Final

Total Maximum Daily Load (TMDL)

For

Mulberry Creek

Assessment Unit ID# AL03150201-1006-101

Pathogens (*E. coli*)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
July 2021

Figure 1: Mulberry Creek Watershed

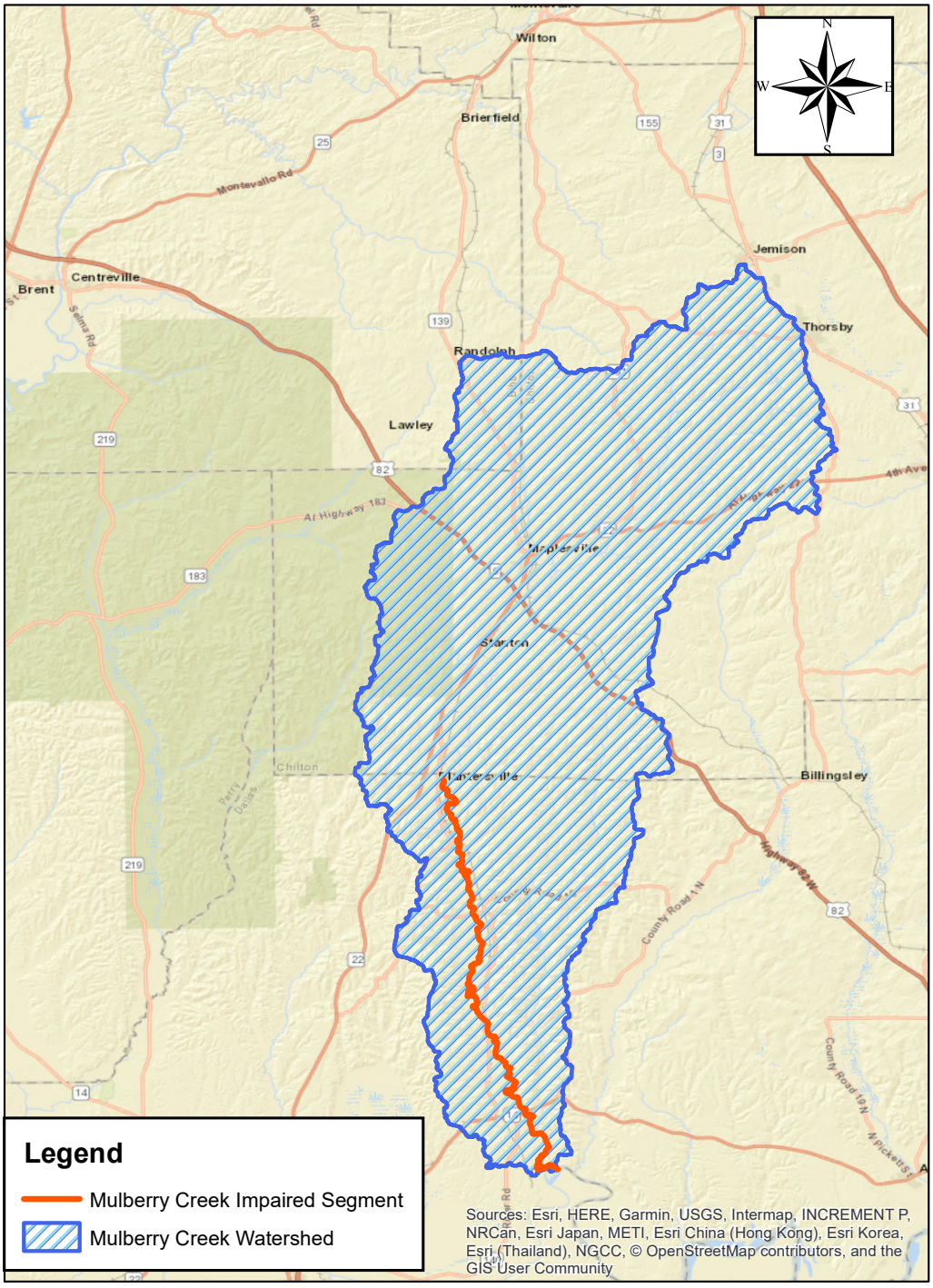


Table of Contents

List of Tables

List of Figures

1.0 Executive Summary

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify waterbodies which are not meeting their designated uses and to determine the total maximum daily load (TMDL) for pollutants causing the use impairment. A TMDL is the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources including natural background levels, and a margin of safety (MOS).

Mulberry Creek, from the Alabama River to Harris Branch, is currently included on Alabama's §303(d) list as impaired for pathogens (*E. coli*). This segment of Mulberry Creek, which is a part of the Alabama River basin, has a designated use classification of Swimming and Other Whole Body Water-Contact Sports/Fish and Wildlife (S/F&W). The headwaters of Mulberry Creek begins near Thorsby, Alabama. It flows along the Dallas County and Autauga County border and ends in Dallas County at its confluence with the Alabama River. The total drainage area for the Mulberry Creek watershed is approximately 277 square miles.

Mulberry Creek was first included on the §303(d) list as impaired for pathogens in 2016 based on data collected by the Alabama Department of Environmental Management (ADEM) from 2010 through 2014. The exceedances were found at station MULD-1. This data, which can be found in Table 3, indicated the stream was impaired for *E.coli*.

Sampling studies were performed by ADEM on Mulberry Creek to further assess the water quality of the impaired stream. For purposes of this TMDL, data from 2015 through 2020 will be used to assess the water quality of Mulberry Creek because it is the most current data and provides the best picture of the current water quality conditions of the stream. The 2020 edition of Alabama's Water Quality Assessment and Listing Methodology, section 4.8.2, prepared by ADEM, provides the rationale for the Department to use the most recent data to prepare a TMDL for an impaired waterbody. All of the recent bacteriological data is listed in the Appendix for reference. ADEM collected 29 samples from Mulberry Creek from 2015 to 2020 and, according to the collected data, Mulberry Creek was not meeting the pathogen criteria applicable to its use classification of S/F&W. Therefore, this TMDL has been developed for pathogens (*E. coli*) for Mulberry Creek.

A mass balance approach was used for calculating the pathogen TMDL for Mulberry Creek. The mass balance approach utilizes the conservation of mass principle. The TMDL was calculated using the single sample or geometric mean sample exceedance event that resulted in the highest percent reduction. Existing loads were calculated by multiplying the *E. coli* concentrations times the respective in-stream flows and a conversion factor. In the same manner as existing loads were calculated, allowable loads were calculated for the single sample *E. coli* target of 211.5 colonies/100 ml (235 colonies/100 ml – 10% Margin of Safety) and geometric mean *E. coli* target of 113.4 colonies/100 ml (126 colonies/100 ml – 10% Margin of Safety). In this case, it was determined that the highest percent reduction was calculated from a single sample *E. coli* violation of 3465.8 colonies/100 mL measured on May 1, 2017 at station MULD-1. This violation calls for a reduction of 94%.

Table 1 is a summary of the estimated existing load, allowable load, and percent reduction for the single sample criterion and the geometric mean criterion. Table 2 lists the TMDL, defined as the maximum allowable *E. coli* loading under critical conditions for Mulberry Creek.

Table 1. *E. coli* Loads and Required Reductions

Source	Existing Load (col/day)	Allowable Load (col/day)	Required Reduction (col/day)	% Reduction
Single Sample Load	8.21E+13	5.01E+12	7.71E+13	94%
Geometric Mean Load	1.60E+12	6.17E+11	9.83E+11	61%
Point Source Load - Maplesville WWTP*	3.82E+8	8.48E+8	0	0%
Point Source Load - Dallas County High School*	7.58E+4	2.03E+8	0	0%

*Point source allowable loads and load reductions are based on permit limits during the month of the highest *E. coli* exceedance.

Table 2. *E. coli* TMDL for Mulberry Creek

TMDL[e]	Margin of Safety (MOS)	Waste Load Allocation (WLA)[a]			Load Allocation (LA)	
		WWTPs[b]	MS4s[c]	Leaking Collection Systems[d]		
(col/day)	(col/day)	(col/day)	% reduction	(col/day)	(col/day)	% reduction
5.57E+12	5.57E+11	1.05E+9	N/A	0	5.01E+12	94%

Note: N/A = not applicable
a. There are no AFOs/CAFOs in the Mulberry Creek watershed. Future AFOs/CAFOs will be assigned a waste load allocation (WLA) of zero.
b. WLA for WWTPs is expressed as a daily maximum. Future WWTPs must meet the applicable instream water quality criteria for pathogens at the point of discharge.
c. Future MS4 areas would be required to demonstrate consistency with the assumptions and requirements of this TMDL.
d. The objective for leaking collection systems is a WLA of zero. It is recognized, however, that a WLA of 0 colonies/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in *E. coli* loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality criteria for *E. coli*.
e. TMDL was established using the single sample criterion of 235 colonies/100 ml.

Compliance with the terms and conditions of existing and future NPDES permits will effectively implement the WLA and demonstrate consistency with the assumptions and requirements of the TMDL. Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and may be eligible for CWA §319 grants.

The Department recognizes that adaptive implementation of this TMDL will be needed to achieve applicable water quality criteria, and we are committed to targeting the load reductions to improve water quality in the Mulberry Creek watershed. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL accordingly.

2.0 Basis for §303(d) Listing

2.1 Introduction

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify waterbodies which are not meeting their designated uses and to determine the total maximum daily load (TMDL) for pollutants causing use impairment. The TMDL process establishes the allowable loading of pollutants for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water-quality based controls to reduce pollution and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Alabama has identified the 22.2-mile segment of Mulberry Creek from the Alabama River to Harris Branch as impaired for pathogens (*E. coli*). Mulberry Creek was originally listed on Alabama's 2016 List of Impaired Waters for pathogens based on data collected from 2010 to 2014. The source of the pathogens impairment on the 2020 §303(d) list is pasture grazing.

2.2 Problem Definition

Waterbody Impaired:	Mulberry Creek – from the Alabama River to Harris Branch
Impaired Reach Length:	22.2 miles
Impaired Drainage Area:	277 square miles
Water Quality Standard Violation:	Pathogens (Single Sample Maximum, Geometric Mean)
Pollutant of Concern:	Pathogens (*E. coli*)
Water Use Classification:	Swimming and Other Whole Body Water-Contact Sports/Fish and Wildlife

Usage Related to Classification:
Mulberry Creek is classified as Swimming and Other Whole Body Water-Contact Sports (S)/Fish and Wildlife (F&W). Usage of waters in the Swimming and Other Whole Body Water-Contact Sports classification is described in ADEM Admin. Code R. 335-6-10-.09(3)(a) and (b).

(a) Best usage of waters: swimming and other whole body water-contact sports.

(b) Conditions related to best usage: the waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming areas and will be considered satisfactory for swimming and other whole body water-contact sports. The quality of waters will also be suitable for the propagation of fish, wildlife and aquatic life. The quality of salt waters and estuarine waters to which this classification is assigned will be suitable for the propagation and harvesting of shrimp and crabs.

Usage of waters in the Fish and Wildlife classification is described in ADEM Admin. Code R. 335-6-10-.09(5)(a), (b), (c), and (d).

(a) Best usage of waters: fishing, propagation of fish, aquatic life, and wildlife.

(b) Conditions related to best usage: the waters will be suitable for fish, aquatic life and wildlife propagation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propagation of shrimp and crabs.

(c) Other usage of waters: it is recognized that the waters may be used for incidental water contact year-round and whole body water-contact recreation during the months of May through October, except that water contact is strongly discouraged in the vicinity of discharges or other conditions beyond the control of the Department or the Alabama Department of Public Health.

(d) Conditions related to other usage: the waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming areas and will be considered satisfactory for swimming and other whole body water-contact sports.

<u>*E. coli* Criteria:</u>
Criteria for acceptable bacteria levels for the Swimming and Other Whole Body Water-Contact Sports use classification are described in ADEM Admin. Code R. 335-6-10-.09(3)(c)6(i), (ii), and (iii) as follows:

6. Bacteria:

(i) Waters in the immediate vicinity of discharges of sewage or other wastes likely to contain bacteria harmful to humans, regardless of the degree of treatment afforded these wastes, are not acceptable for swimming or other whole body water-contact sports.

(ii) In all other areas, the bacterial quality of water is acceptable when a sanitary survey by the controlling health authorities reveals no source of dangerous pollution and when the geometric mean E. coli organism density does not exceed 126 colonies/100 ml nor exceed a maximum of 235 colonies/100 ml in any sample in non-coastal waters. In coastal waters, bacteria of the enterococci group shall not exceed a geometric mean of 35 colonies/100 ml nor exceed a maximum of 104 colonies/100 ml in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not

less than 24 hours. When the geometric mean bacterial organism density exceeds these levels, the bacterial water quality shall be considered acceptable only if a second detailed sanitary survey and evaluation discloses no significant public health risk in the use of the waters.

(iii) The policy of nondegradation of high quality waters shall be stringently applied to bacterial quality of recreational waters.

Criteria for acceptable bacteria levels for the Fish and Wildlife classification are described in ADEM Admin. Code R. 335-6-10-.09(5)(e)7(i) and (ii) as follows:

7. Bacteria:

(i) In non-coastal waters, bacteria of the E. coli group shall not exceed a geometric mean of 548 colonies/100 ml; nor exceed a maximum of 2,507 colonies/100 ml in any sample. In coastal waters, bacteria of the enterococci group shall not exceed a maximum of 275 colonies/100 ml in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours.

(ii) For incidental water contact and whole body water-contact recreation during the months of May through October, the bacterial quality of water is acceptable when a sanitary survey by the controlling health authorities reveals no source of dangerous pollution and when the geometric mean E. coli organism density does not exceed 126 colonies/100 ml nor exceed a maximum of 298 colonies/100 ml in any sample in non-coastal waters. In coastal waters, bacteria of the enterococci group shall not exceed a geometric mean of 35 colonies/100 ml nor exceed a maximum of 158 colonies/100 ml in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours. When the geometric bacterial coliform organism density exceeds these levels, the bacterial water quality shall be considered acceptable only if a second detailed sanitary survey and evaluation discloses no significant public health risk in the use of the waters. Waters in the immediate vicinity of discharges of sewage or other wastes likely to contain bacteria harmful to humans, regardless of the degree of treatment afforded these wastes, are not acceptable for swimming or other whole body water-contact sports.

Criteria Exceeded:

Pathogens (*E. coli*) data collected from 2010 through 2014 was used for listing Mulberry Creek on Alabama's 2016 §303(d) list. Monthly *E. coli* sample results from MULD-1 showed 6 out of 15 samples exceeding the single sample criterion.

Table 3. 2010-2014 *E. coli* data from station MULD-1

Visit Date	*E. coli* (col/100 mL)	Detect Condition*
6/9/2010	59.1	-
8/11/2010	135.4	-
10/26/2010	260.3	-
5/11/2011	123.6	H
7/13/2011	686.7	H
9/13/2011	201.4	H
6/13/2011	547.5	-
8/8/2012	488.4	-
10/10/2012	53.8	-
6/6/2013	117.8	H
8/20/2013	770.1	-
10/8/2013	2419.6	G
5/14/2014	111.9	H
7/23/2014	81.3	H
9/17/2014	185	H

*G denotes that the actual number was probably greater than the number reported;
H denotes that the holding times for analysis were exceeded.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

On December 11, 2009, the Alabama EMC adopted the *E. coli* criteria as the bacterial indicator to assess the levels of bacteria in freshwater. Prior to the adoption of the *E. coli* criteria, the fecal coliform criteria were used by ADEM as the bacterial indicator for freshwater. The *E. coli* criteria were recommended by the EPA as a better correlation to swimming and incidental water contact associated health effects than fecal coliform in the 1986 publication *Quality Criteria for Water* (EPA 440/5-86-001). As a result of this bacterial indicator change, this TMDL will be developed from *E. coli* data collected at station MULD-1, which was sampled most recently from 2015 through 2020.

For the purpose of this TMDL, a single sample maximum *E. coli* target of 211.5 colonies/100 ml will be used. This target was derived by using a 10% explicit margin of safety from the single sample maximum criterion of 235 colonies/100 ml. This target is considered protective of water quality standards and should not allow the single sample maximum of 235 colonies/100 ml to be exceeded. In addition, a geometric mean *E. coli* target of 113.4 colonies/100 ml will be used for a series of five samples taken at least 24 hours apart over the course of 30 days. This target was derived by using a 10% explicit margin of safety from the geometric mean maximum of 126 colonies/100 ml criterion. This target is considered protective of water quality standards and should not allow the geometric mean of 126 colonies/100 ml to be exceeded.

3.2 Source Assessment

3.2.1 Point Sources in the Mulberry Creek Watershed

A point source can be defined as a discernible, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source contributions can typically be attributed to municipal wastewater facilities, illicit discharges, and leaking sewer systems in urban areas. Municipal wastewater treatment facilities are permitted through the National Pollutant Discharge Elimination System (NPDES) process administered by ADEM. In urban settings, sewer lines typically run parallel to streams in the floodplain. If a leaking sewer line is present, high concentrations of bacteria can flow into the stream or leach into the groundwater. Illicit discharges are found at facilities that are discharging bacteria when not permitted, or when the pathogens criterion established in the issued NPDES permit is not being upheld.

Continuous Point Sources

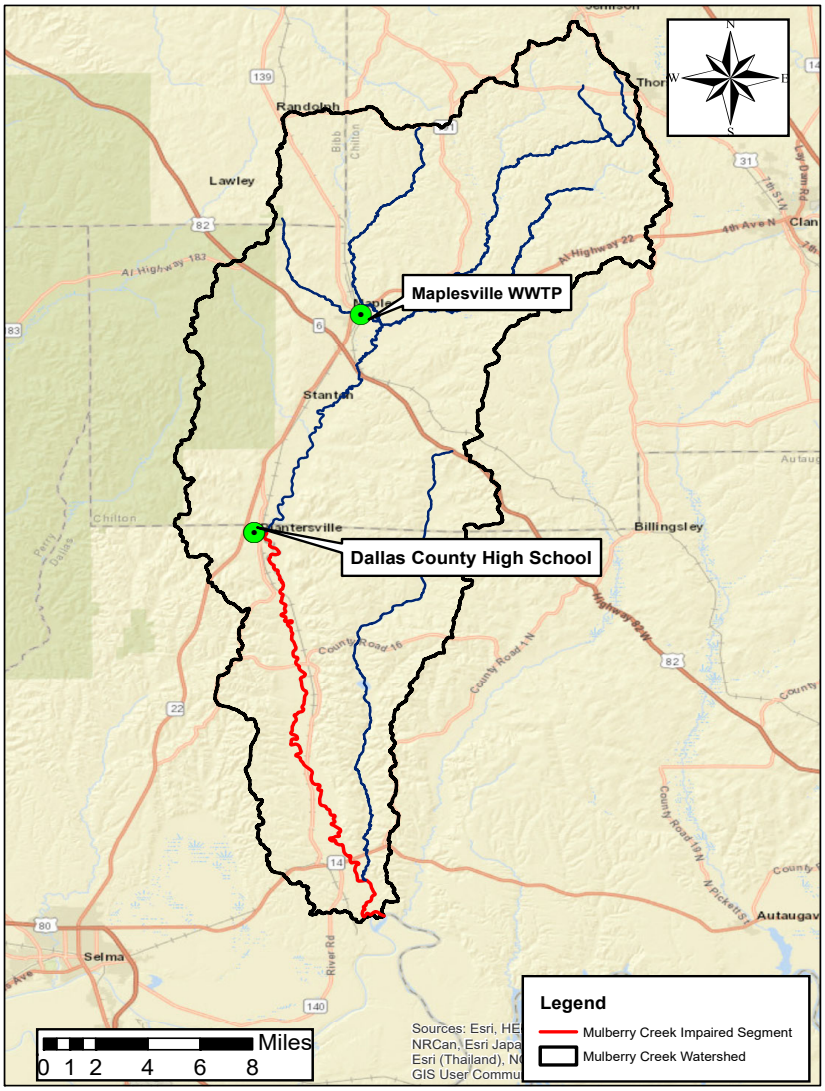
There are currently two NPDES-permitted continuous point sources in the Mulberry Creek watershed. They are as follows:

1. Maplesville WWTP (Permit Number AL0070858)
2. Dallas County High School (Permit Number AL0044342)

The Maplesville WWTP is a public municipal facility that is permitted to discharge to Byrd Creek, which is classified as Fish and Wildlife. It is located in the upper part of the Mulberry Creek watershed. The permit for the Maplesville WWTP has summer *E. coli* limits of 126 col/100 mL (monthly average) and 298 col/100 mL (daily maximum) and winter *E. coli* limits of 548 col/100 mL (monthly average) and 2,507 col/100 mL (daily maximum). These limits are equivalent to the pathogen criteria for the Fish and Wildlife use classification.

Dallas County High School is a semipublic/private facility that is permitted to discharge to an Unnamed Tributary to Mulberry Creek, which is classified as Fish and Wildlife. It is located near the top of the impaired segment of Mulberry Creek. The permit for Dallas County High School has summer *E.coli* limits of 126 col/100 mL (monthly average) and 298 col/100 mL (daily maximum) and winter *E. coli* limits of 548 col/100 mL (monthly average) and 2,507 col/100 mL (daily maximum). These limits are equivalent to the pathogen criteria for the Fish and Wildlife use classification.

Figure 2. NPDES Permitted Continuous Dischargers in the Mulberry Creek Watershed



Any future NPDES-regulated continuous discharges that are considered by the Department to be a pathogen source will be required to meet the in-stream water quality criteria for pathogens at the point of discharge.

Non-Continuous Point Sources

There are currently no Voluntary Animal Feeding Operations (AFOs) or Concentrated Animal Feeding Operations (CAFOs) in the Mulberry Creek watershed. In addition, the Mulberry Creek watershed does not presently qualify as a municipal separate storm sewer system (MS4) area.

There are several individual industrial and general NPDES permits in the watershed; however, it is not believed that they are contributing to the pathogen impairment in Mulberry Creek based on the nature of their activities. No *E. coli* loading will be attributed to these facilities, and they will not receive an allocation in this TMDL.

Future NPDES-regulated storm water discharges will be required to demonstrate consistency with the assumptions and requirements of this TMDL.

Sanitary sewer overflows (SSOs) have the potential to severely impact water quality and can often result in the violation of water quality standards. It is the responsibility of the NPDES wastewater discharger or collection system operator for non-permitted "collection only" systems to ensure that releases do not occur. Unfortunately, releases to surface waters from SSOs are not always preventable or reported. From review of ADEM files, it was found that the Maplesville WWTP and Dallas County High School have not reported any SSOs in recent years.

3.2.2 Nonpoint Sources in the Mulberry Creek Watershed

Nonpoint sources of bacteria do not have a defined discharge point, but rather occur over the entire length of a stream or waterbody. On the land surface, bacteria can accumulate over time and be washed into streams or waterbodies during rain events. Therefore, there is some net loading of bacteria into stream as dictated by the watershed hydrology.

Agricultural land can be a source of *E. coli* bacteria. Runoff from pastures, animal feeding areas, improper land application of animal wastes, and animals with direct access to streams are all mechanisms that can contribute bacteria to waterbodies. To account for the potential influence from animals with direct access to stream reaches in the watershed, *E. coli* loads can be calculated as a direct source into the stream.

E. coli bacteria can also originate from forested areas due to the presence of wild animals such as deer, raccoons, turkey, waterfowl, etc. Wildlife will deposit feces onto land surfaces, where it can be transported during rainfall events to nearby streams. Control of these sources is usually limited to land management best management practices and may be impracticable in most cases. As a result, forested areas are not specifically targeted in this TMDL.

E. coli loading from developed areas is potentially attributable to multiple sources including storm water runoff, unpermitted discharges of wastewater, runoff from improper disposal of waste materials, failing septic tanks, and domestic animals. On-site septic systems are common in unincorporated portions of the watershed and may be direct or indirect sources of bacterial pollution via ground and surface waters due to system failures and malfunctions.

3.3 Land Use Assessment

Land use for the Mulberry Creek watershed was determined using ArcMap with land use datasets derived from the 2016 National Land Cover Dataset (NLCD). The total drainage area of the Mulberry Creek watershed is approximately 277 square miles. Figures 3 and 4 and Table 4 depict the primary land uses in the Mulberry Creek watershed.

The majority of the Mulberry Creek watershed (84.51%) is forested/natural. The remaining land use is approximately 11% agricultural, 4% developed land, and 0.3% open water. Developed land includes both commercial and residential land uses.

Figure 3. Land Use in the Mulberry Creek Watershed

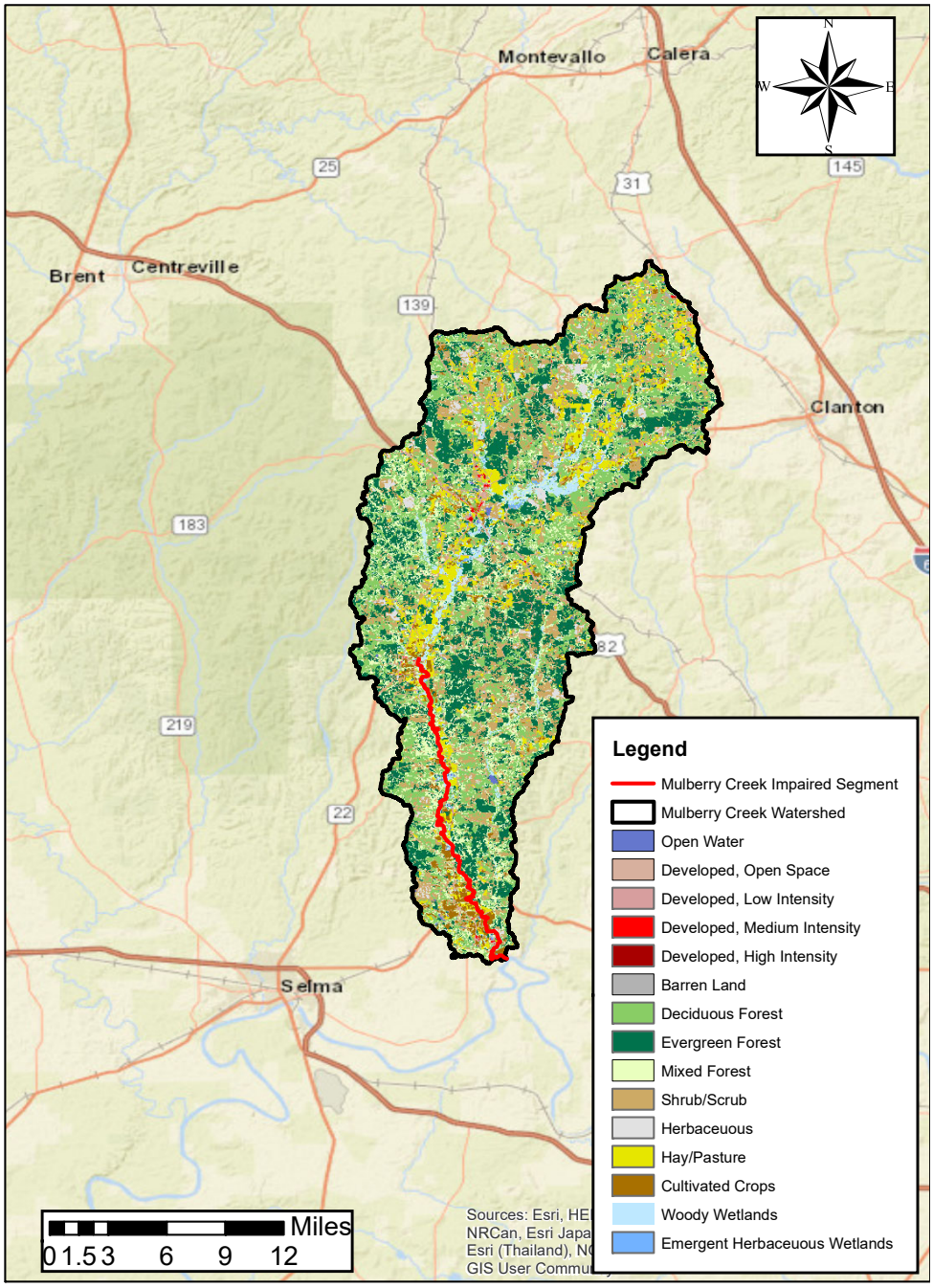


Figure 4: Pie Chart of Land Use Distribution in the Mulberry Creek Watershed

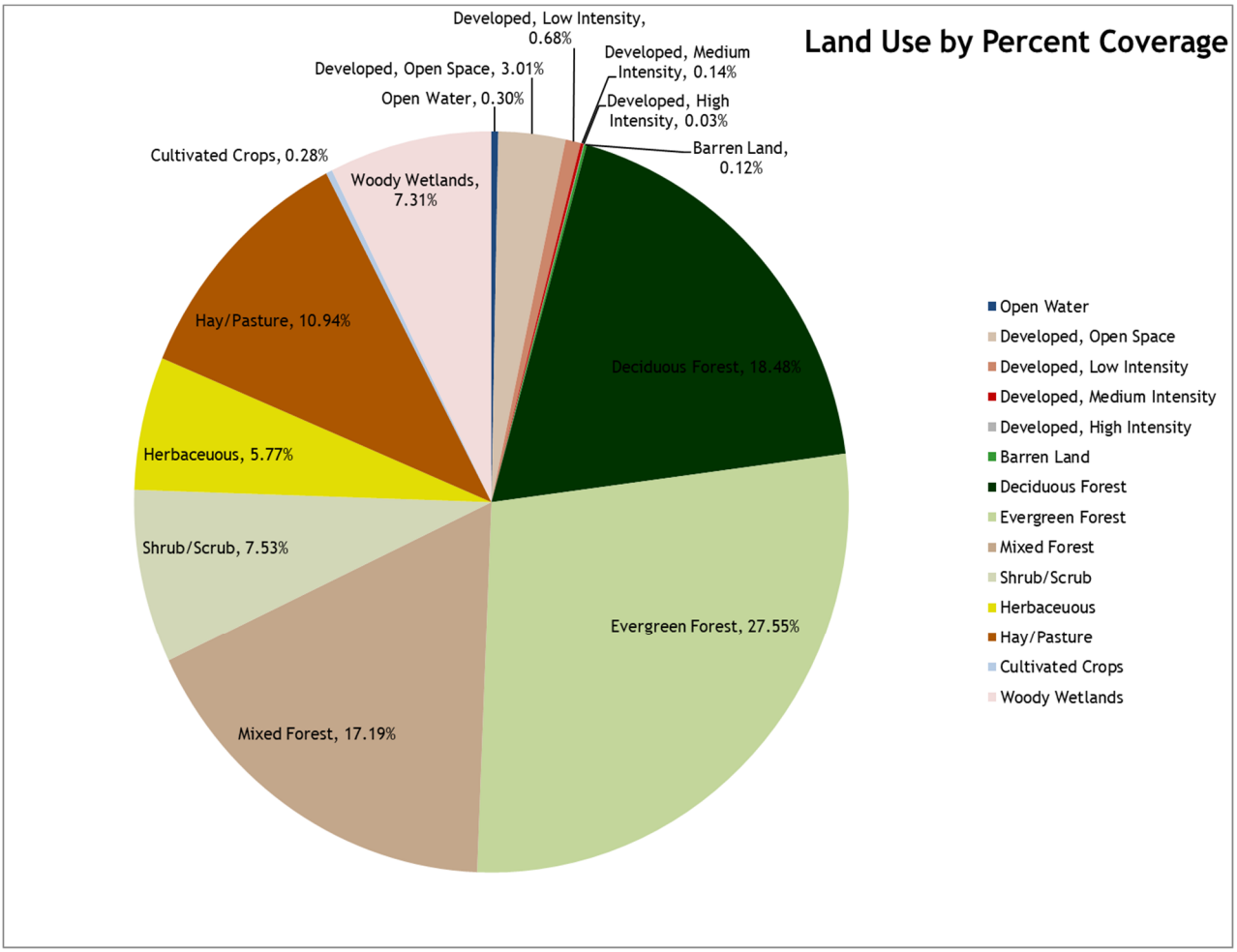


Table 4: Land Use (2016) in the Mulberry Creek Watershed

Land Use	Miles^2	Acres	Percent
Open Water	0.84	537.97	0.30
Developed, Open Space	8.32	5327.69	3.01
Developed, Low Intensity	1.89	1207.83	0.68
Developed, Medium Intensity	0.37	239.30	0.14
Developed, High Intensity	0.07	45.59	0.03
Barren Land	0.32	207.49	0.12
Deciduous Forest	51.09	32696.71	18.48
Evergreen Forest	76.17	48747.61	27.55
Mixed Forest	47.54	30428.50	17.19
Shrub/Scrub	20.83	13328.12	7.53
Herbaceous	15.96	10211.70	5.77
Hay/Pasture	30.24	19353.69	10.94
Cultivated Crops	0.78	499.72	0.28
Woody Wetlands	20.22	12941.15	7.31
Emergent Herbaceous Wetlands	1.87	1196.26	0.68
Totals→	**276.51**	**176969.34**	**100.00%**
Class Description	**Miles^2**	**Acres**	**Percent**
Open Water	0.84	537.97	0.30
Agricultural Lands	31.02	19853.41	11.22
Forested/Natural	233.68	149550.06	84.51
Developed Land (Grouped)	10.97	7027.90	3.97
Totals→	**276.51**	**176969.34**	**100.00%**

3.4 Linkage between Numeric Targets and Sources

The major land usages in the Mulberry Creek watershed are forested/natural, agriculture, and developed land. Pollutant loadings from forested areas tend to be low due to their filtering capabilities and will be considered as background conditions. The most likely sources of pathogen loadings in Mulberry Creek are from the agricultural land uses in the area and leaking or failing septic tanks. It is not considered a logical approach to calculate individual components for nonpoint source loadings. Hence, there will not be individual loads or reductions calculated for the various nonpoint sources. The loadings will be calculated as a single total nonpoint source load and reduction.

3.5 Data Availability and Analysis

From 2015 to 2020, ADEM performed sampling on Mulberry Creek to further assess the water quality of the impaired stream. For purposes of this TMDL, data from 2015 to 2020 will be used to assess the water quality of Mulberry Creek because it is the most current data and provides the best picture of the current water quality conditions of the stream. The 2020 edition of Alabama's Water Quality Assessment and Listing Methodology, section 4.8.2, prepared by ADEM, provides the rationale for the Department to use the most recent data to prepare a TMDL for an impaired waterbody.

ADEM collected monthly water quality data for the Mulberry Creek watershed at station MULD-1 from 2015-2020. A description of the location of station MULD-1 can be found in Table 5, and a map showing the location of station MULD-1 can be found in Figure 5. A total of twenty-nine *E. coli* samples were collected at station MULD-1 from 2015 to 2020. Of the twenty-nine samples, there were eight exceedances of the single sample maximum criterion. The highest single sample violation was recorded on May 1, 2017 with an *E. coli* concentration of 3465.8 col/100 mL. In addition, sampling completed at station MULD-1 from June 10, 2020 through July 8, 2020 and September 10, 2020 through October 8, 2020 yielded geometric mean violations of 294.52 colonies/100 mL and 195.34 colonies/100 mL, respectively. A complete list of available data used in this report and photographs at station MULD-1 can be found in Appendices 7.2 and 7.3, respectively.

Table 5: ADEM Sampling Station in the Mulberry Creek Watershed

Station Name	Agency Name	Latitude	Longitude	Description
MULD-1	ADEM	32.58278	-86.90361	Dallas County Road 52 Bridge

Figure 5: ADEM sampling station in the Mulberry Creek Watershed

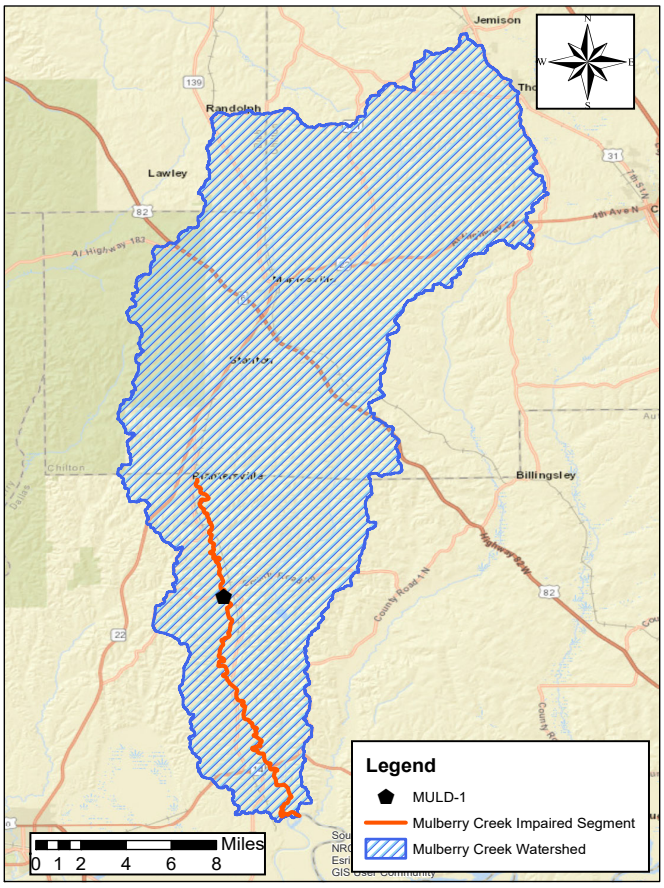


Table 6: *E. coli* Data on Mulberry Creek (AL03150201-1006-101)

Station ID	Visit Date	Single Sample (col/100 ml)	*E. coli* Dc	Single Sample Criteria	Geometric Mean (col/100 ml)	Geometric Mean Criteria (col/100 ml)	Flow (cfs)
MULD-1	5/19/2015	129.6	-	235			116
MULD-1	7/13/2015	67	-	235			79
MULD-1	9/17/2015	110.6	-	235			63
MULD-1	9/25/2015	-	-	235			-
MULD-1	5/4/2016	228.2	H	235			421
MULD-1	7/14/2016	305.8	-	235			135
MULD-1	9/15/2016	193.5	-	235			72
MULD-1	5/1/2017	3465.8	H	235			968
MULD-1	7/31/2017	86.7	H	235			101
MULD-1	10/16/2017	551	H	235			148
MULD-1	5/1/2018	155.3	H	235			313
MULD-1	7/10/2018	111.2	H	235			118
MULD-1	10/24/2018	178.5	-	235			98.2
MULD-1	7/16/2019	135.4	-	235			107
MULD-1	8/13/2019	129.1	-	235			71.1
MULD-1	9/3/2019	461.1	-	235			75
MULD-1	3/11/2020	152.9	-	235			818
MULD-1	5/13/2020	74.9	-	235			203
MULD-1	6/10/2020	1119.9	-	235	294.52	126	476
MULD-1	7/1/2020	570.2	-	235			300
MULD-1	7/6/2020	101.1	-	235			85.2
MULD-1	7/7/2020	275.5	-	235			122
MULD-1	7/8/2020	124.6	-	235			129
MULD-1	8/13/2020	65.7	-	235			-
MULD-1	9/10/2020	139.6	-	235	195.34	126	-
MULD-1	9/28/2020	152.9	-	235			31.1
MULD-1	9/29/2020	980.4	-	235			44.2
MULD-1	9/30/2020	114.5	-	235			36.5
MULD-1	10/8/2020	118.7	-	235			16.3
MULD-1	11/18/2020	143.9	-	235			126

*H denotes that the holding times for analysis were exceeded.

3.6 Critical Conditions/Seasonal Variation

The *E. coli* single sample maximum criterion of 235 colonies/100 ml and geometric mean criterion of 126 colonies/100 ml for the Swimming and Other Whole Body Water-Contact Sports use classification are applicable year-round. The critical condition for this pathogen TMDL was taken to be the one with the highest *E. coli* single sample exceedance value. The highest single sample maximum concentration of 3465.8 colonies/100 ml was collected on May 1, 2017. The measured flow on the date of the exceedance was 968 cfs. The use of the highest exceedance to calculate the TMDL is expected to be protective of water quality in Mulberry Creek year-round.

3.7 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in the TMDL analysis: 1) by implicitly incorporating the MOS using conservative model assumptions to develop allocations, or 2) by explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

The MOS accounts for the uncertainty associated with the limited availability of data used in this analysis. An explicit MOS was applied to the TMDL by reducing the appropriate target criterion concentration by ten percent and calculating a mass loading target with measured flow data. The single sample *E. coli* maximum value of 235 colonies/100 ml was reduced by 10% to 211.5 colonies/100 ml, while the geometric mean criterion was reduced in the same fashion to 113.4 colonies/100 ml.

4.0 TMDL Development

4.1 Definition of a TMDL

A total maximum daily load (TMDL) is the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources including natural background levels, and a margin of safety (MOS). The margin of safety can be included either explicitly or implicitly and accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. As discussed earlier, the MOS is explicit in this TMDL. A TMDL can be denoted by the equation:

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

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody while achieving water quality standards under critical conditions.

For some pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). However, for pathogens, TMDL loads are typically expressed in terms of organism counts per day (colonies/day), in accordance with 40 CFR 130.2(i).

4.2 Load Calculations

A mass balance approach was used to calculate the pathogen TMDL for Mulberry Creek. The mass balance approach utilizes the conservation of mass principle. Total mass loads can be calculated by multiplying the *E. coli* concentration times the in-stream flow times a conversion factor. Existing loads were calculated for the highest geometric mean sample exceedance and the highest single sample exceedance. In the same manner, allowable loads were calculated for both the single sample criterion and geometric mean criterion. The TMDL was based on the violation that produced the highest percent reduction of *E. coli* loads necessary to achieve applicable water quality criteria, whether it was the single sample or geometric mean sample.

4.2.1 Existing Conditions

The **single sample** mass loading was calculated by multiplying the highest single sample *E. coli* concentration of 3465.8 colonies/100 ml times the measured flow at the time the sample was taken. This concentration was measured at station MULD-1 on May 1, 2017. The product of the concentration, measured flow, and a conversion factor gives the total mass loading (colonies per day) of *E. coli* to Mulberry Creek under the single sample exceedance condition.

$$\frac{968\ \text{ft}^3}{\text{s}} \times \frac{3465.8\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{8.21 \times 10^{13}\text{colonies}}{\text{day}}$$

The **geometric mean** mass loading was calculated by multiplying the highest geometric mean exceedance concentration of 294.52 colonies/100 ml times the average of the five measured flows. This concentration was calculated based on measurements at station MULD-1 between June 10, 2020 and July 8, 2020 and can be found in Appendix 7.2, Table 9. The average stream flow was determined to be 222.44 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of *E. coli* to Mulberry Creek under the geometric mean exceedance condition.

$$\frac{222.44\ \text{ft}^3}{\text{s}} \times \frac{294.52\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.60 \times 10^{12}\text{colonies}}{\text{day}}$$

The **continuous point sources** mass loading was calculated by taking the average discharge flow from each facility for the month of May 2017 (since this is when the highest exceedance occurred) and multiplying that by the facility's reported maximum daily *E. coli* value for the same month and the conversion factor. The flows and *E. coli* values were found in the May 2017 Discharge Monitoring Reports (DMRs) submitted by the facilities. A loading was calculated for each point source included in the TMDL.

Maplesville WWTP:

$$0.0112\ MGD\ x\ \frac{1.55\ ft^3}{\text{s} * \text{MGD}} \times \frac{900\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.82 \times 10^{8}\text{colonies}}{\text{day}}$$

Dallas County High School:

$$0.001\ MGD\ x\ \frac{1.55\ ft^3}{\text{s} * \text{MGD}} \times \frac{2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{7.58 \times 10^4 \text{colonies}}{\text{day}}$$

4.2.2 Allowable Conditions

The **allowable load** to the watershed was calculated under the same physical conditions as discussed above for the single sample and geometric mean criteria. This was done by taking the product of the measured flow for the violation event, the allowable concentration, and the conversion factor.

For the **single sample** *E. coli* target concentration of 211.5 colonies/100 ml, the allowable *E. coli* loading is:

$$\frac{968\ \text{ft}^3}{\text{s}} \times \frac{211.5\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.01 \times 10^{12} \text{colonies}}{\text{day}}$$

The explicit margin of safety of 23.5 colonies/100 ml equals a daily loading of:

$$\frac{968\ \text{ft}^3}{\text{s}} \times \frac{23.5\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.57 \times 10^{11} \text{colonies}}{\text{day}}$$

For the **geometric mean** *E. coli* target concentration of 113.4 colonies/100 ml, the allowable *E. coli* loading is:

$$\frac{222.44\ \text{ft}^3}{\text{s}} \times \frac{113.4\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{6.17 \times 10^{11} \text{colonies}}{\text{day}}$$

The explicit margin of safety of 12.6 colonies/100 ml equals a daily loading of:

$$\frac{222.44\ \text{ft}^3}{\text{s}} \times \frac{12.6\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{6.86 \times 10^{10} \text{colonies}}{\text{day}}$$

The **point source** allowable loading was calculated by multiplying the design flow of each of the continuous dischargers in the Mulberry Creek watershed by their applicable daily maximum permit limit and the conversion factor. Since these facilities both discharge to waters with the Fish and Wildlife use classification and the instream violation causing the largest percent reduction occurred in May, the summer single sample maximum criterion for Fish and Wildlife waters is applicable. The loadings from both sources were added together for the total point source allowable loading.

Maplesville WWTP:

$$0.075\ MGD\ x\ \frac{1.55\ \text{ft}^3}{\text{s}} \times \frac{298\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{8.48 \times 10^8 \text{colonies}}{\text{day}}$$

Dallas County High School:

$$0.018\ MGD\ x\ \frac{1.55\ \text{ft}^3}{\text{s}} \times \frac{298\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{2.03 \times 10^8 \text{colonies}}{\text{day}}$$

The difference between the existing conditions (violation event) and the allowable conditions converted to a percent reduction represents the total load reduction needed to achieve the *E. coli* water quality criteria. The TMDL was calculated as the total daily *E. coli* load to Mulberry Creek as evaluated at station MULD-1. Table 7 shows the existing and allowable *E. coli* loads and required reductions for the Mulberry Creek watershed.

Table 7: *E. coli* Loads and Required Reductions

Source	Existing Load (col/day)	Allowable Load (col/day)	Required Reduction (col/day)	% Reduction
Single Sample Load	8.21E+13	5.01E+12	7.71E+13	94%
Geometric Mean Load	1.60E+12	6.17E+11	9.83E+11	61%
Point Source Load - Maplesville WWTP*	3.82E+8	8.48E+8	0	0%
Point Source Load - Dallas County High School*	7.58E+4	2.03E+8	0	0%

*Point source allowable loads and load reductions are based on permit limits during the month of the highest *E. coli* exceedance.

From Table 7, compliance with the single sample *E. coli* criterion of 235 colonies/100 ml requires a reduction of 94% in the *E. coli* load. The TMDL, WLA, LA, and MOS values necessary to achieve the applicable *E. coli* criteria are provided below in Table 8.

Table 8: *E. coli* TMDL for Mulberry Creek

TMDL[e]	Margin of Safety (MOS)	Waste Load Allocation (WLA)[a]			Load Allocation (LA)	
		WWTPs[b]	MS4s[c]	Leaking Collection Systems[d]		
(col/day)	(col/day)	(col/day)	% reduction	(col/day)	(col/day)	% reduction
5.57E+12	5.57E+11	1.05E+9	N/A	0	5.01E+12	94%

Note: N/A = not applicable
a. There are no AFOs/CAFOs in the Mulberry Creek watershed. Future AFOs/CAFOs will be assigned a waste load allocation (WLA) of zero.
b. WLA for WWTPs is expressed as a daily maximum. Future WWTPs must meet the applicable instream water quality criteria for pathogens at the point of discharge.
c. Future MS4 areas would be required to demonstrate consistency with the assumptions and requirements of this TMDL.
d. The objective for leaking collection systems is a WLA of zero. It is recognized, however, that a WLA of 0 colonies/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in *E. coli* loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality criteria for *E. coli*.
e. TMDL was established using the single sample criterion of 235 colonies/100 ml.

4.3 TMDL Summary

Mulberry Creek was placed on Alabama's §303(d) list for pathogens (*E. coli*) in 2016 based on data collected from 2010 to 2014. Additional water quality data was collected by ADEM from 2015 to 2020. The data collected by ADEM during that sampling period confirmed the pathogen impairment and provided the basis for TMDL development.

A mass balance approach was used to calculate the *E. coli* TMDL for Mulberry Creek. Based on the TMDL analysis, it was determined that a 94% reduction in *E. coli* loading was necessary to achieve compliance with applicable water quality standards.

Compliance with the terms and conditions of existing and future NPDES sanitary and storm water permits will effectively implement the WLA and demonstrate consistency with the assumptions and requirements of the TMDL.

Required load reductions in the LA portion of this TMDL will be implemented through voluntary measures/best management practices (BMPs). Cooperation and active participation by the general public and various other groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. Therefore, TMDL implementation activities for nonpoint sources will be coordinated through interaction with local entities and may be eligible for CWA §319 grants through the Department's Nonpoint Source Unit.

The Department recognizes that adaptive implementation of this TMDL will be needed to achieve applicable water quality criteria, and we are committed to targeting the load reductions to improve water quality in the Mulberry Creek watershed. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL accordingly.

5.0 Follow-up Monitoring

ADEM has adopted a statewide approach to water quality management. Each year, ADEM's water quality resources are divided among multiple priorities statewide including §303(d) listed waterbodies, waterbodies with active TMDLs, and other waterbodies as determined by the Department. Monitoring will help further characterize water quality conditions resulting from the implementation of best management practices and load reductions in the watershed.

6.0 Public Participation

As part of the public participation process, this TMDL was placed on public notice and made available for review and comment. The public notice was prepared and published in the four major daily newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who requested to be on ADEM's postal and electronic mailing distributions. In addition, the public notice and subject TMDL were made available on ADEM's Website: www.adem.alabama.gov. The public could also request paper or electronic copies of the TMDL by contacting Ms. Kimberly Minton at 334-271-7826 or kminton@adem.alabama.gov. The public was given an opportunity to review the TMDL and submit comments to the Department in writing. At the end of the public review period, all written comments received during the public notice period became part of the administrative record. ADEM considered all comments received by the public prior to final completion of this TMDL and subsequent submission to EPA Region 4 for final approval.

7.0 Appendices

7.1 References

ADEM Administrative Code, 2017. Water Division - Water Quality Program, Chapter 335-6-10, Water Quality Criteria.

ADEM Administrative Code, 2017. Water Division - Water Quality Program, Chapter 335-6-11, Use Classifications for Interstate and Intrastate Waters.

Alabama's Monitoring Program. 2010-2020. ADEM.

Alabama Department of Environmental Management (ADEM), Alabama's Water Quality Assessment and Listing Methodology, 2020.

Alabama's §303(d) List and Fact Sheet. 2016, 2018, 2020. ADEM.

Alabama Department of Environmental Management (ADEM) Laboratory QA Manual, Chapter 10, Appendix A: ADEM Laboratory Qualifier Codes and Descriptions, 2016.

United States Environmental Protection Agency, 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Office of Water. EPA 440/4-91-001.

United States Environmental Protection Agency, 1986. Quality Criteria for Water. Office of Water. EPA 440/4-91-001.

7.2 Water Quality Data

Table 9: *E. coli* Data for Station MULD-1

Station ID	Visit Date	Single Sample (col/100 ml)	*E. coli* Dc	Single Sample Criteria	Geometric Mean (col/100 ml)	Geometric Mean Criteria (col/100 ml)	Flow (cfs)
MULD-1	5/19/2015	129.6	-	235			116
MULD-1	7/13/2015	67	-	235			79
MULD-1	9/17/2015	110.6	-	235			63
MULD-1	9/25/2015	-	-	235			-
MULD-1	5/4/2016	228.2	H	235			421
MULD-1	7/14/2016	305.8	-	235			135
MULD-1	9/15/2016	193.5	-	235			72
MULD-1	5/1/2017	3465.8	H	235			968
MULD-1	7/31/2017	86.7	H	235			101
MULD-1	10/16/2017	551	H	235			148
MULD-1	5/1/2018	155.3	H	235			313
MULD-1	7/10/2018	111.2	H	235			118
MULD-1	10/24/2018	178.5	-	235			98.2
MULD-1	7/16/2019	135.4	-	235			107
MULD-1	8/13/2019	129.1	-	235			71.1
MULD-1	9/3/2019	461.1	-	235			75
MULD-1	3/11/2020	152.9	-	235			818
MULD-1	5/13/2020	74.9	-	235			203
MULD-1	6/10/2020	1119.9	-	235			476
MULD-1	7/1/2020	570.2	-	235			300
MULD-1	7/6/2020	101.1	-	235	294.52	126	85.2
MULD-1	7/7/2020	275.5	-	235			122
MULD-1	7/8/2020	124.6	-	235			129
MULD-1	8/13/2020	65.7	-	235			-
MULD-1	9/10/2020	139.6	-	235			-
MULD-1	9/28/2020	152.9	-	235			31.1
MULD-1	9/29/2020	980.4	-	235	195.34	126	44.2
MULD-1	9/30/2020	114.5	-	235			36.5
MULD-1	10/8/2020	118.7	-	235			16.3
MULD-1	11/18/2020	143.9	-	235			126

*H denotes that the holding times for analysis were exceeded.

7.3 Mulberry Creek Watershed Photos

Figure 6: At Station MULD-1: Upstream View of Mulberry Creek (6/10/2020)

Figure 7: At Station MULD-1: Downstream View of Mulberry Creek (6/10/2020)