Final
Total Maximum Daily Load (TMDL)
for
Noxubee River Watershed

Bodka Creek
Assessment Unit ID # AL03160108-1005-100

Noxubee River
Assessment Unit ID # AL03160108-1102-100

Sumter County

Pathogens (*E. coli*)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
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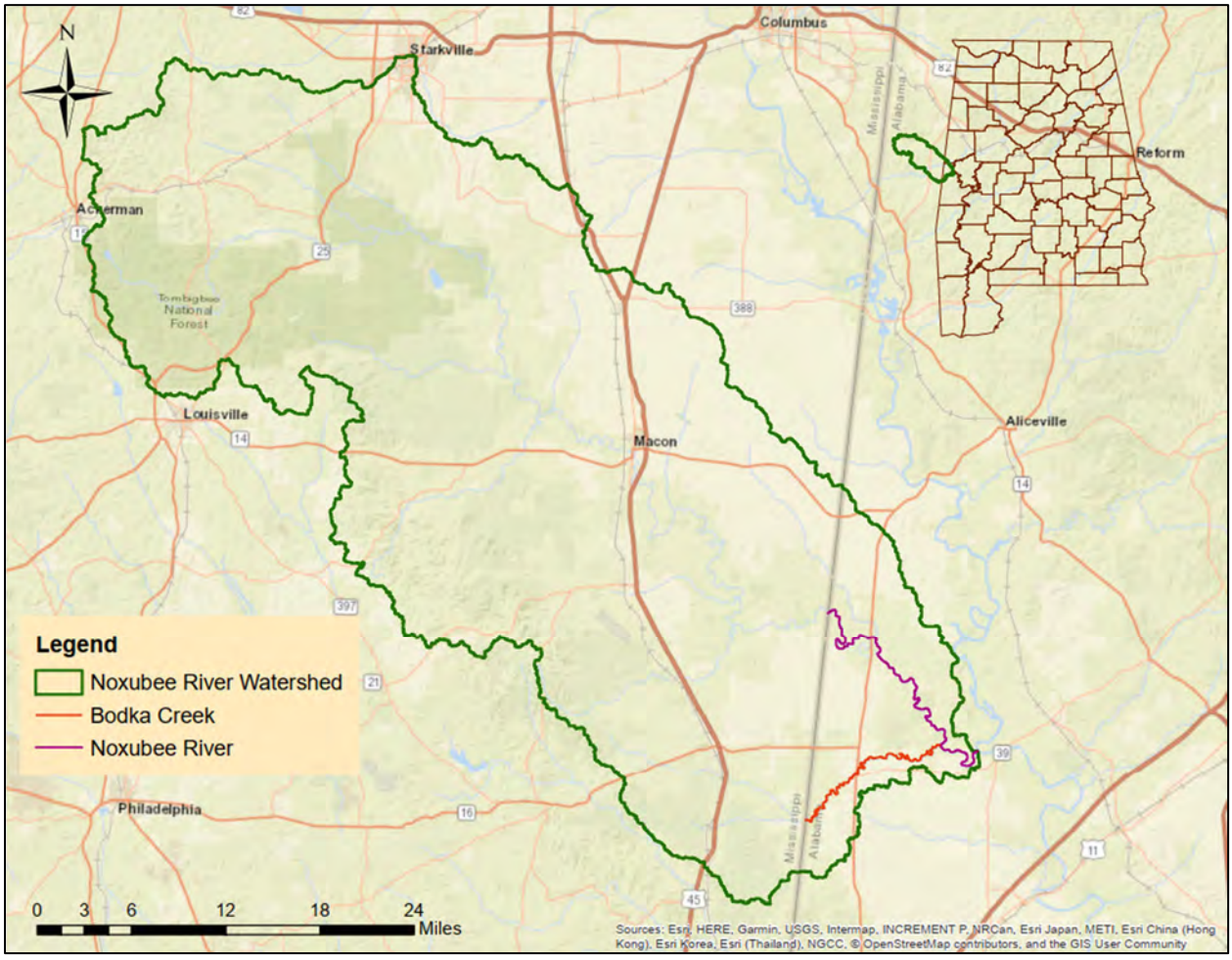
Figure 1: Noxubee River Watershed



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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).

Noxubee River and Bodka Creek (a tributary to Noxubee River) are currently included on Alabama's §303(d) list as impaired for pathogens (*E. coli)*. There is one segment of each waterbody on the most recent §303(d) list: Bodka Creek from the Alabama/Mississippi State line to Noxubee River (AL03160108-1005-100) and Noxubee River from the Alabama/Mississippi State line to the Tombigbee River (AL03160108-1102-100). Bodka Creek and Noxubee River both have a use classification of Fish & Wildlife.

Noxubee River begins near Ackerman, Mississippi and flows southeast to the Alabama/Mississippi State line, where it continues to flow southeast 23.99 miles to the Tombigbee River. The total drainage area for the Noxubee River is 1419 square miles, and the watershed in Alabama is approximately 138.92 square miles. Approximately 90% of the Noxubee River watershed lies within the state of Mississippi.

Bodka Creek is a tributary to the Noxubee River that begins south of Scooba, Mississippi and flows east to the Alabama/Mississippi State line, where it then flows northeast 17.45 miles towards the Noxubee River. The total drainage area for Bodka Creek is 209.29, and the watershed in Alabama is approximately 62.74 square miles. Approximately 70% of the Bodka Creek watershed lies within the state of Mississippi.

Noxubee River (AL003160108-1102-100) was first included on Alabama's §303(d) list for pathogens in 2016 based on data collected by the Alabama Department of Environmental Management (ADEM) from 2010 – 2014 at ADEM station NXBS-50. Bodka Creek (AL0316010108-1005-100) was first included on the §303(d) list for pathogens in 2018 based on data collected by ADEM from 2011 – 2013 and 2015 at ADEM station BDKS-48. This data, which can be found in Table 3, indicated that stream was impaired for pathogens (*E. coli*).

Between 2017 and 2022, sampling studies were performed by ADEM on Noxubee River and Bodka Creek to further assess the water quality of the impaired streams. A review of the general water quality and intensive *E. coli* studies revealed that the listed segments of Noxubee River and Bodka Creek were still not meeting the pathogen criteria applicable to their use classification (Fish & Wildlife).

A mass balance approach was used for calculating the pathogen TMDLs for Noxubee River and Bodka 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 268.2 colonies/100 ml (298 colonies/100 ml – 10% Margin of Safety).

Tables 1-1 and 1-2 are summaries of the estimated existing loads, allowable loads, and percent reductions for the single sample criterion for each segment. There were no exceedances of the applicable geometric mean criterion for either segment. Tables 2-1 and 2-2 list the TMDL for each segment, defined as the maximum allowable *E. coli* loading under critical conditions for Noxubee River and Bodka Creek.

Table 1-1: *E. coli* Loads and Required Reductions for AL03160108-1102-100 at NXBS-50

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	5.54×10^{13}	8.07×10^{12}	4.73×10^{13}	85%

Table 1-2: *E. coli* Loads and Required Reductions for AL03160108-1005-100 at BDKS-48

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	7.93×10^{11}	4.88×10^{10}	7.44×10^{11}	94%

Table 2-1: *E. coli* TMDL for AL03160108-1102-100 at NXBS-50

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
8.97×10^{12}	8.97×10^{11}	NA	NA	0	8.07×10^{12}	85%

Note: NA = not applicable

a. Existing and 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 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.

Table 2-2: *E. coli* TMDL for AL03160108-1005-100 at BDKS-48

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
4.88×10^{10}	4.88×10^{9}	NA	NA	0	4.40×10^{10}	94%

Note: NA = not applicable
a. Existing and 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 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.

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 Noxubee River watershed in Mississippi. The MDEQ currently has a Fecal Coliform TMDL for a section of the Noxubee River from the spillway of Bluff Lake to Alabama that was finalized in July 2003. Based on the results of this TMDL and the TMDL completed by MDEQ, 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 Noxubee River 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 23.99 miles of Noxubee River and 17.45 miles of Bodka Creek as impaired for pathogens. The §303(d) listing for Noxubee River was originally reported on Alabama's 2016 List of Impaired Waters based on data collected from 2010-14 and was included on all subsequent lists. Bodka Creek was added to the 2018 List of Impaired Waters based on data collected in 2011-2013 and 2015 and was included on all subsequent lists.

2.2 Problem Definition

Waterbody Impaired:	Noxubee River – from the Tombigbee River to the AL-MS state line Bodka Creek – from the Noxubee River to the AL-MS state line
Impaired Reach Length:	23.99 miles (Noxubee River); 17.45 miles (Bodka Creek)
Impaired Drainage Area:	138.92 sq. miles
Water Quality Standard Violation:	Pathogens (Single Sample Maximum)
Pollutant of Concern:	Pathogens (*E. coli*)
Water Use Classification:	Fish and Wildlife

Usage Related to Classification:
The impaired segments for both Noxubee River and Bodka Creek are classified as Fish and Wildlife.

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.

E. coli Criteria:

Criteria for acceptable bacteria levels for the Fish and Wildlife 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:

Noxubee River was placed on the §303(d) list for pathogens in 2016 based on data collected during 2010-2014 at station NXBS-50. Bodka Creek was added to the §303(d) list in 2018 based on data collected at station BDKS-48 in 2011-2013 and 2015. *E. coli* sampling showed that the applicable single sample criterion was exceeded in three samples at station NXBS-50 and four samples at BDKS-48. At the time of listings, the source of pathogens was linked to pasture grazing. The listing data is summarized below in Table 3.

Table 3: Data for §303(d) Listing- Ambient Monitoring

Station ID	Visit Date	E. coli (col/100ml)	E. coli Detect Criteria
BDKS-48	3/9/2011	2419.6	G
BDKS-48	5/4/2011	221.2	H
BDKS-48	7/6/2011	159.6	H
BDKS-48	9/7/2011	547.5	H
BDKS-48	5/8/2012	36.4	H
BDKS-48	7/19/2012	1203.3	
BDKS-48	9/13/2012	172.2	
BDKS-48	5/2/2013	2092.4	
BDKS-48	7/29/2013	86.2	
BDKS-48	9/5/2013	23.3	
BDKS-48	5/13/2015	36.9	
BDKS-48	6/30/2015	325.5	H
BDKS-48	9/16/2015	22.8	H
NXBS-50	7/7/2010	36.4	H
NXBS-50	9/8/2010	33.1	H
NXBS-50	3/9/2011	2419.6	G
NXBS-50	7/6/2011	61	H
NXBS-50	9/7/2011	2419.6	GH
NXBS-50	5/8/2012	81.6	H
NXBS-50	7/18/2012	107.6	H
NXBS-50	9/12/2012	23.3	H
NXBS-50	5/2/2013	3465.8	
NXBS-50	7/24/2013	4839.2	G
NXBS-50	9/5/2013	39.3	
NXBS-50	5/14/2014	130	H
NXBS-50	7/23/2014	35	H
NXBS-50	9/17/2014	71.7	H

G - The actual number was probably greater than the number reported
H - The analytical holding times for analysis are exceeded.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

For 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 criterion to be exceeded. In addition, a geometric mean 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 also derived by using a 10%

explicit margin of safety from the geometric mean criterion of 126 colonies/100 ml. This target is considered protective of water quality standards and should not allow the geometric mean criterion to be exceeded.

3.2 Source Assessment

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.

3.2.1 Continuous Point Sources in the Noxubee River watershed

Currently, there are no NPDES-regulated continuous point source discharges located within the Alabama portion of the Noxubee River 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.

3.2.2 Non-Continuous Point Sources in the Noxubee River watershed

There is currently one individual industrial NPDES discharge permit and one general NPDES discharge permit within the Noxubee River watershed in Alabama. See Table 4 below for a list of the non-continuous facilities located within the Noxubee River watershed. Neither of these facilities are considered to be a source of pathogens due to the nature of their operations. As such, no *E. coli* loading will be attributed to these facilities, nor will they receive an allocation in this TMDL.

Table 4: Non-Continuous Point Sources in the Noxubee River Watershed

Facility Name	Permit Number	Receiving Stream
Waste Management Inc.	AL0050580	Bodka Creek
Robbie D Wood Inc. – Emelle 10 Day Yard	ALG141093	UT to Bodka Creek

The Noxubee River watershed in Alabama currently contains zero voluntary Animal Feeding Operations (AFOs) and two Concentrated Animal Feeding Operations (CAFOs). The CAFOs in the watershed are a broiler facility and a large swine facility. AFOs/CAFOs are required to implement and maintain effective best management practices (BMPs) that meet or exceed Natural Resources Conservation Service (NRCS) technical standards and guidelines, and the ADEM AFO/CAFO rules currently prohibit discharges of pollutants from these facilities and their

associated land application activities. As a result, current and future AFOs/CAFOs will receive a waste load allocation of zero.

Urban areas designated as part of the Municipal Separate Storm Sewer System (MS4) program are regulated by NPDES, and as such, are considered to be point sources by EPA and receive waste load allocations (WLAs) in TMDLs. There are currently no MS4 areas within the Alabama portion of the Noxubee River watershed. Any future MS4 stormwater discharges will be required to demonstrate consistency with the assumptions and requirements of this TMDL.

3.2.3 Nonpoint Sources in the Noxubee River 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 is commonly 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 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, sewer overflows, 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 percentages for the Noxubee River watershed were determined from the 2019 National Land Cover Dataset (NLCD). The total drainage area of the Noxubee River watershed is approximately 1419 square miles, and the watershed in Alabama is approximately 138.92 square miles. Table 5 lists the various land uses and their associated percentages for the entire Noxubee River watershed. A pie chart illustrating the major cumulative land use types for the Noxubee River watershed is shown in Figure 2. Table 6 and Figure 3 show the various land uses and their associated percentages for the Alabama portion of the Noxubee River watershed.

Table 5: Noxubee River Watershed Landuse (2019 NLCD)

2019 NLCD Land Cover	NLCD Legend	Area (square miles)	%
Open Water	11	21.28597	1.50%
Developed, Open Space	21	37.61531	2.65%
Developed, Low Intensity	22	14.05779	0.99%
Developed, Medium Intensity	23	5.24609	0.37%
Developed, High Intensity	24	1.05638	0.07%
Barren Land	31	1.16723	0.08%
Deciduous Forest	41	54.31299	3.83%
Evergreen Forest	42	353.98692	24.95%
Mixed Forest	43	202.07247	14.24%
Shrub/Scrub	52	52.12483	3.67%
Herbaceous	71	33.37278	2.35%
Hay/Pasture	81	228.04159	16.07%
Cultivated Crops	82	72.74118	5.13%
Woody Wetlands	90	316.51512	22.31%
Emergent Herbaceous Wetlands	95	25.39923	1.79%
Total Land Use		**1419.00**	**100.00%**
Cumulative Land Cover	**NLCD Legend**	**Area (square miles)**	**%**
Open Water	11	21.29	1.50%
Developed	21,22,23,24	57.98	4.09%
Barren Land	31	1.17	0.08%
Forested	41,42,43	610.37	43.01%
Grassland/Shrub	52,71	85.50	6.03%
Agriculture	81,82	300.78	21.20%
Wetlands	90,95	341.91	24.10%
Total Land Use		**1419.00**	**100.00%**

Figure 2: Noxubee River Watershed Cumulative Land Use

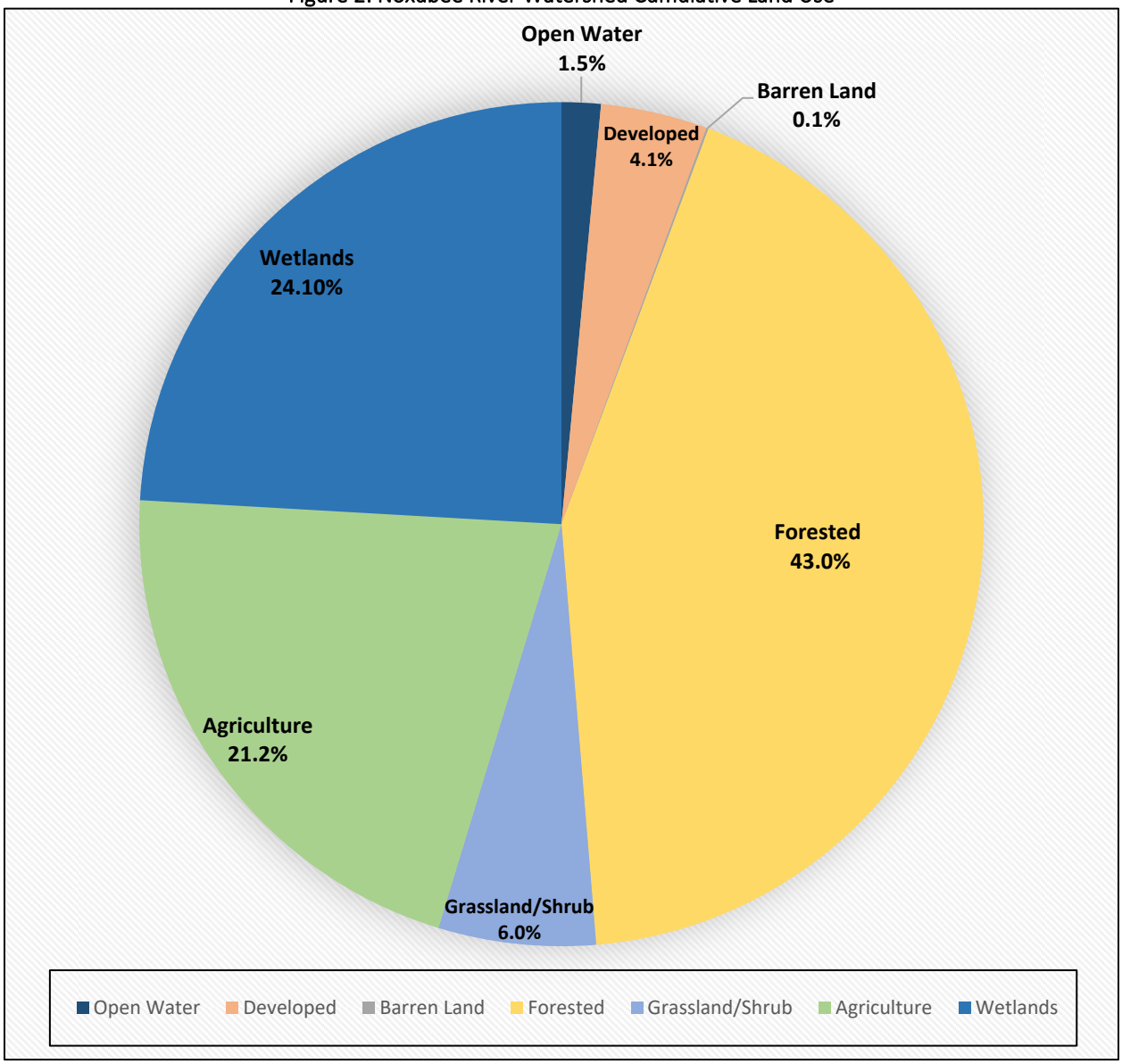


Table 6: Noxubee River Watershed Landuse in Alabama (2019 NLCD)

2019 Alabama NLCD Land Cover	NLCD Legend	Area (square miles)	%
Open Water	11	2.49986	1.80%
Developed, Open Space	21	2.12352	1.53%
Developed, Low Intensity	22	0.96742	0.70%
Developed, Medium Intensity	23	0.21788	0.16%
Developed, High Intensity	24	0.08618	0.06%
Barren Land	31	0.19251	0.14%
Deciduous Forest	41	4.70921	3.39%
Evergreen Forest	42	14.12277	10.17%
Mixed Forest	43	13.51744	9.73%
Shrub/Scrub	52	3.09129	2.23%
Herbaceous	71	2.28302	1.64%
Hay/Pasture	81	46.42736	33.42%
Cultivated Crops	82	6.82370	4.91%
Woody Wetlands	90	39.35659	28.33%
Emergent Herbaceous Wetlands	95	2.50472	1.80%
Total Land Use		**138.92**	**100.00%**
Cumulative Alabama Land Cover	**NLCD Legend**	**Area (square miles)**	**%**
Open Water	11	2.50	1.80%
Developed	21,22,23,24	3.39	2.44%
Barren Land	31	0.19	0.14%
Forested	41,42,43	32.35	23.29%
Grassland/Shrub	52,71	5.37	3.87%
Agriculture	81,82	53.25	38.33%
Wetlands	90,95	41.86	30.13%
Total Land Use		**138.92**	**100.00%**

Figure 3: Noxubee River Watershed Cumulative Land Use in Alabama

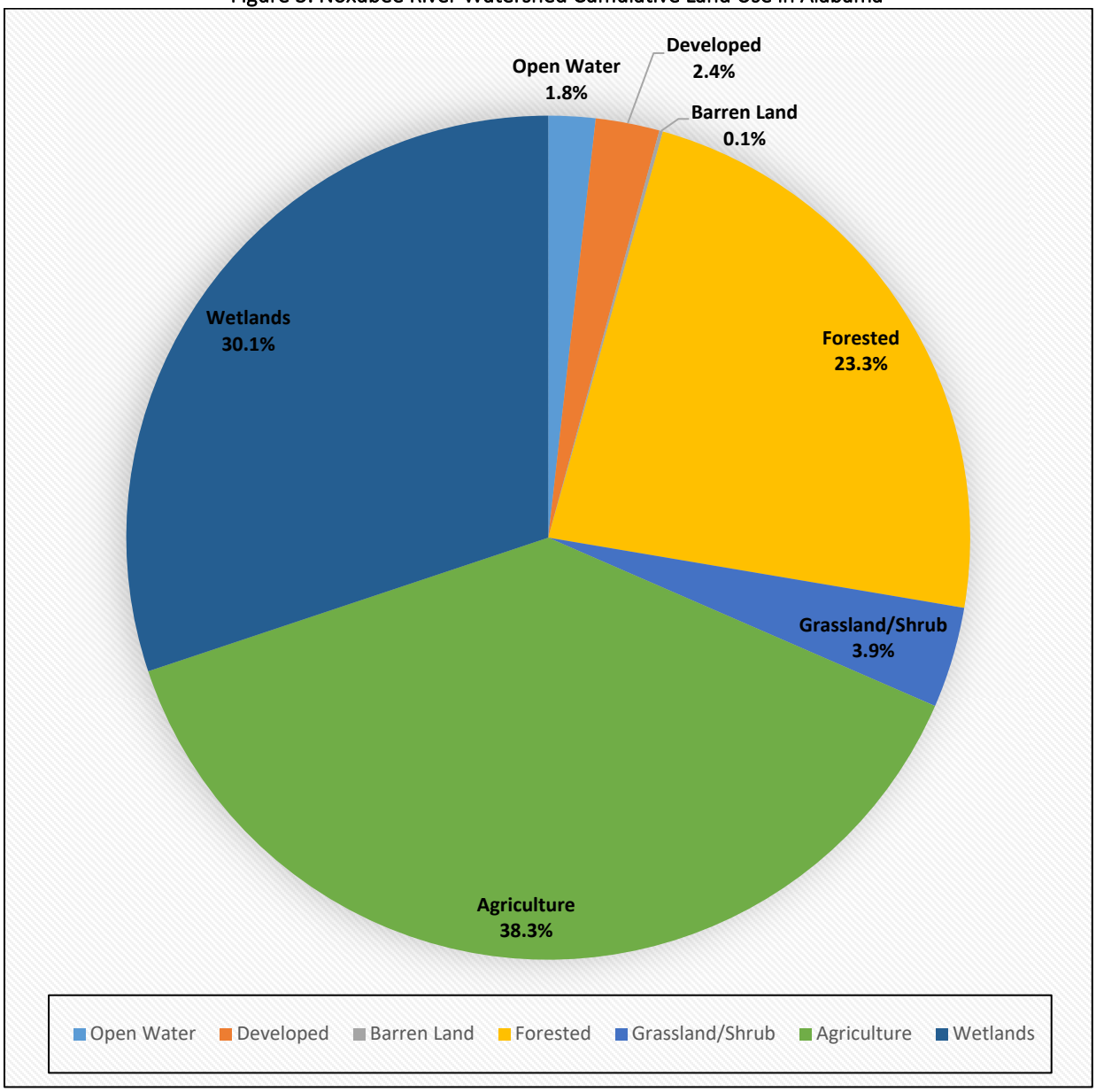
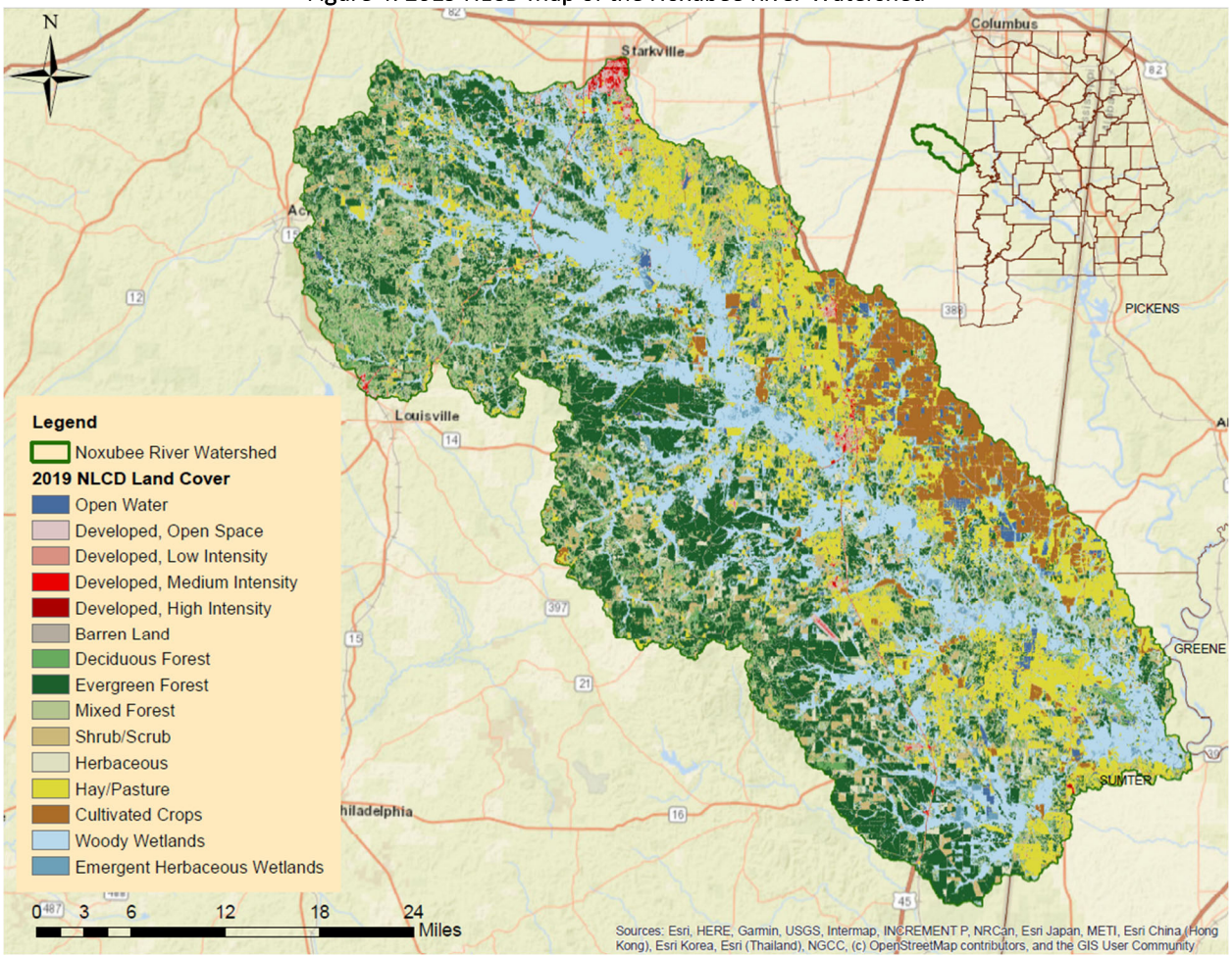


Figure 4: 2019 NLCD Map of the Noxubee River Watershed



As can be seen from an inspection of the tables and map above, the predominant land use for the entire watershed is forested land at 43 percent. Wetlands cover approximately 24 percent, agriculture covers approximately 21 percent, and grassland/shrub covers approximately 6 percent of the watershed. Developed land, which covers approximately 4 percent of the watershed, represents both commercial and residential urbanized land uses, and includes the following individual land use categories: Developed – Open Space, Developed – Low Intensity, Developed – Medium Intensity, and Developed – High Intensity.

For the watershed in Alabama, agriculture covers approximately 38 percent, wetlands cover approximately 30 percent, forested land covers approximately 23 percent, grassland/shrub covers approximately 4 percent, and developed land covers approximately 2 percent.

3.4 Linkage between Numeric Targets and Sources

The dominant land use coverage in the Noxubee River watershed is forested/natural, followed by agriculture. 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 the Noxubee River watershed are from agriculture and failing septic systems. 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 and reductions will only be calculated as a single total nonpoint source load and reduction.

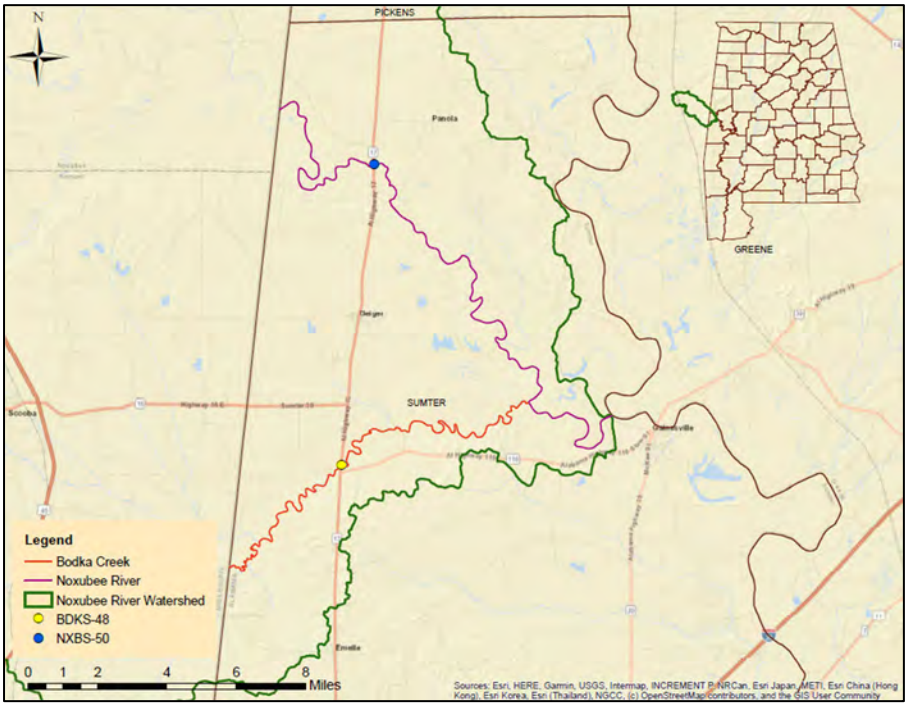
3.5 Data Availability and Analysis

For purposes of this TMDL, the 2017-2022 data at ADEM station NXBS-50 will be used to assess the water quality of Noxubee River, and the 2017-2022 data at ADEM station BDKS-48 will be used to assess the water quality of Bodka Creek. The 2022 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. Table 7 and Figure 5 below detail the locations of the ADEM stations.

Table 7: TMDL Station Descriptions

Station	Agency	Latitude	Longitude	Description
NXBS-50	ADEM	32.806786	-88.312128	Noxubee River at AL Hwy 17 crossing by USGS Gage
BDKS-48	ADEM	32.806786	-88.312128	Bodka Creek @ AL Highway 17 crossing

Figure 5: ADEM TMDL Sampling Stations in Noxubee River Watershed



A total of 27 *E. coli* samples were collected at station NXBS-50 during 2017-2022, and four of the samples exceeded the single sample maximum criterion of 298 colonies/100 ml. A total of 24 *E. coli* samples were collected at station BDKS-48 during 2017-2022, and two of the samples exceeded the single sample maximum criterion of 298 colonies/100 ml.

In 2022, ADEM conducted two intensive bacteria studies at stations NXBS-50 and BDKS-48. Each intensive bacteria study consisted of collecting at least five *E. coli* bacteria samples over a thirty day time window, with a minimum of 24 hours between each sample collection. A geometric mean was calculated from each intensive bacteria study. None of the geometric means from 2022 exceeded the applicable criterion.

A summary of the *E. coli* results is provided in Tables 8 and 9 below. All *E. coli* criteria exceedances are highlighted in red.

Table 8: 2017 - 2022 *E. coli* Data for Noxubee River

Station ID	Visit Date	E. coli (col/100ml)	E. coli Detect Criteria[+]	Single Sample Criteria	Geometric Mean Calculation	Geometric Mean Criteria (col/100ml)	Flow (cfs)
NXBS-50	5/1/2017	1841.6	H	298			1230
NXBS-50	7/31/2017	57.3	H	298			136
NXBS-50	10/16/2017	131.4	H	298			90
NXBS-50	5/1/2018	101.4	H	298			1030
NXBS-50	7/10/2018	44.1	H	298			129
NXBS-50	10/23/2018	77.1	H	298			129
NXBS-50	5/14/2019	461.1	H	298			8780
NXBS-50	7/10/2019	83.3	H	298			169
NXBS-50	9/3/2019	56.3	H	298			257
NXBS-50	3/17/2022	579.4		2507			2690
NXBS-50	4/7/2022	1841.6		2507			4260
NXBS-50	5/2/2022	31.3		298	48.9	126	406
NXBS-50	5/5/2022	43.9		298			324
NXBS-50	5/9/2022	33.2		298			398.5
NXBS-50	5/11/2022	29.5		298			326.5
NXBS-50	5/19/2022	59.4		298			246
NXBS-50	5/23/2022	172		298			194
NXBS-50	6/16/2022	31.8		298			156
NXBS-50	7/26/2022	920.8		298			195
NXBS-50	8/1/2022	66.3		298	94.0	126	152
NXBS-50	8/8/2022	78		298			179
NXBS-50	8/11/2022	73.3		298			234
NXBS-50	8/15/2022	141.4		298			150
NXBS-50	8/18/2022	123.6		298			115
NXBS-50	8/18/2022	104.3		298			114
NXBS-50	9/14/2022	365.4		298			555
NXBS-50	10/12/2022	155.3		298			82.8

+ G - The actual number was probably greater than the number reported; H - The analytical holding times for analysis are exceeded.

Table 9: 2017 - 2022 *E. coli* Data for Bodka Creek

Station ID	Visit Date	E. coli (col/100ml)	E. coli Detect Criteria[+]	Single Sample Criteria	Geometric Mean Calculation	Geometric Mean Criteria (col/100ml)	Flow (cfs)
BDKS-48	5/1/2017	4839.2	GH	298			6.7
BDKS-48	7/31/2017	100.8	H	298			10.9
BDKS-48	10/16/2017	157.9	H	298			1.5
BDKS-48	5/1/2018	115.3	H	298			45.5
BDKS-48	7/10/2018	48.8	H	298			1.8
BDKS-48	10/23/2018	2	H	298			0
BDKS-48	3/13/2019	1297.6		2507			187
BDKS-48	5/14/2019	290.9	H	298			84.3
BDKS-48	7/10/2019	59.4	H	298			3.4
BDKS-48	9/3/2019	12.1	H	298			0
BDKS-48	3/9/2022	1986.3		2507			55.4
BDKS-48	4/7/2022	1203.3		2507			606
BDKS-48	5/2/2022	142.1		298	53.9	126	12.8
BDKS-48	5/5/2022	37.9		298			8.5
BDKS-48	5/9/2022	37.3		298			10.8
BDKS-48	5/11/2022	25.9		298			9.1
BDKS-48	5/19/2022	77.6		298			8.2
BDKS-48	5/23/2022	60.5		298			3.5
BDKS-48	8/1/2022	78.9		298	45.8	126	1
BDKS-48	8/8/2022	30.1		298			0.4
BDKS-48	8/11/2022	30.9		298			0.2
BDKS-48	8/15/2022	39.8		298			0.2
BDKS-48	8/18/2022	68.9		298			0.1
BDKS-48	9/8/2022	2419.6	G	298			144

+ G - The actual number was probably greater than the number reported; H - 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 impaired portions of Noxubee River and Bodka Creek generally follow the trends described above for the summer months of May through October. The critical condition for this pathogen TMDL was taken to be the one with the highest *E. coli* single sample exceedance value. A single sample maximum concentration of 4839.2 colonies/100 ml was collected on May 1, 2017, at station BDKS-48, while a single sample maximum of 1841.6 was collected on May 1, 2017, at

NXBS-50. The use of the highest exceedance to calculate the TMDL is expected to be protective of water quality in Noxubee River and Bodka 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 this 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 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, the MOS is explicit in this TMDL. A TMDL can be denoted by the equation:

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

The TMDL is the total amount of a pollutant that can be assimilated by the receiving waterbody while achieving water quality standards under critical conditions. Pathogen 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 TMDLs for Noxubee River and Bodka 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 single sample exceedance. In the same manner, allowable loads were calculated for the single sample criterion of 298 col/100 ml. There were no exceedances of the applicable geometric mean criteria. The TMDL was based on the violation that produced the highest percent reduction of *E. coli* loads necessary to achieve applicable water quality criteria.

Existing Conditions

The **single sample** mass loading was calculated by multiplying the highest *E. coli* single sample exceedance concentration by the measured flow on the day of the exceedance. For Bodka Creek, the calculation was based on the measurement at BDKS-48 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 Bodka Creek under the single sample exceedance condition.

$$\frac{6.7\ \text{ft}^3}{\text{s}} \times \frac{4839.2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{7.93 \times 10^{11}\text{colonies}}{\text{day}}$$

For Noxubee River, the calculation was based on the measurement at NXBS-50 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 Noxubee River under the single sample exceedance condition.

$$\frac{1230\ \text{ft}^3}{\text{s}} \times \frac{1841.6\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.54 \times 10^{13}\text{colonies}}{\text{day}}$$

Allowable Conditions

The allowable load to the watershed was calculated under the same physical conditions as discussed above for the single sample criterion. 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 for Bodka Creek is:

$$\frac{6.7\ \text{ft}^3}{\text{s}} \times \frac{268.2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{4.40 \times 10^{10}\text{colonies}}{\text{day}}$$

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

$$\frac{6.7\ \text{ft}^3}{\text{s}} \times \frac{29.8\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{4.88 \times 10^{9}\text{colonies}}{\text{day}}$$

For the **single sample** *E. coli* target concentration of 268.2 colonies/100 ml, the allowable *E. coli* loading for Noxubee River is:

$$\frac{1230\ \text{ft}^3}{\text{s}} \times \frac{268.2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{8.07 \times 10^{12}\text{colonies}}{\text{day}}$$

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

$$\frac{1230\ \text{ft}^3}{\text{s}} \times \frac{29.8\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{8.97 \times 10^{11}\text{colonies}}{\text{day}}$$

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. Tables 10-1 and 10-2 below depict the existing and allowable *E. coli* loads and required reductions for Bodka Creek and Noxubee River.

Table 10-1: *E. coli* Loads and Required Reductions for AL03160108-1005-100 at BDKS-48

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	7.93×10^{11}	4.40×10^{10}	7.49×10^{11}	94%

Table 10-2: *E. coli* Loads and Required Reductions for AL03160108-1102-100 at NXBS-50

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	5.54×10^{13}	8.07×10^{12}	4.73×10^{13}	85%

The TMDL, WLA, LA and MOS values necessary to achieve the applicable *E. coli* criteria for each segment are provided in Tables 11-1 and 11-2 below.

Table 11-1: *E. coli* TMDL for AL03160108-1005-100 at BDKS-48

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
4.88×10^{10}	4.88×10^{9}	NA	NA	0	4.40×10^{10}	94%

Note: NA = not applicable
a. Existing and 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 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.

Table 11-2: *E. coli* TMDL for AL03160108-1102-100 at NXBS-50

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
8.97×10^{12}	8.97×10^{11}	NA	NA	0	8.07×10^{12}	85%

Note: NA = not applicable
a. Existing and 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 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.

4.3 TMDL Summary

Noxubee River was first included on the §303(d) list for pathogens in 2016 based on data collected by ADEM from 2010-2014 at ADEM station NXBS-50. Bodka Creek was added in 2018 based on data collected in 2011-2013 and 2015 from ADEM station BDKS-48. Between 2017 and 2022, sampling studies were performed by ADEM on Noxubee River and Bodka Creek to further assess the water quality of the impaired streams. This data confirmed the pathogen impairments and provided the basis for TMDL development.

A mass balance approach was used to calculate the *E. coli* TMDLs for Noxubee River and Bodka Creek. Based on the TMDL analysis, it was determined that *E. coli* reductions of 85% and 94% for Noxubee River and Bodka Creek, respectively, were 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 Noxubee River watershed in Mississippi. The MDEQ currently has a Fecal Coliform TMDL for a section of the Noxubee River from the spillway of Bluff Lake to Alabama that was finalized in July 2003. Based on the results of this TMDL and the TMDL completed by MDEQ, 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 Noxubee River 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 the schedule shown in Table 12.

Table 12: Follow-up Monitoring Schedule

River Basin Group	Years to be Monitored
Coosa, Escatawpa, Tennessee (Guntersville), Tombigbee	2022/2025
Alabama, Cahaba, Mobile, Tallapoosa, Tennessee (Pickwick and Wilson)	2023/2026
Black Warrior, Blackwater, Chattahoochee, Chipola, Choctawhatchee, Escambia, Perdido, Tennessee (Wheeler), Yellow	2024/2027

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 major 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. 2010-2022. ADEM.

Alabama Department of Environmental Management (ADEM), *Alabama's Water Quality Assessment and Listing Methodology*, 2022.

Alabama's §303(d) List and Fact Sheet. 2016, 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 Noxubee River Watershed Photos

Figure 6: At NXBS-50: Upstream View of Noxubee River

Figure 7: At NXBS-50: Downstream View of Noxubee River

Figure 8: At BDKS-48: Upstream View of Bodka Creek

Figure 9: At BDKS-48: Downstream View of Bodka Creek