necessary to determine whether Little North Mouse Creek has re-attained water quality standards.

Based on analysis of data from 2007 through 2018, the condition of **South Mouse Creek at RM 3.5 (TN06020002009_1000)** appears to be improving (Figures F-11 and F-12). There were no exceedances of the single sample maximum criterion during the 2012 and 2017-18 sampling cycles, but there were 2 exceedances in the 2007-08 sampling cycle. Additional monitoring will be necessary to determine whether this segment of South Mouse Creek has re-attained water quality standards.

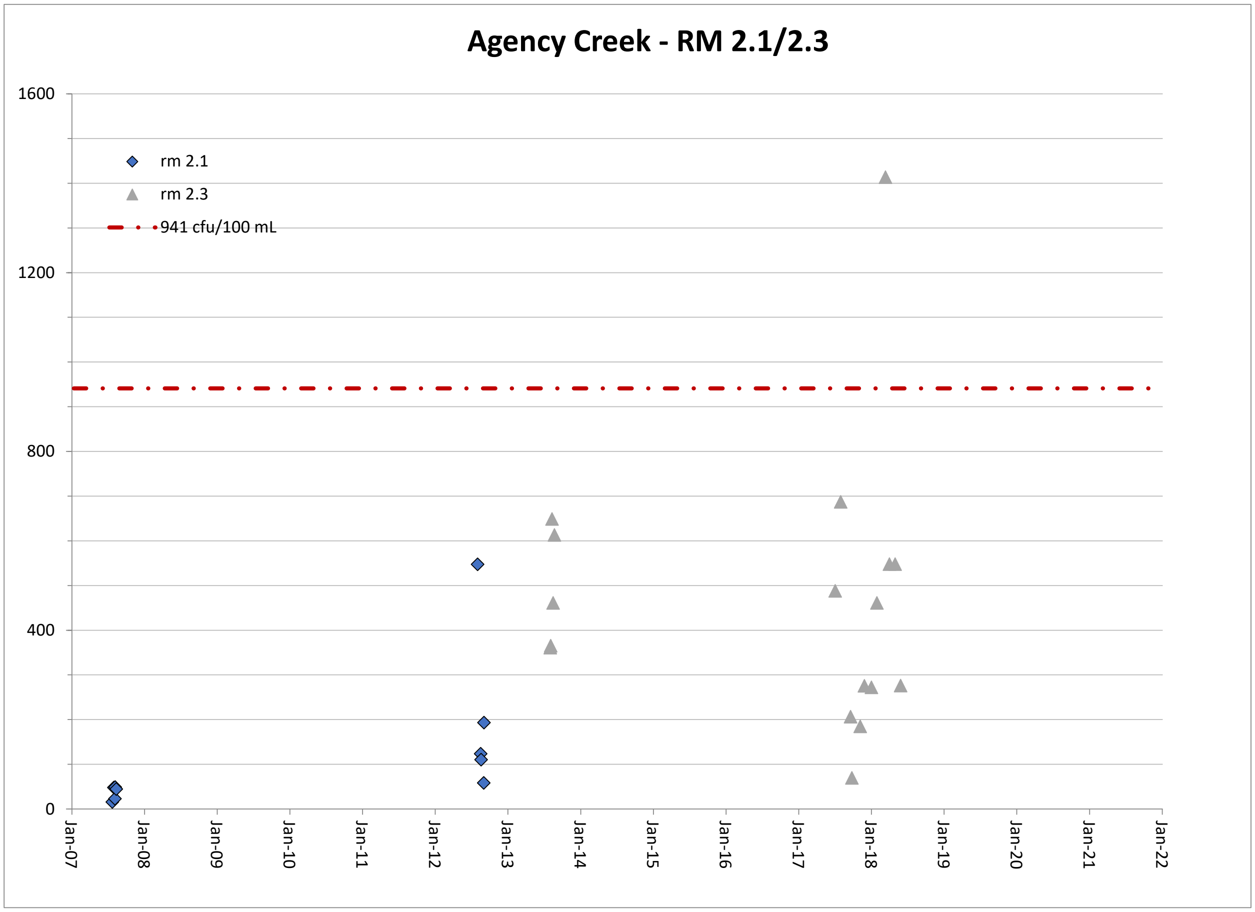

Figure F-1. Time Series Plot for Agency Creek – 2 stations

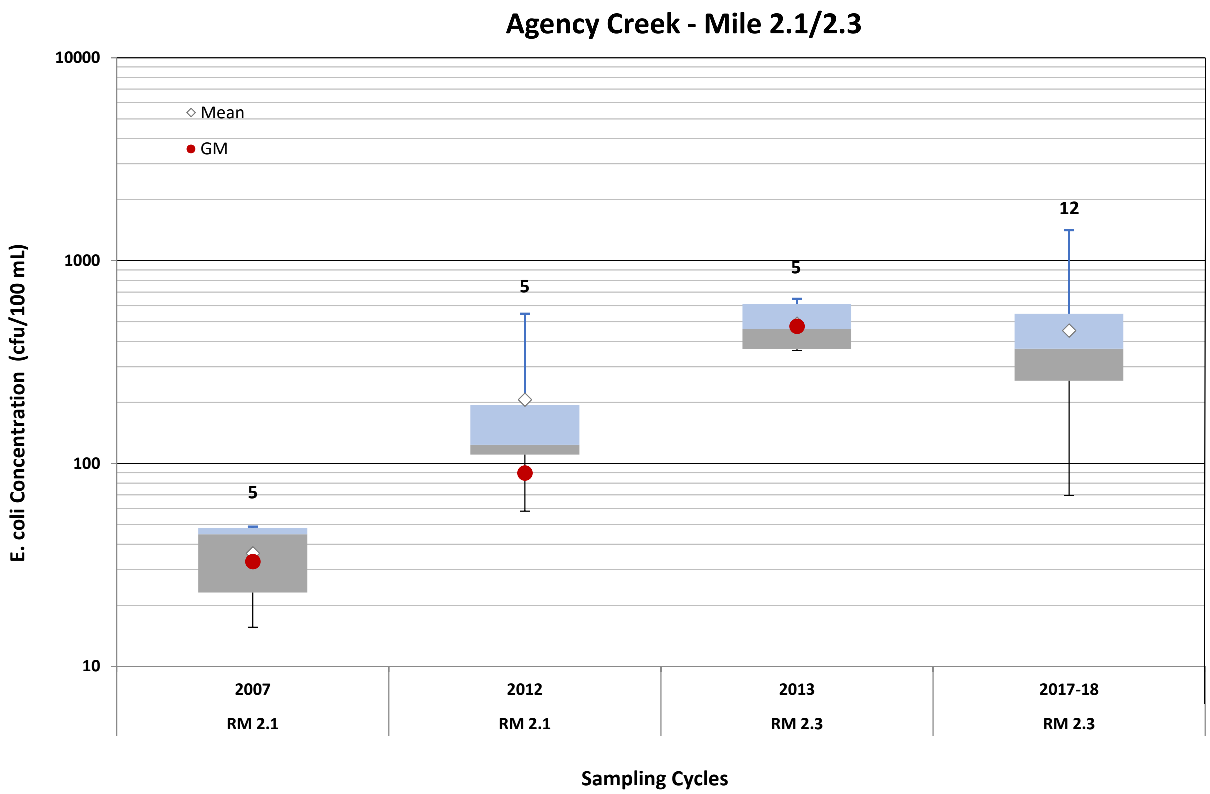

Figure F-2. Box and Whisker Plot for Agency Creek – 2 stations

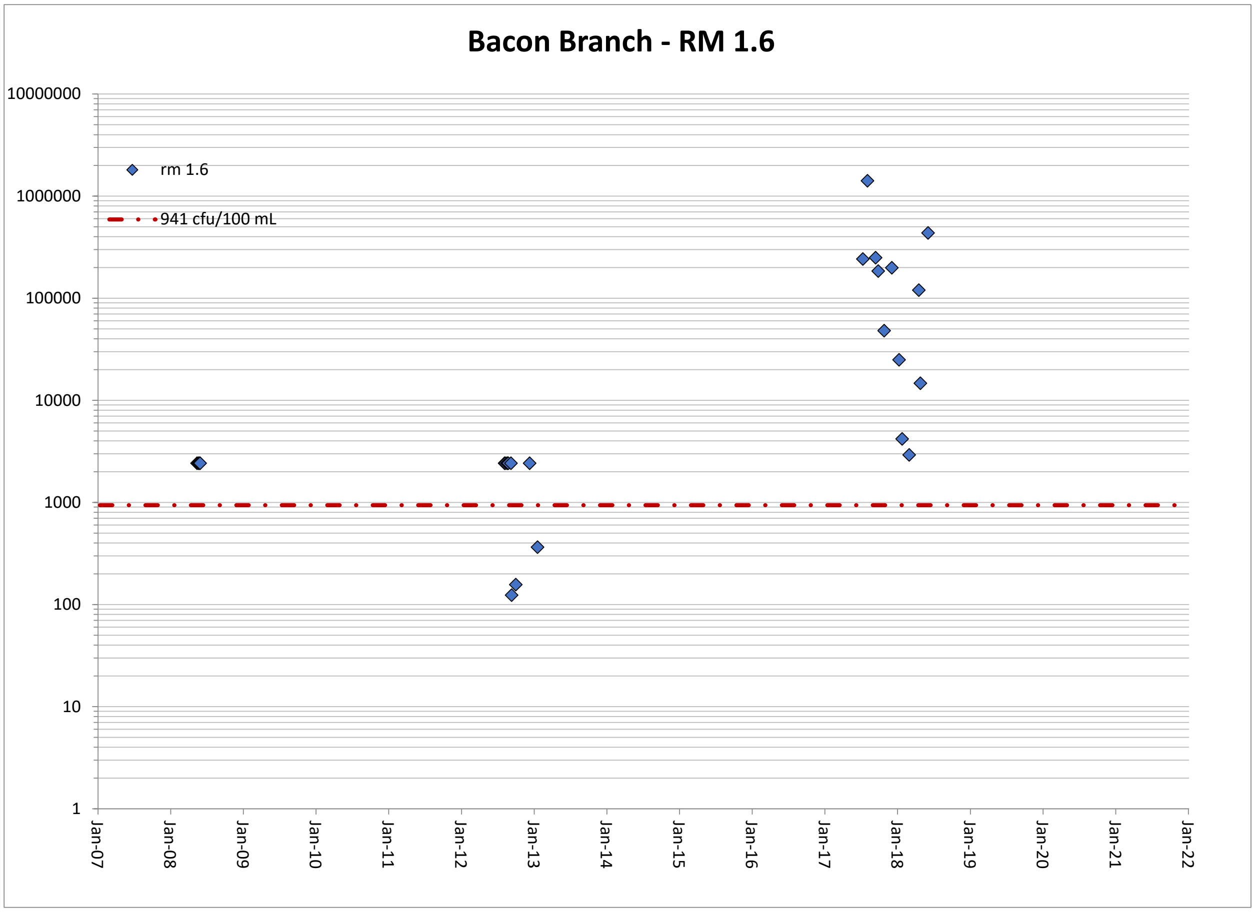

Figure F-3. Time Series Plot for Bacon Branch – RM 1.6

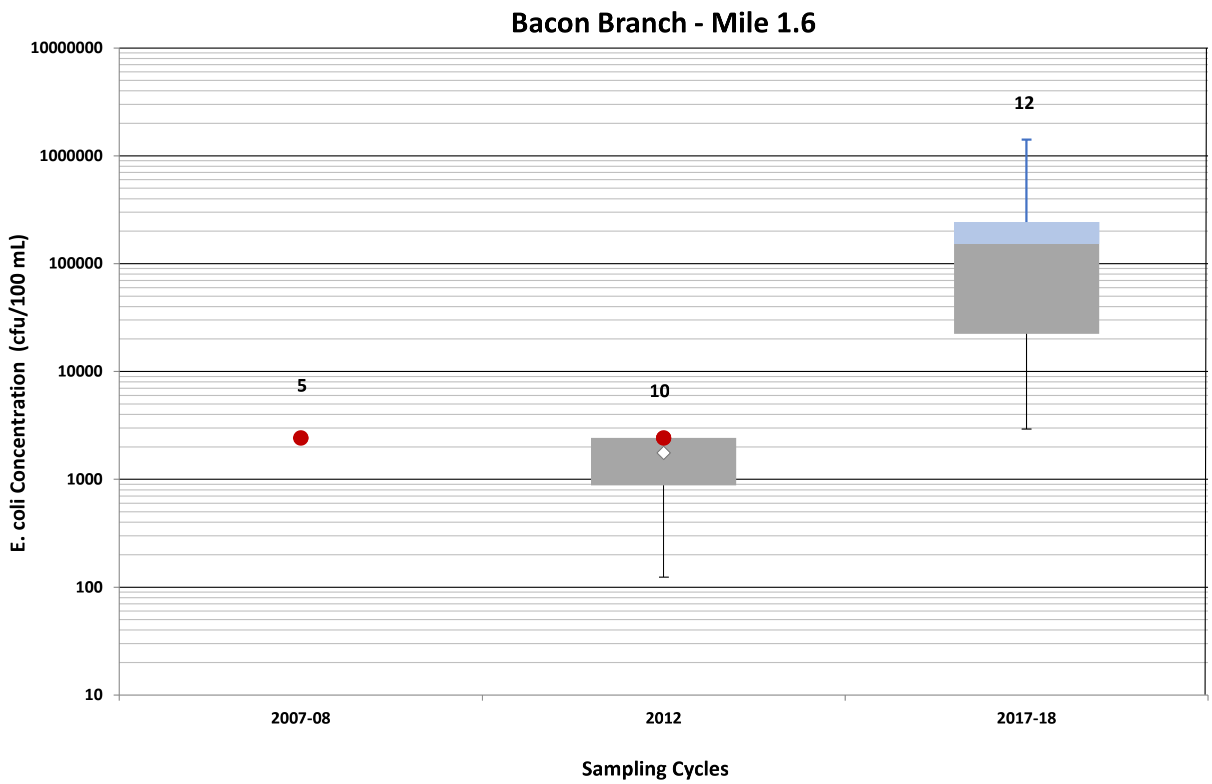

Figure F-4. Box and Whisker Plot for Bacon Branch – RM 1.6

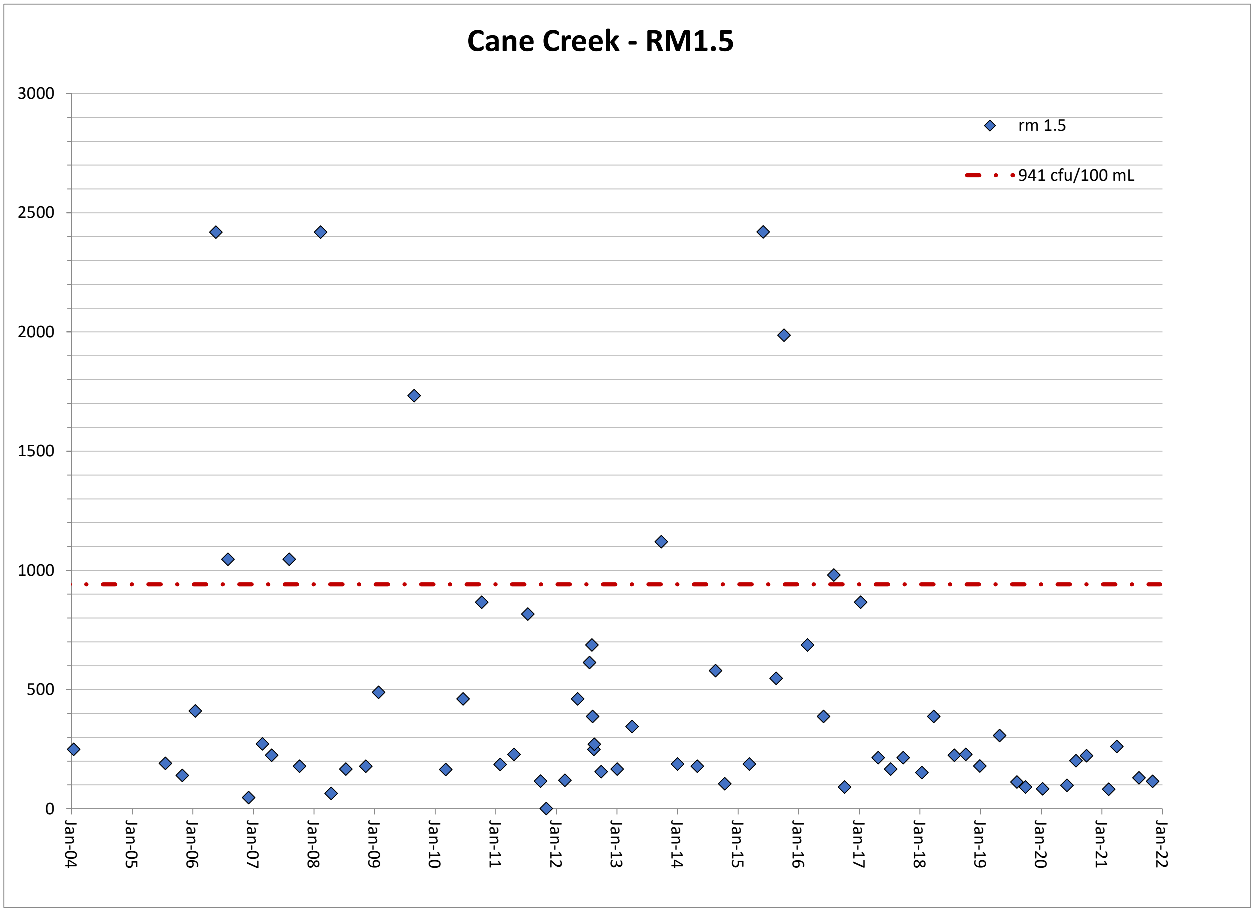

Figure F-5. Time Series Plot for Cane Creek – RM 1.5

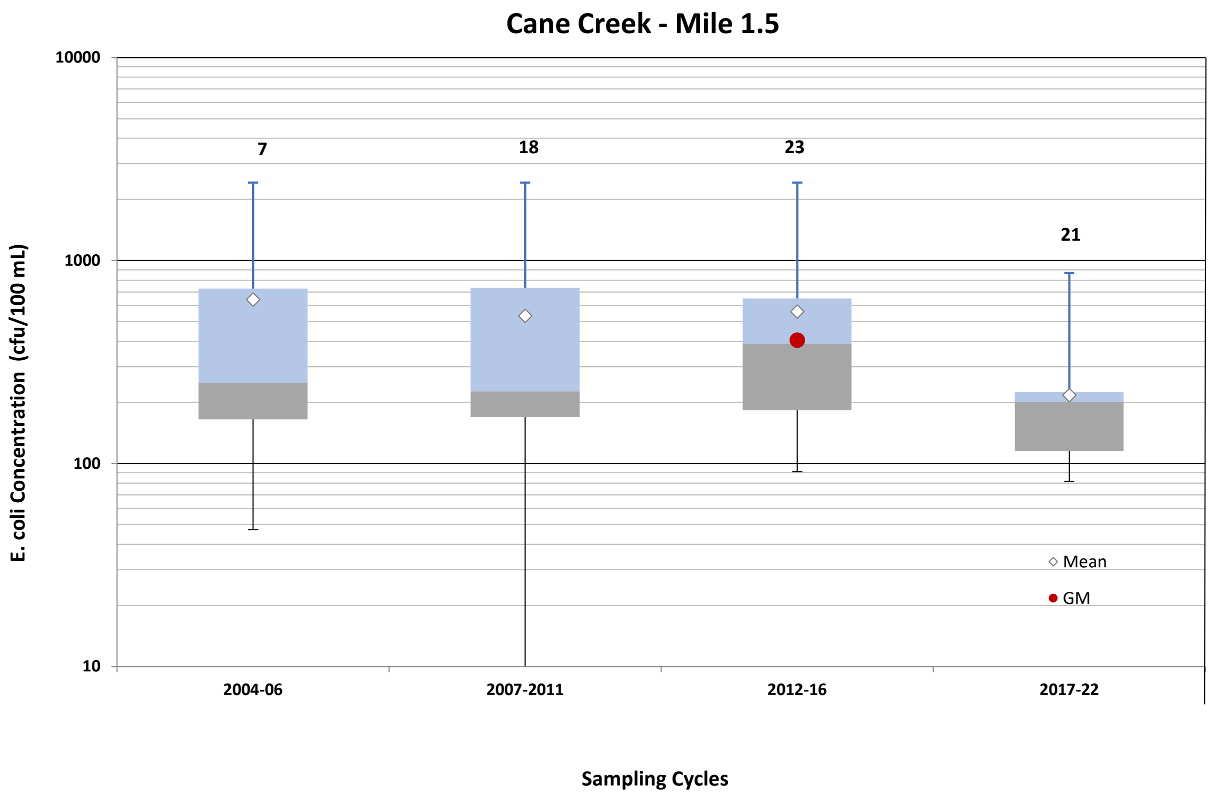

Figure F-6. Box and Whisker Plot for Cane Creek – RM 1.5

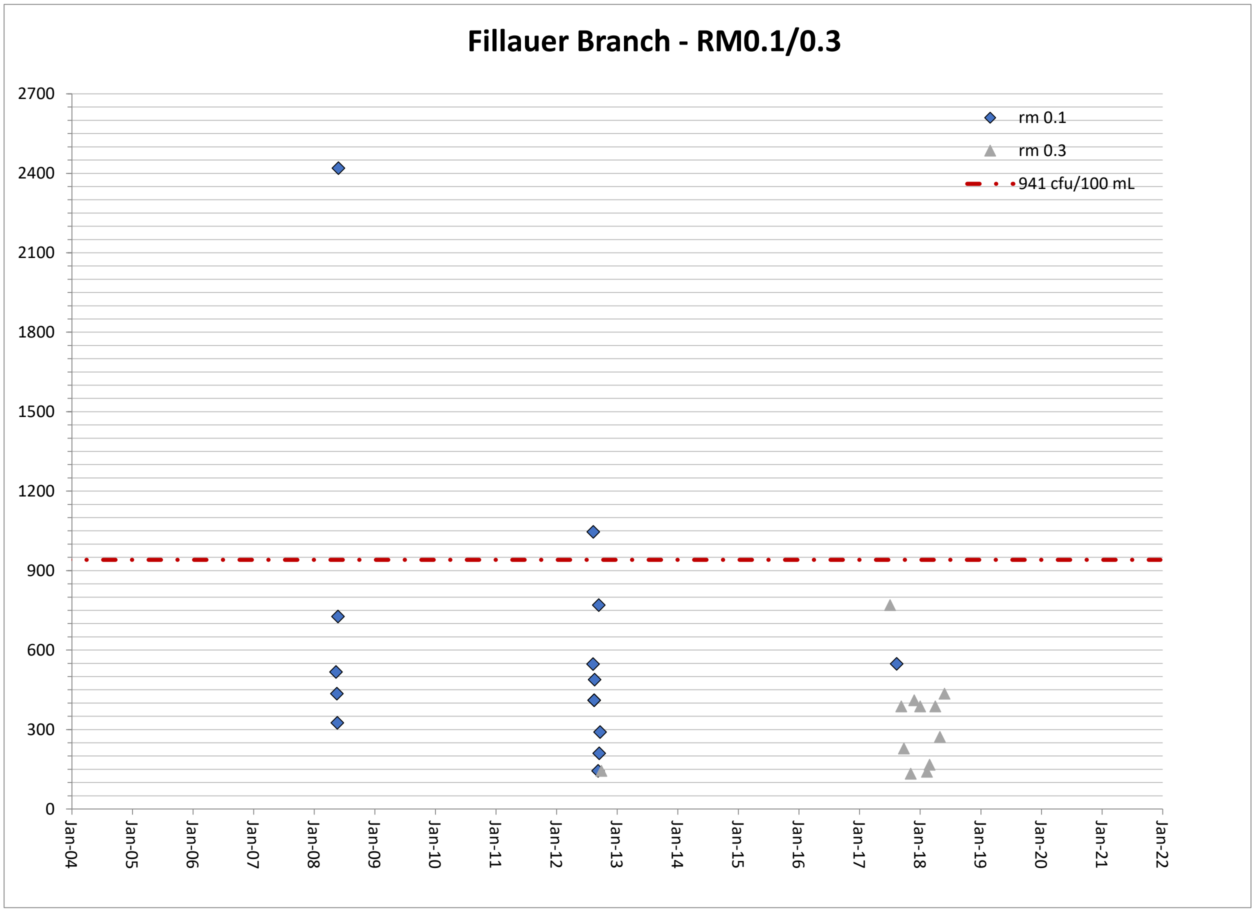

Figure F-7. Time Series Plot for Fillauer Branch – 2 stations

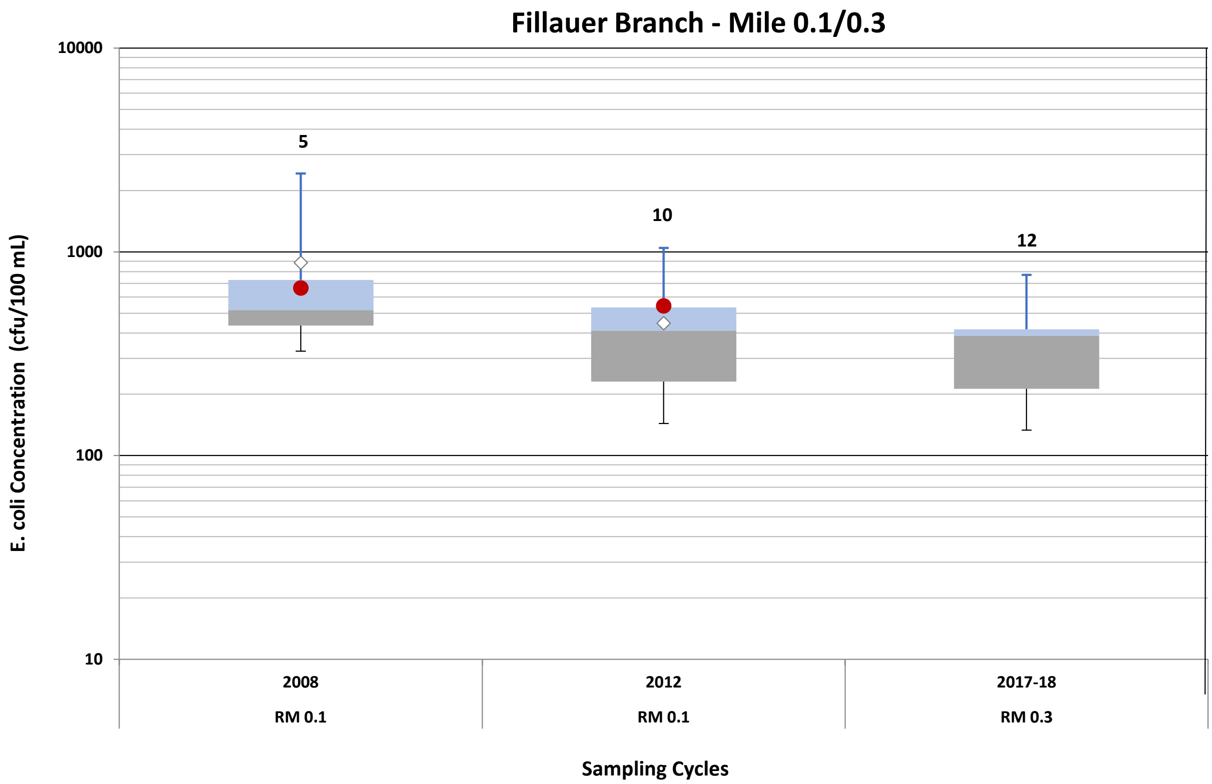

Figure F-8. Box and Whisker Plot for Fillauer Branch – 2 stations

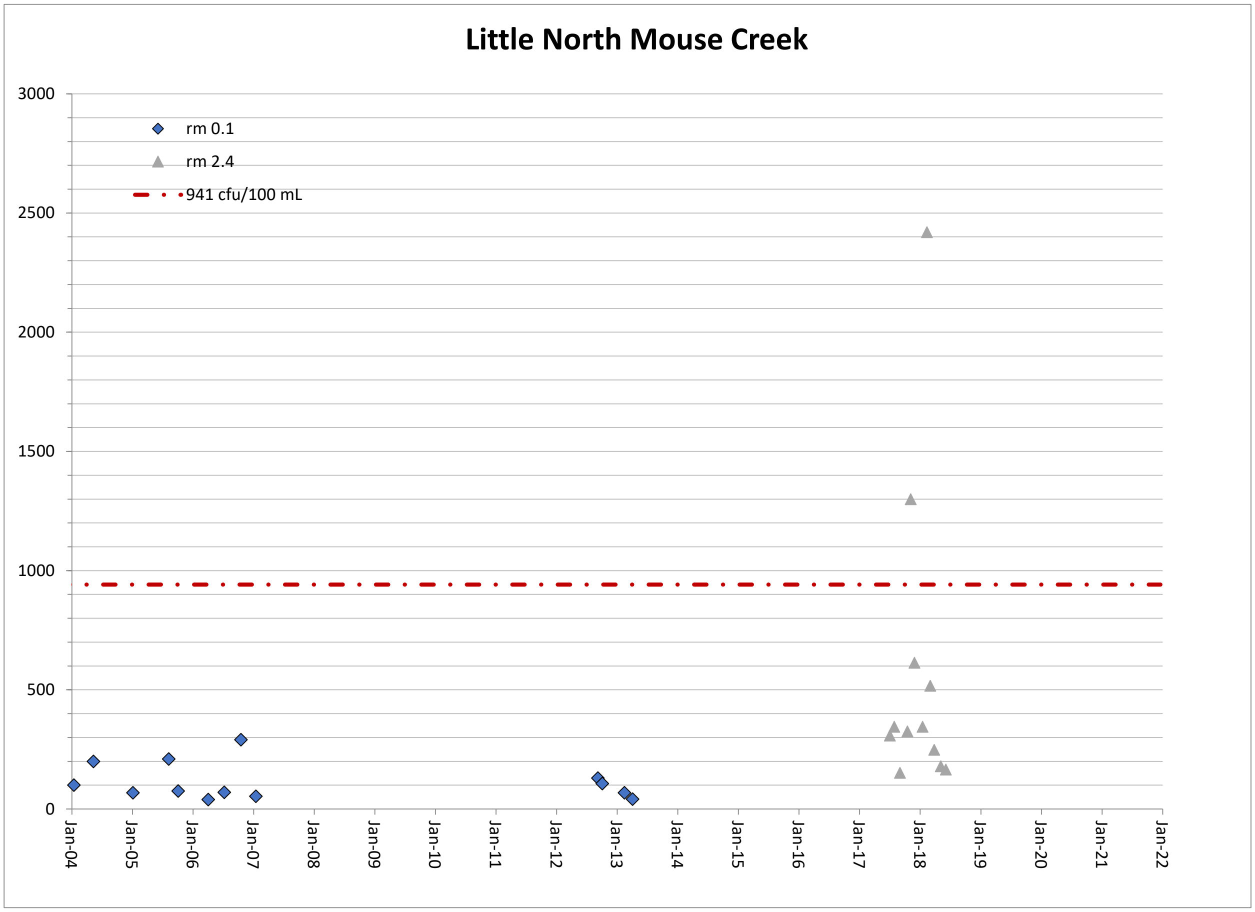

Figure F-9. Time Series Plot for Little North Mouse Creek – 2 stations

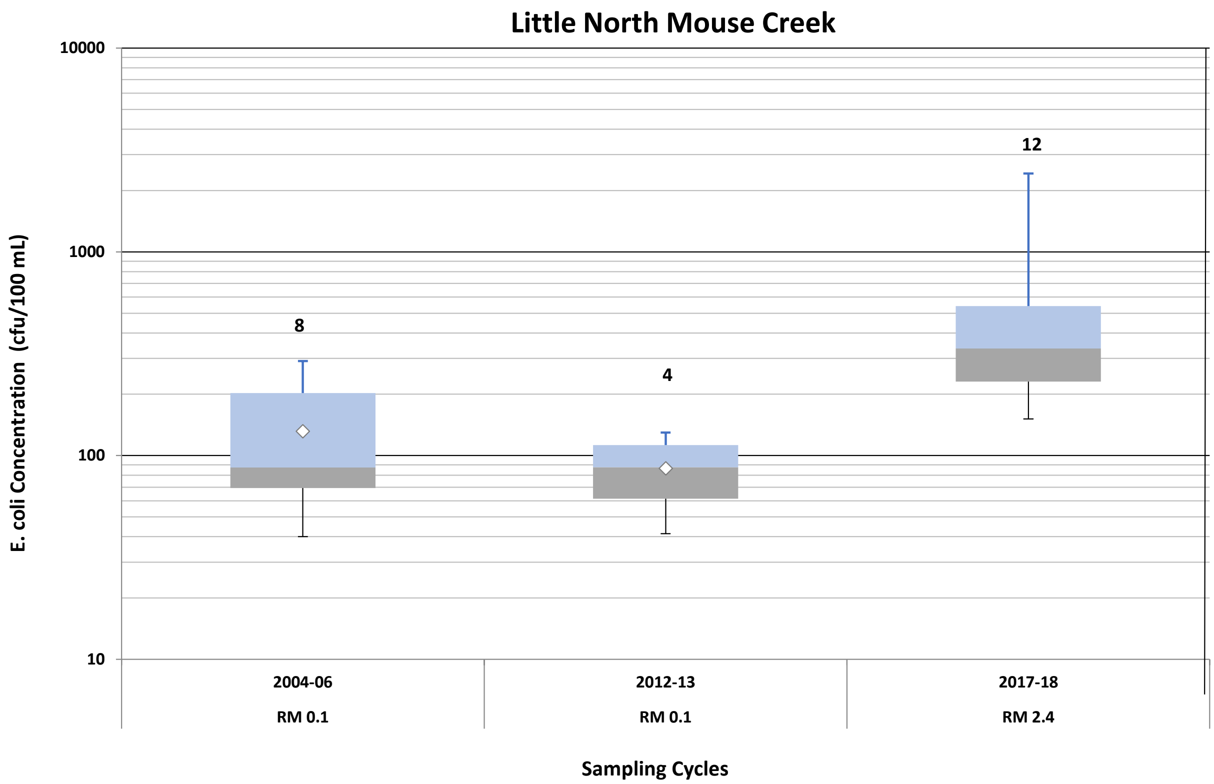

Figure F-10. Box and Whisker Plot for Little North Mouse Creek – 2 stations

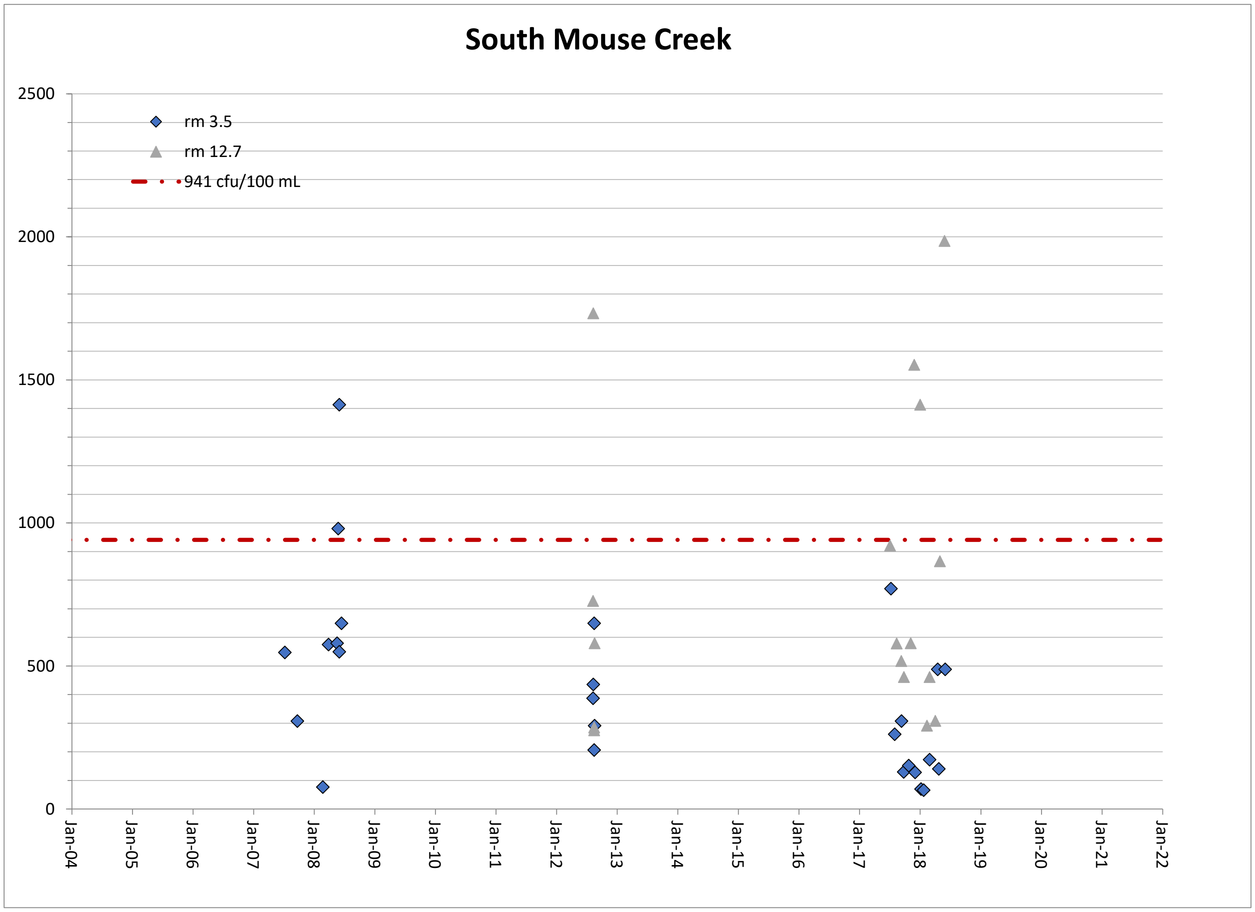

Figure F-11. Time Series Plot for South Mouse Creek – 2 stations

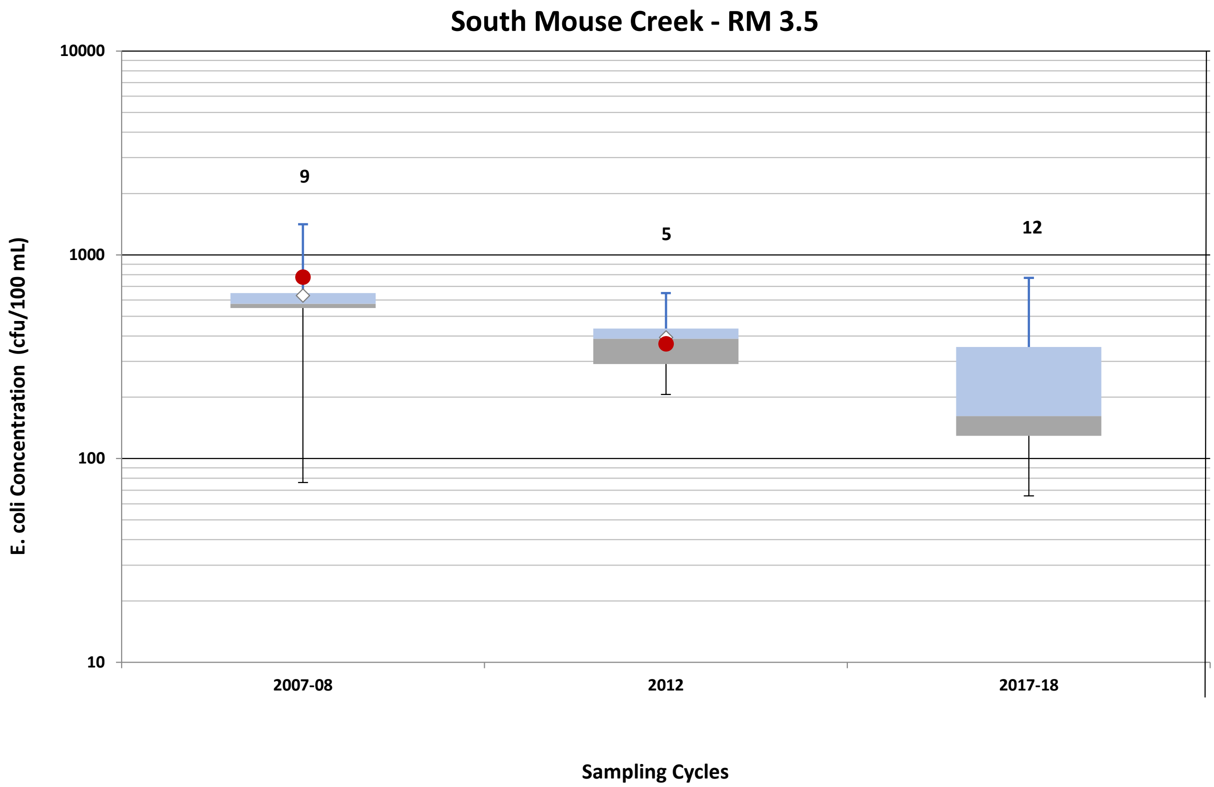

Figure F-12. Box and Whisker Plot for South Mouse Creek – RM 3.5

APPENDIX G

Protection TMDL Analysis

Waterbodies that are located within an impaired HUC-12 or drainage area, but are not currently listed as impaired, were evaluated for protection. (See Table G-1 below and Figures G-1 through G-3.) TMDLs and allocations were developed for these unimpaired (fully supporting) and unassessed waterbodies using the same methodology as for impaired waterbodies. Development of the protection TMDLs will help assure maintenance of good water quality and will maximize the likelihood of each protection waterbody meeting water quality standards in the future.

Table G-1. Waterbodies Evaluated for Protection In the Hiwassee River Watershed (HUC 06020002)

Waterbody ID	Waterbody	Assessment Status for *E. coli*
TN06020002005_0200	Taylor Branch	Not Assessed
TN06020002005_0300	Dry Creek	Not Assessed
TN06020002005_0400	Brymer Creek	Fully Supporting
TN06020002005_1200	*UT to Candies Creek*	*Not Assessed*
TN06020002005_1300	UT to Candies Creek	Fully Supporting
TN06020002005_1400	UT to Candies Creek	Not Assessed
TN06020002012_0100	Five Mile Branch	Not Assessed
TN06020002014_0100	Little South Chestuee Creek	Not Assessed
TN06020002014_0110	Carson Creek	Not Assessed
TN06020002014_0111	UT to Carson Creek	Not Assessed
TN06020002014_0200	London Branch	Not Assessed
TN06020002081_0150	Cane Creek (from UT near north city limit of Etowah to hw)	Not Assessed
TN06020002082_0310	Rocky Branch	Not Assessed
TN06020002082_0400	UT to Chestuee Creek	Not Assessed
TN06020002082_0500	Cave Springs Branch	Not Assessed
TN06020002082_0700	UT to Chestuee Creek	Not Assessed
TN06020002082_0800	Carson Branch	Not Assessed
TN06020002082_1100	Burger Branch	Not Assessed
TN06020002083_0100	UT to Oostanaula Creek	Not Assessed
TN06020002083_0200	UT to Oostanaula Creek	Not Assessed
TN06020002083_0300	Cedar Springs Branch	Fully Supporting
TN06020002083_0400	Sokey Branch	Not Assessed
TN06020002083_0600	Meadow Fork Creek	Not Assessed
TN06020002083_0610	Acre Spring Branch	Not Assessed

Table G-1 (cont'd). Waterbodies Evaluated for Protection In the Hiwassee River Watershed (HUC 06020002)

Waterbody ID	Waterbody	Assessment Status for *E. coli*
TN06020002084_0100	Blue Spring Branch	Not Assessed
TN06020002084_0300	East Fork North Mouse Creek	Not Assessed
TN06020002085_0100	Meadow Branch	Not Assessed
TN06020002085_0110	UT to Meadow Branch	Not Assessed
TN06020002087_0100	Short Creek	Not Assessed
TN06020002087_0300	Shoal Creek	Not Assessed
TN06020002087_0400	Rock Creek	Not Assessed
TN06020002087_0500	Possum Creek	Not Assessed

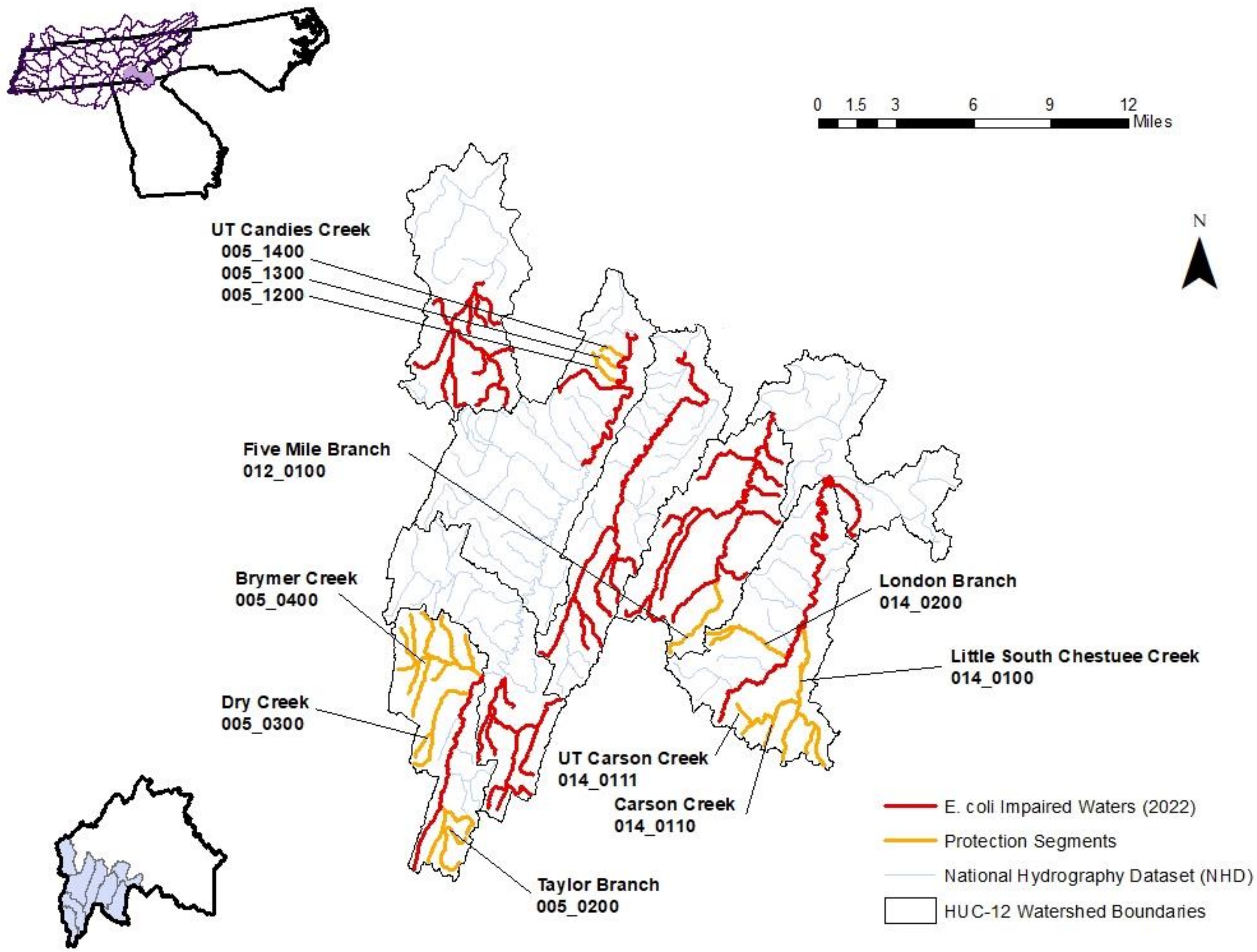

Figure G-1. Waterbodies Covered by Protection TMDLs – Part 1

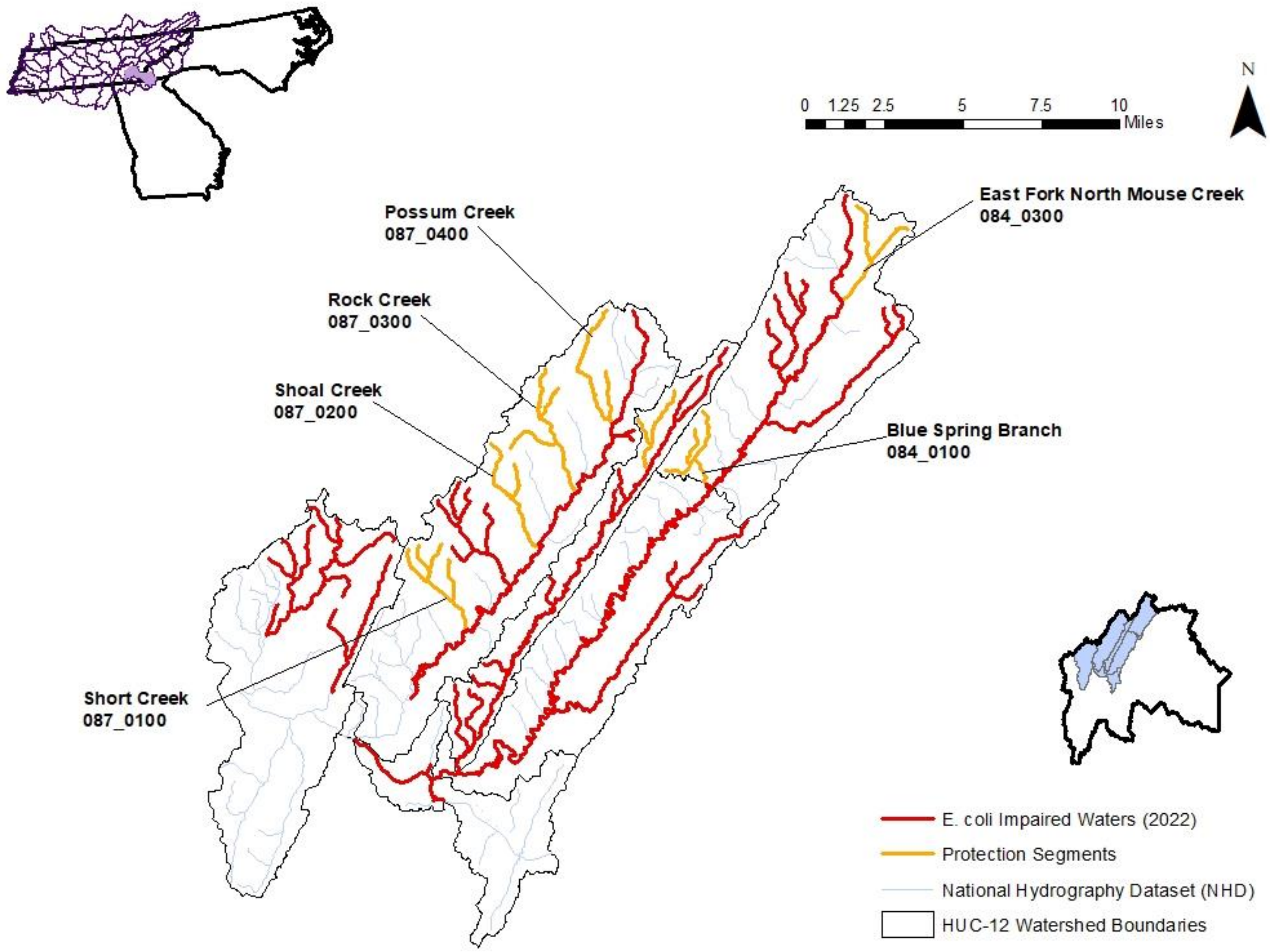

Figure G-2. Waterbodies Covered by Protection TMDLs – Part 2

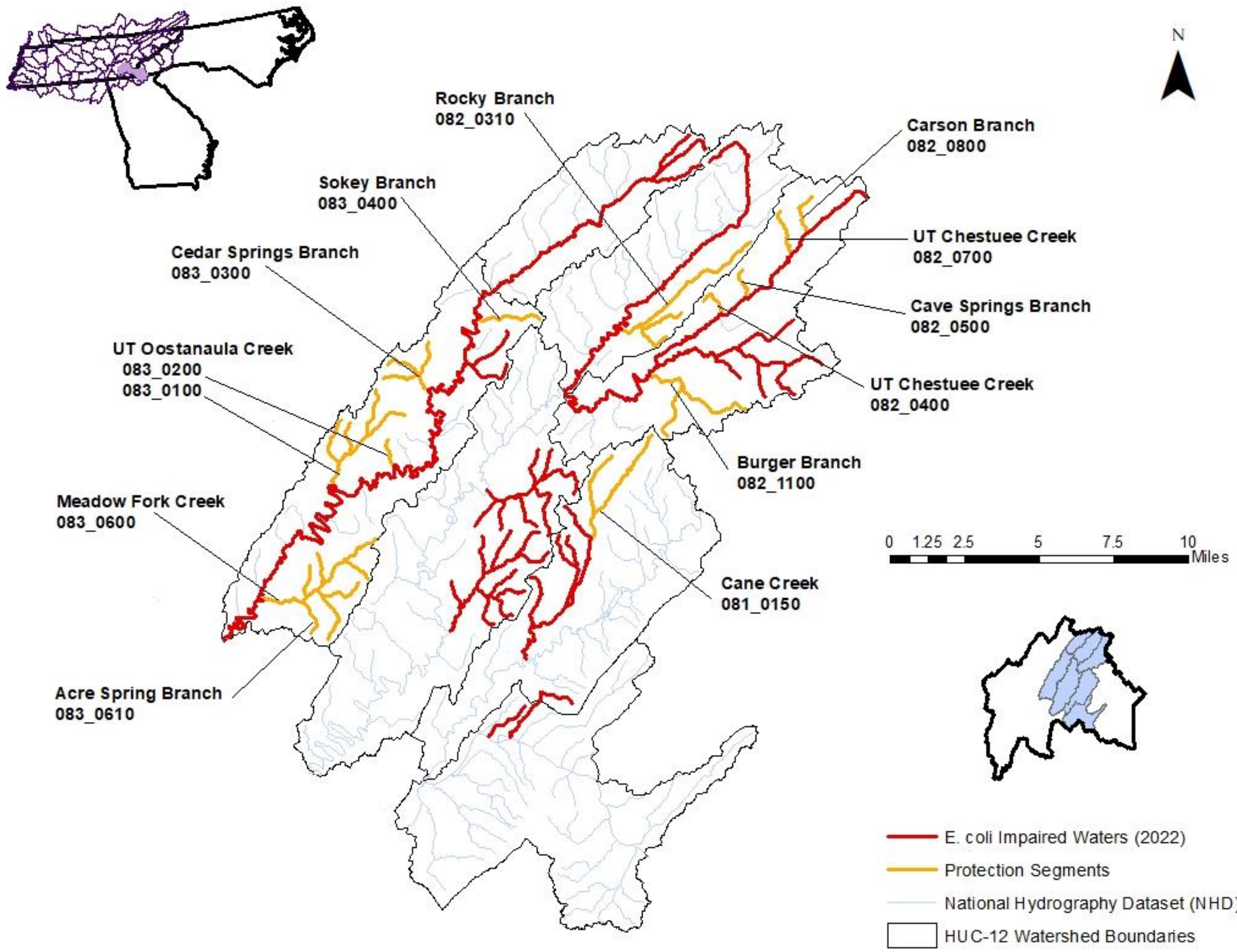

Figure G-3. Waterbodies Covered by Protection TMDLs – Part 3

Table G-2. Protection TMDLs, WLAs, & LAs for Unimpaired (Fully Supporting) and Unassessed Waterbodies Located in Impaired HUC-12s or Drainage Areas of the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Protected Waterbody Name	Protected Waterbody ID	TMDL	MOS	WLAs		LAs [c]
					WWTPs [a]	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
0802	Cane Creek [d,e]	TN06020002081_0150	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(6.346 \times 10^{6} \times Q) - (7.05 \times 10^{6} \times q_d)$	$(6.346 \times 10^{6} \times Q) - (7.05 \times 10^{6} \times q_d)$
1001	Rocky Branch [d,e]	TN06020002082_0310	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(6.436 \times 10^{6} \times Q) - (7.15 \times 10^{6} \times q_d)$	$(6.436 \times 10^{6} \times Q) - (7.15 \times 10^{6} \times q_d)$
1002	UT to Chestuee Creek [d,e]	TN06020002082_0400	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(4.103 \times 10^{7} \times Q) - (4.56 \times 10^{7} \times q_d)$	$(4.103 \times 10^{7} \times Q) - (4.56 \times 10^{7} \times q_d)$
	Cave Springs Branch [d,e]	TN06020002082_0500				$(4.526 \times 10^{7} \times Q) - (5.03 \times 10^{7} \times q_d)$	$(4.526 \times 10^{7} \times Q) - (5.03 \times 10^{7} \times q_d)$
	UT to Chestuee Creek [d,e]	TN06020002082_0700				$(2.468 \times 10^{7} \times Q) - (2.74 \times 10^{7} \times q_d)$	$(2.468 \times 10^{7} \times Q) - (2.74 \times 10^{7} \times q_d)$
	Carson Branch [d,e]	TN06020002082_0800				$(1.815 \times 10^{7} \times Q) - (2.02 \times 10^{7} \times q_d)$	$(1.815 \times 10^{7} \times Q) - (2.02 \times 10^{7} \times q_d)$
	Burger Branch [d,e]	TN06020002082_1100				$(5.558 \times 10^{6} \times Q) - (6.18 \times 10^{6} \times q_d)$	$(5.558 \times 10^{6} \times Q) - (6.18 \times 10^{6} \times q_d)$
1102	UT to Oostanaula Creek [d,e]	TN06020002083_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(6.386 \times 10^{6} \times Q) - (7.10 \times 10^{6} \times q_d)$	$(6.386 \times 10^{6} \times Q) - (7.10 \times 10^{6} \times q_d)$
	UT to Oostanaula Creek [d,e]	TN06020002083_0200				$(9.732 \times 10^{7} \times Q) - (1.08 \times 10^{8} \times q_d)$	$(9.732 \times 10^{7} \times Q) - (1.08 \times 10^{8} \times q_d)$
	Cedar Springs Branch [d,e]	TN06020002083_0300				$(9.520 \times 10^{6} \times Q) - (1.06 \times 10^{7} \times q_d)$	$(9.520 \times 10^{6} \times Q) - (1.06 \times 10^{7} \times q_d)$
	Sokey Branch [d,e]	TN06020002083_0400				$(2.275 \times 10^{7} \times Q) - (2.53 \times 10^{7} \times q_d)$	$(2.275 \times 10^{7} \times Q) - (2.53 \times 10^{7} \times q_d)$
	Meadow Fork Creek [d,e]	TN06020002083_0600				$(4.341 \times 10^{6} \times Q) - (4.82 \times 10^{6} \times q_d)$	$(4.341 \times 10^{6} \times Q) - (4.82 \times 10^{6} \times q_d)$
	Acre Spring Branch [d,e]	TN06020002083_0610				$(2.717 \times 10^{7} \times Q) - (3.02 \times 10^{7} \times q_d)$	$(2.717 \times 10^{7} \times Q) - (3.02 \times 10^{7} \times q_d)$
1201	Blue Spring Branch [d,e]	TN06020002084_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.283 \times 10^{7} \times Q) - (1.43 \times 10^{7} \times q_d)$	$(1.283 \times 10^{7} \times Q) - (1.43 \times 10^{7} \times q_d)$
	E. Fork North Mouse Creek [d,e]	TN06020002084_0300				$(7.929 \times 10^{6} \times Q) - (8.81 \times 10^{6} \times q_d)$	$(7.929 \times 10^{6} \times Q) - (8.81 \times 10^{6} \times q_d)$
1202	Meadow Branch [d,e]	TN06020002085_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.916 \times 10^{7} \times Q) - (2.13 \times 10^{7} \times q_d)$	$(1.916 \times 10^{7} \times Q) - (2.13 \times 10^{7} \times q_d)$
	UT to Meadow Branch [d,e]	TN06020002085_0110				$(8.564 \times 10^{7} \times Q) - (9.52 \times 10^{7} \times q_d)$	$(8.564 \times 10^{7} \times Q) - (9.52 \times 10^{7} \times q_d)$

Table G-2 (cont'd). Protection TMDLs, WLAs, & LAs for Unimpaired (Fully Supporting) and Unassessed Waterbodies Located in Impaired HUC-12s or Drainage Areas of the Hiwassee River Watershed (HUC 06020002)

HUC-12 Subwatershed (06020002__)	Protected Waterbody Name	Protected Waterbody ID	TMDL	MOS	WLAs		LAs [c]
					WWTPs [a]	MS4s [b,c,f]	
			[CFU/day]	[CFU/day]	[CFU/day]	[CFU/d/ac]	[CFU/d/ac]
1301	Taylor Branch [d,e]	TN06020002005_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(8.809 \times 10^6 \times Q) - (9.79 \times 10^6 \times q_d)$	$(8.809 \times 10^6 \times Q) - (9.79 \times 10^6 \times q_d)$
	Dry Creek [d,e]	TN06020002005_0300				$(8.427 \times 10^6 \times Q) - (9.36 \times 10^6 \times q_d)$	$(8.427 \times 10^6 \times Q) - (9.36 \times 10^6 \times q_d)$
	Brymer Creek [d,e]	TN06020002005_0400				$(3.380 \times 10^6 \times Q) - (3.76 \times 10^6 \times q_d)$	$(3.380 \times 10^6 \times Q) - (3.76 \times 10^6 \times q_d)$
1303	UT to Candies Creek [d,e]	TN06020002005_1200	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(2.729 \times 10^7 \times Q) - (3.03 \times 10^7 \times q_d)$	$(2.729 \times 10^7 \times Q) - (3.03 \times 10^7 \times q_d)$
	UT to Candies Creek [d,e]	TN06020002005_1300	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(7.877 \times 10^7 \times Q) - (8.75 \times 10^7 \times q_d)$	$(7.877 \times 10^7 \times Q) - (8.75 \times 10^7 \times q_d)$
	UT to Candies Creek [d,e]	TN06020002005_1400				$(6.137 \times 10^7 \times Q) - (6.82 \times 10^7 \times q_d)$	$(6.137 \times 10^7 \times Q) - (6.82 \times 10^7 \times q_d)$
1401	Little South Chestuee Creek [d,e]	TN06020002014_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(3.250 \times 10^6 \times Q) - (3.61 \times 10^6 \times q_d)$	$(3.250 \times 10^6 \times Q) - (3.61 \times 10^6 \times q_d)$
	Carson Creek [d,e]	TN06020002014_0110				$(9.806 \times 10^7 \times Q) - (1.09 \times 10^7 \times q_d)$	$(9.806 \times 10^7 \times Q) - (1.09 \times 10^7 \times q_d)$
	UT to Carson Creek [d,e]	TN06020002014_0111				$(7.273 \times 10^7 \times Q) - (8.08 \times 10^7 \times q_d)$	$(7.273 \times 10^7 \times Q) - (8.08 \times 10^7 \times q_d)$
	London Branch [d,e]	TN06020002014_0200				$(9.015 \times 10^6 \times Q) - (1.00 \times 10^7 \times q_d)$	$(9.015 \times 10^6 \times Q) - (1.00 \times 10^7 \times q_d)$
1402	Five Mile Branch [d,e]	TN06020002012_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(7.684 \times 10^6 \times Q) - (8.54 \times 10^6 \times q_d)$	$(7.684 \times 10^6 \times Q) - (8.54 \times 10^6 \times q_d)$
1405	Short Creek [d,e]	TN06020002087_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(7.552 \times 10^6 \times Q) - (8.39 \times 10^6 \times q_d)$	$(7.552 \times 10^6 \times Q) - (8.39 \times 10^6 \times q_d)$
	Shoal Creek [d,e]	TN06020002087_0300				$(8.132 \times 10^6 \times Q) - (9.04 \times 10^6 \times q_d)$	$(8.132 \times 10^6 \times Q) - (9.04 \times 10^6 \times q_d)$
	Rock Creek [d,e]	TN06020002087_0400				$(6.273 \times 10^6 \times Q) - (6.97 \times 10^6 \times q_d)$	$(6.273 \times 10^6 \times Q) - (6.97 \times 10^6 \times q_d)$
	Possum Creek [d,e]	TN06020002087_0500				$(6.798 \times 10^6 \times Q) - (7.55 \times 10^6 \times q_d)$	$(6.798 \times 10^6 \times Q) - (7.55 \times 10^6 \times q_d)$

Table G-2 (cont'd). Protection TMDLs, WLAs, & LAs for Unimpaired (Fully Supporting) and Unassessed Waterbodies Located in Impaired HUC-12s or Drainage Areas of the Hiwassee River Watershed (HUC 06020002)

Notes: Q = Mean Daily In-stream Flow (cfs).
q_m = Mean Daily WWTP Flow (cfs)
q_d = Facility (WWTP) Design Flow (cfs)

a. WLAs for WWTPs are expressed as *E. coli* loads (CFU/day). All current and future WWTPs must meet water quality standards as specified in their NPDES permit.
b. Applies to any MS4 discharge loading in the subwatershed. Future MS4s will be assigned waste load allocations (WLAs) consistent with load allocations (LAs) assigned to precipitation induced nonpoint sources. Implementation is discussed in Section 9.2.2.
c. WLAs and LAs expressed as a "per acre" load are calculated based on the drainage area at the pour point of the HUC-12 subwatershed or drainage area. As regulated MS4 area increases (due to future growth and/or new MS4 designation), unregulated LA area decreases by an equivalent amount. The sum will continue to equal total subwatershed area.
d. Waterbody Drainage Area (DA) is not coincident with HUC-12(s).
e. No WWTPs currently discharging into or upstream of the waterbody. (WLA[WWTPs] Expression is future growth term for new WWTPs.)
f. When there are no MS4s currently located in a subwatershed drainage area, the expression is a future growth term for expanding or newly designated MS4s.

APPENDIX H

Public Notice Announcement

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR E. COLI IN THE HIWASSEE RIVER WATERSHED (HUC 06020002), TENNESSEE

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

A number of waterbodies in the Hiwassee River watershed are listed on Tennessee's Final 2022 List of Impaired Waters as not supporting designated use classifications due, in part, to grazing in riparian or shoreline zones and sanitary sewer overflows. The TMDL utilizes Tennessee's general water quality criteria, continuous flow data from a USGS discharge monitoring station located in proximity to the watershed, site specific water quality monitoring data, a calibrated hydrologic model, load duration curves, and an appropriate Margin of Safety (MOS) to establish allowable loadings of pathogens which will result in the reduced in-stream concentrations and attainment of water quality standards. The TMDL requires reductions of E. coli loading on the order of 4.0-99.2% in the listed waterbodies.

The Hiwassee River E. coli TMDL may be downloaded from the Department of Environment and Conservation website:

https://www.tn.gov/environment/program-areas/wr-water-resources/watershed-stewardship/tennessee-s-total-maximum-daily-load--tmdl--program.html

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

Vicki S. Steed, P.E., Watershed Planning Unit
Telephone: 615-532-0707 / Vicki.Steed@tn.gov

Dennis Borders, P.E., Watershed Planning Unit
Telephone: 615-532-0706 / Dennis.Borders@tn.gov

Persons wishing to comment on the proposed TMDLs are invited to submit their comments in writing no later than
March 7, 2023 to:

Department of Environment and Conservation
Division of Water Resources
Watershed Planning Unit
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, TN 37243

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 Resources, William R. Snodgrass Tennessee Tower, 312 Rosa L. Parks Avenue, 11th Floor, Nashville, Tennessee 37243. They may be inspected during normal office hours. Copies of the information on file are available on request.

APPENDIX I

Public Comments Received

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL DIVISION
ENVIRONMENTAL COMPLIANCE OFFICE
SUITE 900, JAMES K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-1402
(615) 741-3655

BUTCH ELEY
DEPUTY GOVERNOR &
COMMISSIONER OF TRANSPORTATION

BILL LEE
GOVERNOR

March 3, 2023

Vicki Steed, P.E.
Tennessee Department of Environment and Conservation
Division of Water Resources
Watershed Management Unit
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, TN 37243

Re: Comments on Proposed E. Coli Total Maximum Daily Load for the Hiwassee River Watershed

TDEC has recently issued a draft document for public comment presenting a proposed Total Maximum Daily Load (TMDL) analysis for E. coli in the Hiwassee River Watershed (HUC 06020002). The Tennessee Department of Transportation (TDOT) Municipal Separate Storm Sewer System (MS4) regulated under NPDES Individual Permit TNS077585 respectfully submits the following comments regarding that document.

In Section 7.1.2 of the subject document, the TDOT MS4 is included as a MS4 point source for the pollutant loading that is the subject of the proposed TMDL. TDOT would like to provide the following comments in order to clarify several issues that TDOT perceives could arise from the TMDL document and propose modifications to the document to reduce the likelihood of future impacts to the TDOT MS4 with regard to the subject TMDL. Compliance with both the MS4 permit and the regulations governing storm water management is a top priority for TDOT. TDOT respectfully requests that TDEC provide a specific response to each enumerated comment so that TDOT can fully understand the TMDL development process utilized by TDEC and adapt our approach to the MS4 Permit compliance program accordingly. This assistance would ensure that the Permitting Agency and the Permittee are following the established U.S. EPA guidance for reviewing TMDL documents, which states: "*EPA policy is that there should be full and meaningful public participation in the TMDL development process*."

TDOT comments and questions specific to this TMDL document include:

1. **Discharges from the TDOT MS4 are not presented in the document as a significant possible pollutant source.** Table 3 (pages 10-13) lists the significant pollutant sources for the various subwatersheds. These include: Grazing in Riparian or Shoreline Zones; Animal Feeding Operations; and/or Sanitary Sewer Overflows. Obviously, none of these pollutant sources could be attributed to the TDOT MS4. TDOT requests that this point be made clear in Section 7.1.2 of the document which is the Source Assessment for NPDES Regulates MS4s. TDOT continues to be concerned that its inclusion in this TMDL document as a point source of contamination could be used by third-party Citizen's Groups (e.g. watershed associations, environmental activist groups) to

sue TDEC and/or TDOT and force implementation of expensive and unnecessary monitoring and control measures in this watershed.

2. **TDOT MS4 permit required stormwater sampling has demonstrated that post-construction highway run-off from the TDOT MS4 is not a significant source of pathogen contamination in receiving streams.** In compliance with MS4 permit requirements, the TDOT stormwater program has been acquiring and analyzing samples of post-construction stormwater runoff from state highways and facilities over the past 15 years. These samples have been acquired from a variety of highway scenarios across the State, ranging from high traffic volume interstate highways in urban/commercial areas, to low traffic volume highways in rural agricultural areas. TDOT has also sponsored research by the University of Tennessee – Knoxville (UTK) under the direction of Professor Qiang He. Professor He's team sampled stormwater discharges from the TDOT MS4 and pathogen impaired stream segments upstream and downstream from the TDOT stormwater discharge points. These samples were evaluated using bacterial source tracking methods at the UTK laboratories for E. coli and other water quality parameters. Preliminary results from the UTK study came to the following conclusion:

> "*The separation of roadway runoff samples from stream samples indicates that the* ***microbial community composition in the stormwater runoff was significantly different from that of the stream water****, suggesting that the* ***receiving stream was not impacted significantly by the stormwater runoff from the roadways****. These results are in support of previous observations that the* ***roadway stormwater runoff was not a primary contributor of pollutant loading to the stream****.*"

Dr. He's team has continued to investigate the use of indicator organisms (such as E.coli) to evaluate the presence of human fecal pollution in stormwater runoff. Organisms previously assumed to be specifically associated with fecal materials have been found to survive and grow in non-fecal environments. Therefore, it is problematic to use the detection of indicator organisms as a tool to evaluate fecal contamination of stormwater runoff. To overcome this problem, the composition of all bacterial constituents in stormwater samples (i.e. community fingerprints) were used as a collective marker. The community fingerprints of stormwater samplers were compared with those representative of human fecal materials (i.e. residential sewage) to determine the potential contribution of human fecal sources to the microbial loading in runoff from the TDOT right-of-way (ROW). Preliminary findings from the use of the microbial fingerprinting techniques at existing TDOT ROW runoff sampling sites and receiving streams suggest that the presence of indicator organisms in TDOT MS4 stormwater could not necessarily be attributed to fecal contamination with public health implications.

Professor He's investigation results have not yet been published, but the existing internal reporting can be made available to TDEC upon request. In Section 9.4.2 of the subject TMDL document, TDEC recognizes the value of this type of microbial source tracking (MST) in the identification of the actual source(s) of contamination; however, it does not appear this methodology has been included in the evaluation of the Hiwassee River Watershed or other recent TMDL analyses. TDOT encourages TDEC to consider the use of this technology to determine the actual source(s) of the pathogen contamination in these watersheds so that the finite remedial action resources available to the State of Tennessee can be properly apportioned to target specific problem areas. TDOT would be happy to share our experience and technical knowledge gained from this research to assist TDEC. TDOT believes that incorporation of these methods and approaches into the TMDL program would be beneficial in ensuring an ongoing state-of-the-art TMDL sampling and analysis program which uses the most current and insightful methods to understand and identify the actual source(s) of contamination in pathogen impaired watersheds. The U.S. EPA also encourages the use of microbial source tracking in multiple guidance documents, including:

- Using Microbial Source Tracking to Support TMDL Development and Implementation, U.S. Environmental Protection Agency, Region 10, https://www.epa.gov/sites/production/files/2015-07/documents/mst_for_tmdls_guide_04_22_11.pdf
- Microbial Source Tracking Guide Document. U.S. Environmental Protection Agency, Washington, D.C., EPA/600/R-05/064. https://nepis.epa.gov/Exe/ZyPDF.cgi/2000D20V.PDF?Dockey=2000D20V.PDF

Based upon the available information, TDOT is unaware of any additional stormwater sampling efforts undertaken by TDEC, in the subject watershed, or any other watershed in Tennessee, which would conclusively demonstrate that post-construction TDOT MS4 stormwater discharges are actually a threat to water quality or a known pollutant source in this watershed. If no additional data or other supporting documentation exists that demonstrates post-construction stormwater discharges are a threat to water quality or a known pollutant source, TDOT respectfully requests that the TDOT MS4 not be included in Section 7.1.2 of the subject document where the TDOT MS4 is identified as the only listed MS4 point sources for the pollutant loading that is the subject of the TMDL.

3. **TDOT believes that the drainage area of the TDOT MS4 which contributes to the subject watershed is a negligible portion of the overall watershed area.** Data from TDOT's outfall mapping program has indicated that the TDOT MS4 has point source discharges (outfalls) to the evaluated impaired stream segments at approximately 1,483 outfall locations, including 2 Rest Areas and a Salt Shed. The total area within the TDOT MS4 that would drain to these 1,483 point source outfalls is calculated to be 5,132.85 acres. However, the total drainage area of the evaluated impaired stream segments is 319,444.79 acres. Thus, the TDOT MS4 drainage area is less than 1.61% of the total drainage area contributing to the evaluated impaired stream segments. Since the volume of stormwater runoff is directly proportional to drainage area, the TDOT MS4 drainage area is so small that if the TDOT MS4 could eliminate its stormwater discharges to the subject stream segments, the ultimate effect on water quality in that watershed would be imperceptible. A change of flow of less than 1.61% is well within the error band of any typical stream flow measurements and would not generally be discerned in such measurements.

   Additionally, numerous sources in the literature have found that impervious areas within a watershed do not significantly impact water quality until the impervious area exceeds 10% of the watershed area. See for example the following online articles:

   - EPA: Caddis Volume 2: Thresholds of Imperviousness
     https://19january2021snapshot.epa.gov/caddis-vol2/caddis-volume-2-sources-stressors-responses-urbanization-stormwater-runoff_.html

   - Center for Watershed Protection: The Importance of Imperviousness
     https://owl.cwp.org/mdocs-posts/elc_pwp1/

   - EPA: Screening to Identify and Prevent Urban Stormwater Problems: Estimating Impervious Area Accurately and Inexpensively
     https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=63937&CFID=5841148&CFTOKEN=61881503&jsessionid=3830106d366c41758a8969772a4b123943b3.

The TDOT MS4 drainage area used to calculate the relative drainage area values of 1.61% of the total area of the subwatersheds includes the total drainage area of the TDOT Right-of-Way, including the impervious roadway and any adjacent pervious shoulders, ditches, vegetated medians, swales, and other vegetated areas. Thus, the actual effective impervious area of the TDOT MS4 that actually drains directly to the subject stream segments would be expected to be significantly lower than 1.61% value. The TDOT MS4 should only be accountable for contamination that originates within its boundaries. Based upon the miniscule area of impact from the ROW, TDOT respectfully requests that TDEC remove the TDOT MS4 from the TMDL document as an identified point known source for the subject contamination unless quantitative stormwater data (of which TDOT is currently unaware) demonstrates post-construction MS4 stormwater discharges are actually a threat to water quality in Tennessee.

4. **TDOT believes, based upon actual acquired data, that stormwater discharges from the TDOT MS4 cannot be demonstrated to meet the regulatory definition of a "known pollutant source" in the subject watershed.** TDOT is aware that TDEC has published the document entitled, *"Tennessee's Consolidated Assessment and Listing Methodology (CALM)"* in January of 2018. The document includes discussions concerning the overall approach to water quality monitoring and assessment activities which include the establishing of TMDLs. The document states that the objective of a TMDL is to allocate loads among all of the **known** pollutant sources throughout a watershed and refers to TCA 69-3-103(26) and (27) with regard to the overall definition of a pollutant and pollution. While TDOT acknowledges that some pathogen contamination has been identified in samples taken from some TDOT stormwater discharges in other watersheds, in the subject watershed there is no identifiable evidence of direct mixing of TDOT stormwater and pollutants, as that term is defined at TCA 69-3-102(26), in that no identifiable sources of sewage, industrial wastes, or other wastes (with the exception of floatables) have been found in TDOT stormwater discharges, or would have a reasonable potential to be found in TDOT stormwater discharges from any available sampling data. This is of importance due to existing and ongoing research TDOT has undertaken in an attempt to identify pathogen sources in stormwater runoff from TDOT Right-of-Way (ROW).

   Several studies, including those conducted by TDOT (see comment 2, above), indicate that many pathogens such as E. coli are naturally occurring within the environment and do not directly come from exposure to sewage or other waste (pollutants). Stormwater discharges containing these naturally occurring microbes would not be considered a waste as defined by statute, since stormwater in and of itself does not meet the definition of what constitutes a pollutant (see *Virginia Department of Transportation, et al, v. EPA, et al.*, No. 12-775 (E.D. Va. 2013). In addition, based upon the small area of influence/contribution the TDOT ROW has in most impaired stream segments (see comment 3), along with TDOT's low flow volume contribution relative to a typical receiving stream (see comment 7, below), the impact of TDOT MS4 stormwater discharges does not meet the definition of pollution as that term is defined in TCA 69-3-102(27). Thus, it is unclear to TDOT, based upon existing data, how its stormwater discharges can be considered a "known" contributor to stream impairment as that term is used in the CALM document.

   TDOT requests that TDEC provide the stormwater sampling data from the subject watershed, or other quantitative analysis they may have relied on, which demonstrates that TDOT post-construction stormwater discharges can be considered a **known** pollutant source in the Hiwassee River watershed, as required by TDEC policy. If TDEC has made the determination that TDOT post-construction stormwater discharges are a known pollutant as that term is defined in the applicable regulations, TDOT requests that TDEC provide that regulatory determination analysis. In the absence of such data or analysis, TDOT respectfully requests that TDEC remove the TDOT MS4 from inclusion in Section 7.1.2 of the subject document as a listed point source for the pollutant loading that is the subject of the

TMDL as it would appear that TDOT post-construction stormwater discharges would not meet the published regulatory criteria for inclusion within the proposed TMDL

5. **TDOT observes that the flow scenarios of TDEC stream sampling and TMDL analysis do not appear to be representative of the TDOT MS4 stormwater discharge conditions.** Sampling of stormwater discharges from the TDOT MS4 to Waters of the State (WOS) indicate that high flow rate stormwater discharges which have the potential to transport contaminants typically **occur only during significant storm events** (e.g. rainfall intensities greater than 0.50 inches/hr.). However, the TDEC Standard Operating Procedure (SOP) for Chemical and Bacteriological Sampling of Surface Water states in Section I.I, Protocol A, Page 3:

   > "…***avoid collecting bacteriological samples during or immediately after storm events.*** *Changes to criteria have reduced the number of required samples for geometric mean calculation from ten to five samples in a 30 consecutive day period. The samples must be taken at least 24 hours apart* ***and not during a rain event.***"

   While Appendix C of that SOP does include a procedure for sampling during high flow events, no procedures for stormwater sampling are included in the SOP. Section 9.1.1 of the TMDL document states that "Few observations are typically available to estimate loads under these adverse conditions due to the difficulty and danger of sample collection" and that the high flow range is "…beyond the scope of E.coli TMDLs and subsequent implementation strategies. Since the TDOT MS4 typically only discharges stormwater to WOS during high flow events (not daily), the specified WLAs and implementation strategies would appear not to apply to discharges from the TDOT MS4.

   Neither Section 6.0 nor Appendix B of the TMDL document indicate if any of the available water quality monitoring data used to develop the TMDL was acquired during high flow conditions. To TDOT's knowledge TDEC has not performed any independent stormwater sampling anywhere in Tennessee that would conclusively demonstrate that post-construction MS4 stormwater discharges are actually a threat to water quality.

   Thus, since both the methods for TDEC stream sample acquisition and the TMDL analysis do not appear to characterize stream water quality during periods of TDOT MS4 discharge conditions where contribution to the stream would occur, it is respectfully requested that the TDOT MS4 be removed from the TMDL document as an identified point source for the subject contamination unless or until quantitative stormwater data is available that demonstrates post-construction MS4 stormwater discharges are actually a threat to water quality in Tennessee.

In general, TDOT is very concerned about the contents of the draft TMDL document because inclusion in the TMDL as a source of contamination will trigger requirements in the TDOT individual MS4 Permit that could include stormwater effluent monitoring, in-stream monitoring, and the implementation of control measures at as many as 1,483 stormwater discharge points in the subject watershed. Due to the inclusion in this TMDL, TDOT MS4 stormwater discharges could be interpreted as not being in strict compliance with its current individual MS4 Permit and could be required to incur significant costs for the permit required response actions, even though the TDOT stormwater discharges do not actually exceed the applicable regulatory standards and do not actually present a threat to water quality.

Because the TDOT MS4 discharges stormwater to almost all watersheds in Tennessee, TDOT's necessary approach in applying its finite resources that can be devoted to improving water quality is to focus on those locations where the efforts can truly be beneficial and cost effective. TDOT has demonstrated that it will take the necessary steps to preserve water quality when the need is clear and financially justifiable. To properly allocate TDOT resources available to improve water quality, TDOT has proposed a prioritization process for all TMDLs to which the TDOT MS4 discharges that would most efficiently allocate finite TDOT resources to remediating the most significant water quality issues. Although TDEC has been conceptually supportive of this approach, TDOT is concerned that its inclusion in this TMDL document as a point source of contamination could be used by third-party Citizen's Groups (e.g. watershed associations, environmental activist groups) to sue TDEC and/or TDOT and force implementation of the letter of the TDOT individual MS4 Permit mandated monitoring and control measure requirements (i.e. Sections 2.2 and 2.3 of the TDOT individual MS4 Permit), regardless of the proposed prioritization process. Recent federal court cases (e.g. Ohio Valley Environmental Coalition v. Fola Coal Co., LLC, No. 16-1024 (4th Cir. 2017) have weakened the protection of permitees by the Clean Water Act permit shield provisions and increases TDOT's vulnerability to such citizen lawsuits. Simply being in compliance with a NPDES permit no longer is a "shield" from prosecution of citizen lawsuits for a permittee.

TDOT does not believe that the inclusion of its MS4 as a point source for the pollutant loading which is the subject of this TMDL is appropriate or in the overall best interest of the State of Tennessee. From this evaluation of the proposed TMDL document, the post-construction stormwater runoff from the TDOT MS4 has been shown to be a negligible and de minimus contributor to the hydrologic regime of the subject watershed, and two independent studies have demonstrated that highway stormwater runoff is not a significant vector of E. coli or other human pathogens. Based on this information, TDOT respectfully requests that this draft TMDL document be revised to remove the TDOT MS4 as a point source for the subject contamination, as has been done in previous TDEC TMDL documents. TDOT's inclusion as an identified point source is unsubstantiated, not technically defensible, nor in the overall best interests of the State of Tennessee.

If you have any questions, or require additional information and/or documentation, please contact me at Klint.Rommel@tn.gov or at 615-253-2419.

Sincerely,

Klint Rommel

Klint Rommel
TDOT Environmental Division
Facility Compliance Section Manager

cc: Karina Bynum, P.E., PhD, TDEC (TDEC/TDOT liaison)
Susannah Kniazewycz, P.E., TDOT
Project Files

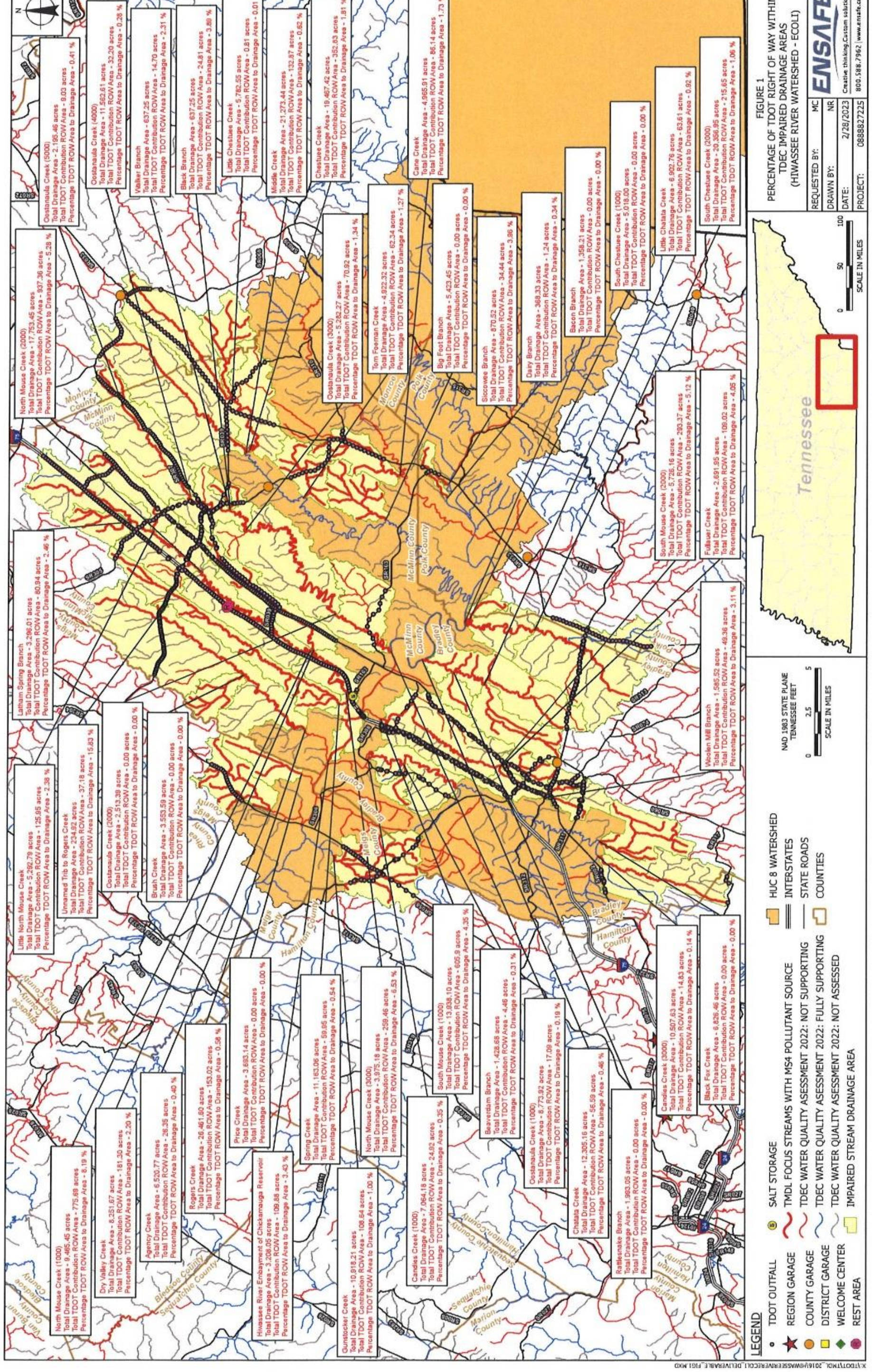
FIGURE 1
PERCENTAGE OF TDOT RIGHT OF WAY WITHIN
TDEC IMPAIRED DRAINAGE AREAS
(HIWASSEE RIVER WATERSHED - ECOLI)
ENSAFE

APPENDIX J

Response to Public Comments

This TMDL document identifies TDOT as a point source with the potential to contribute pathogens to the subject waterbodies. As stated in Section 9.2.2, as long as TDOT meets the requirements of their MS4 permit, it is our expectation that compliance with their permit would achieve the overall goals and requirements of the WLAs of this TMDL. Minor changes have been made to the TMDL document to clarify issues raised by TDOT.