



Final
Total Maximum Daily Load (TMDL)
For
Bogue Chitto

Assessment Unit ID# AL03160106-0504-100

Pathogens (*E. coli*)

Pickens County

Alabama Department of Environmental Management
Water Quality Branch
Water Division
July 2024

Figure 1: Bogue Chitto Watershed

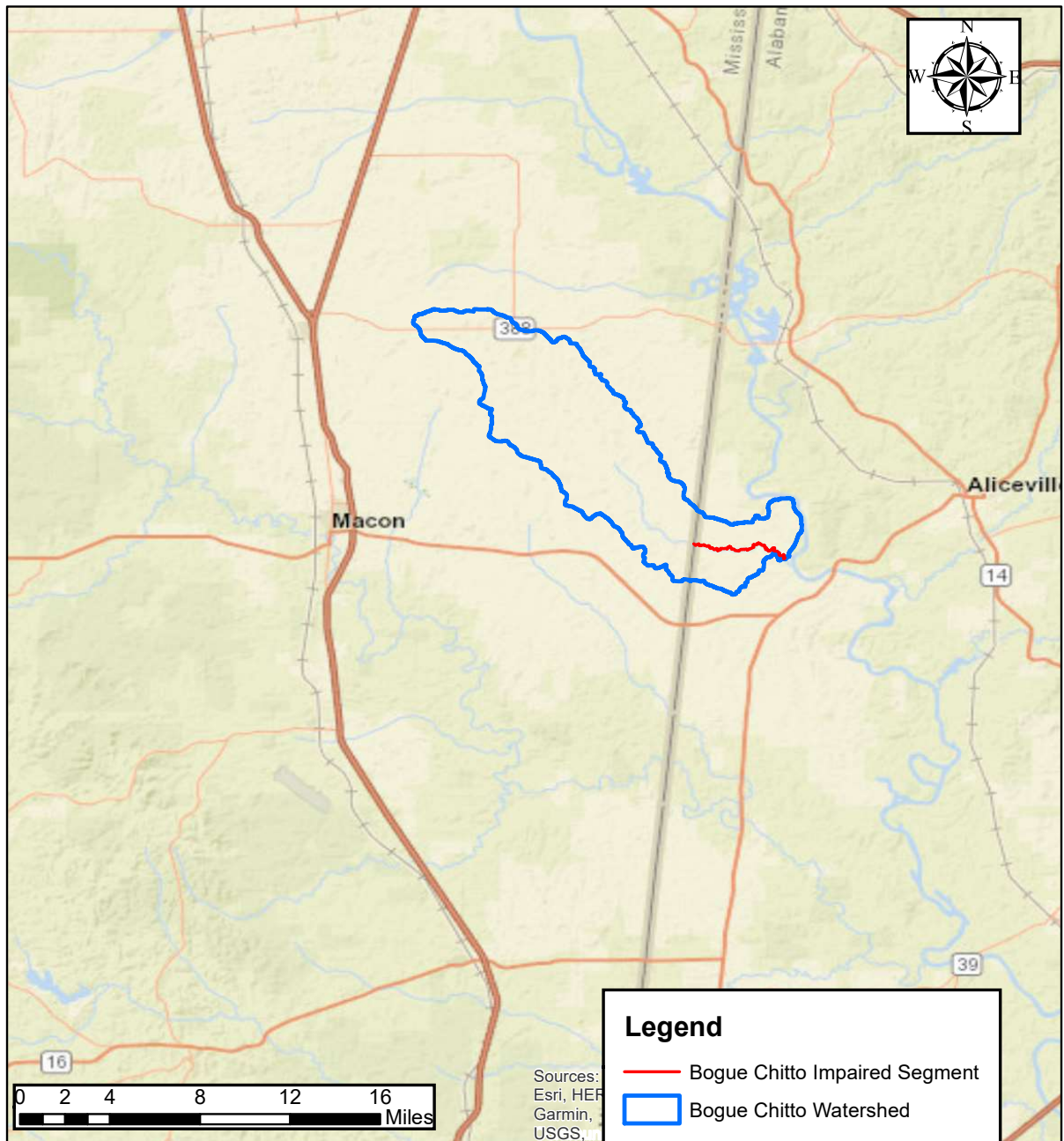


Table of Contents

1.0	Executive Summary	1
2.0	Basis for §303(d) Listing	3
2.1	Introduction	3
2.2	Problem Definition.....	3
3.0	Technical Basis for TMDL Development.....	5
3.1	Water Quality Target Identification	5
3.2	Source Assessment	5
3.2.1	Point Sources in the Bogue Chitto Watershed	5
3.2.2	Nonpoint Sources in the Bogue Chitto Watershed.....	6
3.3	Land Use Assessment.....	6
3.4	Linkage between Numeric Targets and Sources	10
3.5	Data Availability and Analysis	10
3.6	Critical Conditions/Seasonal Variation.....	12
3.7	Margin of Safety	13
4.0	TMDL Development.....	13
4.1	Definition of a TMDL	13
4.2	Load Calculations.....	13
4.3	TMDL Summary	16
5.0	Follow-up monitoring	16
6.0	Public Participation.....	17
7.0	Appendices	18
7.1	References	18
7.2	Water Quality Data	19
7.3	Bogue Chitto Photos	21

List of Tables

Table 1. <i>E. coli</i> Loads and Required Reductions.....	2
Table 2. <i>E. coli</i> TMDL for Bogue Chitto.....	2
Table 3. Cumulative Land Use (2021) in the Bogue Chitto Watershed.....	7
Table 4. Bogue Chitto Watershed Land Use in Alabama (2021 NLCD).....	8
Table 5. ADEM Sampling Station in the Bogue Chitto Watershed.....	11
Table 6. 2018-2022 <i>E. coli</i> Data for Bogue Chitto.....	12
Table 7. <i>E. coli</i> Loads and Required Reductions.....	15
Table 8. <i>E. coli</i> TMDL for Bogue Chitto.....	15
Table 9. Follow-up Monitoring Schedule.....	17
Table 10. 2018-2022 <i>E. coli</i> data for station BCTP-1	19
Table 11. Station BCTP-1 Listing <i>E. coli</i> Data (2011-2016).....	20

List of Figures

Figure 1. Bogue Chitto Watershed.....	ii
Figure 2. Pie Chart of Cumulative Land Use Distribution in the Bogue Chitto Watershed.....	7
Figure 3. Pie Chart of Bogue Chitto Watershed Land Use in Alabama.....	8
Figure 4. Cumulative Land Use in the Bogue Chitto Watershed	9
Figure 5. ADEM Sampling Station in the Bogue Chitto Watershed.....	11
Figure 6. At Station BCTP-1: Upstream View of Bogue Chitto (5/23/2022).....	21
Figure 7. At Station BCTP-1: Downstream View Bogue Chitto (5/23/2022).....	21
Figure 8. At Station BCTP-1: Upstream View of Bogue Chitto (8/1/2022).....	22
Figure 9. At Station BCTP-1: Downstream View of Bogue Chitto (8/1/2022).....	22

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).

Bogue Chitto, part of the Tombigbee River basin, is currently included on Alabama's §303(d) list as impaired for pathogens (*E. coli*) and nutrients from the Alabama-Mississippi state line to the Tombigbee River. This segment of Bogue Chitto has a designated use classification of Fish and Wildlife (F&W). Bogue Chitto begins northeast of Macon, Mississippi and flows southeast across the Mississippi-Alabama state line into the Tombigbee River. The total drainage area for the Bogue Chitto watershed is approximately 59 square miles, and the watershed in Alabama is approximately 11 square miles. Approximately 82% of the Bogue Chitto watershed lies within the state of Mississippi.

This TMDL only addresses the pathogens (*E. coli*) impairment. The nutrients impairment will be addressed in a separate TMDL.

Bogue Chitto was first listed as impaired for pathogens on the §303(d) list in 2018 based on data collected by the Alabama Department of Environmental Management (ADEM) from 2011-2016. The exceedances were found at station BCTP-1. This data, which can be found in Table 10, indicated that the *E. coli* criterion was exceeded in four out of 15 samples.

During 2018-2022, sampling studies were performed by ADEM on Bogue Chitto to further assess the water quality of the impaired stream. For purposes of this TMDL, the 2018-2022 data will be used to assess the water quality of Bogue Chitto because it is the most current data and provides the best picture of the current water quality conditions of the stream. The 2024 edition of *Alabama's Water Quality Assessment and Listing Methodology*, prepared by ADEM, provides the rationale for the Department to use the most recent data to prepare a TMDL for an impaired waterbody. All the available and recent bacterial data is listed in the Appendix for reference. ADEM collected 21 samples at station BCTP-1 on Bogue Chitto during 2018-2022 and, according to the collected data, Bogue Chitto was not meeting the pathogen criteria applicable to its use classification of Fish and Wildlife. Therefore, this TMDL has been developed for pathogens (*E. coli*) for Bogue Chitto.

A mass balance approach was used for calculating the pathogen TMDL for Bogue Chitto. The mass balance approach utilizes the conservation of mass principle. The TMDL was calculated using the single sample or geometric mean sample exceedance event which 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 268.2

colonies/100 mL (298 colonies/100mL-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 3465.5 colonies/100 mL measured on May 23, 2022, at station BCTP-1. This violation calls for a reduction of 92%.

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 Bogue Chitto.

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	4.64E+12	3.59E+11	4.28E+12	92%
Geometric Mean Load	9.65E+10	3.10E+10	6.55E+10	68%

Table 2. *E. coli* TMDL for Bogue Chitto

TMDL ^e (col/day)	Margin of Safety (MOS) (col/day)	Waste Load Allocation (WLA) ^a			Load Allocation (LA) ^f	
		WWTPs ^b (col/day)	MS4s ^c % reduction	Leaking Collection Systems ^d (col/day)	(col/day)	% reduction
3.99E+11	3.99E+10	N/A	N/A	0	3.59E+11	92%

Note: N/A = not applicable

a. There are no CAFOs in the Bogue Chitto watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.

b. Future WWTPs must meet the applicable in-stream 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 maximum criterion of 298 colonies/100 ml.

f. The load allocation represents sources in both Alabama and Mississippi. Alabama's single sample criterion of 298 colonies/100 ml should be met at the Alabama/Mississippi state line.

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.

ADEM will work to verify the possible sources of *E. coli* located in the watershed within Alabama. ADEM will also need to coordinate with the Mississippi Department of Environmental Quality (MDEQ) to determine possible sources of *E. coli* in the Bogue Chitto watershed in Mississippi.

Based on the results of this TMDL, the two agencies will work to generate a plan that can produce the needed reduction in *E. coli* using best management practices.

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 Bogue Chitto 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 5.42-mile segment of Bogue Chitto from the Alabama/Mississippi state line to the Tombigbee River as impaired for pathogens. Bogue Chitto was originally listed on Alabama's 2018 List of Impaired Waters for pathogens based on data collected from 2011-2016. The source of the pathogens impairment is listed as pasture grazing.

2.2 Problem Definition

<u>Waterbody Impaired:</u>	Bogue Chitto – from AL/MS state line to the Tombigbee River
<u>Impaired Reach Length:</u>	5.42 miles
<u>Impaired Drainage Area:</u>	59 square miles
<u>Water Quality Standard Violation:</u>	Pathogens (Single Sample Maximum, Geometric Mean)
<u>Pollutant of Concern:</u>	Pathogens (<i>E. coli</i>)
<u>Water Use Classification:</u>	Fish and Wildlife
<u>Usage Related to Classification:</u>	

The impaired stream segment is classified as Fish and Wildlife (F&W). Usage of waters in this 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.*

E. coli Criteria:

Criteria for acceptable bacteria levels for the F&W use 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:

Bogue Chitto was first included on Alabama's 2018 §303(d) list for pathogens (*E. coli*) based on data collected during 2011-2016. Monthly sample results taken from BCTP-1 for *E. coli* showed

four out of 15 samples exceeding the single sample criterion. The listing data can be seen in Appendix 7.2, Table 10.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

For the purposes of this TMDL, a single sample maximum *E. coli* target of 268.2 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 298 colonies/100 ml. This target is considered protective of water quality standards and should not allow the single sample maximum of 298 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 Bogue Chitto 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.

There are currently no NPDES-regulated point sources in the Alabama portion of the Bogue Chitto watershed. In addition, the Bogue Chitto watershed does not presently qualify as a municipal separate storm sewer system (MS4) area. There are currently also no Animal Feeding Operation/Concentrated Animal Feeding Operation (AFO/CAFO) facilities located within the Alabama portion of the Bogue Chitto watershed. The ADEM AFO/CAFO rules prohibit discharges of pollutants from the facilities and their associated waste land application activities. As a result, future AFOs/CAFOs will receive a waste load allocation of zero.

Any future NPDES-regulated discharges that are considered by the Department to be a pathogen source will be required to demonstrate consistency with the assumptions and requirements of this TMDL.

3.2.2 Nonpoint Sources in the Bogue Chitto 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 streams as dictated by the watershed hydrology.

Agricultural land can be a source of *E. coli* bacteria. Stormwater runoff from pastures and animal feeding areas can be a source of *E. coli*. In addition, improper land application of animal wastes and animals with direct access to streams are 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 BMPs 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 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 Bogue Chitto watershed was determined using ArcMap with land use datasets derived from the 2021 National Land Cover Dataset (NLCD). The total drainage area of the Bogue Chitto watershed is approximately 59 square miles, and the watershed in Alabama is approximately 11 square miles. Table 3 and Figure 2 depict the primary land uses for the entire Bogue Chitto watershed, while Table 4 and Figure 3 show the primary land uses in the Alabama portion of the Bogue Chitto watershed.

Table 3: Cumulative Land Use (2021) in the Bogue Chitto Watershed

Land Use	Miles ²	Acres	Percent
Open Water	2.38	1523.40	4.04%
Developed, Open Space	0.80	514.18	1.36%
Developed, Low Intensity	0.65	418.10	1.11%
Developed, Medium Intensity	0.34	217.72	0.58%
Developed, High Intensity	0.03	20.24	0.05%
Barren Land	0.09	54.93	0.15%
Deciduous Forest	0.62	396.31	1.05%
Evergreen Forest	1.64	1051.26	2.79%
Mixed Forest	1.35	866.45	2.30%
Shrub/Scrub	0.36	229.51	0.61%
Herbaceous	0.38	241.74	0.64%
Hay/Pasture	17.51	11206.25	29.73%
Cultivated Crops	25.26	16164.10	42.88%
Woody Wetlands	5.35	3421.77	9.08%
Emergent Herbaceous Wetlands	2.14	1368.17	3.63%
Totals→	58.90	37694.14	100.00%
Class Description	Miles ²	Acres	Percent
Open Water	2.38	1523.40	4.04%
Agricultural Lands	42.77	27370.35	72.61%
Forested/Natural	11.84	7575.21	20.10%
Developed Land (Grouped)	1.91	1225.17	3.25%
Totals→	58.90	37694.14	100.00%

Figure 2: Pie Chart of Cumulative Land Use Distribution in the Bogue Chitto Watershed

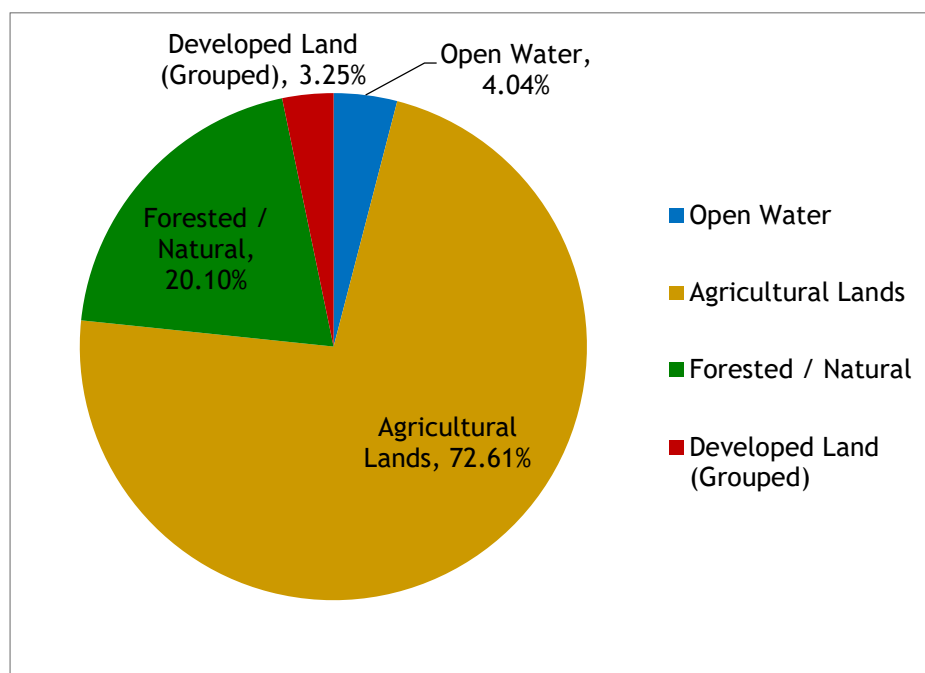


Table 4: Bogue Chitto Watershed Land Use in Alabama (2021 NLCD)

Land Use	Miles ²	Acres	Percent
Open Water	0.26	166.80	2.47%
Developed, Open Space	0.14	89.40	1.33%
Developed, Low Intensity	0.07	46.48	0.69%
Developed, Medium Intensity	0.01	7.12	0.11%
Developed, High Intensity	0.00	0.67	0.01%
Barren Land	0.00	2.67	0.04%
Deciduous Forest	0.10	64.94	0.96%
Evergreen Forest	0.67	427.89	6.35%
Mixed Forest	0.36	230.18	3.42%
Shrub/Scrub	0.10	66.94	0.99%
Herbaceous	0.03	17.79	0.26%
Hay/Pasture	3.52	2250.19	33.39%
Cultivated Crops	3.43	2198.15	32.62%
Woody Wetlands	1.52	971.42	14.41%
Emergent Herbaceous Wetlands	0.31	198.82	2.95%
Totals →	10.53	6739.45	100.00%
Class Description	Miles ²	Acres	Percent
Open Water	0.26	166.80	2.47%
Agricultural Lands	6.95	4448.34	66.00%
Forested / Natural	3.09	1977.98	29.35%
Developed Land (Grouped)	0.23	146.34	2.17%
Totals →	10.53	6739.45	100.00%

Figure 3: Pie Chart of Bogue Chitto Watershed Land Use in Alabama

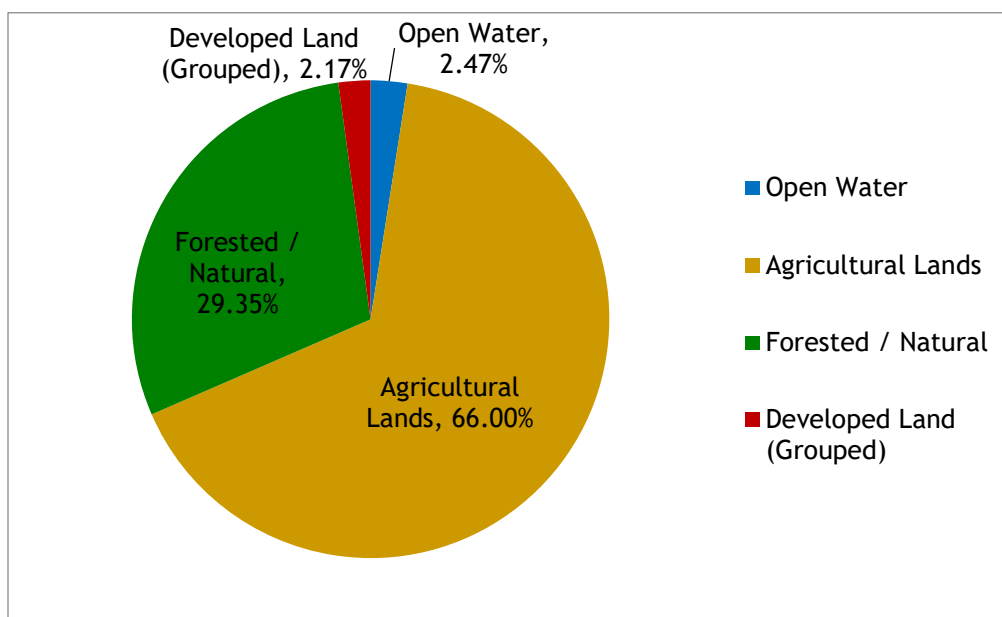
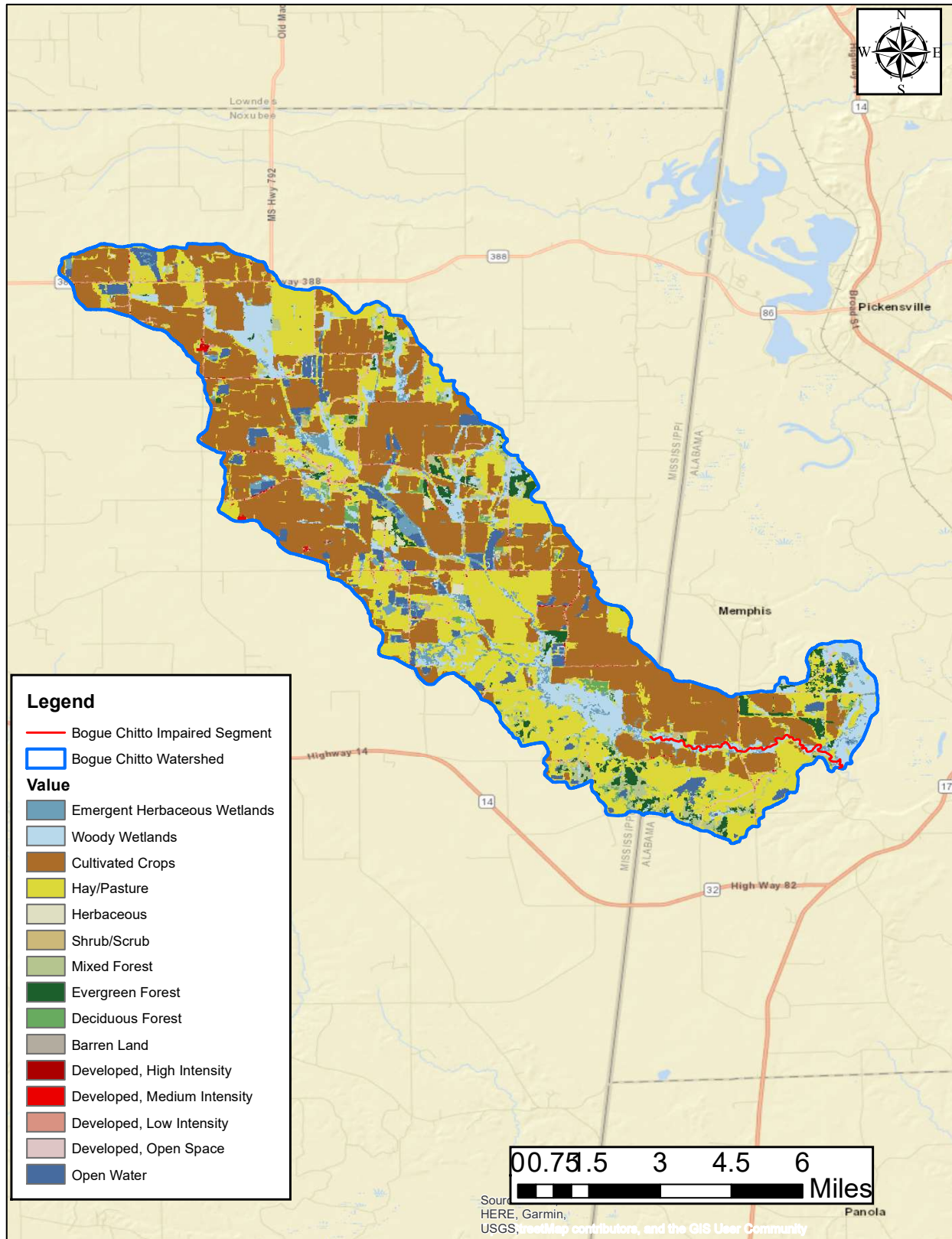


Figure 4. Cumulative Land Use in the Bogue Chitto Watershed



The majority of the Bogue Chitto watershed is comprised of agricultural lands (72.61%). The remaining land use is approximately 20.10% forested and natural lands, 4.04% open water, and 3.25% developed lands. In Alabama, 66% of the watershed is agricultural lands, and the remaining land use is comprised of approximately 29.35% forested and natural lands, 2.47% open water, and 2.17% developed lands. Developed land includes both commercial and residential land uses.

3.4 Linkage between Numeric Targets and Sources

The predominant land usage in the Bogue Chitto watershed is agricultural lands, followed by forested/natural lands. 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 Bogue Chitto are from the agricultural land uses and possibly 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

During 2018-2022, ADEM conducted sampling on Bogue Chitto to further assess the water quality of the impaired stream. For purposes of this TMDL, the data from 2018-2022 will be used to assess the water quality of Bogue Chitto because it is the most current data and provides the best picture of the current water quality conditions of the stream. The 2024 edition of *Alabama's Water Quality Assessment and Listing Methodology*, 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 water quality data for the Bogue Chitto watershed at station BCTP-1. A description of the location of station BCTP-1 can be found in Table 5 and a map showing the location of station BCTP-1 can be found in Figure 5. A total of 21 *E. coli* samples were collected at station BCTP-1 during 2018-2022. Of the 21 samples that were collected, there were seven exceedances of the single sample maximum criterion. In addition, there were geometric mean exceedances at station BCTP-1 in May 2022 and August 2022. Sampling completed at station BCTP-1 from May 2, 2022, to May 23, 2022, yielded a geometric mean of 352.9 colonies/100 ml. Sampling completed at BCTP-1 from August 1, 2022, to August 18, 2022, yielded a geometric mean of 170.0 colonies/100 ml. A complete list of the data used in this report and photographs at BCTP-1 can be found in Appendices 7.2 and 7.3, respectively.

Table 5: ADEM Sampling Station in the Bogue Chitto Watershed

Station Name	Agency Name	Latitude	Longitude	Description
BCTP-1	ADEM	33.09222	-88.300641	Bogue Chitto at Pickens County Rd. 1 (near Memphis)

Figure 5: ADEM Sampling Station in the Bogue Chitto Watershed

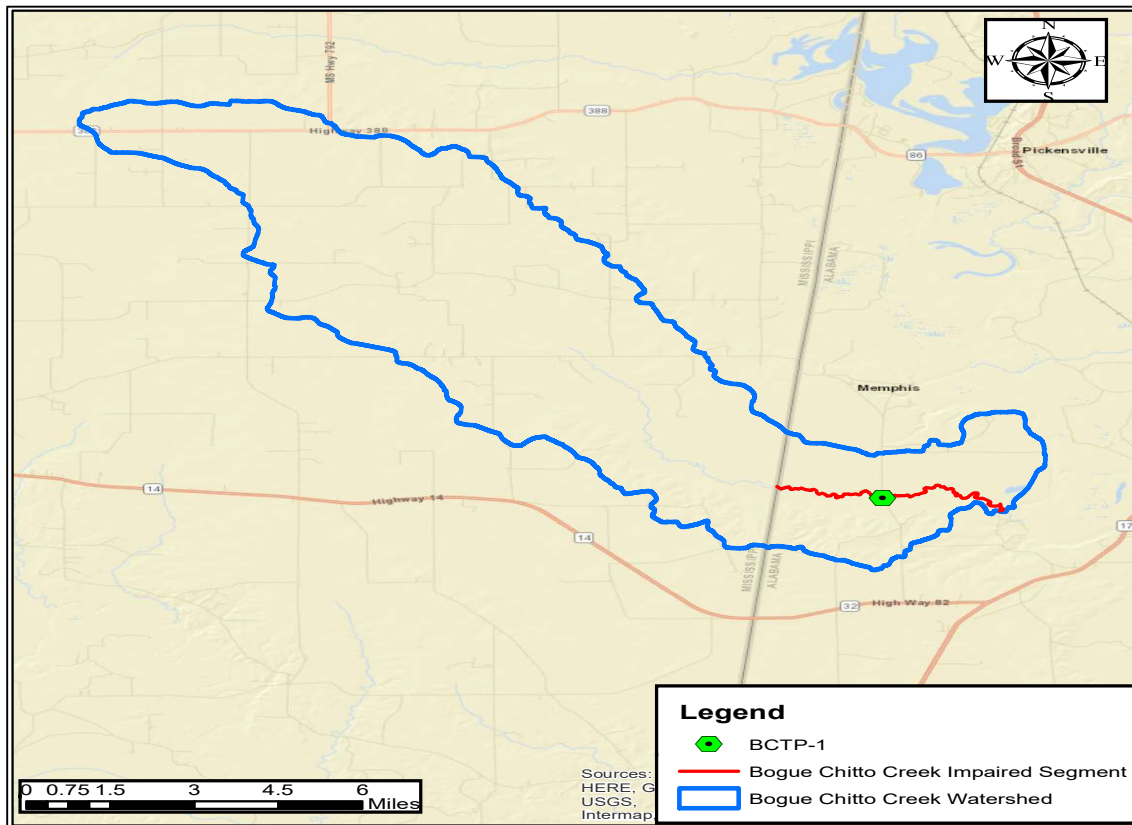


Table 6: 2018-2022 *E. coli* data for Bogue Chitto

Station ID	Visit Date	<i>E. coli</i> (col/100 ml)	<i>E. coli</i> Detect Criteria*	Single Sample Criteria	Geometric Mean (col/100 ml)	Geometric Mean Criteria (col/100 ml)	Flow (cfs)
BCTP-1	5/1/2018	65.7	H	298			7.5
BCTP-1	10/23/2018	72.2	H	298			0.4
BCTP-1	5/14/2019	410.6	H	298			58.1
BCTP-1	7/10/2019	275.5	H	298			-
BCTP-1	9/3/2019	34.1	H	298			3.4
BCTP-1	3/17/2022	410.6	-	2507			20.5
BCTP-1	4/7/2022	922.2	-	2507			40.5
BCTP-1	5/2/2022	69.7	-	298	352.9	126	1.5
BCTP-1	5/5/2022	209.8	-	298			4.9
BCTP-1	5/9/2022	435.2	-	298			3.7
BCTP-1	5/11/2022	435.2	-	298			0.8
BCTP-1	5/19/2022	201.4	-	298			1.4
BCTP-1	5/23/2022	3465.6	-	298			54.7
BCTP-1	6/16/2022	90.9	-	298			1.6
BCTP-1	7/26/2022	70.3	-	298			0.2
BCTP-1	8/1/2022	228.2	-	298	170.0	126	4.9
BCTP-1	8/8/2022	816.4	-	298			2.2
BCTP-1	8/11/2022	344.8	-	298			0.0006
BCTP-1	8/15/2022	21.3	-	298			-
BCTP-1	8/18/2022	103.9	-	298			-
BCTP-1	9/14/2022	344.8	-	298			5.8

*H denotes that the analytical holding times for analysis are exceeded.

3.6 Critical Conditions/Seasonal Variation

Critical conditions typically occur during the summer months (May – October). This can be explained by the nature of storm events in the summer versus the winter. In summer, periods of dry weather interspersed with thunderstorms allow for the accumulation and washing off of bacteria into streams, resulting in spikes of bacteria counts. In winter, frequent low intensity rain events are more typical and do not allow for the build-up of bacteria on the land surface, resulting in a more uniform loading rate.

The Bogue Chitto watershed generally follows the trends described above for the summer months of May through October. The maximum single sample concentration of 3465.6 colonies/100 ml at station BCTP-1 will be used to estimate the TMDL pathogen loading to Bogue Chitto under critical conditions. The highest *E. coli* single sample exceedance value occurred on May 23, 2022, with a flow of 54.7 cfs.

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 or calculated flow data. The single sample *E. coli* maximum criterion of 298 colonies/100 ml was reduced by 10% to 268.2 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, MOS is explicit in this TMDL. A TMDL can be denoted by the equation:

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

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 Bogue Chitto. 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 single sample exceedance and the highest geometric mean 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.

4.2.1 Existing Conditions

The **single sample** mass loading was calculated by multiplying the highest single sample *E. coli* concentration of 3465.6 colonies/100 ml times the measured flow at the time the sample was taken. This concentration was based on a measurement at station BCTP-1 on May 23, 2022, and can be seen above in Table 6. The product of the concentration, measured flow, and a conversion factor gives the total mass loading (colonies per day) of *E. coli* to Bogue Chitto under the single sample exceedance condition.

$$\frac{54.7 \text{ ft}^3}{\text{s}} \times \frac{3465.5 \text{ colonies}}{100 \text{ ml}} \times \frac{24,465,755 * 100 \text{ ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{4.64 \times 10^{12} \text{ colonies}}{\text{day}}$$

The **geometric mean** mass loading was calculated by multiplying the highest geometric mean exceedance concentration of 352.9 colonies/100 ml times the average of the measured flows taken during the geometric mean sampling period. This concentration was calculated based on measurements at station BCTP-1 between May 2, 2022, and May 23, 2022, and can be found in Table 6. The average stream flow was determined to be 11.2 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of *E. coli* to Bogue Chitto under the geometric mean exceedance condition.

$$\frac{11.2 \text{ ft}^3}{\text{s}} \times \frac{352.9 \text{ colonies}}{100 \text{ ml}} \times \frac{24,465,755 * 100 \text{ ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{9.65 \times 10^{10} \text{ colonies}}{\text{day}}$$

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 268.2 colonies/100 ml, the allowable *E. coli* loading is:

$$\frac{54.7 \text{ ft}^3}{\text{s}} \times \frac{268.2 \text{ colonies}}{100 \text{ ml}} \times \frac{24,465,755 * 100 \text{ ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.59 \times 10^{11} \text{ colonies}}{\text{day}}$$

The explicit margin of safety of 29.8 colonies/100 ml equals a daily loading of:

$$\frac{54.7 \text{ ft}^3}{\text{s}} \times \frac{29.8 \text{ colonies}}{100 \text{ ml}} \times \frac{24,465,755 * 100 \text{ ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.99 \times 10^{10} \text{ colonies}}{\text{day}}$$

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

$$\frac{11.2 \text{ ft}^3}{\text{s}} \times \frac{113.4 \text{ colonies}}{100 \text{ ml}} \times \frac{24,465,755 * 100 \text{ ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.10 \times 10^{10} \text{ colonies}}{\text{day}}$$

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

$$\frac{11.2 \text{ ft}^3}{\text{s}} \times \frac{12.6 \text{ colonies}}{100 \text{ ml}} \times \frac{24,465,755 * 100 \text{ ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.45 \times 10^9 \text{ colonies}}{\text{day}}$$

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 Bogue Chitto as evaluated at station BCTP-1. Table 7 shows the existing and allowable *E. coli* loads and required reductions for the Bogue Chitto 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	4.64E+12	3.59E+11	4.28E+12	92%
Geometric Mean Load	9.65E+10	3.10E+10	6.55E+10	68%

From Table 7, compliance with the single sample criterion of 298 colonies/100 ml requires a reduction of 92% 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 Bogue Chitto

TMDL ^e (col/day)	Margin of Safety (MOS) (col/day)	Waste Load Allocation (WLA) ^a			Load Allocation (LA) ^f	
		WWTPs ^b (col/day)	MS4s ^c % reduction	Leaking Collection Systems ^d (col/day)	(col/day)	% reduction
3.99E+11	3.99E+10	N/A	N/A	0	3.59E+11	92%

Note: N/A = not applicable

a. There are no CAFOs in the Bogue Chitto watershed. Future CAFOs will be assigned a waste load allocation (WLA) of zero.

b. Future WWTPs must meet the applicable in-stream 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 maximum criterion of 298 colonies/100 ml.

f. The load allocation represents sources in both Alabama and Mississippi. Alabama's single sample criterion of 298 colonies/100 ml should be met at the Alabama/Mississippi state line.

4.3 TMDL Summary

Bogue Chitto was placed on Alabama's §303(d) list in 2018 based on data collected from 2011-2016. Additional water quality data was collected by ADEM during 2018-2022. 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 Bogue Chitto. Based on the TMDL analysis, it was determined that a 92% 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.

ADEM will work to verify the possible sources of *E. coli* located in the watershed within Alabama. ADEM will also need to coordinate with the Mississippi Department of Environmental Quality (MDEQ) to determine possible sources of *E. coli* in the Bogue Chitto watershed in Mississippi. Based on the results of this TMDL, the two agencies will work to generate a plan that can produce the needed reduction in *E. coli* using best management practices.

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 Bogue Chitto 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 basin approach to water quality monitoring, an approach that divides Alabama's sixteen major river basins into three groups. Each year, ADEM's water quality resources are concentrated in one of the three basin groups and are divided among multiple priorities 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. This monitoring will occur in each basin according to the schedule shown in Table 9.

Table 9: Follow-up Monitoring Schedule

River Basin Group	Years to be Monitored
Black Warrior, Blackwater, Chattahoochee, Chipola, Choctawhatchee, Escambia, Perdido, Tennessee (Wheeler), Yellow	2024/2027
Coosa, Escatawpa, Tennessee (Guntersville), Tombigbee	2025/2028
Alabama, Cahaba, Mobile, Tallapoosa, Tennessee (Pickwick and Wilson)	2026/2029

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 four 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. No written comments were received during the public notice period.

7.0 Appendices

7.1 References

ADEM Administrative Code, 2021. Water Division - Water Quality Program, Chapter 335-6-10, Water Quality Criteria.

ADEM Administrative Code, 2021. Water Division - Water Quality Program, Chapter 335-6-11, Use Classifications for Interstate and Intrastate Waters.

Alabama's Monitoring Program. 2011-2022. ADEM.

Alabama Department of Environmental Management (ADEM), *Alabama's Water Quality Assessment and Listing Methodology*, 2024.

Alabama's §303(d) List and Fact Sheet. 2018, 2020, 2022. ADEM.

Alabama Department of Environmental Management (ADEM), Laboratory Data Qualification SOP #4910 Revision 7.2, 2022.

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 10: 2018-2022 *E. coli* Data for Station BCTP-1

Station ID	Visit Date	<i>E. coli</i> (col/100 ml)	<i>E. coli</i> Detect Criteria*	Single Sample Criteria	Geometric Mean (col/100 ml)	Geometric Mean Criteria (col/100 ml)	Flow (cfs)
BCTP-1	5/1/2018	65.7	H	298			7.5
BCTP-1	10/23/2018	72.2	H	298			0.4
BCTP-1	5/14/2019	410.6	H	298			58.1
BCTP-1	7/10/2019	275.5	H	298			-
BCTP-1	9/3/2019	34.1	H	298			3.4
BCTP-1	3/17/2022	410.6	-	2507			20.5
BCTP-1	4/7/2022	922.2	-	2507			40.5
BCTP-1	5/2/2022	69.7	-	298	352.9	126	1.5
BCTP-1	5/5/2022	209.8	-	298			4.9
BCTP-1	5/9/2022	435.2	-	298			3.7
BCTP-1	5/11/2022	435.2	-	298			0.8
BCTP-1	5/19/2022	201.4	-	298			1.4
BCTP-1	5/23/2022	3465.6	-	298			54.7
BCTP-1	6/16/2022	90.9	-	298			
BCTP-1	7/26/2022	70.3	-	298		0.2	
BCTP-1	8/1/2022	228.2	-	298	170.0	126	4.9
BCTP-1	8/8/2022	816.4	-	298			2.2
BCTP-1	8/11/2022	344.8	-	298			0.0006
BCTP-1	8/15/2022	21.3	-	298			-
BCTP-1	8/18/2022	103.9	-	298			-
BCTP-1	9/14/2022	344.8	-	298			

*H denotes that the analytical holding times for analysis are exceeded.

Table 11. Station BCTP-1 *E. coli* Listing Data (2011-2016)

Station ID	Visit Date	<i>E. coli</i> (col/ 100 mL)	<i>E. coli</i> Detect Criteria	Single Sample Criteria	Flow (cfs)
BCTP-1	3/21/2011	36.4	H	2507	11.5
BCTP-1	5/9/2011	67	H	298	4.8
BCTP-1	7/7/2011	28.2	-	298	0.09
BCTP-1	9/14/2011	3.1	H	298	1.3
BCTP-1	5/8/2012	77.6	H	298	-
BCTP-1	7/18/2012	2419.6	GH	298	-
BCTP-1	9/12/2012	77.1	H	298	1.1
BCTP-1	5/1/2013	419.6	H	298	-
BCTP-1	7/23/2013	4839.2	GH	298	-
BCTP-1	5/14/2014	88.6	H	298	6.0
BCTP-1	7/23/2014	2	H	298	-
BCTP-1	9/17/2014	52	H	298	-
BCTP-1	5/13/2015	35.5	-	298	1.0
BCTP-1	6/30/2015	1119.9	H	298	3.5
BCTP-1	5/9/2016	83.9	H	298	2.0

*H denotes that the analytical holding times for analysis are exceeded.

*G denotes that the actual number was probably greater than the number reported.

7.3 Bogue Chitto Photos

Figure 6. At Station BCTP-1: Upstream View of Bogue Chitto (5/23/2022)



Figure 7. At Station BCTP-1: Downstream View of Bogue Chitto (5/23/2022)



Figure 8. At Station BCTP-1: Upstream View of Bogue Chitto (8/1/2022)



Figure 9. At Station BCTP-1: Downstream View of Bogue Chitto (8/1/2022)

