TOTAL MAXIMUM DAILY LOAD (TMDL)

for

Escherichia coli (E. coli)

in the

Cheatham Lake Watershed

(HUC 05130202)

Cheatham, Davidson, Robertson, Sumner, and Williamson Counties, Tennessee

Final

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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
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 Cheatham Lake Watershed (HUC 05130202)

Impaired Waterbody Information (Based on TDEC's Final 2020 List of Impaired and Threatened Waters)

State: Tennessee
Counties: Cheatham, Davidson, Robertson, Sumner, and Williamson
Constituents of Concern: *E. coli*

Impaired Waterbodies Addressed in This Document:

Waterbody ID	Waterbody	Miles Impaired
TN05130202001_3000	*Cheatham Reservoir (from Bordeaux Bridge to Woodland Street Bridge)*	*994 acres*
TN05130202001T_0800	Davidson Branch	2.83
TN05130202001T_0900	Overall Creek	7.83
TN05130202007_0100 [a]	Sims Branch	1.5
TN05130202007_0300 [a]	Finley Branch	1.2
TN05130202007_0700	*Turkey Creek*	*1.6*
TN05130202007_0800	*Indian Creek*	*5.7*
TN05130202007_1000	*Mill Creek (from Cheatham Reservoir to Elm Hill Pike)*	*3.5*
TN05130202007_1100	*Holt Creek*	*6.2*
TN05130202007_1200	*Whittemore Branch*	*2.9*
TN05130202007_1300	*Sorghum Branch*	*3.1*
TN05130202007_1400 [a]	*Sevenmile Creek (from Mill Creek to Nolensville Road)*	*2.4*
TN05130202007_1410 [a]	*Shasta Branch*	*1.84*
TN05130202007_1450 [a]	*Sevenmile Creek (from Nolensville Road to headwaters [h/w])*	*4.99*
TN05130202007_1490	*Cathy Jo Branch*	*1.1*
TN05130202007_1500 [a]	*Pavilion Branch*	*1.3*
TN05130202007_2000	*Mill Creek (from Elm Hill Pike to Briley Parkway Bridge)*	*4.0*
TN05130202007_3000 [a]	*Mill Creek (from Briley Parkway Bridge to Whittemore Branch near Antioch)*	*5.9*
TN05130202010_0200 [a]	Drake Branch	2.7
TN05130202010_0900 [a]	Ewing Creek	17.6
TN05130202014_0900	Blue Spring Creek	9.8
TN05130202023_0100 [a]	East Fork Browns Creek	2.2
TN05130202023_0200	Middle Fork Browns Creek	3.5
TN05130202023_0300 [a]	West Fork Browns Creek	3.6

Waterbody ID	Waterbody	Miles Impaired
TN05130202023_1000 [a]	Browns Creek (from Cheatham Reservoir to Visco Drive)	0.2
TN05130202023_2000 [a]	Browns Creek (from Visco Drive to h/w)	4.1
TN05130202027_1000 [a]	Dry Creek (from Cheatham Reservoir to the railroad bridge)	0.5
TN05130202027_2000	Dry Creek (from the railroad bridge to h/w)	5.9
TN05130202202_1000 [a]	Pages Branch	5.11
TN05130202209_1000 [a]	Cooper Creek	3.9
TN05130202212_0100 [a]	Neeleys Branch	1.7
TN05130202220_0100 [a]	Lumsley Fork	4.7
TN05130202220_0300 [a]	Slaters Creek (from Manskers Creek to Unnamed Trib)	0.99
TN05130202220_0350	Slaters Creek (from Unnamed Trib to h/w)	10.24
TN05130202220_1000 [a]	Manskers Creek (from Cheatham Reservoir to Slaters Creek)	7.9
TN05130202220_2000 [a]	Manskers Creek (from Slaters Creek to h/w)	7.6
TN05130202314_0300 [a]	Bosley Springs Branch	1.5
TN05130202314_0400 [a]	Sugartree Creek	4.3
TN05130202314_0700 [a]	Vaughns Gap Branch (from Richland Creek to Highway 70)	0.6
TN05130202314_0750 [a]	Vaughns Gap Branch (from Highway 70 to h/w)	1.9
TN05130202314_0800 [a]	*Jocelyn Hollow Branch*	*2.0*
TN05130202314_1000 [a]	Richland Creek (from Cheatham Reservoir to Briley Parkway near West Park)	1.9
TN05130202314_2000 [a]	Richland Creek (from Briley Parkway near West Park to Jocelyn Hollow Branch)	6.7
TN05130202314_3000 [a]	*Richland Creek (from Jocelyn Hollow Branch to h/w)*	*4.0*

* 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.

[a] Waterbodies covered by TMDLs approved by EPA in 2008. The TMDLs included in this document supersede the TMDLs approved by EPA in 2008.

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*
TN05130202007_0150	*Sims Branch*	*Not Assessed*
TN05130202007_0200	*Elissa Branch*	*Not Assessed*
TN05130202007_0400	*Ezell Branch*	*Not Assessed*
TN05130202007_0500	*Franklin Branch*	*Not Assessed*
TN05130202007_1420	*Hilson Branch*	*Not Assessed*
TN05130202007_1430	*Carbine Branch*	*Not Assessed*
TN05130202007_1440	*Apple Branch*	*Not Assessed*
TN05130202007_1460	*Brentwood Branch*	*Not Assessed*
TN05130202007_1470	*Briarwood Branch*	*Not Assessed*
TN05130202007_1480	*Paragon Branch*	*Not Assessed*
TN05130202023_0400	UT to Browns Creek	Not Assessed
TN05130202220_0200	Walkers Creek	Fully Supporting as of 2020
TN05130202220_0210	UT to Walkers Creek	Not Assessed
TN05130202220_0220	Bakers Fork	Not Assessed
TN05130202220_0400	Madison Creek	Fully Supporting as of 2020
TN05130202220_0500	Center Point Branch	Fully Supporting as of 2020
TN05130202314_0100	UT to Richland Creek	Not Assessed
TN05130202314_0100	Murphy Road Branch	Not Assessed
TN05130202314_0100	Belle Meade Branch	Not Assessed
TN05130202314_0100	*Chickering Branch*	*Not Assessed*

* 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.

Designated Uses:

The designated use classifications for all waterbodies in the Cheatham Lake watershed include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation.

Portions of the following impaired or protection waterbodies have been classified as Exceptional Tennessee Waters. The Cheatham Lake Reservoir portion of the Cumberland River will also be treated as an Exceptional Tennessee Water because it is a reservoir.

Waterbodies Classified as Exceptional Tennessee Waters

Waterbody Name	Portion	Reason for Classification			
		Presence of Nashville Crayfish	Presence of Water Stitchwort	Presence of State endangered streamside salamander Ambystom	Belle Meade Mansion State Historic Area
Mill Creek	Entirety and all tributaries	✓	✓		
- Apple Branch	Entirety	✓	✓		
- Brentwood Branch	Entirety	✓	✓		
- Briarwood Branch	Entirety	✓	✓		
- Carbine Branch	Entirety	✓	✓		
- Cathy Jo Branch	Entirety	✓	✓		
- Elissa Branch	Entirety	✓	✓		
- Ezell Branch	Entirety	✓	✓		
- Finley Branch	Entirety	✓	✓		
- Franklin Branch	Entirety	✓	✓		
- Hilson Branch	Entirety	✓	✓		
- Holt Creek	Entirety	✓	✓		
- Indian Creek	Entirety	✓	✓		
- Paragon Branch	Entirety	✓	✓		
- Pavilion Branch	Entirety	✓	✓		

Waterbodies Classified as Exceptional Tennessee Waters (*Cont.*)

Waterbody Name	Portion	Reason for Classification			
		Presence of Nashville Crayfish	Presence of Water Stitchwort	Presence of State endangered streamside salamander Ambystom	Belle Meade Mansion State Historic Area
- Sevenmile Creek	Entirety	✓	✓		
- Shasta Branch	Entirety	✓	✓		
- Sims Branch	Entirety	✓	✓		
- Sorghum Branch	Entirety	✓	✓		
- Turkey Creek	Entirety	✓	✓		
- Whittemore Branch	Entirety	✓	✓		
Ewing Creek	From Hillside Road to origin			✓	
Chickering Branch	Entirety			✓	
Jocelyn Hollow Branch	Portion in Belle Meade Mansion State Historic Area				✓
Richland Creek	Portion in Belle Meade Mansion State Historic Area (segment 314_3000)			✓	✓

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.

For further information on Tennessee's general water quality standards, see:

https://publications.tnsosfiles.com/rules/0400/0400-40/0400-40-03.20190911.pdf

TMDL Scope:

Waterbodies identified in the Tennessee Department of Environment and Conservation's (TDEC) Final 2020 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 Cheatham Lake watershed in 2008. Since that time, (1) additional monitoring data have been collected; and (2) fifteen 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 Cheatham Lake (HUC 05130202) watershed. The *E. coli* TMDLs developed in this document supersede the *E. coli* TMDLs approved by the U.S. Environmental Protection Agency (EPA) on April 17, 2008 for selected waterbodies in the Cheatham Lake watershed.

Analysis/Methodology:

The TMDLs for the impaired waterbodies in the Cheatham Lake 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 Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0101	Turkey Creek [d,e]	TN05130202007_0700	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(9.014 \times 10^6 \times Q) - (1.00 \times 10^7 \times q_d)$	$(9.014 \times 10^6 \times Q) - (1.00 \times 10^7 \times q_d)$
	Indian Creek [d,e]	TN05130202007_0800				$(3.667 \times 10^6 \times Q) - (4.08 \times 10^6 \times q_d)$	$(3.667 \times 10^6 \times Q) - (4.08 \times 10^6 \times q_d)$
	Holt Creek [d,e]	TN05130202007_1100				$(3.299 \times 10^6 \times Q) - (3.67 \times 10^6 \times q_d)$	$(3.299 \times 10^6 \times Q) - (3.67 \times 10^6 \times q_d)$
0102	Sims Branch [d,e]	TN05130202007_0100	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(4.049 \times 10^6 \times Q) - (4.50 \times 10^6 \times q_d)$	$(4.049 \times 10^6 \times Q) - (4.50 \times 10^6 \times q_d)$
	Finley Branch [d,e]	TN05130202007_0300				$(1.753 \times 10^7 \times Q) - (1.95 \times 10^7 \times q_d)$	$(1.753 \times 10^7 \times Q) - (1.95 \times 10^7 \times q_d)$
	Mill Creek [d,e]	TN05130202007_1000				$(1.596 \times 10^5 \times Q) - (1.77 \times 10^5 \times q_d)$	$(1.596 \times 10^5 \times Q) - (1.77 \times 10^5 \times q_d)$
	Whittemore Branch [d,e]	TN05130202007_1200				$(4.764 \times 10^6 \times Q) - (5.29 \times 10^6 \times q_d)$	$(4.764 \times 10^6 \times Q) - (5.29 \times 10^6 \times q_d)$
	Sorghum Branch [d,e]	TN05130202007_1300				$(6.416 \times 10^6 \times Q) - (7.13 \times 10^6 \times q_d)$	$(6.416 \times 10^6 \times Q) - (7.13 \times 10^6 \times q_d)$
	Sevenmile Creek [d,e]	TN05130202007_1400				$(9.965 \times 10^5 \times Q) - (1.11 \times 10^6 \times q_d)$	$(9.965 \times 10^5 \times Q) - (1.11 \times 10^6 \times q_d)$
	Shasta Branch [d,e]	TN05130202007_1410				$(2.173 \times 10^7 \times Q) - (2.42 \times 10^7 \times q_d)$	$(2.173 \times 10^7 \times Q) - (2.42 \times 10^7 \times q_d)$
	Sevenmile Creek [d,e]	TN05130202007_1450				$(2.215 \times 10^6 \times Q) - (2.46 \times 10^6 \times q_d)$	$(2.215 \times 10^6 \times Q) - (2.46 \times 10^6 \times q_d)$
	Cathy Jo Branch [d,e]	TN05130202007_1490				$(1.294 \times 10^7 \times Q) - (1.44 \times 10^7 \times q_d)$	$(1.294 \times 10^7 \times Q) - (1.44 \times 10^7 \times q_d)$
	Pavillion Branch [d,e]	TN05130202007_1500				$(1.897 \times 10^7 \times Q) - (2.11 \times 10^7 \times q_d)$	$(1.897 \times 10^7 \times Q) - (2.11 \times 10^7 \times q_d)$
	Mill Creek [d,e]	TN05130202007_2000				$(1.698 \times 10^5 \times Q) - (1.89 \times 10^5 \times q_d)$	$(1.698 \times 10^5 \times Q) - (1.89 \times 10^5 \times q_d)$
	Mill Creek [d,e]	TN05130202007_3000				$(2.665 \times 10^5 \times Q) - (2.96 \times 10^5 \times q_d)$	$(2.665 \times 10^5 \times Q) - (2.96 \times 10^5 \times q_d)$
0203	Blue Spring Creek [d,e]	TN05130202014_0900	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(4.323 \times 10^6 \times Q) - (4.80 \times 10^6 \times q_d)$	$(4.323 \times 10^7 \times Q) - (4.80 \times 10^7 \times q_d)$
0301	Lumsley Fork [d,e]	TN05130202220_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.004 \times 10^7 \times Q) - (1.12 \times 10^7 \times q_d)$	$(1.004 \times 10^7 \times Q) - (1.12 \times 10^7 \times q_d)$
	Slaters Creek [d,e]	TN05130202220_0300				$(4.255 \times 10^6 \times Q) - (4.73 \times 10^6 \times q_d)$	$(4.255 \times 10^6 \times Q) - (4.73 \times 10^6 \times q_d)$
	Slaters Creek [d,e]	TN05130202220_0350				$(4.634 \times 10^6 \times Q) - (5.15 \times 10^6 \times q_d)$	$(4.634 \times 10^6 \times Q) - (5.15 \times 10^6 \times q_d)$
	Manskers Creek [e]	TN05130202220_1000				$(7.068 \times 10^5 \times Q) - (7.85 \times 10^5 \times q_d)$	$(7.068 \times 10^5 \times Q) - (7.85 \times 10^5 \times q_d)$
	Manskers Creek [d,e]	TN05130202220_2000				$(6.231 \times 10^6 \times Q) - (6.92 \times 10^6 \times q_d)$	$(6.231 \times 10^6 \times Q) - (6.92 \times 10^6 \times q_d)$

Summary of TMDLs, WLAs, & LAs expressed as daily loads for the Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202) (*Cont.*)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0301 (cont'd)	Manskers Creek [e]	TN05130202220_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(7.068 \times 10^{5} \times Q) - (7.85 \times 10^{5} \times q_d)$	$(7.068 \times 10^{5} \times Q) - (7.85 \times 10^{5} \times q_d)$
	Manskers Creek [d,e]	TN05130202220_2000				$(6.231 \times 10^{6} \times Q) - (6.92 \times 10^{6} \times q_d)$	$(6.231 \times 10^{6} \times Q) - (6.92 \times 10^{6} \times q_d)$
0302	Dry Creek [d,e]	TN05130202027_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(3.806 \times 10^{6} \times Q) - (4.23 \times 10^{6} \times q_d)$	$(3.806 \times 10^{6} \times Q) - (4.23 \times 10^{6} \times q_d)$
	Dry Creek [d,e]	TN05130202027_2000				$(5.049 \times 10^{6} \times Q) - (5.61 \times 10^{6} \times q_d)$	$(5.049 \times 10^{6} \times Q) - (5.61 \times 10^{6} \times q_d)$
	Cooper Creek [d,e]	TN05130202209_1000				$(8.710 \times 10^{6} \times Q) - (9.68 \times 10^{6} \times q_d)$	$(8.710 \times 10^{6} \times Q) - (9.68 \times 10^{6} \times q_d)$
	Neeleys Branch [d,e]	TN05130202212_0100				$(1.594 \times 10^{7} \times Q) - (1.77 \times 10^{7} \times q_d)$	$(1.594 \times 10^{7} \times Q) - (1.77 \times 10^{7} \times q_d)$
0303	Drake Branch [d,e]	TN05130202010_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.665 \times 10^{7} \times Q) - (1.85 \times 10^{7} \times q_d)$	$(1.665 \times 10^{7} \times Q) - (1.85 \times 10^{7} \times q_d)$
	Ewing Creek [d,e]	TN05130202010_0900				$(2.430 \times 10^{6} \times Q) - (2.70 \times 10^{6} \times q_d)$	$(2.430 \times 10^{6} \times Q) - (2.70 \times 10^{6} \times q_d)$
0304	Bosley Springs Branch [d,e]	TN05130202314_0300	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.508 \times 10^{7} \times Q) - (1.68 \times 10^{7} \times q_d)$	$(1.508 \times 10^{7} \times Q) - (1.68 \times 10^{7} \times q_d)$
	Sugartree Creek [d,e]	TN05130202314_0400				$(6.892 \times 10^{6} \times Q) - (7.66 \times 10^{6} \times q_d)$	$(6.892 \times 10^{6} \times Q) - (7.66 \times 10^{6} \times q_d)$
	Vaughns Gap Branch [d,e]	TN05130202314_0700				$(1.102 \times 10^{7} \times Q) - (1.22 \times 10^{6} \times q_d)$	$(1.102 \times 10^{7} \times Q) - (1.22 \times 10^{6} \times q_d)$
	Vaughns Gap Branch [d,e]	TN05130202314_0750				$(2.177 \times 10^{7} \times Q) - (2.42 \times 10^{7} \times q_d)$	$(2.177 \times 10^{7} \times Q) - (2.42 \times 10^{7} \times q_d)$
	Richland Creek [e]	TN05130202314_1000				$(1.213 \times 10^{6} \times Q) - (1.35 \times 10^{6} \times q_d)$	$(1.213 \times 10^{6} \times Q) - (1.35 \times 10^{6} \times q_d)$
	Richland Creek [d,e]	TN05130202314_2000				$(1.549 \times 10^{6} \times Q) - (1.72 \times 10^{6} \times q_d)$	$(1.549 \times 10^{6} \times Q) - (1.72 \times 10^{6} \times q_d)$
	Jocelyn Hollow Branch [d,e]	TN05130202314_0800	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(1.250 \times 10^{7} \times Q) - (1.39 \times 10^{7} \times q_d)$	$(1.250 \times 10^{7} \times Q) - (1.39 \times 10^{7} \times q_d)$
	Richland Creek [d,e]	TN05130202314_3000				$(2.808 \times 10^{6} \times Q) - (3.12 \times 10^{6} \times q_d)$	$(2.808 \times 10^{6} \times Q) - (3.12 \times 10^{6} \times q_d)$
0305	Cheatham Reservoir	TN05130202001_3000	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(1.313 \times 10^{3} \times Q) - (1.46 \times 10^{3} \times q_d)$	$(1.313 \times 10^{3} \times Q) - (1.46 \times 10^{3} \times q_d)$
	East Fork Browns Creek [d,e]	TN05130202023_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.527 \times 10^{7} \times Q) - (1.70 \times 10^{7} \times q_d)$	$(1.527 \times 10^{7} \times Q) - (1.70 \times 10^{7} \times q_d)$
	Middle Fork Browns Creek [d,e]	TN05130202023_0200				$(1.220 \times 10^{7} \times Q) - (1.36 \times 10^{7} \times q_d)$	$(1.220 \times 10^{7} \times Q) - (1.36 \times 10^{7} \times q_d)$

Summary of TMDLs, WLAs, & LAs expressed as daily loads for the Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202) (*Cont.*)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0306	Davidson Branch [d,e]	TN05130202001T_0800	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(9.124 \times 10^{6} \times Q) - (1.01 \times 10^{7} \times q_d)$	$(9.124 \times 10^{6} \times Q) - (1.01 \times 10^{7} \times q_d)$
0306	Overall Creek [d,e]	TN05130202001T_0900	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(4.126 \times 10^{6} \times Q) - (4.58 \times 10^{6} \times q_d)$	$(4.126 \times 10^{6} \times Q) - (4.58 \times 10^{6} \times q_d)$

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

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)
Cheatham Lake Watershed (HUC 05130202)

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 Cheatham Lake watershed, identified in TDEC's Final 2020 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.

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 Cheatham Lake watershed in 2008. Since that time, (1) additional monitoring data have been collected; and (2) fifteen 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 Cheatham Lake (HUC 05130202) watershed. The *E. coli* TMDLs developed in this document supersede the *E. coli* TMDLs approved by the U.S. Environmental Protection Agency (EPA) on April 17, 2008 for selected waterbodies in the Cheatham Lake 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 pourpoint. Watersheds vary is 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 Cheatham Lake watershed is part of the Ohio Region or HUC-2 05. The Ohio Region is sub-divided into fourteen Sub-Regions. The Cheatham Lake watershed is part of the Cumberland Sub-Region or HUC-4 0513. The Cumberland Sub-Region has a drainage area of approximately 17,700 mi^2. The Cumberland Sub-Region is sub-divided into the Upper Cumberland Accounting Unit or HUC-6 051301 and the Lower Cumberland Accounting Unit or HUC-6 051302. Each Accounting Unit is further sub-divided into Cataloging Units or HUC-8s.

Cheatham Lake is a portion of the Cumberland River created by the presence of Cheatham Dam. The Cheatham Lake HUC-8 watershed (HUC 05130202) is located in Cheatham, Davidson, Robertson, Sumner, and Williamson Counties, in middle Tennessee (Figure 1). The Cheatham Lake HUC-8 has approximately 773 miles of streams (based on EPA's National Hydrography Dataset [NHD] Medium Resolution [1:100,000]) and 7,500 reservoir acres, and has a drainage area of approximately 647 square miles (mi^2). Because Cheatham Lake is part of the Cumberland River, the portion of the Cumberland River located upstream of Cheatham Lake is considered part of the contributing drainage area of the Cheatham Lake watershed. This TMDL document does not address waterbodies located in the contributing drainage area that are not located within the Cheatham Lake HUC-8.

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 Cheatham Lake watershed have occurred since 2016 as a result of development, this is the most current land use data available. Land use for the Cheatham Lake watershed is summarized in Table 1 and shown in Figure 2. Predominant land use in the Cheatham Lake watershed is forest (54.4%) followed by urban (31.6%) and agriculture (14.1%). Details of land use distribution of impaired subwatersheds in the Cheatham Lake watershed are presented in Appendix A.

The Cheatham Lake watershed lies within one Level III ecoregion (Interior Plateau) and contains four Level IV subecoregions as shown in Figure 3 (USEPA, 1997):

- The **Western Pennyroyal Karst (71e)** is a flatter area of irregular plains, with fewer perennial streams, compared to the open hills of the Western Highland Rim (71f). Small sinkholes and depressions are common. The productive soils of this notable agricultural area are formed mostly from a thin loess mantle over residuum of Mississippian-age limestones. Most of the region is cultivated or in pasture; tobacco and livestock are the principal agricultural products, with some corn, soybeans, and small grains. The natural vegetation consisted of oak-hickory forest with mosaics of bluestem prairie. The barrens of Kentucky that extended south into Stewart, Montgomery, and Robertson counties, were once some of the largest natural grasslands in Tennessee.
- The **Western Highland Rim (71f)** is characterized by dissected, rolling terrain of open hills, with elevations of 400 to 1000 feet. The geologic base of Mississippian-age limestone, chert, and shale is covered by soils that tend to be cherty, acidic, and low to moderate in fertility. Streams are characterized by coarse chert gravel and sand substrates with areas

of bedrock, moderate gradients, and relatively clear water. The oak-hickory natural vegetation was mostly deforested in the mid to late 1800's, in conjunction with the iron ore related mining and smelting of the mineral limonite, but now the region is again heavily forested. Some agriculture occurs on the flatter areas between streams and in the stream and river valleys: mostly hay, pasture, and cattle, with some cultivation of corn and tobacco.

- The **Outer Nashville Basin (71h)** is a more heterogeneous region than the Inner Nashville Basin, with more rolling and hilly topography and slightly higher elevations. The region encompasses most all of the outer areas of the generally non-cherty Ordovician limestone bedrock. The higher hills and knobs are capped by the more cherty Mississippian-age formations, and some Devonian-age Chattanooga shale, remnants of the Highland Rim. The region's limestone rocks and soils are high in phosphorus, and commercial phosphate is mined. Deciduous forests with pasture and cropland are the dominant land covers. Streams are low to moderate gradient, with productive nutrient-rich waters, resulting in algae, rooted vegetation, and occasionally high densities of fish. The Nashville Basin as a whole has a distinctive fish fauna, notable for fish that avoid the region, as well as those that are present.
- The **Inner Nashville Basin (71i)** is less hilly and lower than the Outer Nashville Basin. Outcrops of the Ordovician-age limestone are common, and the generally shallow soils are redder and lower in phosphorus than those of the Outer Basin. Streams are lower gradient than surrounding regions, often flowing over large expanses of limestone bedrock. The most characteristic hardwoods within the Inner Basin are a maple-oak-hickory-ash association. The limestone cedar glades of Tennessee, a unique mixed grassland/forest/cedar glades vegetation type with many endemic species, are located primarily on the limestone of the Inner Nashville Basin. The more xeric, open characteristics and shallow soils of the cedar glades also result in a distinct distribution of amphibian and reptile species.

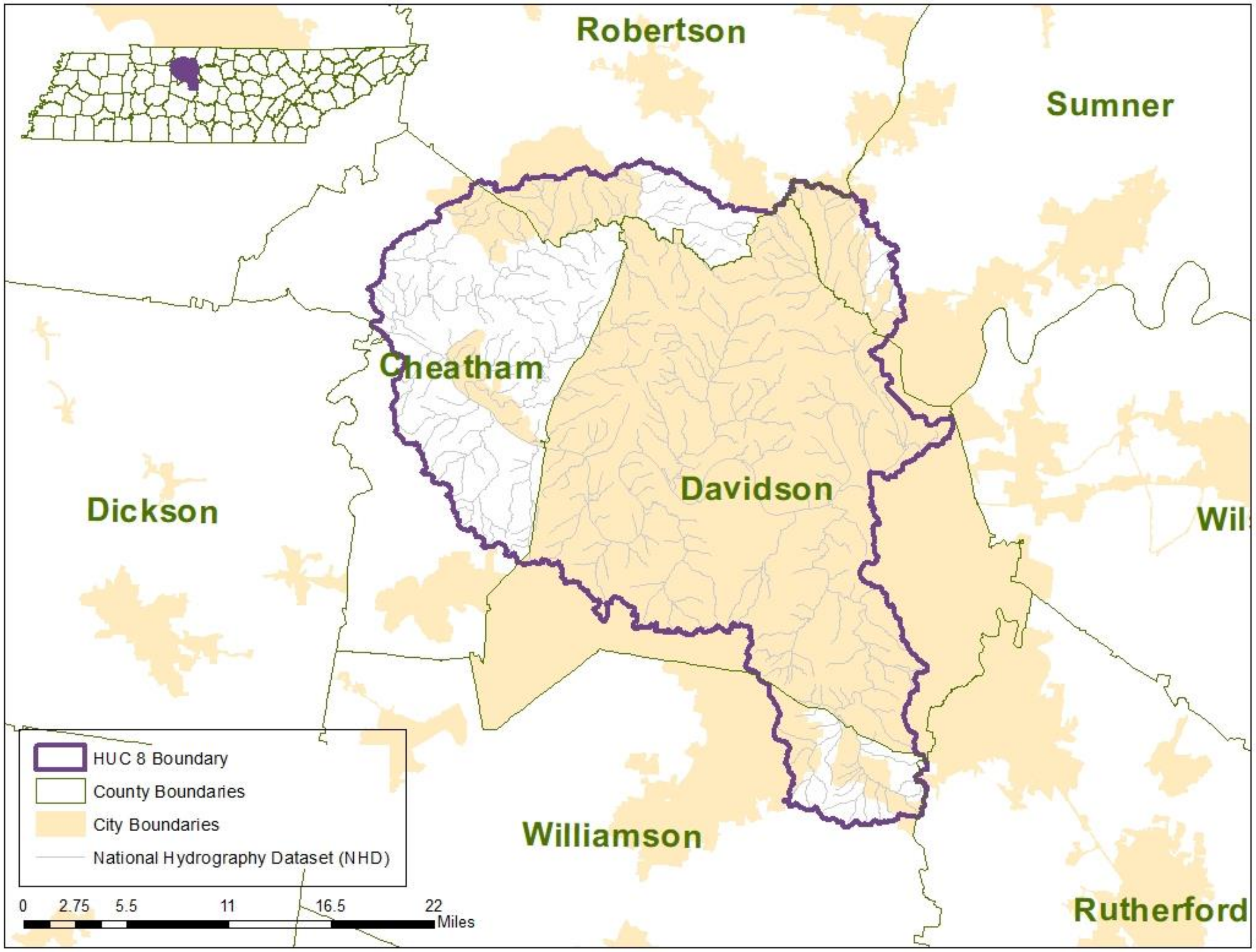

Figure 1. Location of the Cheatham Lake Watershed

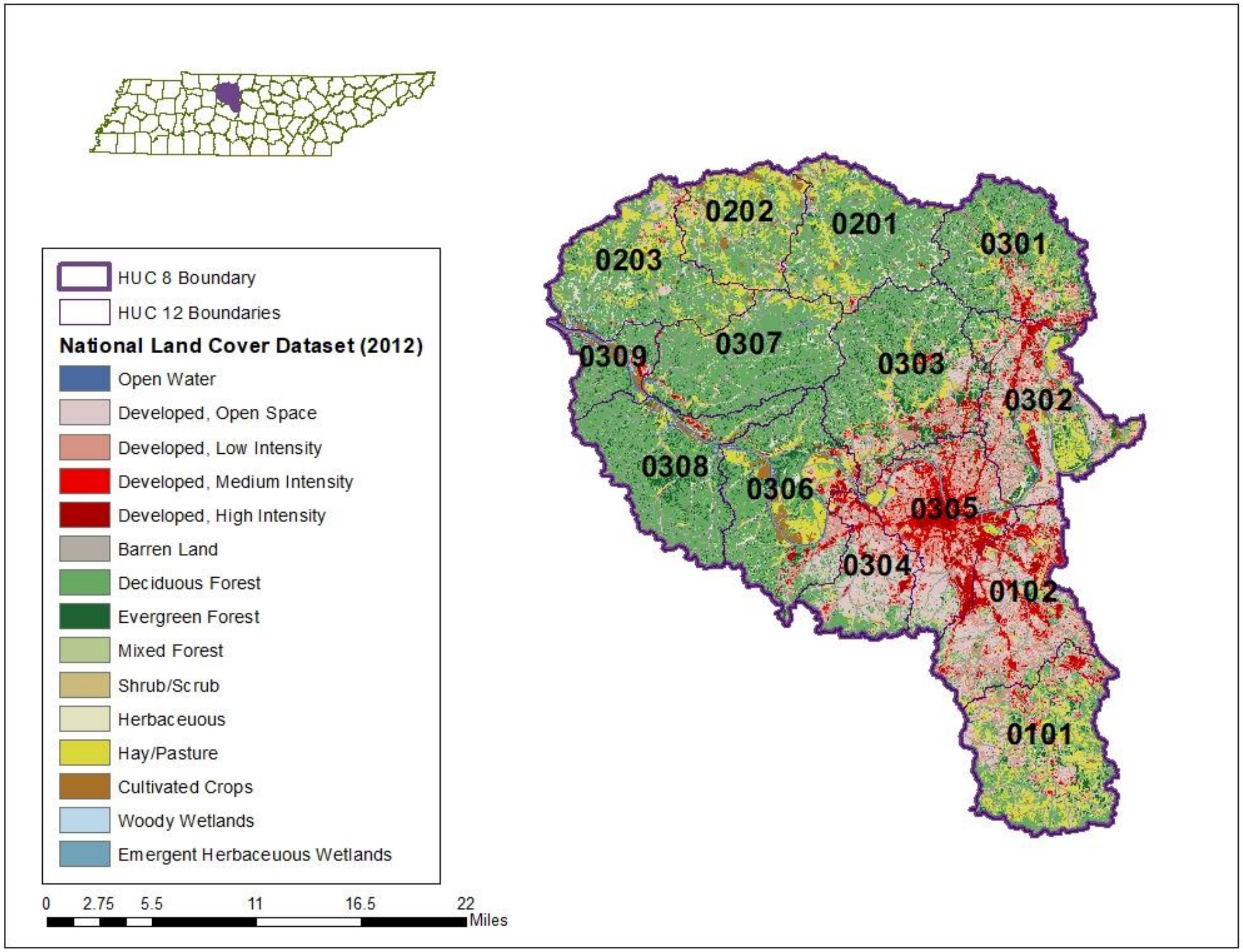

Figure 2. Land Use Characteristics of the Cheatham Lake Watershed

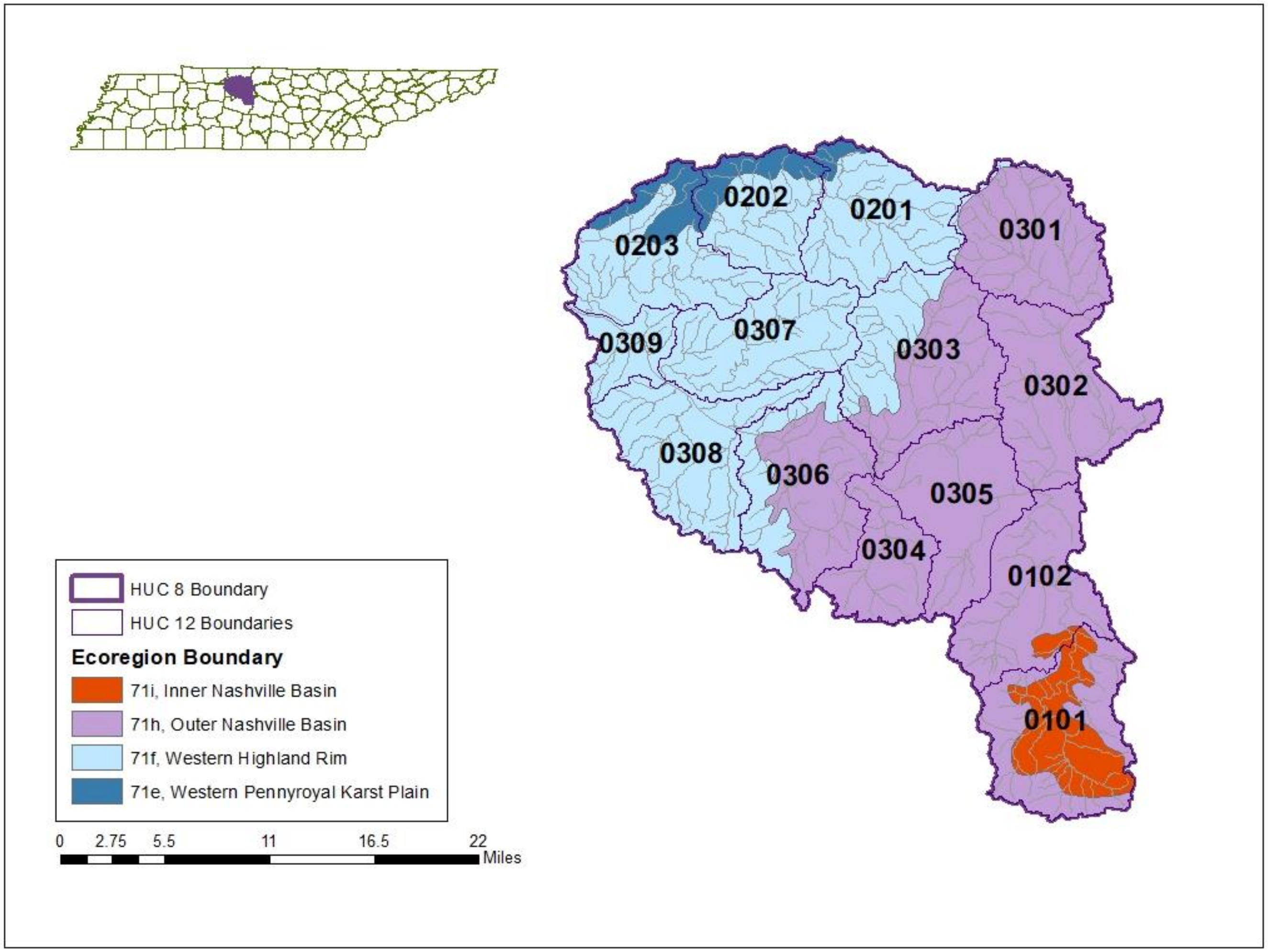

Figure 3. Level IV Ecoregions in the Cheatham Lake Watershed

Table 1. MRLC Land Use Distribution – Cheatham Lake Watershed

Land use		Entire Watershed	
Code	Description	[acres]	[%]
11	Open Water	5,552	1.34
21	Developed Open Spaces	61,282	14.8
22	Low Intensity Residential	39,860	9.62
23	Medium Intensity Residential	18,977	4.58
24	High Intensity Residential	10,773	2.60
31	Bare Rock/Sand/Clay	663	0.16
41	Deciduous Forest	172,038	41.5
42	Evergreen Forest	6,049	1.46
43	Mixed Forest	35,054	8.46
52	Shrub/Scrub	1,160	0.28
71	Grassland/Herbaceous	2,403	0.58
81	Pasture/Hay	52,581	12.7
82	Cultivated Crops	5,677	1.37
90	Woody Wetlands	1,284	0.31
95	Emergent Herbaceous Wetlands	1,077	0.26
	Total	414,432	100%

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

4.0 PROBLEM DEFINITION

The State of Tennessee's Final 2020 List of Impaired and Threatened Waters (TDEC, 2020), https://www.tn.gov/environment/program-areas/wr-water-resources/water-quality/water-quality-reports---publications.html, was approved by EPA, Region 4 on April 15, 2020. This list identified a number of waterbodies in the Cheatham Lake watershed as not fully supporting designated use classifications due, in part, to *E. coli* (see Table 2 & Figures 4 through 6). The designated use classifications for these waterbodies include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation.

Table 2. Extract from TDEC's Final 2020 List of Impaired and Threatened Waterbodies – Cheatham Lake Watershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)	Pollutant Source
TN05130202001_3000	Cheatham Reservoir (from Bordeaux Bridge to Woodland Street Bridge)	994	Escherichia coli	Municipal (Urbanized High Density Area) Combined Sewer Overflows
TN05130202001T_0800	Davidson Branch	2.83	Escherichia coli	Municipal (Urbanized High Density Area) Collection System Failures
TN05130202001T_0900	Overall Creek	7.83	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202007_0100 [a]	Sims Branch	1.5	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202007_0300 [a]	Finley Branch	1.2	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202007_0700	Turkey Creek	1.6	Escherichia coli	Municipal (Urbanized High Density Area) Grazing in Riparian or Shoreline Zones
TN05130202007_0800	Indian Creek	5.7	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202007_1000	Mill Creek (from Cheatham Reservoir to Elm Hill Pike)	3.5	Escherichia coli	Collection System Failures
TN05130202007_1100	Holt Creek	6.2	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202007_1200	Whittemore Branch	2.9	Escherichia coli	Municipal (Urbanized High Density Area) Onsite Treatment Systems Sanitary Sewer Overflows
TN05130202007_1300	Sorghum Branch	3.1	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202007_1400 [a]	Sevenmile Creek (from Mill Creek to Nolensville Road)	2.4	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202007_1410 [a]	Shasta Branch	1.84	Escherichia coli	Municipal (Urbanized High Density Area) Collection System Failures
TN05130202007_1450 [a]	Sevenmile Creek (from Nolensville Road to h/w)	4.99	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202007_1490	Cathy Jo Branch	1.1	Escherichia coli	Animal Feeding Operations (NPS)
TN05130202007_1500 [a]	Pavilion Branch	1.3	Escherichia coli	Municipal (Urbanized High Density Area)

Table 2 (cont'd). Extract from TDEC's Final 2020 List of Impaired and Threatened Waterbodies – Cheatham Lake Watershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)	Pollutant Source
TN05130202007_2000	Mill Creek (from Elm Hill Pike to Briley Parkway Bridge)	4.0	Escherichia coli	Collection System Failures
TN05130202007_3000 [a]	Mill Creek (from Briley Parkway Bridge to Whittemore Branch near Antioch)	5.9	Escherichia coli	Collection System Failures
TN05130202010_0200 [a]	Drake Branch	2.7	Escherichia coli	Collection System Failures
TN05130202010_0900 [a]	Ewing Creek	17.6	Escherichia coli	Collection System Failures
TN05130202014_0900	Blue Spring Creek	9.8	Escherichia coli	Grazing in Riparian or Shoreline Zones
TN05130202023_0100 [a]	East Fork Browns Creek	2.2	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202023_0200	Middle Fork Browns Creek	3.5	Escherichia coli	Municipal (Urbanized High Density Area) Collection System Failures
TN05130202023_0300 [a]	West Fork Browns Creek	3.6	Escherichia coli	Collection System Failures
TN05130202023_1000 [a]	Browns Creek (from Cheatham Reservoir to Visco Drive)	0.2	Escherichia coli	Municipal (Urbanized High Density Area) Collection System Failures
TN05130202023_2000 [a]	Browns Creek (from Visco Drive to h/w)	4.1	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202027_1000 [a]	Dry Creek (from Cheatham Reservoir to railroad bridge)	0.5	Escherichia coli	Collection System Failures
TN05130202027_2000	Dry Creek (from railroad bridge to h/w)	5.9	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202202_1000 [a]	Pages Branch	5.11	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202209_1000 [a]	Cooper Creek	3.9	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202212_0100 [a]	Neeleys Branch	1.7	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202220_0100 [a]	Lumsley Fork	4.7	Escherichia coli	Municipal (Urbanized High Density Area)

Table 2 (cont'd). Extract from TDEC's Final 2020 List of Impaired and Threatened Waterbodies – Cheatham Lake Watershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)	Pollutant Source
TN05130202220_0300 [a]	Slaters Creek (from Manskers Creek to Unnamed Trib)	0.99	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202220_0350	Slaters Creek (from Unnamed Trib to h/w)	10.24	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202220_1000 [a]	Manskers Creek (from Cheatham Reservoir to Slaters Creek)	7.9	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202220_2000 [a]	Manskers Creek (from Slaters Creek to h/w)	7.6	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202314_0300 [a]	Bosley Springs Branch	1.5	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202314_0400 [a]	Sugartree Creek	4.3	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202314_0700 [a]	Vaughns Gap Branch (from Richland Creek to Highway 70)	0.6	Escherichia coli	Collection System Failures
TN05130202314_0750 [a]	Vaughns Gap Branch (from Highway 70 to h/w)	1.9	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202314_0800 [a]	Jocelyn Hollow Branch	2.0	Escherichia coli	Municipal (Urbanized High Density Area)
TN05130202314_1000 [a]	Richland Creek (from Cheatham Reservoir to Briley Parkway near West Park)	1.9	Escherichia coli	Collection System Failures
TN05130202314_2000 [a]	Richland Creek (from Briley Parkway near West Park to Jocelyn Hollow Branch)	6.7	Escherichia coli	Collection System Failures
TN05130202314_3000 [a]	Richland Creek (from Jocelyn Hollow Branch to h/w)	4.0	Escherichia coli	Municipal (Urbanized High Density Area)

[a] Waterbodies covered by TMDLs approved by EPA in 2008. The TMDLs included in this document supersede the TMDLs approved by EPA in 2008.

5.0 WATER QUALITY CRITERIA & TMDL TARGET

As previously stated, the designated use classifications for the Cheatham Lake 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).

Portions of waterbodies that have been classified as Exceptional Tennessee Waters are listed in Table 3. The Cheatham Lake Reservoir portion of the Cumberland River will also be treated as an Exceptional Tennessee Water because it is a reservoir.

As of August 1, 2021, none of the other impaired or protection waterbodies in the Cheatham Lake Watershed are classified as lakes or reservoirs, or classified as State Scenic Rivers or Exceptional Tennessee Waters.

For further information concerning Tennessee's general water quality criteria and Tennessee's Antidegradation Statement, including the definition of Exceptional Tennessee Water, see:

https://publications.tnsosfiles.com/rules/0400/0400-40/0400-40-03.20190911.pdf

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.

Table 3. Waterbodies Classified as Exceptional Tennessee Waters

Waterbody Name	Portion	Reason for Classification			
		Presence of Nashville Crayfish	Presence of Water Stitchwort	Presence of State endangered streamside salamander Ambystom	Belle Meade Mansion State Historic Area
Mill Creek	Entirety and all tributaries	✓	✓		
- Apple Branch	Entirety	✓	✓		
- Brentwood Branch	Entirety	✓	✓		
- Briarwood Branch	Entirety	✓	✓		
- Carbine Branch	Entirety	✓	✓		
- Cathy Jo Branch	Entirety	✓	✓		
- Elissa Branch	Entirety	✓	✓		
- Ezell Branch	Entirety	✓	✓		
- Finley Branch	Entirety	✓	✓		
- Franklin Branch	Entirety	✓	✓		
- Hilson Branch	Entirety	✓	✓		
- Holt Creek	Entirety	✓	✓		
- Indian Creek	Entirety	✓	✓		
- Paragon Branch	Entirety	✓	✓		
- Pavilion Branch	Entirety	✓	✓		
- Sevenmile Creek	Entirety	✓	✓		
- Shasta Branch	Entirety	✓	✓		
- Sims Branch	Entirety	✓	✓		
- Sorghum Branch	Entirety	✓	✓		
- Turkey Creek	Entirety	✓	✓		
- Whittemore Branch	Entirety	✓	✓		

Table 3 (cont'd). Waterbodies Classified as Exceptional Tennessee Waters

Waterbody Name	Portion	Reason for Classification			
		Presence of Nashville Crayfish	Presence of Water Stitchwort	Presence of State endangered streamside salamander Ambystom	Belle Meade Mansion State Historic Area
Ewing Creek	From Hillside Road to origin			✓	
Chickering Branch	Entirety			✓	
Jocelyn Hollow Branch	Portion in Belle Meade Mansion State Historic Area				✓
Richland Creek	Portion in Belle Meade Mansion State Historic Area (segment 314_3000)			✓	✓

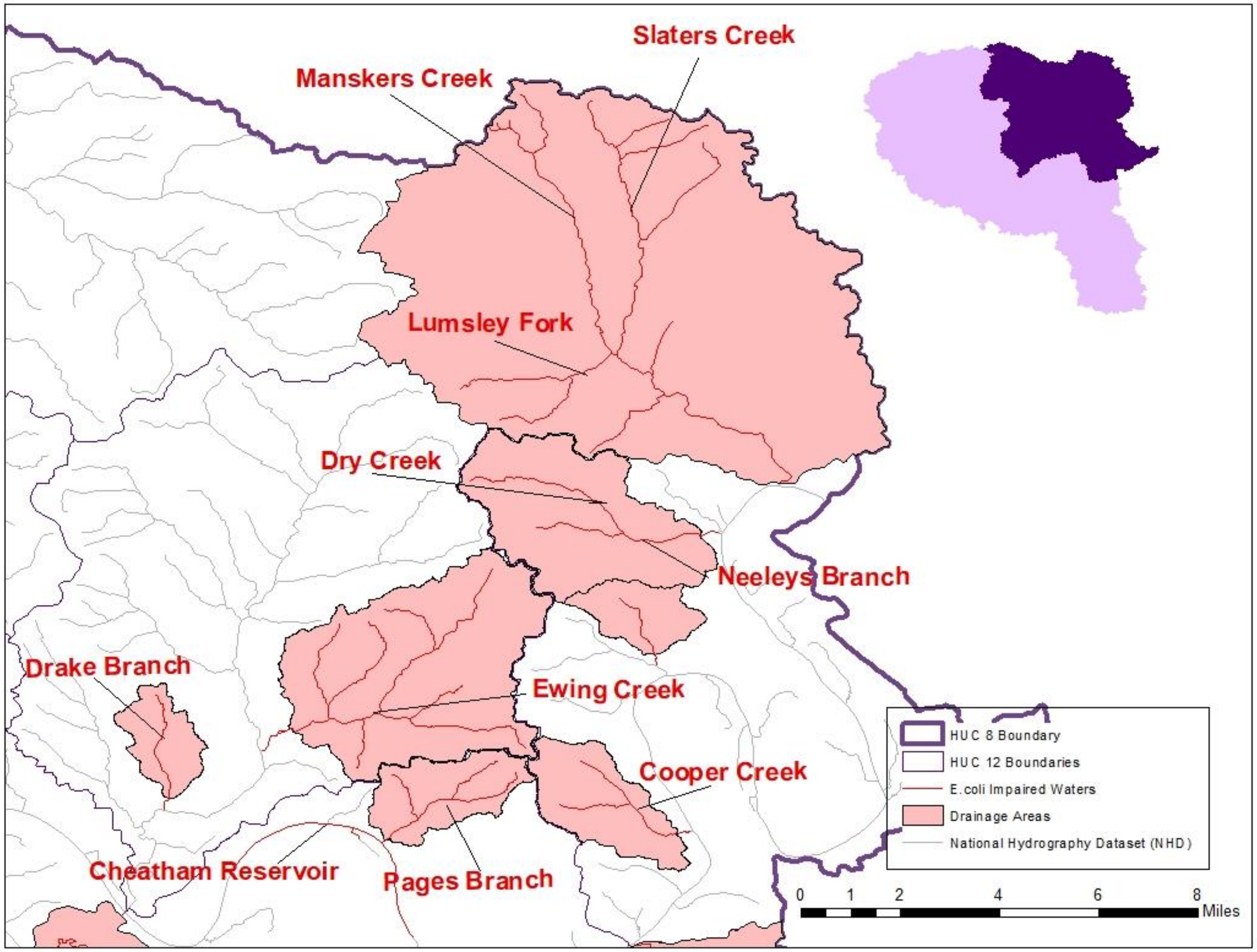

Figure 4. Waterbodies Impaired by *E. coli* (as Documented on TDEC's Final 2020 List of Impaired and Threatened Waterbodies) – Part 1

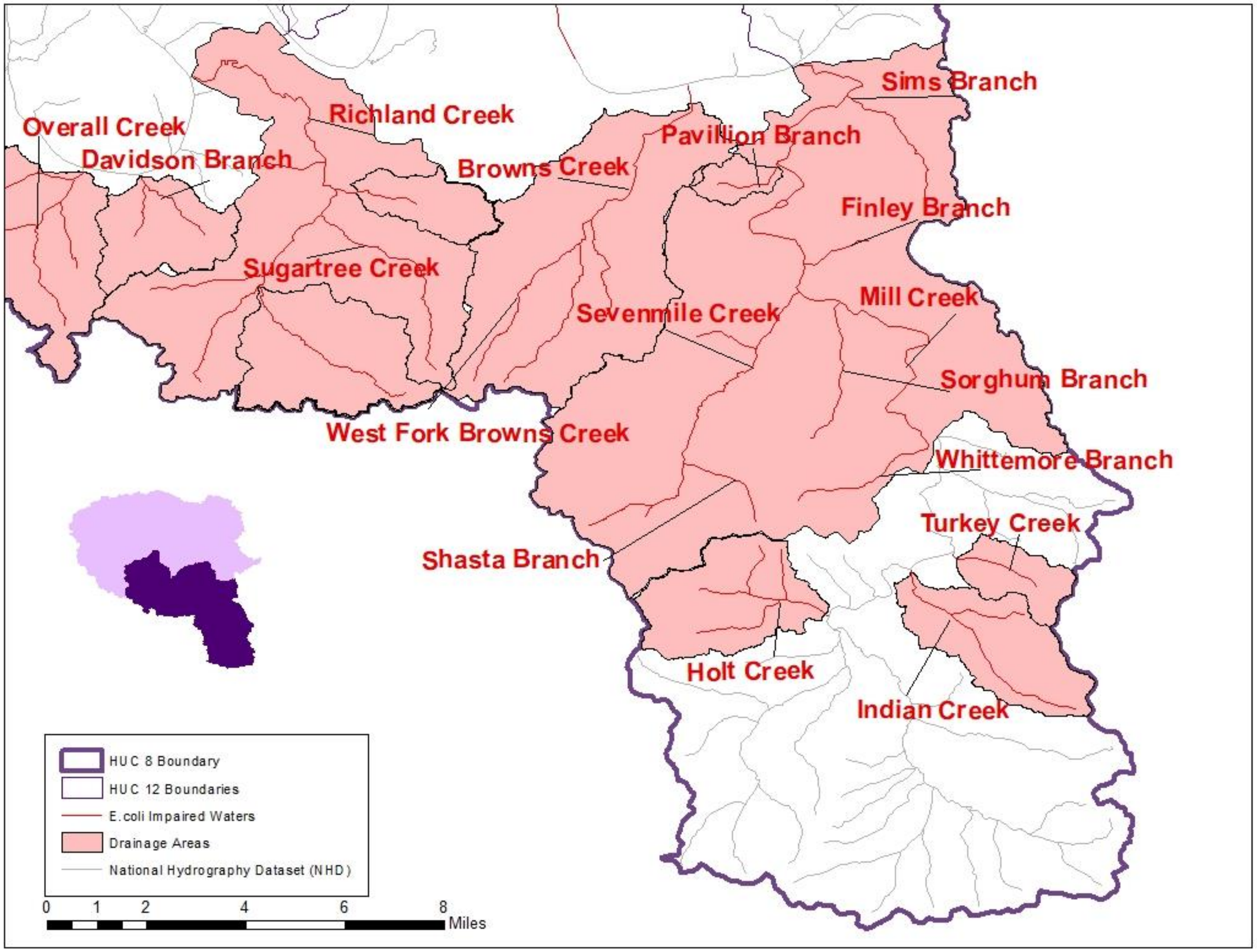

Figure 5. Waterbodies Impaired by *E. coli* (as Documented on TDEC's Final 2020 List of Impaired and Threatened Waterbodies) – Part 2

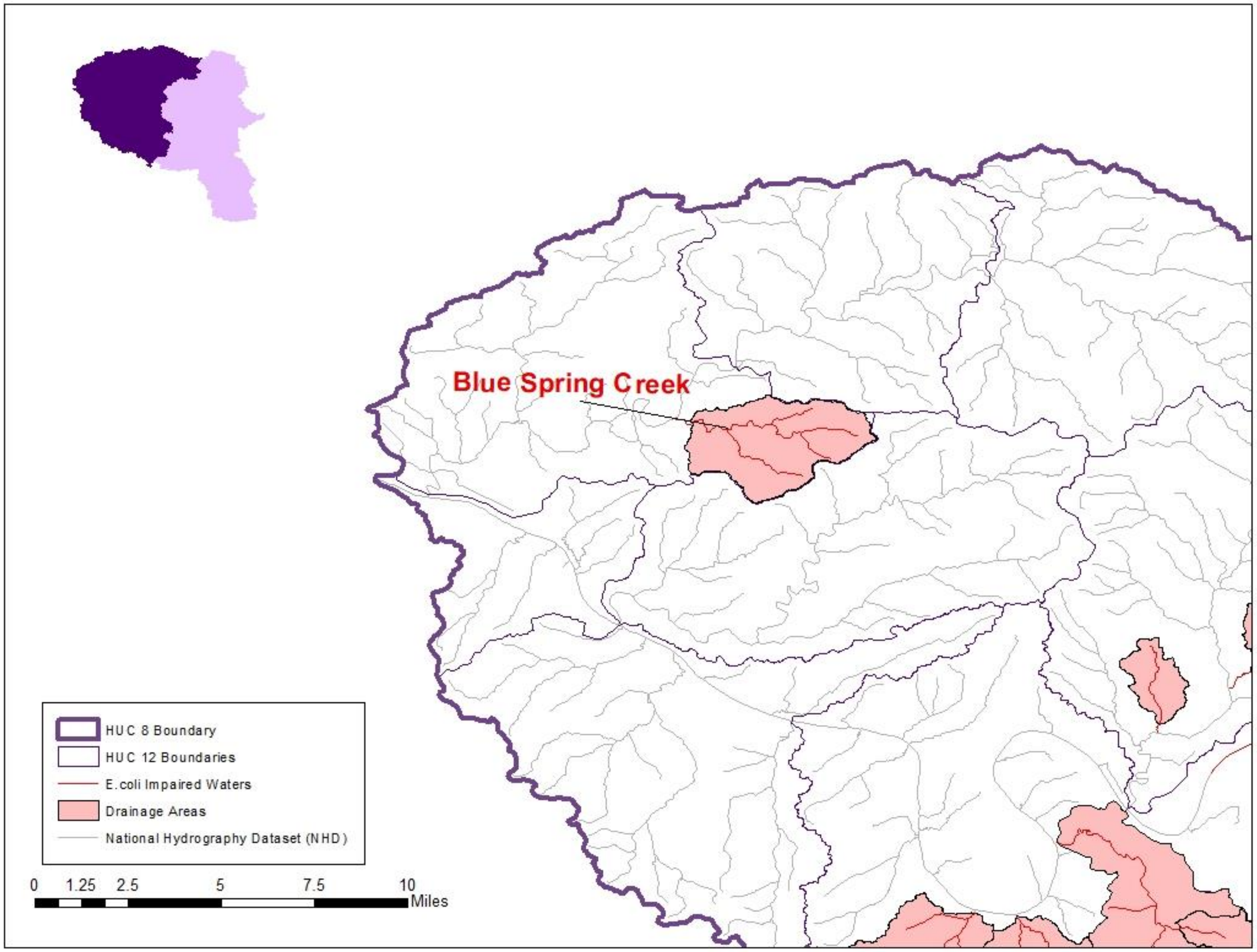

Figure 6. Waterbodies Impaired by *E. coli* (as Documented on TDEC's Final 2020 List of Impaired and Threatened Waterbodies) – Part 3

6.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

Monitoring data for the Cheatham Lake watershed was collected by both TDEC and Metro Nashville. Where a TDEC monitoring station coincided with a Metro Nashville monitoring station, both names are given (TDEC/Metro Nashville). The following water quality monitoring stations provided data for waterbodies identified as impaired for *E. coli* in the Cheatham Lake watershed:

Table 4. Water Quality Monitoring Stations

HUC-12	Stream Name	TDEC Station	Metro Station	Location
0101	*Holt Creek*	*HOLT000.4DA*	*Holt*	*at 6459 Holt Road*
	Indian Creek	*INDIA000.4DA*	*Indian*	*at Old Hickory Blvd*
	Turkey Creek		*Turkey*	*at Pettus Road*
0102	*Cathy Jo Branch*	*CJO000.8DA*		*at downstream (d/s) edge of Zoo property, right fork below last pond*
	Finley Branch	*FINLE000.1DA*	*Finley*	*t Currey Road near McGavock Pike*
	Mill Creek		*Mill 1*	*at Lebanon Pike*
		MILL003.3DA		*at Elm Hill Pike*
		MILL009.6DA	*Mill 3*	*at the Greenway at Harding Pike*
		MILL11.0DA		*Upstream (u/s) of Franklin-Limestone Bridge*
	Pavillion Branch		*Pavillion*	*u/s of confluence with Mill Creek*
	Sevenmile Creek	*SEVEN000.2DA*	*Sevenmile 1*	*at Antioch Pike*
		SEVEN003.8	*Sevenmile 2*	*at Ellington Ag Center*
	Shasta Branch		*Shasta*	*at Edmondson Pike*
	Sims Branch	*SIMS000.2DA*	*Sims 1*	*adjacent to Sanborn Drive, approx.. 600 ft u/s of confluence of Sims Branch and Mill Creek*
		SIMS000.8DA		*at Elm Hill Pike*
		SIMS001.2DA		*d/s walkway bridge*
	Sorghum Branch	*SORGH000.3DA*	*Sorghum*	*d/s Antioch Pike*
	Whittemore Branch	*WHITT001.0DA*	*Whittemore*	*at Tusculum Road*

Table 4 (cont'd). Water Quality Monitoring Stations

HUC-12	Stream Name	TDEC Station	Metro Station	Location
0203	Blue Springs Creek	BSPRI000.5CH		at George Boyd Road/W. Blue Springs Rd.
		BSPRI003.9CH		off Bennett Road (0.2 mi East of Blue Springs Road)
0301	Lumsley Fork	LUMSL000.1DA	Lumsley	at mouth of Manskers Creek, at Brick Church Pike and Hitt Lane
	Manskers Creek	MANSK002.8SR	Manskers 1	at Caldwell Drive (off Long Hollow Pike, behind Kroger)
		MANSK005.8SR		at Norfolk Lane
		MANSK006.2SR	Manskers 2	u/s Bakers Fork confluence, off Hwy 41
	Slaters Creek	SLATE000.3SR		off 31W, d/s I-65
		SLATE001.1SR		off Hwy31W/41 at American Limestone U.T. Drainage
0302	Cooper Creek	COOPE001.5DA	Cooper	at McGavock Pike
	Dry Creek	DRY000.3DA		at Myatt Drive
		DRY001.1DA		at Gallatin Road
	Neeley's Branch		Neeley's Branch	
0303	Drake Branch	DRAKE000.2DA	Drakes	at West Hamilton Road
	Ewing Creek	EWING000.8DA	Ewing	at White Creek Pike
0304	Bosley Springs Branch	BSPRI000.4DA	Bosley	in front of St. Cecilias/Aquinas Jr. College/Brixworth Ln.
	Jocelyn Hollow	*JHOLL000.2DA*	*Jocelyn Hollow*	*off Post Road*
	Richland Creek	RICHL002.0DA	Richland 1	at Briley Parkway Bridge below Pep Industries
		RICHL002.2DA		at West Park/Conway Street
			Richland 2	at Charlotte Ave.
		RICHL004.5DA		d/s Mccabe Golf Course
		RICHL005.0DA		u/s Mccabe Golf Course
		RICHL007.8DA		*at Harding Road*
		RICHL008.9DA	*Richland 3*	*at Belle Meade Blvd and West Tyne Boulevard*

Table 4 (cont'd). Water Quality Monitoring Stations

HUC-12	Stream Name	TDEC Station	Metro Station	Location
0304 (cont'd)	Sugartree Creek	SUGAR000.1DA	Sugartree	at West End (by Kroger)
	Vaughns Gap Branch	VGAP000.2DA	Vaughns Gap 1	at Harding Place
		VGAP001.2DA	Vaughns Gap 2	at St. Henry's Road (off Edwin Warner/Percy Warner Roads)
0305	Browns Creek	BROWN000.4DA	Browns 1	Off Fessler's Lane
		BROWN002.9DA	Browns 2	at the Fairgrounds, u/s of USGS gage
	Cumberland River	*CUMBE185.7DA*	*Bordeaux Bridge*	*at Bordeaux Bridge, Nashville*
	East Fork Browns Creek	EFBRO000.2DA	E Fork Browns	at Berry Road
	Middle Fork Browns Creek	MFBRO000.1DA	M Fork Browns	at Park Terrace Drive
	Pages Branch		Pages Branch	at Brick Church Pike
	West Fork Browns Creek	WFBRO000.1DA	W Fork Browns	at Park Terrace, u/s Brown Creek confluence
0306	Davidson Branch	DAVID000.4DA	Davidson	at Downey Drive
	Overall Creek	OVERA001.3DA		at Old Charlotte Road

The locations of these monitoring stations are shown in Figures 7 through 10. 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 5.

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 was calculated.

25 of the 53 water quality monitoring stations (Table 5 and Appendix B) have at least one *E. coli* sample value reported as ">2419" or ">2420". For the purpose of calculating summary data statistics, TMDLs, Waste Load Allocations (WLAs), and Load Allocations (LAs), these data values are treated as (equal to) 2419 or 2420, respectively. Therefore, the calculated results are considered to be estimates. 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.).

Table 5. 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
BROWN000.4DA/ Browns 1	2005-2020	74	42	>1273	10,460	2104.1	26
	2016-2020	25	42	>823.9	>2420	2104.1	8
BROWN002.9DA/ Browns 2	2005-2020	79	28.5	>708.2	10,950	756.5	12
	2016-2020	23	48.8	374.9	1732.9	585.1	1
BSPRI000.4DA/ Bosley	2005-2020	85	67.6	>957.5	5,810	1733.0	20
	2016-2020	30	68	>640.4	>2419.6	859.8	3
BSPRI000.5CH	2015-2020	9	8	219.1	1553	52.7	1
	2016-2020	5	33	56.0	93	52.7	0
BSPRI003.9CH	2006-2012	18	60	563.9	2600	794.6	3
CJO000.8DA	*2005-2020*	*16*	*31*	*461.7*	*2420*	*Ngd*	*3*
	2020	*2*	*150*	*257.5*	*365*	*Ngd*	*0*
COOPE001.5DA/ Cooper	2010-2018	53	21.4	228.5	2050	340.5	1
	2017-2018	16	47.4	179.9	313	261.9	0
CUMBE185.7DA	*2015-2020*	*12*	*<1*	*<38.6*	*93*	*Ngd*	*0*
	2016-2020	*11*	*6*	*42.0*	*93*	*Ngd*	*0*
DAVID000.4DA/ Davidson	2015-2020	37	36.4	203.3	1553.1	287.1	1
	2016-2020	32	36.4	183.0	1553.1	217.8	1
DRAKE000.2DA/ Drakes	2005-2020	47	7.5	>398.2	>2420	695.1	3
	2016-2020	18	7.5	362.2	2419.6	379.3	1
DRY000.3DA	2015-2020	14	9	>369.1	>2420	Ngd	2
	2016-2020	9	41	>434.3	>2420	Ngd	1

Table 5 (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
DRY001.1DA/ Dry Creek	2005-2020	46	2	394.2	2419.6	1033.6	5
	2016-2020	23	2	284.7	1732.9	294.9	2
EFBRO000.2DA/ E Fork Browns	2005-2020	83	14	>412.5	>2419.6	464.5	9
	2016-2020	30	32	>359.3	>2419.6	464.5	2
EWING000.8DA/ Ewing	2005-2020	88	4	>297.6	>2420	435.3	5
	2016-2020	31	4.1	229.7	2420	125.0	1
FINLE000.1DA/ Finley	*2005-2020*	*59*	*31.1*	*>575.7*	*3080*	*473.8*	*13*
	2016-2020	*25*	*31.1*	*>586.3*	*>2420*	*469.8*	*4*
HOLT000.4DA/ Holt	2005-2020	*51*	*9*	*>288.5*	*>2420*	*245.3*	*6*
	2016-2020	*6*	*53*	*166.0*	*260*	*Ngd*	*0*
INDIA000.4DA/ Indian	*2005-2020*	*51*	*<1*	*>385.5*	*>2400*	*238.5*	*9*
	2016-2020	*10*	*61*	*208.1*	*579*	*Ngd*	*1*
JHOLL000.2DA/ Jocelyn Hollow	2005-2020	81	17	>680.6	7120	829.0	33
	2016-2020	29	101	465.7	1413.6	754.3	10
LUMSL000.1DA/ Lumsley	2012-2020	41	6.3	248.7	2419.6	396.9	1
	2016-2020	21	10.9	268.5	2419.6	244.5	1
MANSK002.8SR/ Manskers 1	2005-2020	71	16	567.3	17,330	1226.7	7
	2016-2020	21	19.9	277.7	770	466.5	0
MANSK005.8SR	2020	3	155	344.0	687	Ngd	0
MANSK006.2SR/ Manskers 2	2005-2020	67	<1	>551.5	9140	1963.7	7
	2016-2020	21	14.8	329.6	1986.3	87.7	2

Table 5 (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
MFBRO000.1DA/ M Fork Browns	2005-2020	83	52	>740.0	3410	818.2	19
	2016-2020	29	101	534.7	2420	Ngd	2
Mill 1	*2005-2016*	*52*	*10*	*276.0*	*2419.6*	*300.2*	*6*
	2016	*10*	*37.9*	*92.5*	*178.5*	*119.3*	*0*
MILL003.3DA	*2010-2016*	*21*	*23*	*394.8*	*>2420*	*Ngd*	*4*
	2016	*4*	*31*	*>658.8*	*>2420*	*Ngd*	*1*
MILL009.6DA/ Mill 3	*2010-2020*	*52*	*12*	*>255.9*	*>2420*	*138.9*	*4*
	2016-2020	*21*	*14.4*	*>312.6*	*>2420*	*80.5*	*2*
MILL011.0DA	*2005-2011*	*23*	*9*	*>243.2*	*>2420*	*Ngd*	*1*
Neeley's Branch	2012-2019	*45*	*93.2*	*>513.9*	*>2419.6*	*799.0*	*5*
	2017-2019	*21*	*93.2*	*>378.2*	*>2419.6*	*359.9*	*1*
OVERA001.3DA	2005-2020	30	10	>426.2	>2420	957.8	5
	2020	5	116	655.6	1733	351.4	2
Pages Branch	2012-2018	42	35	164.8	648.8	251.2	0
	2017-2018	16	42.6	171.0	488.4	155.8	0
Pavillion	*2015-2020*	*29*	*67.9*	*382.9*	*920.8*	*565.5*	*9*
	2016-2020	*19*	*67.9*	*381.2*	*816.4*	*565.5*	*6*
RICHL002.0DA/ Richland 1	2011-2020	70	19.7	476.6	8300	369.4	6
	2016-2020	39	33.3	237.7	1413.6	369.4	1
RICHL002.2DA	2005-2012	28	90	>533.2	4610	369.6	2
Richland 2	2011-2018	58	40.5	526.7	7120	528.9	6
	2016-2018	28	40.5	350.0	1011.2	528.9	1

Table 5 (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
RICHL004.5DA	2020	2	461	638.5	816	867.4	0
RICHL005.0DA	2015-2016	12	35	280.5	613	Ngd	0
	2016	6	35	311.7	613	Ngd	0
RICHL007.8DA	*2010-2020*	*26*	*10*	*166.5*	*866*	*Ngd*	*3*
	2016-2020	*9*	*10*	*152.3*	*687*	*Ngd*	*1*
RICHL008.9DA/ Richland 3	*2005-2018*	*59*	*22.8*	*712.7*	*5120*	*867.4*	*22*
	2016-2018	*21*	*22.8*	*662.6*	*2419.3*	*867.4*	*9*
SEVEN000.2DA/ Sevenmile 1	2005-2020	*61*	*49.4*	*410.2*	*2400*	*437.8*	*13*
	2016-2020	*23*	*49.4*	*321.0*	*727*	*431.4*	*7*
SEVEN003.8DA/ Sevenmile 2	2005-2020	*63*	*<1*	*>543.7*	*7700*	*1201.4*	*11*
	2016-2020	*25*	*62.1*	*252.3*	*501.2*	*401.1*	*1*
Shasta	*2015-2020*	*29*	*61.4*	*483.0*	*1732.9*	*1006.3*	*12*
	2016-2020	*19*	*61.4*	*389.2*	*686.7*	*546.2*	*6*
SIMS000.2DA/ Sims 1	*2015-2020*	*40*	*42*	*278.6*	*1300*	*374.5*	*3*
	2016-2020	*23*	*75.7*	*324.6*	*1300*	*374.5*	*3*
SIMS000.8DA	*2005-2016*	*32*	*29*	*365.9*	*2400*	*249.7*	*6*
	2016	*4*	*79*	*241.5*	*411*	*Ngd*	*0*
SIMS001.2DA	*2020*	*2*	*135*	*213.0*	*291*	*Ngd*	*0*

Table 5 (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
SLATE000.3SR	2005-2020	33	14	1061.7	19,860	996.5	4
	2016-2020	5	48	201.8	579	141.8	0
SLATE001.1SR	2015-2020	10	55	224.5	770	189.7	0
	2016-2020	5	55	182.8	517	129.4	0
SORGH000.3DA/ Sorghum	*2010-2015*	*36*	*49.5*	*>805.6*	*6490*	*1601.8*	*16*
SUGAR000.1DA/ Sugartree	2005-2020	71	16	>837.2	19,860	542.3	10
	2016-2020	29	44.1	>375.7	>2420	393.1	3
Turkey	*2014-2020*	*25*	*8.6*	*>398.4*	*>2419.6*	*263.7*	*5*
	2019-2020	*15*	*8.6*	*343.5*	*1413.6*	*174.2*	*3*
VGAP000.2DA/ Vaughns Gap 1	2005-2020	88	16	546.8	8130	670.2	10
	2016-2020	29	25	171.0	461	193.0	0
VGAP001.2DA/ Vaughns Gap 2	2011-2017	50	29.5	>633.4	4260	1150.0	10
	2016-2017	20	31.7	288.0	1732.9	272.1	1
WFBRO000.1DA/ W Fork Browns	2005-2020	83	1	>883.1	29,090	668.2	13
	2016-2020	29	1	>277.9	>2420	312.6	1
WHITT001.0DA/ Whittemore	*2005-2015*	*36*	*104.6*	*>813.0*	*4610*	1841.2	*18*

* 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

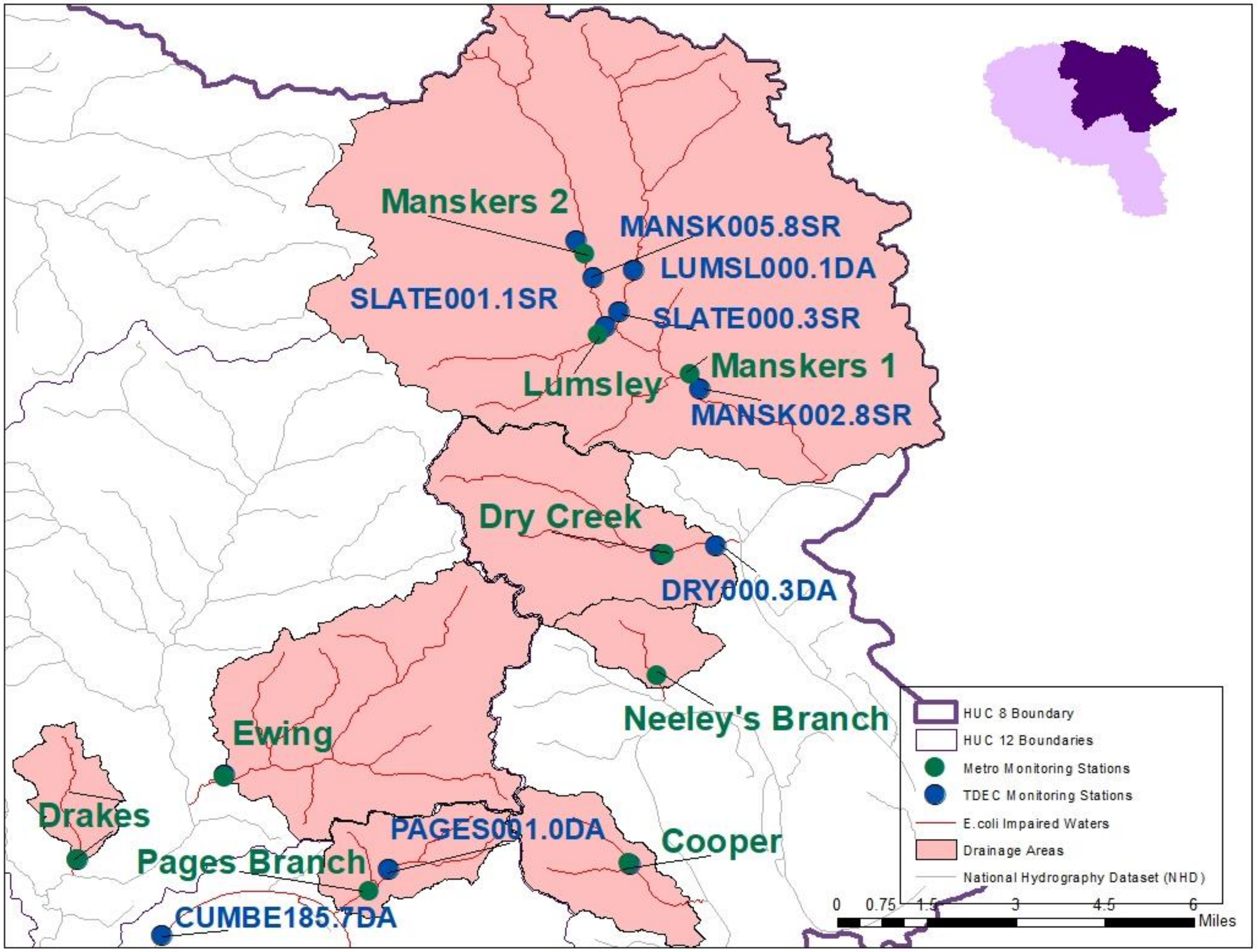

Figure 7. Water Quality Monitoring Stations in the Cheatham Lake Watershed – Part 1

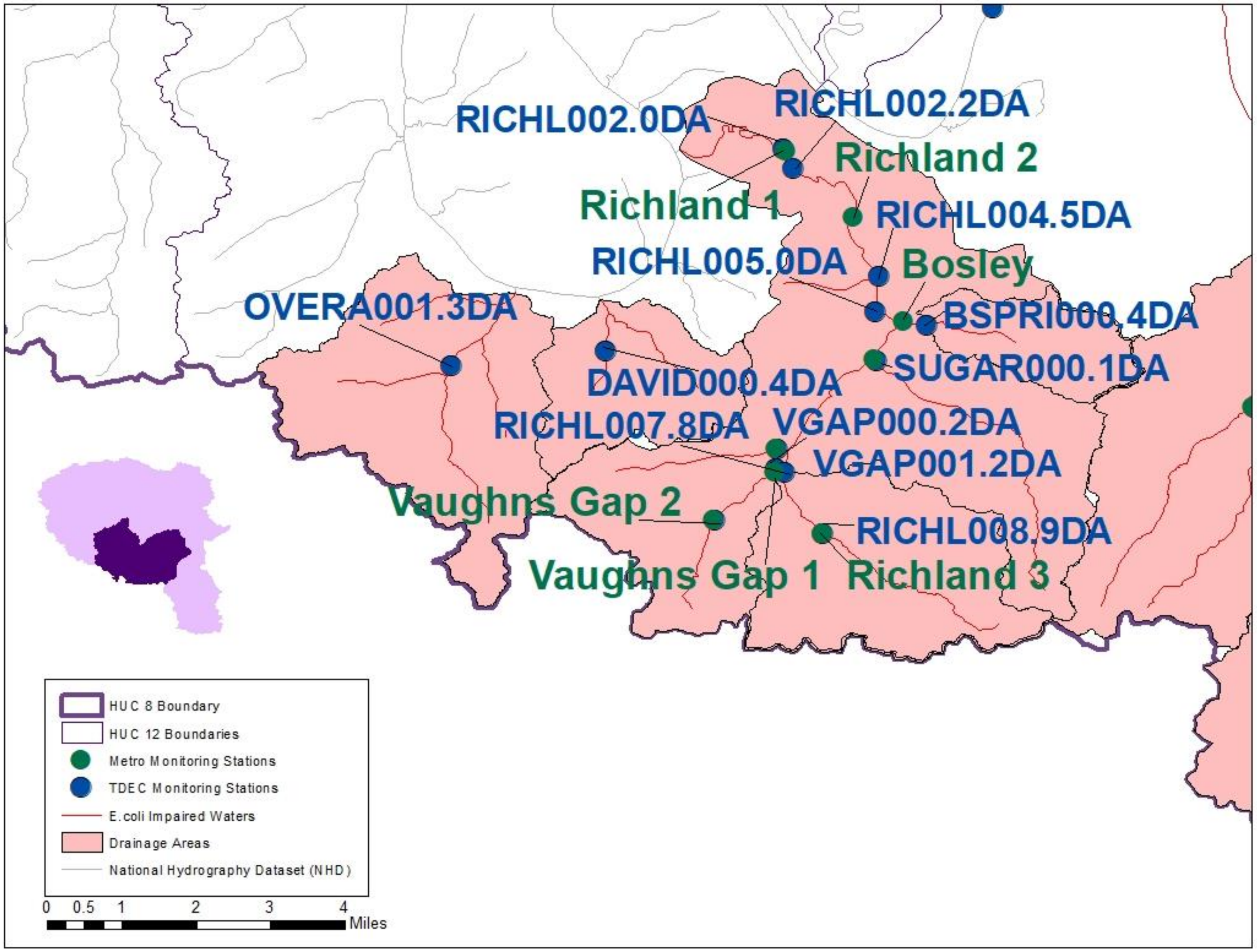

Figure 8. Water Quality Monitoring Stations in the Cheatham Lake Watershed – Part 2

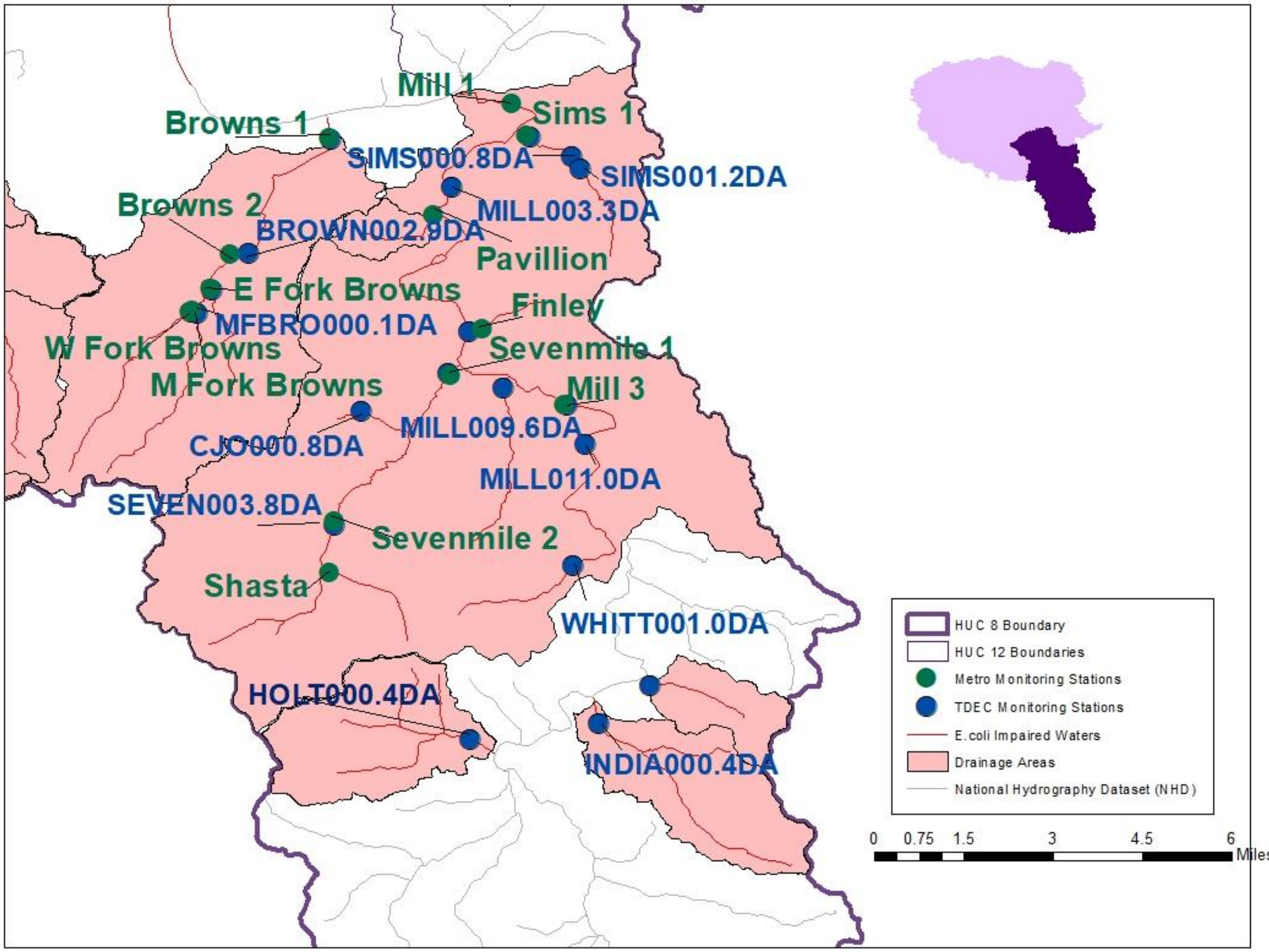

Figure 9. Water Quality Monitoring Stations in the Cheatham Lake Watershed – Part 3

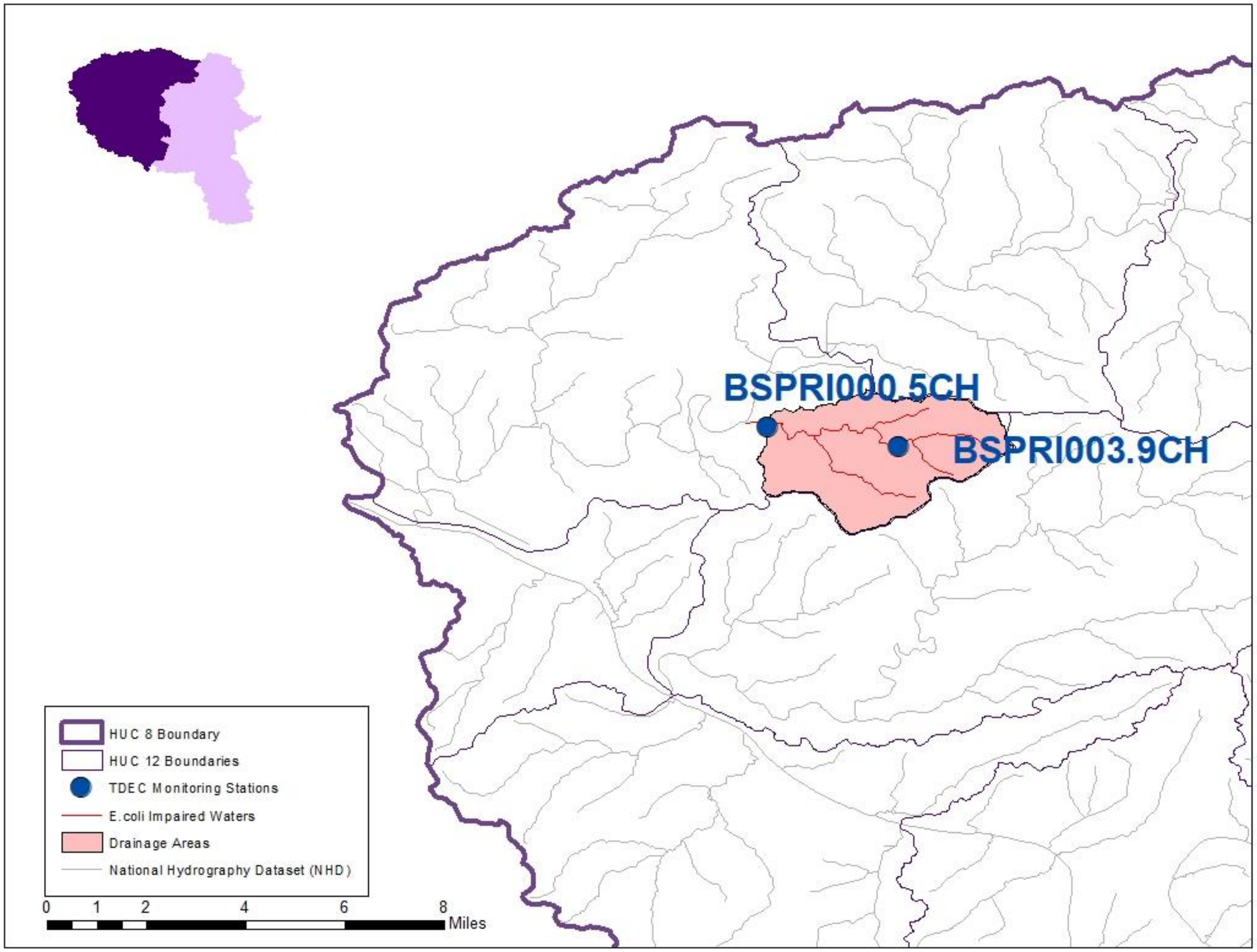

Figure 10. Water Quality Monitoring Stations in the Cheatham Lake Watershed – Part 4

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.

Under the Clean Water Act, sources are classified as either point or nonpoint sources. Under 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 four facilities located in or upstream of impaired subwatersheds or drainage areas within the Cheatham Lake watershed that have NPDES permits authorizing the discharge of treated sanitary or process wastewater. (Figure 11 and Table 6). All four of the facilities are wastewater treatment plants (WWTPs) serving municipalities with design capacities equal to or greater than 1.0 million gallons per day (MGD). The permit limits for discharges from these WWTPs are in accordance with the coliform criteria specified in Tennessee Water Quality Standards for the protection of the recreation use classification.

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

Nashville is one of only three cities in Tennessee with a Combined Sewer System (CSS). A CSS consists of a single set of pipes that conveys both sanitary sewage and storm water. The use of a CSS was common in cities that developed in the 19th century to address public health problems caused by lack of proper sanitation. The treatment of wastewater began in the 20th century, and interceptors were constructed to convey sanitary sewage along with storm water to treatment plants to improve water quality. However, intense rainfall often leads to flows in the CSS that exceeds the capacity of the treatment plants. These high flows are discharged without treatment and are referred to as combined sewer overflows (CSO).

When the Overflow Abatement Program began in 1990, there were a total of 32 CSO discharge points in downtown Nashville. With the expenditure of over $265 million on improvements, significant reductions in CSO discharges have been attained. These improvements have eliminated 26 CSO discharge sites and greatly reduced the total volume of untreated discharges into the Cumberland River on an annual basis (AECOM, 2011). See Appendix F – Trend Analysis for an illustration of the reduction in exceedances occurring at Bordeaux Bridge of the Cumberland River.

Table 6. Facilities with NPDES Permits to Discharge Sanitary Wastewater Located in Impaired Subwatersheds and Drainage Areas of the Cheatham Lake Watershed

NPDES Permit No.	Facility	Design Flow [MGD*]	Receiving Stream
TN0020575	Metro Water Services – Central STP and CSO	0-220	Cumberland River Mile 189.2
TN0020648	Metro Water Services – Nashville Dry Creek STP	24	Cumberland River Mile 213.9
TN0024970	Metro Water Services – Nashville Whites Creek STP	37.5	Cumberland River Mile 182.6
TN0074748	Harpeth Valley Utility District	10	Cumberland River Mile 172.4

*Million Gallons/Day (MGD)

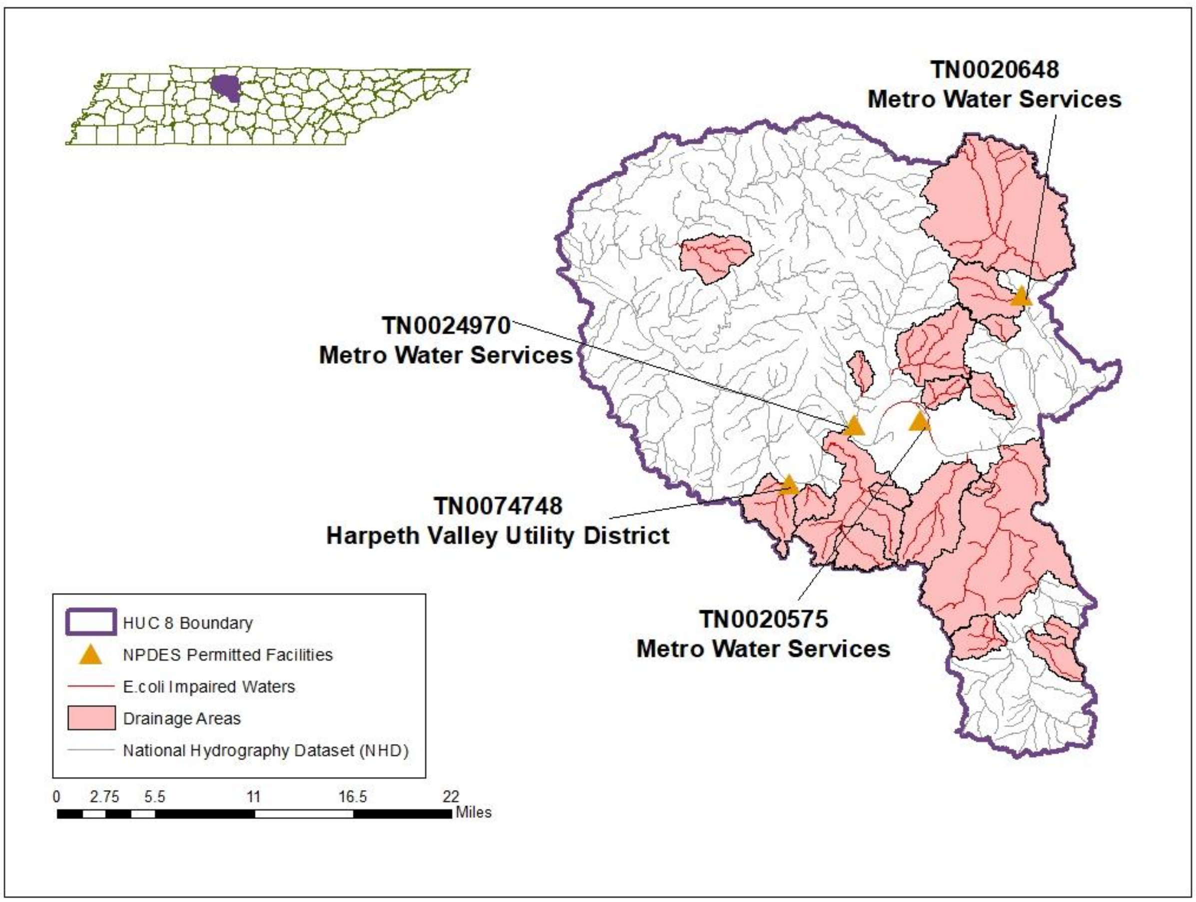

Figure 11. Facilities with NPDES Permits to Discharge Sanitary Wastewater To Impaired Subwatersheds and Drainage Areas of the Cheatham Lake Watershed

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, Nashville/Davidson County is the only large or medium (Phase 1) MS4 located in the Cheatham Lake 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, 2016).

Belle Meade, Berry Hill, Brentwood, Forest Hills, Goodlettsville, Millersville, Nolensville, Oak Hill, Sumner County, and Williamson County are covered under Phase II of the NPDES Stormwater Program.

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 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 newly passed legislation, changes to the CAFO program in Tennessee are being implemented. As of July 1, 2018, only large CAFOs that have the outdoor storage of liquid manure will be 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 Cheatham Lake 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 2020 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 Cheatham Lake 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 Cheatham Lake 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 Cheatham Lake watershed were derived from 2010 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 Cheatham Lake watershed ranges from 6.13% to 96.9%. Land use for the Cheatham Lake drainage areas is summarized in Figures 12-21, and tabulated in Appendix A. 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 Cheatham Lake Watershed

County	Livestock Population (2017 Census of Agriculture)							
	Beef Cow	Milk Cow	Poultry		Hogs	Sheep	Goats	Horse
			Layers	Broilers				
Cheatham	3,921	31	1,648	365	257	92	973	668
Davidson	3,148	40	1,898	3,205	125	62	824	829
Robertson	14,239	1,466	3,244	1,569	1,284	554	1,346	1,294
Sumner	17,961	602	4,980	2,650	436	813	2,210	1,720
Williamson	13,644	464	5,205	1,905	277	1,494	2,167	2,941

* 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 Cheatham Lake Watershed

County	% of Population on Septic Systems (1990)	Total Population (2010 Census)	Estimated Population on Septic (2010)*
Cheatham	80.1	39,105	31,323
Davidson	7.8	626,681	48,881
Robertson	56.9	66,283	37,715
Sumner	47.4	160,645	76,146
Williamson	48.1	183,182	88,111

* Estimate based on 2010 census and 1990 percent of population on septic.

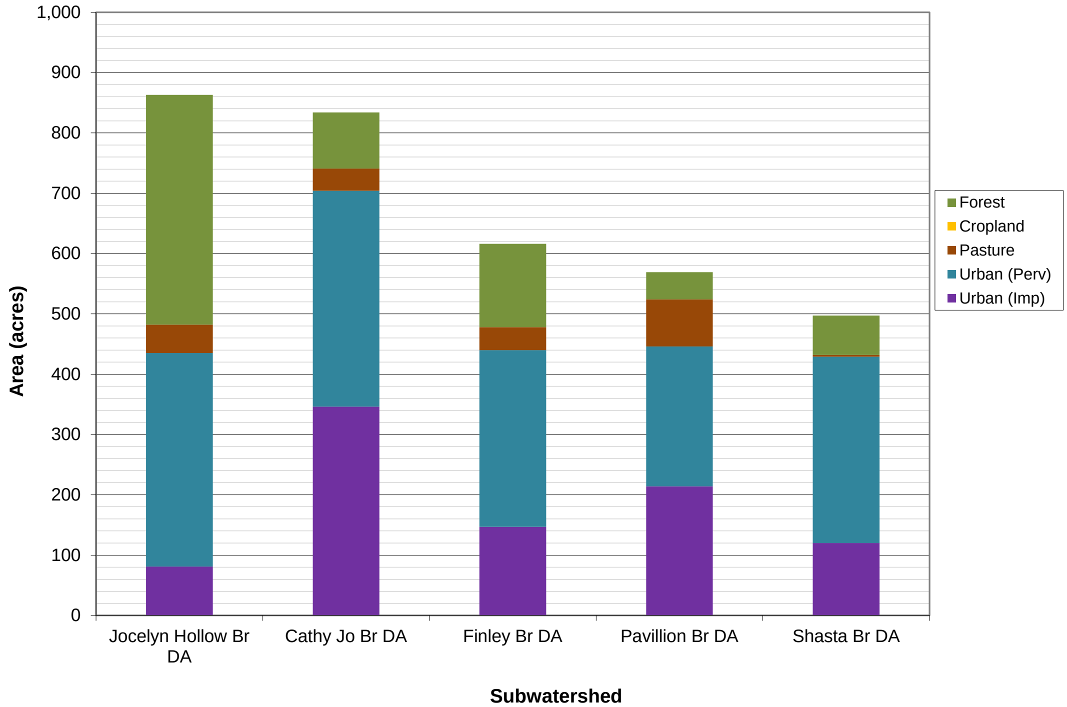

Figure 12. Land Use Area of Cheatham Lake *E. coli*-Impaired Subwatersheds (less than 1,000 acres)

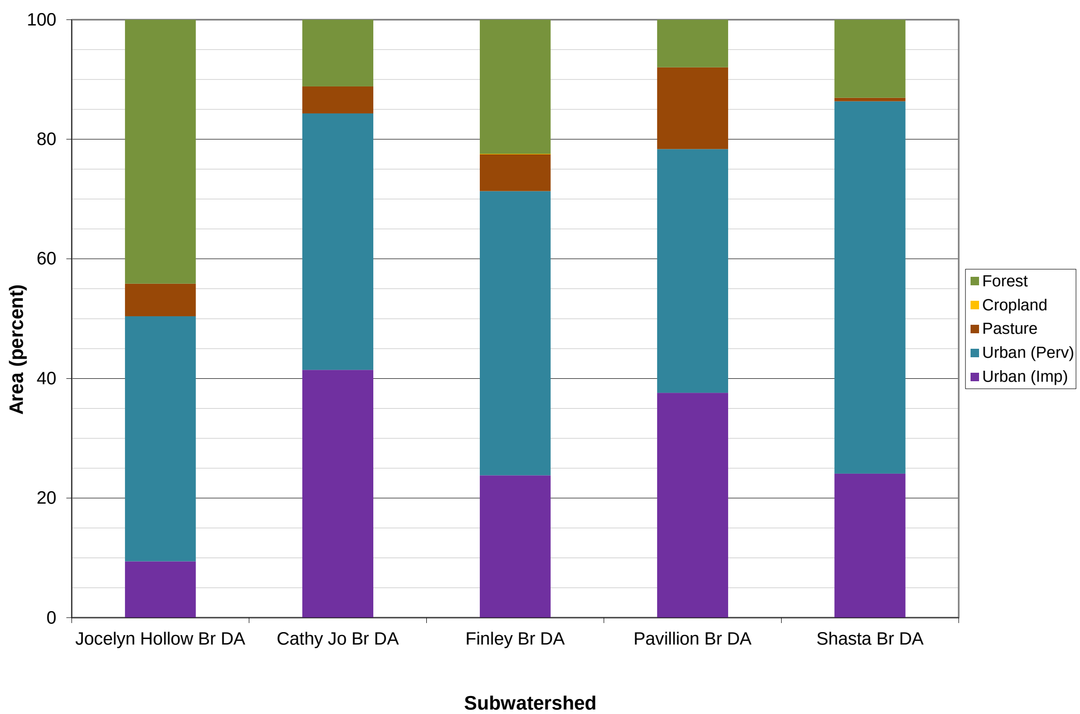

Figure 13. Land Use Percent of Cheatham Lake *E. coli*-Impaired Subwatersheds (less than 1,000 acres)

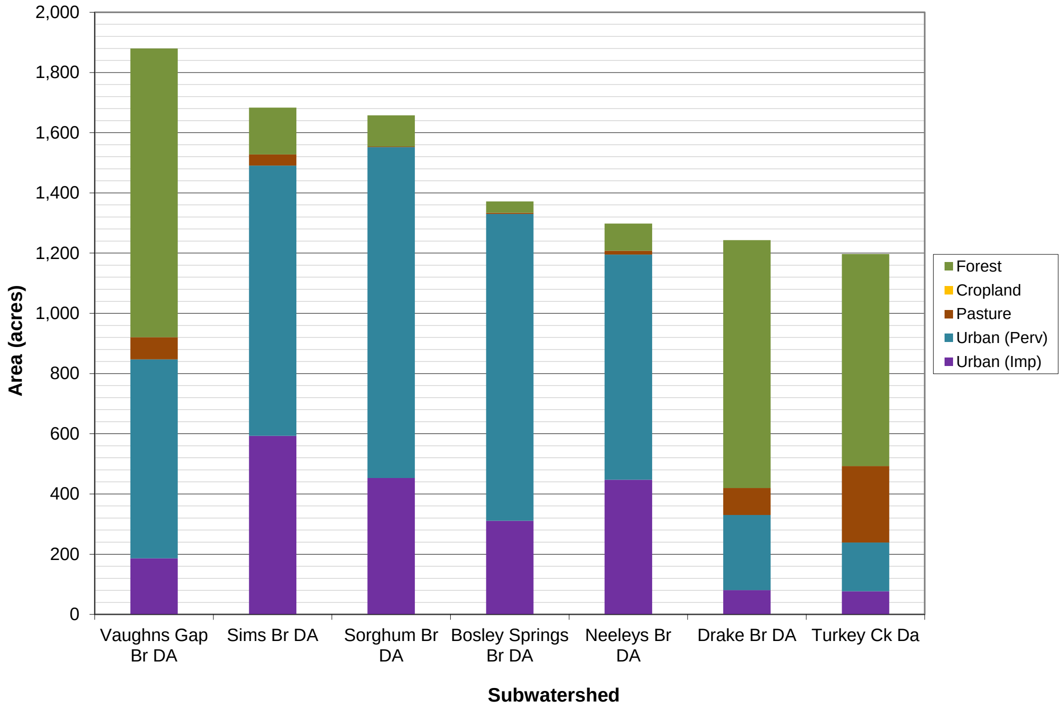

Figure 14. Land Use Area of Cheatham Lake *E. coli*-Impaired Subwatersheds (greater than 1,000 and less than 2,000 acres)

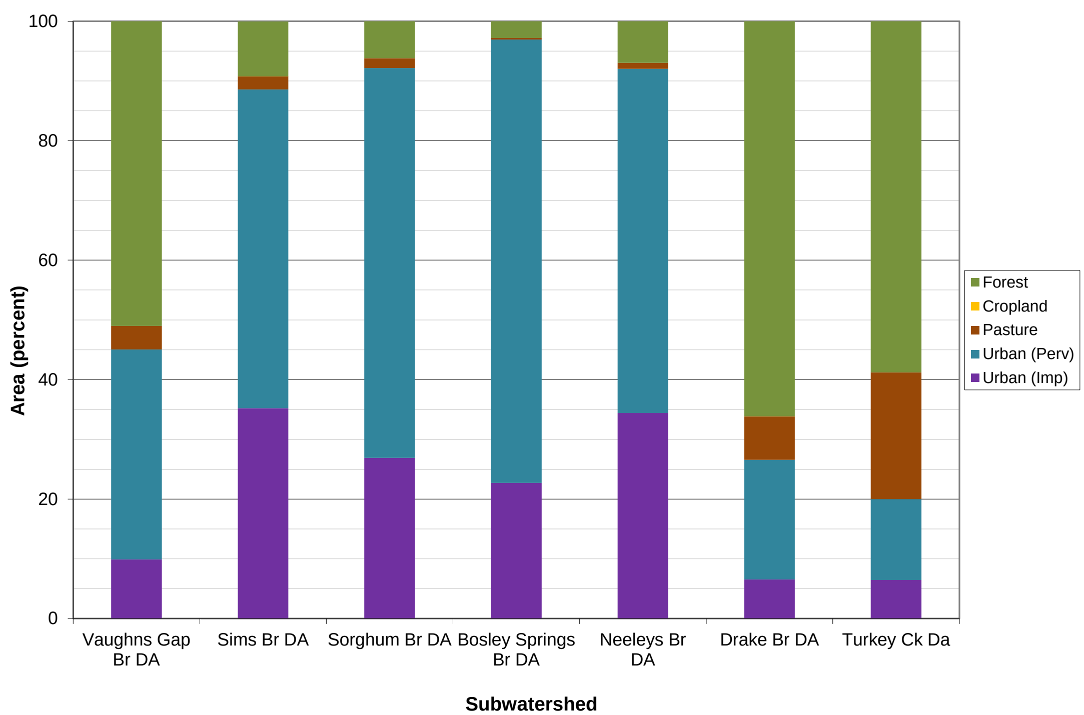

Figure 15. Land Use Percent of Cheatham Lake *E. coli*-Impaired Subwatersheds (greater than 1,000 and less than 2,000 acres)

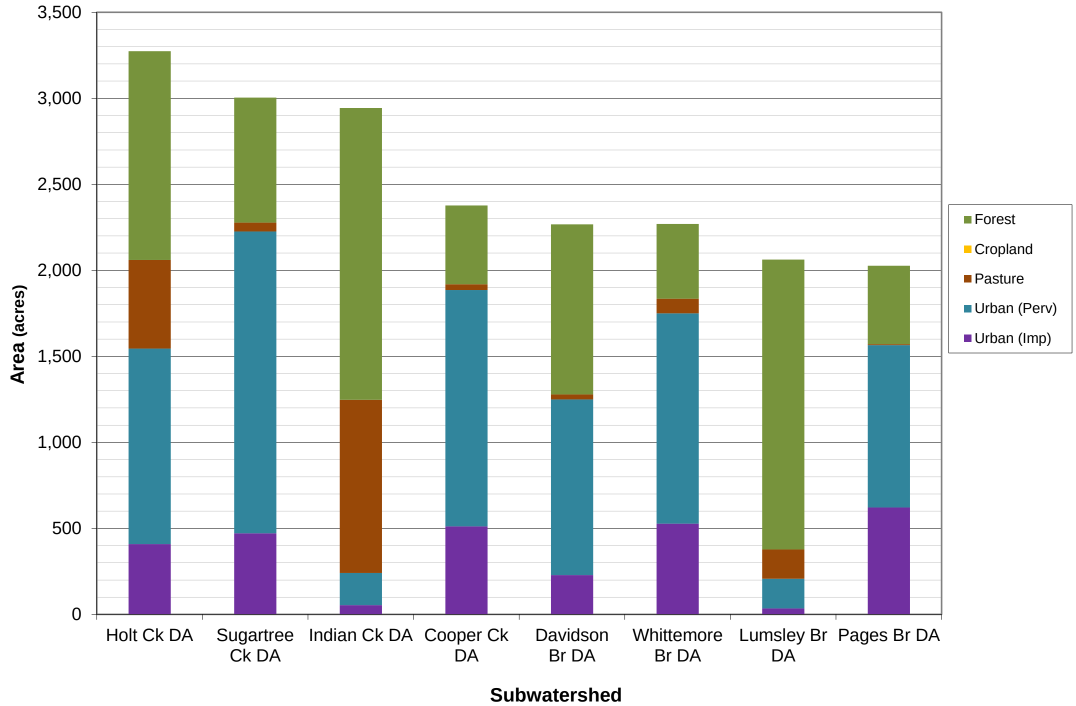

Figure 16. Land Use Area of Cheatham Lake *E. coli*-Impaired Subwatersheds (greater than 2,000 and less than 4,000 acres)

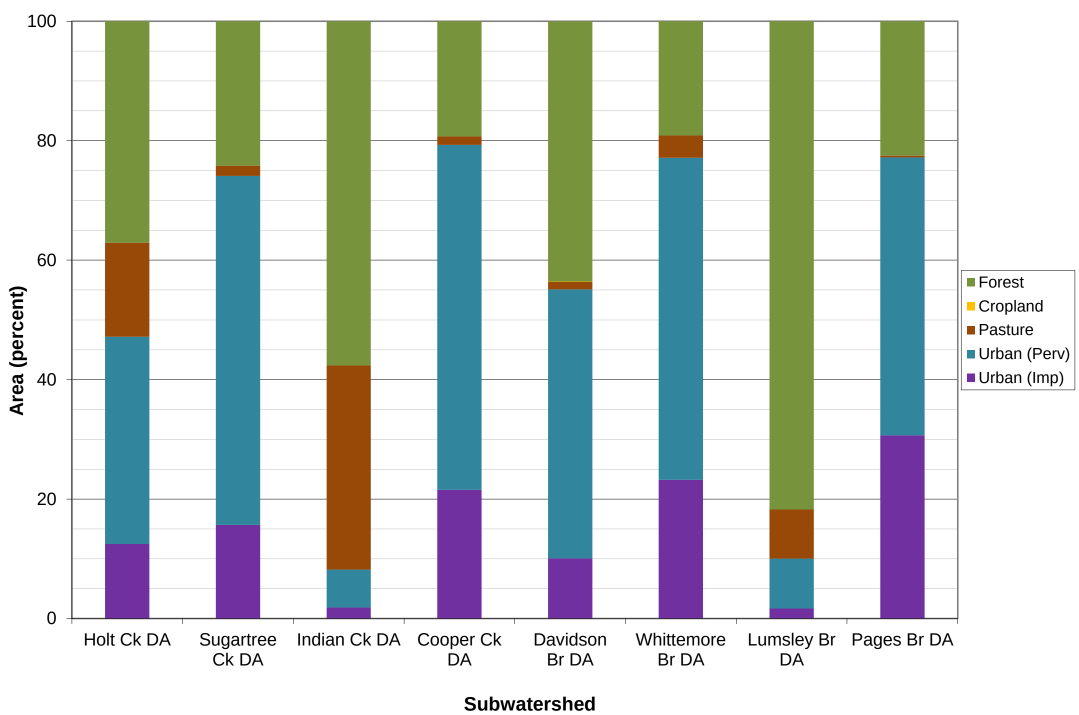

Figure 17. Land Use Percent of Cheatham Lake *E. coli*-Impaired Subwatersheds (greater than 2,000 and less than 4,000 acres)

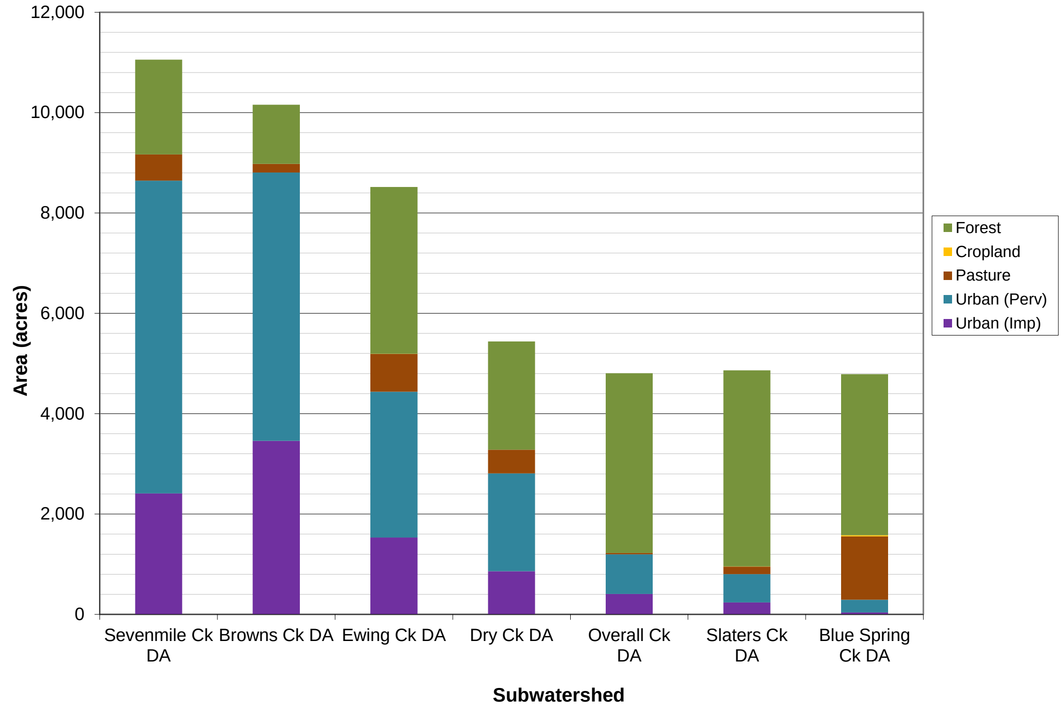

Figure 18. Land Use Area of Cheatham Lake *E. coli*-Impaired Subwatersheds (greater than 4,000 and less than 15,000 acres)

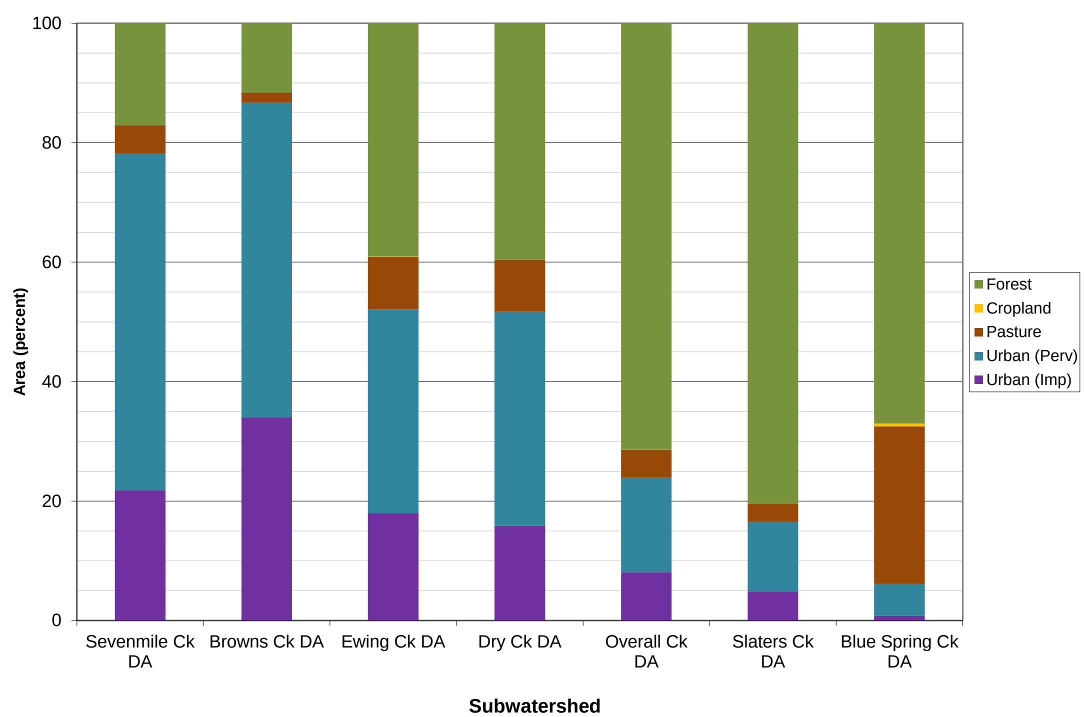

Figure 19. Land Use Percent of Cheatham Lake *E. coli*-Impaired Subwatersheds (greater than 4,000 and less than 15,000 acres)

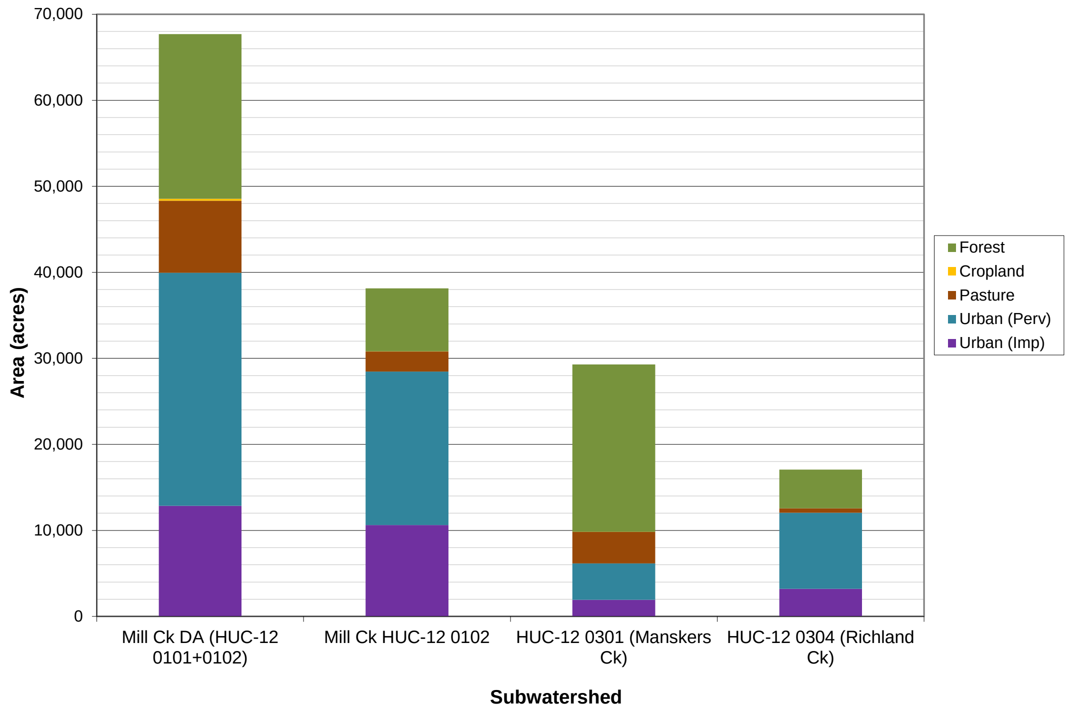

Figure 20. Land Use Area of Cheatham Lake *E. coli*-Impaired Subwatersheds (greater than 15,000 acres)

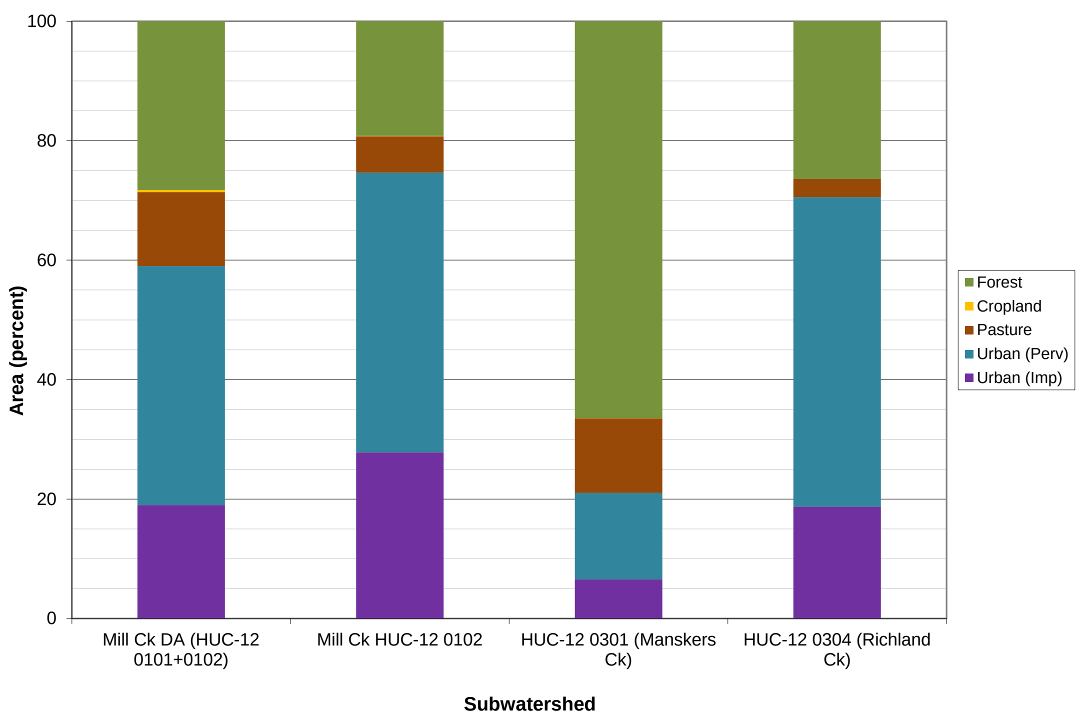

Figure 21. Land Use Percent of Cheatham Lake *E. coli*-Impaired Subwatersheds (greater than 15,000 acres)

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:

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

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

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 2020 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. 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 2020 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 (05130202____)	Impaired Waterbody	Area
0101	Holt Creek	DA
	Indian Creek	DA
	Turkey Creek	DA
0102	Mill Creek (007_1000)	HUC-12
	Mill Creek (007_2000)	
	Mill Creek (007_3000)	
	Cathy Jo Branch	
	Finley Branch	
	Sevenmile Creek (007_1400)	
	Sevenmile Creek (007_1450)	
	Shasta Branch	
	Sims Branch	
	Sorghum Branch	
	Whittemore Branch	
	Pavillion Branch	DA
0203	Blue Spring Creek	DA
0301	Lumsley Fork	HUC-12
	Manskers Creek (220_1000)	
	Manskers Creek (220_2000)	
	Slaters Creek (220_0300)	
	Slaters Creek (220_0350)	
0302	Cooper Creek	DA
	Dry Creek (027_1000)	DA
	Dry Creek (027_2000)	
	Neeleys Branch	DA
0303	Drake Branch	DA
	Ewing Creek	DA
0304	Bosley Springs Branch	DA
	Jocelyn Hollow Branch	HUC-12
	Richland Creek (314_1000)	
	Richland Creek (314_2000)	
	Richland Creek (314_3000)	DA
0304 (cont'd)	Sugartree Creek	HUC-12
	Vaughns Gap Branch (314_0700)	
	Vaughns Gap Branch (314_0750)	
0305	Cheatham Reservoir	DA
	Browns Creek (023_1000)	DA
	Browns Creek (023_2000)	
	East Fork Browns Creek	
	Middle Fork Browns Creek	
	West Fork Browns Creek	
	Pages Branch	DA

Table 9 (cont'd). Determination of Analysis Areas for TMDL Development

Subwatershed (05130202____)	Impaired Waterbody	Area
0306	Davidson Branch	DA
	Overall Creek	DA

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

HUC-12 0101 is part of the drainage area of Mill Creek. However, Mill Creek within HUC-12 0101 is not impaired for *E. coli* and the landuse of the *E. coli* impaired waterbodies in HUC-12 0101 is different from the landuse in HUC-12 0102 (Figure 22). For the *E. coli* impaired waterbodies in HUC-12 0101, the percentages of urban area are lower than the percentages of urban area in HUC-12 0102, and the percentages of forest and pasture are almost double the percentages of forest and pasture in HUC-12 0102. Therefore, the *E. coli* impaired waterbodies in HUC-12 0101 (Holt Creek, Indian Creek, and Turkey Creek) will be analyzed as drainage areas rather than on a HUC-12 basis.

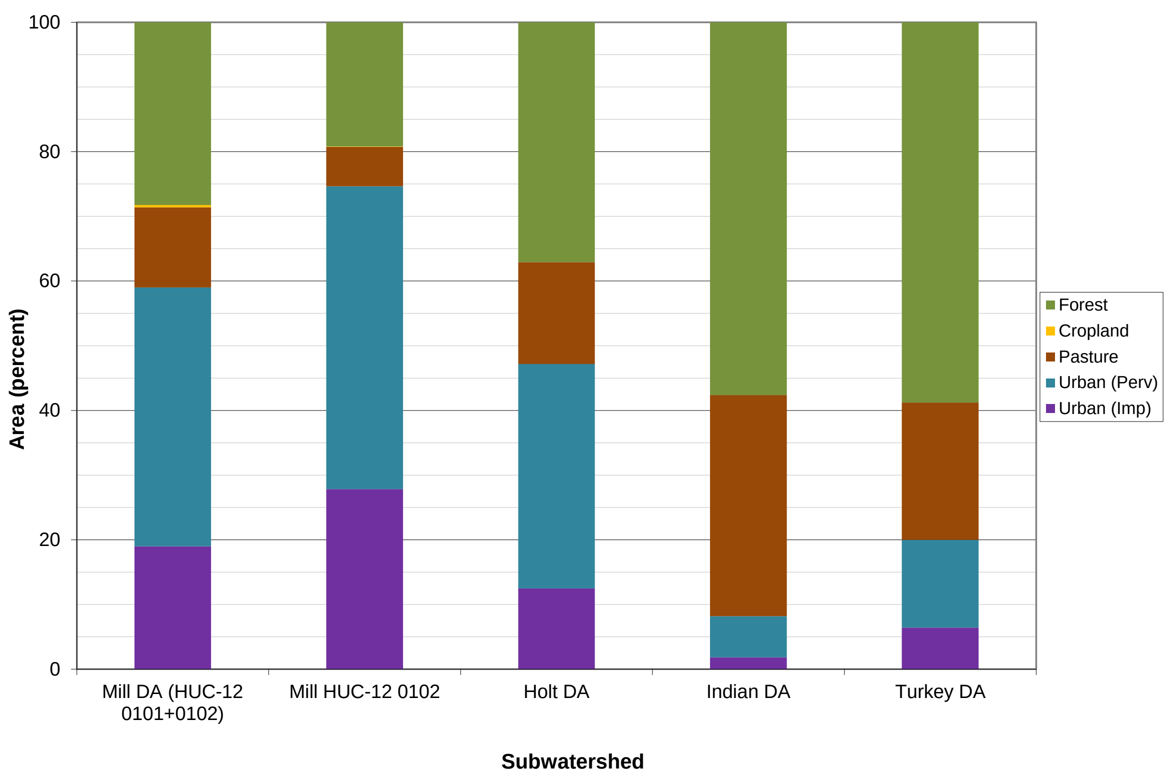

Figure 22. Comparison of Land Use Percent of Cheatham Lake *E. coli*-Impaired Subwatersheds in HUC-12 0101 (Mill Creek)

Most of HUC-12 0102 (Mill Creek) was analyzed on a HUC-12 basis. However, the Pavillion Branch drainage area was almost 15% agriculture while the remainder of HUC-12 0102 was less than 10% agriculture (Figure 23). Therefore, Pavillion Branch DA will be analyzed separately from the rest of the HUC-12.

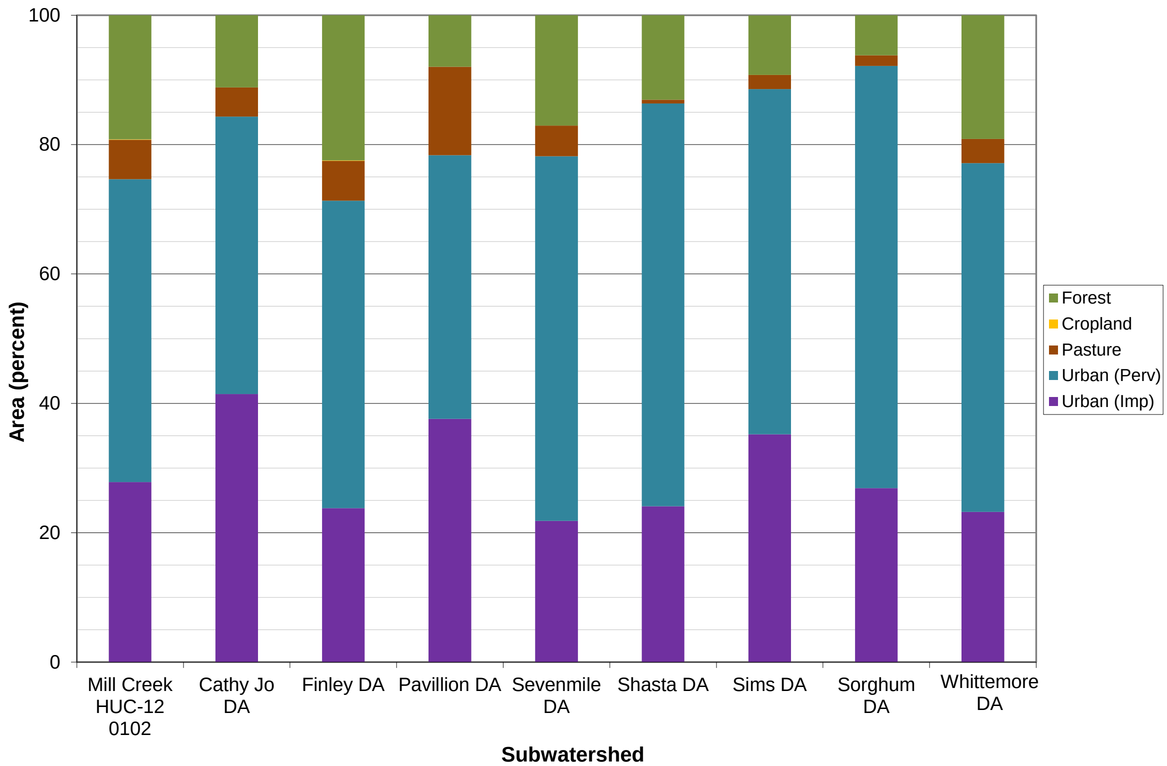

Figure 23. Comparison of Land Use Percent of Cheatham Lake *E. coli*-Impaired Subwatersheds in HUC-12 0102 (Mill Creek)

Most of HUC-12 0304 (Richland Creek) was analyzed on a HUC-12 basis. However, the Bosley Springs drainage area was almost entirely urban while the remainder of HUC-12 0304 was 50-70% urban (Figure 24). Therefore, Bosley Springs DA will be analyzed separately from the rest of the HUC-12. The upstream portion of Richland Creek, including Jocelyn Hollow and Vaughns Gap Branch, was identified as an Exceptional Tennessee Waters. This portion of Richland Creek will be analyzed as a separate drainage area.

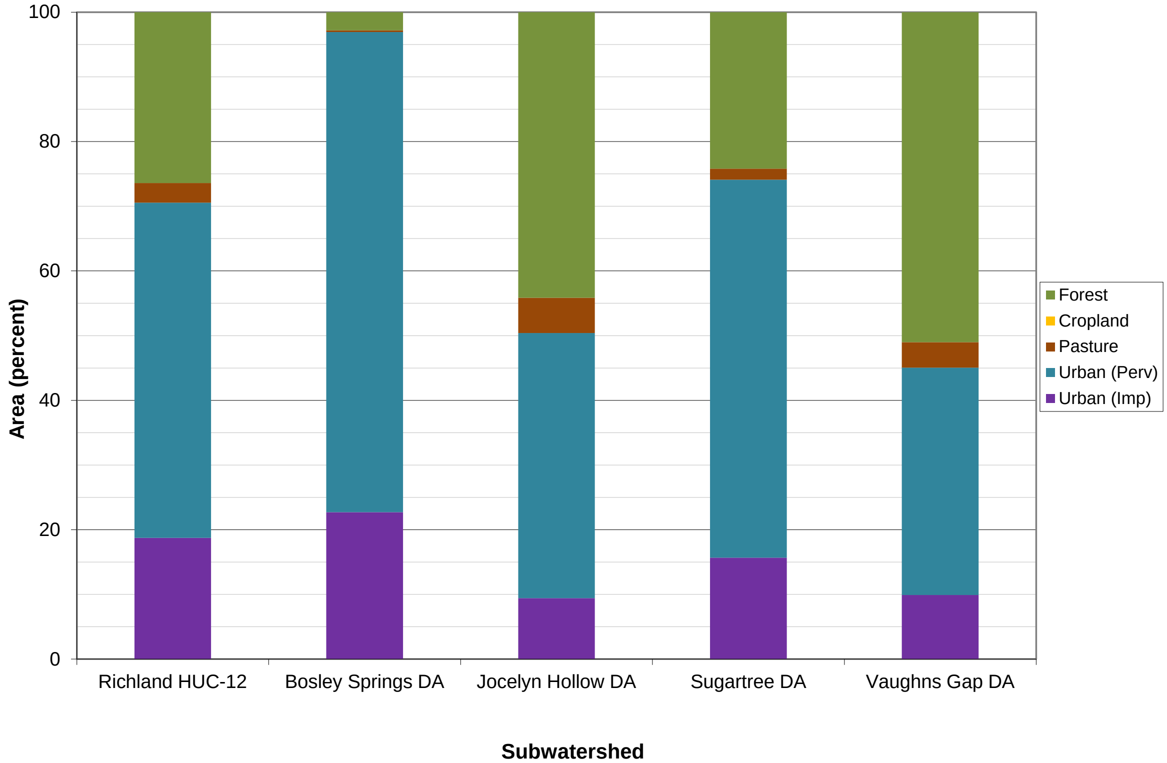

Figure 24. Comparison of Land Use Percent of Cheatham Lake *E. coli*-Impaired Subwatersheds in HUC-12 0304 (Richland Creek)

8.3 TMDL Analysis Methodology

TMDLs for the Cheatham Lake 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 existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the portion of the waterbody flow zone represented by these existing loads. Load duration curves are considered to be well suited for analysis of periodic monitoring data collected by grab sample. LDCs were developed at monitoring site locations in impaired waterbodies and 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.

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, 2005 and December 31, 2020 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 Cheatham Lake 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 Cheatham Lake 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 Cheatham Lake 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.

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) 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 Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0101	Turkey Creek [d,e]	TN05130202007_0700	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2\times10^{10} \times q_m)$	$(9.014 \times 10^6 \times Q) – (1.00 \times 10^7 \times q_d)$	$(9.014 \times 10^6 \times Q) – (1.00 \times 10^7 \times q_d)$
	Indian Creek [d,e]	TN05130202007_0800				$(3.667 \times 10^6 \times Q) – (4.08 \times 10^6 \times q_d)$	$(3.667 \times 10^6 \times Q) – (4.08 \times 10^6 \times q_d)$
	Holt Creek [d,e]	TN05130202007_1100				$(3.299 \times 10^6 \times Q) – (3.67 \times 10^6 \times q_d)$	$(3.299 \times 10^6 \times Q) – (3.67 \times 10^6 \times q_d)$
0102	Sims Branch [d,e]	TN05130202007_0100	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2\times10^{10} \times q_m)$	$(4.049 \times 10^6 \times Q) – (4.50 \times 10^6 \times q_d)$	$(4.049 \times 10^6 \times Q) – (4.50 \times 10^6 \times q_d)$
	Finley Branch [d,e]	TN05130202007_0300				$(1.753 \times 10^7 \times Q) – (1.95 \times 10^7 \times q_d)$	$(1.753 \times 10^7 \times Q) – (1.95 \times 10^7 \times q_d)$
	Mill Creek [d,e]	TN05130202007_1000				$(1.596 \times 10^5 \times Q) – (1.77 \times 10^5 \times q_d)$	$(1.596 \times 10^5 \times Q) – (1.77 \times 10^5 \times q_d)$
	Whittemore Branch [d,e]	TN05130202007_1200				$(4.764 \times 10^6 \times Q) – (5.29 \times 10^6 \times q_d)$	$(4.764 \times 10^6 \times Q) – (5.29 \times 10^6 \times q_d)$
	Sorghum Branch [d,e]	TN05130202007_1300				$(6.416 \times 10^6 \times Q) – (7.13 \times 10^6 \times q_d)$	$(6.416 \times 10^6 \times Q) – (7.13 \times 10^6 \times q_d)$
	Sevenmile Creek [d,e]	TN05130202007_1400				$(9.965 \times 10^5 \times Q) – (1.11 \times 10^6 \times q_d)$	$(9.965 \times 10^5 \times Q) – (1.11 \times 10^6 \times q_d)$
	Shasta Branch [d,e]	TN05130202007_1410				$(2.173 \times 10^7 \times Q) – (2.42 \times 10^7 \times q_d)$	$(2.173 \times 10^7 \times Q) – (2.42 \times 10^7 \times q_d)$
	Sevenmile Creek [d,e]	TN05130202007_1450				$(2.215 \times 10^6 \times Q) – (2.46 \times 10^6 \times q_d)$	$(2.215 \times 10^6 \times Q) – (2.46 \times 10^6 \times q_d)$
	Cathy Jo Branch [d,e]	TN05130202007_1490				$(1.294 \times 10^7 \times Q) – (1.44 \times 10^7 \times q_d)$	$(1.294 \times 10^7 \times Q) – (1.44 \times 10^7 \times q_d)$
	Pavillion Branch [d,e]	TN05130202007_1500				$(1.897 \times 10^7 \times Q) – (2.11 \times 10^7 \times q_d)$	$(1.897 \times 10^7 \times Q) – (2.11 \times 10^7 \times q_d)$
	Mill Creek [d,e]	TN05130202007_2000				$(1.698 \times 10^5 \times Q) – (1.89 \times 10^5 \times q_d)$	$(1.698 \times 10^5 \times Q) – (1.89 \times 10^5 \times q_d)$
	Mill Creek [d,e]	TN05130202007_3000				$(2.665 \times 10^5 \times Q) – (2.96 \times 10^5 \times q_d)$	$(2.665 \times 10^5 \times Q) – (2.96 \times 10^5 \times q_d)$
0203	Blue Spring Creek [d,e]	TN05130202014_0900	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	$(4.323 \times 10^6 \times Q) – (4.80 \times 10^6 \times q_d)$	$(4.323 \times 10^7 \times Q) – (4.80 \times 10^7 \times q_d)$
0301	Lumsley Fork [d,e]	TN05130202220_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3\times10^{10} \times q_m)$	$(1.004 \times 10^7 \times Q) – (1.12 \times 10^7 \times q_d)$	$(1.004 \times 10^7 \times Q) – (1.12 \times 10^7 \times q_d)$
	Slaters Creek [d,e]	TN05130202220_0300				$(4.255 \times 10^6 \times Q) – (4.73 \times 10^6 \times q_d)$	$(4.255 \times 10^6 \times Q) – (4.73 \times 10^6 \times q_d)$
	Slaters Creek [d,e]	TN05130202220_0350				$(4.634 \times 10^6 \times Q) – (5.15 \times 10^6 \times q_d)$	$(4.634 \times 10^6 \times Q) – (5.15 \times 10^6 \times q_d)$

Table 10 (cont'd) TMDLs, WLAs, & LAs expressed as daily loads for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0301 (cont'd)	Manskers Creek [e]	TN05130202220_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(7.068 \times 10^{5} \times Q) - (7.85 \times 10^{5} \times q_d)$	$(7.068 \times 10^{5} \times Q) - (7.85 \times 10^{5} \times q_d)$
	Manskers Creek [d,e]	TN05130202220_2000				$(6.231 \times 10^{6} \times Q) - (6.92 \times 10^{6} \times q_d)$	$(6.231 \times 10^{6} \times Q) - (6.92 \times 10^{6} \times q_d)$
0302	Dry Creek [d,e]	TN05130202027_1000	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(3.806 \times 10^{6} \times Q) - (4.23 \times 10^{6} \times q_d)$	$(3.806 \times 10^{6} \times Q) - (4.23 \times 10^{6} \times q_d)$
	Dry Creek [d,e]	TN05130202027_2000				$(5.049 \times 10^{6} \times Q) - (5.61 \times 10^{6} \times q_d)$	$(5.049 \times 10^{6} \times Q) - (5.61 \times 10^{6} \times q_d)$
	Cooper Creek [d,e]	TN05130202209_1000				$(8.710 \times 10^{6} \times Q) - (9.68 \times 10^{6} \times q_d)$	$(8.710 \times 10^{6} \times Q) - (9.68 \times 10^{6} \times q_d)$
	Neeleys Branch [d,e]	TN05130202212_0100				$(1.594 \times 10^{7} \times Q) - (1.77 \times 10^{7} \times q_d)$	$(1.594 \times 10^{7} \times Q) - (1.77 \times 10^{7} \times q_d)$
0303	Drake Branch [d,e]	TN05130202010_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.665 \times 10^{7} \times Q) - (1.85 \times 10^{7} \times q_d)$	$(1.665 \times 10^{7} \times Q) - (1.85 \times 10^{7} \times q_d)$
	Ewing Creek [d,e]	TN05130202010_0900				$(2.430 \times 10^{6} \times Q) - (2.70 \times 10^{6} \times q_d)$	$(2.430 \times 10^{6} \times Q) - (2.70 \times 10^{6} \times q_d)$
0304	Bosley Springs Branch [d,e]	TN05130202314_0300	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.508 \times 10^{7} \times Q) - (1.68 \times 10^{7} \times q_d)$	$(1.508 \times 10^{7} \times Q) - (1.68 \times 10^{7} \times q_d)$
	Sugartree Creek [d,e]	TN05130202314_0400				$(6.892 \times 10^{6} \times Q) - (7.66 \times 10^{6} \times q_d)$	$(6.892 \times 10^{6} \times Q) - (7.66 \times 10^{6} \times q_d)$
	Vaughns Gap Branch [d,e]	TN05130202314_0700				$(1.102 \times 10^{7} \times Q) - (1.22 \times 10^{6} \times q_d)$	$(1.102 \times 10^{7} \times Q) - (1.22 \times 10^{6} \times q_d)$
	Vaughns Gap Branch [d,e]	TN05130202314_0750				$(2.177 \times 10^{7} \times Q) - (2.42 \times 10^{7} \times q_d)$	$(2.177 \times 10^{7} \times Q) - (2.42 \times 10^{7} \times q_d)$
	Richland Creek [e]	TN05130202314_1000				$(1.213 \times 10^{6} \times Q) - (1.35 \times 10^{6} \times q_d)$	$(1.213 \times 10^{6} \times Q) - (1.35 \times 10^{6} \times q_d)$
	Richland Creek [d,e]	TN05130202314_2000				$(1.549 \times 10^{6} \times Q) - (1.72 \times 10^{6} \times q_d)$	$(1.549 \times 10^{6} \times Q) - (1.72 \times 10^{6} \times q_d)$
	Jocelyn Hollow Branch [d,e]	TN05130202314_0800	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(1.250 \times 10^{7} \times Q) - (1.39 \times 10^{7} \times q_d)$	$(1.250 \times 10^{7} \times Q) - (1.39 \times 10^{7} \times q_d)$
	Richland Creek [d,e]	TN05130202314_3000				$(2.808 \times 10^{6} \times Q) - (3.12 \times 10^{6} \times q_d)$	$(2.808 \times 10^{6} \times Q) - (3.12 \times 10^{6} \times q_d)$
0305	Cheatham Reservoir	TN05130202001_3000	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(1.313 \times 10^{3} \times Q) - (1.46 \times 10^{3} \times q_d)$	$(1.313 \times 10^{3} \times Q) - (1.46 \times 10^{3} \times q_d)$
	East Fork Browns Creek [d,e]	TN05130202023_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.527 \times 10^{7} \times Q) - (1.70 \times 10^{7} \times q_d)$	$(1.527 \times 10^{7} \times Q) - (1.70 \times 10^{7} \times q_d)$
	Middle Fork Browns Creek [d,e]	TN05130202023_0200				$(1.220 \times 10^{7} \times Q) - (1.36 \times 10^{7} \times q_d)$	$(1.220 \times 10^{7} \times Q) - (1.36 \times 10^{7} \times q_d)$

Table 10 (cont'd) TMDLs, WLAs, & LAs expressed as daily loads for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0305 (cont'd)	West Fork Browns Creek [d,e]	TN05130202023_0300	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(8.973 \times 10^6 \times Q) - (9.97 \times 10^6 \times q_d)$	$(8.973 \times 10^6 \times Q) - (9.97 \times 10^6 \times q_d)$
	Browns Creek [d,e]	TN05130202023_1000				$(2.038 \times 10^6 \times Q) - (2.26 \times 10^6 \times q_d)$	$(2.038 \times 10^6 \times Q) - (2.26 \times 10^6 \times q_d)$
	Browns Creek [d,e]	TN05130202023_2000				$(2.770 \times 10^6 \times Q) - (3.08 \times 10^6 \times q_d)$	$(2.770 \times 10^6 \times Q) - (3.08 \times 10^6 \times q_d)$
	Pages Branch [d,e]	TN05130202202_1000				$(1.021 \times 10^7 \times Q) - (1.14 \times 10^7 \times q_d)$	$(1.021 \times 10^7 \times Q) - (1.14 \times 10^7 \times q_d)$
0306	Davidson Branch [d,e]	TN05130202001T_0800	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(9.124 \times 10^6 \times Q) - (1.01 \times 10^7 \times q_d)$	$(9.124 \times 10^6 \times Q) - (1.01 \times 10^7 \times q_d)$
	Overall Creek [d,e]	TN05130202001T_0900				$(4.126 \times 10^6 \times Q) - (4.58 \times 10^6 \times q_d)$	$(4.126 \times 10^6 \times Q) - (4.58 \times 10^6 \times q_d)$

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

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 Cheatham Lake 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 25): 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.

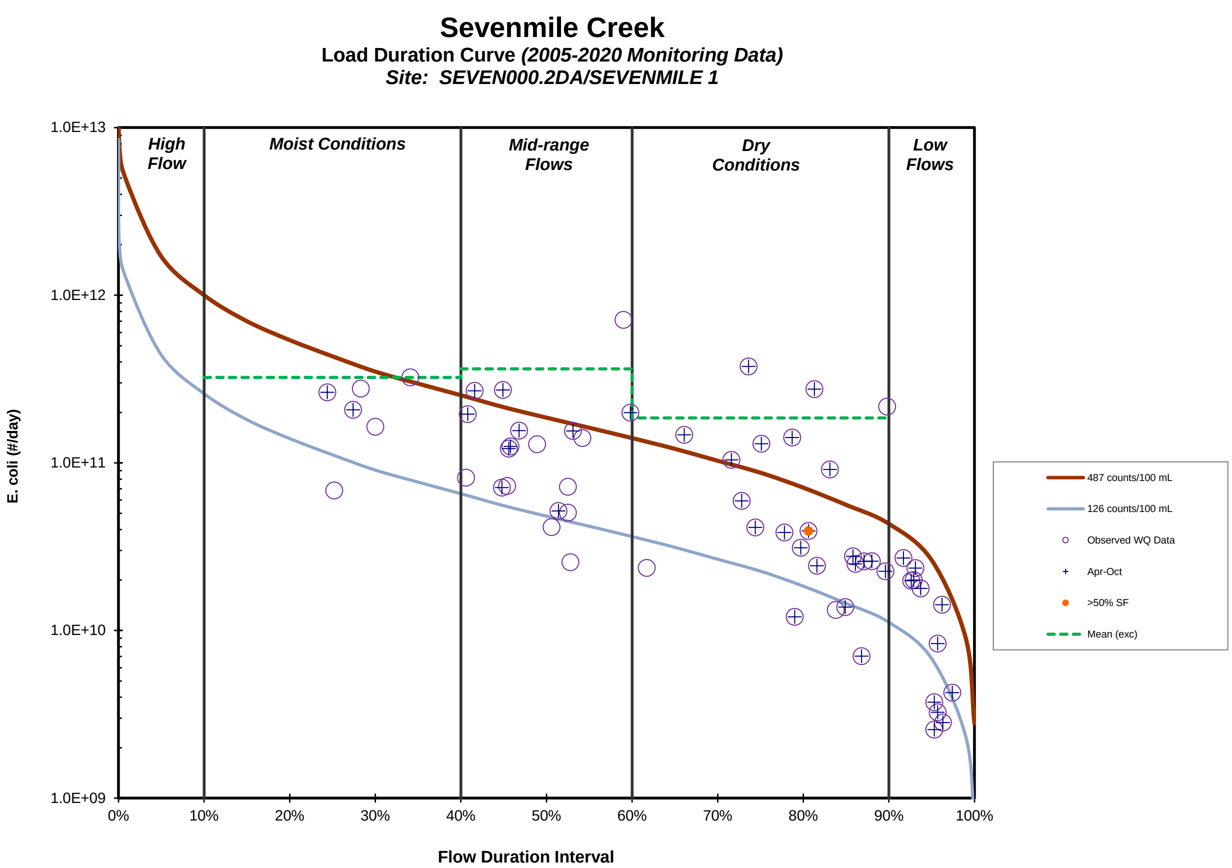

Figure 25. Five-Zone Flow Duration Curve for Sevenmile Creek at RM 0.2

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 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 Regulated Concentrated Animal Feeding Operations (CAFOs)

There are currently no CAFOs present in the Cheatham Lake 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.

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 Identificaton 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 NPS. The Cumberland River Compact (Compact) was formed in 1997 and has been active in several watersheds, including the Cheatham Lake Watershed. The goal of the Compact is to give people the tools to be smart, impactful stewards of their watershed and to constructively partner in policy planning with government agencies. The Compact established the Compensatory Mitigation program in 2018 with the goal of creating a mechanism and source of revenue for stream restoration projects in the Tennessee portion of the Cumberland River Basin. The program allows the Compact to sell credits that are used to implement effective stream restoration, enhancement, establishment, and preservation projects to compensate for the loss of ecological functions affected by permitted activities. The Compact offers virtual classroom programs that bring place-based environmental education straight to the classroom. Program options include Creek Critters, What's Up with Water Pollution, Get to Know Trees, and Career Chats. The Compact collaborates with cities like Nashville, Franklin, Clarksville, Gallatin and more to address urban stormwater issues through programs like Adopt-A-Stream, rain gardens, rain barrels, DePave, and tree plantings. Since 2006, the Compact has been sponsoring the Cumberland River Dragon Boat Festival, which promotes the health and enjoyment of the Cumberland River first-hand. Additional information about the Cumberland River Compact is available at: https://cumberlandrivercompact.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 September, 2016, 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 Cheatham Lake 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 Cheatham Lake 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 Cheatham Lake watershed are shown in Figure 26. The NRCS has also implemented BMPs in the Cheatham Lake 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.

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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 Cheatham Lake 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).

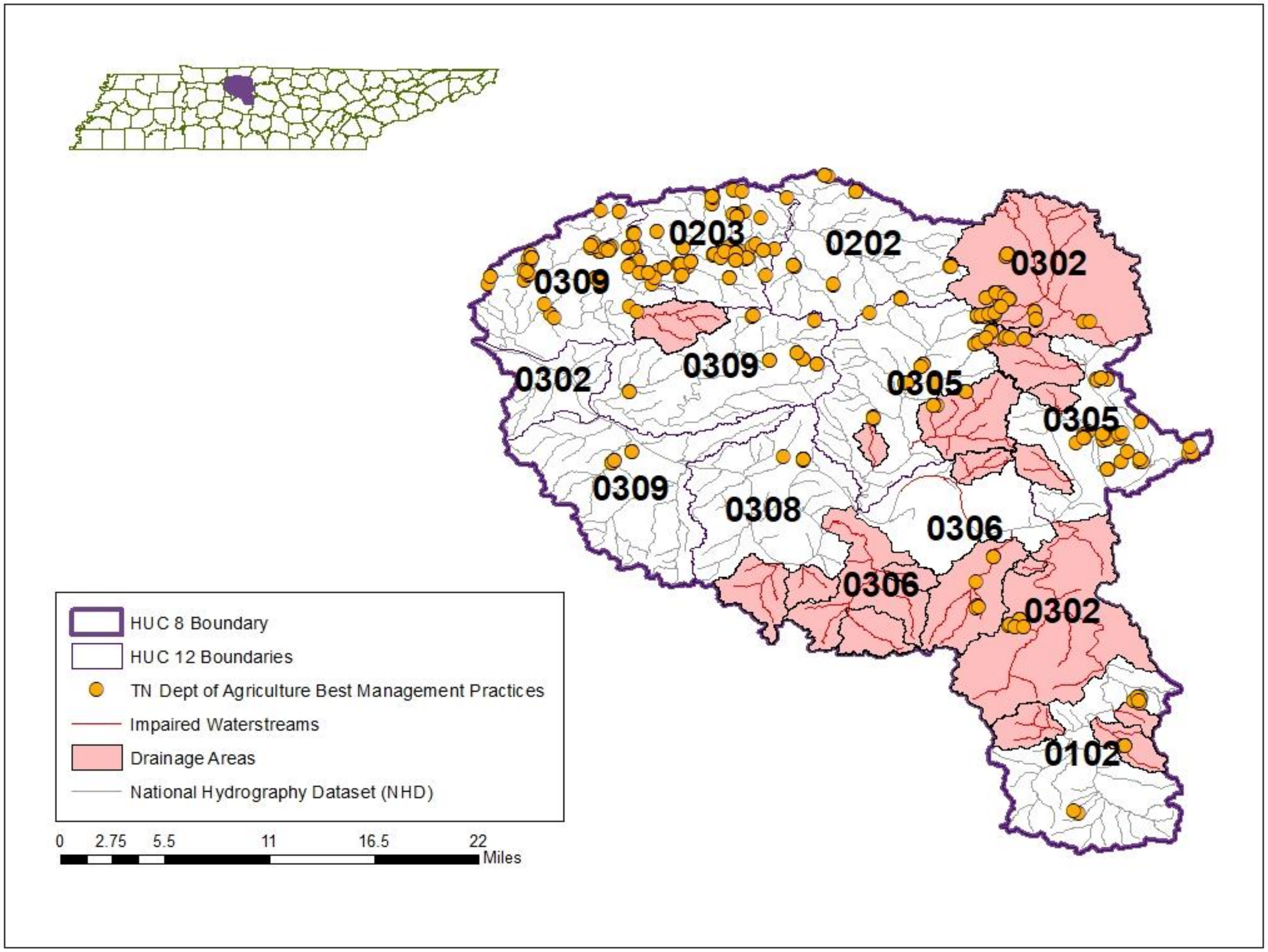

Figure 26. TDA-Administered Best Management Practices located in the Cheatham Lake Watershed

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.

Metro Nashville began conducting PCR analysis (AllBac and HuBac) as part of their monitoring in 2011. (PCR results are presented along with the *E. coli* analysis in Appendix B.) AllBac is a real-time PCR assay designed to target Bacteriodes species present in human, cattle, and equine feces. HuBac is similar to AllBac, but targets human-associated Bacteriodes 16S rRNA genes (Layton, 2006).

In most cases where both AllBac and HuBac were present, the value of HuBac was less than 25% of the value of ALLBAC, suggesting that humans were not the dominant source. The only exception occurred on Bosley Springs Branch. For three samples taken in 2011 and 2012, the E.

coli values were greater than 2000 CFU/100 mL and the HUBAC was 30-50% of the AllBac. In this case, it appears that humans were a significant source.

HuBac analysis was conducted on 884 samples in a variety of waterbodies in the Cheatham Lake watershed and under a variety of flow conditions. HuBac was not detected in 497 of the 884 samples. Of the remaining samples, only 29 were detected at a level greater than 5 mg/L. Eight of these occurrences were on Sorghum Branch, four were on Bosley Springs Branch (including the three occurrences mentioned above), and three each were on Browns Creek, Mill Creek, and Sevenmile Creek. All occurrences on Bosley Springs Branch and Browns Creek, and half of the occurrences on Sorghum Branch coincided with instances where *E. coli* values exceeded the single sample maximum water quality criterion of 941 CFU/100 mL. These occurrences may have some contribution from human 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 chase 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).

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 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 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 Cheatham Lake watershed are summarized in Table E-39.

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
HUC-12 0102 (Lower Mill Creek) [including Cathy Jo Branch, Finley Branch, Sevenmile Creek, Shasta Branch, Sims Branch, and Whittemore Branch]	✓			
HUC-12 0301 (Manskers Creek) [including Lumsley Fork and Slaters Branch]			✓	
HUC-12 0304 (Richland Creek) [including Sugartree Creek]			✓	
Blue Spring Creek DA		✓		
Bosley Springs Branch DA	✓			
Browns Creek DA	✓			
Cheatham Reservoir/Cumberland River DA			✓	
Cooper Creek DA	✓			
Davidson Branch DA	✓			
Drake Branch DA	✓			
Dry Creek DA	✓			
Ewing Creek DA	✓			
Holt Creek DA			✓	
Indian Creek DA		✓		
Neeleys Branch DA	✓			
Overall Creek DA	✓			
Pages Branch DA	✓			
Pavillion Branch DA	✓			
Richland Creek (314-3000) DA [including Jocelyn Hollow Branch and Vaughns Gap Branch]	✓			
Turkey Creek 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

In the Cheatham Lake watershed, 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.

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. There were no monitoring sites in the Cheatham Lake watershed with a similar quantity of monitoring data available and showing a definite trend.

Figure 27 shows best fit curve analyses (regressions) of flow (percent time exceeded) versus *E. coli* loading, for a historical (1999-2004) period versus a 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 28 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 29 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 27-29 present the same data, each clearly illustrating improving conditions between historical and recent periods.

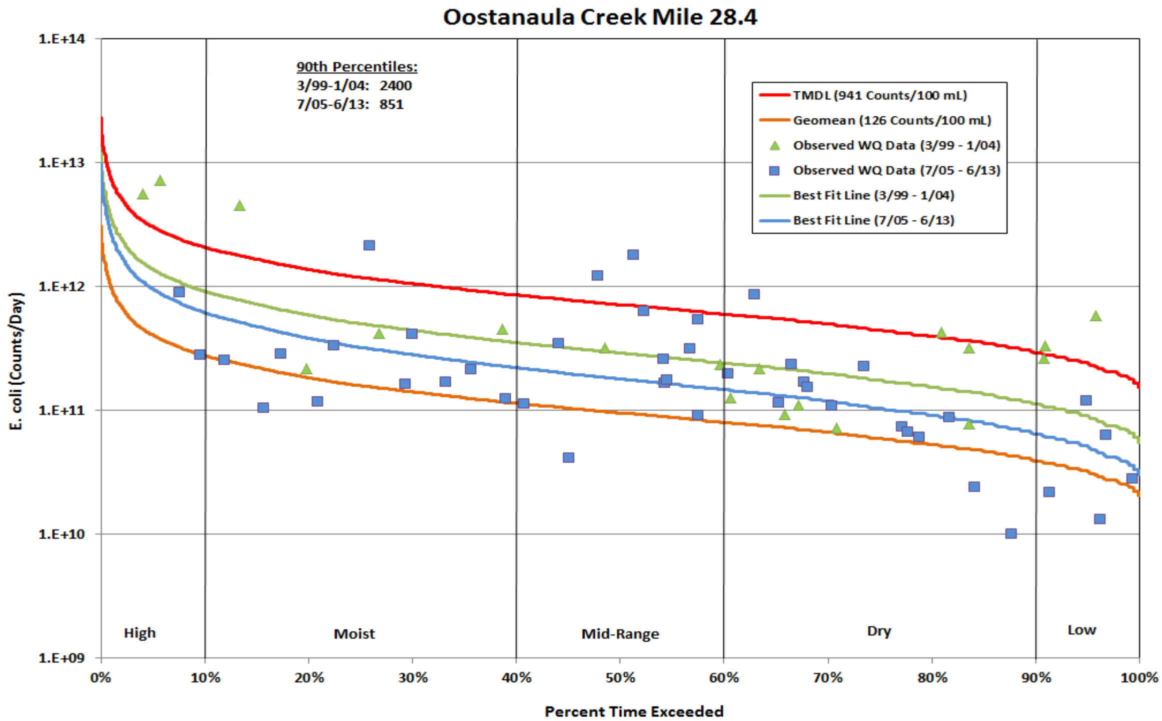

Figure 27. Example Graph of TMDL implementation effectiveness (LDC regression analysis)

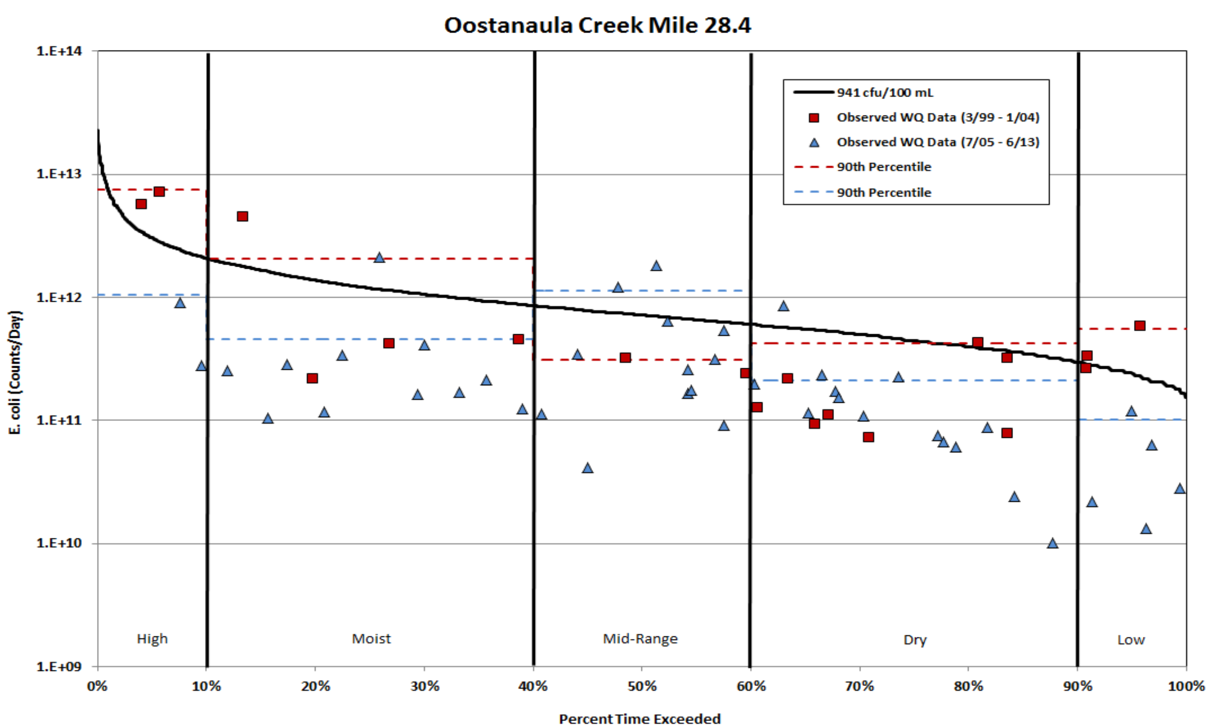

Figure 28. Example Graph of TMDL implementation effectiveness (LDC analysis)

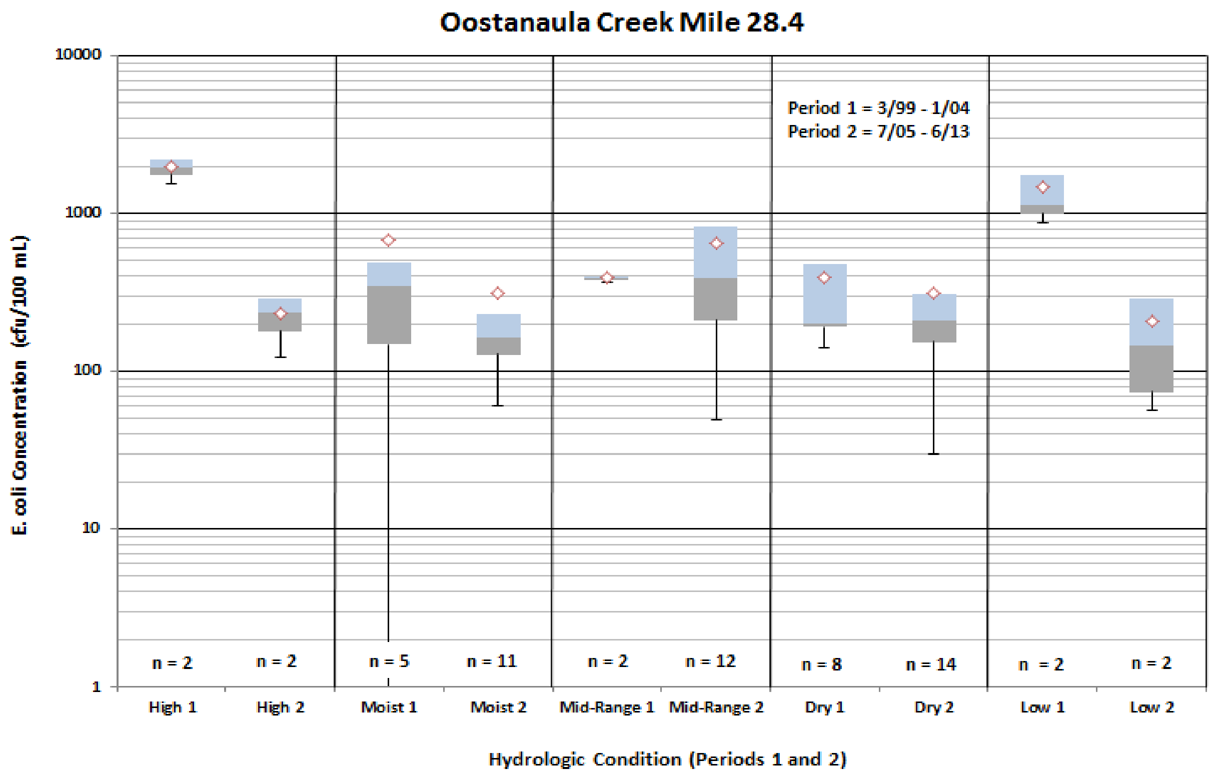

Figure 29. Example Graph of TMDL implementation effectiveness (box and whisker plot)

10.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed *E. coli* TMDLs for the Cheatham Lake 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) Notice of the proposed TMDLs was posted on the DWR Facebook page. The announcement invited public and stakeholder comment and provided a link to a downloadable version of the TMDL document.

4) Letters were sent via e-mail to WWTPs and other facilities located in *E. coli*-impaired subwatersheds or drainage areas in the Cheatham Lake 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:

    Metro Water Services – Central STP and CSO (TN0020575)
    Metro Water Services – Nashville Dry Creek STP (TN0020648)
    Metro Water Services – Nashville Whites Creek STP (TN0024970)
    Harpeth Valley Utility District (TN0074748)

5) 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:

City of Belle Meade, Tennessee (TNS075159)
City of Berry Hill, Tennessee (TNS075167)
City of Brentwood, Tennessee (TNS075175)
City of Forest Hills, Tennessee (TNS075302)
City of Goodlettsville, Tennessee (TNS075345)
City of Millersville, Tennessee (TNS077887)
City of Nolensville, Tennessee (TNS077801)
City of Oak Hill, Tennessee (TNS075477)
City of Nashville/Davidson County, Tennessee (TNS068047)
Sumner County, Tennessee (TNS075680)
Williamson County, Tennessee (TNS075795)
Tennessee Dept. of Transportation (TNS077585)

6) Letters were sent via e-mail to local interagency and stakeholder groups in the Cheatham Lake 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:

Cumberland Coalition
Cumberland River Compact
Tennessee Wildlife Federation
Natural Resources Conservation Service
Tennessee Valley Authority
United States Forest Service
Tennessee Department of Agriculture
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 DWR staff:

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APPENDIX A

Land Use Distribution in the Cheatham Lake Watershed

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		HUC-12s 0101-0102 (Mill Creek)		HUC-12 0102 (Lower Mill Creek)		HUC-12 0301 (Manskers Creek)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	41	0.06	225	0.59	38	0.13
21	Developed, Open Space	17,808	26.3	10,965	28.8	2,949	10.1
22	Developed, Low Intensity	13,314	19.7	9,001	23.6	1,869	6.38
23	Developed, Medium Intensity	6,085	8.99	5,156	13.5	943	3.22
24	Developed, High Intensity	2,735	4.04	3,345	8.77	398	1.36
31	Barren Land (Rock/Sand/Clay)	61	0.09	92	0.24	29	0.10
41	Deciduous Forest	9,429	13.9	3,669	9.62	15,364	52.5
42	Evergreen Forest	2,220	3.28	610	1.60	448	1.53
43	Mixed Forest	6,694	9.89	2,441	6.40	3,371	11.5
52	Shrub/Scrub	135	0.20	72	0.19	32	0.11
71	Grassland/Herbaceous	481	0.71	153	0.40	161	0.55
81	Pasture/Hay	8,380	12.4	2,334	6.12	3,664	12.5
82	Cultivated Crops	237	0.35	15	0.04	6	0.02
90	Woody Wetlands	34	0.05	31	0.08	12	0.04
95	Emergent Herbaceous Wetlands	34	0.05	34	0.09	6	0.02
	Subtotal – Urban	39,942	59.0	28,467	74.6	6,159	21.0
	Subtotal – Agriculture	8,617	12.7	2,349	6.16	3,670	12.5
	Subtotal - Forest	19,128	28.3	7,327	19.2	19,462	66.5
	Total	67,687	100.0	38,143	100.0	29,291	100.0

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		HUC-12 0304 (Richland Creek)		Blue Spring Creek DA (in HUC-12 0203)		Bosley Springs Branch DA (in HUC-12 0304)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	3	0.02	3	0.06	0	0.00
21	Developed, Open Space	7,129	41.8	269	5.61	817	59.5
22	Developed, Low Intensity	2,890	16.9	19	0.39	353	25.7
23	Developed, Medium Intensity	1,393	8.16	5	0.10	152	11.
24	Developed, High Intensity	633	3.71	1	0.03	9	0.62
31	Barren Land (Rock/Sand/Clay)	14	0.08	0	0.01	0	0.01
41	Deciduous Forest	2,707	15.9	2,730	57.0	4	0.27
42	Evergreen Forest	114	0.67	16	0.33	6	0.43
43	Mixed Forest	1,606	9.41	410	8.57	26	1.89
52	Shrub/Scrub	34	0.20	10	0.21	3	0.20
71	Grassland/Herbaceous	26	0.15	36	0.75	0	0.00
81	Pasture/Hay	517	3.03	1,263	26.4	4	0.28
82	Cultivated Crops	0	0.00	23	0.47	0	0.00
90	Woody Wetlands	2	0.01	1	0.02	0	0.00
95	Emergent Herbaceous Wetlands	0	0.00	2	0.04	0	0.00
	Subtotal – Urban	12,045	70.6	294	6.13	1,330	96.9
	Subtotal – Agriculture	517	3.03	1,286	26.9	4	0.28
	Subtotal - Forest	4,506	26.4	3,208	67.0	38	2.80
	Total	17,068	100.0	4,788	100.0	1,372	100.0

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		Browns Creek DA (in HUC-12 0305)		Cathy Jo Branch DA (in HUC-12 0102)		Cooper Creek DA (in HUC-12 0302)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	0	0.00	2	0.09	0	0.00
21	Developed, Open Space	3,667	36.1	820	34.5	192	22.96
22	Developed, Low Intensity	2,048	20.2	911	38.4	171	20.46
23	Developed, Medium Intensity	1,637	16.1	109	4.57	162	19.41
24	Developed, High Intensity	1,456	14.3	45	1.88	179	21.51
31	Barren Land (Rock/Sand/Clay)	6	0.06	0	0.01	13	1.50
41	Deciduous Forest	506	4.98	224	9.44	60	7.16
42	Evergreen Forest	17	0.17	21	0.89	0	0.00
43	Mixed Forest	626	6.16	200	8.42	15	1.80
52	Shrub/Scrub	12	0.12	0	0.01	2	0.26
71	Grassland/Herbaceous	10	0.10	10	0.40	4	0.44
81	Pasture/Hay	172	1.69	34	1.44	37	4.49
82	Cultivated Crops	0	0.00	0	0.00	0	0.00
90	Woody Wetlands	0	0.00	0	0.00	0	0.00
95	Emergent Herbaceous Wetlands	0	0.00	0	0.00	0	0.00
	Subtotal – Urban	8,808	86.7	1,884	79.3	704	84.3
	Subtotal – Agriculture	172	1.69	34	1.44	37	4.49
	Subtotal - Forest	1,177	11.6	458	19.3	93	11.2
	Total		100	2,376	100	834	100

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		Davidson Creek DA (in HUC-12 0306)		Drake Branch DA (in HUC-12 0303)		Dry Creek DA (in HUC-12 0302)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	3	0.15	1	0.09	0	0.00
21	Developed, Open Space	989	43.6	165	13.2	1,343	24.7
22	Developed, Low Intensity	158	6.96	145	11.7	907	16.7
23	Developed, Medium Intensity	76	3.36	18	1.48	379	6.96
24	Developed, High Intensity	27	1.21	3	0.21	183	3.36
31	Barren Land (Rock/Sand/Clay)	0	0.00	1	0.12	2	0.03
41	Deciduous Forest	537	23.7	617	49.6	1,397	25.7
42	Evergreen Forest	32	1.40	32	2.60	62	1.14
43	Mixed Forest	407	17.9	157	12.6	628	11.6
52	Shrub/Scrub	4	0.18	3	0.24	10	0.18
71	Grassland/Herbaceous	4	0.18	10	0.80	56	1.03
81	Pasture/Hay	29	1.28	90	7.27	473	8.69
82	Cultivated Crops	0	0.01	0	0.01	0	0.00
90	Woody Wetlands	1	0.04	1	0.11	0	0.00
95	Emergent Herbaceous Wetlands	0	0.01	0	0.00	0	0.00
	Subtotal – Urban	1,251	55.1	330	26.6	2,811	51.7
	Subtotal – Agriculture	29	1.29	91	7.28	473	8.69
	Subtotal - Forest	988	43.6	823	66.2	2,155	39.6
	Total	2,268	100	1,244	100	5,438	100

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		Ewing Creek DA (in HUC-12 0303)		Finley Creek DA (in HUC-12 0102)		Holt Creek DA (in HUC-12 0101)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	14	0.16	0	0.00	0	0.00
21	Developed, Open Space	1,756	20.6	246	39.9	695	21.2
22	Developed, Low Intensity	1,597	18.8	64	10.4	715	21.8
23	Developed, Medium Intensity	711	8.35	69	11.2	131	4.01
24	Developed, High Intensity	372	4.37	61	9.91	4	0.12
31	Barren Land (Rock/Sand/Clay)	13	0.15	0	0.00	0	0.00
41	Deciduous Forest	2,067	24.3	68	11.1	596	18.2
42	Evergreen Forest	374	4.39	17	2.68	118	3.61
43	Mixed Forest	811	9.52	50	8.08	471	14.4
52	Shrub/Scrub	3	0.03	4	0.59	9	0.29
71	Grassland/Herbaceous	40	0.47	0	0.00	19	0.59
81	Pasture/Hay	752	8.83	38	6.17	515	15.7
82	Cultivated Crops	5	0.06	0	0.05	0	0.00
90	Woody Wetlands	1	0.01	0	0.00	0	0.00
95	Emergent Herbaceous Wetlands	3	0.03	0	0.00	0	0.00
	Subtotal – Urban	4,437	52.1	440	71.3	1,545	47.2
	Subtotal – Agriculture	757	8.89	38	6.22	515	15.7
	Subtotal - Forest	3,325	39.0	138	22.5	1,214	37.1
	Total	8,519	100	616	100	3,274	100

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		Indian Creek DA (in HUC-12 0101)		Jocelyn Hollow DA (in HUC-12 0304)		Lumsley Fork DA (in HUC-12 0301)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	1	0.02	0	0.00	0	0.00
21	Developed, Open Space	146	4.97	337	39.0	151	7.32
22	Developed, Low Intensity	75	2.55	64	7.41	55	2.65
23	Developed, Medium Intensity	20	0.67	24	2.83	1	0.05
24	Developed, High Intensity	0	0.01	11	1.22	0	0.00
31	Barren Land (Rock/Sand/Clay)	1	0.04	0	0.00	1	0.06
41	Deciduous Forest	873	29.7	253	29.3	1,319	64.0
42	Evergreen Forest	228	7.75	7	0.85	79	3.82
43	Mixed Forest	576	19.6	119	13.8	265	12.9
52	Shrub/Scrub	4	0.12	1	0.10	5	0.23
71	Grassland/Herbaceous	14	0.49	1	0.06	17	0.81
81	Pasture/Hay	1,006	34.2	47	5.43	170	8.24
82	Cultivated Crops	0	0.00	0	0.00	0	0.00
90	Woody Wetlands	0	0.01	0	0.00	0	0.00
95	Emergent Herbaceous Wetlands	0	0.00	0	0.00	0	0.00
	Subtotal – Urban	241	8.20	436	50.4	207	10.0
	Subtotal – Agriculture	1,006	34.2	47	5.43	170	8.24
	Subtotal - Forest	1,697	57.6	381	44.2	1,685	81.7
	Total	2,945	100	864	100	2,062	100

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		Neeleys Branch DA (in HUC-12 0302)		Overall Creek DA (in HUC-12 0306)		Pages Branch DA (in HUC-12 0305)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	0	0.00	12	0.23	0	0.00
21	Developed, Open Space	361	27.8	519	10.4	400	19.8
22	Developed, Low Intensity	519	39.9	376	7.50	700	34.5
23	Developed, Medium Intensity	220	17.0	206	4.11	325	16.0
24	Developed, High Intensity	96	7.37	98	1.95	140	6.89
31	Barren Land (Rock/Sand/Clay)	0	0.01	11	0.22	0	0.02
41	Deciduous Forest	29	2.22	2,818	56.2	315	15.5
42	Evergreen Forest	0	0.01	141	2.82	55	2.73
43	Mixed Forest	47	3.59	506	10.1	63	3.10
52	Shrub/Scrub	0	0.00	39	0.77	4	0.20
71	Grassland/Herbaceous	15	1.13	48	0.95	15	0.74
81	Pasture/Hay	13	1.02	234	4.67	6	0.31
82	Cultivated Crops	0	0.00	1	0.01	0	0.00
90	Woody Wetlands	0	0.00	6	0.12	3	0.17
95	Emergent Herbaceous Wetlands	0	0.00	4	0.07	0	0.00
	Subtotal – Urban	1,195	92.0	1,200	23.9	1,564	77.2
	Subtotal – Agriculture	13	1.02	235	4.68	6	0.31
	Subtotal - Forest	90	6.96	3,583	71.4	456	22.5
	Total	1,299	100	5,018	100	2,027	100

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		Pavillion Branch DA (in HUC-12 0102)		Sevenmile Creek DA (in HUC-12 0102)		Shasta Branch DA (in HUC-12 0102)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	0	0.00	9	0.08	0	0.00
21	Developed, Open Space	114	19.98	4,357	39.4	174	35.0
22	Developed, Low Intensity	115	20.22	3,016	27.3	215	43.2
23	Developed, Medium Intensity	133	23.33	890	8.05	36	7.29
24	Developed, High Intensity	84	14.83	381	3.45	4	0.80
31	Barren Land (Rock/Sand/Clay)	0	0.03	15	0.14	0	0.10
41	Deciduous Forest	26	4.48	969	8.77	35	7.03
42	Evergreen Forest	1	0.26	50	0.45	1	0.13
43	Mixed Forest	18	3.11	791	7.16	9	1.91
52	Shrub/Scrub	1	0.09	17	0.15	0	0.00
71	Grassland/Herbaceous	0	0.00	35	0.32	19	3.78
81	Pasture/Hay	78	13.67	522	4.72	3	0.60
82	Cultivated Crops	0	0.00	0	0.00	0	0.00
90	Woody Wetlands	0	0.00	0	0.00	0	0.10
95	Emergent Herbaceous Wetlands	0	0.00	0	0.00	0	0.00
	Subtotal – Urban	446	78.4	8,645	78.2	429	86.3
	Subtotal – Agriculture	78	13.7	522	4.72	3	0.60
	Subtotal - Forest	45	7.97	1,887	17.1	65	13.1
	Total	569	100	11,053	100	497	100

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)					
		Sims Branch DA (in HUC-12 0102)		Slaters Creek DA (in HUC-12 0301)		Sorghum Branch DA (in HUC-12 0102)	
Code	Description	[acres]	[%]	[acres]	[%]	[acres]	[%]
11	Open Water	1	0.05	0	0.00	0	0.00
21	Developed, Open Space	564	33.5	381	7.83	744	44.2
22	Developed, Low Intensity	398	23.7	275	5.66	541	32.1
23	Developed, Medium Intensity	315	18.7	117	2.41	204	12.1
24	Developed, High Intensity	213	12.7	30	0.62	63	3.74
31	Barren Land (Rock/Sand/Clay)	2	0.12	3	0.07	0	0.02
41	Deciduous Forest	88	5.23	3,299	67.8	55	3.26
42	Evergreen Forest	7	0.40	84	1.73	1	0.05
43	Mixed Forest	42	2.47	508	10.4	47	2.77
52	Shrub/Scrub	5	0.32	2	0.04	1	0.07
71	Grassland/Herbaceous	10	0.61	14	0.29	0	0.01
81	Pasture/Hay	37	2.19	150	3.09	28	1.65
82	Cultivated Crops	0	0.02	1	0.02	0	0.00
90	Woody Wetlands	0	0.00	0	0.00	0	0.00
95	Emergent Herbaceous Wetlands	0	0.00	0	0.00	0	0.00
	Subtotal – Urban	1,491	88.66	804	16.5	1,551	92.2
	Subtotal – Agriculture	37	2.21	151	3.11	28	1.65
	Subtotal - Forest	155	9.20	3,910	80.4	104	6.18
	Total	1,683	100	4,865	100	1,683	100

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)			
		Sugartree Creek DA (in HUC-12 0304)		Turkey Creek DA (in HUC-12 0101)	
Code	Description	[acres]	[%]	[acres]	[%]
11	Open Water	0	0.00	0	0.04
21	Developed, Open Space	1,622	54.0	91	7.56
22	Developed, Low Intensity	343	11.4	97	8.11
23	Developed, Medium Intensity	186	6.19	50	4.15
24	Developed, High Intensity	75	2.51	2	0.16
31	Barren Land (Rock/Sand/Clay)	2	0.05	1	0.09
41	Deciduous Forest	320	10.7	292	24.4
42	Evergreen Forest	25	0.82	164	13.7
43	Mixed Forest	369	12.3	235	19.6
52	Shrub/Scrub	7	0.23	3	0.26
71	Grassland/Herbaceous	4	0.13	9	0.71
81	Pasture/Hay	51	1.69	254	21.2
82	Cultivated Crops	0	0.00	0	0.00
90	Woody Wetlands	0	0.00	0	0.00
95	Emergent Herbaceous Wetlands	0	0.00	0	0.00
	Subtotal – Urban	2,226	74.1	239	20.0
	Subtotal – Agriculture	51	1.69	254	21.2
	Subtotal - Forest	727	24.2	704	58.8
	Total	3,004	100	1,198	100

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

Landuse		Impaired Watershed (05130202____) or Waterbody Drainage Area (DA)			
		Vaughns Gap Branch DA (in HUC-12 0304)		Whittemore Branch DA (in HUC-12 0102)	
Code	Description	[acres]	[%]	[acres]	[%]
11	Open Water	1	0.07	0	0.00
21	Developed, Open Space	572	30.44	1,622	54.00
22	Developed, Low Intensity	180	9.58	343	11.41
23	Developed, Medium Intensity	78	4.13	186	6.19
24	Developed, High Intensity	17	0.91	75	2.51
31	Barren Land (Rock/Sand/Clay)	0	0.00	2	0.05
41	Deciduous Forest	751	39.95	320	10.67
42	Evergreen Forest	13	0.70	25	0.82
43	Mixed Forest	192	10.20	369	12.30
52	Shrub/Scrub	1	0.06	7	0.23
71	Grassland/Herbaceous	1	0.04	4	0.13
81	Pasture/Hay	74	3.93	51	1.69
82	Cultivated Crops	0	0.00	0	0.00
90	Woody Wetlands	0	0.00	0	0.00
95	Emergent Herbaceous Wetlands	0	0.00	0	0.00
	Subtotal – Urban	847	45.1	1,749	77.1
	Subtotal – Agriculture	74	3.93	85	3.73
	Subtotal - Forest	959	51.0	434	19.1
	Total	1,879	100	2,268	100

APPENDIX B

Water Quality Monitoring Data for the Cheatham Lake Watershed

The location of monitoring stations in the Cheatham Lake watershed are shown in Figures 7-10. Monitoring data recorded by TDEC and Metro Nashville at these stations are tabulated in Table B-1. The “Source” column indicates whether the monitoring data was collected by TDEC (“T”) or Metro Nashville (“M”). Exceedances of the appropriate *E. coli* standard are shown in red.

Table B-1. Water Quality Monitoring Data

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
BROWN000.4DA	Browns 1	7/26/05	T	310		
		9/8/05	T	770		
		10/6/05	T	260		
		11/30/05	T	460		
		12/13/05	T	240		
		1/17/06	T	>2400		
		2/21/06	T	100		
		3/20/06	T	1700		
		4/5/06	T	190		
		5/31/06	T	820		
		6/6/06	T	390		
		8/3/10	T	210		
		8/5/10	T	365		
		8/9/10	T	276		
		8/17/10	T	161		
		8/23/10	T	435		
		8/25/10	T	1203		
		4/11/11	M	290.9	2.8	
		5/6/11	M	185.0	1.8	
		5/7/11	M	201.4	1.3	
		5/9/11	M	344.1	4.8	
		5/10/11	M	686.7	13.3	1.4
		5/24/11	T	10460		
		5/25/11	T	1860		
		6/1/11	T	2280		
		6/2/11	T	1300		
		6/6/11	T	9140		
		6/27/11	M	2419.6	4.2	
		7/11/11	M	866.4	2	
		7/12/11	M	1553.1	0.3	
		7/14/11	M	1413.6	4.9	
		7/18/11	M	290.9	16.4	3.6

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
BROWN000.4DA (cont'd)	Browns 1 (cont'd)	7/21/11	M	517.2	2.2	
		10/3/11	M	1413.6	3.1	
		10/4/11	M	2419.6	7.7	
		10/5/11	M	>2419.6	13.9	3.3
		10/6/11	M	2419.6	3.4	3.3
		10/24/11	M	325.5	2.7	
		11/15/11	M	6830.0	19.8	1.2
		1/4/12	M	137.6	3.5	
		1/5/12	M	137.4	1	
		1/11/12	M	9880.0	12.5	
		1/30/12	M	117.8	1.3	
		1/31/12	M	275.5	0.5	
		2/7/12	M	344.8	1.7	
		7/14/15	T	>2420		
		8/13/15	T	135		
		9/9/15	T	192		
		10/12/15	T	921		
		11/5/15	T	113		
		12/7/15	T	59		
		1/12/16	T	93		
		4/19/16	T	84		
		5/18/16	T	1300		
		6/14/16	T	>2420		
		7/12/16	M	193.5		
		7/13/16	M	222.4		
		7/14/16	M	152.9		
		7/18/16	M	472.1		
		7/26/16	M	238.2		ND
		10/5/16	M	249.5		ND
		10/6/16	M	410.6		ND
		10/11/16	M	238.2		ND
		10/17/16	M	344.8		ND
		10/25/16	M	285.1		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
BROWN000.4DA (cont'd)	Browns 1 (cont'd)	1/9/17	M	238.2		ND
		1/24/17	M	148.3		ND
		1/26/17	M	93.4		ND
		1/31/17	M	69.7		ND
		2/1/17	M	42		ND
		5/9/17	M	2419.6	0	3.3
		5/10/17	M	1203.3	0	0.5
		5/16/17	M	>2419.6	0	9.9
		5/18/17	M	>2419.6	0	12
		6/1/17	M	>2419.6	0	10.6
		7/23/20	T	>2420		
BROWN002.9DA	Browns 2	7/26/05	T	410		
		9/8/05	T	380		
		10/6/05	T	160		
		11/30/05	T	260		
		12/13/05	T	110		
		1/17/06	T	1600		
		2/21/06	T	86		
		3/20/06	T	1000		
		4/5/06	T	170		
		5/31/06	T	440		
		6/6/06	T	460		
		5/11/10	T	260		
		5/13/10	T	291		
		5/16/10	T	1160		
		5/20/10	T	8660		
		5/24/10	T	326		
		8/3/10	T	435		
		8/5/10	T	192		
		8/9/10	T	727		
		8/17/10	T	461		
		8/23/10	T	517		
		8/25/10	T	980		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
BROWN002.9DA (cont'd)	Browns 2 (cont'd)	4/11/11	M	150.0	3.7	
		4/19/11	M	121.1	3.2	
		5/6/11	M	307.6	3.5	
		5/7/11	M	172.3	3.3	
		5/9/11	M	272.3	4.3	
		5/24/11	T	3080		
		5/24/11	M	>2419.6	3.5	
		5/25/11	T	600		
		6/1/11	T	340		
		6/2/11	T	240		
		6/6/11	T	1300		
		6/27/11	M	488.4	1.4	
		7/11/11	M	307.6	1	
		7/12/11	M	248.9	7.4	
		7/14/11	M	166.4	2.8	
		7/18/11	M	387.3	5.5	
		7/21/11	M	260.3	5.7	
		9/15/11	M	1203.3	9.7	
		10/3/11	M	48.0	3.3	
		10/4/11	M	87.8	2.2	
		10/5/11	M	56.5	9.7	
		10/6/11	M	66.3	1	
		10/24/11	M	42.8	1.4	
		11/15/11	M	3130.0	17.2	1.2
		1/4/12	M	28.5	3.9	
		1/5/12	M	44.8	1.2	
		1/11/12	M	10950.0	5	
		1/30/12	M	90.6	2.7	
		1/31/12	M	68.9	1.5	
		2/7/12	M	117.2	1.1	
		2/28/12	M	648.8		
		3/6/12	M	61.3		
		5/17/12	M	344.1		
		5/22/12	M	387.3		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
BROWN002.9DA (cont'd)	Browns 2 (cont'd)	7/12/16	M	248.9		
		7/13/16	M	172.5		
		7/14/16	M	313.0		
		7/18/16	M	547.2		
		7/26/16	M	770.1		ND
		10/5/16	M	488.4		
		10/6/16	M	461.1		ND
		10/11/16	M	1732.9		ND
		10/17/16	M	770.1		ND
		10/25/16	M	228.2		0.3
		1/9/17	M	48.8		ND
		1/25/17	M	261.3		ND
		1/26/17	M	325.5		ND
		1/31/17	M	193.5		ND
		2/1/17	M	56.3		ND
		4/10/17	M	93.3	0	0
		5/9/17	M	261.3	0	0.1
		5/10/17	M	275.5	0	0.9
		5/16/17	M	228.2	0	ND
		5/18/17	M	290.9	0	ND
		6/1/17	M	167	0	ND
		6/8/17	M	344.8	0	0.5
		6/28/17	M	344.8		
BSPRI000.4DA	Bosley	7/27/05	T	>2400		
		8/17/05	T	>2400		
		9/7/05	T	>2400		
		10/20/05	T	520		
		11/22/05	T	>2400		
		12/6/05	T	>2400		
		1/19/06	T	770		
		2/9/06	T	520		
		3/2/06	T	870		
		4/11/06	T	870		
		5/18/06	T	2400		
		6/20/06	T	2400		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
BSPRI000.4DA (cont'd)	Bosley (cont'd)	5/9/11	M	770.1	11.4	2.3
		5/10/11	M	1732.9	19.1	0.8
		5/11/11	M	>2419.6	3.6	
		5/12/11	M	1986.3	2.6	
		5/18/11	M	727.0	4.4	
		5/24/11	M	5810.0	16.4	5.3
		6/27/11	M	261.3	3	
		7/11/11	M	>2419.6	16.2	8.6
		7/12/11	M	1553.1	5.8	
		7/13/11	M	2419.6	8.7	
		7/14/11	M	1203.3	5.9	
		7/21/11	M	224.7	5.6	
		8/4/11	T	390		
		8/8/11	T	440		
		8/11/11	T	460		
		8/15/11	T	860		
		8/25/11	T	200		
		8/29/11	T	230		
		9/15/11	M	579.4	2.2	
		10/3/11	M	137.4	137.4	
		10/4/11	M	272.3	272.3	
		10/5/11	M	159.7	159.7	
		10/6/11	M	206.4	206.4	
		10/24/11	M	185.0	185	
		11/15/11	M	5560.0	16.9	
		1/4/12	M	178.0	2.9	
		1/5/12	M	68.9	3	
		1/11/12	M	5380.0	45.3	13.5
		1/30/12	M	67.6	11.7	
		1/31/12	M	86.0	2.3	
		2/7/12	M	307.6	1.5	
		4/4/12	T	640		
		4/9/12	T	310		
		4/16/12	T	310		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
BSPRI000.4DA (cont'd)	Bosley (cont'd)	4/19/12	T	150		
		4/24/12	T	430		
		4/26/12	T	470		
		7/15/15	T	364		
		8/18/15	T	248		
		9/15/15	T	387		
		10/6/15	T	770		
		11/23/15	T	248		
		12/3/15	T	199		
		1/4/16	T	816		
		1/28/16	T	68		
		3/23/16	T	135		
		4/21/16	T	579		
		5/26/16	T	816		
		6/9/16	T	162		
		6/9/16	M	162		
		7/19/16	M	613.1		0.6
		7/26/16	M	104.6		ND
		7/27/16	M	116.2		ND
		8/1/16	M	224.7		ND
		8/16/16	M	158.5		ND
		10/4/16	M	162.4		1.6
		10/5/16	M	461.1		0.2
		10/6/16	M	410.6		ND
		10/13/16	M	547.5		0.6
		10/25/16	M	248.1		ND
		1/9/17	M	727		4.5
		1/25/17	M	127.4		ND
		1/26/17	M	>2419.6		3.1
		1/30/17	M	>2419.6		2.1
		2/1/17	M	866.4		0.9
		5/9/17	M	387.3	0	ND
		5/11/17	M	325.5	0	0.4
		5/16/17	M	435.2	0	0.6

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
BSPRI000.4DA (cont'd)	Bosley (cont'd)	5/17/17	M	816.4	0	0.4
		5/31/17	M	>2419.6	0	12.8
		6/26/18	M	816.4		ND
		7/16/20	T	687		
		9/2/20	T	816		
		10/14/20	T	326		
BSPRI000.5CH	na	8/4/15	T	8		
		8/18/15	T	1553		
		8/20/15	T	80		
		8/25/15	T	51		
		8/4/20	T	60		
		8/18/20	T	93		
		8/19/20	T	44		
		8/25/20	T	50		
		8/27/20	T	33		
BSPRI003.9CH	na	11/8/06	T	520		
		8/8/07	T	980		
		8/16/07	T	365		
		8/20/07	T	579		
		8/28/07	T	770		
		8/30/07	T	1986		
		8/4/11	T	70		
		8/8/11	T	200		
		8/11/11	T	200		
		8/15/11	T	80		
		8/25/11	T	2600		
		8/29/11	T	330		
		4/4/12	T	80		
		4/9/12	T	100		
		4/16/12	T	320		
		4/19/12	T	60		
		4/24/12	T	740		
		4/26/12	T	170		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
CJO000.8DA	na	8/15/05	T	260		
		9/12/05	T	31		
		9/27/05	T	820		
		7/27/10	T	411		
		8/12/10	T	365		
		9/15/10	T	687		
		10/19/10	T	914		
		12/8/10	T	102		
		1/27/11	T	110		
		2/22/11	T	91		
		3/22/11	T	152		
		4/20/11	T	2420		
		5/17/11	T	74		
		6/30/11	T	435		
		9/2/20	T	365		
		10/14/20	T	150		
COOPE001.5DA	Cooper	8/3/10	T	118		
		8/5/10	T	238		
		8/9/10	T	225		
		8/17/10	T	157		
		8/24/10	T	437		
		8/25/10	T	126		
		5/19/11	T	300		
		5/24/11	T	2050		
		5/25/11	T	310		
		6/1/11	T	150		
		6/2/11	T	160		
		6/6/11	T	270		
		7/31/12	M	104.6		0.4
		8/13/12	M	131.4	1.5	0.3
		8/20/12	M	133.3		1
		8/22/12	M	159.4		0.6
		8/28/12	M	90.6		0.7

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
COOPE001.5DA (cont'd)	Cooper (cont'd)	10/10/12	M	86.0		2
		10/11/12	M	21.4		2.6
		10/22/12	M	155.3		0.4
		10/24/12	M	110.0		0.7
		10/30/12	M	152.9		0.1
		1/8/13	M	37.3		0.4
		1/22/13	M	33.2		0.1
		1/28/13	M	172.3		1.3
		1/29/13	M	172.5		1.2
		2/6/13	M	115.3		1.1
		8/28/14	M	461.1		ND
		9/18/14	M	547.5		0.4
		11/11/14	M	365.4		0.5
		1/29/15	M	53.8		
		4/23/15	M	198.9		
		7/14/15	T	179		
		7/16/15	T	>291		
		7/21/15	T	260		
		7/23/15	T	272		
		7/30/15	T	387		
		7/19/17	M	105		
		8/1/17	M	313	0	0.2
		8/10/17	M	273.3		ND
		8/14/17	M	290.9		ND
		8/21/17	M	235.9		2.4
		8/22/17	M	209.8		0.2
		9/28/17	M	172.3		0.6
		10/19/17	M	172.2		ND
		11/15/17	M	275.5		ND
		12/13/17	M	135.4		ND
		1/31/18	M	52.9		ND
		2/21/18	M	69.1		ND
		3/23/18	M	98.8		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
COOPE001.5DA (cont'd)	Cooper (cont'd)	4/19/18	M	47.4		ND
		5/14/18	M	248.1		ND
		6/14/18	M	178.5		
CUMBE185.7DA	Bordeaux Bridge	9/16/15	T	<1		
		6/15/16	T	60		
		8/10/16	T	16		
		6/20/17	T	93		
		8/30/17	T	6		
		6/6/18	M	4		
		6/14/18	M	18		
		6/19/18	T	74		
		6/21/18	M	26		
		6/27/18	M	2420		
		7/2/18	M	15		
		7/12/18	M	5		
		7/17/18	T	82		
		7/18/18	M	38		
		7/25/18	M	11		
		8/1/18	M	6		
		8/8/18	M	14		
		8/15/18	M	25		
		8/28/18	M	17		
		9/5/18	M	10		
		9/12/18	M	121		
		9/19/18	M	86		
		9/26/18	M	399		
		10/3/18	M	63		
		10/10/18	M	16		
		10/17/18	M	135		
		10/22/18	M	22		
		11/7/18	M	210		
		11/14/18	M	61		
		11/19/18	M	194		
		11/28/18	M	22		
		12/5/18	M	192		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
CUMBE185.7DA (cont'd)	Bordeaux Bridge (cont'd)	12/13/18	M	40		
		12/19/18	M	172		
		12/26/18	M	59		
		1/2/19	M	2420		
		1/8/19	M	162		
		1/17/19	M	15		
		1/23/19	M	270		
		2/6/19	M	8		
		2/13/19	M	673		
		2/19/19	M	548		
		2/27/19	M	555		
		3/6/19	M	129		
		3/13/19	M	503		
		3/20/19	M	34		
		3/27/19	M	7		
		4/3/19	M	4		
		4/10/19	M	59		
		4/17/19	M	206		
		4/24/19	M	179		
		5/1/19	M	5		
		5/8/19	M	4		
		5/15/19	M	12		
		5/15/19	T	8		
		5/22/19	M	4		
		6/5/19	M	11		
		6/12/19	M	99		
		6/19/19	M	73		
		6/25/19	T	47		
		6/26/19	M	25		
		9/4/19	M	72		
		9/11/19	M	120		
		9/19/19	M	8		
		9/24/19	T	8		
		9/26/19	M	399		
		6/2/20	T	32		
		7/30/20	T	36		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
CUMBE193.7DA	Omohundo Water Plant	6/6/18		6		
		6/14/18		4		
		6/21/18		5		
		6/27/18		276		
		7/2/18		6		
		7/12/18		6		
		7/18/18		13		
		7/25/18		2		
		8/1/18		5		
		8/8/18		5		
		8/15/18		4		
		8/28/18		5		
		9/5/18		6		
		9/12/18		5		
		9/19/18		10		
		9/26/18		30		
		10/3/18		17		
		10/10/18		6		
		10/17/18		75		
		10/22/18		20		
		11/7/18		504		
		11/14/18		64.0		
		11/19/18		187.0		
		11/28/18		20.0		
		12/5/18		238		
		12/13/18		115		
		12/19/18		933		
		12/26/18		521		
		1/2/19		1986		
		1/8/19		162.0		
		1/17/19		15		
		1/23/19		411		
		2/6/19		16.0		
		2/13/19		1553		
		2/19/19		1083.0		
		2/27/19		816		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
CUMBE193.7DA (cont'd)	Omohundo Water Plant (cont'd)	3/6/19	M	192		
		3/13/19	M	517.0		
		3/20/19	M	29.0		
		3/27/19	M	6.0		
		4/3/19	M	2.0		
		4/10/19	M	66.0		
		4/17/19	M	206.0		
		4/24/19	M	114.0		
		5/1/19	M	7.0		
		5/8/19	M	6.0		
		5/15/19	M	7.0		
		5/22/19	M	6.0		
		6/5/19	M	5.0		
		6/12/19	M	88.0		
		6/19/19	M	6.0		
		6/26/19	M	13.0		
		9/4/19	M	4.0		
		9/11/19	M	93.0		
		9/19/19	M	8.0		
		9/26/19	M	14.0		
DAVID000.4DA	Davidson	7/13/15	M	275.5		ND
		7/14/15	M	275.5		ND
		7/20/15	M	727		ND
		7/27/15	M	148.3		ND
		7/28/15	M	238.2		ND
		7/19/16	M	410.6		ND
		7/26/16	M	157.6		ND
		7/27/16	M	110.6		ND
		8/1/16	M	248.9		3
		8/1/16	M	161.6		
		8/16/16	M	248.9		ND
		10/4/16	M	129.6		ND
		10/5/16	M	71.7		ND
		10/6/16	M	1553.1		ND
		10/13/16	M	36.4		ND
		10/25/16	M	135.4		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
DAVID000.4DA (cont'd)	Davidson (cont'd)	1/9/17	M	39.3		ND
		1/25/17	M	74.9		ND
		1/26/17	M	71.2		ND
		1/30/17	M	46.5		ND
		1/30/17	M	40.2		
		2/1/17	M	60.9		ND
		4/10/17	M	95.9		
		5/9/17	M	66.3		ND
		5/9/17	M	79.4		
		5/11/17	M	71.7		ND
		5/16/17	M	75.9		1
		5/17/17	M	74.3		0.1
		5/31/17	M	83		ND
		6/8/17	M	285.1		0.3
		6/28/17	M	52		ND
		6/28/17	M	43.5		
		7/7/20	T	308		
		7/8/20	T	308		
		7/29/20	T	517		
		8/4/20	T	99		
		8/6/20	T	101		
DRAKE000.2DA	Drakes	9/8/05	T	240		
		11/16/05	T	490		
		12/14/05	T	40		
		1/18/06	T	440		
		2/23/06	T	78		
		3/22/06	T	160		
		4/12/06	T	10		
		5/16/06	T	110		
		6/15/06	T	>2400		
		7/31/12	M	325.5		0.8
		8/9/12	M	579.4		2.9
		8/13/12	M	770.1	1	3.2
		8/21/12	M	120.1		0.7
		8/28/12	M	613.1		0.6

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
DRAKE000.2DA (cont'd)	Drakes (cont'd)	10/10/12	M	142.1		1.1
		10/16/12	M	85.7		ND
		10/22/12	M	272.3		ND
		10/24/12	M	67.6		ND
		10/30/12	M	57.3		0.7
		1/8/13	M	9.7		0.2
		1/22/13	M	113.7		0.5
		1/28/13	M	79.4		1.8
		1/29/13	M	161.6		1.8
		2/6/13	M	307.6		4.7
		7/14/15	T	727		
		7/16/15	T	365		
		7/21/15	T	461		
		7/23/15	T	>2420		
		7/30/15	T	548		
		7/19/17	M	325.5	0	0.1
		8/1/17	M	209.9		ND
		8/10/17	M	435.2		0.1
		8/14/17	M	2419.6		1
		8/21/17	M	61.3		ND
		8/22/17	M	579.4		ND
		9/28/17	M	129.1		ND
		10/19/17	M	166.4		1
		11/15/17	M	43.5		ND
		12/13/17	M	7.5		ND
		1/31/18	M	44.1		ND
		2/21/18	M	224.7		ND
		3/23/18	M	98.8		ND
		4/19/18	M	82.3		ND
		5/14/18	M	307.6		0.7
		6/14/18	M	816.4		0.9
		8/4/20	T	308		
		8/27/20	T	261		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
DRY000.3DA	na	8/25/15	T	31		
		9/17/15	T	46		
		10/7/15	T	53		
		11/17/15	T	9		
		12/14/15	T	1120		
		1/13/16	T	41		
		2/29/16	T	132		
		3/9/16	T	186		
		4/20/16	T	219		
		5/5/16	T	>2420		
		6/1/16	T	54		
		7/8/20	T	435		
		8/6/20	T	228		
		9/8/20	T	194		
DRY001.1DA	Dry Creek	7/31/12	M	2419.6		1
		8/13/12	M	686.7	8.7	0.7
		8/21/12	M	478.6		0.8
		8/22/12	M	613.1		1.2
		8/28/12	M	2419.6		0.9
		10/10/12	M	209.8		2.3
		10/11/12	M	44.5		1.4
		10/23/12	M	115.3		ND
		10/24/12	M	178.5		ND
		10/31/12	M	290.9		0.1
		1/8/13	M	142.1		0.4
		1/22/13	M	101.0		1.1
		1/28/13	M	104.3		1.6
		1/29/13	M	52.0		1
		2/6/13	M	59.4		2.5
		10/15/13	M	727.0		
		2/11/14	M	30.1		
		4/24/14	M	156.5		ND
		7/13/15	M	770.1		4.5
		7/14/15	M	478.6		0.3

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
DRY001.1DA (cont'd)	Dry Creek (cont'd)	7/20/15	M	140.3		5.3
		7/27/15	M	248.1		
		7/28/15	M	1119.9		ND
		1/23/17	M	146.7		ND
		7/20/17	M	980.4	0	ND
		8/2/17	M	178		ND
		8/10/17	M	108.1		ND
		8/14/17	M	1732.9		1
		8/21/17	M	141.4		0.7
		8/22/17	M	105.8		0.4
		9/28/17	M	40.4		0.3
		10/19/17	M	56.8		1.1
		11/15/17	M	70.3		0.1
		12/13/17	M	2.0		ND
		1/31/18	M	57.1		ND
		2/21/18	M	172.5		ND
		3/23/18	M	98.5		ND
		4/19/18	M	151.5		ND
		5/14/18	M	648.8		0.1
		6/14/18	M	185.0		0.2
		8/20/19	M	108.1		ND
		8/4/20	T	517		
		8/18/20	T	248		
		8/19/20	T	194		
		8/25/20	T	260		
		8/27/20	T	345		
EFBRO000.2DA	E Fork Browns	7/26/05	T	820		
		9/8/05	T	160		
		10/6/05	T	140		
		11/30/05	T	110		
		12/13/05	T	14		
		1/17/06	T	580		
		2/21/06	T	69		
		3/20/06	T	1700		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
EFBRO000.2DA (cont'd)	E Fork Browns (cont'd)	4/5/06	T	130		
		5/31/06	T	650		
		6/6/06	T	460		
		8/3/10	T	291		
		8/5/10	T	328		
		8/9/10	T	121		
		8/17/10	T	210		
		8/23/10	T	88		
		8/25/10	T	291		
		4/11/11	M	272.3	5.7	
		4/19/11	M	78.9	1.8	
		5/6/11	M	195.6	2.1	
		5/7/11	M	58.3	1.3	
		5/9/11	M	272.3	5.2	
		5/16/11	T	670		
		5/24/11	T	860		
		5/24/11	M	1413.6	2.4	
		5/25/11	T	290		
		6/1/11	T	340		
		6/2/11	T	460		
		6/6/11	T	1210		
		6/27/11	M	517.2	1.6	
		7/11/11	M	261.3	3.5	
		7/12/11	M	547.5	1	
		7/14/11	M	488.4	2.1	
		7/18/11	M	248.1	2.7	
		7/21/11	M	579.4	1.7	
		9/15/11	M	866.4	3.7	
		10/3/11	M	101.7	1.6	
		10/4/11	M	88.2	6.5	
		10/5/11	M	91.0	0.9	
		10/6/11	M	90.8	1.4	
		10/24/11	M	37.3	0.5	
		11/15/11	M	2419.6	10.2	0.7

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
EFBRO000.2DA (cont'd)	E Fork Browns (cont'd)	1/4/12	M	68.3	1.8	
		1/5/12	M	50.4	1	
		1/11/12	M	1046.2	12.7	
		1/30/12	M	67.6	4.6	
		1/31/12	M	30.9	1.2	
		2/7/12	M	111.9	0.2	
		8/11/15	T	1046		
		9/17/15	T	162		
		10/7/15	T	62		
		11/17/15	T	210		
		12/14/15	T	1986		
		1/13/16	T	93		
		2/29/16	T	32		
		3/9/16	T	75		
		4/20/16	T	135		
		5/5/16	T	548		
		6/1/16	T	1120		
		7/12/16	M	116.9		
		7/13/16	M	141.4		
		7/14/16	M	119.8		
		7/18/16	M	116.0		
		7/26/16	M	191.8		ND
		10/5/16	M	238.2		ND
		10/6/16	M	235.9		ND
		10/11/16	M	>2419.6		ND
		10/14/16	M	307.6		ND
		10/17/16	M	517.2		ND
		10/25/16	M	222.4		ND
		1/9/17	M	275.5		ND
		1/24/17	M	344.8		ND
		1/26/17	M	275.5		ND
		1/31/17	M	307.6		ND
		2/1/17	M	275.5		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
EFBRO000.2DA (cont'd)	E Fork Browns (cont'd)	5/9/17	M	344.8	0	0.1
		5/10/17	M	224.7	0	0.1
		5/16/17	M	866.4	0	ND
		5/18/17	M	435.2	0	ND
		6/1/17	M	344.8	0	ND
		7/16/20	T	185		
		9/2/20	T	152		
		10/14/20	T	116		
EWING000.8DA	Ewing	8/25/05	T	110		
		9/8/05	T	170		
		10/26/05	T	190		
		11/16/05	T	>2400		
		12/14/05	T	140		
		1/18/06	T	270		
		2/23/06	T	29		
		3/22/06	T	84		
		4/12/06	T	4		
		5/16/06	T	360		
		6/15/06	T	180		
		5/11/10	T	344		
		5/13/10	T	148		
		5/18/10	T	548		
		5/20/10	T	687		
		5/24/10	T	517		
		5/27/10	T	687		
		6/1/10	T	411		
		7/14/10	T	1120		
		8/26/10	T	291		
		9/21/10	T	137		
		10/13/10	T	1120		
		11/22/10	T	50		
		12/21/10	T	214		
		1/5/11	T	91		
		2/1/11	T	99		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
EWING000.8DA (cont'd)	Ewing (cont'd)	3/31/11	T	435		
		4/13/11	T	613		
		5/18/11	T	816		
		6/29/11	T	1414		
		7/31/12	M	88.2		0.6
		8/20/12	M	275.5		3.3
		8/21/12	M	186.0		0.9
		8/23/12	M	770.1		1.6
		8/28/12	M	248.9		0.9
		10/10/12	M	133.4		2.2
		10/16/12	M	178.5		ND
		10/22/12	M	95.9		0.1
		10/24/12	M	272.3		ND
		10/30/12	M	157.6		0.3
		1/8/13	M	26.6		
		1/23/13	M	57.4		0.9
		1/24/13	M	41.0		1.2
		1/29/13	M	70.8		2.1
		2/5/13	M	27.5		2.2
		7/14/15	T	126		
		7/14/15	M	275.5		ND
		7/16/15	T	43		
		7/20/15	M	93.4		ND
		7/21/15	T	73		
		7/21/15	M	78.0		ND
		7/22/15	M	113.7		ND
		7/23/15	T	1414		
		7/27/15	M	148.3		ND
		7/30/15	T	122		
		11/17/15	T	34		
		12/7/15	T	238		
		1/5/16	T	2420		
		2/23/16	T	248		
		3/22/16	T	161		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
EWING000.8DA (cont'd)	Ewing (cont'd)	4/27/16	T	345		
		5/4/16	T	249		
		6/21/16	T	261		
		7/19/17	M	96	0	8.5
		8/1/17	M	7.2		ND
		8/10/17	M	126.8		ND
		8/14/17	M	387.3		1.2
		8/21/17	M	378.4		1.2
		8/22/17	M	228.2		ND
		9/28/17	M	231.0		ND
		10/19/17	M	30.9		ND
		11/15/17	M	80.1		0.1
		12/13/17	M	4.1		ND
		1/31/18	M	33.2		ND
		2/21/18	M	248.9		0.3
		3/23/18	M	98.5		ND
		4/19/18	M	127.4		ND
		5/14/18	M	104.6		0.9
		6/14/18	M	151.5		0.2
		8/8/18	M	9.7		ND
		8/15/18	M	81.6		ND
		8/30/18	M	33.6		ND
		9/4/18	M	31.8		ND
		9/5/18	M	18.3		0.1
		11/26/18	M	115.3		
		7/8/20	T	285		
		8/6/20	T	219		
		9/8/20	T	308		
FINLE000.1DA	Finley	7/26/05	T	340		
		9/8/05	T	1100		
		11/30/05	T	410		
		12/13/05	T	240		
		1/17/06	T	1100		
		2/21/06	T	54		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
FINLE000.1DA (cont'd)	Finley (cont'd)	2/21/06	T	54		
		3/20/06	T	920		
		4/5/06	T	230		
		5/31/06	T	1000		
		6/6/06	T	390		
		9/22/10	T	980		
		9/23/10	T	1553		
		9/28/10	T	199		
		4/4/11	T	190		
		4/11/11	T	160		
		4/14/11	T	3080		
		4/19/11	T	250		
		4/25/11	T	1020		
		7/14/15	T	>2420		
		7/28/15	M	90.8		0.7
		8/3/15	M	172.2		1
		8/4/15	M	153.9		
		8/5/15	M	184.2		ND
		8/12/15	M	248.1		2
		8/13/15	T	130		
		9/9/15	T	1733		
		10/7/15	M	73.3		2.7
		10/8/15	M	71.7		ND
		10/12/15	T	291		
		10/20/15	M	90.6		ND
		10/21/15	M	150.0		ND
		11/5/15	T	91		
		11/5/15	M	143.9		
		12/7/15	T	46		
		1/12/16	T	43		
		2/22/16	M	85.7		ND
		2/29/16	M	1203.3		0.4
		3/7/16	M	686.7		0.4
		3/8/16	M	325.5		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
FINLE000.1DA (cont'd)	Finley (cont'd)	3/9/16	M	1732.9		ND
		4/19/16	T	770		
		4/19/16	M	>2419.6		4.7
		4/20/16	M	170.2		ND
		4/25/16	M	141.4		ND
		5/9/16	M	488.4		ND
		5/16/16	M	410.6		ND
		5/18/16	T	921		
		6/14/16	T	>2420		
		1/23/17	M	85.7		ND
		5/1/18	M	727.0		ND
		7/15/20	M	151.5		ND
		7/16/20	M	275.5		ND
		7/20/20	M	214.3		ND
		7/21/20	M	365.4		ND
		8/6/20	M	517.2		ND
		8/26/20	M	101.7		0.7
		9/21/20	M	151.5		
		10/15/20	M	218.7		ND
		11/9/20	M	31.1		0.3
HOLT000.4DA	HOLT	7/5/05	T	45		
		8/2/05	T	190		
		9/14/05	T	62		
		10/12/05	T	190		
		11/3/05	T	9		
		12/15/05	T	>2400		
		1/12/06	T	57		
		2/28/06	T	17		
		3/9/06	T	52		
		4/27/06	T	120		
		5/25/06	T	520		
		6/22/06	T	980		
		9/8/10	T	228		
		9/14/10	t	308		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
HOLT000.4DA (cont'd)	HOLT (cont'd)	4/4/11	T	280		
		4/11/11	T	170		
		4/14/11	T	110		
		4/19/11	T	170		
		4/25/11	T	200		
		7/14/14	M	101.7		ND
		7/22/14	M	920.8		ND
		7/23/14	M	387.3		0.2
		7/31/14	M	248.1		0.5
		8/4/14	M	98.7		ND
		10/2/14	M	67		0.2
		10/20/14	M	148.3		ND
		10/21/14	M	95.9		ND
		10/22/14	M	88.2		0.6
		10/28/14	M	43.5		8
		1/21/15	M	101.2		ND
		1/22/15	M	127.4		ND
		1/29/15	M	62.4		8
		2/9/15	M	57.3		ND
		2/10/15	M	66.4		ND
		4/13/15	M	298.7		ND
		4/23/15	M	298.7		ND
		4/24/15	M	178.5		ND
		4/29/15	M	218.7		ND
		4/30/15	M	124.6		0.1
		7/21/15	T	231		
		8/11/15	T	816		
		9/17/15	T	219		
		10/7/15	T	112		
		11/17/15	T	80		
		12/14/15	T	>2420		
		1/13/16	T	53		
		2/29/16	T	135		
		3/9/16	T	233		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
HOLT000.4DA (cont'd)	HOLT (cont'd)	4/20/16	T	260		
		5/5/16	T	197		
		6/1/16	T	118		
INDIA000.4DA	Indian	8/2/05	T	220		
		9/14/05	T	520		
		10/12/05	T	36		
		11/3/05	T	8		
		12/15/05	T	>2400		
		1/12/06	T	130		
		2/28/06	T	25		
		3/9/06	T	230		
		4/27/06	T	160		
		5/25/06	T	>2400		
		6/22/06	T	460		
		9/8/10	T	1986		
		4/4/11	T	180		
		4/11/11	T	140		
		4/14/11	T	190		
		4/25/11	T	320		
		7/22/14	M	1413.6		1.8
		7/23/14	M	344.8		ND
		7/31/14	M	461.1		ND
		8/4/14	M	261.3		0.2
		10/2/14	M	139.6		ND
		10/20/14	M	<1		ND
		10/21/14	M	248.9		ND
		10/22/14	M	472.1		ND
		10/28/14	M	36.8		ND
		1/21/15	M	61.3		ND
		1/22/15	M	1046.2		0.1
		1/29/15	M	123.6		1.7
		2/9/15	M	178.9		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
INDIA000.4DA (cont'd)	Indian (cont'd)	2/10/15	M	122.3		3.6
		4/13/15	M	387.3		ND
		4/23/15	M	365.4		ND
		4/24/15	M	135.4		1.7
		4/29/15	M	248.1		ND
		4/30/15	M	162.4		ND
		7/21/15	T	102		
		8/11/15	T	111		
		9/17/15	T	93		
		10/7/15	T	162		
		11/17/15	T	770		
		12/14/15	T	727		
		1/13/16	T	167		
		2/29/16	T	166		
		3/9/16	T	108		
		4/20/16	T	112		
		5/5/16	T	111		
		6/1/16	T	61		
		8/12/20	T	291		
		8/20/20	T	579		
		9/10/20	T	99		
		10/13/20	T	387		
JHOLL000.2DA	Jocelyn Hollow	7/27/05		280		
		8/17/05		490		
		9/7/05		240		
		11/22/05		240		
		12/6/05		17		
		1/19/06		60		
		2/9/06		110		
		3/2/06		55		
		4/11/06		82		
		5/18/06		730		
		6/20/06		>2400		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
JHOLL000.2DA (cont'd)	Jocelyn Hollow (cont'd)	5/9/11	M	461.1	5.7	
		5/10/11	M	547.5	6.4	
		5/11/11	M	461.1	6.1	
		5/12/11	M	2419.6	1.2	
		5/18/11	M	261.3	0.4	
		5/24/11	M	4410.0	4.4	
		6/27/11	M	365.4	1.5	
		7/11/11	M	1732.9	7.4	
		7/12/11	M	435.2	2.9	
		7/13/11	M	1986.3	15.4	2.5
		7/14/11	M	613.1	8.9	
		7/21/11	M	488.4	2.6	
		8/4/11	T	310		
		8/8/11	T	370		
		8/11/11	T	640		
		8/15/11	T	650		
		9/15/11	M	488.4	9.5	
		10/3/11	M	105.4	5.2	
		10/4/11	M	307.6	1.4	
		10/5/11	M	248.1	0.8	
		10/6/11	M	166.4	2.9	
		10/24/11	M	365.4	0.9	
		11/15/11	M	1119.9	7.3	
		1/4/12	M	272.3	0.4	
		1/5/12	M	307.6	2.5	
		1/11/12	M	7120.0	9.7	
		1/31/12	M	36.4	0.6	
		2/6/12	M	47.3	0.6	
		2/7/12	M	118.7	0.7	
		4/4/12	T	60		
		4/9/12	T	270		
		4/16/12	T	750		
		4/19/12	T	3870		
		4/24/12	T	930		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
JHOLL000.2DA (cont'd)	Jocelyn Hollow (cont'd)	4/26/12	T	510		
		7/15/15	T	579		
		8/18/15	T	1203		
		9/15/15	T	921		
		10/6/15	T	214		
		11/23/15	T	548		
		12/3/15	T	210		
		1/4/16	T	435		
		1/28/16	T	115		
		3/23/16	T	131		
		4/21/16	T	101		
		5/26/16	T	1120		
		6/9/16	T	649		
		7/19/16	M	290.9		ND
		7/26/16	M	191.8		ND
		7/27/16	M	148.3		ND
		8/1/16	M	488.4		ND
		8/16/16	M	1299.7		ND
		10/4/16	M	579.4		ND
		10/5/16	M	344.1		ND
		10/6/16	M	1413.6		0.4
		10/13/16	M	1413.6		0.2
		10/25/16	M	613.1		ND
		1/9/17	M	185		ND
		1/25/17	M	101.2		ND
		1/26/17	M	107.6		ND
		1/30/17	M	152.3		ND
		2/1/17	M	123.6		ND
		5/9/17	M	235.9	0	0.2
		5/11/17	M	387.3	0	ND
		5/16/17	M	613.1	0	0.3
		5/17/17	M	270	0	ND
		5/31/17	M	1413.6	0	ND

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
JHOLL000.2DA (cont'd)	Jocelyn Hollow (cont'd)	7/16/20	T	225		
		9/2/20	T	172		
		10/14/20	T	186		
LUMSL000.1DA	Lumsley	7/31/12	M	365.4		0.6
		8/20/12	M	298.7		2.6
		8/21/12	M	201.4		0.9
		8/22/12	M	866.4		0.5
		8/23/12	M	517.2		0.5
		10/10/12	M	128.1		1.3
		10/11/12	M	64.5		1.4
		10/23/12	M	61.3		0.1
		10/24/12	M	86.7		ND
		10/31/12	M	6.3		0.1
		1/8/13	M	57.3		0.6
		1/23/13	M	107.6		0.9
		1/24/13	M	76.3		1.5
		1/29/13	M	98.5		3.2
		2/5/13	M	57.8		2.7
		8/27/15	T	62		
		8/31/15	T	79		
		9/2/15	T	70		
		9/10/15	T	488		
		9/14/15	T	866		
		7/20/17	M	201.4		ND
		8/2/17	M	190.4		ND
		8/10/17	M	70.8		ND
		8/14/17	M	360.9		0.4
		8/21/17	M	74.3		ND
		8/22/17	M	2419.6		ND
		9/28/17	M	52.8		ND
		10/19/17	M	77.1		ND
		11/15/17	M	88.4		ND
		12/13/17	M	10.9		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
LUMSL000.1DA (cont'd)	Lumsley (cont'd)	1/31/18	M	135.4		ND
		2/21/18	M	129.1		ND
		3/23/18	M	547.5		ND
		4/19/18	M	104.6		ND
		5/14/18	M	145.5		ND
		6/14/18	M	261.3		0.1
		8/4/20	T	365		
		8/18/20	T	108		
		8/19/20	T	79		
		8/25/20	T	102		
		8/27/20	T	115		
MANSK002.8SR	Manskers 1	7/7/05	T	150		
		8/18/05	T	2900		
		9/27/05	T	98		
		10/5/05	T	240		
		11/29/05	T	770		
		12/8/05	T	100		
		1/30/06	T	100		
		2/7/06	T	82		
		3/8/06	T	16		
		4/17/06	T	130		
		5/11/06	T	1700		
		6/14/06	T	290		
		5/11/10	T	308		
		5/13/10	T	185		
		5/18/10	T	1203		
		5/20/10	T	249		
		8/3/10	T	155		
		8/5/10	T	84		
		8/9/10	T	148		
		8/17/10	T	45		
		8/23/10	T	238		
		8/25/10	T	228		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
MANSK002.8SR (cont'd)	Manskers 1 (cont'd)	5/16/11	T	390		
		5/24/11	T	17330		
		5/25/11	T	1210		
		6/1/11	T	300		
		6/2/11	T	460		
		6/6/11	T	960		
		7/26/12	M	260.3		
		7/26/12	M	410.6		0.7
		7/31/12	M	1046.2		1.1
		8/20/12	M	298.7		3.2
		8/21/12	M	203.5		2
		8/22/12	M	122.3		0.6
		10/10/12	M	129.6		2.2
		10/11/12	M	25.6		1.8
		10/23/12	M	122.3		0
		10/24/12	M	34.4		0.3
		10/31/12	M	101.7		0.4
		1/8/13	M	123.6		0.2
		1/23/13	M	39.9		1.2
		1/24/13	M	116.9		1.2
		1/29/13	M	63.3		0.9
		2/5/13	M	32.7		4.6
		6/20/13	M	313.0		
		8/31/15	T	201		
		9/2/15	T	115		
		9/8/15	T	211		
		9/10/15	T	326		
		9/14/15	T	77		
		7/20/17	M	79.5		ND
		8/2/17	M	93.4		ND
		8/10/17	M	727		ND
		8/14/17	M	579.4		0.7
		8/22/17	M	85.4		0.7
		8/30/17	M	109		1.4

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
MANSK002.8SR (cont'd)	Manskers 1 (cont'd)	9/28/17	M	111.8		0.1
		10/19/17	M	298.7		0.4
		11/15/17	M	54.8		ND
		12/13/17	M	19.9		ND
		1/31/18	M	39.7		ND
		2/21/18	M	120.1		0.3
		3/23/18	M	290.9		ND
		4/5/18	M	238.2		ND
		5/9/18	M	261.3		0.4
		6/14/18	M	148.3		0.1
		8/4/20	T	770		
		8/18/20	T	248		
		8/19/20	T	326		
		8/25/20	T	770		
		8/27/20	T	461		
MANSK005.8SR	na	7/8/20	T	687		
		8/6/20	T	155		
		9/8/20	T	190		
MANSK006.2SR	Manskers 2	7/7/05	T	290		
		8/18/05	T	>2400		
		9/27/05	T	130		
		10/5/05	T	110		
		11/29/05	T	870		
		12/8/05	T	80		
		1/30/06	T	230		
		2/7/06	T	370		
		3/8/06	T	140		
		4/17/06	T	110		
		5/11/06	T	920		
		6/14/06	T	870		
		8/3/10	T	435		
		8/5/10	T	517		
		8/9/10	T	179		
		8/17/10	T	579		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
MANSK006.2SR (cont'd)	Manskers 2 (cont'd)	8/23/10	T	488		
		8/25/10	T	411		
		5/16/11	T	580		
		5/24/11	T	9140		
		5/25/11	T	2600		
		6/1/11	T	810		
		6/2/11	T	820		
		6/6/11	T	1850		
		7/31/12	M	43.1		0.3
		8/20/12	M	114.5		3.2
		8/21/12	M	125.9		0.9
		8/22/12	M	118.7		0.7
		8/23/12	M	58.3		0.6
		10/10/12	M	30.9		1.9
		10/11/12	M	53.7		1.9
		10/23/12	M	42.6		0
		10/24/12	M	24.9		0.5
		10/31/12	M	71.2		0.3
		1/8/13	M	98.3		0.9
		1/23/13	M	31.3		1.7
		1/24/13	M	39.3		0.9
		1/29/13	M	81.3		4.1
		2/5/13	M	51.2		2.8
		8/27/15	T	84		
		8/31/15	T	44		
		9/2/15	T	99		
		9/10/15	T	>2420		
		9/14/15	T	548		
		11/17/15	T	<1		
		12/7/15	T	921		
		1/5/16	T	47		
		2/23/16	T	687		
		3/22/16	T	210		
		4/27/16	T	727		

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

Monitoring Station		Date	Source	*E. coli*	PCR	
TDEC	Metro		(T/M)	[CFU/100mL]	ALLBAC	HUBAC
MANSK006.2SR (cont'd)	Manskers 2 (cont'd)	5/4/16	T	1733		
		6/21/16	T	205		
		7/20/17	M	193.5		ND
		8/2/17	M	64.6		ND
		8/10/17	M	436.6		ND
		8/14/17	M	71.2		1
		8/21/17	M	54.6		0.8
		8/22/17	M	47.3		ND
		9/28/17	M	44.3		ND
		10/19/17	M	14.8		ND
		11/15/17	M	19.7		ND
		12/13/17	M	21.3		ND
		1/31/18	M	27.9		ND
		3/23/18	M	88.4		ND
		4/19/18	M	83.6		ND
		5/14/18	M	157.6		ND
MFBRO000.1DA	M Fork Browns	7/26/05	T	>2400		
		9/8/05	T	2400		
		10/6/05	T	550		
		11/30/05	T	260		
		12/13/05	T	490		
		1/17/06	T	1700		
		2/21/06	T	86		
		3/20/06	T	1400		
		4/5/06	T	>2400		
		5/31/06	T	>2400		
		6/6/06	T	1600		
		8/3/10	T	326		
		8/5/10	T	365		
		8/9/10	T	770		
		8/17/10	T	411		
		8/23/10	T	275		
		8/25/10	T	291		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
MFBRO000.1DA (cont'd)	M Fork Browns (cont'd)	4/11/11	M	166.4	1.4	
		4/19/11	M	156.5	3.1	
		5/6/11	M	161.6	1.5	
		5/7/11	M	131.4	3.4	
		5/9/11	M	275.5	7.5	
		5/16/11	T	300		
		5/24/11	T	580		
		5/24/11	M	920.8	3.1	
		5/25/11	T	380		
		6/1/11	T	1110		
		6/2/11	T	1110		
		6/6/11	T	1020		
		6/27/11	M	686.7	3	
		7/11/11	M	365.4	3.6	
		7/12/11	M	980.4	2	
		7/14/11	M	>2419.6	6.3	
		7/18/11	M	488.4	10.9	
		7/21/11	M	866.4	3.5	
		9/15/11	M	>2419.6	5.3	
		10/3/11	M	129.1	2.7	
		10/4/11	M	275.5	9.5	
		10/5/11	M	307.6	6.1	
		10/6/11	M	145.5	2.9	
		10/24/11	M	177.5	0.3	
		11/15/11	M	3410.0	11.5	0.6
		1/4/12	M	52.0	2.8	
		1/5/12	M	90.5	1.2	
		1/11/12	M	1986.3	2.7	
		1/30/12	M	139.6	6.7	
		1/31/12	M	61.3	1.1	
		2/7/12	M	135.2	1.4	
		7/21/15	T	1553		
		8/11/15	T	866		
		9/17/15	T	548		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
MFBRO000.1DA (cont'd)	M Fork Browns (cont'd)	10/7/15	T	344		
		11/17/15	T	613		
		12/14/15	T	>2420		
		1/13/16	T	101		
		2/29/16	T	142		
		3/9/16	T	222		
		4/20/16	T	261		
		5/5/16	T	1414		
		6/1/16	T	2420		
		7/12/16	M	517.2		
		7/13/16	M	509.9		
		7/14/16	M	816.4		
		7/18/16	M	488.4		
		7/26/16	M	517.2		
		10/5/16	M	517.2		
		10/6/16	M	866.4		
		10/11/16	M	280.9		
		10/17/16	M	228.2		
		10/25/16	M	435.2		
		1/9/17	M	344.8		
		1/24/17	M	920.8		
		1/26/17	M	435.2		
		1/31/17	M	172.2		
		2/1/17	M	517.2		
		5/9/17	M	325.5		
		5/10/17	M	410.6		
		5/16/17	M	218.7		
		5/18/17	M	260.3		
		6/1/17	M	517.2		
		7/16/20	T	488		
		9/2/20	T	921		
		10/14/20	T	238		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
	Mill 1	8/16/05	M	280		
		10/27/05	M	10		
		2/16/06	M	40		
		6/6/06	M	300		
		8/28/06	M	170		
		9/24/06	M	110		
		3/7/07	M	45		
		4/10/07	M	20		
		7/23/07	M	110		
		3/8/10	M	24.6		
		3/10/10	M	49.6		
		3/17/10	M	98.4		
		3/24/10	M	123.6		
		3/31/10	M	33.2		
		5/11/10	M	686.7		
		5/13/10	M	206.0		
		5/19/10	M	292.4		
		5/25/10	M	107.6		
		5/26/10	M	547.5		
		6/8/10	M	36.8		
		6/15/10	M	135.4		
		6/16/10	M	172.5		
		6/22/10	M	2419.6		
		6/23/10	M	209.8		
		9/20/10	M	83.9		
		10/5/10	M	90.5		
		10/13/10	M	2419.6		
		12/7/10	M	155.3		
		1/6/11	M	36.9		
		1/28/11	M	50.4		
		2/24/11	M	1460.0		
		4/26/11	M	1413.6		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
	Mill 1 (cont'd)	7/28/15	M	16		
		8/3/15	M	84.2		
		8/4/15	M	105.4		
		8/5/15	M	58.3		
		8/12/15	M	75.9		
		10/7/15	M	117.8		
		10/8/15	M	79.4		
		10/20/15	M	50.4		
		10/21/15	M	77.1		
		11/5/15	M	825		
		2/8/16	M	98.8		
		2/22/16	M	118.7		
		2/29/16	M	123.6		
		3/1/16	M	178.5		
		3/8/16	M	93.3		
		4/19/16	M	46.1		
		4/20/16	M	37.9		
		4/25/16	M	73.3		
		5/9/16	M	75.4		
		5/16/16	M	79.4		
MILL003.3DA	na	7/21/10	T	579		
		8/12/10	T	192		
		9/15/10	T	225		
		10/19/10	T	93		
		12/8/10	T	313		
		1/27/11	T	90		
		2/22/11	T	228		
		3/22/11	T	23		
		4/20/11	T	285		
		5/17/11	T	195		
		6/30/11	T	517		
		7/14/15	T	>2420		
		8/13/15	T	46		
		9/9/15	T	118		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
MILL003.3DA (cont'd)	na	10/12/15	T	120		
		11/5/15	T	76		
		12/7/15	T	135		
		1/12/16	T	91		
		4/19/16	T	31		
		5/18/16	T	93		
		6/14/16	T	>2420		
MILL009.6DA	Mill 3	5/11/10	T	210		
		5/13/10	T	108		
		5/19/10	T	687		
		5/24/10	T	416		
		7/14/14	M	18.5		ND
		7/22/14	M	334.8		0.1
		7/23/14	M	167.0		ND
		7/31/14	M	98.4		0.1
		8/4/14	M	25.6		ND
		10/2/14	M	74.9		ND
		10/20/14	M	86.2		0.4
		10/21/14	M	137.4		4.2
		10/22/14	M	63.7		ND
		10/28/14	M	60.9		1.9
		1/20/15	M	307.6		0.2
		1/21/15	M	195.6		0.1
		1/22/15	M	23.3		0.9
		2/9/15	M	33.6		ND
		2/10/15	M	18.3		ND
		4/13/15	M	114.5		1.2
		4/23/15	M	387.3		12.628
		4/24/15	M	178.5		9.056
		4/29/15	M	140.1		ND
		4/30/15	M	46.7		0.5
		7/14/15	T	>2420		
		8/13/15	T	44		
		9/9/15	T	75		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
MILL009.6DA (cont'd)	Mill 3 (cont'd)	10/12/15	T	41		
		11/5/15	T	66		
		11/17/15	M	43.5		ND
		12/7/15	T	120		
		1/12/16	T	64		
		2/23/16	M	1553.1		2.3
		4/19/16	T	36		
		4/26/16	M	12.0		5.3
		5/18/16	T	260		
		6/14/16	T	>2420		
		7/9/19	M	93.4		ND
		7/10/19	M	46.5		ND
		7/16/19	M	48.8		ND
		7/26/19	M	190.4		0.1
		7/29/19	M	83.9		0.3
		8/29/19	M	73.3		ND
		9/24/19	M	157.3		0.1
		10/24/19	M	77.1		ND
		11/26/19	M	39.5		0.7
		12/4/19	M	133.4		0.2
		1/23/20	M	111.9		0.6
		2/28/20	M	325.5		0.5
		4/22/20	M	436.0		ND
		5/26/20	M	387.3		ND
		6/15/20	M	14.4		0.4
MILL011.0DA	na	7/5/05		110		
		8/2/05		91		
		9/14/05		28		
		10/12/05		55		
		11/3/05		9		
		12/15/05		>2400		
		1/12/06		78		
		2/28/06		18		
		3/9/06		17		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
MILL011.0DA (cont'd)	na	4/27/06	T	170		
		5/25/06	T	250		
		6/22/06	T	410		
		7/21/10	T	64		
		8/12/10	T	135		
		9/15/10	T	19		
		10/19/10	T	133		
		12/8/10	T	147		
		1/27/11	T	170		
		2/22/11	T	172		
		3/22/11	T	33		
		4/20/11	T	178		
		5/17/11	T	328		
		6/30/11	T	579		
na	Neeley's Branch	7/31/12	M	>2419.6		0.5
		8/13/12	M	1203.3	1	4
		8/20/12	M	387.3		1
		8/22/12	M	201.4		0.9
		8/28/12	M	488.4		0.6
		10/10/12	M	547.5		3.8
		10/11/12	M	613.1		2.3
		10/23/12	M	410.6		0.6
		10/24/12	M	298.7		0.6
		10/31/12	M	387.3		0.1
		1/8/13	M	238.2		0.1
		1/22/13	M	98.7		0.4
		1/28/13	M	365.4		1.6
		1/29/13	M	206.4		2.2
		2/6/13	M	118.7		1.7
		10/15/13	M	547.5		0.2
		10/15/13	M	547.5		
		2/11/14	M	461.1		17.9
		4/24/14	M	193.5		ND
		7/13/15	M	344.8		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
na	Neeley's Branch (cont'd)	7/14/15	M	461.1		
		7/20/15	M	2419.6		
		7/22/15	M	1732.9		
		7/27/15	M	488.4		
		7/20/17	M	770.1		
		8/2/17	M	152.9		
		8/10/17	M	488.4		
		8/14/17	M	>2419.6		
		8/21/17	M	218.7		
		8/22/17	M	152.9		
		9/11/17	M	157.6		
		9/18/17	M	110.0		
		9/19/17	M	290.9		
		9/28/17	M	248.9		
		10/19/17	M	104.6		
		11/15/17	M	107.1		
		12/13/17	M	93.2		
		1/31/18	M	206.4		
		2/21/18	M	248.1		
		3/23/18	M	344.8		
		4/19/18	M	387.3		
		5/14/18	M	365.4		
		6/14/18	M	816.4		
		8/20/19	M	129.6		
		8/22/19	M	129.6		
OVERA001.3DA	na	7/21/05	T	270		
		8/23/05	T	140		
		9/14/05	T	57		
		10/25/05	T	23		
		12/6/05	T	28		
		1/25/06	T	60		
		2/8/06	T	10		
		3/7/06	T	28		
		4/27/06	T	80		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
OVERA001.3DA (cont'd)	na	5/30/06	T	390		
		6/20/06	T	370		
		7/14/10	T	613		
		8/26/10	T	93		
		12/21/10	T	62		
		1/5/11	T	16		
		2/1/11	T	24		
		3/31/11	T	131		
		4/13/11	T	22		
		5/18/11	T	44		
		6/29/11	T	411		
		7/14/15	T	161		
		7/16/15	T	1203		
		7/23/15	T	1986		
		7/30/15	T	866		
		8/6/15	T	>2420		
		7/7/20	T	1733		
		7/8/20	T	162		
		7/29/20	T	1120		
		8/4/20	T	147		
		8/6/20	T	116		
na	Pages Branch	7/31/12	M	241.5		0.5
		8/13/12	M	272.3	1.5	0.8
		8/20/12	M	201.4		1
		8/21/12	M	228.2		0.5
		8/28/12	M	93.3		0.5
		10/10/12	M	146.7		1.4
		10/16/12	M	81.3		ND
		10/22/12	M	248.9		ND
		10/24/12	M	105.0		0.1
		10/30/12	M	35.5		ND
		1/8/13	M	40.4		0.2
		1/22/13	M	39.9		1.6
		1/28/13	M	137.6		3.7

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
na	Pages Branch (cont'd)	1/29/13	M	209.8		2.4
		2/6/13	M	44.1		2.1
		8/28/14	M	95.9		ND
		9/18/14	M	67.0		ND
		11/11/14	M	83.9		ND
		1/29/15	M	35.0		ND
		4/23/15	M	209.8		ND
		7/13/15	M	648.8		ND
		7/14/15	M	261.3		ND
		7/20/15	M	249.5		ND
		7/22/15	M	225.4		
		7/27/15	M	76.7		4.9
		7/27/15	M	105.0	0	1.9
		7/19/17	M	307.6		0.8
		8/1/17	M	110		ND
		8/10/17	M	365.4		ND
		8/14/17	M	488.4		ND
		8/21/17	M	63.8		0.9
		8/22/17	M	73.3		ND
		9/28/17	M	51.2		0.7
		10/19/17	M	45.9		ND
		11/15/17	M	42.6		ND
		12/13/17	M	98.8		ND
		1/31/18	M	42.8		ND
		2/21/18	M	261.3		ND
		3/23/18	M	78.0		ND
		4/19/18	M	111.2		ND
		5/14/18	M	270.0		ND
		6/14/18	M	325.5		ND
na	Pavillion	7/28/15	M	488.4		ND
		8/3/15	M	456.9		ND
		8/4/15	M	629.4		ND
		8/5/15	M	920.8		1.3
		8/12/15	M	285.1		0.3

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
na	Pavillion (cont'd)	10/7/15	M	235.9		1.1
		10/8/15	M	222.4		1.3
		10/20/15	M	360.9		ND
		10/21/15	M	193.5		ND
		11/5/15	M	68.9		
		2/22/16	M	137.6		0.2
		2/29/16	M	166.4		0.1
		3/1/16	M	129.6		ND
		3/7/16	M	139.6		ND
		3/8/16	M	159.7		0.9
		4/19/16	M	72.4		ND
		4/20/16	M	67.9		ND
		4/25/16	M	410.6		ND
		5/9/16	M	770.1		ND
		5/16/16	M	248.9		ND
		7/15/20	M	816.4		ND
		7/16/20	M	770.1		0.5
		7/20/20	M	816.4		ND
		7/21/20	M	387.3		ND
		8/6/20	M	290.9		0.2
		8/26/20	M	517.2		ND
		9/21/20	M	686.7		ND
		10/15/20	M	461.1		ND
		11/9/20	M	193.5		ND
RICHL002.0DA	Richland 1	3/8/11	M	1413.6	8.6	
		3/18/11	M	95.9	2.4	
		3/21/11	M	98.8	2.6	
		3/22/11	M	85.7	5.7	
		3/23/11	M	68.3	1.9	
		5/24/11	M	8300.0	6.8	
		6/27/11	M	186.0	4.8	
		7/11/11	M	84.2	4.6	
		7/12/11	M	127.4	4.3	
		7/13/11	M	155.3	12.5	2.5

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
RICHL002.0DA (cont'd)	Richland 1 (cont'd)	7/14/11	M	82.3	8.8	
		7/21/11	M	34.5	4.5	
		9/15/11	M	1986.3	3.9	
		10/3/11	M	218.7	6.7	
		10/4/11	M	58.6	1.2	
		10/5/11	M	53.8	1.4	
		10/6/11	M	69.7	7.5	
		10/24/11	M	19.7	1.7	
		11/15/11	M	4480.0	19.3	0.3
		1/4/12	M	48.0	2.7	
		1/5/12	M	19.9	1.5	
		1/11/12	M	4850.0	6.6	
		1/31/12	M	133.4	1.1	
		2/6/12	M	133.4	3.9	
		2/7/12	M	70.6	1.5	
		7/15/15	T	488		
		8/18/15	T	206		
		9/15/15	T	133		
		10/6/15	T	93		
		11/23/15	T	88		
		12/3/15	T	210		
		1/4/16	T	435		
		1/28/16	T	46		
		3/23/16	T	96		
		4/21/16	T	108		
		5/26/16	T	866		
		6/9/16	T	411		
		7/19/16	M	61.2		ND
		7/26/16	M	116.0		ND
		7/27/16	M	82.0		ND
		8/1/16	M	80.8		3.8
		8/16/16	M	1413.6		ND
		10/4/16	M	88.4		ND
		10/5/16	M	86.2		0.1

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
RICHL002.0DA (cont'd)	Richland 1 (cont'd)	10/6/16	M	74.4		ND
		10/13/16	M	95.9		0.2
		10/25/16	M	75.9		ND
		1/9/17	M	38.4		ND
		1/25/17	M	88.6		ND
		1/26/17	M	65		ND
		1/30/17	M	90.6		ND
		2/1/17	M	48.7		ND
		4/10/17	M	93.3		
		5/9/17	M	261.3		0.1
		5/11/17	M	435.2		ND
		5/16/17	M	648.8		0.2
		5/17/17	M	214.2		ND
		6/1/17	M	435.2		ND
		6/8/17	M	260.3		ND
		6/28/17	M	84.5		0.1
		6/26/18	M	190.4		0.4
		8/30/18	M	33.3		ND
		9/4/18	M	124.6		1.1
		9/5/18	M	59.1		0.2
		9/12/18	M	461.1		0.7
		9/13/18	M	191.8		ND
		10/31/18	M	122.2		ND
		11/20/18	M	121.1		0.3
		7/23/20	T	548		
		9/3/20	T	517		
RICHL002.2DA	na	7/27/05	T	690		
		8/17/05	T	370		
		9/7/05	T	240		
		10/20/05	T	170		
		11/22/05	T	730		
		12/6/05	T	93		
		1/19/06	T	230		
		2/9/06	T	99		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
RICHL002.2DA	na	3/2/06	T	150		
		4/11/06	T	180		
		5/18/06	T	870		
		6/20/06	T	>2400		
		5/11/10	T	135		
		5/13/10	T	272		
		5/18/10	T	649		
		5/20/10	T	411		
		8/4/11	T	170		
		8/8/11	T	450		
		8/11/11	T	680		
		8/15/11	T	90		
		8/25/11	T	120		
		8/29/11	T	90		
		4/4/12	T	220		
		4/9/12	T	160		
		4/16/12	T	4610		
		4/19/12	T	170		
		4/24/12	T	250		
		4/26/12	T	230		
na	Richland 2	3/8/11	M	1299.7	8.5	
		3/18/11		160.7	2.8	
		3/21/11		209.8	4.6	
		3/22/11		135.4	2.5	
		3/23/11		122.3	4.1	
		3/25/11		146.7	2.5	
		5/24/11		7120.0	12.4	3.6
		6/27/11		88.9	6.3	
		7/11/11		224.7	6	
		7/12/11		206.4	5.2	
		7/13/11		131.4	12.4	1.4
		7/14/11		50.4	3.6	
		7/21/11		151.5	9	
		9/15/11		410.6	11.7	3.1

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
na	Richland 2 (cont'd)	10/3/11	M	155.3	5	
		10/4/11	M	160.7	3.1	
		10/5/11	M	75.4	3.1	
		10/6/11	M	51.2	2.7	
		10/24/11	M	65.7	1.8	
		11/15/11	M	1970.0	32.2	0.6
		1/4/12	M	52.9	2.5	
		1/5/12	M	58.6	3.2	
		1/11/12	M	4350.0	13.9	1.2
		1/31/12	M	108.1	1.1	
		2/6/12	M	261.3	3.5	
		2/7/12	M	161.6	1.6	
		2/28/12	M	2419.6		
		3/6/12	M	102.2		
		5/17/12	M	135.4		
		5/22/12	M	159.7		
		7/19/16	M	120.1		ND
		7/26/16	M	40.5		ND
		7/27/16	M	84.2		ND
		8/1/16	M	218.7		ND
		8/16/16	M	396.8		ND
		10/4/16	M	478.6		ND
		10/5/16	M	547.5		ND
		10/6/16	M	260.3		ND
		10/13/16	M	121.1		ND
		10/25/16	M	222.4		ND
		1/9/17	M	76.7		ND
		1/25/17	M	129.6		ND
		1/26/17	M	88.2		0.2
		1/30/17	M	248.1		ND
		2/1/17	M	62.4		ND
		5/9/17	M	206.4		ND
		5/11/17	M	224.7		0.2
		5/16/17	M	686.7		0.3

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
na	Richland 2 (cont'd)	5/17/17	M	1011.2		ND
		5/31/17	M	866.4		ND
		6/26/18	M	488.4		ND
		8/30/18	M	770.1		0.4
		9/4/18	M	461.1		0.9
		9/5/18	M	290.9		1.2
		9/12/18	M	920.8		ND
		9/13/18	M	435.2		0.1
		10/31/18	M	214.2		ND
		11/20/18	M	129.6		0.3
RICHL004.5DA	na	7/23/20	T	816		
		9/3/20	T	461		
RICHL005.0DA	na	7/15/15	T	579		
		8/18/15	T	219		
		9/15/15	T	115		
		10/6/15	T	214		
		11/23/15	T	119		
		12/3/15	T	250		
		1/4/16	T	517		
		1/28/16	T	86		
		3/23/16	T	102		
		4/21/16	T	35		
		5/26/16	T	613		
		6/9/16	T	517		
RICHL007.8DA	na	7/14/10	T	866		
		9/21/10	T	42		
		10/13/10	T	76		
		11/22/10	T	47		
		12/21/10	T	23		
		1/5/11	T	66		
		2/1/11	T	29		
		3/31/11	T	770		
		4/13/11	T	196		
		5/18/11	T	16		

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

Monitoring Station		Date	Source	*E. coli*	PCR	
TDEC	Metro		(T/M)	[CFU/100mL]	ALLBAC	HUBAC
RICHL007.8DA (cont'd)	na	6/29/11	T	139		
		7/15/15	T	45		
		8/18/15	T	108		
		9/15/15	T	84		
		10/6/15	T	101		
		11/23/15	T	58		
		12/3/15	T	291		
		1/4/16	T	687		
		1/28/16	T	31		
		3/23/16	T	10		
		4/21/16	T	12		
		5/26/16	T	102		
		6/9/16	T	194		
		7/16/20	T	36		
		9/2/20	T	238		
		10/14/20	T	61		
RICHL008.9DA	Richland 3	7/27/05	T	340		
		8/17/05	T	410		
		9/7/05	T	93		
		10/20/05	T	460		
		11/22/05	T	160		
		12/6/05	T	110		
		1/19/06	T	690		
		2/9/06	T	61		
		3/2/06	T	180		
		4/11/06	T	91		
		5/18/06	T	160		
		6/20/06	T	2400		
		3/8/11	M	>2419.6	155.6	0.9
		3/18/11	M	240.0	1.6	
		3/21/11	M	98.7	2.1	
		3/22/11	M	117.8	5.1	
		3/23/11	M	365.4	5	
		3/25/11	M	121.1	5.2	

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
RICHL008.9DA (cont'd)	Richland 3 (cont'd)	5/24/11	M	1299.7	2.2	
		6/27/11	M	1119.9	1.7	
		7/11/11	M	325.5	2.4	
		7/12/11	M	461.1	2.6	
		7/13/11	M	1046.2	4.5	
		7/14/11	M	1986.3	3.9	
		7/21/11	M	866.4	2.2	
		9/15/11	M	>2419.6	5.2	
		10/3/11	M	488.4	1.6	
		10/4/11	M	517.2	1.4	
		10/5/11	M	275.5	13.9	1.5
		10/6/11	M	378.4	2	
		10/24/11	M	60.5	1	
		11/15/11	M	5120.0	22.4	0.8
		1/4/12	M	224.7	1.5	
		1/5/12	M	160.7	0.5	
		1/11/12	M	2530.0	7.5	
		1/31/12	M	142.1	1	
		2/6/12	M	93.4	1.8	
		2/7/12	M	101.4	0.8	
		7/19/16	M	325.5		ND
		7/26/16	M	1119.9		9.1
		7/27/16	M	1413.6		ND
		8/1/16	M	816.4		ND
		8/16/16	M	22.8		0.1
		10/4/16	M	38.8		ND
		10/5/16	M	36.4		ND
		10/6/16	M	64.0		0.1
		10/13/16	M	123.4		ND
		10/25/16	M	488.4		ND
		1/9/17	M	86.3		4
		1/25/17	M	328.2		ND
		1/26/17	M	1732.9		0.4
		1/30/17	M	387.3		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
RICHL008.9DA (cont'd)	Richland 3 (cont'd)	2/1/17	M	686.7		ND
		5/9/17	M	290.9		0.1
		5/11/17	M	410.6		0.2
		5/16/17	M	1732.9		0.2
		5/17/17	M	2419.3		ND
		5/31/17	M	980.4		ND
		1/10/18	M	410.6		ND
SEVEN000.2DA	Sevenmile 1	7/26/05	T	140		
		9/8/05	T	440		
		10/6/05	T	240		
		11/30/05	T	360		
		12/13/05	T	72		
		1/17/06	T	>2400		
		2/21/06	T	86		
		3/20/06	T	>2400		
		4/5/06	T	280		
		5/31/06	T	2000		
		6/6/06	T	920		
		9/8/10	T	1986		
		9/14/10	T	308		
		9/21/10	T	345		
		9/22/10	T	276		
		9/23/10	T	276		
		9/28/10	T	172		
		4/4/11	T	290		
		4/11/11	T	160		
		4/14/11	T	260		
		4/19/11	T	290		
		4/25/11	T	370		
		7/14/15	T	387		
		7/28/15	M	225.4		ND
		8/3/15	M	721.5		ND
		8/4/15	M	228.2		
		8/5/15	M	248.1		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
SEVEN000.2DA (cont'd)	Sevenmile 1 (cont'd)	8/12/15	M	209.8		0.7
		8/13/15	T	178		
		9/9/15	T	111		
		10/7/15	M	248.1		5.4
		10/12/15	T	79		
		10/20/15	M	118.7		0.5
		10/21/15	M	66.3		ND
		11/4/15	M	325.5		ND
		11/5/15	T	141		
		11/5/15	M	201.4		
		12/7/15	T	78		
		1/12/16	T	411		
		2/22/16	M	228.2		0.4
		2/29/16	M	517.2		0.6
		3/7/16	M	159.7		1.5
		3/8/16	M	167.0		ND
		3/9/16	M	110.0		ND
		4/19/16	T	72		
		4/19/16	M	49.4		7.8
		4/20/16	M	61.7		ND
		4/25/16	M	66.3		ND
		5/9/16	M	290.9		7.6
		5/16/16	M	307.6		ND
		5/18/16	T	276		
		6/21/16	T	345		
		7/15/20	M	517.2		ND
		7/16/20	M	727.0		ND
		7/20/20	M	248.9		ND
		7/21/20	M	260.3		ND
		8/6/20	M	613.1		ND
		8/26/20	M	686.7		ND
		9/21/20	M	547.5		0.4
		10/15/20	M	613.1		ND
		11/9/20	M	107.6		0.3

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
SEVEN003.8DA	Sevenmile 2	7/26/05	T	520		
		9/8/05	T	210		
		10/6/05	T	140		
		11/30/05	T	390		
		12/13/05	T	100		
		1/17/06	T	1700		
		2/21/06	T	38		
		3/20/06	T	>2400		
		4/5/06	T	160		
		5/31/06	T	1700		
		6/6/06	T	330		
		9/8/10	T	7700		
		9/14/10	T	1986		
		9/21/10	T	461		
		9/22/10	T	816		
		9/23/10	T	435		
		9/28/10	T	411		
		4/4/11	T	1070		
		4/11/11	T	170		
		4/14/11	T	480		
		4/19/11	T	640		
		4/25/11	T	280		
		7/21/15	T	326		
		7/28/15	M	209.8		2.7
		8/3/15	M	198.9		ND
		8/4/15	M	290.9		
		8/5/15	M	298.7		0.6
		8/11/15	T	<1		
		8/12/15	M	325.5		ND
		9/17/15	T	345		
		10/7/15	T	411		
		10/7/15	M	260.3		ND
		10/20/15	M	248.9		ND
		10/21/15	M	186.0		1.4

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
SEVEN003.8DA (cont'd)	Sevenmile 2 (cont'd)	11/4/15	M	73.3		ND
		11/5/15	M	114.5		
		11/17/15	T	102		
		12/14/15	T	2420		
		1/13/16	T	179		
		2/22/16	M	95.9		0.8
		2/29/16	T	126		
		2/29/16	M	193.5		ND
		3/7/16	M	80.1		3.7
		3/8/16	M	133.4		1.2
		3/9/16	T	205		
		3/9/16	M	75.9		ND
		4/19/16	M	62.1		5.3
		4/20/16	T	167		
		4/20/16	M	70.3		2.6
		4/25/16	M	185.0		1.5
		5/5/16	T	435		
		5/9/16	M	185.0		0.6
		5/16/16	M	501.2		1
		6/1/16	T	308		ND
		7/15/20	M	435.2		ND
		7/16/20	M	410.6		0.3
		7/20/20	M	387.3		ND
		7/21/20	M	461.1		ND
		8/6/20	M	325.5		0.6
		8/26/20	M	461.1		ND
		9/21/20	M	290.9		ND
		10/15/20	M	224.7		ND
		11/9/20	M	307.6		ND
na	Shasta	7/28/15	M	816.4		5.2
		8/3/15	M	579.4		ND
		8/4/15	M	1732.9		1.1
		8/5/15	M	1046.2		1
		8/12/15	M	1203.3		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
na	Shasta (cont'd)	10/7/15	M	238.2		ND
		10/20/15	M	261.3		ND
		10/21/15	M	501.2		0.4
		11/4/15	M	116.0		ND
		11/5/15	M	117.8		
		2/22/16	M	410.6		0.7
		2/29/16	M	307.6		1.8
		3/7/16	M	222.4		0.7
		3/8/16	M	191.8		ND
		3/9/16	M	193.5		0.6
		4/19/16	M	61.4		1.1
		4/20/16	M	73.3		ND
		4/25/16	M	686.7		ND
		5/9/16	M	325.5		0.5
		5/16/16	M	270.0		1.5
		7/15/20	M	344.1		ND
		7/16/20	M	648.8		ND
		7/20/20	M	686.7		0.3
		7/21/20	M	547.5		ND
		8/6/20	M	579.4		ND
		8/26/20	M	410.6		0.3
		9/21/20	M	325.5		0.6
		10/15/20	M	461.1		ND
		11/9/20	M	648.8		ND
SIMS000.2DA	Sims 1	7/14/15	T	228		
		7/28/15	M	387.3		ND
		8/3/15	M	187.2		
		8/3/15	M	248.9		4.3
		8/4/15	M	201.4		
		8/5/15	M	230.0		
		8/12/15	M	249.5		ND
		8/13/15	T	308		
		9/9/15	T	231		
		10/7/15	M	290.9		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
SIMS000.2DA (cont'd)	Sims 1 (cont'd)	10/8/15	M	290.9		ND
		10/12/15	T	145		
		10/20/15	M	111.9		ND
		10/21/15	M	231.0		ND
		11/5/15	T	199		
		11/5/15	M	96.0		
		12/7/15	T	42		
		1/12/16	T	133		
		2/8/16	M	96.0		ND
		2/22/16	M	172.2		0.2
		2/29/16	M	129.6		ND
		3/1/16	M	178.5		ND
		3/8/16	M	275.5		0.5
		4/19/16	T	186		
		4/19/16	M	75.7		ND
		4/20/16	M	87.6		ND
		4/25/16	M	117.8		ND
		5/9/16	M	1119.9		0.5
		5/16/16	M	184.2		ND
		5/18/16	T	152		
		6/14/16	T	1300		
		7/15/20	M	360.9		ND
		7/16/20	M	387.3		ND
		7/20/20	M	579.4		ND
		7/21/20	M	365.4		ND
		8/6/20	M	248.9		ND
		8/26/20	M	344.8		ND
		9/21/20	M	307.6		ND
		10/15/20	M	228.2		ND
		11/9/20	M	435.2		ND
SIMS000.8DA	na	7/26/05	T	170		
		9/8/05	T	100		
		10/6/05	T	160		
		11/30/05	T	140		
		12/13/05	T	88		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
SIMS000.8DA (cont'd)	na	1/17/06	T	1400		
		2/21/06	T	100		
		3/20/06	T	820		
		4/5/06	T	520		
		5/31/06	T	2400		
		6/6/06	T	190		
		9/8/10	T	649		
		9/14/10	T	186		
		9/21/10	T	194		
		9/22/10	T	172		
		9/23/10	T	145		
		9/28/10	T	166		
		4/4/11	T	260		
		4/11/11	T	230		
		4/14/11	T	120		
		4/19/11	T	220		
		4/25/11	T	110		
		7/14/15	T	192		
		8/13/15	T	1733		
		9/9/15	T	99		
		10/12/15	T	93		
		11/5/15	T	29		
		12/7/15	T	56		
		1/12/16	T	185		
		4/19/16	T	291		
		5/18/16	T	79		
		6/14/16	T	411		
SIMS001.2DA	na	7/23/20	T	291		
		9/3/20	T	135		
SLATE000.3SR	na	7/7/05	T	150		
		8/18/05	T	4600		
		9/27/05	T	240		
		10/5/05	T	84		
		11/29/05	T	650		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
SLATE000.3SR (cont'd)	na	12/8/05	T	64		
		1/30/06	T	38		
		2/7/06	T	14		
		3/8/06	T	26		
		5/11/06	T	1300		
		6/14/06	T	370		
		8/3/10	T	326		
		8/5/10	T	128		
		8/9/10	T	308		
		8/17/10	T	236		
		8/23/10	T	387		
		8/25/10	T	649		
		5/16/11	T	400		
		5/24/11	T	19860		
		5/25/11	T	1550		
		6/1/11	T	210		
		6/2/11	T	380		
		6/6/11	T	570		
		8/27/15	T	166		
		8/31/15	T	119		
		9/2/15	T	461		
		9/8/15	T	55		
		9/14/15	T	687		
		8/4/20	T	579		
		8/18/20	T	48		
		8/19/20	T	129		
		8/25/20	T	131		
		8/27/20	T	122		
SLATE001.1SR	na	8/27/15	T	770		
		8/31/15	T	185		
		9/2/15	T	141		
		9/8/15	T	78		
		9/14/15	T	157		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
SLATE001.1SR (cont'd)	na	8/4/20	T	517		
		8/18/20	T	82		
		8/19/20	T	93		
		8/25/20	T	167		
		8/27/20	T	55		
SORGH000.3DA	Sorghum	9/8/10	T	6490		
		9/14/10	T	150		
		9/21/10	T	172		
		9/22/10	T	228		
		9/23/10	T	276		
		9/28/10	T	613		
		4/4/11	T	410		
		4/11/11	T	290		
		4/14/11	T	380		
		4/19/11	T	600		
		4/25/11	T	360		
		7/14/14	M	224.7		ND
		7/22/14	M	866.4		0.3
		7/23/14	M	866.4		ND
		7/31/14	M	290.9		0.2
		8/4/14	M	49.5		ND
		10/2/14	M	>2419.6		ND
		10/20/14	M	>2419.6		ND
		10/21/14	M	1413.6		13.5
		10/22/14	M	1299.7		7.3
		10/28/14	M	980.4		6.3
		1/20/15	M	816.4		ND
		1/21/15	M	313		0.5
		1/22/15	M	275.5		1.2
		2/9/15	M	328.2		6.2
		2/10/15	M	172.3		0.2
		4/13/15	M	178.5		6.2
		4/23/15	M	517.2		13.5
		4/24/15	M	410.6		7.3

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
SORGH000.3DA (cont'd)	Sorghum (cont'd)	4/29/15	M	>2419.6		6.2
		4/30/15	M	579.4		4.3
		7/28/15	M	648.8		0.7
		8/3/15	M	920.8		0.8
		8/4/15	M	185		
		8/5/15	M	187.2		1.7
		8/12/15	M	248.1		2.3
SUGAR000.1DA	Sugartree	5/9/11	M	290.9	8.5	
		5/10/11	M	160.7	8.7	
		5/11/11	M	218.7	1.5	
		5/12/11	M	365.4	0.9	
		5/18/11	M	191.8	1.6	
		5/24/11	M	3990.0	6.5	
		6/27/11	M	325.5	2.7	
		7/11/11	M	410.6	2.8	
		7/12/11	M	365.4	2.9	
		7/13/11	M	387.3	7.1	
		7/14/11	M	365.4	3.2	
		7/21/11	M	307.6	2.9	
		8/4/11	M	1520		
		8/8/11	M	400		
		8/11/11	M	390		
		8/15/11	M	430		
		8/25/11	M	460		
		9/15/11	M	>2419.6	2.6	
		10/3/11	M	151.5	2.9	
		10/4/11	M	113.7	6.1	
		10/5/11	M	275.5	1.3	
		10/6/11	M	178.9	1.3	
		10/24/11	M	123.6	3.4	
		11/15/11	M	3730.0	27.5	0.4
		1/4/12	M	16.0	1	
		1/5/12	M	24.1	0.9	
		1/11/12	M	6020.0	51.9	2.8

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
SUGAR000.1DA (cont'd)	Sugartree (cont'd)	1/30/12	M	488.4	4.8	
		1/31/12	M	488.4	1.2	
		2/7/12	M	248.9	1.8	
		4/4/12	T	200		
		4/9/12	T	130		
		4/16/12	T	19860		
		4/19/12	T	160		
		4/24/12	T	40		
		4/26/12	T	60		
		7/15/15	T	1986		
		8/18/15	T	411		
		9/15/15	T	225		
		10/6/15	T	248		
		11/23/15	T	66		
		12/3/15	T	299		
		1/4/16	T	201		
		1/28/16	T	93		
		3/23/16	T	218		
		4/21/16	T	108		
		5/26/16	T	1203		
		6/9/16	T	>2420		
		7/26/16	M	435.2		ND
		7/27/16	M	285.1		ND
		8/1/16	M	524.7		ND
		8/16/16	M	866.4		ND
		8/17/16	M	166.4		ND
		10/4/16	M	103.9		ND
		10/5/16	M	218.7		ND
		10/6/16	M	435.2		ND
		10/13/16	M	248.9		ND
		10/25/16	M	209.8		ND
		1/9/17	M	81.3		ND
		1/25/17	M	166.4		ND
		1/26/17	M	51.2		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
SUGAR000.1DA (cont'd)	Sugartree (cont'd)	1/30/17	M	44.1		ND
		2/1/17	M	52		ND
		5/9/17	M	1046.2		ND
		5/11/17	M	185		0.1
		5/16/17	M	159.7		0.6
		5/17/17	M	135.4		ND
		5/31/17	M	185		0.5
		7/16/20	T	238		
		9/2/20	T	649		
		10/14/20	T	166		
na	Turkey	10/20/14	M	>2419.6		
		1/21/15	M	307.6		
		1/22/15	M	193.5		
		1/29/15	M	387.3		
		2/9/15	M	80.5		
		2/10/15	M	686.7		
		4/13/15	M	363.4		
		4/23/15	M	172.5		
		4/24/15	M	83.6		
		4/29/15	M	260.3		
		4/30/15	M	196.8		
		7/9/19	M	517.2		
		7/10/19	M	172.3		
		7/16/19	M	51.2		
		7/26/19	M	325.5		
		7/29/19	M	108.1		
		8/29/19	M	1413.6		
		9/24/19	M	Dry		
		10/24/19	M	1413.6		
		11/26/19	M	30.5		
		12/4/19	M	133.3		
		1/23/20	M	*75.4*		
		2/28/20	M	*193.5*		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
na	Turkey (cont'd)	4/22/20	M	106.7		
		5/26/20	M	259.5		
		6/15/20	M	8.6		
VGAP000.2DA	Vaughns Gap 1	7/27/05	T	1100		
		8/17/05	T	650		
		9/7/05	T	260		
		10/20/05	T	490		
		11/22/05	T	1100		
		12/6/05	T	160		
		1/19/06	T	250		
		2/9/06	T	1600		
		3/2/06	T	16		
		4/11/06	T	170		
		5/18/06	T	690		
		6/20/06	T	1400		
		5/10/10	T	411		
		5/12/10	T	365		
		5/19/10	T	461		
		5/25/10	T	488		
		5/9/11	M	410.6	4.3	
		5/10/11	M	387.3	7.3	
		5/11/11	M	613.1	0.7	
		5/12/11	M	387.3	2	
		5/18/11	M	365.4	0.5	
		5/24/11	M	6570.0	3.2	
		6/27/11	M	517.2	2.6	
		7/11/11	M	488.4	3.6	
		7/12/11	M	218.7	3.1	
		7/13/11	M	325.5	11.4	1.8
		7/14/11	M	488.4	11.9	1.8
		7/21/11	M	387.3	3.1	
		8/4/11	T	2760		
		8/8/11	T	470		
		8/11/11	T	450		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
VGAP000.2DA (cont'd)	Vaughns Gap 1 (cont'd)	8/15/11	T	200		
		8/25/11	T	410		
		8/29/11	T	220		
		9/15/11	M	980.4	6	
		10/3/11	M	119.9	3.5	
		10/4/11	M	461.1	0.9	
		10/5/11	M	770.1	0.6	
		10/6/11	M	648.8	1.3	
		10/24/11	M	151.5	0.4	
		11/15/11	M	8130.0	10.2	
		1/4/12	M	43.5	0.9	
		1/5/12	M	52.9	1.3	
		1/11/12	M	1986.3	3.7	
		1/31/12	M	69.7	1.2	
		2/6/12	M	101.9	0.7	
		2/7/12	M	172.2	1.5	
		4/4/12	T	150		
		4/9/12	T	310		
		4/16/12	T	1350		
		4/19/12	T	90		
		4/24/12	T	100		
		4/26/12	T	70		
		7/15/15	T	727		
		8/18/15	T	260		
		9/15/15	T	326		
		10/6/15	T	147		
		11/23/15	T	225		
		12/3/15	T	435		
		1/4/16	T	308		
		1/28/16	T	59		
		3/23/16	T	210		
		4/21/16	T	25		
		5/26/16	T	461		
		6/9/16	T	101		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
VGAP000.2DA (cont'd)	Vaughns Gap 1 (cont'd)	7/19/16	M	325.5		ND
		7/26/16	M	90.8		ND
		7/27/16	M	127.4		ND
		8/1/16	M	261.3		ND
		8/16/16	M	272.3		ND
		10/4/16	M	167.0		ND
		10/5/16	M	260.3		ND
		10/6/16	M	123.6		ND
		10/13/16	M	125.9		ND
		10/25/16	M	101.7		ND
		1/9/17	M	66.3		ND
		1/25/17	M	117.8		ND
		1/26/17	M	95.9		ND
		1/30/17	M	121.1		ND
		2/1/17	M	90.8		ND
		5/9/17	M	201.4	0	ND
		5/11/17	M	116.9	0	ND
		5/16/17	M	61.3	0	ND
		5/17/17	M	224.7	0	ND
		5/31/17	M	111.2	0	0.1
		7/16/20	T	185		
		9/2/20	T	435		
		10/14/20	T	112		
VGAP001.2DA	Vaughns Gap 2	5/9/11	M	344.8	4.7	
		5/10/11	M	344.8	5.4	
		5/11/11	M	920.8	8	
		5/12/11	M	816.4	2.6	
		5/18/11	M	228.2	0.9	
		5/24/11	M	4260.0	2.2	
		6/27/11	M	1046.2	2.6	
		7/11/11	M	1413.6	3.5	
		7/12/11	M	>2419.6	4.8	
		7/13/11	M	866.4	12.3	2.9
		7/14/11	M	648.8	2	

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
VGAP001.2DA (cont'd)	Vaughns Gap 2 (cont'd)	7/21/11	M	146.7	3.9	
		9/15/11	M	1553.1	2.8	
		10/3/11	M	161.6	2.5	
		10/4/11	M	186.0	3.1	
		10/5/11	M	387.3	1.5	
		10/6/11	M	214.2	0.7	
		10/24/11	M	110.0	0.6	
		11/15/11	M	2590.0	9.5	
		1/11/12	M	1732.9	4.8	
		1/31/12	M	90.8	1.6	
		2/6/12	M	64.5	1.6	
		2/7/12	M	48.7	0.7	
		7/14/15	T	435		
		7/16/15	T	387		
		7/21/15	T	1733		
		7/23/15	T	>2420		
		7/30/15	T	276		
		7/19/16	M	1732.9		ND
		7/26/16	M	163.1		ND
		7/27/16	M	129.6		ND
		8/1/16	M	178.5		ND
		8/16/16	M	73.8		0.2
		10/4/16	M	190.4		ND
		10/5/16	M	166.4		ND
		10/6/16	M	261.3		ND
		10/13/16	M	155.3		ND
		10/25/16	M	161.6		ND
		1/9/17	M	83.9		ND
		1/25/17	M	107.1		ND
		1/26/17	M	70.3		ND
		1/30/17	M	31.7		ND
		2/1/17	M	90.8		ND

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
VGAP001.2DA (cont'd)	Vaughns Gap 2 (cont'd)	5/9/17	M	137.6	0	ND
		5/11/17	M	920.8	0	0.1
		5/16/17	M	866.4	0	ND
		5/17/17	M	145.5	0	ND
		5/31/17	M	93.3		
WFBRO000.1DA	W Fork Browns	7/26/05	T	240		
		9/8/05	T	210		
		10/6/05	T	520		
		11/30/05	T	250		
		12/13/05	T	44		
		1/17/06	T	2400		
		2/21/06	T	53		
		3/20/06	T	>2400		
		4/5/06	T	160		
		5/31/06	T	>2400		
		6/6/06	T	1000		
		8/3/10	T	121		
		8/5/10	T	129		
		8/9/10	T	228		
		8/17/10	T	219		
		8/23/10	T	345		
		8/25/10	T	166		
		4/11/11		156.5	1.1	
		4/19/11		121.1	3.3	
		5/6/11		344.8	1.8	
		5/7/11		387.3	1	
		5/9/11		1203.3	4.9	
		5/16/11		500		
		5/24/11		1300		
		5/24/11		648.8	5.1	
		5/25/11		220		
		6/1/11		240		
		6/2/11		240		
		6/6/11		1330		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
WFBRO000.1DA (cont'd)	W Fork Browns (cont'd)	6/27/11	M	648.8	1.3	
		7/11/11	M	579.4	0.8	
		7/12/11	M	488.4	1.4	
		7/14/11	M	1986.3	2.8	
		7/18/11	M	365.4	4	
		7/21/11	M	344.1	1.5	
		9/15/11	M	980.4	4.3	
		10/3/11	M	387.3	1.5	
		10/4/11	M	290.9	3.5	
		10/5/11	M	115.3	1.8	
		10/6/11	M	185.0	0.8	
		10/24/11	M	54.6	1.1	
		11/15/11	M	8650.0	43.5	2.9
		1/4/12	M	30.9	1.1	
		1/5/12	M	23.3	2.4	
		1/11/12	M	29090.0	1.7	
		1/30/12	M	51.2	1.9	
		1/31/12	M	79.4	1.8	
		2/7/12	M	101.7	0.2	
		7/21/15	T	124		
		8/11/15	T	326		
		9/17/15	T	125		
		10/7/15	T	82		
		11/17/15	T	133		
		12/14/15	T	2420		
		1/13/16	T	42		
		2/29/16	T	157		
		3/9/16	T	88		
		4/20/16	T	50		
		5/5/16	T	179		
		6/1/16	T	548		
		7/12/16	M	165.8		
		7/13/16	M	410.6		
		7/14/16	M	191.8		

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

Monitoring Station		Date	Source (T/M)	*E. coli* [CFU/100mL]	PCR	
TDEC	Metro				ALLBAC	HUBAC
WFBRO000.1DA (cont'd)	W Fork Browns (cont'd)	7/18/16	M	193.5		ND
		7/26/16	M	206.4		ND
		10/5/16	M	222.4		ND
		10/6/16	M	410.6		ND
		10/11/16	M	344.8		ND
		10/17/16	M	275.5		ND
		10/25/16	M	344.1		ND
		1/9/17	M	31.3		ND
		1/24/17	M	83.9		ND
		1/26/17	M	27.2		ND
		1/31/17	M	1		ND
		2/1/17	M	4.1		ND
		5/9/17	M	184.2	0	ND
		5/10/17	M	240	0	0.5
		5/16/17	M	77.1	0	ND
		5/18/17	M	98.5	0	ND
		6/1/17	M	114.5	0	ND
		7/16/20	T	727		
		9/2/20	T	>2420		
		10/14/20	T	222		
WHITT001.0DA	Whittemore	9/8/10	T	4610		
		9/14/10	T	140		
		9/21/10	T	119		
		9/22/10	T	154		
		9/23/10	T	141		
		9/28/10	T	248		
		4/4/11	T	440		
		4/11/11	T	190		
		4/14/11	T	550		
		4/19/11	T	520		
		4/25/11	T	330		
		7/14/14	M	648.8		
		7/22/14	M	1299.7		
		7/23/14	M	1299.7		

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

Monitoring Station		Date	Source (T/M)	*E. coli*	PCR	
TDEC	Metro			[CFU/100mL]	ALLBAC	HUBAC
WHITT001.0DA (cont'd)	Whittemore (cont'd)	7/31/14	M	435.2		
		8/4/14	M	>2419.6		
		10/2/14	M	178.5		
		10/20/14	M	488.4		
		10/21/14	M	285.1		
		10/22/14	M	365.4		
		10/28/14	M	517.2		
		1/20/15	M	178.5		
		1/21/15	M	104.6		
		1/22/15	M	114.5		
		2/9/15	M	201.4		
		2/10/15	M	111.9		
		4/13/15	M	325.5		
		4/23/15	M	1413.6		
		4/24/15	M	517.2		
		4/29/15	M	727		
		4/30/15	M	686.7		
		7/14/15	T	>1733		
		7/16/15	T	1203		
		7/21/15	T	1733		
		7/23/15	T	>2420		
		7/30/15	T	>2420		

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 Cheatham Lake 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 Cheatham Lake watershed were derived from WinHSPF hydrologic simulations based on parameters derived from calibrations at USGS gaging stations in or near the Cheatham Lake watershed (see Appendix D for details of calibration). For example, a flow duration curve for Sevenmile Creek at mile 0.2 was constructed using simulated daily mean flow for the period from 1/1/05 through 12/31/20 (RM 0.2 corresponds to the location of monitoring station SEVEN000.2DA). 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 Cheatham Lake watershed were developed from the flow duration curves developed 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 (Sevenmile Creek at RM 0.2 is shown as an example):

1. A target load duration curve (LDC) was generated for Sevenmile Creek by applying the *E. coli* target concentration of 487 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:

   $(\text{Target Load})_{\text{Sevenmile Creek}}$ = (487 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 ($2.44\text{x}10^{7}$ mL-s/ft^3-day)

   TMDL = ($1.20\text{x}10^{10}$) x (Q) CFU/day

2. Daily loads were calculated for each of the water quality samples collected at monitoring station SEVEN000.2DA (ref.: Table B-1) by multiplying the sample concentration by the daily mean flow for the sampling date and the required unit conversion factor. SEVEN000.2DA 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 – 8/3/15 sampling event
Modeled Flow = 5.25 cfs
Concentration = 721.5 CFU/100 mL
Daily Load = 9.26×10^{10} *CFU/day*

3. Using the flow duration curves developed 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. The resulting *E. coli* load duration curve for Sevenmile Creek 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:

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

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

- $[\sum\text{WLAs}]_{\text{WWTP}}$ 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.
- $[\sum\text{WLAs}]_{\text{CAFO}}$ 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:

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

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:

$$WLA[MS4] = LA = \{TMDL - MOS - WLA[WWTPs]\} / DA$$

where: DA = waterbody drainage area (acres)

Using Sevenmile Creek as an example:

$TMDL_{\text{Sevenmile Creek}} = (487 \text{ CFU/100 mL}) \times (Q) \times (UCF)$

$$\mathbf{TMDL = (1.20\times10^{10}) \times (Q) \text{ CFU/day}}$$

$MOS_{\text{Sevenmile Creek}} = TMDL \times 0.10 = 1.20\times10^{9} \times Q$

$$\mathbf{MOS = (1.20\times10^{9}) \times (Q) \text{ CFU/day}}$$

$WLA[WWTPs]_{\text{Sevenmile Creek}} = q_m \text{ (cfs)} \times 487 \text{ (CFU/100 mL)} \times UCF$

$$\mathbf{WLA[WWTPs]_{\text{Sevenmile Creek}} = (1.20\times10^{10}) \times (q_m) \text{ CFU/day}}$$

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):

$$WLA[MS4]_{\text{Sevenmile Creek}} = LA_{\text{Sevenmile Creek}}$$
$$= \{TMDL - MOS - WLA[WWTPs]_d\} / DA$$
$$= \{(1.20\times10^{10} \times Q) - (1.20\times10^{9} \times Q) - (1.20\times10^{10} \times q_d)\} / (10{,}898)$$

$$\mathbf{WLA[MS4]_{\text{Sevenmile Creek}} = LA_{\text{Sevenmile Creek}}}$$
$$\mathbf{= [9.965\times10^{5} \times Q] - [1.11\times10^{6} \times q_d]}$$

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.

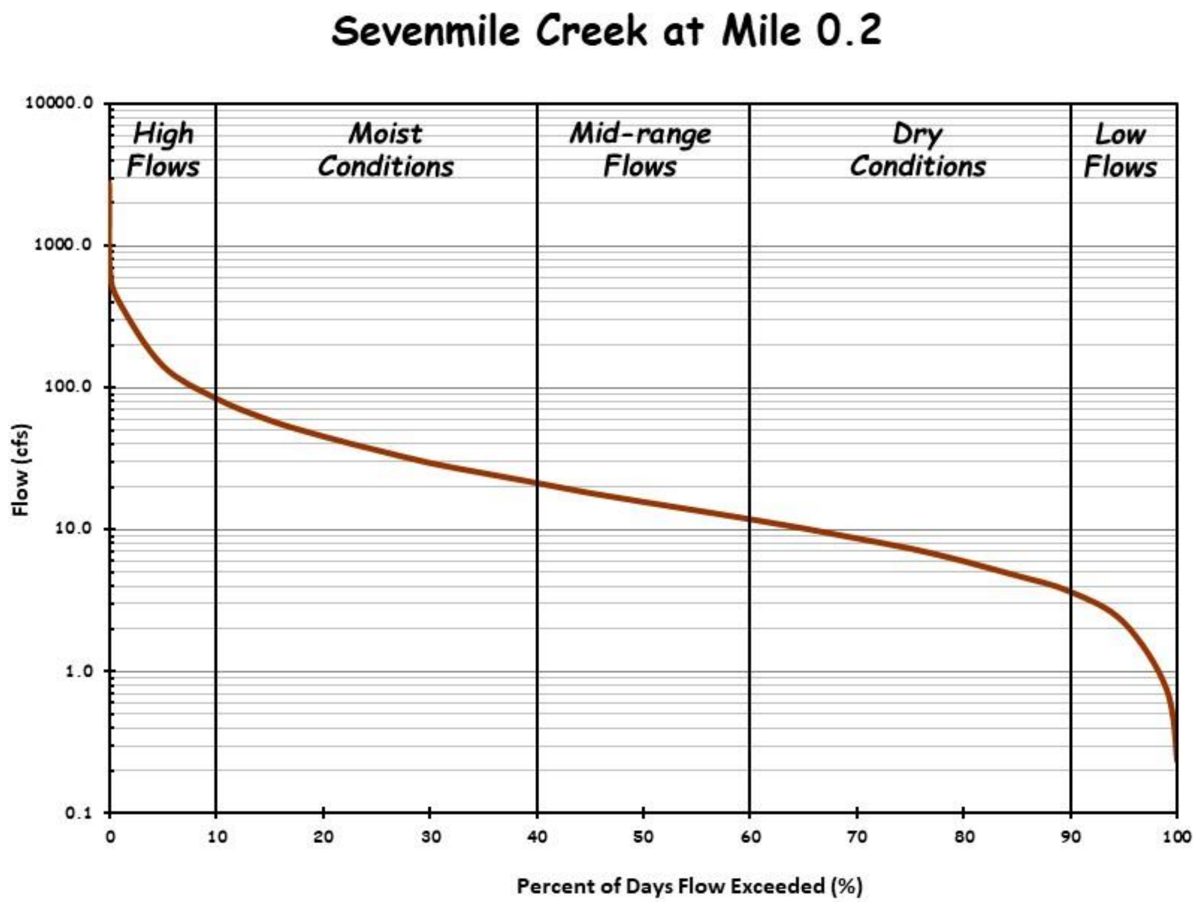


Figure C-1. Flow Duration Curve for Sevenmile Creek at RM 0.2

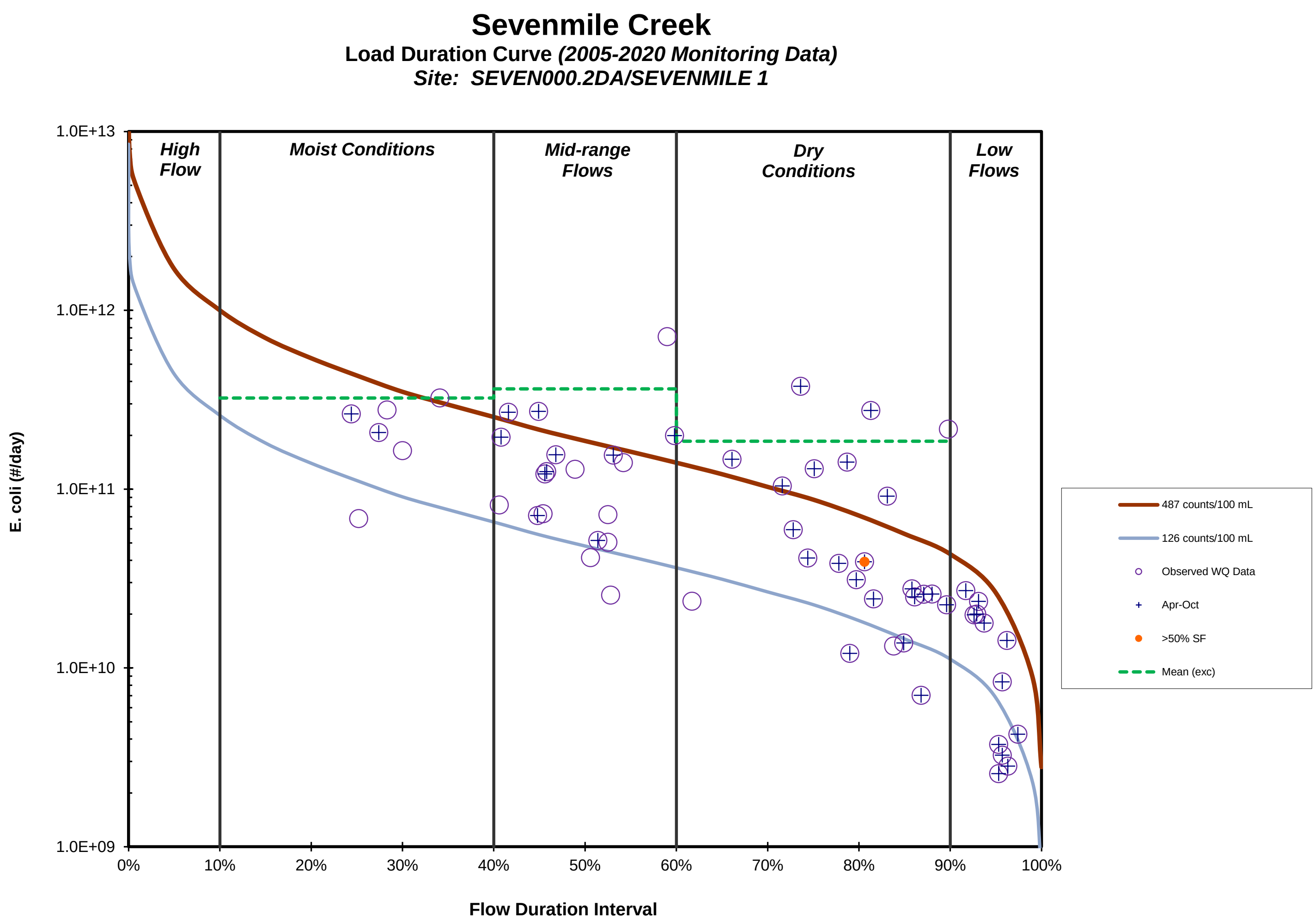


Figure C-2. *E. coli* Load Duration Curve for Sevenmile Creek at RM 0.2

Table C-1. TMDLs, WLAs, & LAs for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0101	Turkey Creek [d,e]	TN05130202007_0700	1.2 x 10^{10} x Q	1.2 x 10^9 x Q	(1.2x10^{10} x q_m)	(9.014 x 10^6 x Q) – (1.00 x 10^7 x q_d)	(9.014 x 10^6 x Q) – (1.00 x 10^7 x q_d)
	Indian Creek [d,e]	TN05130202007_0800				(3.667 x 10^6 x Q) – (4.08 x 10^6 x q_d)	(3.667 x 10^6 x Q) – (4.08 x 10^6 x q_d)
	Holt Creek [d,e]	TN05130202007_1100				(3.299 x 10^6 x Q) – (3.67 x 10^6 x q_d)	(3.299 x 10^6 x Q) – (3.67 x 10^6 x q_d)
0102	Sims Branch [d,e]	TN05130202007_0100	1.2 x 10^{10} x Q	1.2 x 10^9 x Q	(1.2x10^{10} x q_m)	(4.049 x 10^6 x Q) – (4.50 x 10^6 x q_d)	(4.049 x 10^6 x Q) – (4.50 x 10^6 x q_d)
	Finley Branch [d,e]	TN05130202007_0300				(1.753 x 10^7 x Q) – (1.95 x 10^7 x q_d)	(1.753 x 10^7 x Q) – (1.95 x 10^7 x q_d)
	Mill Creek [d,e]	TN05130202007_1000				(1.596 x 10^5 x Q) – (1.77 x 10^5 x q_d)	(1.596 x 10^5 x Q) – (1.77 x 10^5 x q_d)
	Whittemore Branch [d,e]	TN05130202007_1200				(4.764 x 10^6 x Q) – (5.29 x 10^6 x q_d)	(4.764 x 10^6 x Q) – (5.29 x 10^6 x q_d)
	Sorghum Branch [d,e]	TN05130202007_1300				(6.416 x 10^6 x Q) – (7.13 x 10^6 x q_d)	(6.416 x 10^6 x Q) – (7.13 x 10^6 x q_d)
	Sevenmile Creek [d,e]	TN05130202007_1400				(9.965 x 10^5 x Q) – (1.11 x 10^6 x q_d)	(9.965 x 10^5 x Q) – (1.11 x 10^6 x q_d)
	Shasta Branch [d,e]	TN05130202007_1410				(2.173 x 10^7 x Q) – (2.42 x 10^7 x q_d)	(2.173 x 10^7 x Q) – (2.42 x 10^7 x q_d)
	Sevenmile Creek [d,e]	TN05130202007_1450				(2.215 x 10^6 x Q) – (2.46 x 10^6 x q_d)	(2.215 x 10^6 x Q) – (2.46 x 10^6 x q_d)
	Cathy Jo Branch [d,e]	TN05130202007_1490				(1.294 x 10^7 x Q) – (1.44 x 10^7 x q_d)	(1.294 x 10^7 x Q) – (1.44 x 10^7 x q_d)
	Pavillion Branch [d,e]	TN05130202007_1500				(1.897 x 10^7 x Q) – (2.11 x 10^7 x q_d)	(1.897 x 10^7 x Q) – (2.11 x 10^7 x q_d)
	Mill Creek [d,e]	TN05130202007_2000				(1.698 x 10^5 x Q) – (1.89 x 10^5 x q_d)	(1.698 x 10^5 x Q) – (1.89 x 10^5 x q_d)
	Mill Creek [d,e]	TN05130202007_3000				(2.665 x 10^5 x Q) – (2.96 x 10^5 x q_d)	(2.665 x 10^5 x Q) – (2.96 x 10^5 x q_d)
0203	Blue Spring Creek [d,e]	TN05130202014_0900	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	(4.323 x 10^6 x Q) – (4.80 x 10^6 x q_d)	(4.323 x 10^7 x Q) – (4.80 x 10^7 x q_d)
0301	Lumsley Fork [d,e]	TN05130202220_0100	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	(1.004 x 10^7 x Q) – (1.12 x 10^7 x q_d)	(1.004 x 10^7 x Q) – (1.12 x 10^7 x q_d)
	Slaters Creek [d,e]	TN05130202220_0300				(4.255 x 10^6 x Q) – (4.73 x 10^6 x q_d)	(4.255 x 10^6 x Q) – (4.73 x 10^6 x q_d)
	Slaters Creek [d,e]	TN05130202220_0350				(4.634 x 10^6 x Q) – (5.15 x 10^6 x q_d)	(4.634 x 10^6 x Q) – (5.15 x 10^6 x q_d)

Table C-1 (cont'd). TMDLs, WLAs, & LAs for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0301 (cont'd)	Manskers Creek [e]	TN05130202220_1000	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	(7.068 x 10^5 x Q) – (7.85 x 10^5 x q_d)	(7.068 x 10^5 x Q) – (7.85 x 10^5 x q_d)
	Manskers Creek [d,e]	TN05130202220_2000				(6.231 x 10^6 x Q) – (6.92 x 10^6 x q_d)	(6.231 x 10^6 x Q) – (6.92 x 10^6 x q_d)
0302	Dry Creek [d,e]	TN05130202027_1000	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	(3.806 x 10^6 x Q) – (4.23 x 10^6 x q_d)	(3.806 x 10^6 x Q) – (4.23 x 10^6 x q_d)
	Dry Creek [d,e]	TN05130202027_2000				(5.049 x 10^6 x Q) – (5.61 x 10^6 x q_d)	(5.049 x 10^6 x Q) – (5.61 x 10^6 x q_d)
	Cooper Creek [d,e]	TN05130202209_1000				(8.710 x 10^6 x Q) – (9.68 x 10^6 x q_d)	(8.710 x 10^6 x Q) – (9.68 x 10^6 x q_d)
	Neeleys Branch [d,e]	TN05130202212_0100				(1.594 x 10^7 x Q) – (1.77 x 10^7 x q_d)	(1.594 x 10^7 x Q) – (1.77 x 10^7 x q_d)
0303	Drake Branch [d,e]	TN05130202010_0200	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	(1.665 x 10^7 x Q) – (1.85 x 10^7 x q_d)	(1.665 x 10^7 x Q) – (1.85 x 10^7 x q_d)
	Ewing Creek [d,e]	TN05130202010_0900				(2.430 x 10^6 x Q) – (2.70 x 10^6 x q_d)	(2.430 x 10^6 x Q) – (2.70 x 10^6 x q_d)
0304	Bosley Springs Branch [d,e]	TN05130202314_0300	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	(1.508 x 10^7 x Q) – (1.68 x 10^7 x q_d)	(1.508 x 10^7 x Q) – (1.68 x 10^7 x q_d)
	Sugartree Creek [d,e]	TN05130202314_0400				(6.892 x 10^6 x Q) – (7.66 x 10^6 x q_d)	(6.892 x 10^6 x Q) – (7.66 x 10^6 x q_d)
	Vaughns Gap Branch [d,e]	TN05130202314_0700				(1.102 x 10^7 x Q) – (1.22 x 10^6 x q_d)	(1.102 x 10^7 x Q) – (1.22 x 10^6 x q_d)
	Vaughns Gap Branch [d,e]	TN05130202314_0750				(2.177 x 10^7 x Q) – (2.42 x 10^7 x q_d)	(2.177 x 10^7 x Q) – (2.42 x 10^7 x q_d)
	Richland Creek [e]	TN05130202314_1000				(1.213 x 10^6 x Q) – (1.35 x 10^6 x q_d)	(1.213 x 10^6 x Q) – (1.35 x 10^6 x q_d)
	Richland Creek [d,e]	TN05130202314_2000				(1.549 x 10^6 x Q) – (1.72 x 10^6 x q_d)	(1.549 x 10^6 x Q) – (1.72 x 10^6 x q_d)
	Jocelyn Hollow Branch [d,e]	TN05130202314_0800	1.2 x 10^{10} x Q	1.2 x 10^9 x Q	(1.2x10^{10} x q_m)	(1.250 x 10^7 x Q) – (1.39 x 10^7 x q_d)	(1.250 x 10^7 x Q) – (1.39 x 10^7 x q_d)
	Richland Creek [d,e]	TN05130202314_3000				(2.808 x 10^6 x Q) – (3.12 x 10^6 x q_d)	(2.808 x 10^6 x Q) – (3.12 x 10^6 x q_d)
0305	Cheatham Reservoir	TN05130202001_3000	1.2 x 10^{10} x Q	1.2 x 10^9 x Q	(1.2x10^{10} x q_m)	(1.313 x 10^3 x Q) – (1.46 x 10^3 x q_d)	(1.313 x 10^3 x Q) – (1.46 x 10^3 x q_d)
	East Fork Browns Creek [d,e]	TN05130202023_0100	2.3 x 10^{10} x Q	2.3 x 10^9 x Q	(2.3x10^{10} x q_m)	(1.527 x 10^7 x Q) – (1.70 x 10^7 x q_d)	(1.527 x 10^7 x Q) – (1.70 x 10^7 x q_d)
	Middle Fork Browns Creek [d,e]	TN05130202023_0200				(1.220 x 10^7 x Q) – (1.36 x 10^7 x q_d)	(1.220 x 10^7 x Q) – (1.36 x 10^7 x q_d)

Table C-1 (cont'd). TMDLs, WLAs, & LAs for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	Impaired Waterbody Name	Impaired 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]
0305 (cont'd)	West Fork Browns Creek [d,e]	TN05130202023_0300	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(8.973 \times 10^6 \times Q) - (9.97 \times 10^6 \times q_d)$	$(8.973 \times 10^6 \times Q) - (9.97 \times 10^6 \times q_d)$
	Browns Creek [d,e]	TN05130202023_1000				$(2.038 \times 10^6 \times Q) - (2.26 \times 10^6 \times q_d)$	$(2.038 \times 10^6 \times Q) - (2.26 \times 10^6 \times q_d)$
	Browns Creek [d,e]	TN05130202023_2000				$(2.770 \times 10^6 \times Q) - (3.08 \times 10^6 \times q_d)$	$(2.770 \times 10^6 \times Q) - (3.08 \times 10^6 \times q_d)$
	Pages Branch [d,e]	TN05130202202_1000				$(1.021 \times 10^7 \times Q) - (1.14 \times 10^7 \times q_d)$	$(1.021 \times 10^7 \times Q) - (1.14 \times 10^7 \times q_d)$
0306	Davidson Branch [d,e]	TN05130202001T_0800	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(9.124 \times 10^6 \times Q) - (1.01 \times 10^7 \times q_d)$	$(9.124 \times 10^6 \times Q) - (1.01 \times 10^7 \times q_d)$
	Overall Creek [d,e]	TN05130202001T_0900				$(4.126 \times 10^6 \times Q) - (4.58 \times 10^6 \times q_d)$	$(4.126 \times 10^6 \times Q) - (4.58 \times 10^6 \times q_d)$

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

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 Cheatham Lake watershed. HSPF is a watershed model capable of performing flow routing through stream reaches.

D.2 Model Set Up

The Cheatham Lake 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, 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 2019. Meteorological data for a selected 11- to 16-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 15-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. Three USGS continuous record stations located in the Cheatham Lake watershed were selected as the basis of the hydrology calibration. Station 03431000 is located on Mill Creek near Antioch, TN, within Level IV ecoregion 71i and has a drainage area of 64 square miles. Station 03431700 is located on Richland Creek at Charlotte Avenue in Nashville, TN, within Level IV ecoregion 71h and has a drainage area of 24.3 square miles. Station 03431800 is located on Sycamore Creek near Ashland City, TN, within Level IV ecoregion 71f and has a drainage area of 97.2 square miles. Meteorological data from the station at Nashville Airport was used for all calibrations.

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 Mill Creek near Antioch, TN, (USGS Station 03431000) are shown in Table D-1 and Figures D-1 and D-2. The results of the hydrologic calibration for Richland Creek at Charlotte Ave., (USGS Station 03431700) are shown in Table D-2 and Figures D-3 and D-4. The results of the hydrologic calibration for Sycamore Creek near Ashland City, TN, (USGS Station 03431800) are shown in Table D-3 and Figures D-5 and D-6.

Table D-1. Hydrologic Calibration Summary: Mill Creek near Antioch, TN (USGS 03431000)

Simulation Name:	USGS03431000	**Simulation Period:**	
		Watershed Area (ac):	40552.00
Period for Flow Analysis			
Begin Date:	**10/01/10**	**Baseflow PERCENTILE:**	2.5
End Date:	**10/01/18**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**144.25**	Total Observed In-stream Flow:	**138.95**
Total of highest 10% flows:	**87.98**	Total of Observed highest 10% flows:	**77.13**
Total of lowest 50% flows:	**10.59**	Total of Observed Lowest 50% flows:	**11.66**
Simulated Summer Flow Volume (months 7-9):	**18.63**	Observed Summer Flow Volume (7-9):	**14.65**
Simulated Fall Flow Volume (months 10-12):	**38.10**	Observed Fall Flow Volume (10-12):	**33.74**
Simulated Winter Flow Volume (months 1-3):	**56.25**	Observed Winter Flow Volume (1-3):	**56.94**
Simulated Spring Flow Volume (months 4-6):	**31.28**	Observed Spring Flow Volume (4-6):	**33.62**
Total Simulated Storm Volume:	**141.01**	Total Observed Storm Volume:	**135.22**
Simulated Summer Storm Volume (7-9):	**17.82**	Observed Summer Storm Volume (7-9):	**13.71**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**3.82**	10	
Error in 50% lowest flows:	**-9.18**	10	
Error in 10% highest flows:	**14.07**	15	
Seasonal volume error - Summer:	**27.14**	30	
Seasonal volume error - Fall:	**12.91**	30	
Seasonal volume error - Winter:	**-1.21**	30	
Seasonal volume error - Spring:	**-6.96**	30	
Error in storm volumes:	**4.28**	20	
Error in summer storm volumes:	**29.96**	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	**0.1244**	Model accuracy increases as E or R^2 approaches 1.0	
Coefficient of Determination, R^2	**0.3787**		

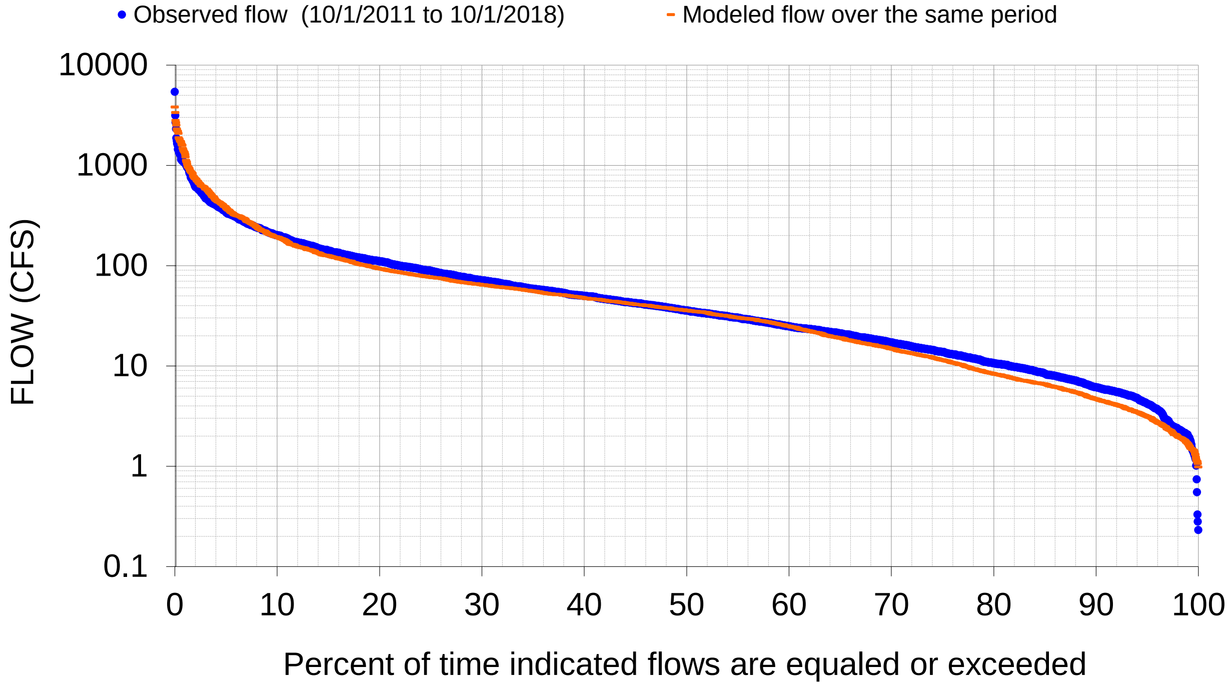


Figure D-1. Hydrologic Calibration: Mill Creek, USGS 03431000 (WY 2012-2018)

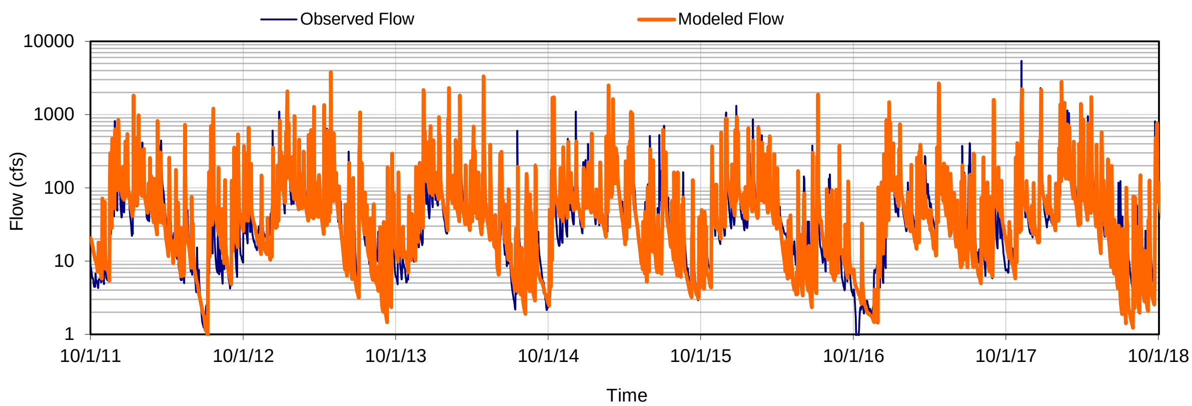


Figure D-2. 7-Year Hydrologic Comparison: Mill Creek, USGS 03431000

Table D-2. Hydrologic Calibration Summary: Richland Creek at Charlotte Ave. (USGS 03431700)

Simulation Name:	USGS03431700	**Simulation Period:**	
		Watershed Area (ac):	13844.00
Period for Flow Analysis			
Begin Date:	**10/01/11**	**Baseflow PERCENTILE:**	2.5
End Date:	**10/01/20**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**226.45**	Total Observed In-stream Flow:	**218.64**
Total of highest 10% flows:	**108.45**	Total of Observed highest 10% flows:	**113.32**
Total of lowest 50% flows:	**24.56**	Total of Observed Lowest 50% flows:	**24.25**
Simulated Summer Flow Volume (months 7-9):	**37.10**	Observed Summer Flow Volume (7-9):	**29.72**
Simulated Fall Flow Volume (months 10-12):	**51.86**	Observed Fall Flow Volume (10-12):	**47.77**
Simulated Winter Flow Volume (months 1-3):	**88.27**	Observed Winter Flow Volume (1-3):	**93.76**
Simulated Spring Flow Volume (months 4-6):	**49.22**	Observed Spring Flow Volume (4-6):	**47.39**
Total Simulated Storm Volume:	**220.21**	Total Observed Storm Volume:	**205.35**
Simulated Summer Storm Volume (7-9):	**35.52**	Observed Summer Storm Volume (7-9):	**26.38**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**3.57**	10	
Error in 50% lowest flows:	**1.25**	10	
Error in 10% highest flows:	**-4.30**	15	
Seasonal volume error - Summer:	**24.84**	30	
Seasonal volume error - Fall:	**8.56**	30	
Seasonal volume error - Winter:	**-5.86**	30	
Seasonal volume error - Spring:	**3.85**	30	
Error in storm volumes:	**7.24**	20	
Error in summer storm volumes:	**34.63**	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	**0.1280**	Model accuracy increases as E or R^2 approaches 1.0	
Coefficient of Determination, R^2	**0.2812**		

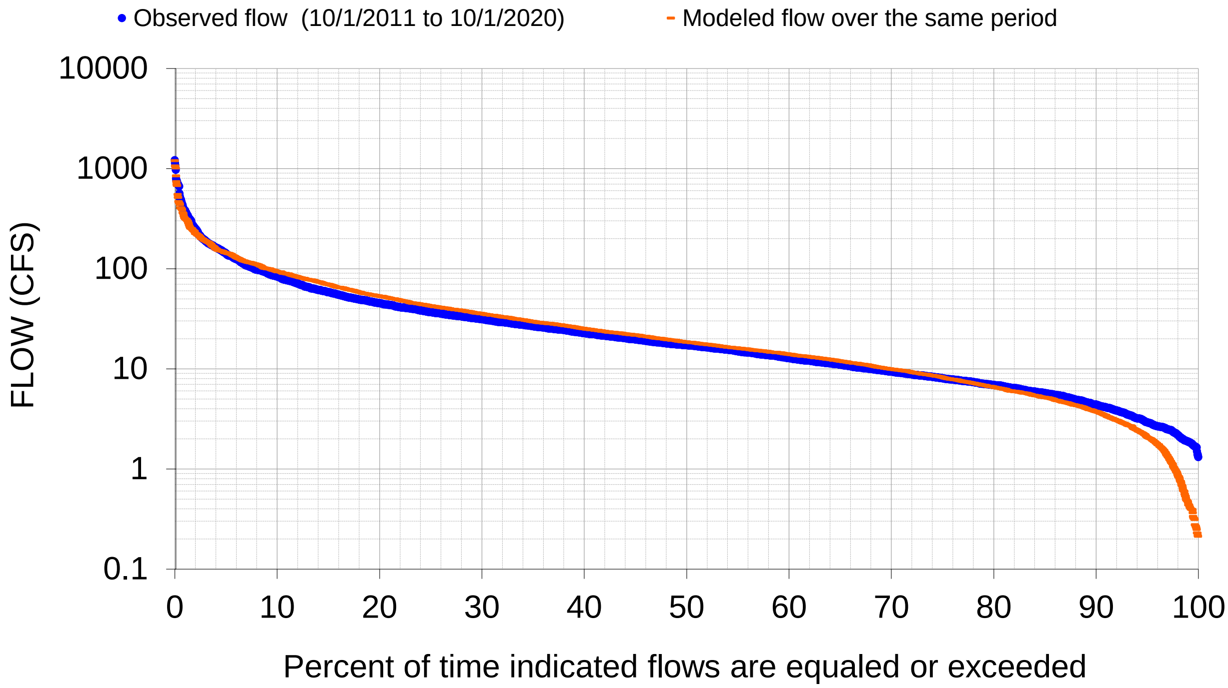


Figure D-3. Hydrologic Calibration: Richland Creek, USGS 03431700 (WY 2012-2020)

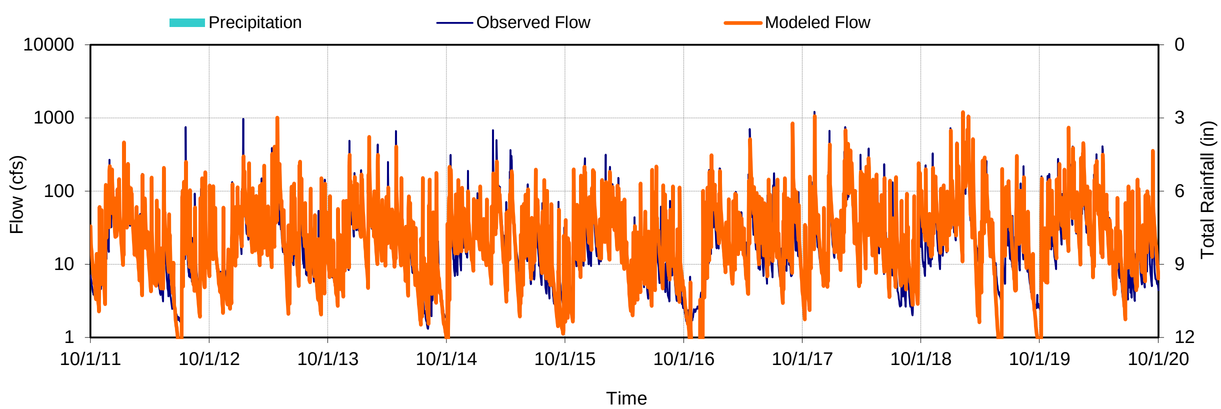


Figure D-4. 9-Year Hydrologic Comparison: Richland Creek, USGS 03431700

Table D-3. Hydrologic Calibration Summary: Sycamore Creek near Ashland City, TN (USGS 03431800)

Simulation Name:	USGS03431800	**Simulation Period:**	
		Watershed Area (ac):	60755.00
Period for Flow Analysis			
Begin Date:	**10/01/12**	**Baseflow PERCENTILE:**	2.5
End Date:	**10/01/19**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**166.32**	Total Observed In-stream Flow:	**170.00**
Total of highest 10% flows:	**77.32**	Total of Observed highest 10% flows:	**88.13**
Total of lowest 50% flows:	**23.09**	Total of Observed Lowest 50% flows:	**24.27**
Simulated Summer Flow Volume (months 7-9):	**21.82**	Observed Summer Flow Volume (7-9):	**21.46**
Simulated Fall Flow Volume (months 10-12):	**35.78**	Observed Fall Flow Volume (10-12):	**30.87**
Simulated Winter Flow Volume (months 1-3):	**70.15**	Observed Winter Flow Volume (1-3):	**72.92**
Simulated Spring Flow Volume (months 4-6):	**38.57**	Observed Spring Flow Volume (4-6):	**44.74**
Total Simulated Storm Volume:	**156.25**	Total Observed Storm Volume:	**148.87**
Simulated Summer Storm Volume (7-9):	**19.26**	Observed Summer Storm Volume (7-9):	**16.17**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**-2.16**	10	
Error in 50% lowest flows:	**-4.87**	10	
Error in 10% highest flows:	**-12.26**	15	
Seasonal volume error - Summer:	**1.64**	30	
Seasonal volume error - Fall:	**15.91**	30	
Seasonal volume error - Winter:	**-3.81**	30	
Seasonal volume error - Spring:	**-13.78**	30	
Error in storm volumes:	**4.96**	20	
Error in summer storm volumes:	**19.12**	50	
Nash-Sutcliffe Coefficient of Efficiency, E:	**0.3216**	Model accuracy increases as E or R^2 approaches 1.0	
Coefficient of Determination, R^2	**0.3732**		

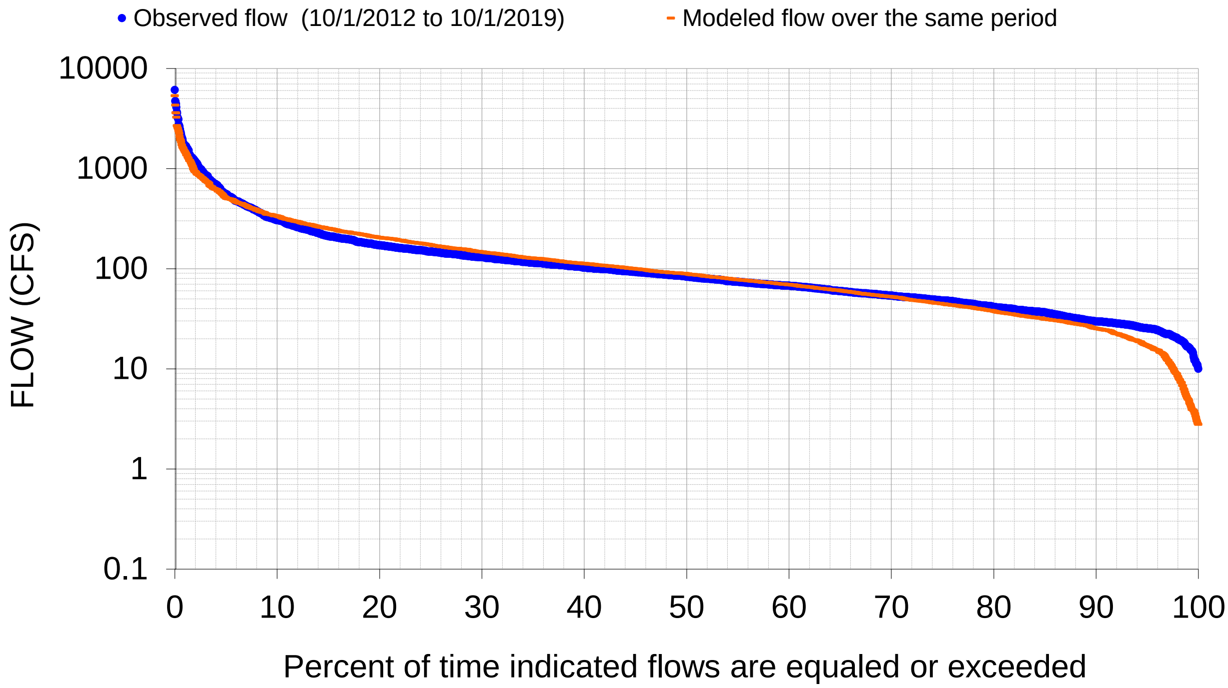


Figure D-5. Hydrologic Calibration: Sycamore Creek, USGS 03431800 (WY 2013-2019)

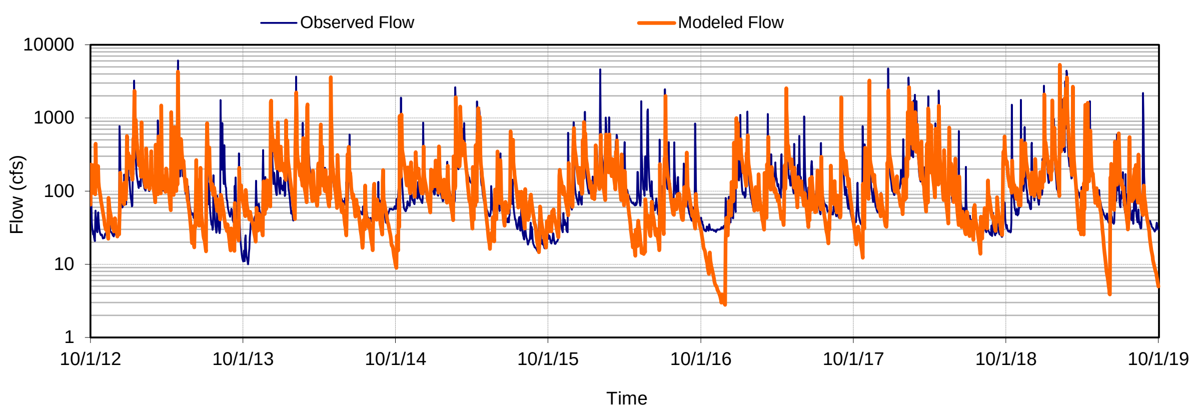


Figure D-6. 7-Year Hydrologic Comparison: Sycamore Creek, USGS 03431800

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, Sevenmile Creek provides an example for implementation analysis. Sevenmile Creek was selected because of its high proportion (78.2 percent) of urban area. The Sevenmile Creek subwatershed lies in HUC-12 051302020102 and includes portions of Nashville. The drainage area for Sevenmile Creek at mile 0.2 is approximately 10,838 acres (16.9 mi^2). Five flow zones were used for the duration curve analysis (see Sect. 9.1.1).

The flow duration curve for Sevenmile Creek at mile 0.2 was constructed using simulated daily mean flow for the period from 1/1/05 through 12/31/20 (mile 0.2 corresponds to the location of monitoring station SEVEN000.2DA). 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 Sevenmile 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 (487 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 the greatest exceedance occurring during dry conditions (Table E-3, Section E.4), indicating that the Sevenmile Creek subwatershed may be impacted by point sources, dominant during low-flow/baseflow conditions.

Results indicate the implementation strategy for the Sevenmile Creek subwatershed will require BMPs targeting point sources. Table E-1 presents an allocation table of LDC analysis statistics for Sevenmile 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 Cheatham Lake 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-24. The LDCs shown in Figures E-5 through E-24 (and the associated Tables E-4 through E-38) 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-39 presents LDC analyses (TMDLs, WLAs, LAs, and MOS) and PLRGs for all flow zones for all *E. coli* impaired waterbodies in the Cheatham Lake watershed.

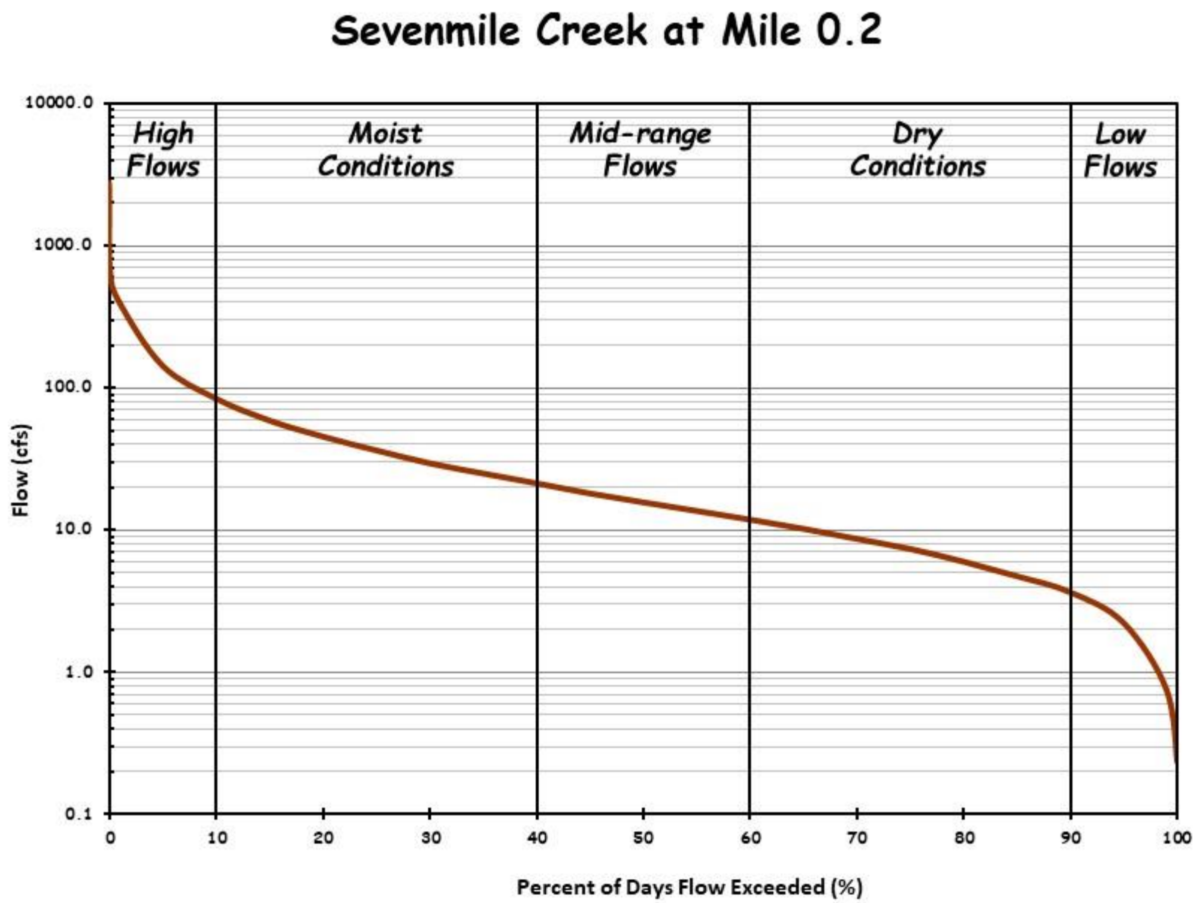


Figure E-1. Flow Duration Curve for Sevenmile Creek – RM 0.2

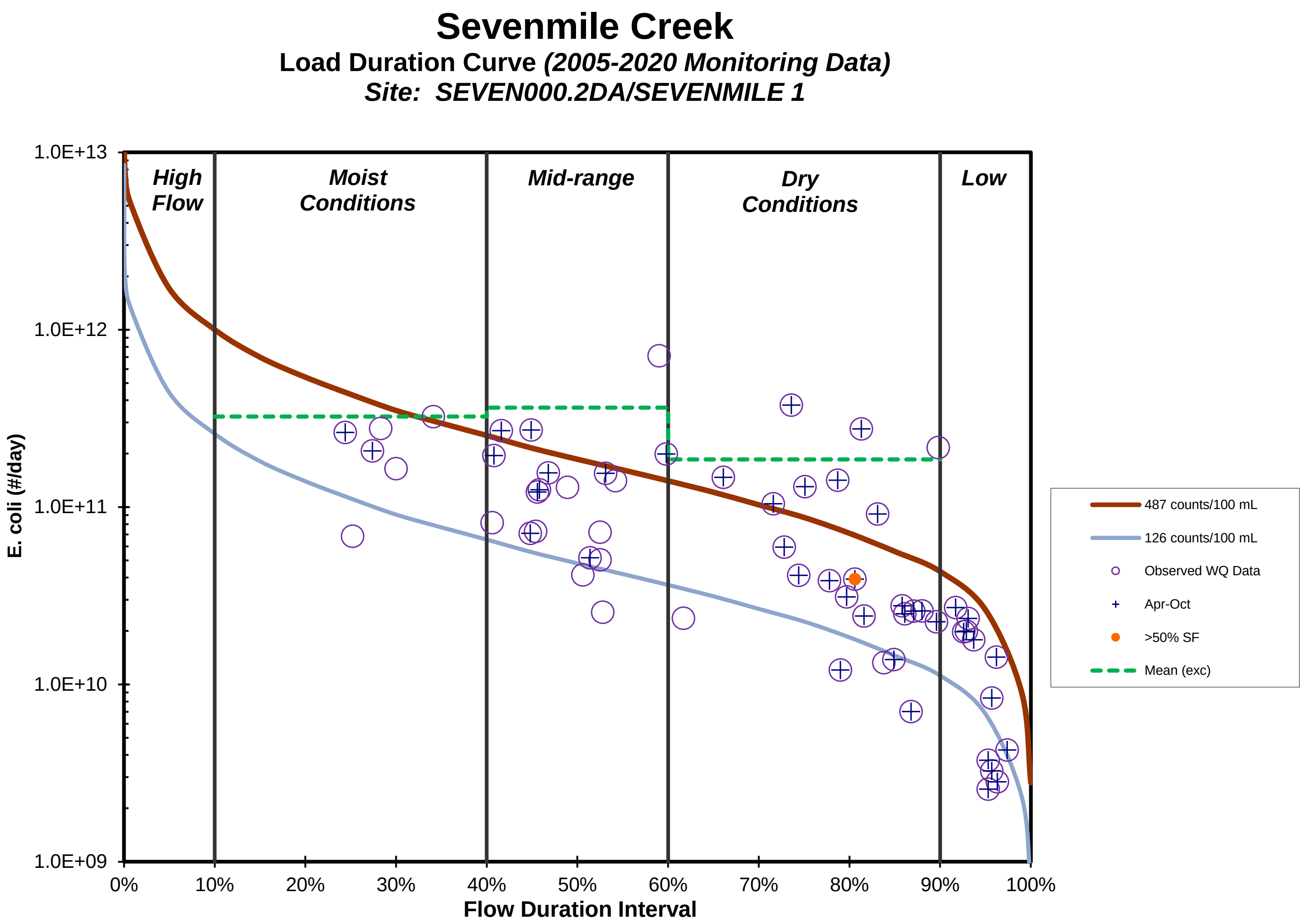


Figure E-2. ***E. coli* Load Duration Curve for Sevenmile Creek – RM 0.2**

Table E-1. Load Duration Curve Summary for Urban Area Implementation Strategies (Example: Sevenmile Creek subwatershed, part of HUC-12 051302020102) (5 Flow Zones).

Hydrologic Condition		High	Moist	Mid-range	Dry*	Low
% Time Flow Exceeded		0-10	10-40	40-60	60-90	90-100
Sevenmile Creek (051302020102) RM 0.2	Number of Samples	0	6	19	24	12
	% > 487 CFU/100 mL[1]	NA	16.7	21.1	33.3	0.0
	Load Reduction[2]	NA	5.8%	35.1	46.2	NR
TMDL (CFU/day)		1.714E+12	4.350E+11	1.873E+11	8.796E+10	2.652E+10
Margin of Safety (CFU/day)		1.714E+11	4.350E+10	1.873E+10	8.796E+09	2.652E+09
WLA (WWTPs) (CFU/day)		1.20E+10 x q_m	1.20E+10 x q_m	1.20E+10 x q_m	1.20E+10 x q_m	1.20E+10 x q_m
WLAs (MS4s) (CFU/day/acre)[3]		(1.423E+08) - (1.11E+06 x q_d)	(3.612E+07) - (1.11+06 x q_d)	(1.556E+07) - (1.11E+06 x q_d)	(7.304E+06) - (1.11E+06 x q_d)	(2.202E+06) - (1.11E+06 x q_d)
LA (CFU/day/acre)[3]		(1.423E+08) - (1.11E+06 x q_d)	(3.612E+07) - (1.11+06 x q_d)	(1.556E+07) - (1.11E+06 x q_d)	(7.304E+06) - (1.11E+06 x q_d)	(2.202E+06) - (1.11E+06 x q_d)
Implementation Strategies[4]						
Municipal NPDES			L	M	H	H
Stormwater and CSO 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 Dry Conditions represent the critical condition for *E. coli* loading in the Sevenmile 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, Indian Creek provides an example for implementation analysis.

The Indian Creek drainage area, part of HUC-12 051302020101 lies in a rural area of Davidson and Williamson counties. The drainage area for Indian Creek is approximately 2,995 acres (4.6 mi^2). Five flow zones were used for the duration curve analysis (see Sect. 9.1.1). The landuse for Indian Creek is approximately 34.2% agricultural, with the remainder split between forest (47.1%) and urban (14.6%).

The flow duration curve for Indian Creek at mile 0.4 was constructed using simulated daily mean flow for the period from 1/1/05 through 12/31/20 (mile 0.4 corresponds to the location of monitoring station INDIA000.4DA). 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 Indian Creek (Figure E-4) was analyzed to determine the frequency with which observed daily water quality loads exceed the *E. coli* target maximum daily loading (487 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 the greatest number of exceedances occurring in the dry conditions zone (see Table E-3, Section E.4). The Indian Creek subwatershed appears to be impacted by sources dominant during low flow/baseflow conditions.

Results indicate the implementation strategy for the Indian Creek drainage area will require BMPs targeting sources dominant during low flow/baseflow conditions. Table E-2 presents an allocation table of LDC analysis statistics for Indian Creek *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 Cheatham Lake 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 13 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-24. The LDCs shown in Figures E-5 through E-24 (and the associated Tables E-4 through E-38) 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-39 presents LDC analyses (TMDLs, WLAs, LAs, and MOS) and PLRGs for all flow zones for all *E. coli* impaired waterbodies in the Cheatham Lake watershed.

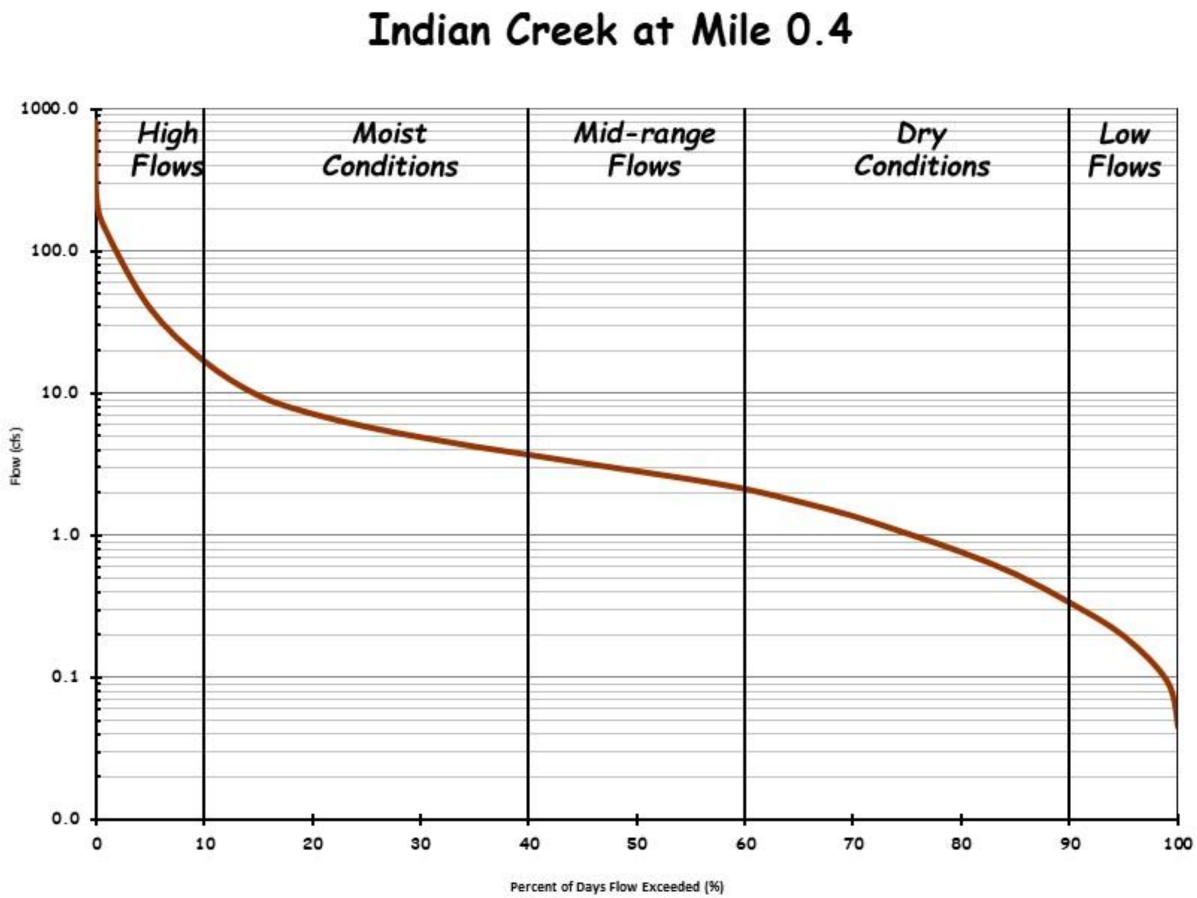


Figure E-3. Flow Duration Curve for Indian Creek – RM 0.4

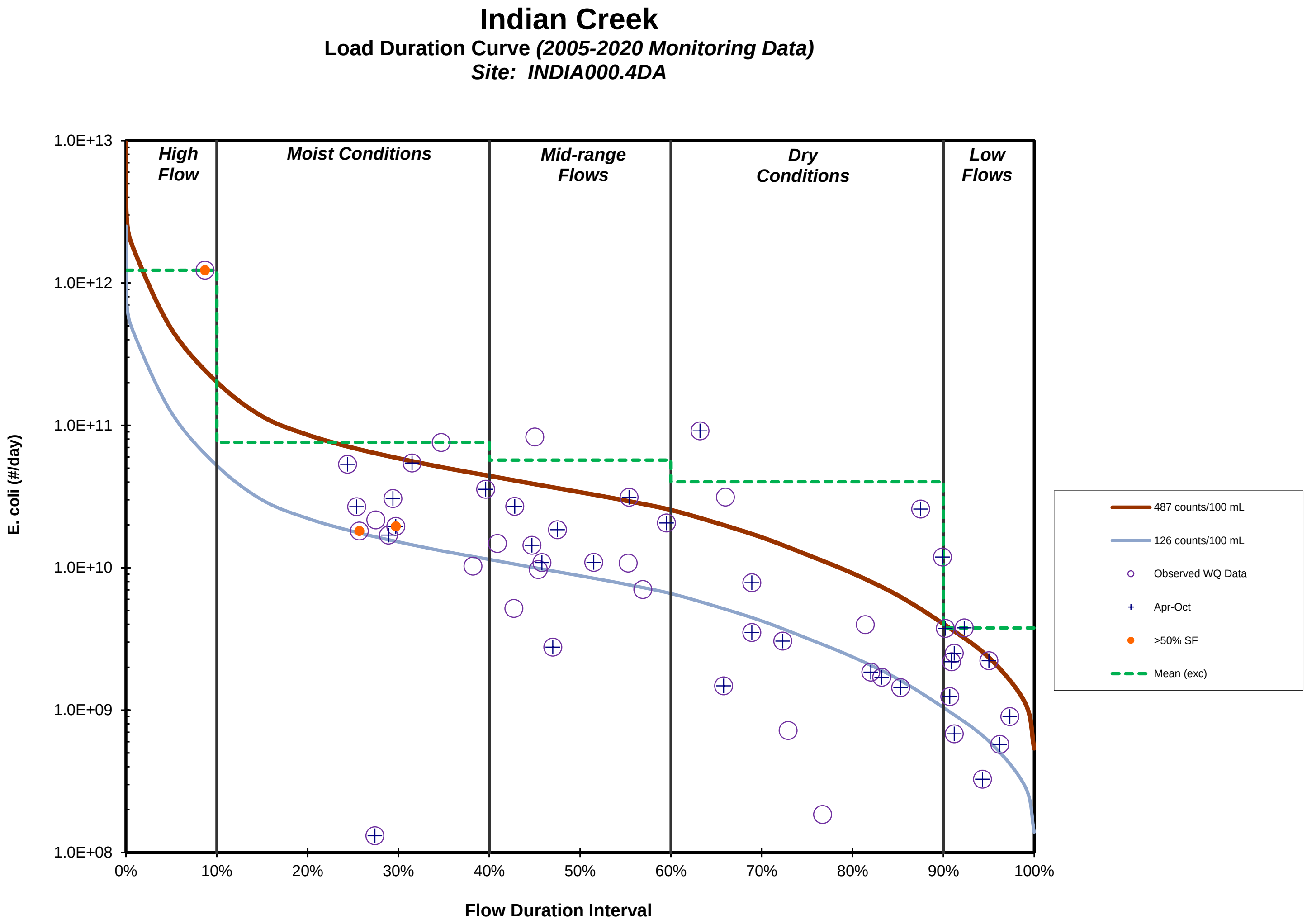


Figure E-4. ***E. coli*** **Load Duration Curve for Indian Creek – RM 0.4**

Table E-2. Load Duration Curve Summary for Agricultural Area Implementation Strategies (Example: Indian Creek subwatershed, in HUC-12 051302020101) (5 Flow Zones)

Hydrologic Condition		High	Moist	Mid-range	Dry*	Low
% Time Flow Exceeded		0-10	10-40	40-60	60-90	90-100
Indian Creek (051302020101) RM 0.4	Number of Samples	1	12	14	14	10
	% > 487 CFU/100 mL[1]	100.0	8.3	14.3	28.6	10.0
	Load Reduction[2]	79.7%	33.0%	29.9%	64.4%	15.9%
TMDL (CFU/day)		4.784E+11	6.996E+10	3.420E+10	1.248E+10	2.400E+09
Margin of Safety (CFU/day)		4.784E+10	6.996E+09	3.420E+09	1.248E+09	2.400E+08
WLA (WWTPs) (CFU/day)		1.20E+10 x q_m	1.20E+10 x q_m	1.20E+10 x q_m	1.20E+10 x q_m	1.20E+10 x q_m
WLAs (MS4s) (CFU/day/acre)[3]		(1.462E+08) - (4.08E+06 x q_d)	(2.138E+07) - (4.08E+06 x q_d)	(1.045E+07) - (4.08E+06 x q_d)	(3.814E+06) - (4.08E+06 x q_d)	(7.335E+05) - (4.08E+06 x q_d)
LA (CFU/day/acre)[3]		(1.462E+08) - (4.08E+06 x q_d)	(2.138E+07) - (4.08E+06 x q_d)	(1.045E+07) - (4.08E+06 x q_d)	(3.814E+06) - (4.08E+06 x q_d)	(7.335E+05) - (4.08E+06 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 Dry Conditions flow zone represents the critical conditions for *E. coli* loading in the Indian Creek 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 Cheatham Lake 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 Sevenmile Creek at mile 0.2 (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 most recent sampling cycle:

Date	Sample Conc. (CFU/100 mL)	Flow (cfs)	Existing Load (CFU/Day)	Target (TMDL) Load (CFU/Day)	Percent Reduction
3/7/16	159.7	21.2	8.30E+10	4.89E+11	NR
9/21/20	547.5	20.5	2.74E+11	4.71E+11	**11.1**
10/15/20	613.1	18.5	2.77E+11	4.25E+11	**20.6**
3/8/16	167.0	18.2	7.42E+10	4.18E+11	NR
3/9/16	110.0	15.6	4.21E+10	3.60E+11	NR
1/12/16	411	14.2	1.43E+11	3.28E+11	NR
8/26/20	686.7	12.0	2.02E+11	2.77E+11	**29.1**
Percent Load Reduction Goal (PLRG) for Moist Conditions (Mean)					**20.2**

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 Sevenmile Creek at mile 0.2.

   Example – *High Flow Zone Percent Load Reduction Goal = NA*
   Moist Conditions Flow Zone Percent Load Reduction Goal = 5.8
   Mid-Range Flow Zone Percent Load Reduction Goal = 20.2
   Dry Conditions Flow Zone Percent Load Reduction Goal = 19.8
   Low Flow Zone Percent Load Reduction Goal =NR

   Therefore, <u>based on the most recent sampling cycle</u>, the critical flow zone for prioritization of Sevenmile Creek implementation activities is the Mid-Range Flow Zone (and subsequently actions targeting point source and nonpoint source controls).

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 Sevenmile Creek at mile 0.2:

Flow Zone	Total # of Samples	# of Samples > 487 CFU/100 mL	% Samples > 487 CFU/100 mL
High	0	0	0
Moist	2	1	50.0
Mid-Range	**7**	**3**	**42.9**
Dry	**7**	**3**	**42.9**
Low	7	0	0

Based on the number of exceedances in each flow zone, the critical flow zone for prioritization of Sevenmile Creek implementation activities is identified as the Mid-Range flow zone. 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 2 Cycles (2005-20)			Most Recent Cycle (2016-2020)		
	# of samples	% Red.	% Exceed.	# of samples	% Red.	% Exceed.
High	0	NA	0	0	NA	0
Moist	6	5.8	16.7	2	5.8	50.0
Mid-Range	19	35.1	21.1	**7**	**20.2**	**42.9**
Dry	**24**	**46.2**	**33.3**	7	19.8	42.9
Low	12	NR	0	7	NR	0

Steps 1 and 2 already identified the Mid-Range flow zones as the critical flow zones. 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-38.

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 = Sevenmile Creek Mile 0.2*
Sampling Period = 7/15/20 – 8/6/20
Geometric Mean Concentration = 431.4 CFU/100 mL
Target Concentration = 126 CFU/100 mL
Reduction to Target = 70.8%

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 Cheatham Lake Watershed

Waterbody Name	Analysis Area [a]	Moist	Mid-Range	Dry	Low	Monitoring Station	Drainage Area (ac)
Holt Creek *	DAs in 0101					HOLT000.4DA/Holt	1,513
Indian Creek					✓	INDIA000.4DA/Indian	2,945
Turkey Creek				✓		Turkey	1,198
Mill Creek	HUC-12 0102				✓	MILL009.6DA/Mill 3	43,726
Pavillion Branch	DA in 0102				✓	Pavillion	569
Blue Spring Creek *	DA in 0203					BSPRI000.3DA	4,789
Manskers Creek *	0301					MANSK002.8SR/Manskers 1	19,832
Cooper Creek *	DAs in 0302					COOPE001.5DA/Cooper	890
Dry Creek *				✓		DRY000.3DA	5,438
Neeleys Branch				✓		Neeley's Branch	1,299
Drake Branch	DAs in 0303			✓		DRAKE000.2DA/Drakes	1,244
Ewing Creek		✓				EWING000.8DA/Ewing	8,518
Bosley Springs Branch	DA in 0304	✓	✓			BSPRI000.4DA/Bosley	1,372
Richland Creek	HUC-12 0304			✓		RICHL002.0DA/2.2/Richland1	16,057
Richland Creek (ETW area)	DA in 0304	✓				RICHL007.8DA	3,846
Brown Creek	DAs in 0305				✓	BROWN000.4DA/Browns 1	10,158
Cheatham Reservoir/ Cumberland River *						CUMBE185.7DA	8,227,840
Pages Branch *						Pages Branch	813
Davidson Branch	DAs in 0306				✓	DAVID000.4DA/Davidson	1,223
Overall Creek				✓		OVERA001.3DA	2,946

*Critical condition could not be determined. Waterbody had no exceedances of the single sample maximum criteria, or exceedances only in the high flow zone, for both the current monitoring cycle and the previous cycle.
[a] Analysis Area as identified in Table 9.

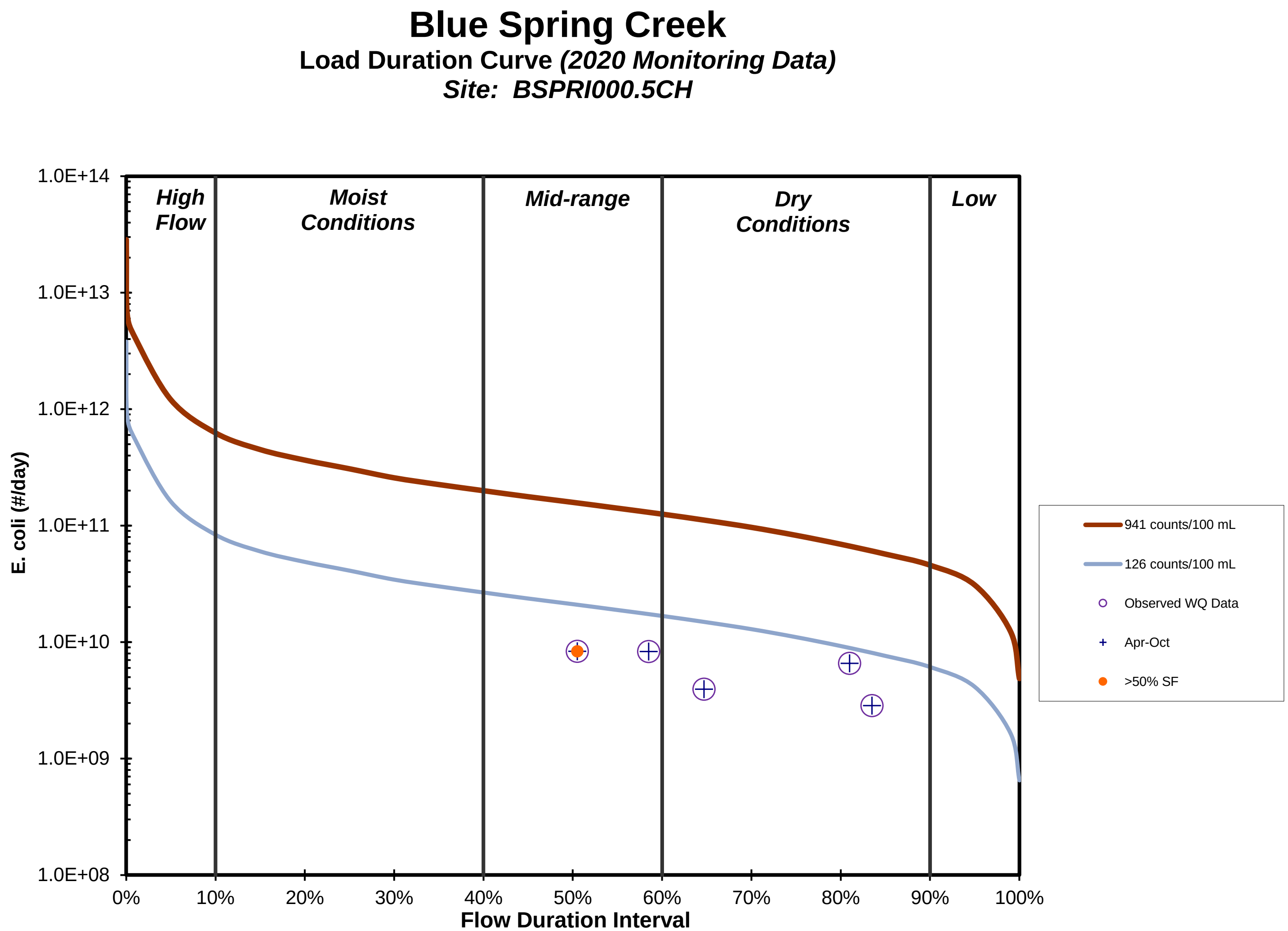


Figure E-5. *E. coli* Load Duration Curve for Blue Spring Creek – RM 0.5

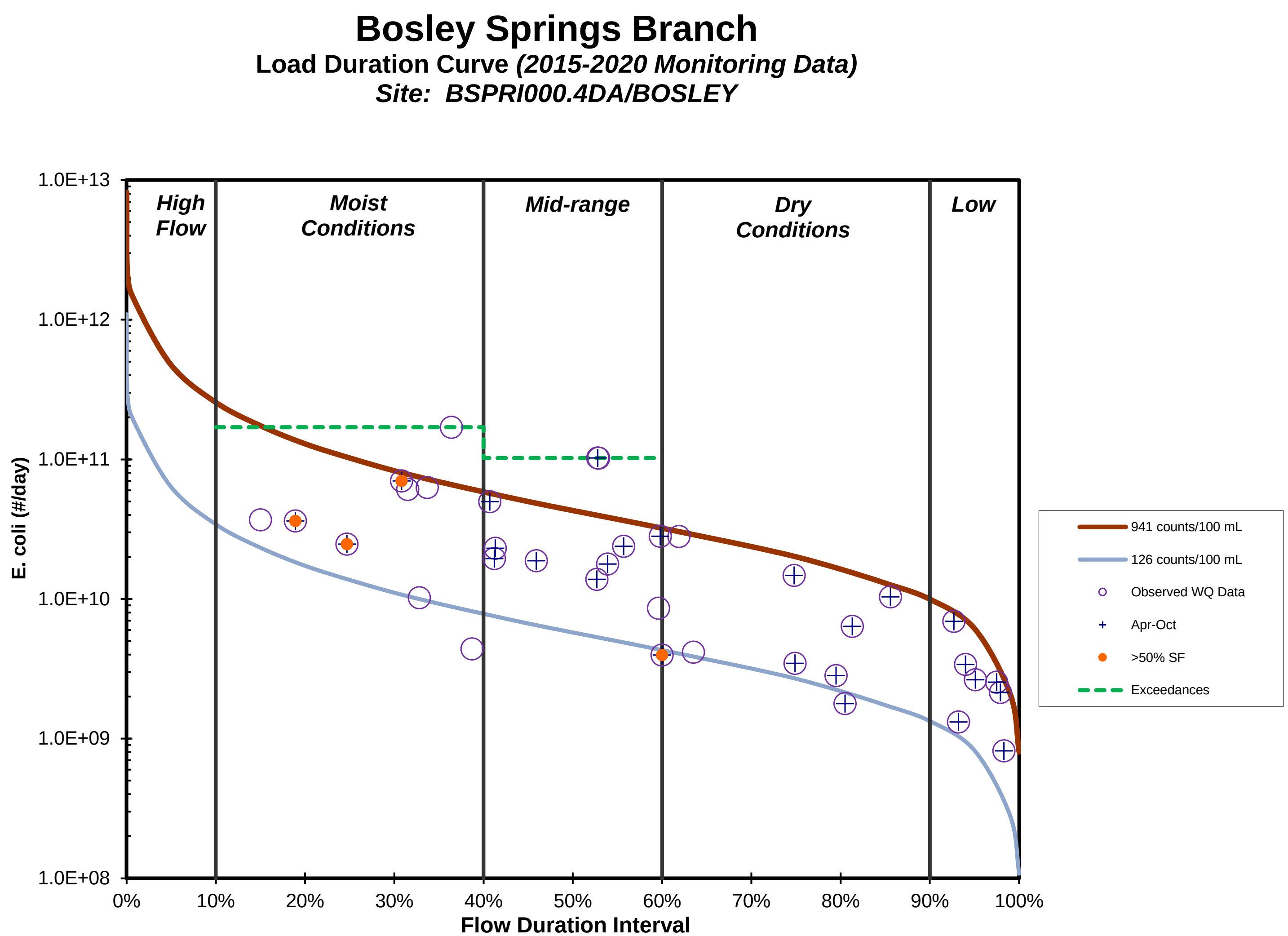


Figure E-6. ***E. coli*** **Load Duration Curve for Bosley Springs Branch – RM 0.4/Bosley**

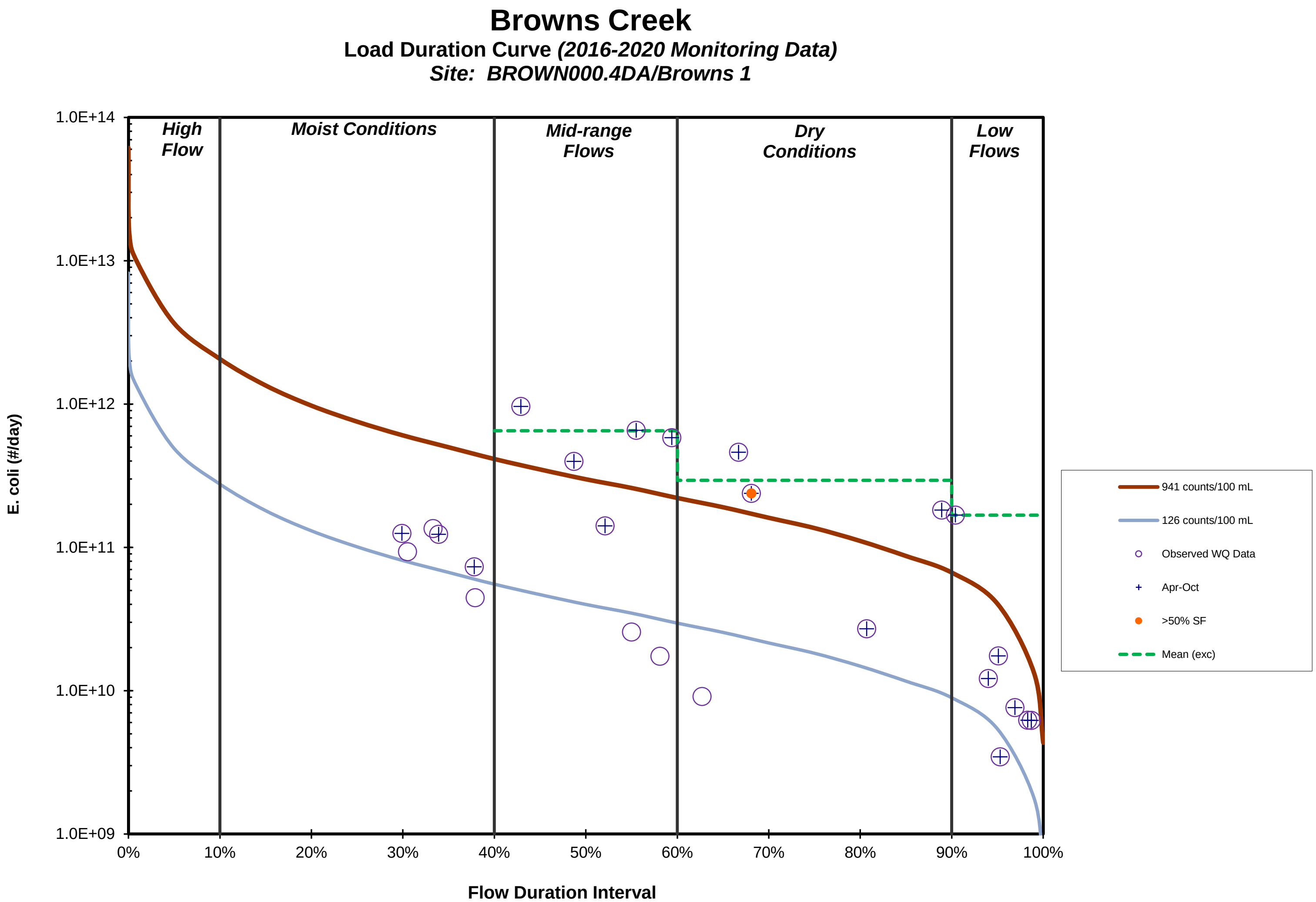


Figure E-7. ***E. coli*** **Load Duration Curve for Browns Creek – RM 0.4/Browns 1**

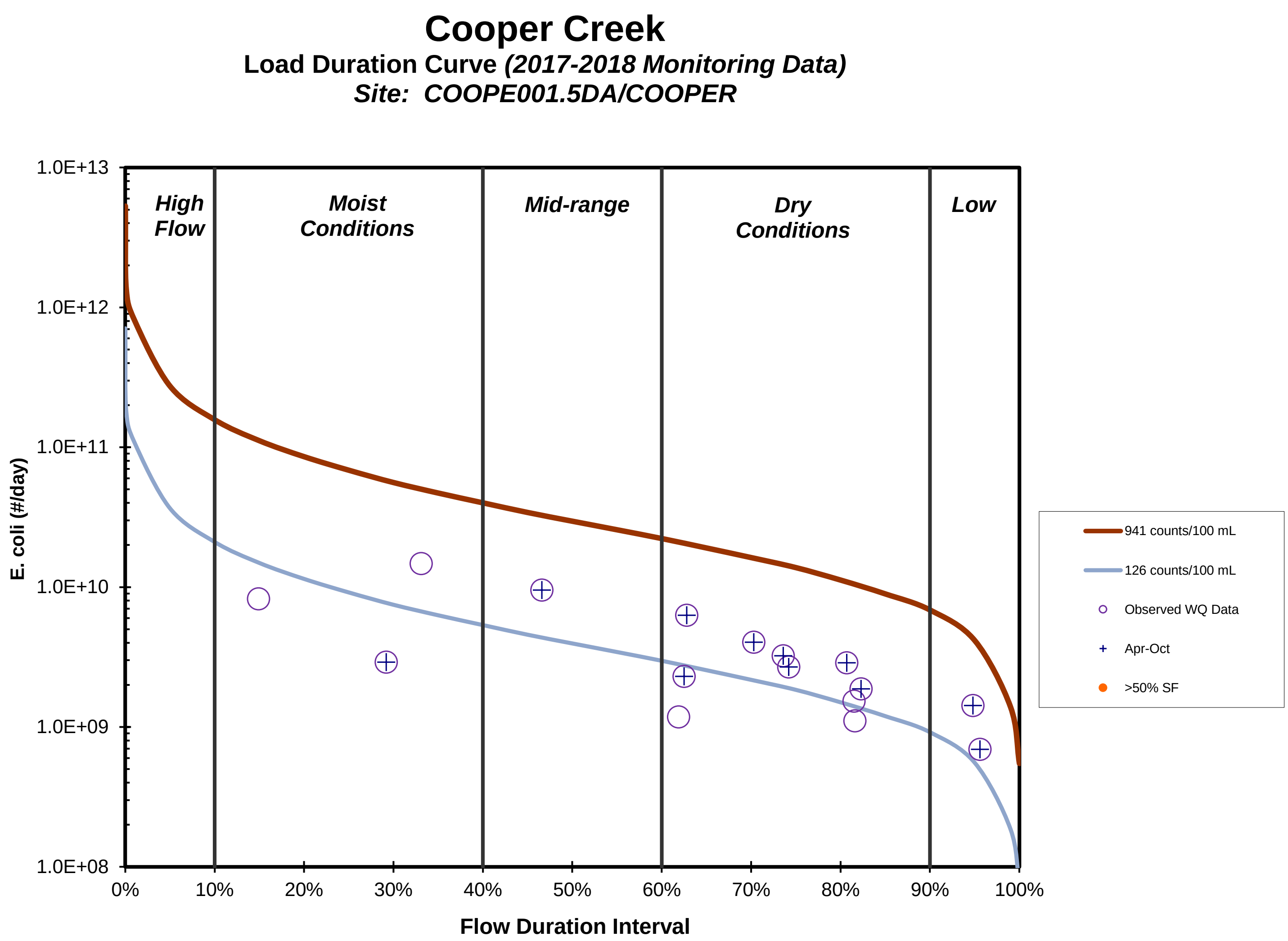


Figure E-8. ***E. coli* Load Duration Curve for Cooper Creek – RM 1.5/Cooper**

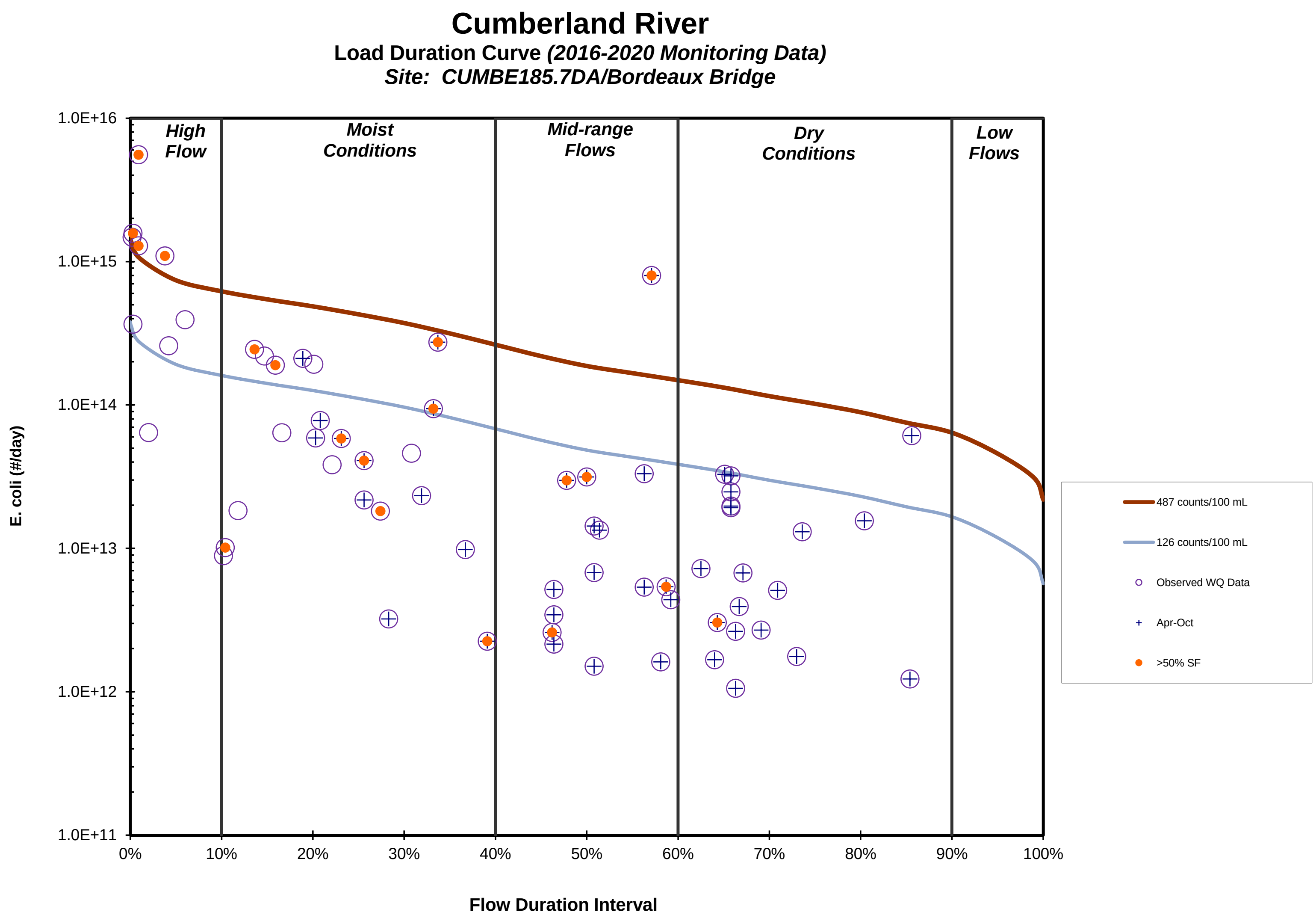


Figure E-9. ***E. coli* Load Duration Curve for Cumberland River – RM 185.7/Bordeaux Bridge**

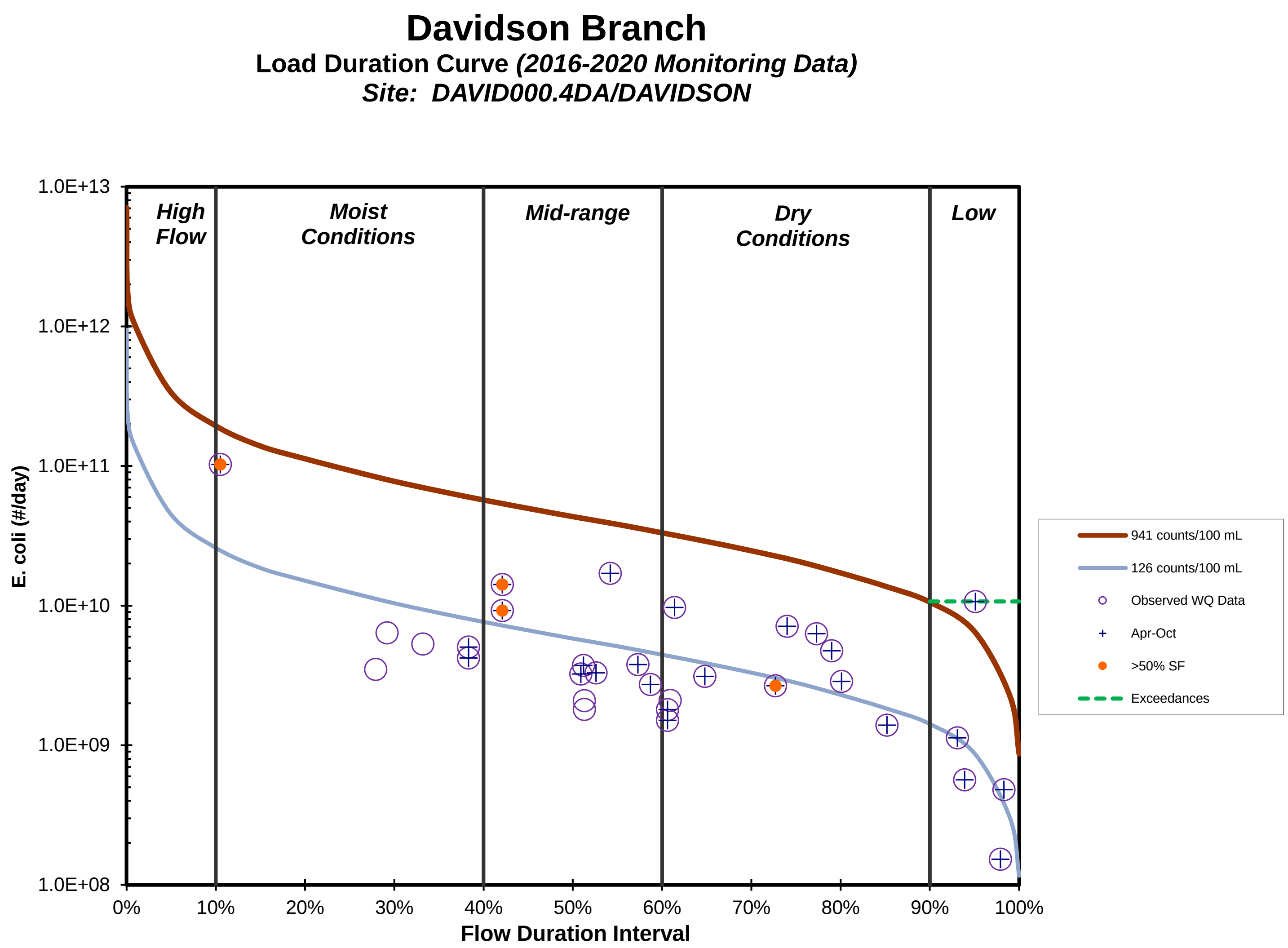


Figure E-10. *E. coli* Load Duration Curve for Davidson Branch – RM 0.4/Davidson

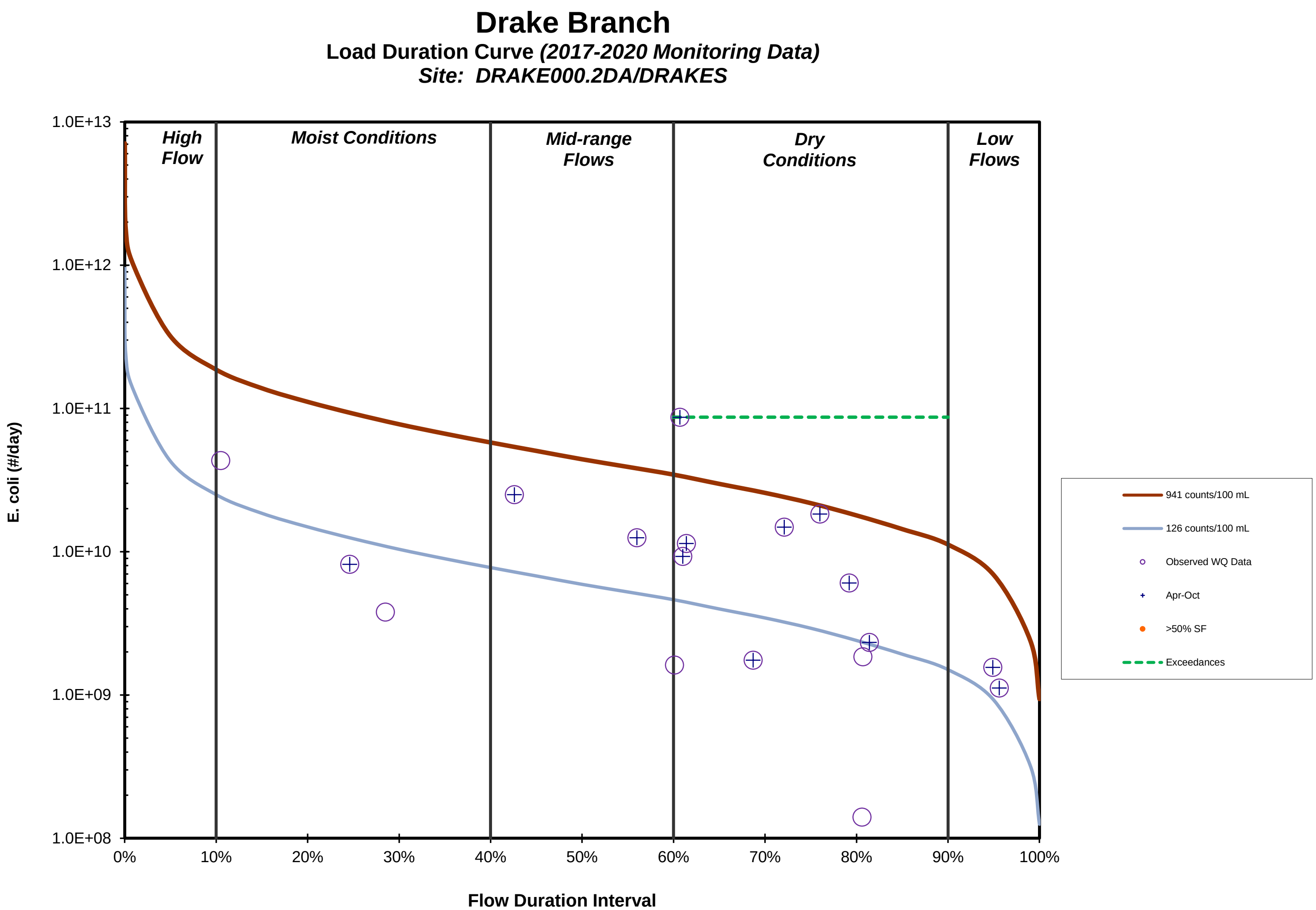


Figure E-11. *E. coli* Load Duration Curve for Drake Branch – RM 0.2/Drakes

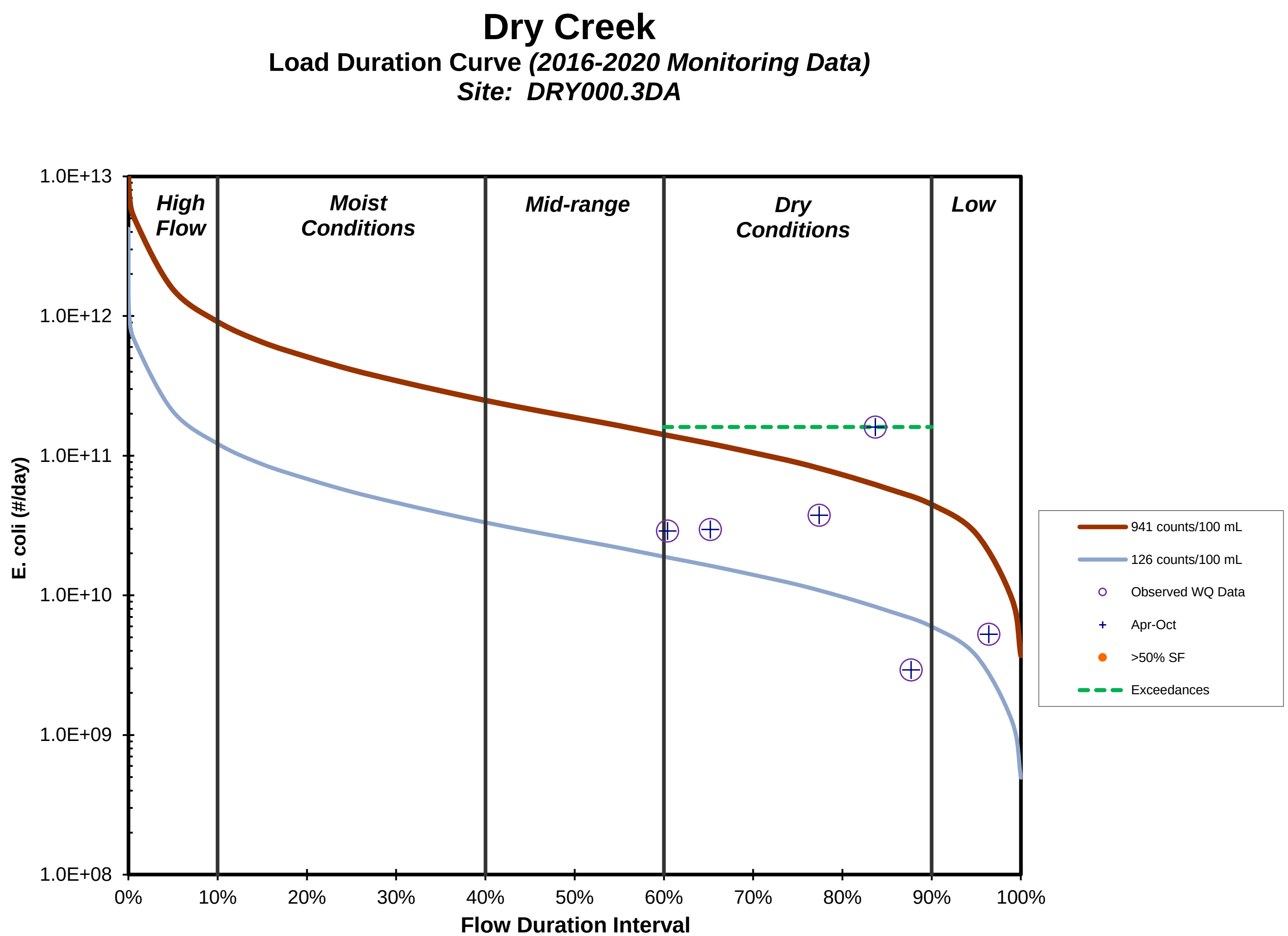


Figure E-12. ***E. coli*** **Load Duration Curve for Dry Creek – RM 0.3**

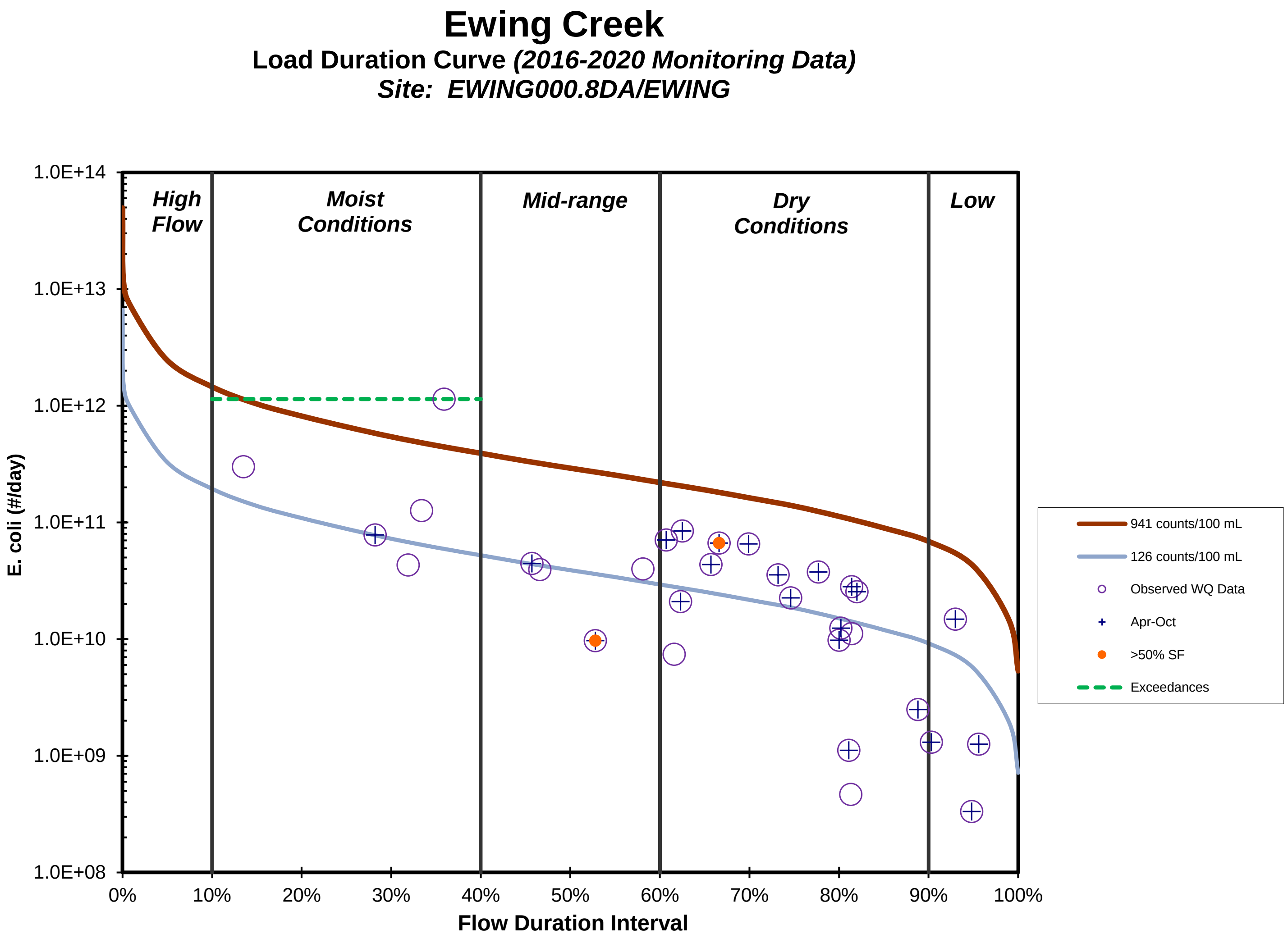


Figure E-13. *E. coli* Load Duration Curve for Ewing Creek – RM 0.8/Ewing

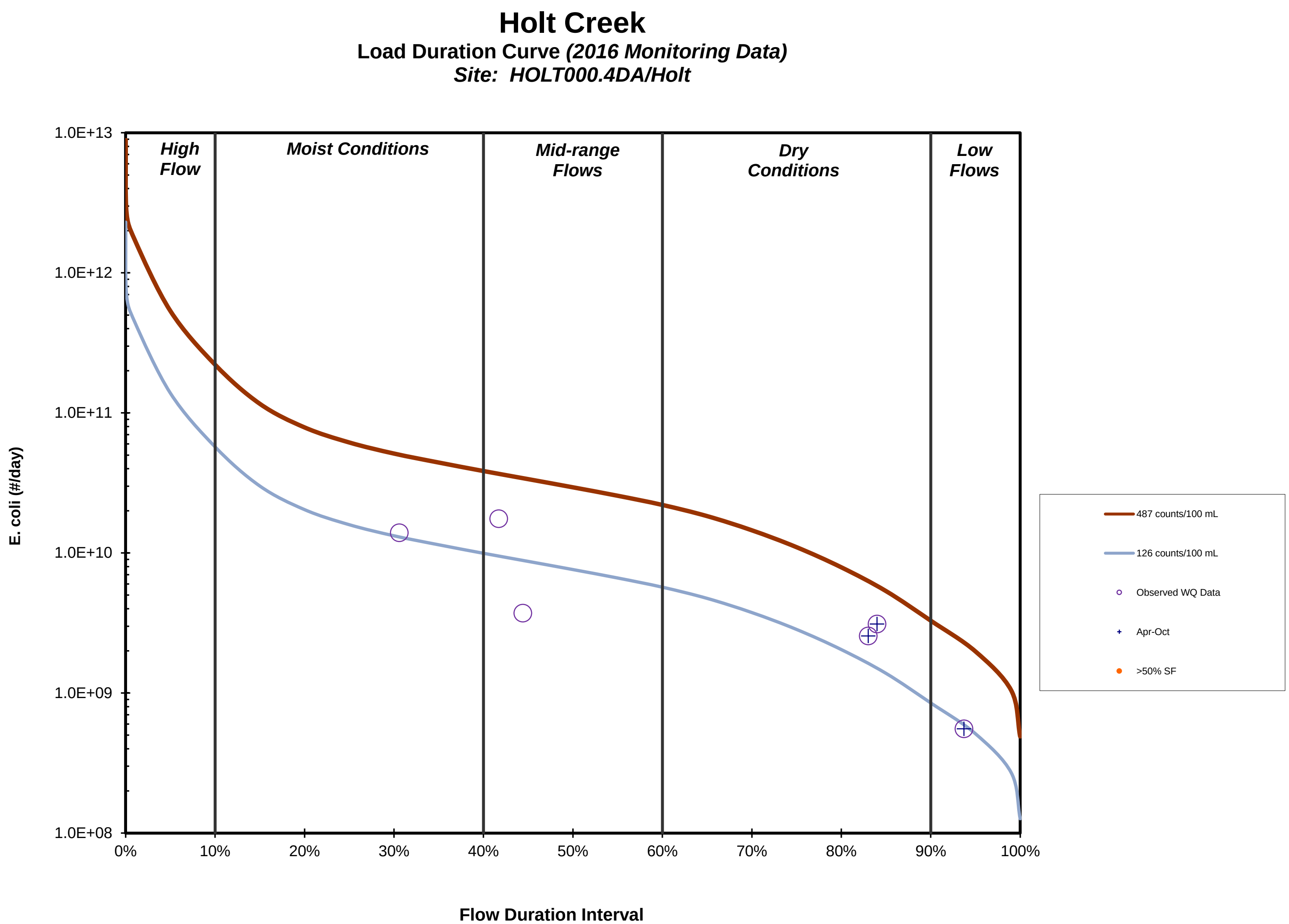


Figure E-14. *E. coli* Load Duration Curve for Holt Creek – RM 0.4/Holt

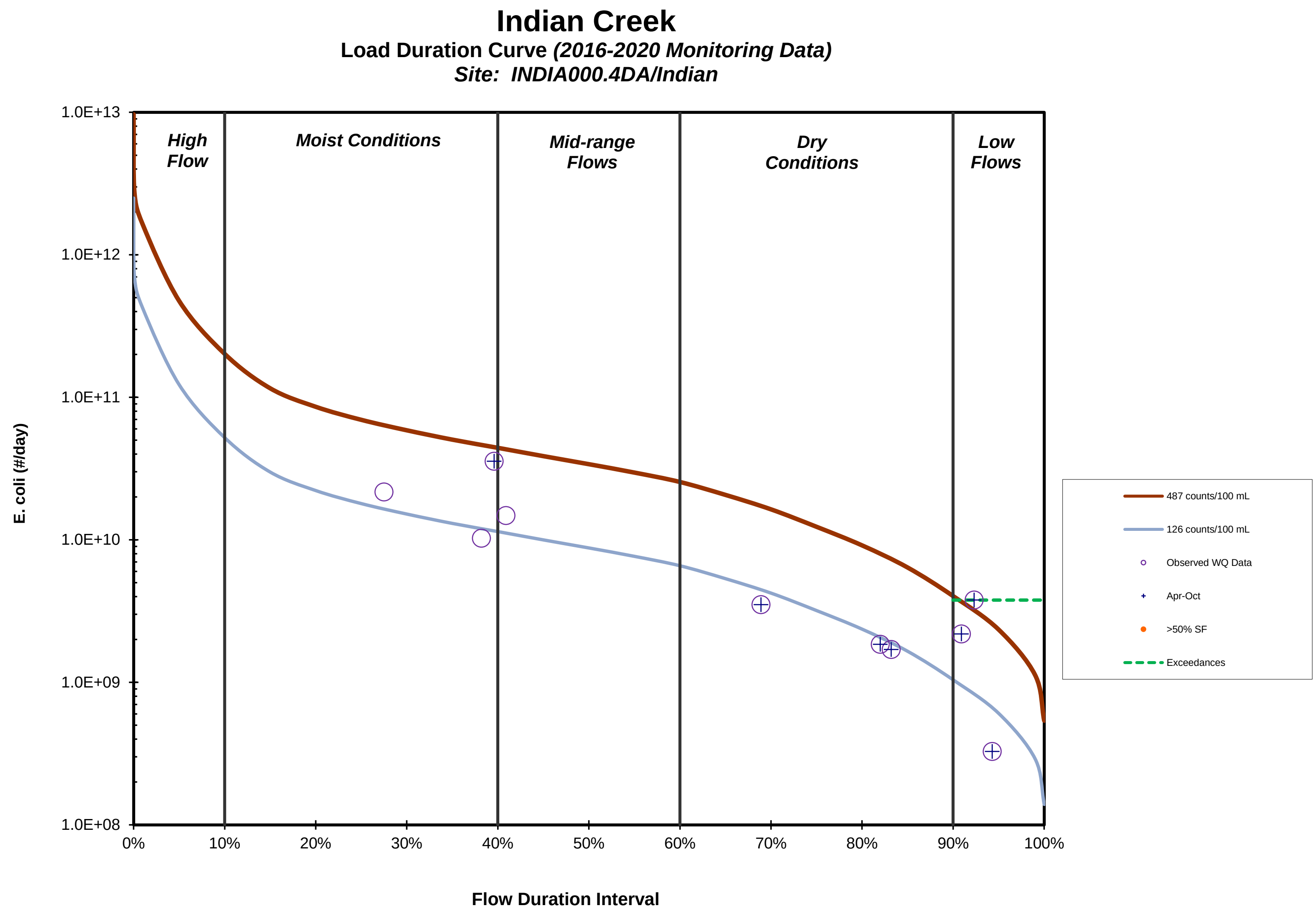


Figure E-15. *E. coli* Load Duration Curve for Indian Creek – RM 0.4/Indian

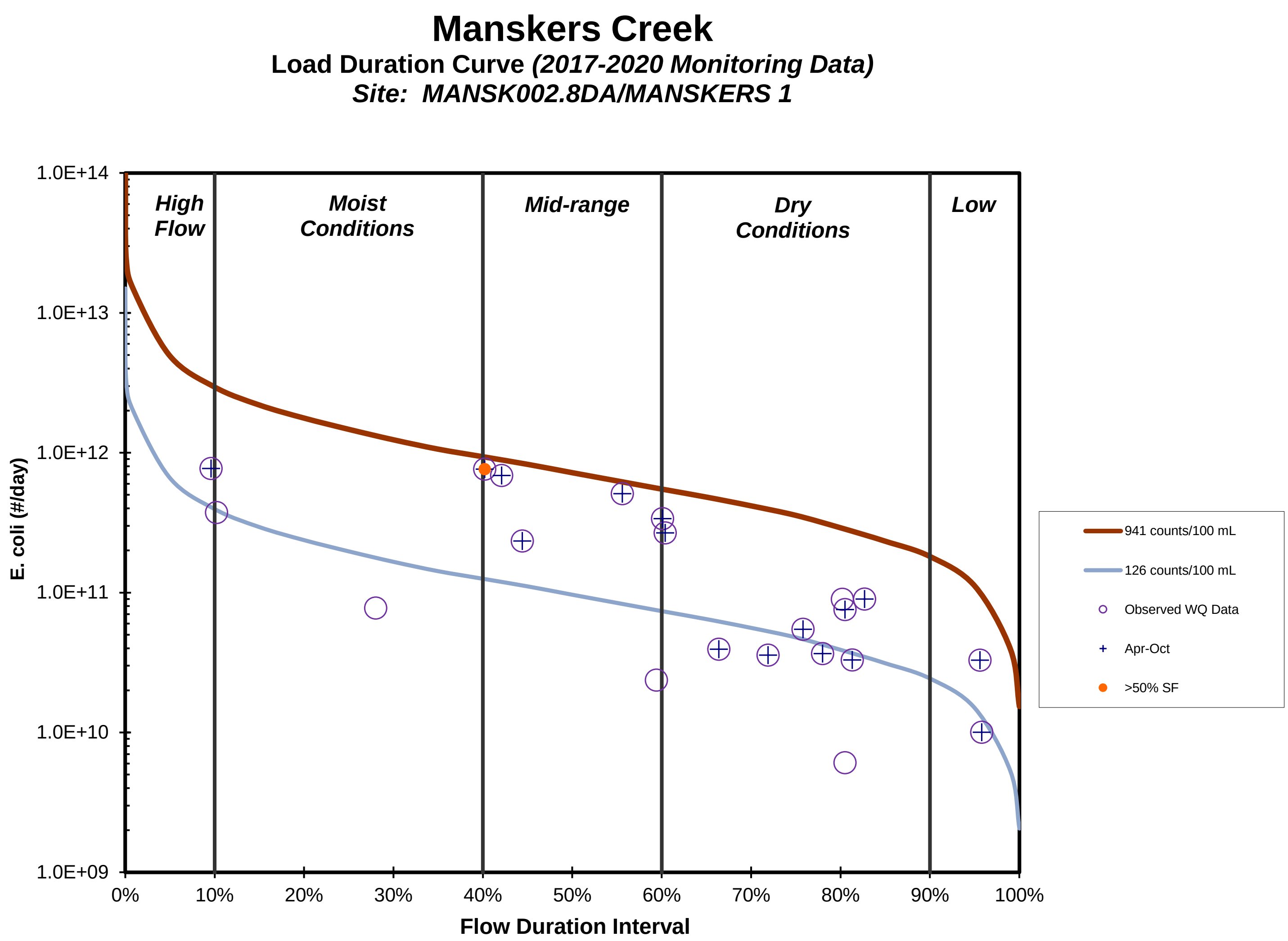


Figure E-16. *E. coli* Load Duration Curve for Manskers Creek – RM 2.8/Manskers 1

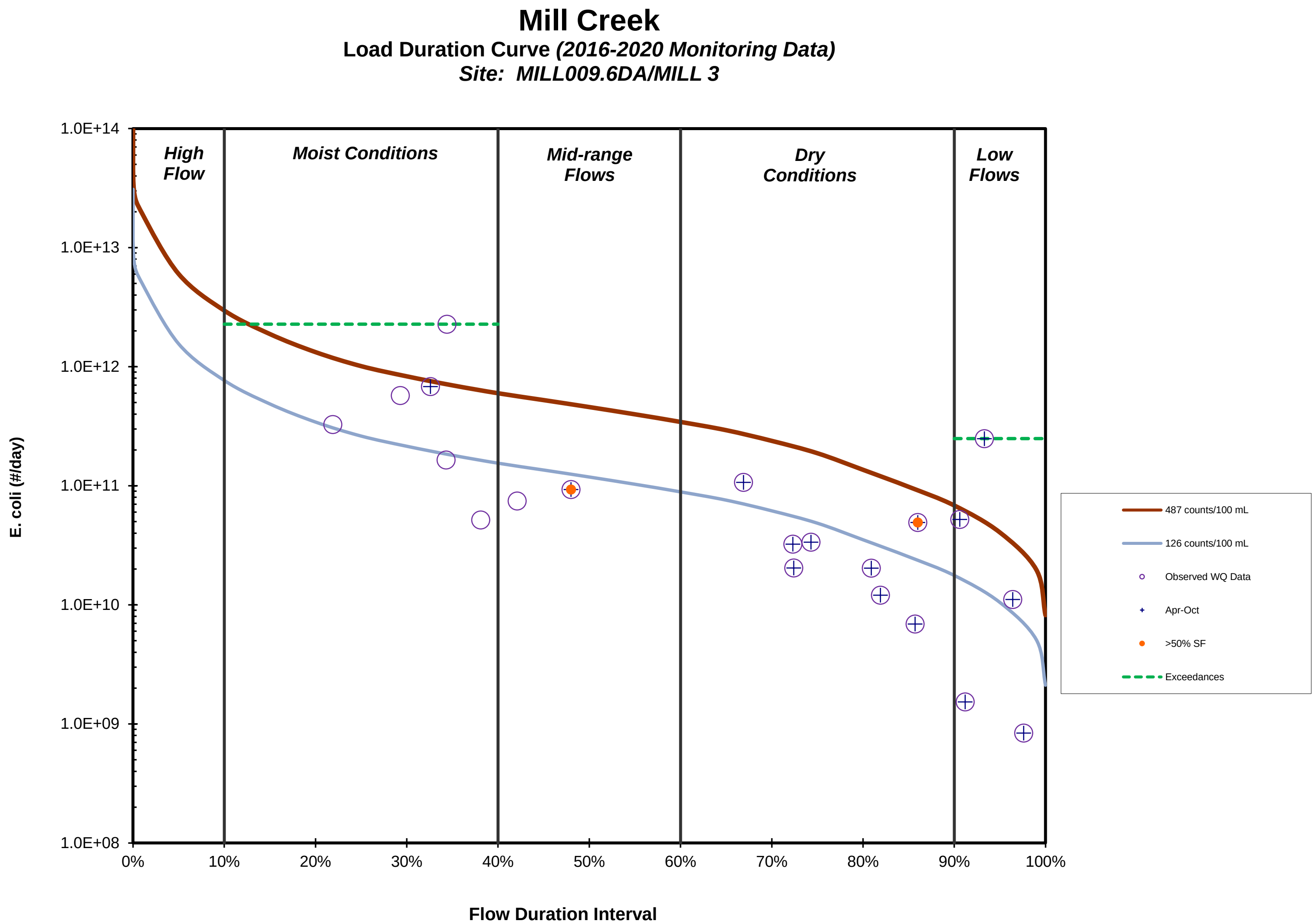


Figure E-17. *E. coli* Load Duration Curve for Mill Creek – RM 9.6/Mill 3

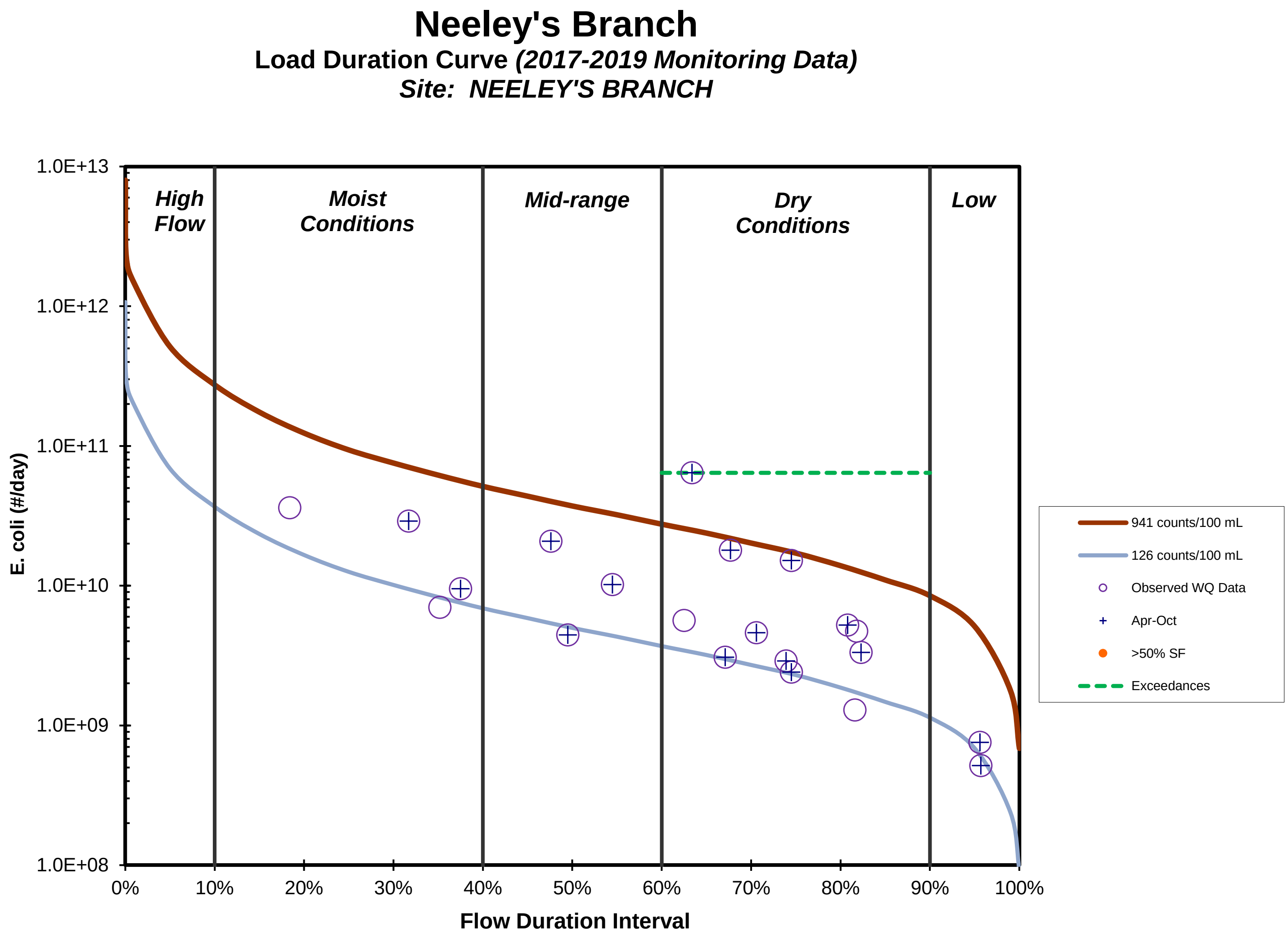


Figure E-18. *E. coli* Load Duration Curve for Neeleys Branch – Neeleys Branch

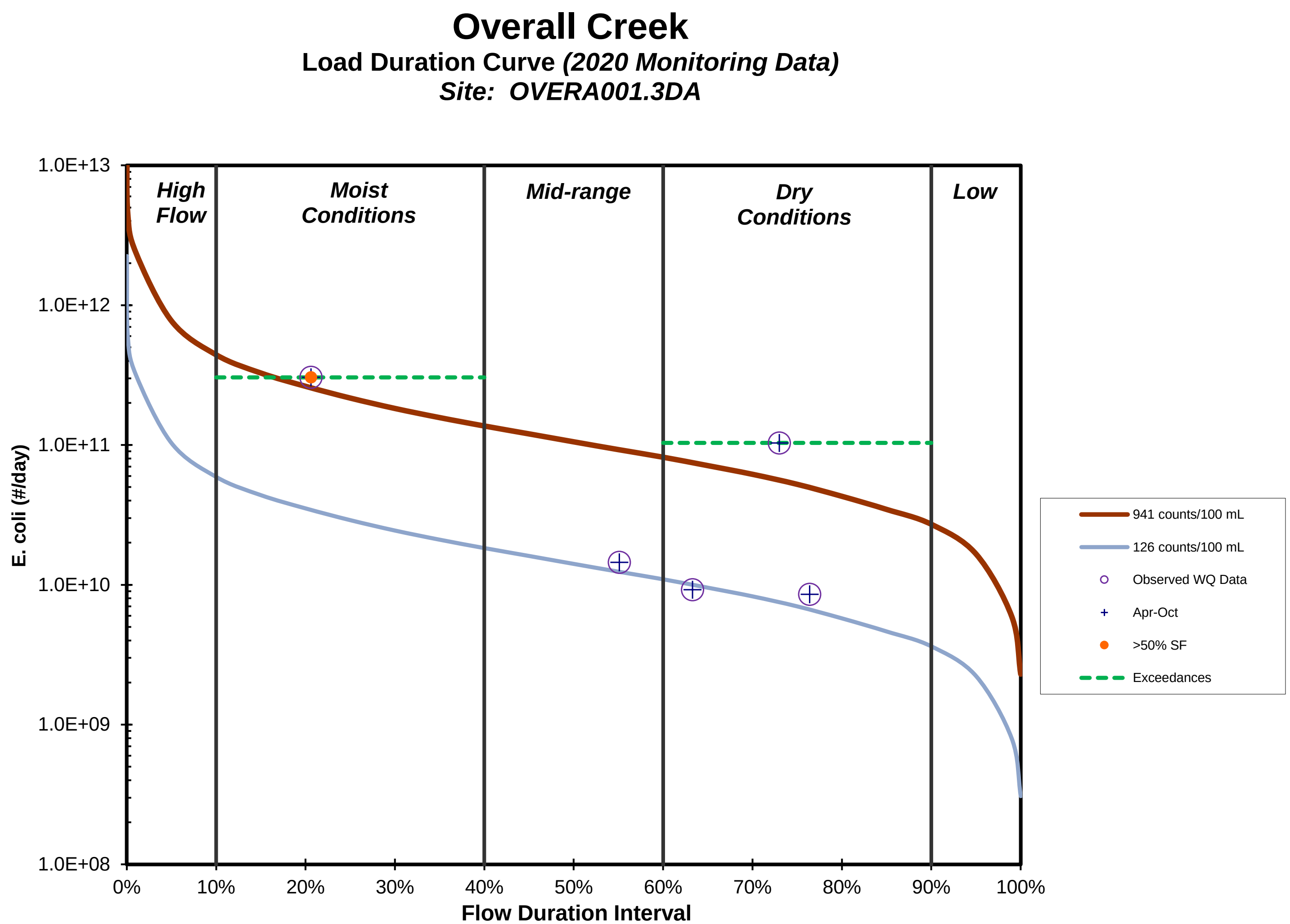


Figure E-19. ***E. coli*** **Load Duration Curve for Overall Creek – RM 1.3**

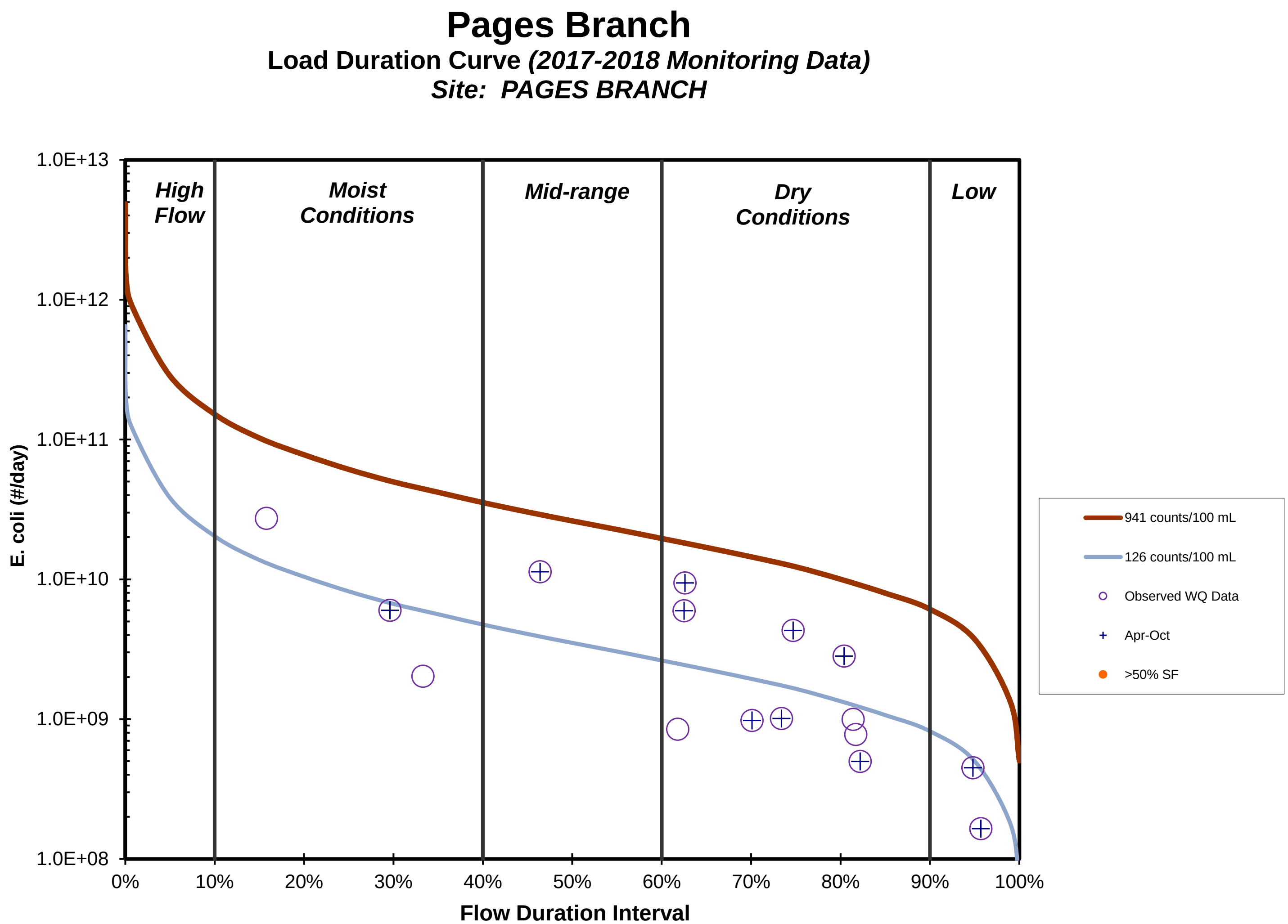


Figure E-20. *E. coli* Load Duration Curve for Pages Branch – Pages Branch

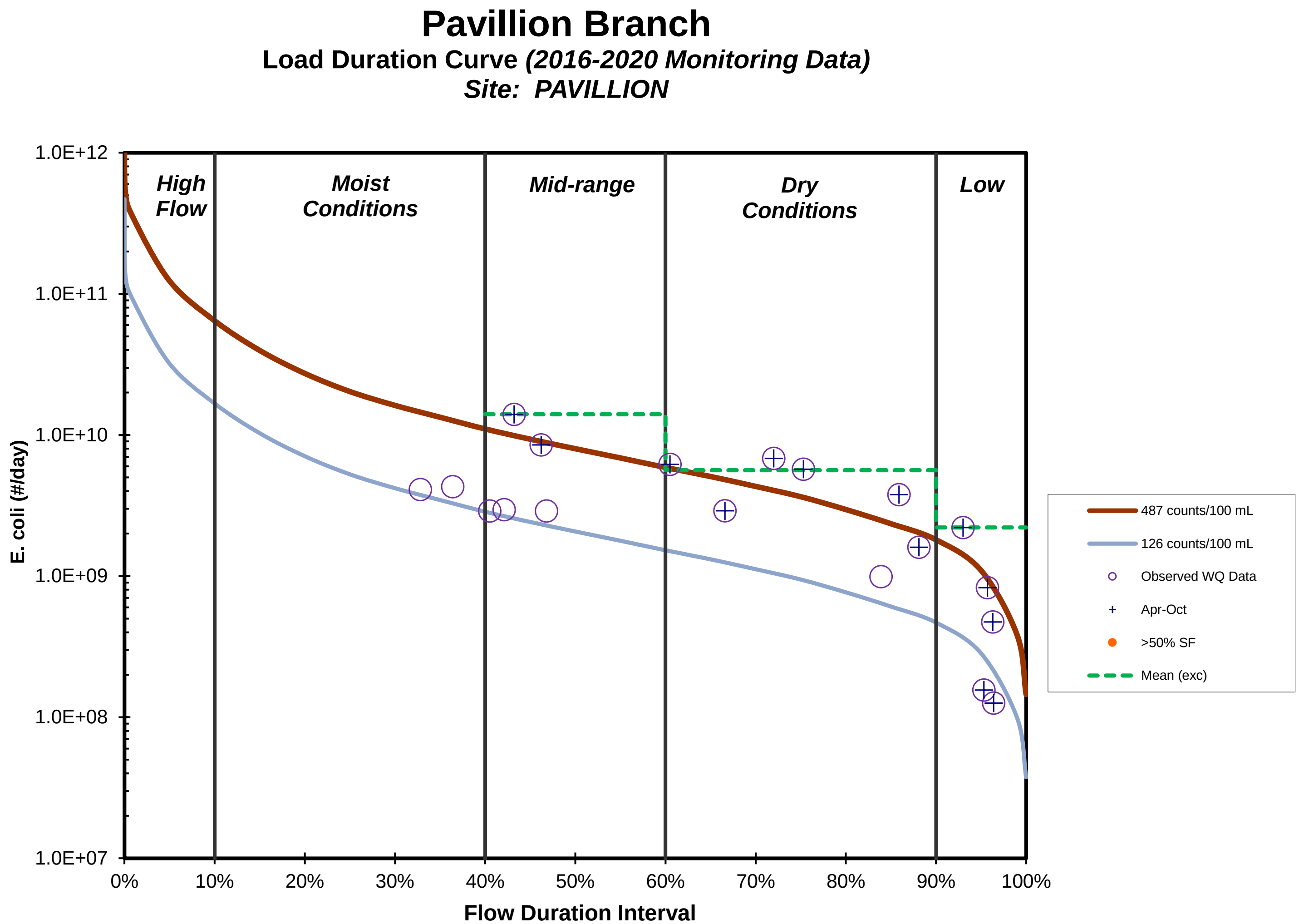


Figure E-21. *E. coli* Load Duration Curve for Pavillion Branch – Pavillion

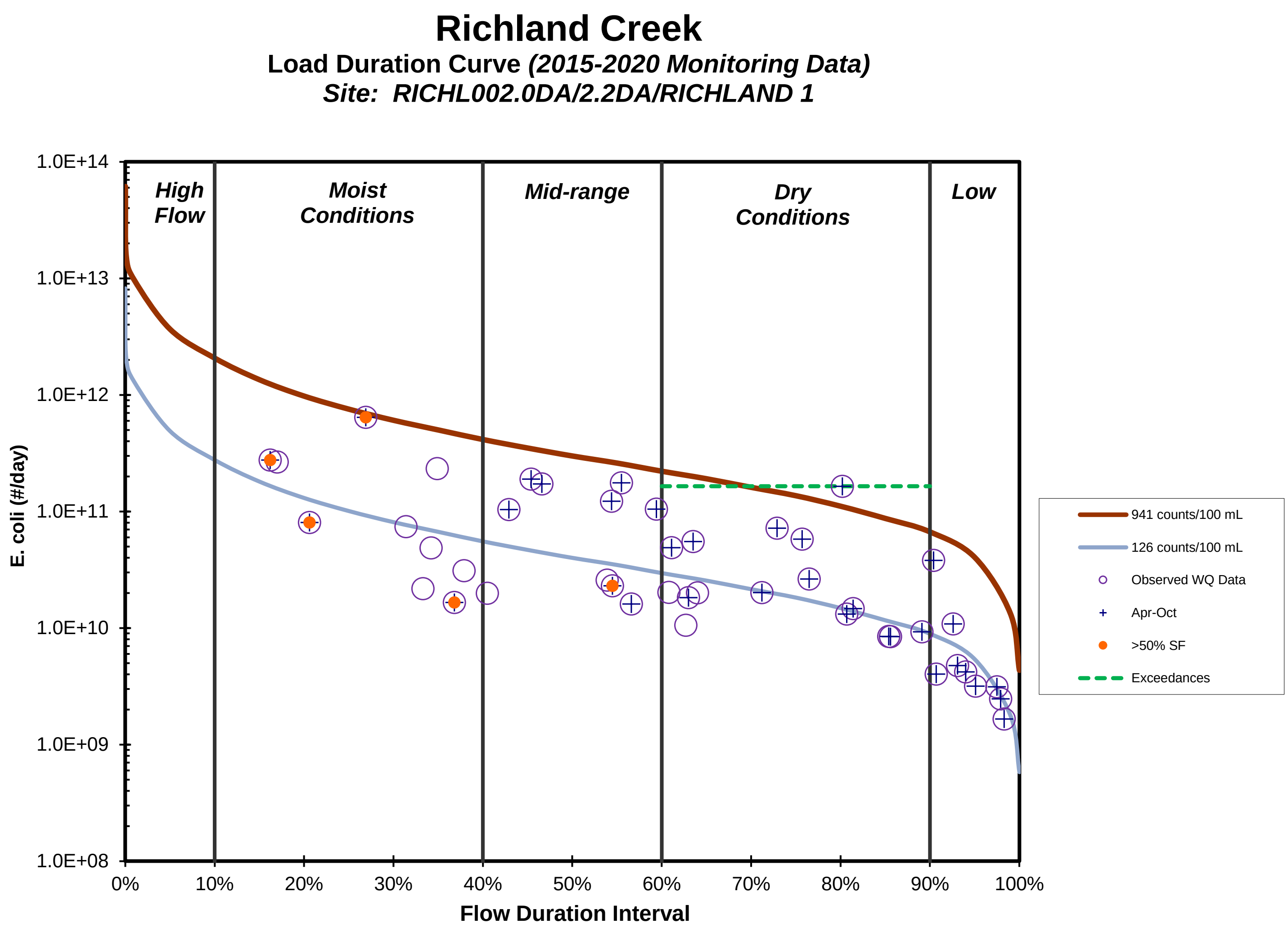


Figure E-22. *E. coli* Load Duration Curve for Richland Creek – RM 2.0/2.2/Richland 1

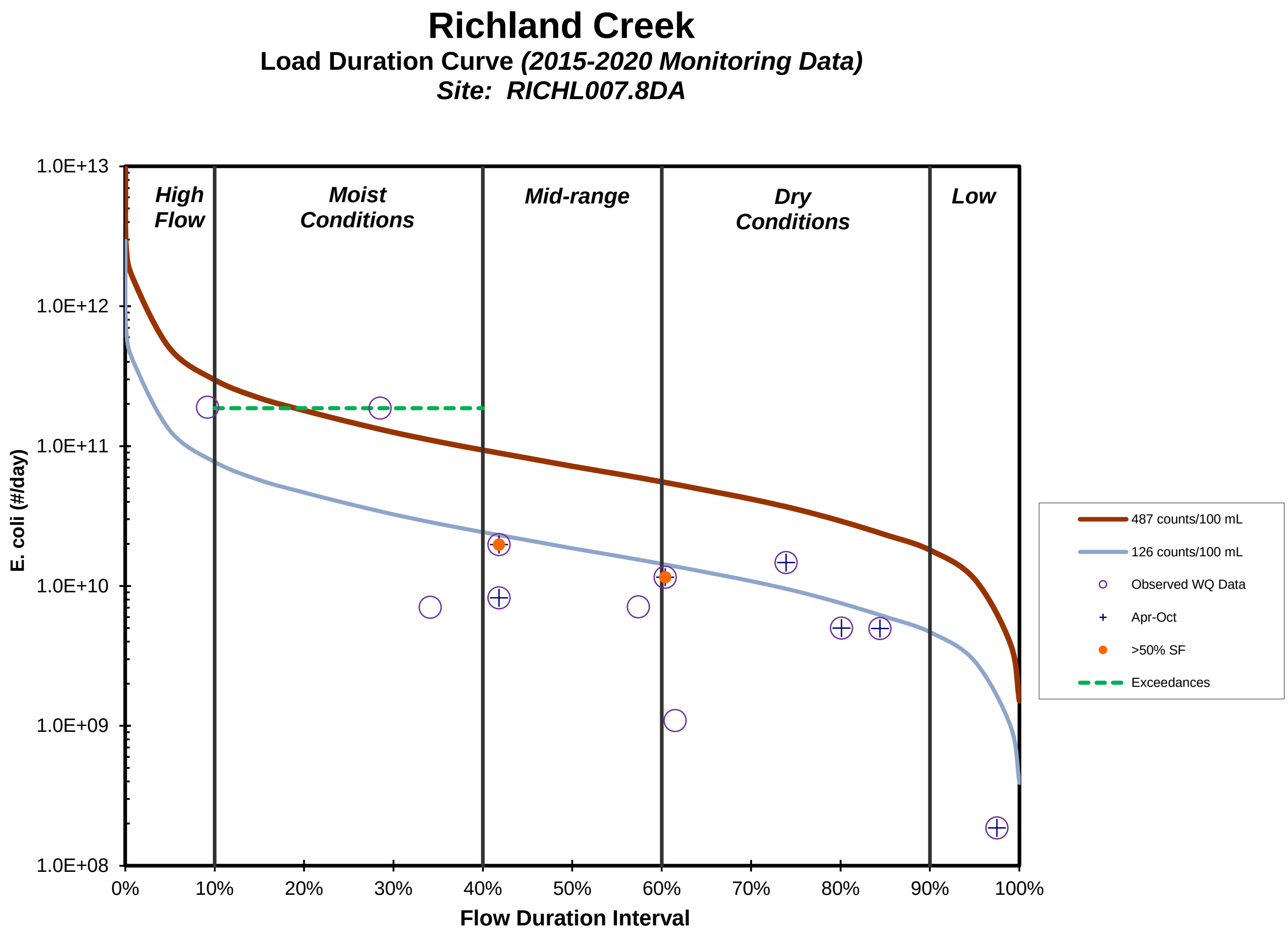


Figure E-23. *E. coli* Load Duration Curve for Richland Creek – RM 7.8

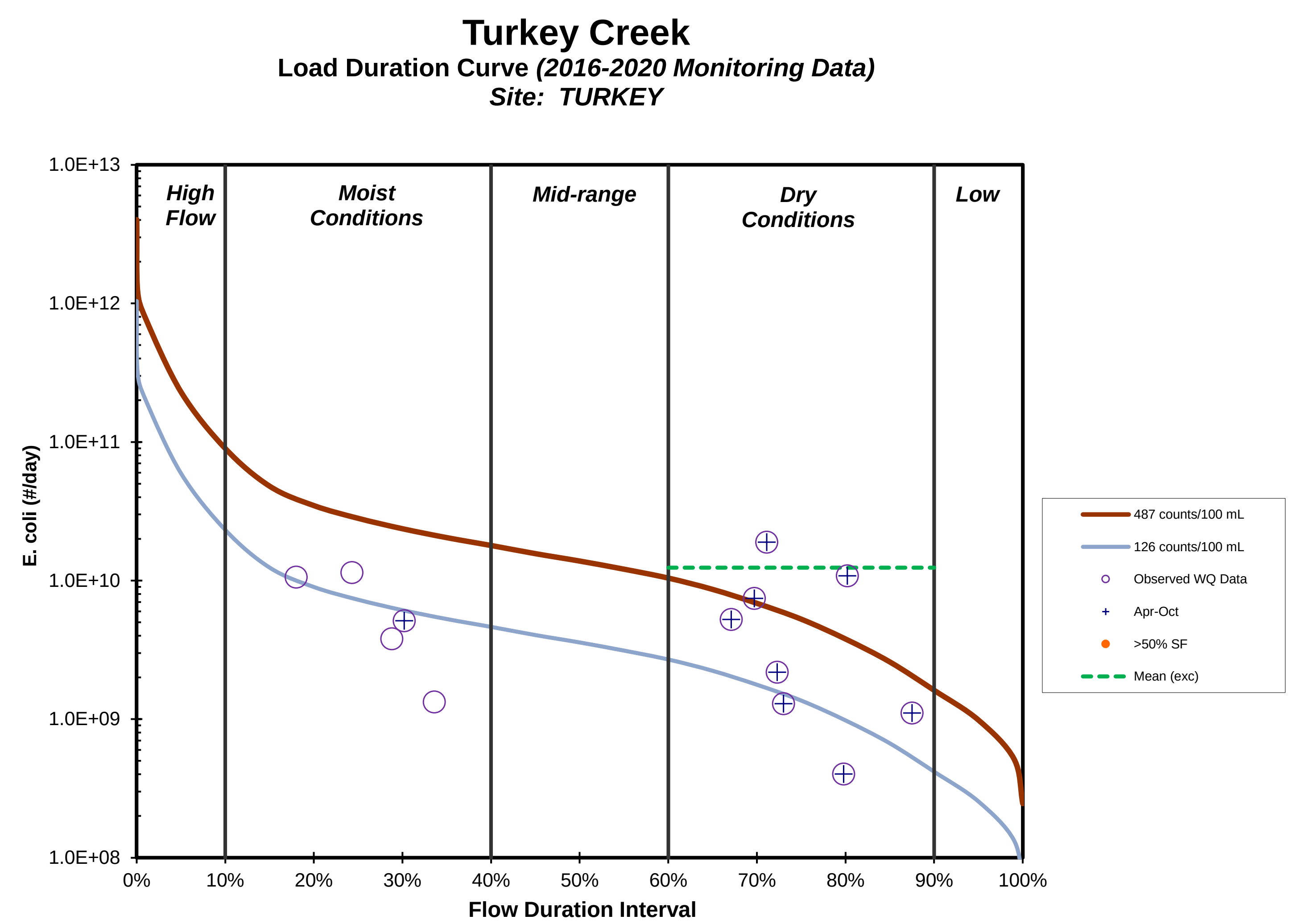


Figure E-24. ***E. coli*** **Load Duration Curve for Turkey Creek – Turkey**

Table E-4. Calculated Load Reduction Based on Daily Loading – Blue Spring 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]	[%]		[%]	[%]
8/25/20	Mid-Range Flows	6.80	50.5%	50	8.32E+09	NR	NR	**NR**	**NR**
8/4/20		5.65	58.5%	60	8.29E+09	NR	NR		
8/27/20	Dry Conditions	4.88	64.7%	33	3.94E+09	NR	NR	**NR**	**NR**
8/18/20		2.89	81.0%	93	6.58E+09	NR	NR		
8/19/20		2.65	83.5%	44	2.85E+09	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 Geomean Data – Blue Spring Creek– RM 0.5

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]	[%]	[%]
8/4/20	5.65	58.5%	60			
8/18/20	2.89	81.0%	93			
8/19/20	2.65	83.5%	44			
8/25/20	6.80	50.5%	50			
8/27/20	4.88	64.7%	33	**52.7**	**NR**	**NR**

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

Table E-6. Calculated Load Reduction Based on Daily Loading – Bosley Springs Branch – RM 0.4/Bosley

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]	[%]		[%]	[%]
8/1/16	Moist Conditions	4.49	24.7%	224.7	2.47E+10	NR	NR	61.1	65.0
5/26/16		3.51	30.8%	816	7.01E+10	NR	NR		
1/9/17		3.42	31.5%	727	6.09E+10	NR	NR		
1/25/17		3.27	32.8%	127.4	1.02E+10	NR	NR		
1/4/16		3.15	33.7%	816	6.29E+10	NR	NR		
1/26/17		2.87	36.4%	>2419.6	1.70E+11	**61.1**	**65.0**		
1/28/16		2.64	38.7%	68	4.40E+09	NR	NR		
9/2/20	Mid-Range Flows	2.49	40.7%	816	4.97E+10	NR	NR	61.1	65.0
10/14/20		2.44	41.2%	326	1.95E+10	NR	NR		
5/9/17		2.44	41.3%	387.3	2.31E+10	NR	NR		
5/11/17		1.74	52.7%	325.5	1.38E+10	NR	NR		
5/31/17		1.73	52.8%	>2419.6	1.02E+11	**61.1**	**65.0**		
1/30/17		1.72	52.9%	>2419.6	1.02E+11	**61.1**	**65.0**		
5/16/17		1.67	53.9%	435.2	1.78E+10	NR	NR		
7/19/16		1.59	55.7%	613.1	2.38E+10	NR	NR		
5/17/17		1.41	59.8%	816.4	2.82E+10	NR	NR		
7/27/16		1.40	60.0%	116.2	3.98E+09	NR	NR		
2/1/17	Dry Conditions	1.32	61.9%	866.4	2.80E+10	NR	NR	**NR**	**2.2**
3/23/16		1.26	63.5%	135	4.16E+09	NR	NR		
7/16/20		0.879	74.8%	687	1.48E+10	NR	NR		
6/9/16		0.874	74.9%	162	3.47E+09	NR	NR		
8/16/16		0.728	79.5%	158.5	2.82E+09	NR	**2.2**		
7/26/16		0.697	80.5%	104.6	1.78E+09	NR	NR		

Table E-6 (cont'd). Calculated Load Reduction Based on Daily Loading – Bosley Springs Branch – RM 0.4/Bosley

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]	[%]		[%]	[%]
6/26/18	Low Flows	0.347	92.7%	816.4	6.92E+09	NR	NR	**NR**	**NR**
10/4/16		0.331	93.2%	162.4	1.32E+09	NR	NR		
10/5/16		0.301	94.0%	461.1	3.40E+09	NR	NR		
10/6/16		0.263	95.1%	410.6	2.64E+09	NR	NR		
4/21/16		0.179	97.5%	579	2.53E+09	NR	NR		
10/13/16		0.160	97.9%	547.5	2.15E+09	NR	NR		
10/25/16		0.135	98.3%	248.1	8.18E+08	NR	NR		

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

Table E-7. Calculated Load Reduction Based on Geomean Data – Bosley Springs Branch– RM 0.4/Bosley

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]	[%]	[%]
7/19/16	1.59	55.7%	613.1			
7/26/16	0.697	80.5%	104.6			
7/27/16	1.40	60.0%	116.2			
8/1/16	4.49	24.7%	224.7			
8/16/16	0.728	79.5%	158.5	**192.7**	**34.6%**	**41.3%**
10/4/16	0.331	93.2%	162.4			
10/5/16	0.301	94.0%	461.1			
10/6/16	0.263	95.1%	410.6			
10/13/16	0.160	97.9%	547.5			
10/25/16	0.135	98.3%	248.1	**334.3**	**62.3%**	**66.2%**
1/9/17	3.42	31.5%	727			
1/25/17	3.27	32.8%	127.4			
1/26/17	2.87	36.4%	>2419.6			
1/30/17	1.72	52.9%	>2419.6			
2/1/17	1.32	61.9%	866.4	**859.8**	**85.3%**	**86.9%**
5/9/17	2.44	41.3%	387.3			
5/11/17	1.74	52.7%	325.5			
5/16/17	1.67	53.9%	435.2			
5/17/17	1.41	59.8%	816.4			
5/31/17	1.73	52.8%	>2419.6	**641.2**	**80.3%**	**82.4%**

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

Table E-8. Calculated Load Reduction Based on Daily Loading – Browns Creek – RM 0.4/Browns 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]	[%]		[%]	[%]
7/12/16	Moist Conditions	26.5	29.9%	193.5	1.25E+11	NR	NR	**NR**	**NR**
1/24/17		25.7	30.5%	148.3	9.33E+10	NR	NR		
1/9/17		23.2	33.3%	238.2	1.35E+11	NR	NR		
7/13/16		22.7	33.9%	222.4	1.24E+11	NR	NR		
7/14/16		19.6	37.8%	152.9	7.32E+10	NR	NR		
1/26/17		19.5	37.9%	93.4	4.45E+10	NR	NR		
5/9/17	Mid-Range Flows	16.3	42.9%	2419.6	9.64E+11	**61.1**	**65.0**	**51.3**	**56.1**
5/10/17		13.5	48.7%	1203.3	3.99E+11				
7/18/16		12.2	52.1%	472.1	1.41E+11	NR	NR		
1/12/16		11.3	55.0%	93	2.57E+10	NR	NR		
5/16/17		11.1	55.5%	>2419.6	6.57E+11	**61.1**	**65.0**		
1/31/17		10.2	58.1%	69.7	1.74E+10	NR	NR		
6/1/17		9.85	59.4%	>2419.6	5.83E+11	**61.1**	**65.0**		
2/1/17	Dry Conditions	8.88	62.7%	42	9.12E+09	NR	NR	**49.9**	**54.9**
5/18/17		7.80	66.7%	>2419.6	4.62E+11	**61.1**	**65.0**		
5/18/16		7.49	68.1%	1300	2.38E+11				
7/26/16		4.65	80.7%	238.2	2.71E+10	NR	NR		
6/14/16		3.08	88.9%	2420	1.82E+11	**61.1**	**65.0**		

Table E-8 (cont'd). Calculated Load Reduction Based on Daily Loading – Browns Creek – RM 0.4/Browns 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]	[%]		[%]	[%]
7/23/20	Low Flows	2.83	90.4%	2420	1.68E+11	**61.1**	**65.0**	**61.1**	**65.0**
10/5/16		1.99	94.0%	249.5	1.22E+10	NR	NR		
10/6/16		1.74	95.1%	410.6	1.75E+10	NR	NR		
4/19/16		1.68	95.3%	84	3.46E+09	NR	NR		
10/11/16		1.31	96.9%	238.2	7.62E+09	NR	NR		
10/25/16		0.894	98.3%	285.1	6.24E+09	NR	NR		
10/17/16		0.736	98.7%	344.8	6.21E+09	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 Geomean Data – Browns Creek– RM 0.4/Browns 1

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
7/12/16	26.5	29.9%	193.5			
7/13/16	22.7	33.9%	222.4			
7/14/16	19.6	37.8%	152.9			
7/18/16	12.2	52.1%	472.1			
7/26/16	4.65	80.7%	238.2	**236.5**	**46.7%**	**52.2%**
10/5/16	1.99	94.0%	249.5			
10/6/16	1.74	95.1%	410.6			
10/11/16	1.31	96.9%	238.2			
10/17/16	0.736	98.7%	344.8			
10/25/16	0.894	98.3%	285.1	**299.2**	**57.9%**	**62.2%**
1/9/17	23.2	33.3%	238.2			
1/24/17	25.7	30.5%	148.3			
1/26/17	19.5	37.9%	93.4			
1/31/17	10.2	58.1%	69.7			
2/1/17	8.88	62.7%	42	**99.3**	**NR**	**NR**
5/9/17	16.3	42.9%	2419.6			
5/10/17	13.5	48.7%	1203.3			
5/16/17	11.1	55.5%	>2419.6			
5/18/17	7.80	66.7%	>2419.6			
6/1/17	9.85	59.4%	>2419.6	**2104.1**	**94.0%**	**94.6%**

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

Table E-10. Calculated Load Reduction Based on Daily Loading – Cooper Creek – RM 1.5/Cooper

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]	[%]		[%]	[%]
2/21/18	Moist Conditions	4.87	14.9%	69.1	8.23E+09	NR	NR		
4/19/18		2.51	29.2%	47.4	2.91E+09	NR	NR		
11/15/17		2.19	33.1%	275.5	1.47E+10	NR	NR	**NR**	**NR**
8/10/17	Mid-Range Flows	1.42	46.6%	273.3	9.51E+09	NR	NR	**NR**	**NR**
1/31/18	Dry Conditions	0.912	61.9%	52.9	1.18E+09	NR	NR		
7/19/17		0.894	62.5%	105	2.30E+09	NR	NR		
8/14/17		0.885	62.8%	290.9	6.30E+09	NR	NR		
8/21/17		0.701	70.3%	235.9	4.04E+09	NR	NR		
8/22/17		0.629	73.6%	209.8	3.23E+09	NR	NR		
6/14/18		0.615	74.2%	178.5	2.69E+09	NR	NR		
5/14/18		0.475	80.7%	248.1	2.88E+09	NR	NR		
12/13/17		0.461	81.5%	135.4	1.53E+09	NR	NR		
3/23/18		0.458	81.6%	98.8	1.11E+09	NR	NR		
9/28/17		0.445	82.3%	172.3	1.87E+09	NR	NR	**NR**	**NR**
8/1/17	Low Flows	0.186	94.8%	313	1.42E+09	NR	NR		
10/19/17		0.164	95.6%	172.2	6.93E+08	NR	NR	**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 Geomean Data – Cooper Creek– RM 1.5/Cooper

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
8/1/17	0.186	94.8%	313			
8/10/17	1.42	46.6%	273.3			
8/14/17	0.885	62.8%	290.9			
8/21/17	0.701	70.3%	235.9			
8/22/17	0.629	73.6%	209.8	**261.9**	**51.9%**	**56.8%**

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

Table E-12. Calculated Load Reduction Based on Daily Loading – Cumberland River/Cheatham Lake – RM 185.7

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]	B[CFU/day]	[%]	[%]	[%]	[%]
3/13/19	High Flows	120,000	0.2%	503.0	1.48E+15	**3.2**	**13.5**	**26.8**	**34.6**
2/27/19		116,000	0.3%	555.0	1.58E+15	**12.3**	**21.6**		
3/6/19		116,000	0.3%	129.0	3.66E+14	NR	NR		
1/2/19		93,900	0.9%	2420	5.56E+15	**79.9**	**82.0**		
2/19/19		95,900	0.9%	548.0	1.29E+15	**11.1**	**20.6**		
3/20/19		77,100	2.0%	34.0	6.41E+13	NR	NR		
2/13/19		66,600	3.8%	673.0	1.10E+15	**27.6**	**35.4**		
1/8/19		65,200	4.2%	162	2.58E+14	NR	NR		
1/23/19		59,500	6.0%	270.0	3.93E+14	NR	NR		
3/27/19	Moist Conditions	51,900	10.2%	7.0	8.89E+12	NR	NR		
2/6/19		51,700	10.4%	8.0	1.01E+13	NR	NR		
1/17/19		50,000	11.8%	15.0	1.83E+13	NR	NR		
11/7/18		47,500	13.6%	210	2.44E+14	NR	NR		
11/19/18		46,200	14.7%	194.0	2.19E+14	NR	NR		
12/19/18		45,000	15.9%	172	1.89E+14	NR	NR		
12/26/18		44,300	16.6%	59.0	6.39E+13	NR	NR		
4/17/19		41,900	18.9%	206.0	2.11E+14	NR	NR		
12/5/18		40,900	20.1%	192	1.92E+14	NR	NR		
4/10/19		40,800	20.3%	59.0	5.89E+13	NR	NR		
4/24/19		40,300	20.8%	79.0	7.79E+13	NR	NR		
12/13/18		39,200	22.1%	40.0	3.84E+13	NR	NR		
10/3/18		37,900	23.1%	63.0	5.84E+13	NR	NR		
6/25/19		35,600	25.6%	47.0	4.09E+13	NR	NR		
6/26/19		35,600	25.6%	25.0	2.18E+13	NR	NR		
11/28/18		33,800	27.4%	22	1.82E+13	NR	NR		

Table E-12 (cont'd). Calculated Load Reduction Based on Daily Loading – Cumberland River/Cheatham Lake – RM 185.7

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]	B[CFU/day]	[%]	[%]	[%]	[%]
4/3/19	Moist Conditions (cont'd)	32,900	28.3%	4.0	3.22E+12	NR	NR	**NR**	**NR**
11/14/18		30,900	30.8%	61	4.61E+13	NR	NR		
6/2/20		29,800	31.9%	32	2.33E+13	NR	NR		
10/17/18		28,500	33.2%	135	9.41E+13	NR	NR		
9/26/18		28,100	33.7%	399.0	2.74E+14	NR	NR		
10/10/18		25,100	36.7%	16	9.83E+12	NR	NR		
5/8/19		23,000	39.1%	4.0	2.25E+12	NR	NR		
8/30/17	Mid-Range Flows	17,700	46.2%	6	2.60E+12	NR	NR	**79.9**	**82.0**
5/1/19		17,600	46.4%	5.0	2.15E+12	NR	NR		
5/15/19		17,600	46.4%	12	5.17E+12	NR	NR		
5/15/19		17,600	46.4%	8.0	3.44E+12	NR	NR		
6/19/19		16,700	47.8%	73	2.98E+13	NR	NR		
7/17/18		15,700	50.0%	82	3.15E+13	NR	NR		
6/6/18		15,400	50.8%	4	1.51E+12	NR	NR		
6/14/18		15,400	50.8%	18	6.78E+12	NR	NR		
7/18/18		15,400	50.8%	38	1.43E+13	NR	NR		
7/30/20		15,200	51.4%	36	1.34E+13	NR	NR		
8/10/16		13,700	56.3%	16	5.36E+12	NR	NR		
6/12/19		13,700	56.3%	99.0	3.32E+13	NR	NR		
6/27/18		13,500	57.1%	2420	7.99E+14	**79.9**	**82.0**		
7/12/18		13,200	58.1%	5	1.61E+12	NR	NR		
8/28/18		13,000	58.7%	17	5.41E+12	NR	NR		
8/8/18		12,800	59.2%	14	4.38E+12	NR	NR		

Table E-12 (cont'd). Calculated Load Reduction Based on Daily Loading – Cumberland River/Cheatham Lake – RM 185.7

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]	B[CFU/day]	[%]	[%]	[%]	[%]
8/15/18	Dry Conditions	11,800	62.5%	25	7.22E+12	NR	NR	**NR**	**NR**
8/1/18		11,400	64.0%	6	1.67E+12	NR	NR		
7/25/18		11,300	64.3%	11	3.04E+12	NR	NR		
9/12/18		11,100	65.1%	121	3.29E+13	NR	NR		
6/20/17		10,900	65.8%	93	2.48E+13	NR	NR		
6/19/18		10,900	65.8%	74	1.97E+13	NR	NR		
9/4/19		10,900	65.8%	72	1.92E+13	NR	NR		
9/11/19		10,900	65.8%	120.0	3.20E+13	NR	NR		
9/5/18		10,800	66.3%	10	2.64E+12	NR	NR		
5/22/19		10,800	66.3%	4.0	1.06E+12	NR	NR		
7/2/18		10,700	66.7%	15	3.93E+12	NR	NR		
6/21/18		10,600	67.1%	26	6.74E+12	NR	NR		
6/5/19		10,000	69.1%	11.0	2.69E+12	NR	NR		
10/22/18		9,460	70.9%	22	5.09E+12	NR	NR		
9/19/19		9,000	73.0%	8	1.76E+12	NR	NR		
6/15/16		8,900	73.6%	60	1.31E+13	NR	NR		
9/19/18		7,410	80.4%	86.0	1.56E+13	NR	NR		
9/24/19		6,280	85.4%	8.0	1.23E+12	NR	NR		
9/26/19		6,260	85.6%	399.0	6.11E+13	NR	NR		

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

Table E-13. Calculated Load Reduction Based on Daily Loading – Davidson Branch – RM 0.4/Davidson

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]	[%]		[%]	[%]
7/29/20	Moist Conditions	8.10	10.5%	517	1.02E+11	NR	NR	**NR**	**NR**
1/9/17		3.63	27.9%	39.3	3.49E+09	NR	NR		
1/25/17		3.48	29.2%	74.9	6.38E+09	NR	NR		
1/26/17		3.05	33.2%	71.2	5.31E+09	NR	NR		
5/9/17		2.60	38.3%	66.3	4.22E+09	NR	NR		
5/9/17		2.60	38.3%	79.4	5.05E+09	NR	NR		
8/1/16	Mid-Range Flows	2.33	42.1%	248.9	1.42E+10	NR	NR	**NR**	**NR**
8/1/16		2.33	42.1%	161.6	9.21E+09	NR	NR		
5/11/17		1.85	50.9%	71.7	3.24E+09	NR	NR		
5/31/17		1.84	51.2%	83	3.73E+09	NR	NR		
1/30/17		1.83	51.3%	46.5	2.09E+09	NR	NR		
1/30/17		1.83	51.3%	40.2	1.80E+09	NR	NR		
5/16/17		1.78	52.6%	75.9	3.30E+09	NR	NR		
7/19/16		1.70	54.2%	410.6	1.71E+10	NR	NR		
8/4/20		1.56	57.3%	99	3.78E+09	NR	NR		
5/17/17		1.50	58.7%	74.3	2.73E+09	NR	NR		
6/28/17	Dry Conditions	1.42	60.6%	52	1.80E+09	NR	NR		
6/28/17		1.42	60.6%	43.5	1.51E+09	NR	NR		
2/1/17		1.41	60.9%	60.9	2.10E+09	NR	NR		
6/8/17		1.39	61.4%	285.1	9.70E+09	NR	NR		
8/6/20		1.26	64.8%	101	3.11E+09	NR	NR		
7/27/16		0.986	72.7%	110.6	2.67E+09	NR	NR		
7/7/20		0.945	74.0%	308	7.12E+09	NR	NR		

Table E-13 (cont'd). Calculated Load Reduction Based on Daily Loading – Davidson Branch – RM 0.4/Davidson

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]	[%]		[%]	[%]
7/8/20	Dry Conditions (cont'd)	0.834	77.3%	308	6.28E+09	NR	NR		
8/16/16		0.779	79.0%	248.9	4.74E+09	NR	NR		
7/26/16		0.744	80.1%	157.6	2.87E+09	NR	NR		
4/10/17		0.593	85.2%	95.9	1.39E+09	NR	NR	**NR**	**NR**
10/4/16	Low Flows	0.357	93.1%	129.6	1.13E+09	NR	NR		
10/5/16		0.323	93.9%	71.7	5.66E+08	NR	NR		
10/6/16		0.282	95.1%	1553.1	1.07E+10	**39.4**	**45.5**		
10/13/16		0.172	97.9%	36.4	1.53E+08	NR	NR		
10/25/16		0.145	98.3%	135.4	4.80E+08	NR	NR	**39.4**	**45.5**

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

Table E-14. Calculated Load Reduction Based on Geomean Data – Davidson Branch– RM 0.4/Davidson

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
7/19/16	1.70	54.2%	410.6			
7/26/16	0.744	80.1%	157.6			
7/27/16	0.986	72.7%	110.6			
8/1/16	2.33	42.1%	248.9			
8/16/16	0.779	79.0%	248.9	**213.5**	**41.0%**	**47.1%**

Table E-14 (cont'd). Calculated Load Reduction Based on Geomean Data – Davidson Branch– RM 0.4/Davidson

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
10/4/16	0.357	93.1%	129.6			
10/5/16	0.323	93.9%	71.7			
10/6/16	0.282	95.1%	1553.1			
10/13/16	0.172	97.9%	36.4			
10/25/16	0.145	98.3%	135.4	**148.1**	**14.9%**	**23.7%**
1/9/17	3.63	27.9%	39.3			
1/25/17	3.48	29.2%	74.9			
1/26/17	3.05	33.2%	71.2			
1/30/17	1.83	51.3%	46.5			
1/30/17	1.83	51.3%	40.2	**52.3**	**NR**	**NR**
2/1/17	1.41	60.9%	60.9	**53.7**	**NR**	**NR**
5/9/17	2.60	38.3%	79.4			
5/11/17	1.85	50.9%	71.7			
5/16/17	1.78	52.6%	75.9			
5/17/17	1.50	58.7%	74.3			
5/31/17	1.84	51.2%	83	**76.8**	**NR**	**NR**
6/8/17	1.39	61.4%	285.1	**95.5**	**NR**	**NR**
7/7/20	0.945	74.0%	308			
7/8/20	0.834	77.3%	308			
7/29/20	8.10	10.5%	517			
8/4/20	1.56	57.3%	99			
8/6/20	1.26	64.8%	101	**217.8**	**42.2%**	**48.1%**

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

Table E-15. Calculated Load Reduction Based on Daily Loading – Drake Branch – RM 0.2/Drakes

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]	[%]		[%]	[%]
2/21/18	Moist Conditions	7.88	10.5%	224.7	4.33E+10	NR	NR	**NR**	**NR**
4/19/18		4.06	24.6%	82.3	8.17E+09	NR	NR		
11/15/17		3.56	28.5%	43.5	3.79E+09	NR	NR		
8/10/17	Mid-Range Flows	2.35	42.6%	435.2	2.50E+10	NR	NR	**NR**	**NR**
8/4/20		1.66	56.0%	308	1.25E+10	NR	NR		
1/31/18	Dry Conditions	1.50	60.1%	44.1	1.62E+09	NR	NR	**61.1**	**65.0**
8/14/17		1.47	60.7%	2419.6	8.68E+10	**61.1**	**65.0**		
8/27/20		1.45	61.0%	261	9.28E+09	NR	NR		
7/19/17		1.43	61.4%	325.5	1.14E+10	NR	NR		
8/21/17		1.17	68.7%	61.3	1.75E+09	NR	NR		
8/22/17		1.05	72.1%	579.4	1.49E+10	NR	NR		
6/14/18		0.917	76.0%	816.4	1.83E+10	NR	NR		
5/14/18		0.805	79.2%	307.6	6.06E+09	NR	NR		
12/13/17		0.767	80.6%	7.5	1.41E+08	NR	NR		
3/23/18		0.764	80.7%	98.8	1.85E+09	NR	NR		
9/28/17		0.738	81.4%	129.1	2.33E+09	NR	NR		
8/1/17	Low Flows	0.304	94.9%	209.9	1.56E+09	NR	NR	**NR**	**NR**
10/19/17		0.275	95.6%	166.4	1.12E+09	NR	NR		

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

Table E-16. Calculated Load Reduction Based on Geomean Data – Drake Branch– RM 0.2/Drakes

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]	[%]	[%]
8/1/17	0.304	94.9%	209.9			
8/10/17	2.35	42.6%	435.2			
8/14/17	1.47	60.7%	2419.6			
8/21/17	1.17	68.7%	61.3			
8/22/17	1.05	72.1%	579.4	**379.3**	**66.8%**	**70.2%**

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

Table E-17. Calculated Load Reduction Based on Daily Loading – Dry 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]	B[CFU/day]	[%]		[%]	[%]
2/29/16	Moist Conditions	13.6	32.6%	132	4.40E+10	NR	NR	**NR**	**NR**
3/9/16	Mid-Range Flows	8.22	49.7%	186	3.74E+10	NR	NR	**NR**	**NR**
1/13/16		6.51	58.1%	41	6.53E+09	NR	NR		
9/8/20	Dry Conditions	6.08	60.4%	194	2.89E+10	NR	NR	**61.1**	**65.0**
8/6/20		5.30	65.2%	228	2.96E+10	NR	NR		
7/8/20		3.52	77.4%	435	3.75E+10	NR	NR		
5/5/16		2.71	83.7%	2420	1.60E+11	**61.1**	**65.0**		
6/1/16		2.21	87.7%	54	2.92E+09	NR	NR		
4/20/16	Low Flows	0.984	96.4%	219	5.27E+09	NR	NR	**NR**	**NR**

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

Table E-18. Calculated Load Reduction Based on Daily Loading – Ewing Creek – RM 0.8/Ewing

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]	[%]		[%]	[%]
2/21/18	Moist Conditions	49.3	13.5%	248.9	3.00E+11	NR	NR	61.1	65.0
4/19/18		25.1	28.2%	127.4	7.83E+10	NR	NR		
11/15/17		22.0	31.9%	80.1	4.31E+10	NR	NR		
2/23/16		20.8	33.4%	248	1.26E+11	NR	NR		
1/5/16		19.3	35.9%	2420	1.14E+12	**61.1**	**65.0**		
8/10/17	Mid-Range Flows	14.3	45.7%	126.8	4.45E+10	NR	NR	**NR**	**NR**
11/26/18		14.0	46.6%	115.3	3.94E+10	NR	NR		
8/30/18		11.8	52.8%	33.6	9.71E+09	NR	NR		
3/22/16		10.1	58.1%	161	4.00E+10	NR	NR		
9/8/20	Dry Conditions	9.37	60.7%	308	7.06E+10	NR	NR		
1/31/18		9.15	61.6%	33.2	7.43E+09	NR	NR		
7/19/17		8.94	62.3%	96	2.10E+10	NR	NR		
8/14/17		8.92	62.5%	387.3	8.45E+10	NR	NR		
8/6/20		8.12	65.7%	219	4.35E+10	NR	NR		
4/27/16		7.88	66.6%	345	6.65E+10	NR	NR		
8/21/17		7.08	69.9%	378.4	6.55E+10	NR	NR		
8/22/17		6.35	73.2%	228.2	3.55E+10	NR	NR		
6/14/18		6.09	74.6%	151.5	2.26E+10	NR	NR		
7/8/20		5.38	77.7%	285	3.75E+10	NR	NR		
8/15/18		4.90	80.0%	81.6	9.78E+09	NR	NR		
5/14/18		4.86	80.2%	104.6	1.24E+10	NR	NR		
8/8/18		4.69	81.1%	9.7	1.11E+09	NR	NR		
12/13/17		4.65	81.3%	4.1	4.66E+08	NR	NR		
5/4/16		4.63	81.4%	249	2.82E+10	NR	NR		
3/23/18		4.63	81.4%	98.5	1.12E+10	NR	NR		

Table E-18 (cont'd). Calculated Load Reduction Based on Daily Loading – Ewing Creek – RM 0.8/Ewing

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]	[%]		[%]	[%]
9/28/17	Dry Conditions (cont'd)	4.50	82.0%	231.0	2.54E+10	NR	NR		
9/4/18		3.20	88.8%	31.8	2.49E+09	NR	NR	**NR**	**NR**
9/5/18	Low Flows	2.92	90.3%	18.3	1.31E+09	NR	NR		
6/21/16		2.33	93.0%	261	1.49E+10	NR	NR		
8/1/17		1.89	94.8%	7.2	3.33E+08	NR	NR		
10/19/17		1.67	95.6%	30.9	1.26E+09	NR	NR	**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 Geomean Data – Ewing Creek– RM 0.8/Ewing

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
8/1/17	1.89	94.8%	7.2			
8/10/17	14.3	45.7%	126.8			
8/14/17	8.92	62.5%	387.3			
8/21/17	7.08	69.9%	378.4			
8/22/17	6.35	73.2%	228.2	**125.0**	**NR**	**9.6%**
8/8/18	4.69	81.1%	9.7			
8/15/18	4.90	80.0%	81.6			
8/30/18	11.8	52.8%	33.6			
9/4/18	3.20	88.8%	31.8			
9/5/18	2.92	90.3%	18.3	**27.4**	**NR**	**NR**

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

Table E-20. Calculated Load Reduction Based on Daily Loading – Holt Creek – RM 0.4/Holt

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]	[%]		[%]	[%]
2/29/16	Moist Conditions	4.23	30.6%	135	1.40E+10	NR	NR	**NR**	**NR**
3/9/16	Mid-Range Flows	3.08	41.7%	233	1.76E+10	NR	NR	**NR**	**NR**
1/13/16		2.87	44.4%	53	3.72E+09	NR	NR		
5/5/16	Dry Conditions	0.530	83.0%	197	2.56E+09	NR	NR	**NR**	**NR**
4/20/16		0.489	84.0%	260	3.11E+09	NR	NR		
6/1/16	Low Flows	0.193	93.7%	118	5.56E+08	NR	NR	**NR**	**NR**

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

Table E-21. Calculated Load Reduction Based on Daily Loading – Indian Creek – RM 0.4/Indian

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]	[%]		[%]	[%]
2/29/16	Moist Conditions	5.34	27.5%	166	2.17E+10	NR	NR	**NR**	**NR**
3/9/16		3.89	38.2%	108	1.03E+10	NR	NR		
10/13/20		3.76	39.6%	387	3.56E+10	NR	NR		
1/13/16	Mid-Range Flows	3.62	40.9%	167	1.48E+10	NR	NR	**NR**	**NR**
9/10/20	Dry Conditions	1.45	68.9%	99	3.51E+09	NR	NR	**NR**	**NR**
5/5/16		0.681	82.0%	111	1.85E+09	NR	NR		
4/20/16		0.620	83.2%	112	1.70E+09	NR	NR		
8/12/20	Low Flows	0.307	90.9%	291	2.19E+09	NR	NR	**15.9**	**24.9**
8/20/20		0.267	92.3%	579	3.78E+09	**15.9**	**24.9**		
6/1/16		0.220	94.3%	61	3.28E+08	NR	NR		

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

Table E-22. Calculated Load Reduction Based on Daily Loading – Manskers Creek – RM 2.8/Manskers 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]	[%]		[%]	[%]
4/5/18	High Flows	133	9.6%	238.2	7.72E+11	NR	NR	**NR**	**NR**
2/21/18	Moist Conditions	127	10.2%	120.1	3.74E+11	NR	NR		
11/15/17		57.9	28.0%	54.8	7.76E+10	NR	NR	**NR**	**NR**
8/25/20	Mid-Range Flows	40.5	40.2%	770	7.63E+11	NR	NR		
8/10/17		38.7	42.1%	727	6.88E+11	NR	NR		
5/9/18		36.6	44.4%	261.3	2.34E+11	NR	NR		
8/4/20		27.0	55.6%	770	5.09E+11	NR	NR		
1/31/18		24.4	59.4%	39.7	2.37E+10	NR	NR	**NR**	**NR**
8/14/17	Dry Conditions	23.8	60.1%	579.4	3.38E+11	NR	NR		
8/27/20		23.7	60.4%	461	2.67E+11	NR	NR		
7/20/17		20.2	66.4%	79.5	3.94E+10	NR	NR		
8/22/17		17.1	71.9%	85.4	3.58E+10	NR	NR		
6/14/18		15.1	75.8%	148.3	5.47E+10	NR	NR		
8/30/17		13.7	78.0%	109	3.66E+10	NR	NR		
3/23/18		12.6	80.2%	290.9	8.95E+10	NR	NR		
12/13/17		12.5	80.5%	19.9	6.07E+09	NR	NR		
8/18/20		12.5	80.5%	248	7.57E+10	NR	NR		
9/28/17		12.1	81.3%	111.8	3.30E+10	NR	NR		
8/19/20		11.3	82.7%	326	8.98E+10	NR	NR	**NR**	**NR**
10/19/17	Low Flows	4.49	95.6%	298.7	3.28E+10	NR	NR		
8/2/17		4.39	95.8%	93.4	1.00E+10	NR	NR	**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 Geomean Data – Manskers Creek– RM 2.8/Manskers 1

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]	[%]	[%]
8/2/17	4.39	95.8%	93.4			
8/10/17	38.7	42.1%	727			
8/14/17	23.8	60.1%	579.4			
8/22/17	17.1	71.9%	85.4			
8/30/17	13.7	78.0%	109	**205.5**	**38.7%**	**45.0%**
8/4/20	27.0	55.6%	770			
8/18/20	12.5	80.5%	248			
8/19/20	11.3	82.7%	326			
8/25/20	40.5	40.2%	770			
8/27/20	23.7	60.4%	461	**466.5**	**73.0%**	**75.8%**

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

Table E-24. Calculated Load Reduction Based on Daily Loading – Mill Creek – RM 9.6/Mill 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]	[%]		[%]	[%]
12/4/19	Moist Conditions	100	21.9%	133.4	3.27E+11	NR	NR		
2/28/20		72.0	29.3%	325.5	5.73E+11	NR	NR		
4/22/20		63.8	32.6%	436.0	6.80E+11	NR	**0.2**		
1/23/20		60.1	34.3%	111.9	1.65E+11	NR	NR		
2/23/16		59.8	34.4%	1553.1	2.27E+12	**68.6**	**72.0**		
11/26/19		53.5	38.1%	39.5	5.17E+10	NR	NR	**68.6**	**36.1**
1/12/16	Mid-Range Flows	47.6	42.1%	64	7.45E+10	NR	NR		
7/9/19		40.8	48.0%	93.4	9.31E+10	NR	NR	**NR**	**NR**
7/26/19	Dry Conditions	22.9	66.9%	190.4	1.07E+11	NR	NR		
8/29/19		18.0	72.3%	73.3	3.23E+10	NR	NR		
7/10/19		17.9	72.4%	46.5	2.04E+10	NR	NR		
7/29/19		16.3	74.3%	83.9	3.36E+10	NR	NR		
10/24/19		10.8	80.9%	77.1	2.03E+10	NR	NR		
7/16/19		10.1	81.9%	48.8	1.21E+10	NR	NR		
4/19/16		7.84	85.7%	36	6.90E+09	NR	NR		
5/18/16		7.72	86.0%	260	4.91E+10	NR	NR	**NR**	**NR**
5/26/20	Low Flows	5.51	90.6%	387.3	5.22E+10	NR	NR		
4/26/16		5.21	91.2%	12.0	1.53E+09	NR	NR		
6/14/16		4.20	93.3%	2420	2.49E+11	**79.9**	**82.0**		
9/24/19		2.88	96.4%	157.3	1.11E+10	NR	NR		
6/15/20		2.38	97.6%	14.4	8.39E+08	NR	NR	**79.9**	**82.0**

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

Table E-25. Calculated Load Reduction Based on Geomean Data – Mill Creek– RM 9.6/Mill 3

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
7/9/19	40.8	48.0%	93.4			
7/10/19	17.9	72.4%	46.5			
7/16/19	10.1	81.9%	48.8			
7/26/19	22.9	66.9%	190.4			
7/29/19	16.3	74.3%	83.9	**80.5**	**NR**	**NR**

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

Table E-26. Calculated Load Reduction Based on Daily Loading – Neeleys Branch – Neeley's Branch

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]	[%]		[%]	[%]
2/21/18	Moist Conditions	5.95	18.4%	248.1	3.61E+10	NR	NR		
4/19/18		3.06	31.7%	387.3	2.90E+10	NR	NR		
11/15/17		2.68	35.2%	107.1	7.01E+09	NR	NR		
9/11/17		2.47	37.5%	157.6	9.50E+09	NR	NR	**NR**	**NR**
8/10/17	Mid-Range Flows	1.74	47.6%	488.4	2.08E+10	NR	NR		
9/18/17		1.65	49.5%	110.0	4.44E+09	NR	NR		
9/19/17		1.43	54.5%	290.9	1.02E+10	NR	NR	**NR**	**NR**
1/31/18	Dry Conditions	1.12	62.5%	206.4	5.64E+09	NR	NR		
8/14/17		1.09	63.4%	>2419.6	6.43E+10	**61.1**	**65.0**		
8/20/19		0.971	67.1%	129.6	3.08E+09	NR	NR		
7/20/17		0.953	67.7%	770.1	1.80E+10	NR	NR		
8/21/17		0.862	70.6%	218.7	4.61E+09	NR	NR		
8/22/17		0.774	73.9%	152.9	2.89E+09	NR	NR		
6/14/18		0.757	74.5%	816.4	1.51E+10	NR	NR		
8/22/19		0.759	74.5%	129.6	2.41E+09	NR	NR		
5/14/18		0.584	80.8%	365.4	5.22E+09	NR	NR		
12/13/17		0.566	81.6%	93.2	1.29E+09	NR	NR		
3/23/18		0.561	81.8%	344.8	4.73E+09	NR	NR		
9/28/17		0.547	82.3%	248.9	3.33E+09	NR	NR	**61.1**	**65.0**
8/2/17	Low Flows	0.202	95.6%	152.9	7.57E+08	NR	NR		
10/19/17		0.202	95.7%	104.6	5.16E+08	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 Geomean Data – Neeleys Branch – Neeley's Branch

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
8/2/17	0.202	95.6%	152.9			
8/10/17	1.74	47.6%	488.4			
8/14/17	1.09	63.4%	>2419.6			
8/21/17	0.862	70.6%	218.7			
8/22/17	0.774	73.9%	152.9	**359.9**	**65.0**	**68.6**
9/11/17	2.47	37.5%	157.6			
9/18/17	1.65	49.5%	110.0			
9/19/17	1.43	54.5%	290.9	**176.0**	**28.4**	**35.8**

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

Table E-28. Calculated Load Reduction Based on Daily Loading – Overall Creek – 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]	[%]		[%]	[%]
7/29/20	Moist Conditions	11.13	20.6%	1120	3.05E+11	**16.0**	**24.4**	**16.0**	**24.4**
8/4/20	Mid-Range Flows	4.02	55.1%	147	1.45E+10	NR	NR	**NR**	**NR**
8/6/20	Dry Conditions	3.24	63.3%	116	9.21E+09	NR	NR		
7/7/20		2.44	73.0%	1733	1.04E+11	**45.7**	**51.1**		
7/8/20		2.16	76.4%	162	8.55E+09	NR	NR	**45.7**	**51.1**

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

Table E-29. Calculated Load Reduction Based on Geomean Data – Overall Creek– RM 1.3

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]	[%]	[%]
7/9/19	40.8	48.0%	93.4			
7/10/19	17.9	72.4%	46.5			
7/16/19	10.1	81.9%	48.8			
7/26/19	22.9	66.9%	190.4			
7/29/19	16.3	74.3%	83.9	**80.5**	**NR**	**NR**

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

Table E-30. Calculated Load Reduction Based on Daily Loading – Pages Branch – Pages Branch

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]	[%]		[%]	[%]
2/21/18	Moist Conditions	4.28	15.8%	261.3	2.73E+10	NR	NR		
4/19/18		2.20	29.6%	111.2	5.99E+09	NR	NR		
11/15/17		1.94	33.3%	42.6	2.03E+09	NR	NR	**NR**	**NR**
8/10/17	Mid-Range Flows	1.27	46.4%	365.4	1.13E+10	NR	NR	**NR**	**NR**
1/31/18	Dry Conditions	0.808	61.8%	42.8	8.46E+08	NR	NR		
7/19/17		0.793	62.5%	307.6	5.97E+09	NR	NR		
8/14/17		0.789	62.6%	488.4	9.43E+09	NR	NR		
8/21/17		0.627	70.1%	63.8	9.78E+08	NR	NR		
8/22/17		0.563	73.4%	73.3	1.01E+09	NR	NR		
6/14/18		0.541	74.7%	325.5	4.31E+09	NR	NR		
5/14/18		0.428	80.4%	270.0	2.83E+09	NR	NR		
12/13/17		0.411	81.4%	98.8	9.95E+08	NR	NR		
3/23/18		0.407	81.7%	78.0	7.77E+08	NR	NR		
9/28/17		0.398	82.2%	51.2	4.99E+08	NR	NR	**NR**	**NR**
8/1/17	Low Flows	0.167	94.8%	110	4.49E+08	NR	NR		
10/19/17		0.147	95.7%	45.9	1.65E+08	NR	NR	**NR**	**NR**

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

Table E-31. Calculated Load Reduction Based on Geomean Data – Pages Branch – Pages Branch

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]	[%]	[%]
8/1/17	0.167	94.8%	110			
8/10/17	1.27	46.4%	365.4			
8/14/17	0.789	62.6%	488.4			
8/21/17	0.627	70.1%	63.8			
8/22/17	0.563	73.4%	73.3	**155.8**	**19.1**	**27.5**

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

Table E-32. Calculated Load Reduction Based on Daily Loading – Pavillion Branch – Pavillion

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]	[%]		[%]	[%]
2/22/16	Moist Conditions	1.22	32.8%	137.6	4.10E+09	NR	NR		
2/29/16		1.06	36.4%	166.4	4.31E+09	NR	NR	**NR**	**NR**
3/1/16	Mid-Range Flows	0.913	40.5%	129.6	2.89E+09	NR	NR		
3/7/16		0.865	42.1%	139.6	2.95E+09	NR	NR		
9/21/20		0.834	43.2%	686.7	1.40E+10	**29.1**	**36.7**		
10/15/20		0.753	46.2%	461.1	8.50E+09	NR	**5.7**		
3/8/16		0.739	46.8%	159.7	2.89E+09	NR	NR	**29.1**	**21.2**
8/26/20	Dry Conditions	0.489	60.5%	517.2	6.18E+09				
8/6/20		0.407	66.6%	290.9	2.90E+09	NR	NR		
7/15/20		0.342	72.0%	816.4	6.84E+09				
7/16/20		0.304	75.3%	770.1	5.73E+09				
11/9/20		0.209	83.9%	193.5	9.92E+08	NR	NR		
7/20/20		0.189	85.9%	816.4	3.78E+09				
7/21/20		0.169	88.1%	387.3	1.60E+09	NR	NR	**30.8**	**38.2**
5/9/16	Low Flows	0.117	93.0%	770.1	2.21E+09	**36.8**	**43.5**		
4/19/16		0.088	95.3%	72.4	1.56E+08	NR	NR		
4/25/16		0.082	95.7%	410.6	8.28E+08	NR	NR		
5/16/16		0.078	96.3%	248.9	4.73E+08	NR	NR		
4/20/16		0.076	96.4%	67.9	1.26E+08	NR	NR	**36.8**	**43.5**

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

Table E-33. Calculated Load Reduction Based on Geomean Data – Pavillion Branch – Pavillion

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
2/22/16	1.22	32.8%	137.6			
2/29/16	1.06	36.4%	166.4			
3/1/16	0.913	40.5%	129.6			
3/7/16	0.865	42.1%	139.6			
3/8/16	0.739	46.8%	159.7	**145.9**	**13.7**	**22.6**
4/19/16	0.088	95.3%	72.4			
4/20/16	0.076	96.4%	67.9			
4/25/16	0.082	95.7%	410.6			
5/9/16	0.117	93.0%	770.1			
5/16/16	0.078	96.3%	248.9	**207.7**	**39.3**	**45.6**
7/15/20	0.342	72.0%	816.4			
7/16/20	0.304	75.3%	770.1			
7/20/20	0.189	85.9%	816.4			
7/21/20	0.169	88.1%	387.3			
8/6/20	0.407	66.6%	290.9	**565.5**	**77.7**	**80.0**

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

Table E-34. Calculated Load Reduction Based on Daily Loading – Richland Creek – Mile 2.0&2.2/Richland 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]	[%]		[%]	[%]
8/1/16	Moist Conditions	40.7	20.6%	80.8	8.05E+10	NR	NR	**NR**	**0.2**
5/26/16		30.3	26.9%	866	6.43E+11	NR	**0.2**		
11/20/18		25.0	31.4%	121.1	7.40E+10	NR	NR		
1/9/17		23.2	33.3%	38.4	2.18E+10	NR	NR		
1/25/17		22.4	34.2%	88.6	4.86E+10	NR	NR		
1/4/16		21.9	34.9%	435	2.33E+11	NR	NR		
8/30/18		20.4	36.8%	33.3	1.66E+10	NR	NR		
1/26/17		19.5	37.9%	65	3.10E+10	NR	NR		
1/28/16	Mid-Range Flows	17.7	40.5%	46	1.99E+10	NR	NR	**NR**	**NR**
5/9/17		16.3	42.9%	261.3	1.04E+11	NR	NR		
9/3/20		15.0	45.4%	517	1.90E+11	NR	NR		
1/30/17		11.6	53.9%	90.6	2.57E+10	NR	NR		
5/11/17		11.5	54.4%	435.2	1.23E+11	NR	NR		
7/27/16		11.5	54.5%	82.0	2.30E+10	NR	NR		
5/16/17		11.1	55.5%	648.8	1.76E+11	NR	NR		
7/19/16		10.7	56.6%	61.2	1.60E+10	NR	NR		
6/1/17		9.85	59.4%	435.2	1.05E+11	NR	NR		
5/17/17	Dry Conditions	9.32	61.1%	214.2	4.88E+10	NR	NR		
2/1/17		8.88	62.7%	48.7	1.06E+10	NR	NR		
6/28/17		8.80	63.0%	84.5	1.82E+10	NR	NR		
6/8/17		8.66	63.5%	260.3	5.51E+10	NR	NR		
3/23/16		8.53	64.0%	96	2.00E+10	NR	NR		
10/31/18		6.74	71.2%	122.2	2.01E+10	NR	NR		
9/12/18		6.38	72.9%	461.1	7.19E+10	NR	NR		

Table E-34 (cont'd). Calculated Load Reduction Based on Daily Loading – Richland Creek – Mile 2.0&2.2/Richland 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]	[%]		[%]	[%]
6/9/16	Dry Conditions (cont'd)	5.77	75.7%	411	5.80E+10	NR	NR	33.4	40.1
9/13/18		5.62	76.5%	191.8	2.64E+10	NR	NR		
8/16/16		4.75	80.2%	1413.6	1.64E+11	**33.4**	**40.1**		
7/26/16		4.65	80.7%	116.0	1.32E+10	NR	NR		
4/10/17		3.70	85.6%	93.3	8.44E+09	NR	NR		
9/4/18		3.05	89.1%	124.6	9.28E+09	NR	NR		
7/23/20	Low Flows	2.83	90.4%	548	3.80E+10	NR	NR	**NR**	**NR**
9/5/18		2.78	90.7%	59.1	4.02E+09	NR	NR		
6/26/18		2.33	92.6%	190.4	1.09E+10	NR	NR		
10/4/16		2.20	93.1%	88.4	4.77E+09	NR	NR		
10/5/16		1.99	94.0%	86.2	4.20E+09	NR	NR		
10/6/16		1.74	95.1%	74.4	3.17E+09	NR	NR		
4/21/16		1.18	97.5%	108	3.13E+09	NR	NR		
10/13/16		1.05	97.9%	95.9	2.46E+09	NR	NR		
10/25/16		0.894	98.3%	75.9	1.66E+09	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 Geomean Data – Richland Creek – Mile 2.0&2.2/Richland 1

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
7/19/16	10.7	56.6%	61.2			
7/26/16	4.65	80.7%	116.0			
7/27/16	11.5	54.5%	82.0			
8/1/16	40.7	20.6%	80.8			
8/16/16	4.75	80.2%	1413.6	**146.1**	**13.7**	**22.6**
10/4/16	2.20	93.1%	88.4			
10/5/16	1.99	94.0%	86.2			
10/6/16	1.74	95.1%	74.4			
10/13/16	1.05	97.9%	95.9			
10/25/16	0.894	98.3%	75.9	**83.8**	**NR**	**NR**
1/9/17	23.2	33.3%	38.4			
1/25/17	22.4	34.2%	88.6			
1/26/17	19.5	37.9%	65			
1/30/17	11.6	53.9%	90.6			
2/1/17	8.88	62.7%	48.7	**62.8**	**NR**	**NR**
5/9/17	16.3	42.9%	261.3			
5/11/17	11.5	54.4%	435.2			
5/16/17	11.1	55.5%	648.8			
5/17/17	9.32	61.1%	214.2			
6/1/17	9.85	59.4%	435.2	**369.4**	**65.9**	**69.4**
6/8/17	8.66	63.5%	260.3	**369.1**	**65.9**	**69.4**
8/30/18	20.4	36.8%	33.3			
9/4/18	3.05	89.1%	124.6			
9/5/18	2.78	90.7%	59.1			
9/12/18	6.38	72.9%	461.1			
9/13/18	5.62	76.5%	191.8	**116.7**	**NR**	**3.2**

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

Table E-36. Calculated Load Reduction Based on Daily Loading – Richland Creek – Mile 7.8

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]	[%]		[%]	[%]
1/4/16	Moist Conditions	11.1	28.5%	687	1.87E+11	**29.1**	**36.7**	**29.1**	**36.7**
1/28/16		9.29	34.1%	31	7.05E+09	NR	NR		
9/2/20		8.94	35.4%	238	5.21E+10	NR	NR		
10/14/20		8.63	36.5%	61	1.29E+10	NR	NR		
5/26/16	Dry Conditions	4.62	60.4%	102	1.15E+10	NR	NR	**NR**	**NR**
3/23/16		4.47	61.5%	10	1.09E+09	NR	NR		
7/16/20		3.12	73.7%	36	2.74E+09	NR	NR		
6/9/16		3.09	73.9%	194	1.47E+10	NR	NR		
4/21/16	Low Flows	0.636	97.5%	12	1.87E+08	NR	NR	**NR**	**NR**

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

Table E-37. Calculated Load Reduction Based on Daily Loading – Turkey Creek – Turkey

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]	[%]		[%]	[%]
12/4/19	Moist Conditions	3.25	18.0%	133.3	1.06E+10	NR	NR	**NR**	**NR**
2/28/20		2.42	24.3%	193.5	1.14E+10	NR	NR		
1/23/20		2.06	28.8%	75.4	3.80E+09	NR	NR		
4/22/20		1.97	30.2%	106.7	5.13E+09	NR	NR		
11/26/19		1.79	33.6%	30.5	1.33E+09	NR	NR		
7/26/19	Dry Conditions	0.659	67.1%	325.5	5.24E+09	NR	NR	**29.1**	**36.7**
7/9/19		0.587	69.7%	517.2	7.43E+09	**5.8**	**15.9**		
8/29/19		0.548	71.1%	1413.6	1.90E+10	**65.5**	**69.2**		
7/10/19		0.517	72.3%	172.3	2.18E+09	NR	NR		
7/29/19		0.490	73.0%	108.1	1.30E+09	NR	NR		
7/16/19		0.321	79.8%	51.2	4.02E+08	NR	NR		
10/24/19		0.313	80.2%	1413.6	1.08E+10	**65.5**	**69.2**		
5/26/20		0.175	87.5%	259.5	1.11E+09	NR	NR		
6/15/20	Low Flows	0.073	96.0%	8.6	1.54E+07	NR	NR	**NR**	**NR**

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

Table E-38. Calculated Load Reduction Based on Geomean Data – Turkey Creek – Turkey

Sample Date	Flow	PDFE	Concentration	Geometric Mean	Calculated Reduction	
					to Target GM (126 CFU/100 mL)	to Target - MOS (113 CFU/100 mL)
	[cfs]	[%]	[CFU/100 ml]	[CFU/100 ml]	[%]	[%]
7/9/19	0.587	69.7%	517.2			
7/10/19	0.517	72.3%	172.3			
7/16/19	0.321	79.8%	51.2			
7/26/19	0.659	67.1%	325.5			
7/29/19	0.490	73.0%	108.1	**174.2**	**27.7**	**35.1**

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

Table E-39. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202)

Waterbody Description **(05130202____)**	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]
Holt Creek [e]	High Flows	0-10	18.5 – 226	44.9	NA	5.383E+11	1.143E+10		(1.833E+08) - (4.54E+6 x q_d)	(1.833E+08) - (4.54E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	3.23 – 18.5	5.16	NR	6.192E+10	3.524E+09		(2.109E+07) - (4.54E+6 x q_d)	(2.109E+07) - (4.54E+6 x q_d)
007_1100	Mid-Range	40-60	1.85 – 3.23	2.47	NR	2.964E+10	1.817E+09	1.2E+10 x q_m	(1.009E+07) - (4.54E+6 x q_d)	(1.009E+07) - (4.54E+6 x q_d)
	Dry Conditions	60-90	0.280 – 1.85	0.920	NR	1.104E+10	7.866E+09		(3.760E+06) - (4.54E+6 x q_d)	(3.760E+06) - (4.54E+6 x q_d)
HUC-12: 0101	Low Flows	90-100	0.090– 0.280	0.170	NR	2.040E+09	2.162E+08		(6.947E+05) - (4.54E+6 x q_d)	(6.947E+05) - (4.54E+6 x q_d)
Indian Creek [e]	High Flows	0-10	16.9 – 228	39.9	NA	4.784E+11	1.139E+10		(1.462E+08) - (4.08E+6 x q_d)	(1.462E+08) - (4.08E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	3.71 – 16.9	5.83	NR	6.996E+10	3.459E+09		(2.138E+07) - (4.08E+6 x q_d)	(2.138E+07) - (4.08E+6 x q_d)
007_0800	Mid-Range	40-60	2.14 – 3.71	2.85	NR	3.420E+10	1.806E+09	1.2E+10 x q_m	(1.045E+07) - (4.08E+6 x q_d)	(1.045E+07) - (4.08E+6 x q_d)
	Dry Conditions	60-90	0.340 – 2.14	1.04	NR	1.248E+10	7.843E+09		(3.814E+06) - (4.08E+6 x q_d)	(3.814E+06) - (4.08E+6 x q_d)
HUC-12: 0101	Low Flows	90-100	0.090 – 0.340	0.200	15.9	2.400E+09	2.093E+08		(7.335E+05) - (4.08E+6 x q_d)	(7.335E+05) - (4.08E+6 x q_d)
Turkey Creek [e]	High Flows	0-10	7.51 – 103	19.2	NA	2.308E+11	2.082E+10		(1.733E+08) - (1.00E+7 x q_d)	(1.733E+08) - (1.00E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	1.50 – 7.51	2.36	NR	2.832E+10	1.136E+09		(2.127E+07) - (1.00E+7 x q_d)	(2.127E+07) - (1.00E+7 x q_d)
007_0700	Mid-Range	40-60	0.870 – 1.50	1.16	NA	1.392E+10	7.958E+09	1.2E+10 x q_m	(1.046E+07) - (1.00E+7 x q_d)	(1.046E+07) - (1.00E+7 x q_d)
	Dry Conditions	60-90	0.140 – 0.870	0.440	45.6	5.280E+09	5.474E+08		(3.966E+06) - (1.00E+7 x q_d)	(3.966E+06) - (1.00E+7 x q_d)
HUC-12: 0101	Low Flows	90-100	0.040 – 0.140	0.080	NR	9.600E+08	3.013E+07		(7.211E+05) - (1.00E+7 x q_d)	(7.211E+05) - (1.00E+7 x q_d)

Table E-39. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202) (cont'd)

Waterbody Description (05130202____)	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]
Mill Creek [e]	High Flows	0-10	249 – 2,546	505	NA	6.056E+12	6.721E+11	1.2E+10 x q_m	(1.247E+08) - (2.74E+5 x q_d)	(1.247E+08) - (2.74E+5 x q_d)
Waterbody ID:	Moist Conditions	10-40	50.2 – 249	84.8	68.6	1.018E+12	3.641E+11		(2.095E+07) - (2.74E+5 x q_d)	(2.095E+07) - (2.74E+5 x q_d)
007_3000	Mid-Range	40-60	28.8 – 50.2	38.4	NR	4.613E+11	2.539E+10		(9.494E+06) - (2.74E+5 x q_d)	(9.494E+06) - (2.74E+5 x q_d)
	Dry Conditions	60-90	5.73 – 28.8	15.8	NR	1.890E+11	1.737E+10		(3.890E+06) - (2.74E+5 x q_d)	(3.890E+06) - (2.74E+5 x q_d)
HUC-12: 0102	Low Flows	90-100	1.65– 5.73	3.40	79.9	4.080E+10	9.591E+09		(8.398E+05) - (2.74E+5 x q_d)	(8.398E+05) - (2.74E+5 x q_d)
Pavillion Branch [e]	High Flows	0-10	5.42 – 44.6	10.4	77.7 [b]	1.248E+11	1.248E+10	1.2E+10 x q_m	(1.973E+08) - (2.11E+7 x q_d)	(1.973E+08) - (2.11E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	0.930 – 5.42	1.71		2.052E+10	2.052E+09		(3.244E+07) - (2.11E+7 x q_d)	(3.244E+07) - (2.11E+7 x q_d)
007_1500	Mid-Range	40-60	0.490 – 0.930	0.670		8.040E+09	8.040E+08		(1.271E+07) - (2.11E+7 x q_d)	(1.271E+07) - (2.11E+7 x q_d)
	Dry Conditions	60-90	0.150 – 0.490	0.310		3.720E+09	3.720E+08		(5.881E+06) - (2.11E+7 x q_d)	(5.881E+06) - (2.11E+7 x q_d)
HUC-12: 0102	Low Flows	90-100	0.030 – 0.150	0.090		1.080E+09	1.080E+08		(1.707E+06) - (2.11E+7 x q_d)	(1.707E+06) - (2.11E+7 x q_d)
Blue Spring Creek [e]	High Flows	0-10	27.1 – 284	52.1	NA	1.199E+12	1.199E+11	2.3E+10 x q_m	(2.253E+08) - (2.51E+6 x q_d)	(2.253E+08) - (2.51E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	8.66 – 27.1	13.3	NA	3.068E+11	3.068E+10		(5.766E+07) - (2.51E+6 x q_d)	(5.766E+07) - (2.51E+6 x q_d)
014_0900	Mid-Range	40-60	5.45 – 8.66	6.88	NR	1.582E+11	1.582E+10		(2.974E+07) - (2.51E+6 x q_d)	(2.974E+07) - (2.51E+6 x q_d)
	Dry Conditions	60-90	1.98 – 5.45	3.58	NR	8.234E+10	8.234E+09		(1.547E+07) - (2.51E+6 x q_d)	(1.547E+07) - (2.51E+6 x q_d)
HUC-12: 0203	Low Flows	90-100	0.540– 1.98	1.34	NA	3.082E+10	3.082E+09		(5.792E+06) - (2.51E+6 x q_d)	(5.792E+06) - (2.51E+6 x q_d)

Table E-39. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202) (cont'd)

Waterbody Description (05130202____)	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]
Manskers Creek [e]	High Flows	0-10	128 – 1,053	214		4.911E+12	4.911E+11		(2.229E+08) - (6.05E+5 x q_d)	(2.229E+08) - (6.05E+5 x q_d)
Waterbody ID:	Moist Conditions	10-40	40.7 – 128	63.9		1.470E+12	1.470E+11		(6.673E+07) - (6.05E+5 x q_d)	(6.673E+07) - (6.05E+5 x q_d)
220_1000	Mid-Range	40-60	23.9 – 40.7	31.3	73.0 [b]	7.199E+11	7.199E+10	2.3E+10 x q_m	(3.267E+07) - (6.05E+5 x q_d)	(3.267E+07) - (6.05E+5 x q_d)
	Dry Conditions	60-90	7.90 – 23.9	15.5		3.567E+11	3.567E+10		(1.619E+07) - (6.05E+5 x q_d)	(1.619E+07) - (6.05E+5 x q_d)
HUC-12: 0301	Low Flows	90-100	1.71 – 7.90	4.85		1.116E+11	1.116E+10		(5.062E+06) - (6.05E+5 x q_d)	(5.062E+06) - (6.05E+5 x q_d)
Cooper Creek [e]	High Flows	0-10	6.82 – 58.8	11.9		2.730E+11	2.730E+10		(2.762E+08) - (1.35E+7 x q_d)	(2.762E+08) - (1.35E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	1.74 – 6.82	2.97		6.831E+10	6.831E+09		(6.910E+07) - (1.35E+7 x q_d)	(6.910E+07) - (1.35E+7 x q_d)
209_0100	Mid-Range	40-60	0.970 – 1.74	1.28	51.9 [b]	2.944E+10	2.944E+09	2.3E+10 x q_m	(2.978E+07) - (1.35E+7 x q_d)	(2.978E+07) - (1.35E+7 x q_d)
	Dry Conditions	60-90	0.300 – 0.970	0.600		1.380E+10	1.380E+09		(1.396E+07) - (1.35E+7 x q_d)	(1.396E+07) - (1.35E+7 x q_d)
HUC-12: 0302	Low Flows	90-100	0.060 – 0.300	0.180		4.140E+09	4.140E+08		(4.188E+06) - (1.35E+7 x q_d)	(4.188E+06) - (1.35E+7 x q_d)
Dry Creek [e]	High Flows	0-10	39.5 – 321	67.4	NA	1.550E+12	1.550E+11		(2.564E+08) - (2.21E+6 x q_d)	(2.564E+08) - (2.21E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	10.8 – 39.5	17.9	NR	4.122E+12	4.122E+11		(6.821E+07) - (2.21E+6 x q_d)	(6.821E+07) - (2.21E+6 x q_d)
027_1000	Mid-Range	40-60	6.14 – 10.8	8.15	NR	1.875E+12	1.875E+11	2.3E+10 x q_m	(3.102E+07) - (2.21E+6 x q_d)	(3.102E+07) - (2.21E+6 x q_d)
	Dry Conditions	60-90	1.94 – 6.14	3.87	61.1	8.901E+12	8.901E+11		(1.473E+07) - (2.21E+6 x q_d)	(1.473E+07) - (2.21E+6 x q_d)
HUC-12: 0302	Low Flows	90-100	0.410 – 1.94	1.20	NR	2.760E+11	2.760E+10		(4.568E+06) - (2.21E+6 x q_d)	(4.568E+06) - (2.21E+6 x q_d)

Table E-39. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202) (cont'd)

Waterbody Description (05130202____)	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]
Neeleys Branch [e]	High Flows	0-10	11.9 – 98.9	22.3	65.0 [b]	5.131E+11	5.131E+10	2.3E+10 x q_m	(3.555E+08) - (1.77E+7 x q_d)	(3.555E+08) - (1.77E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	2.24 – 11.9	4.07		9.361E+10	9.361E+09		(6.486E+07) - (1.77E+7 x q_d)	(6.486E+07) - (1.77E+7 x q_d)
212_0100	Mid-Range	40-60	1.20 – 2.24	1.62		3.726E+10	3.726E+09		(2.582E+07) - (1.77E+7 x q_d)	(2.582E+07) - (1.77E+7 x q_d)
	Dry Conditions	60-90	0.370 – 1.20	0.740		1.702E+10	1.702E+09		(1.179E+07) - (1.77E+7 x q_d)	(1.179E+07) - (1.77E+7 x q_d)
HUC-12: 0302	Low Flows	90-100	0.080 – 0.370	0.220		5.060E+09	5.060E+08		(3.506E+06) - (1.77E+7 x q_d)	(3.506E+06) - (1.77E+7 x q_d)
Drake Branch [e]	High Flows	0-10	8.11 – 782	13.9	66.8 [b]	3.190E+11	3.190E+10	2.3E+10 x q_m	(2.309E+08) - (1.85E+7 x q_d)	(2.309E+08) - (1.85E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	2.52 – 8.11	4.00		9.200E+10	9.200E+09		(6.658E+07) - (1.85E+7 x q_d)	(6.658E+07) - (1.85E+7 x q_d)
010_0200	Mid-Range	40-60	1.50 – 2.52	1.92		4.416E+10	4.416E+09		(3.196E+07) - (1.85E+7 x q_d)	(3.196E+07) - (1.85E+7 x q_d)
	Dry Conditions	60-90	0.490 – 1.50	0.950		2.185E+10	2.185E+09		(1.581E+07) - (1.85E+7 x q_d)	(1.581E+07) - (1.85E+7 x q_d)
HUC-12: 0303	Low Flows	90-100	0.100 – 0.490	0.300		6.900E+09	6.900E+08		(4.994E+06) - (1.85E+7 x q_d)	(4.994E+06) - (1.85E+7 x q_d)
Ewing Creek [e]	High Flows	0-10	63.0 – 504	106	NA	2.442E+12	2.442E+11	2.3E+10 x q_m	(2.580E+08) - (2.70E+6 x q_d)	(2.580E+08) - (2.70E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	17.0 – 63.0	28.6	61.1	6.583E+11	6.583E+10		(6.955E+07) - (2.70E+6 x q_d)	(6.955E+07) - (2.70E+6 x q_d)
010_0900	Mid-Range	40-60	9.53 – 17.0	12.7	NR	2.912E+11	2.912E+10		(3.076E+07) - (2.70E+6 x q_d)	(3.076E+07) - (2.70E+6 x q_d)
	Dry Conditions	60-90	2.98 – 9.53	5.99	NR	1.378E+11	1.378E+10		(1.456E+07) - (2.70E+6 x q_d)	(1.456E+07) - (2.70E+6 x q_d)
HUC-12: 0303	Low Flows	90-100	0.620 – 2.98	1.83	NR	4.209E+10	4.209E+09		(4.447E+06) - (2.70E+6 x q_d)	(4.447E+06) - (2.70E+6 x q_d)

Table E-39. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202) (cont'd)

Waterbody Description (05130202____)	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]
Bosley Springs	High Flows	0-10	11.1 – 91.8	20.5		4.717E+11	4.717E+10		(3.094E+08) - (1.68E+7 x q_d)	(3.094E+08) - (1.68E+7 x q_d)
Branch [e]	Moist Conditions	10-40	2.54 – 11.1	4.44		1.021E+11	1.021E+10		(6.697E+07) - (1.68E+7 x q_d)	(6.697E+07) - (1.68E+7 x q_d)
Waterbody ID:	Mid-Range	40-60	1.40 – 2.54	1.87	85.3 [b]	4.301E+10	4.301E+09	2.3E+10 x q_m	(2.821E+07) - (1.68E+7 x q_d)	(2.821E+07) - (1.68E+7 x q_d)
314_0300	Dry Conditions	60-90	0.430 – 1.40	0.870		2.001E+10	2.001E+09		(1.312E+07) - (1.68E+7 x q_d)	(1.312E+07) - (1.68E+7 x q_d)
HUC-12: 0304	Low Flows	90-100	0.090 – 0.430	0.270		6.210E+09	6.210E+08		(4.072E+06) - (1.68E+7 x q_d)	(4.072E+06) - (1.68E+7 x q_d)
Richland Creek [e]	High Flows	0-10	89.7 – 670	159		3.654E+12	3.654E+11		(2.048E+08) - (1.43E+6 x q_d)	(2.048E+08) - (1.43E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	18.0 – 89.7	32.7		7.530E+11	7.530E+10		(4.221E+07) - (1.43E+6 x q_d)	(4.221E+07) - (1.43E+6 x q_d)
314_1000	Mid-Range	40-60	9.61 – 18.0	13.0	65.9 [b]	2.985E+11	2.985E+10	2.3E+10 x q_m	(1.673E+07) - (1.43E+6 x q_d)	(1.673E+07) - (1.43E+6 x q_d)
	Dry Conditions	60-90	2.90 – 9.61	5.92		1.362E+11	1.362E+10		(7.632E+06) - (1.43E+6 x q_d)	(7.632E+06) - (1.43E+6 x q_d)
HUC-12: 0304	Low Flows	90-100	0.580 – 2.90	1.75		4.025E+10	4.025E+09		(2.256E+06) - (1.43E+6 x q_d)	(2.256E+06) - (1.43E+6 x q_d)
Richland Creek [e]	High Flows	0-10	24.9 – 218	41.7	NA	5.005E+11	5.005E+10		(1.171E+08) - (5.98E+6 x q_d)	(1.171E+08) - (5.98E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	7.86 – 24.9	12.5	29.1	1.502E+11	1.502E+10		(3.515E+07) - (5.98E+6 x q_d)	(3.515E+07) - (5.98E+6 x q_d)
314_3000	Mid-Range	40-60	4.66 – 7.86	6.02	NA	7.224E+11	7.224E+10	1.2E+10 x q_m	(1.690E+07) - (5.98E+6 x q_d)	(1.690E+07) - (5.98E+6 x q_d)
	Dry Conditions	60-90	1.52 – 4.66	2.98	NR	3.576E+10	3.576E+09		(8.367E+06) - (5.98E+6 x q_d)	(8.367E+06) - (5.98E+6 x q_d)
HUC-12: 0304	Low Flows	90-100	0.320 – 1.52	0.940	NR	1.128E+10	1.128E+09		(2.639E+06) - (5.98E+6 x q_d)	(2.639E+06) - (5.98E+6 x q_d)

Table E-39. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202) (cont'd)

Waterbody Description (05130202____)	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]
Browns Creek [e]	High Flows	0-10	89.7 – 670	159	94.0 [b]	3.654E+12	3.654E+11	2.3E+10 x q_m	(3.238E+08) - (2.26E+6 x q_d)	(3.238E+08) - (2.26E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	18.0 – 89.7	32.7		7.530E+11	7.530E+10		(6.672E+07) - (2.26E+6 x q_d)	(6.672E+07) - (2.26E+6 x q_d)
023_2000	Mid-Range	40-60	9.61 – 18.0	13.0		2.985E+11	2.985E+10		(2.645E+07) - (2.26E+6 x q_d)	(2.645E+07) - (2.26E+6 x q_d)
	Dry Conditions	60-90	2.90 – 9.61	5.92		1.362E+11	1.362E+10		(1.206E+07) - (2.26E+6 x q_d)	(1.206E+07) - (2.26E+6 x q_d)
HUC-12: 0305	Low Flows	90-100	0.580 – 2.90	1.75		4.025E+10	4.025E+09		(3.566E+06) - (2.26E+6 x q_d)	(3.566E+06) - (2.26E+6 x q_d)
Cheatham Reservoir	High Flows	0-10	52,100 – 115,247	62,200	NA	7.464E+14	7.464E+13	1.2E+10 x q_m	(8.164E+07) - (2.80E+3 x q_d)	(8.164E+07) - (2.80E+3 x q_d)
Waterbody ID:	Moist Conditions	10-40	22,100 – 52,100	36,000	NR	4.320E+14	4.320E+13		(4.725E+07) - (2.80E+3 x q_d)	(4.725E+07) - (2.80E+3 x q_d)
001_3000	Mid-Range	40-60	12,500 – 22,100	15,700	NR	1.884E+14	1.884E+13		(2.061E+07) - (2.80E+3 x q_d)	(2.061E+07) - (2.80E+3 x q_d)
	Dry Conditions	60-90	5,380 – 12,500	8,555	NR	1.027E+14	1.027E+13		(1.123E+07) - (2.80E+3 x q_d)	(1.123E+07) - (2.80E+3 x q_d)
HUC-12: 0305	Low Flows	90-100	1,840 – 5,380	3,845	NA	4.614E+13	4.614E+12		(5.047E+06) - (2.80E+3 x q_d)	(5.047E+06) - (2.80E+3 x q_d)
Pages Branch [e]	High Flows	0-10	6.59 – 60.0	12.4	19.1 [b]	2.847E+11	2.847E+10	1.2E+10 x q_m	(3.152E+08) - (2.83E+7 x q_d)	(3.152E+08) - (2.83E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	1.54 – 6.59	2.66		6.118E+10	6.118E+09		(6.774E+07) - (2.83E+7 x q_d)	(6.774E+07) - (2.83E+7 x q_d)
202_1000	Mid-Range	40-60	0.850 – 1.54	1.14		2.622E+10	2.622E+09		(2.903E+07) - (2.83E+7 x q_d)	(2.903E+07) - (2.83E+7 x q_d)
	Dry Conditions	60-90	0.270 – 0.850	0.530		1.219E+10	1.219E+09		(1.350E+07) - (2.83E+7 x q_d)	(1.350E+07) - (2.83E+7 x q_d)
HUC-12: 0305	Low Flows	90-100	0.060 – 0.270	0.160		3.680E+09	3.680E+08		(4.074E+06) - (2.83E+7 x q_d)	(4.074E+06) - (2.83E+7 x q_d)

Table E-39. Summary of TMDLs, WLAs, & LAs by Flow Regime for Impaired Waterbodies in the Cheatham Lake Watershed (HUC 05130202) (cont'd)

Waterbody Description (05130202____)	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]
Davidson Branch [e]	High Flows	0-10	8.41 – 77.9	14.5	42.2 [b]	3.342E+11	3.342E+10	2.3E+10 x q_m	(2.458E+08) - (1.88E+7 x q_d)	(2.458E+08) - (1.88E+7 x q_d)
Waterbody ID:	Moist Conditions	10-40	2.48 – 8.41	4.04		9.292E+10	9.292E+09		(6.836E+07) - (1.88E+7 x q_d)	(6.836E+07) - (1.88E+7 x q_d)
001T_0800	Mid-Range	40-60	1.44 – 2.48	1.88		4.324E+10	4.324E+09		(3.181E+07) - (1.88E+7 x q_d)	(3.181E+07) - (1.88E+7 x q_d)
	Dry Conditions	60-90	0.460 – 1.44	0.910		2.093E+10	2.093E+09		(1.540E+07) - (1.88E+7 x q_d)	(1.540E+07) - (1.88E+7 x q_d)
HUC-12: 0306	Low Flows	90-100	0.100 – 0.460	0.280		6.440E+09	6.440E+08		(4.738E+06) - (1.88E+7 x q_d)	(4.738E+06) - (1.88E+7 x q_d)
Overall Creek [e]	High Flows	0-10	19.2 – 197	33.5	64.1 [b]	7.698E+11	7.698E+10	2.3E+10 x q_m	(2.352E+08) - (7.81E+6 x q_d)	(2.352E+08) - (7.81E+6 x q_d)
Waterbody ID:	Moist Conditions	10-40	5.94 – 19.2	9.41		2.164E+11	2.164E+10		(6.613E+07) - (7.81E+6 x q_d)	(6.613E+07) - (7.81E+6 x q_d)
001T_0900	Mid-Range	40-60	3.55 – 5.94	4.58		1.053E+11	1.053E+10		(3.219E+07) - (7.81E+6 x q_d)	(3.219E+07) - (7.81E+6 x q_d)
	Dry Conditions	60-90	1.18 – 3.55	2.27		5.221E+10	5.221E+09		(1.595E+07) - (7.81E+6 x q_d)	(1.595E+07) - (7.81E+6 x q_d)
HUC-12: 0306	Low Flows	90-100	0.260 – 1.18	0.720		1.656E+10	1.656E+09		(5.060E+06) - (7.81E+6 x q_d)	(5.060E+06) - (7.81E+6 x q_d)

Notes: NA = Not Applicable.
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. For some waterbodies, critical flow zone could not be determined. Either the waterbody had no exceedances, or exceedances only in the high flow zone.

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 Cheatham Lake Watershed

In the Cheatham Lake 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.”

21 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.

All of the waterbodies in the Cheatham Lake 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 required before the waterbodies can re-attain water quality standards.

There was one waterbody that appears to be unchanged, but has very few exceedances. For the **Cumberland River/Cheatham Reservoir (TN05130202001_3000)**, the values of most monitoring data are below 100 CFU/100 mL (Figure F-1). Analysis of the monitoring data suggests that all but one of the exceedances occurred during high flow conditions and rainfall events, consistent with a Combined Sewer Overflow event. Recent EPA guidance recommends that waterbodies where exceedances occur less than 10 percent of the time be considered to meet water quality standards. Therefore, it may be possible to remove this segment from the List of Impaired Waterbodies.

The conditions of several waterbodies in the Cheatham Lake watershed appear to be changing. The conditions of three waterbodies appear to be worsening, while the conditions of six waterbodies show some improvement.

Worsening Conditions

Based on analysis of data from 2005 through 2020, the condition of **Overall Creek (TN05130202001T_0900)** appears to be worsening (Figures F-2 and F-3). There were exceedances of both the single sample maximum and geomean criteria. There were no exceedances of the single sample maximum criterion prior to 2015, but there were multiple exceedances in 2015 and 2020. Improvement will be required before Overall Creek can re-attain water quality standards.

Based on analysis of data from 2010 through 2015, the condition of **Sorghum Branch (TN05130202007_1300)** appears to be worsening (Figures F-4 and F-5). There have been exceedances of both the single sample maximum and geomean criteria. However, there were more exceedances during the 2014-15 sampling cycle than during the 2010-2011 sampling cycle. Improvement will be required before Sorghum Branch can re-attain water quality standards.

Based on analysis of data from 2010 through 2015, the condition of **Whittemore Branch (TN05130202007_1200)** appears to be worsening (Figures F-6 and F-7). There have been exceedances of both the single sample maximum and geomean criteria. However, there were more exceedances of the single sample maximum criterion during the 2014-15 sampling cycle than during the 2010-11 sampling cycle. Improvement will be required before Whittemore Branch can re-attain water quality standards.

Improving Conditions

Based on analysis of data from 2006 through 2020, the condition of **Blue Spring Creek (TN05130202014_0900)** appears to be improving over time (Figures F-8 and F-9). There were no exceedances of the single sample maximum criterion or the geomean criterion during the most recent sampling period. However, few samples were collected during the most recent sampling cycle. Additional monitoring and improvement will be required before Blue Spring Creek can re-attain water quality standards.

Based on analysis of data from 2005 through 2020, the condition of **Finley Branch (TN05130202007_0300)** appears to be improving (Figures F-10 and F-11). There have been exceedances of both the single sample maximum and geomean criteria. However, all monitoring values for 2020 are below 1000 cfu/100 mL. Additional improvement will be required before Finley Branch can re-attain water quality standards.

Based on analysis of data from 2005 through 2020, the condition of **Indian Creek (TN05130202007_0800)** appears to show slight improvement (Figures F-12 and F-13). There have been exceedances of both the single sample maximum and geomean criteria. However, the maximum values have steadily decreased. Additional improvement will be required before Indian Creek can re-attain water quality standards.

Based on analysis of data from 2005 through 2020, the condition of **Sevenmile Creek (TN05130202007_1400, and _1450)** appears to show slight improvement (Figures F-14 through F-16). There were exceedances of both the single sample maximum and geomean criteria. However, all monitoring values for 2020 are below 1000 cfu/100 mL. Improvement will be required before Sevenmile Creek can re-attain water quality standards.

Based on analysis of data from 2011 through 2020, the condition of **Sugartree Creek (TN05130202314_0400)** shows slight improvement (Figures F-17 and F-18). There have been exceedances of both the single sample maximum and geomean criteria. However, there were fewer exceedances of the single sample maximum criterion during the 2015-17 sampling cycle than during the 2011-12 sampling cycle. There was limited data available for 2020, but there were no exceedances of the single sample maximum criterion. Improvement will be required before Sugartree Creek can re-attain water quality standards.

Based on analysis of data from 2014 through 2020, the condition of **West Fork Browns Creek (TN05130202023_0300)** shows slight improvement (Figures F-19 and F-20). There have been exceedances of both the single sample maximum and geomean criteria. However, there were fewer exceedances of the single sample maximum criterion during the 2015-17 sampling cycle than during the 2010-12 sampling cycle. Improvement will be required before West Fork Browns Creek can re-attain water quality standards.

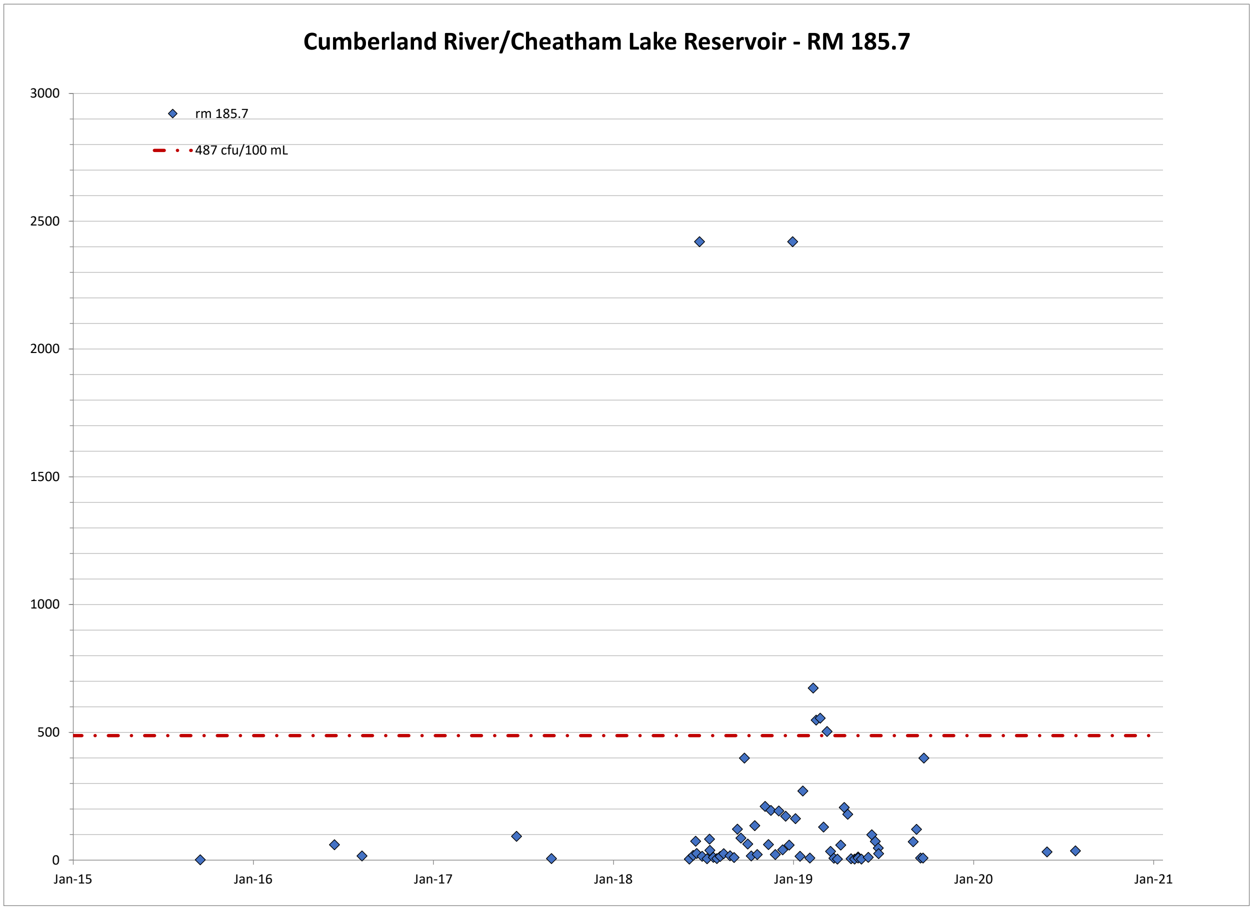


Figure F-1. Time Series Plot for Cumberland River – RM 185.7

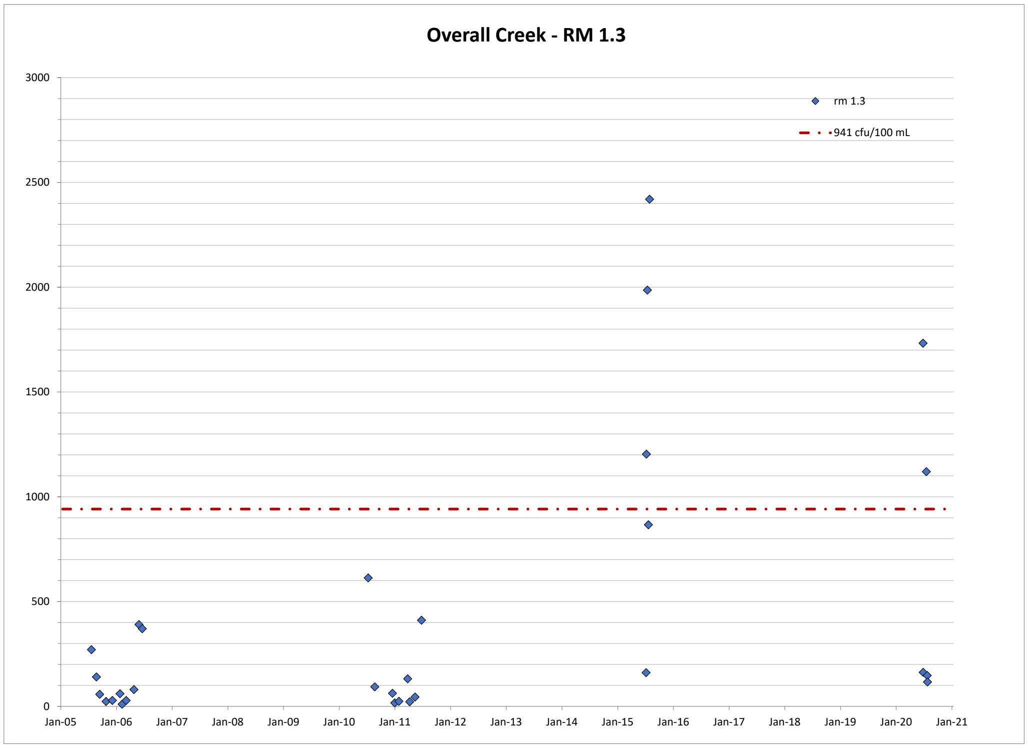


Figure F-2. Time Series Plot for Overall Creek – RM 1.3

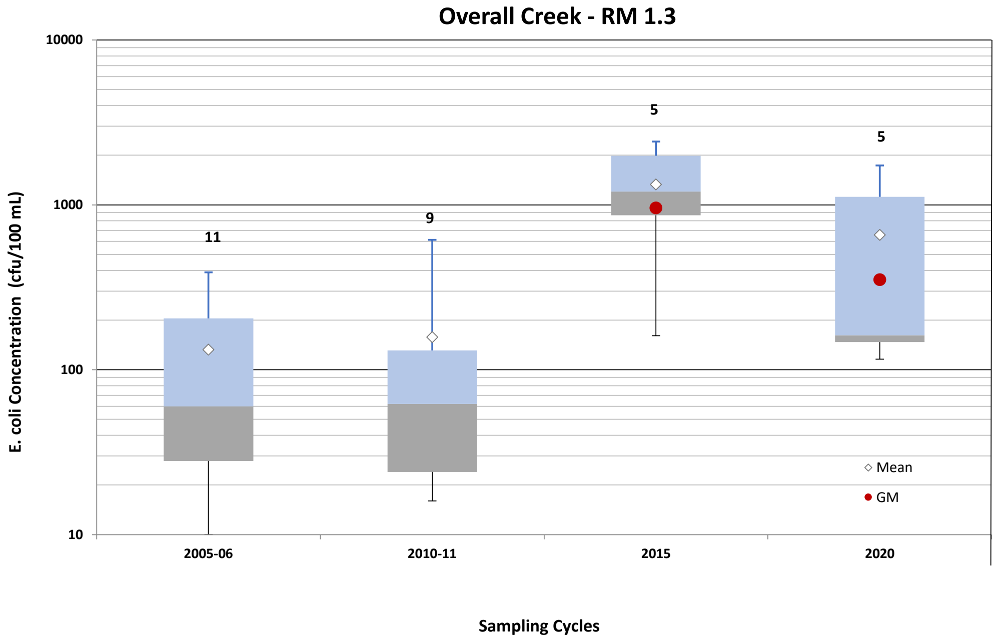


Figure F-3. Box and Whisker Plot for Overall Creek – RM 1.3

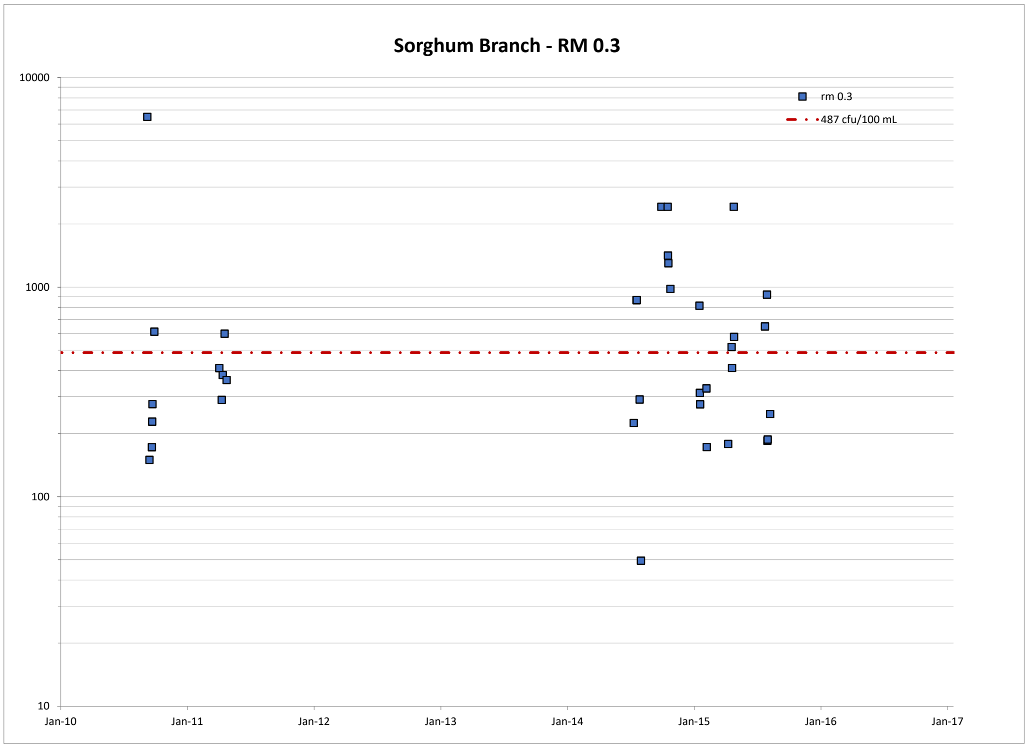


Figure F-4. Time Series Plot for Sorghum Branch – RM 0.3

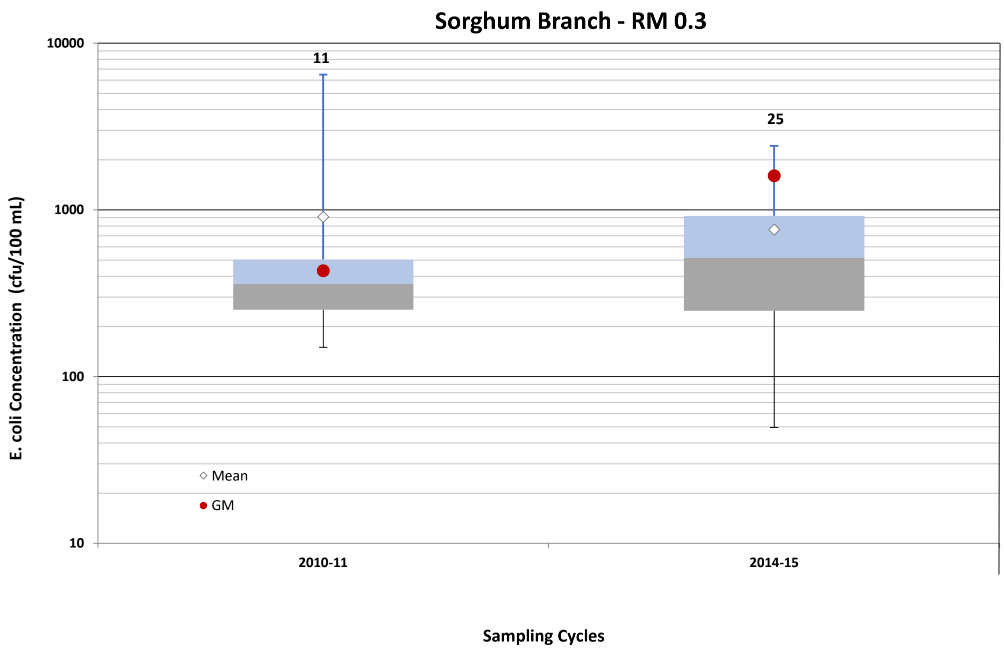


Figure F-5. Box and Whisker Plot for Sorghum Branch – RM 0.3

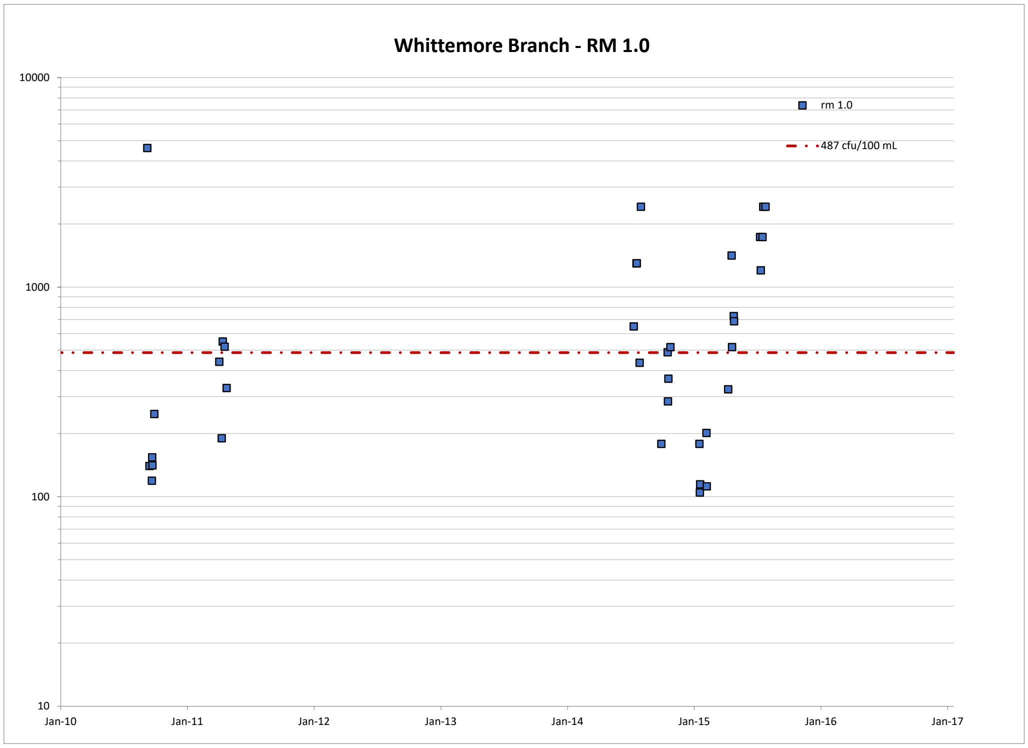


Figure F-6. Time Series Plot for Whittemore Branch – RM 1.0

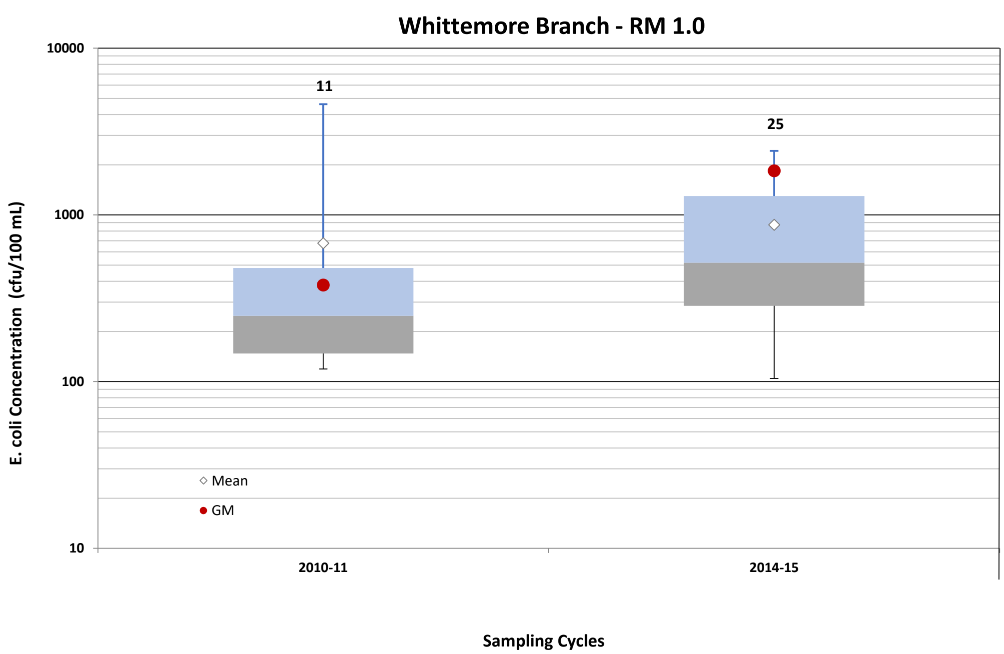


Figure F-7. Box and Whisker Plot for Whittemore Branch – RM 1.0

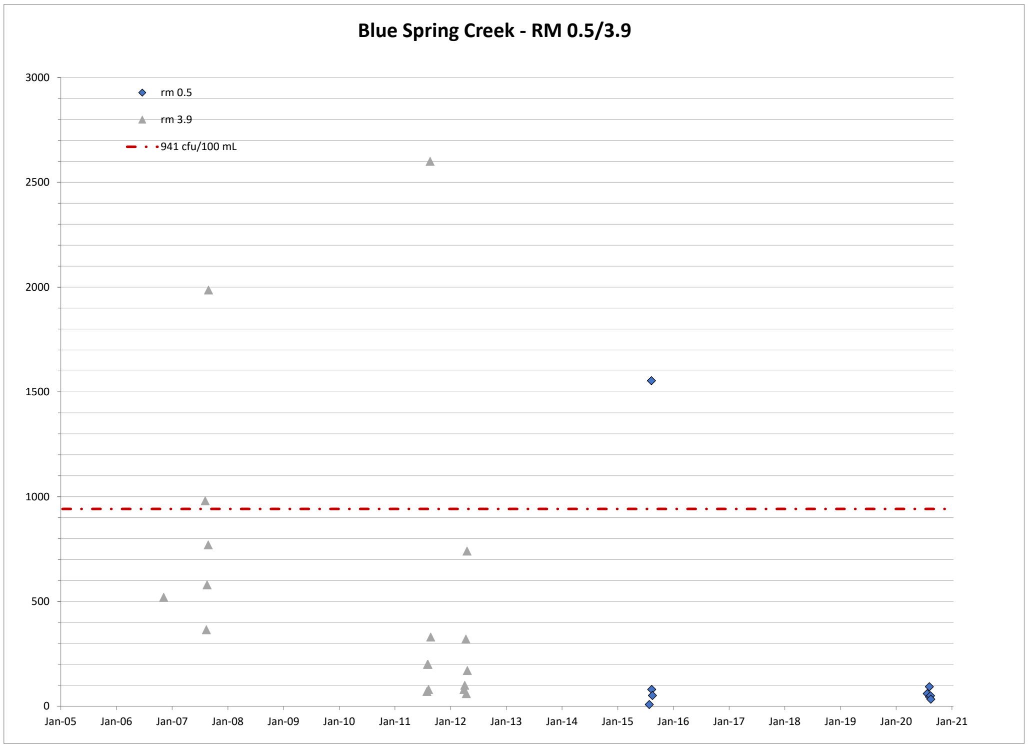


Figure F-8. Time Series Plot for Blue Spring Creek – RM 0.5/3.9

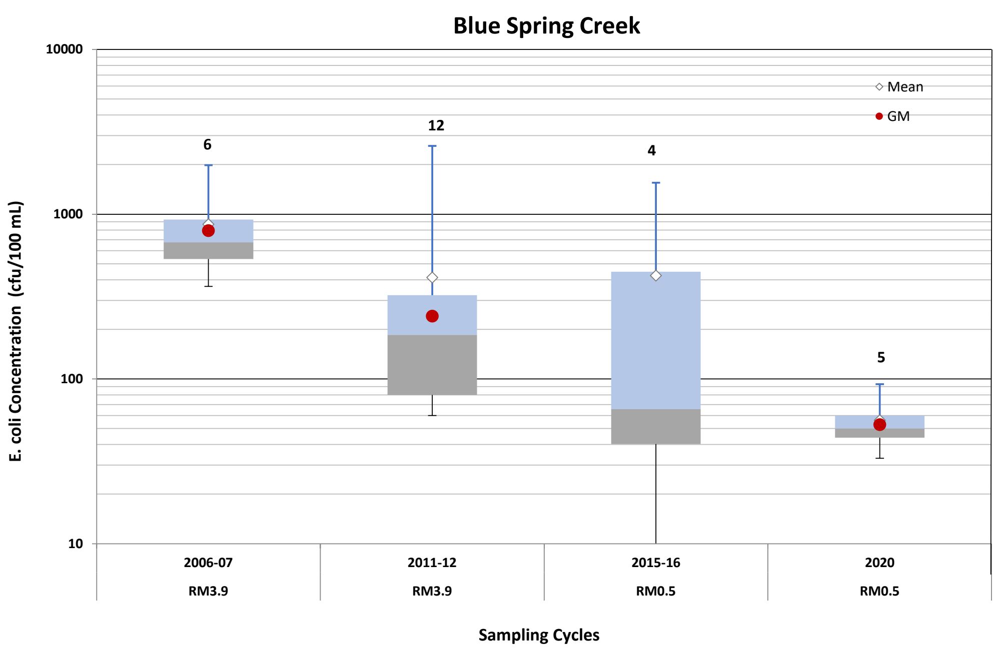


Figure F-9. Box and Whisker Plot for Blue Spring Creek – RM 0.5/3.9

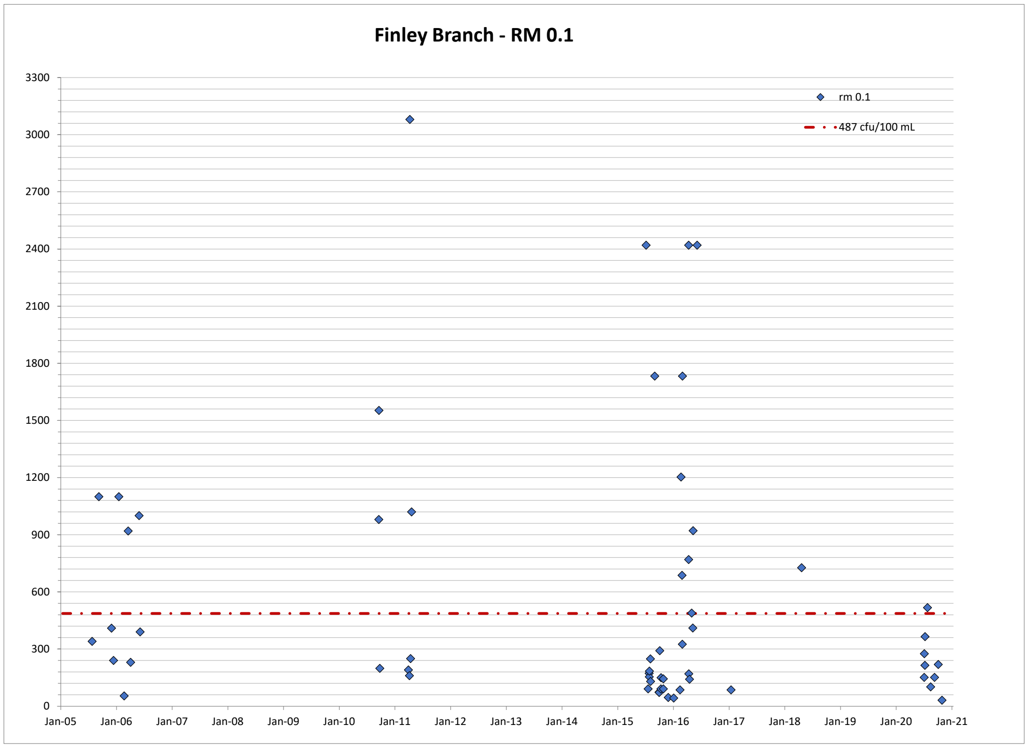


Figure F-10. Time Series Plot for Finley Branch – RM 0.1

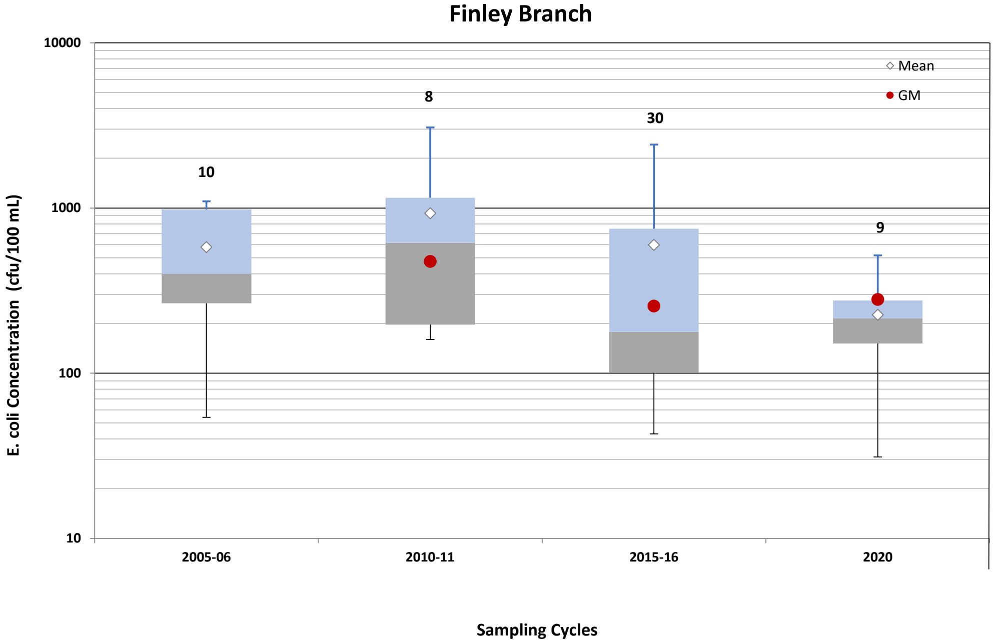


Figure F-11. Box and Whisker Plot for Finley Branch – RM 0.1

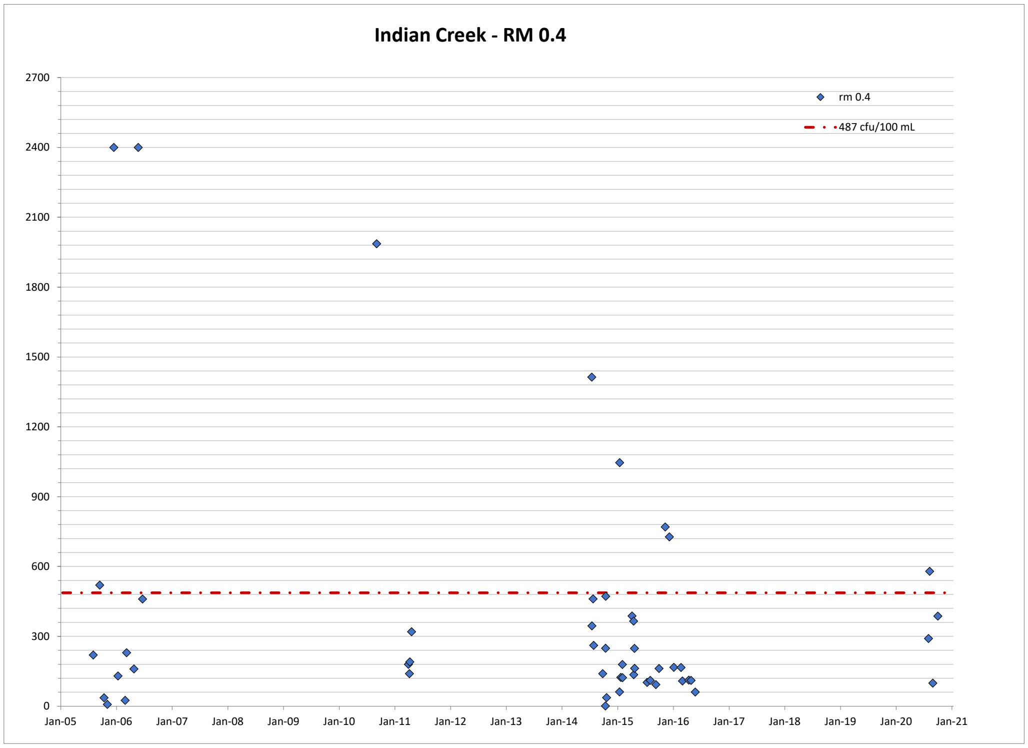


Figure F-12. Time Series Plot for Indian Creek – RM 0.4

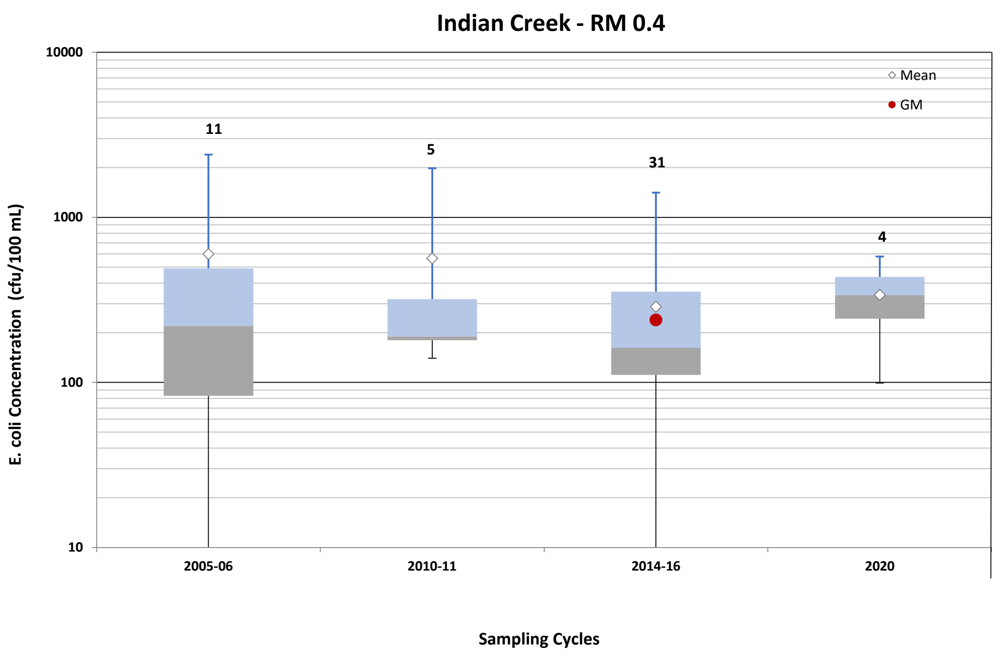


Figure F-13. Box and Whisker Plot for Indian Creek – RM 0.4

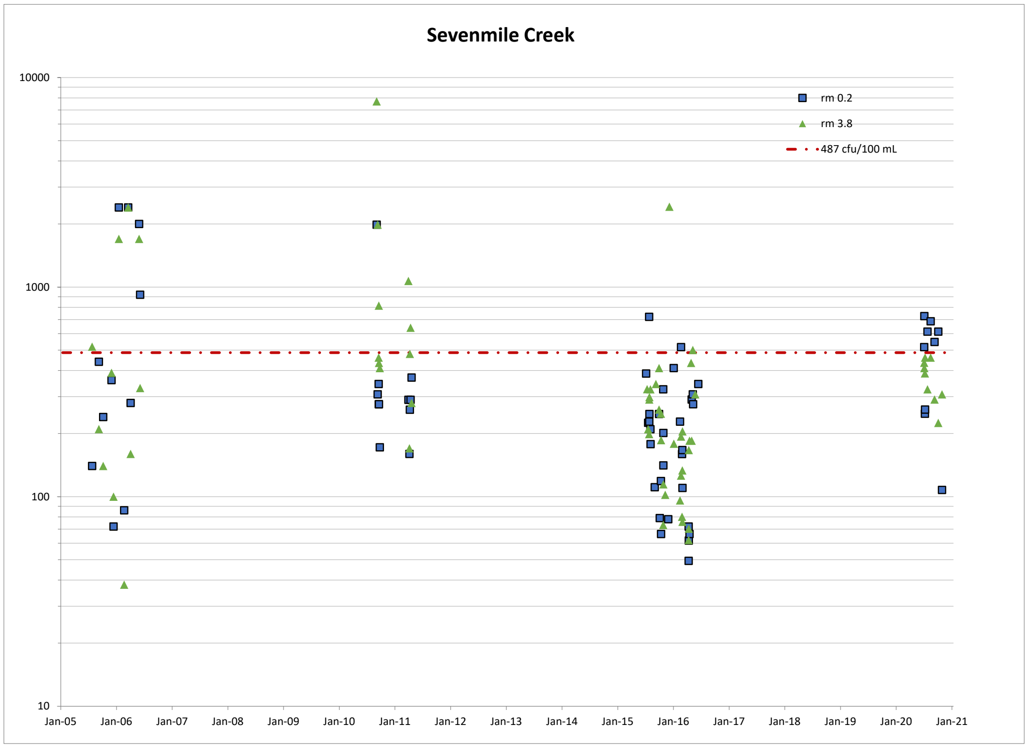


Figure F-14. Time Series Plot for Sevenmile Creek – 2 sites

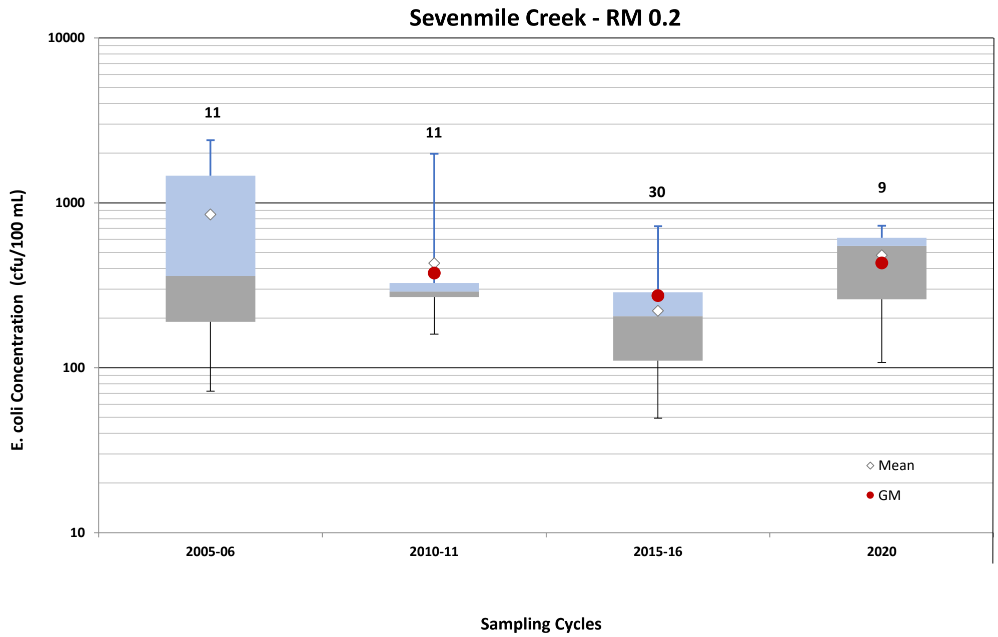


Figure F-15. Box and Whisker Plot for Sevenmile Creek – RM 0.2

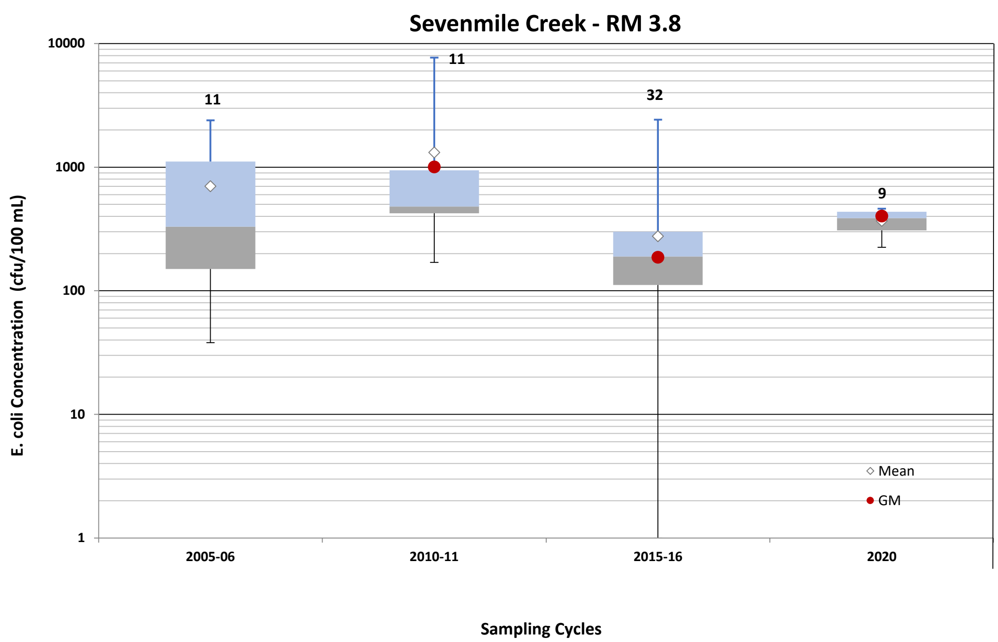


Figure F-16. Box and Whisker Plot for Sevenmile Creek – RM 3.8

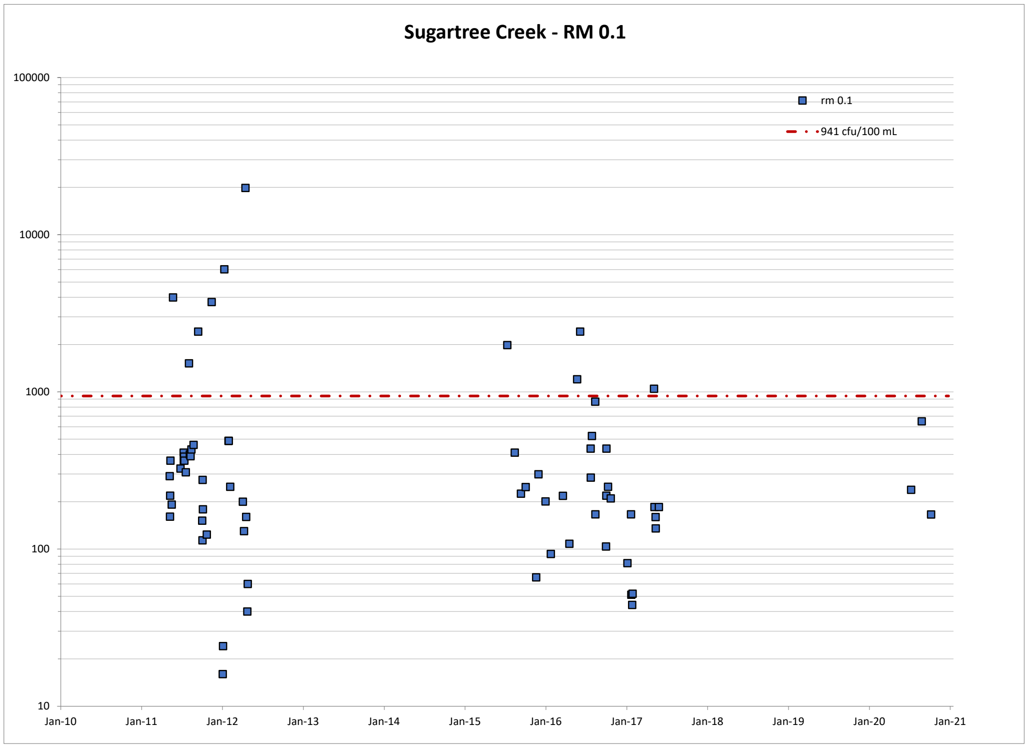


Figure F-17. Time Series Plot for Sugartree Creek – RM 0.1

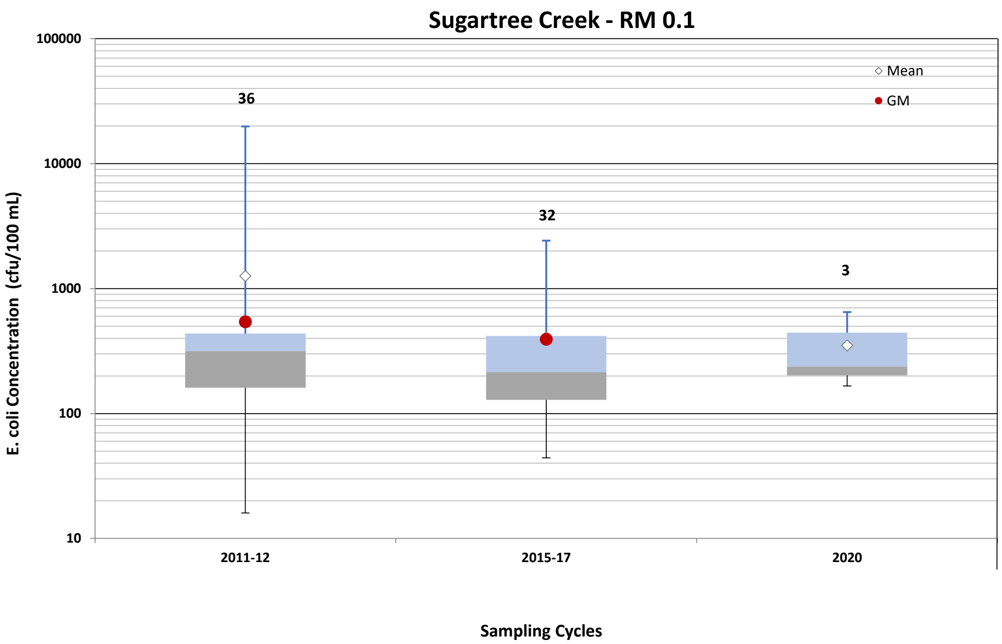


Figure F-18. Box and Whisker Plot for Sugartree Creek – RM 0.1

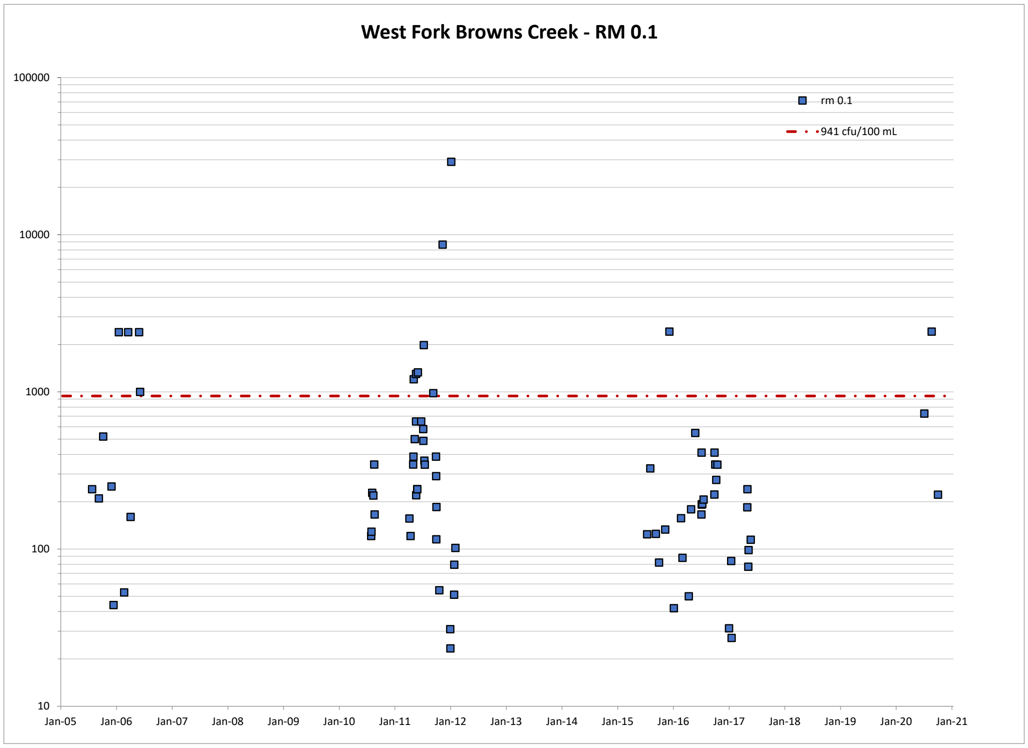


Figure F-19. Time Series Plot for West Fork Browns Creek – RM 0.1

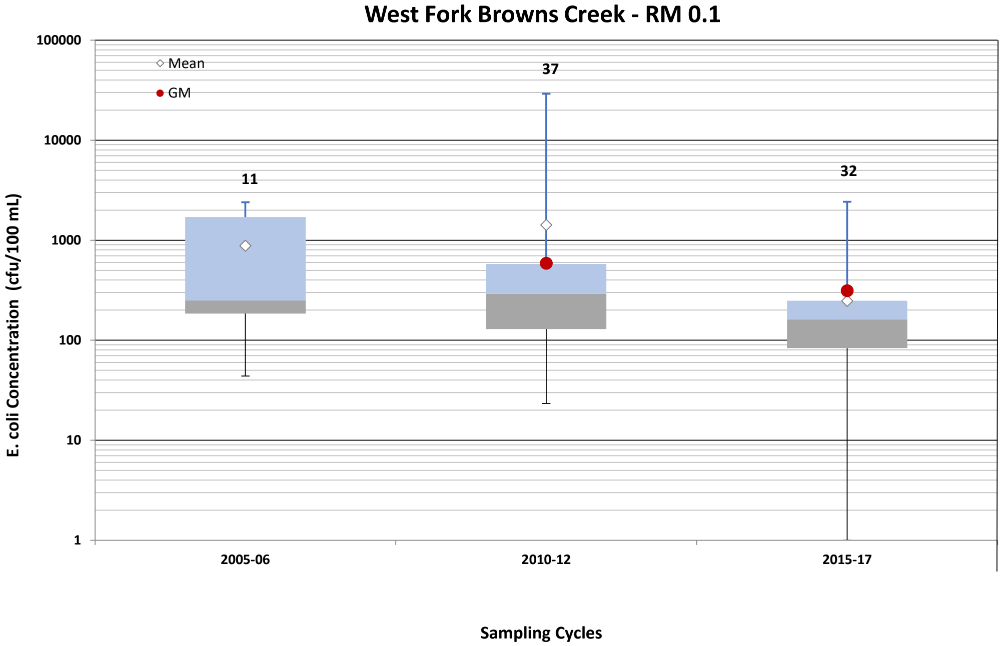


Figure F-20. Box and Whisker Plot for West Fork Browns Creek – RM 0.1

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 Figure G-1.) 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 Cheatham Lake Watershed (HUC 05130202)

Waterbody ID	Waterbody	Assessment Status for *E. coli*
TN05130202007_0150	*Sims Branch*	*Not Assessed*
TN05130202007_0200	*Elissa Branch*	*Not Assessed*
TN05130202007_0400	*Ezell Branch*	*Not Assessed*
TN05130202007_0500	*Franklin Branch*	*Not Assessed*
TN05130202007_1420	*Hilson Branch*	*Not Assessed*
TN05130202007_1430	*Carbine Branch*	*Not Assessed*
TN05130202007_1440	*Apple Branch*	*Not Assessed*
TN05130202007_1460	*Brentwood Branch*	*Not Assessed*
TN05130202007_1470	*Briarwood Branch*	*Not Assessed*
TN05130202007_1480	*Paragon Branch*	*Not Assessed*
TN05130202023_0400	UT to Browns Creek	Not Assessed
TN05130202220_0200	Walkers Creek	Fully Supporting
TN05130202220_0210	UT to Walkers Creek	Not Assessed
TN05130202220_0220	Bakers Fork	Not Assessed
TN05130202220_0400	Madison Creek	Fully Supporting
TN05130202220_0500	Center Point Branch	Fully Supporting
TN05130202314_0100	UT to Richland Creek	Not Assessed
TN05130202314_0200	Murphy Road Branch	Not Assessed
TN05130202314_0500	Belle Meade Branch	Not Assessed
TN05130202314_0600	Chickering Branch	Not Assessed

* 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.

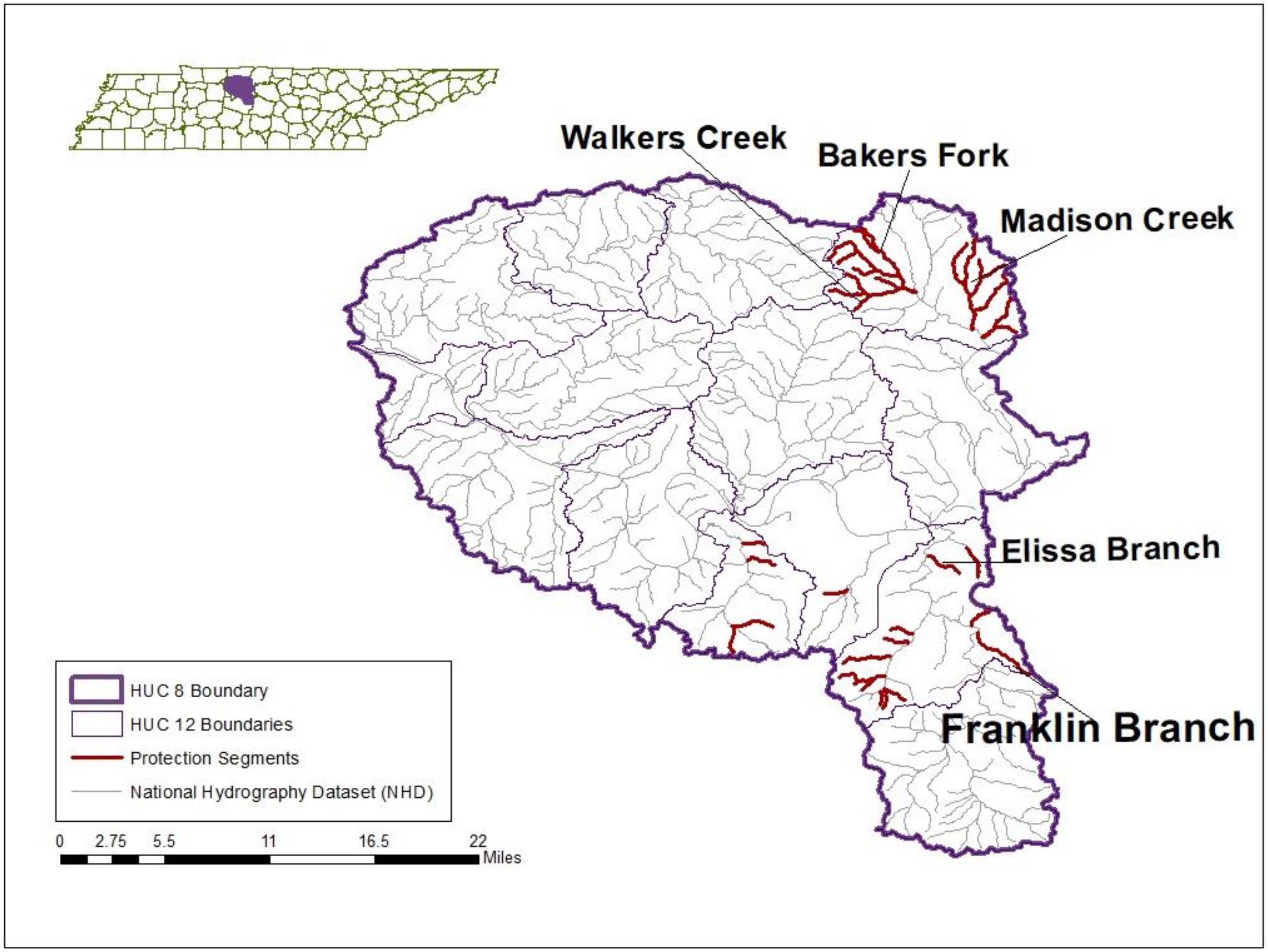


Figure G-1. Waterbodies Covered by Protection TMDLs

Table G-2. Protection TMDLs, WLAs, & LAs for Unimpaired (Fully Supporting) and Unassessed Waterbodies Located in Impaired HUC-12s or Drainage Areas of the Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	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]
0102	Sims Branch [d,e]	TN05130202007_0150	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(7.885 \times 10^6 \times Q) - (8.76 \times 10^6 \times q_d)$	$(7.885 \times 10^6 \times Q) - (8.76 \times 10^6 \times q_d)$
	Elissa Branch [d,e]	TN05130202007_0200				$(1.280 \times 10^7 \times Q) - (1.42 \times 10^7 \times q_d)$	$(1.280 \times 10^7 \times Q) - (1.42 \times 10^7 \times q_d)$
	Ezell Branch [d,e]	TN05130202007_0400				$(3.184 \times 10^7 \times Q) - (3.54 \times 10^7 \times qd)$	$(3.184 \times 10^7 \times Q) - (3.54 \times 10^7 \times qd)$
	Franklin Branch [d,e]	TN05130202007_0500				$(5.525 \times 10^6 \times Q) - (6.14 \times 10^6 \times q_d)$	$(5.525 \times 10^6 \times Q) - (6.14 \times 10^6 \times q_d)$
	Hilson Branch [d,e]	TN05130202007_1420				$(3.444 \times 10^7 \times Q) - (3.83 \times 10^7 \times q_d)$	$(3.444 \times 10^7 \times Q) - (3.83 \times 10^7 \times q_d)$
	Carbine Branch [d,e]	TN05130202007_1430				$(2.220 \times 10^7 \times Q) - (2.47 \times 10^7 \times q_d)$	$(2.220 \times 10^7 \times Q) - (2.47 \times 10^7 \times q_d)$
	Apple Branch [d,e]	TN05130202070_1440				$(2.280 \times 10^7 \times Q) - (2.53 \times 10^7 \times q_d)$	$(2.280 \times 10^7 \times Q) - (2.53 \times 10^7 \times q_d)$
	Brentwood Branch [d,e]	TN05130202007_1460				$(6.277 \times 10^6 \times Q) - (6.97 \times 10^6 \times q_d)$	$(6.277 \times 10^6 \times Q) - (6.97 \times 10^6 \times q_d)$
	Briarwood Branch [d,e]	TN05130202007_1470				$(5.484 \times 10^6 \times Q) - (6.09 \times 10^6 \times q_d)$	$(5.484 \times 10^6 \times Q) - (6.09 \times 10^6 \times q_d)$
	Paragon Branch [d,e]	TN05130202007_1480				$(3.068 \times 10^7 \times Q) - (3.41 \times 10^7 \times q_d)$	$(3.068 \times 10^7 \times Q) - (3.41 \times 10^7 \times q_d)$
0302	Walkers Creek [d,e]	TN05130202220_0200	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(2.955 \times 10^6 \times Q) - (3.28 \times 10^6 \times q_d)$	$(2.955 \times 10^6 \times Q) - (3.28 \times 10^6 \times q_d)$
	UT to Walkers Creek [d,e]	TN05130202220_0210				$(5.881 \times 10^7 \times Q) - (6.53 \times 10^7 \times q_d)$	$(5.881 \times 10^7 \times Q) - (6.53 \times 10^7 \times q_d)$
	Bakers Fork [d,e]	TN05130202220_0220				$(5.091 \times 10^6 \times Q) - (5.66 \times 10^6 \times q_d)$	$(5.091 \times 10^6 \times Q) - (5.66 \times 10^6 \times q_d)$
	Madison Creek [d,e]	TN05130202220_0400				$(3.388 \times 10^6 \times Q) - (3.76 \times 10^6 \times q_d)$	$(3.388 \times 10^6 \times Q) - (3.76 \times 10^6 \times q_d)$
	Center Point Branch [d,e]	TN05130202220_0500				$(1.269 \times 10^7 \times Q) - (1.41 \times 10^7 \times q_d)$	$(1.269 \times 10^7 \times Q) - (1.41 \times 10^7 \times q_d)$

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 Cheatham Lake Watershed (HUC 05130202)

HUC-12 Subwatershed (05130202__)	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]
0304	UT to Richland Creek [d,e]	TN05130202314_0100	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(1.155 \times 10^8 \times Q) - (1.28 \times 10^8 \times q_d)$	$(1.155 \times 10^8 \times Q) - (1.28 \times 10^8 \times q_d)$
	Murphy Road Branch [d,e]	TN05130202314_0200				$(3.212 \times 10^7 \times Q) - (3.57 \times 10^7 \times q_d)$	$(3.212 \times 10^7 \times Q) - (3.57 \times 10^7 \times q_d)$
	Belle Meade Branch [d,e]	TN05130202314_0500	$1.2 \times 10^{10} \times Q$	$1.2 \times 10^{9} \times Q$	$(1.2 \times 10^{10} \times q_m)$	$(1.347 \times 10^7 \times Q) - (1.50 \times 10^7 \times q_d)$	$(1.347 \times 10^7 \times Q) - (1.50 \times 10^7 \times q_d)$
	Chickering Branch [d,e]	TN05130202314_0600				$(1.856 \times 10^7 \times Q) - (2.06 \times 10^7 \times q_d)$	$(1.856 \times 10^7 \times Q) - (2.06 \times 10^7 \times q_d)$
0305	UT to Browns Creek [d,e]	TN05130202023_0400	$2.3 \times 10^{10} \times Q$	$2.3 \times 10^{9} \times Q$	$(2.3 \times 10^{10} \times q_m)$	$(2.981 \times 10^7 \times Q) - (3.31 \times 10^7 \times q_d)$	$(2.981 \times 10^7 \times Q) - (3.31 \times 10^7 \times q_d)$

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

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 (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 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 CHEATHAM LAKE WATERSHED (HUC 051310202), TENNESSEE

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

A number of waterbodies in the Cheatham Lake River watershed are listed on Tennessee's Final 2020 List of Impaired Waters as not supporting designated use classifications due, in part, to pasture grazing or municipal (urbanized high density area). 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 15.9-94.0% in the listed waterbodies.

The Cheatham Lake 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

Dennis Borders, P.E., Watershed Planning Unit
Telephone: 615-532-0706

Persons wishing to comment on the proposed TMDLs are invited to submit their comments in writing no later than
February 22, 2022 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

I.1 Letter from Kevin Key

RECEIVED
FEB 22 2022
By

February 17th, 2022

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

Re: Proposed e. coli TMDL
Cheatham Lake watershed

Dear Sirs,

I set forth a few comments on the proposed Cheatham Lake TMDL.

1) Vaughns Gap Branch is listed on being on the grounds of Belle Meade mansion historic area. The confluence of Vaughns Gap Branch is approximately 100 yards upstream of the Belle Meade mansion historic property. If this stream is removed from classification as an exceptional stream, then the single occurrence limit would be 941 cfu rather than the 487 cfu for e. coli. Vaughns Gap Branch does flow into the 3000 segment of Richland Creek which does flow through the Belle Meade mansion grounds.

2) One of the testing points is listed as Ezell Park and Harding Pike. The latter should be Harding Place.

3) Metro Water Services has eliminated 26 CSO points along the Cumberland River rather than 27. Of the remaining six, Driftwood has not overflowed since the May, 2010 flood. It could be noted that three more, Boscobel, Benedict & Crutcher, and Schrader are to be eliminated under the EPA approved LTCP amendment. In addition, Metro Water Services is expanding the Central Plant by 75 MGD among other steps which should reduce or possibly eliminate CSO's from the Kerrigan CSS.

4) Indian Creek is listed as subject to remediation as an agricultural area. While the description of e. coli issues from agriculture is correct historically, this area is rapidly suburbanizing and any steps to remediate agricultural practices would be an ineffective allocation of resources. Perhaps Blue Spring Creek would be a better example for agricultural remediation.

Thank you for your consideration of these points.

Sincerely yours,

Kevin S. Key

I.2 Letter from TDOT

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

JOSEPH GALBATO, III
INTERIM COMMISSIONER

BILL LEE
GOVERNOR

February 22, 2022

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 Cheatham Lake 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 Cheatham Lake Watershed (HUC 05130202). 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 the only 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. **TDOT 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 MS4 Program has been acquiring and analyzing samples of post-construction stormwater runoff from state highways and facilities over the past 14 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 also investigated 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 Cheatham Lake 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

The final sentence of Section 9.4.2 of the subject document states: "…MST has great potential to improve water quality management and help protect public health." TDOT agrees with this statement and encourages TDEC to work with them in pursuing the use of MST in TMDL analyses.

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, that 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 a listed MS4 point source for the pollutant loading that is the subject of the TMDL.

2. **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 1,862 outfall locations. The total area within the TDOT MS4 that would drain to these 1,862 point source outfalls is calculated to be 5,334.89 acres. However, the total drainage area of the evaluated impaired stream segments is 141,731.52 acres. Thus, the TDOT MS4 drainage area is less than 3.76% 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 3.76% 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://www3.epa.gov/caddis/ssr_urb_is4.html
   - Center for Watershed Protection: The Importance of Imperviousness
     http://scc.wa.gov/wp-content/uploads/2015/06/The-Importance-of-Imperviousness_Schueler_2000.pdf
   - 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 3.76% 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 3.76% 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.

3. **If the TDOT MS4 post-construction stormwater discharges continue to be identified as a source of pathogen contamination, then TDOT respectfully requests clarification that identifies the TDEC recommended criteria to be used to demonstrate compliance with its current MS4 Permit and TMDL requirements.** In a TDEC response to TDOT comments regarding a previous TMDL document, TDEC has stated:

> "... as long as TDOT meets the requirements of their MS4 permit, they will be considered to be consistent with the assumptions and requirements of the WLAs of this TMDL."

However, Section 9.2.2 of this TMDL document states:

> "For discharges from current and future regulated municipal separate storm sewer systems (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 BMPs is also typically included in the SWMP."

Considering that the current TDOT MS4 Permit does not include a requirement for a specific Storm Water Management Plan (SWMP) and does not include a monitoring component to assess the effectiveness of BMPs. The current version of the TDOT MS4 Permit only requires stormwater sampling and does not require any specific in-stream sampling. TDOT requires clarification and guidance on how compliance with the current TDOT MS4 Permit is in line with this section of the TMDL document.

Additionally, in Table 10 (Page 47) of the subject TMDL document, a specific numeric WLA is provided for MS4s in each subwatershed. In footnote "b" for the MS4 WLA it states:

> " Applies to any MS4 discharge loading in the subwatershed."

Since the TDOT MS4 discharges into all of the impaired subwatersheds included in the TMDL document, the implication would appear to be that the TDOT MS4 is subject to the numeric WLA in those subwatersheds. 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 TDEC's documented statement of permit compliance.

TDOT requests assistance and guidance from TDEC for the clarification of this apparent inconsistency in the required criteria for compliance. If the criterion from the previous comment response is applicable, TDOT will require clear and specific guidance as to how to demonstrate compliance with the stormwater characterization and discharge control measures required in Section 2.2 of its current MS4 Permit. This is of critical importance as a revision to the existing TDOT permit is expected to be under development in the near future; thus, it is unclear what the specific measures that will be required are at this juncture which are necessary to comply with the requirements in Section 2.2 of the current version of the TDOT MS4 Permit. If the numeric criterion from this TMDL document is applicable, TDOT respectfully requests that TDEC provide their guidance on the specific methods and requirements for the translation of stormwater discharge monitoring measurements into pathogen levels which would correspond to the stated numeric in-stream criteria.

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 1, 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 2), along with TDOT's low flow volume contribution relative to a typical receiving stream, 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 Cheatham Lake 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 or 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.

6. **TDEC indicates there is a relationship between sediment levels and pathogen loading.** The second paragraph of Section 9.3.1 discusses the purported relationship between sediments and pathogen contamination levels in stormwater treatment systems. This purported relationship in stormwater is also alluded in to in Section C.2 (Appendix C) regarding the development of WLAs for MS4s. TDOT has sponsored extensive sampling and analysis of pathogen transport in stormwater and streams and the indications are that pathogen development and transport is very complex and is not well understood. For example, a highway stormwater runoff treatment study that TDOT is currently performing has to date achieved Total Suspended Solids (TSS) reductions in treated highway stormwater runoff of greater than 90%. However, results from the same post-treatment sampling include pathogen (i.e. E.coli) levels that have not shown any corresponding decrease in concentration.

   Additionally, a recent report from the International Stormwater BMP Database (2020 Summary Statistics page 27) stated:

> *"With regard to bacteria association with specific particle sizes, only a limited number of studies exist and their results are not consistent enough to predict particle size associations. As an example, Jeng et al. (2005) found that between 63% and 88% of fecal coliform bacteria in stormwater exist as free-floating in the water column and not associated with suspended sediment."*

Clearly TSS reduction is not an "indicator" of pathogen reduction for this treatment method. TDOT requests that the source for the basis of the purported relationship between sediment levels and pathogen in stormwater and treatment systems be provided so TDOT can incorporate this information into its current programs.

Section C.2 (Appendix C) also states: "E.coli loading from MS4s is the result of buildup/wash-off processes associated with storm events." The TDOT MS4 has to date collected and analyzed over 1,230 post-construction stormwater samples for a number of potential contaminants, including E.coli. No clear correlation with antecedent rainfall intervals has been established from any of the analyses for any parameter. TDOT requests that TDEC provide the stormwater data that supports the comment from Section C.2 and/or provide a citation in the literature which establishes this correlation from Tennessee stormwater sampling.

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 1,862 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.

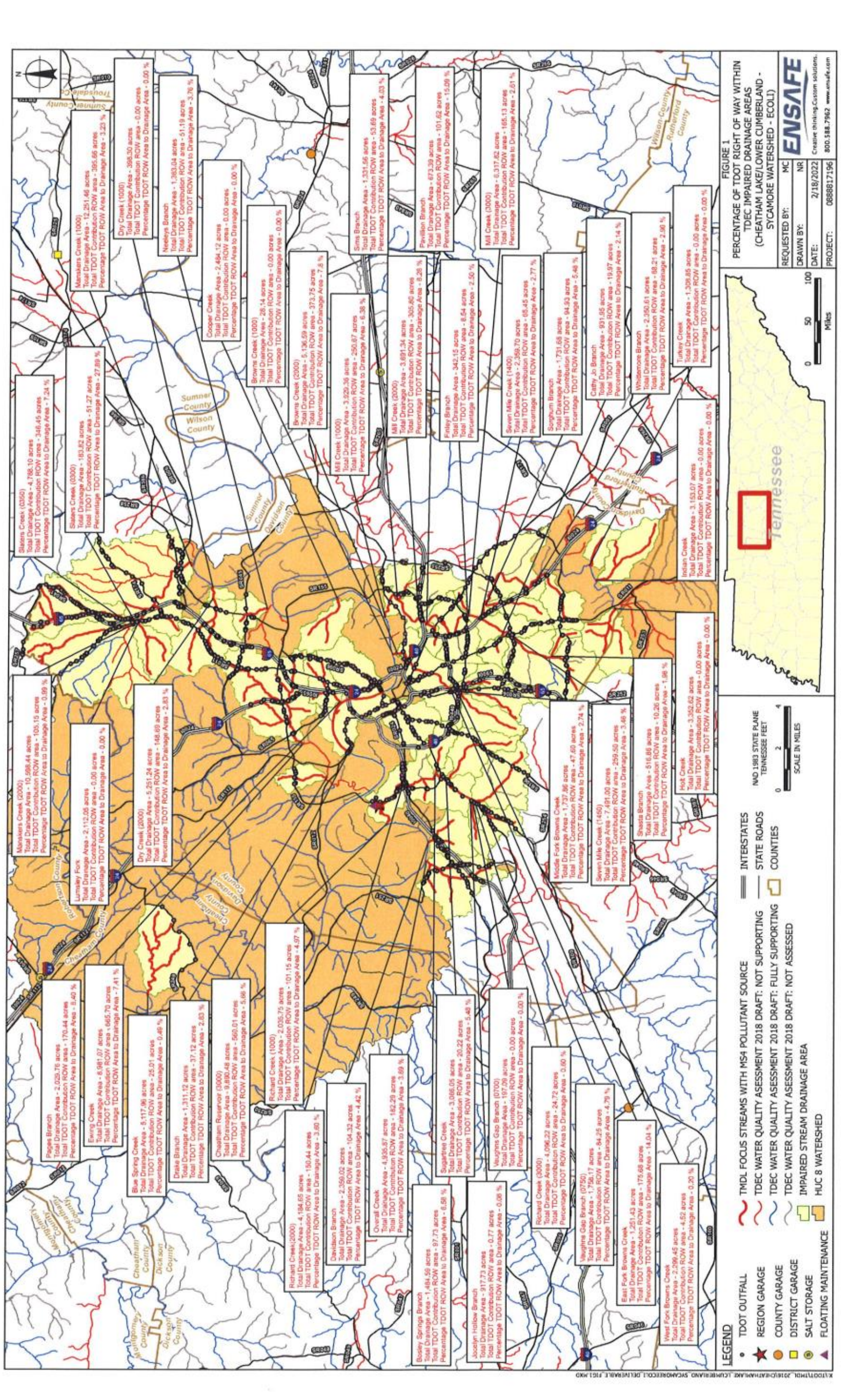
TDOT does not believe that the inclusion of its MS4 as a point source for the pollutant loading which is the subject of this TMDL is appropriate or in the overall best interest of the State of Tennessee. From this evaluation of the proposed TMDL document, the post-construction stormwater runoff from 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 documentation, please contact me at Klint.Rommel@tn.gov or at 615-253-2419.

Sincerely,

Klint Rommel
TDOT Environmental Division
Environmental Compliance Office Manager

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



I.3 Letter from Harpeth Conservancy

HARPETH
CONSERVANCY

February 22, 2022

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

Re: PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR *E. COLI* IN CHEATHAM LAKE WATERSHED (HUC 051310202), TENNESSEE

Dear Sir or Madam:

Thank you for the opportunity to comment on the proposed TMDL. Harpeth Conservancy ("HC") is a science-based conservation organization dedicated to clean water and healthy ecosystems for rivers in Tennessee. Since 1999, the Harpeth Conservancy's mission is to restore and protect clean water and healthy ecosystems for rivers in Tennessee. We employ scientific expertise and collaborative relationships to develop, promote and support broad community stewardship and action. HC's areas of concern include the Richland Creek and Mill Creek watersheds in the Nashville area.

We offer these comments because it is important to note the purposes of a TMDL, and the uses to which a TMDL is supposed to be put – cleaning up an impaired waterway.[1] Unfortunately, the TMDL falls considerably short of its statutory goals, and we must respectfully request that the Department strengthen this proposed TMDL or "start over." Our principal concern is that the TMDL does NOT offer any realistic plan for attaining the statutory goals of a TMDL – cleaning up the impaired waterways – in any timeframe whatsoever -- so that they can be removed from the state's list of impaired waters under Tennessee law or the federal Clean Water Act (CWA) section 303(d).[2] **A principal issue with the TMDL is that the so-called implementation plan (Section 9 of the TMDL) does not propose any realistic way – including any credible monitoring plan – to assure improvement in the waterways of Cheatham Lake sufficient to restore these waterbodies.**

Cleaning up Nashville's urban waterways is critically important for the next stage of the City's development – a massive turn toward the Cumberland River and Cheatham Lake.

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[1] *See* the Tennessee Water Quality Control Act ("TNWQCA"), T.C.A. § 69-3-101 *et seq*., incl.§ 69-3-102(c).
[2] 33 U.S. Code § 1313(d).

Given the example such river-facing development can provide for the entire state, TDEC must take this opportunity to "get it right."

With Nashville's Growth Turning to the Cumberland River and Cheatham Lake, the Need to Improve Water Quality is Urgent

As was recently observed in *The Tennessean*:

> Nashville's urban core is on the verge of a historic blitz of riverfront development meant to hoist the city into the future with a new look and feel, laying crucial groundwork for entire new neighborhoods built to grow up and sprawl out for decades.
>
> In the initial surge, downtown's footprint will more than double as new bridges and other connections bring it across the river that now divides the state's most lucrative urban tourism center.
>
> The Cumberland River's downtown bend is the centerpiece of the vision, which is largely shared by city leaders and developers sinking billions into a series of massive projects along the river.
>
> In an unprecedented boom period that has seen shimmering glass office towers, high-end condo buildings and elegant hotels rise in nearly every corner of the city, the Cumberland has remained an afterthought, skirted by industrial land traveled mostly by barges.
>
> Now, Nashville is turning to face the river. [3]

With such increased river-focused development, more people will actually be using and will be ***in*** the waters in the Cheatham Lake area, and clean water will be an important economic asset to the area. Conversely, failing to have clean, healthful water will detract from that development and the economic benefits it promises to all.

Indeed, it is questionable whether any source that might substantially contribute to failure to meet water quality standards ("WQS")[4] for *E. coli* can be permitted. Under settled law, a permit cannot be issued for any new or increased source of a pollutant for which a waterbody is already listed if it would result in measurable degradation.[5] Thus, Nashville's ability to develop its riverfront should not be imperiled by failing to clean up waterbodies surrounding Cheatham Lake.

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[3] Sandy Mazza, Cassandra Stephenson and Arcelia Martin, ***Nashville's next chapter is being written on the banks of the Cumberland***, THE TENNESSEAN, Jan. 2, 2022, available at https://www.tennessean.com/in-depth/news/2022/01/02/nashville-downtown-riverfront-development-along-cumberland-new-neighborhoods/8911596002/ (accessed Feb. 15, 2022)

[4] The CWA requires states to establish WQS. *See generally* 40 C.F.R. § 131.

[5] TDEC's rules provide that when a water is impaired by a particular pollutant (it has an "unavailable parameter") new or increased discharges are NOT allowed if measurable degradation would result: "In waters with unavailable parameters, new or increased discharges that would cause measurable degradation of the parameter that is unavailable shall not be authorized…. " TN Comp. R. & Regs., Rule § 0400-40-03-.06(2)(a). Note also that general antidegradation and anti-backsliding rules must also be complied with. " TN Comp. R. & Regs., Rule § 0400-40-03-.06 and Rule § 0400-40-05-.08(1)(j).

The Purposes of the Tennessee Water Quality Control Act and CWA

The purposes of the Tennessee Water Quality Control Act ("TNWQCA") are well-known and consistent with those of the CWA[6]:

> **(a)** Recognizing that the waters of Tennessee are the property of the state and are **held in public trust for the use of the people of the state**, it is declared to be the public policy of Tennessee that the people of Tennessee, as beneficiaries of this trust, **have a right to unpolluted waters**. In the exercise of its public trust over the waters of the state, the government of Tennessee has an obligation to take all prudent steps to secure, protect, and preserve this right.
>
> **(b)** It is further declared that the **purpose of this part is to abate existing pollution of the waters of Tennessee, to reclaim polluted waters, to prevent the future pollution of the waters,** and to plan for the future use of the waters so that the water resources of Tennessee might be used and enjoyed to the fullest extent consistent with the maintenance of unpolluted waters.[7]

TMDLs are supposed to be part of a robust and vigorous effort to clean up and restore our waterways, and not a mechanistic exercise. Every two (2) years, states are required to assess their waters and report to the US Environmental Protection Agency ("USEPA") those waters which do not meet water quality standards ("WQS") that the states themselves set. [8]

Waters that do not meet state WQS even after the using "end-of-pipe" discharge controls[9] are supposed to go through the process of preparing a "total maximum daily load" or "TMDL."

The goal of a TMDL is to clean up the affected waterway by achieving the applicable WQS:

> Each State shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the Administrator identifies under section 1314(a)(2) of this title as suitable for such calculation. <u>**Such load shall be established at a level necessary to implement the applicable water quality standards**</u> with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.[10]

Federal regulations further amplify this goal – that TMDLs **must be designed to achieve WSQ**:

> Each State shall establish TMDLs for the water quality limited segments identified in paragraph (b)(1) of this section, and in accordance with the priority ranking. For pollutants other than heat, <u>**TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical WQS**</u> with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water

[6] 33 U.S. Code § 1251(a).
[7] T.C. A. § 69-3-102 (emphasis added).
[8] 33 U.S. Code § 1313(a)-(d).
[9] Formally "technology-based effluent limits" or "TBELS" under, e.g., 40 C.F.R.§ 125.3(a).
[10] 33 U.S. Code § 1313(d)(1)(c) (emphasis added).

> quality. Determinations of TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters.[11]

Simply put, if a TMDL does not comply with these requirements, USEPA is not supposed to approve it, and thus, by definition, it will not meet WQS, and the waterway cannot be removed from the 303(d) list.

The TMDL's Treatment of Point Source Issues Raises Questions about Tennessee's Commitment to Improving Water Quality

The TMDL's treatment of point source issues raises questions about Tennessee's commitment to improving water quality. First, Section 8.7 of the TMDL ("Determination of WLAs & LAs") provides that:

> 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.

Section 9.2.1 of the TMDL ("NPDES Regulated Municipal Wastewater Treatment Facilities") similarly states that:

> 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. (Emphasis added.)

Thus, the TMDL is effectively ignoring its statutory place and purpose. TMDLs are required when existing controls such as TBELS are unable to cause the waterbody to come into compliance with WQS. In the case of the waterbodies in the Cheatham Lake watershed subject to the TMDL, by definition, the existing controls such as TBELS are simply "not doing the job."[12] The existing controls are not improving water quality even though the applicable WWTPs are meeting permit requirements and presumably the TBELS on which those permits rely. Yet, the TMDL says that "no additional reduction is required." This flies in the face of accepted law and practice about how improvements in water quality are supposed to be achieved.[13] Such improvements can be done through a TMDL,[14] but regulators cannot wait for a

[11] 40 C.F R. § 130.7(c)(1) (emphasis added).
[12] This is without even reaching the issue of the number of unassessed streams in the Cheatham Lake area.
[13] 33 USC §§ 1311(b)(1(C), 1312(a), 1313(e)(3)(A), 40 CFR § 122.44(d).
[14] *See* 33 USC § 1313(d)(1)(C), 40 CFR § 130.7(c)(1).

TMDL to be completed.[15] Permits are required to include "any more stringent limitation, including those necessary to meet water quality standards."[16]

The TMDL Wrongfully Rejects the First and Perhaps Most Effective Tool for Improving Water Quality

The TMDL wrongfully rejects the first and perhaps most effective tool for improving water quality – the reduction in permit discharge limits from point sources. The TMDL offers no specific assurances that WQS will be met, or any timetable for attaining WQS. It is well settled that the first step a regulatory agency must take to improve water quality when confronted with such a situation, is to reduce the permitted waste load allocations of contributing point sources (such as publicly-owned treatment works or "POTWs"). As a leading authority in the field notes:

> "[W]here a state reduces the WLAs in a TMDL based upon anticipated future reductions in nonpoint source loading, the state should provide specific assurances that the reductions will in fact occur. Absent such assurances, the state must allocate the entire load reduction necessary to attain water quality standards to point sources."[17]

The TMDL not only declines to provide such "specific assurances" it also refuses to consider any further load reductions for point sources. AND, on top of this, it refuses to consider what WQBELs may be necessary to attain WQS.

TDEC's Treatment of Nonpoint Source Pollution Shows it is Not Serious About Implementing Measures to Improve Water Quality

The TMDL's treatment of nonpoint source pollution is further evidence that it is not serious about implementing measures to meet its own water quality standards. For example, section 9.3 ("Nonpoint Sources (NPS)") of the TMDL states that:

> 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

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[15] *See, e.g., Upper Blackstone Water Pollution Abatement District v. U.S. EPA, 690 F.3d 9, n 8. (1st Cir. 2012); City of Taunton Dept. of Public Works, 17 EAB (Env. Appeals Board 5/3/2016), aff'd, City of Taunton v. United States Environmental Protection Agency, 895 F.3d 120 (1st Cir. 2018). 40 CFR § 122.44(d); American Paper Institute v. U.S. EPA, 996 F.2d 346, 350 (D.C. Cir. 1993). Prairie Rivers Network v. Illinois Pollution Control Board, 2016 IL App (1st) 150971 ¶¶29-33, 38 (Ill. App. Ct. 2016); Ala. Dept. of Env. Mgt. v. Ala. Rivers Alliance, Inc. 14 So. 3d 853, 866-68 (Ala. Civ. App. 2007).*

[16] 33 USC § 1311(b)(1)(C).

[17] Mark A. Ryan, Editor, THE CLEAN WATER ACT HANDBOOK (3rdEDITION) (American Bar Ass'n, 2011), Ch. 11 *citing* EPA, GUIDANCE FOR WATER QUALITY–BASED DECISIONS: THE TMDL PROCESS, ch.1 at 2, ch.2 at 8, ch.3 at 5 (Apr. 1991).

> 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.

The statement that TDEC has no direct regulatory authority over must NPS discharges is simply incorrect. TMDLs that deal only with nonpoint sources – not the case here -- are clearly allowed.[18]

The voluntary measures that TDEC suggests may help improve water quality cannot be considered as even a part of a program to improve water quality. Including programs like "Creek Critters, What's Up with Water Pollution, Get to Know Trees, and Career Chats" in TDEC's list of voluntary programs belie any intent to actually improve water quality. In fact, such programs originated not to directly improve water quality but as part of a Civil Penalty (the "State Project") under the Consent Decree for improvements to Nashville's sewer system.[19]

To similar effect are the "measures" provided in sections 9.3.1 ("Urban NPS") and 9.3.2 ("Agricultural NPS") of the TMDL. These sections are a *pro forma* catalog of pre-existing or potentially available "best management practices" (BMPs) which are already ineffective in achieving WQS. The TMDL makes no effort show how these BMPs will achieve WQS, or how existing BMPs might be tailored or improved, or what additional BMPs are required and how they will help, to achieve the statutory goal of removing the waterbodies from the 303(d) list.

The TMDL's Treatment of Stormwater Controls and Monitoring is Deficient

The portions of the TMDL's implementation plan dealing with stormwater controls and monitoring are also deficient and do not help assure attainment of WQS.

The most recent annual report (November 2021) on Metro Nashville's Municipal Separate Storm Sewer System (MS4) permit and TDEC's most recent compliance review of that program, finds Metro's program in compliance with permit requirements.[20] And yet, the waterbodies of Cheatham Lake subject to the TMDL are still coliform impaired. The TMDL does not make clear on what basis TDEC expects compliance with the present MS4 permit to allow WQS to be met.

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[18] *See, e.g.*, Pronsolino v. Marcus, 91 F. Supp. 2d 1337 (N.D. Cal. 2000), *aff 'd sub nom.* Pronsolino v. Nastri, 291 F.3d 1123 (9th Cir. 2002); Am. Farm Bur. Fed. v. USEPA, 984 F.Supp.2d 289 (M.D. PA 2013).

[19] Section IX.A.2. and Appendix F to the Consent Decree lodged October 24, 2007, in *United States of America and the State of Tennessee v. Metropolitan Government of Nashville and Davidson County, Tennessee*, US District Court, Middle District of Tennessee, Case 3-07-1056, available at https://www.epa.gov/enforcement/consent-decree-metropolitan-government-nashville-and-davidson-county-tenn-agree (accessed Feb. 9, 2022).

[20] 2021 Annual Report, Metro Nashville Municipal Separate Stormwater Permit TNS068047, and TDEC's review of same are both available at https://dataviewers.tdec.tn.gov/pls/enf_reports/f?p=9034:34051::::34051:P34051_PERMIT_NUMBER:TNS068047 (accessed Feb. 22, 2022).

For example, Section 9.2.2 of the TMDL at page 53 of 73, states that the TMDL depends on stormwater controls.[21] Yet, just a page away, at Section 9.3.1 of the TMDL at page 54 of 73, second paragraph, the TMDL does not express confidence in stormwater controls.[22]

The TMDL's treatment of monitoring (in Section 9.4.1) is also grossly deficient. The TMDL speaks of monitoring for "not less than one year." Monitoring is likely to be required for considerably longer than one year, particularly in light of the failure of the TMDL to require measures that are likely to attain applicable WQS.

Conclusion

We very much appreciate the opportunity to comment on the *E. coli* TMDL for Cheatham Lake. We do not believe that the TMDL is designed, not does it offer any realistic pathway or timetable, to attain Tennessee's WQS. As such, it fails to advance or achieve the basic purposes of the CWA or of Tennessee's Water Quality Control Act, namely, to "abate existing pollution of the waters of Tennessee, to reclaim polluted waters, to prevent the future pollution of the waters,...."

We are particularly concerned about these issues in light of the substantial increase in river-facing developments expected in the Nashville area. If we do not make a good start now on improving water quality in the Cheatham Lake area, that goal will be ever harder to achieve, with concomitant deleterious economic, public health, and environmental effects.

We respectfully request that TDEC substantially modify the TMDL so that it can achieve these purposes in a reasonable timeframe, or "start over" so that it can.

Sincerely yours,

Harpeth Conservancy

By: ______________
James M. Redwine, Esq.
Senior Policy Advisor

[21] "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."
[22] "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."

cc: Dorene Bolze
K. Grace Stranch, Esq.
Ryan Jackwood, Ph.D.
Tennessee Water Groups

Hon. John Cooper, Mayor, Metropolitan Government of Nashville & Davidson County, Tennessee
TDEC Commissioner David Salyers
TDEC Deputy Commissioner Gregory Young, Esq.
Director Jeaneanne Gettle, Water Division, USEPA Region 4

APPENDIX J

Response to Public Comments

J.1 Response to Letter from Kevin Key

1) The list of Exceptional Tennessee Waters (ETW) is updated as new data come in or mistakes are identified. Vaughns Gap was removed from the list of ETW sometime in the past six months. The table of Waterbodies Classified as ETW has been updated to reflect this change. TMDLs, WLAs, and LAs have also been updated.
2) We were unable to locate a testing point at Ezell Park or Ezell Pike anywhere in the document.
3) The number of CSO points has been updated.
4) Indian Creek may be changing but it will remain as an example of analysis for an agricultural area. Blue Spring Creek would not be a good example because there is much less monitoring data available and there were no exceedances to indicate a critical zone.

J.2 Response to Letter from TDOT

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.

J.3 Response to Letter from Harpeth Conservancy

TMDLs are developed using all data available at the time. Additional monitoring is recommended. However, TDEC has limited resources for monitoring. The Watershed Approach allows TDEC to focus efforts on the entire state, providing resources for monitoring each HUC-8 for one year during each five year cycle. We work with MS4 permittees and others to share data to further the assessment process and TMDL development. For example, we were able to use E. coli and PCR data collected by Metro Nashville in this Cheatham Lake E. coli TMDL.

The implementation section of the TMDL is currently very basic. TDEC plans to update the E. coli template in the future and hopes to grow the implementation plan and consider more specific measures. However, implementation plans are not a required element of EPA's TMDL approval process. Local citizen-led and implemented management measures have the potential to provide the most efficient and comprehensive avenue for reduction of loading rates from NPS.

Point sources in the Cheatham Lake watershed are permitted to discharge at or below the Water Quality Standards. No additional reduction in permitted discharges is required. All point sources listed in Table 6 discharge to the Cumberland River and therefore cannot contribute to impairment of other listed waterbodies. However, overflows and treatment bypasses are not permitted. Any occurrence must be reported and corrected. As a permit violation, it would be addressed by our Compliance and Enforcement section, not by a TMDL. DWR is in the process of implementing a better method to track overflows, including latitude/longitude of the overflow. All point sources listed in Table 6 now report their information electronically.

Nashville is one of three cities in Tennessee with a Combined Sewer System. CSOs can and do contribute to a condition of impairment. Segment 001_3000 of the Cumberland River/

Cheatham Reservoir was listed due to discharges from Nashville's CSS. However, due to elimination of many CSO discharge sites and reduction in CSO volume, the condition of this segment has improved (see Appendix F). Nashville is operating under a Long Term Control Plan and continues to make improvements to the CSS.

As stated in Section 9.3 of this TMDL, TDEC has no direct regulatory authority over most NPS discharges. TDEC does not have authority to "permit" agricultural or other NPS runoff. Agricultural sources simply have to follow "normal ag practices". Congress established the Nonpoint Source Program, which is funded by the USEPA through Section 319 of the CWA. In Tennessee, the Department of Agriculture administers the NPS program on behalf of USEPA. Funds are used to install BMPs to mitigate NPS pollution and to monitor water quality. The 319 program is non-regulatory, promoting voluntary, incentive-based solutions. The 319 program is not part of 303(d) program activities.

If the Harpeth Conservancy has specific concerns about stormwater monitoring under Nashville's MS4 permit, they are welcome to comment when that permit is placed on public notice later this year.