Final
Total Maximum Daily Load (TMDL)
for

Rock Creek
Assessment Unit ID # AL06030006-0304-500

and

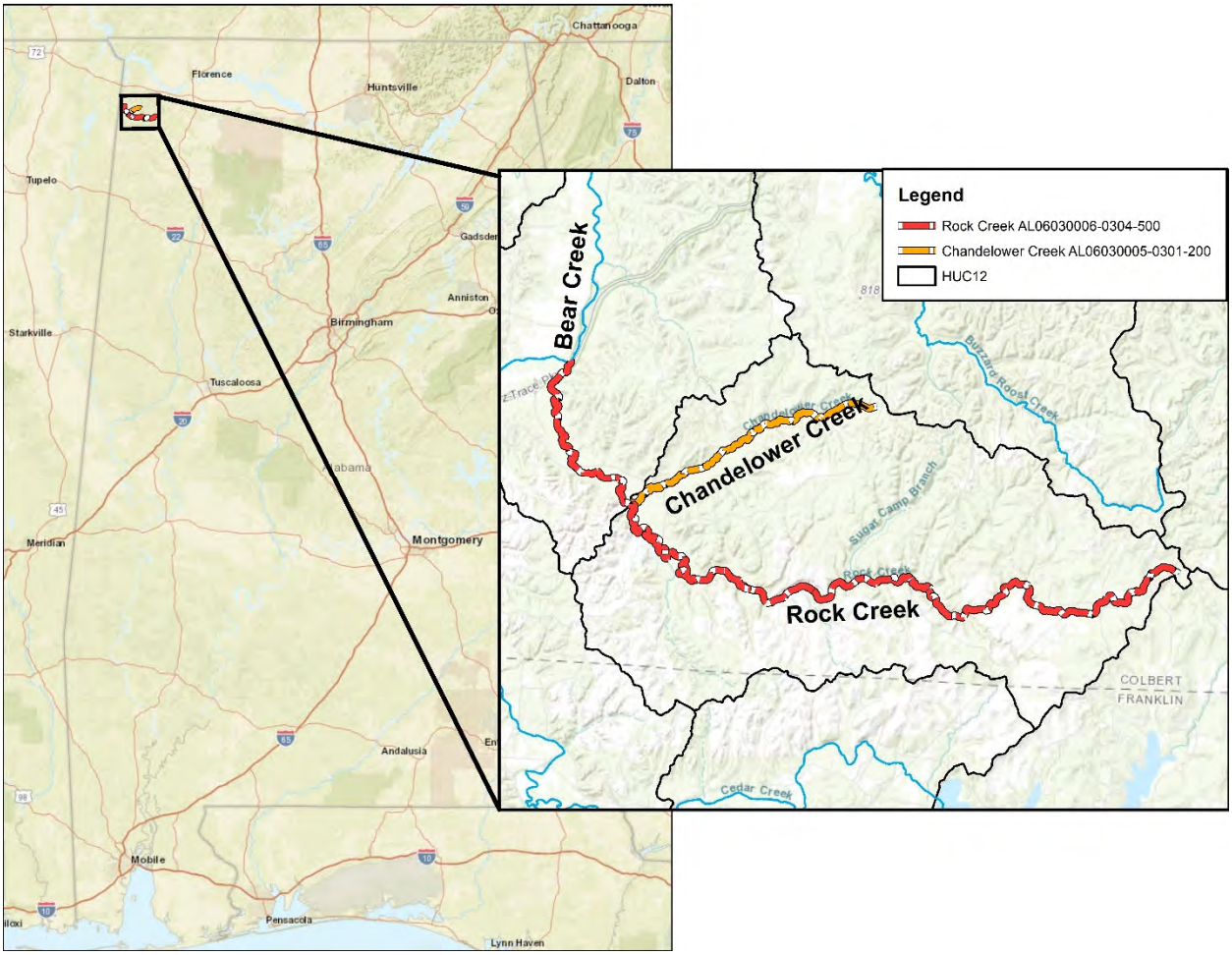
Chandelower Creek
Assessment Unit ID # AL06030005-0301-200

Colbert County

Pathogens (*E. coli*)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
August 2023

Figure 1: Rock Creek and Chandelower Creek



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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).

Rock Creek, located in Colbert County, is a tributary to Bear Creek. Rock Creek is currently included on Alabama's §303(d) list as impaired for pathogens (*E. coli*) from Bear Creek to its source. The listed portion of Rock Creek has a designated use classification of Fish and Wildlife (F&W). Rock Creek flows northwest for a total length of 20.7 miles, ending at the confluence with Bear Creek. The total drainage area for the Rock Creek watershed is approximately 53.5 square miles.

Rock Creek was placed on the Department's 2018 §303(d) list for pathogens based upon data collected during 2016. An evaluation of the available monthly water quality samples and results from an intensive *E. coli* study revealed that Rock Creek was not meeting the pathogen criteria applicable to its use classification (F&W). The 2016 data (which included both monthly samples and calculated geometric means) along with additional data collected in 2017 and 2018 will be utilized in this TMDL.

Chandelower Creek, located in Colbert County, is a tributary to Rock Creek. Chandelower Creek is currently included on Alabama's §303(d) list as impaired for pathogens (*E. coli*) from Rock Creek to its source. The listed portion of Chandelower Creek has a designated use classification of Fish and Wildlife (F&W). Chandelower Creek flows southwest for a total length of 5.95 miles, ending at the confluence with Rock Creek. The total drainage area for the Chandelower Creek watershed is approximately 8.95 square miles.

Chandelower Creek was placed on the Department's 2018 §303(d) list for pathogens based upon data collected during 2013 and 2016. An evaluation of the available monthly water quality samples and results from an intensive *E. coli* study revealed Chandelower Creek was not meeting the pathogen criteria applicable to its use classification (F&W). For the purposes of this TMDL, the most recent data from 2016 (which included both monthly samples and calculated geometric means) will be utilized in this TMDL.

A mass balance approach was used for calculating the pathogen TMDLs for both Rock Creek and Chandelower Creek. The mass balance approach utilizes the conservation of mass principle. 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). The TMDL was calculated using the single sample or geometric mean sample exceedance event which resulted in the highest percent reduction.

Table 1.1 is a summary of the estimated existing load, allowable load, and percent reduction for the single sample criterion and the geometric mean criterion for Rock Creek. Table 1.2 lists the TMDL, defined as the maximum allowable *E. coli* loading under critical conditions, for Rock Creek.

Table 1.1: Rock Creek - *E. coli* Loads and Required Reductions

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	2.47E+11	9.12E+10	1.56E+11	63%
Geometric Mean Load	8.97E+09	4.99E+09	3.98E+09	44%

Table 1.2: *E. coli* TMDL for Rock 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
1.01E+11	1.01E+10	N/A	N/A	0	9.12E+10	63%

Note: N/A = not applicable
a. There are no CAFOs in the Rock Creek 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.

Table 1.3 is a summary of the estimated existing load, allowable load, and percent reduction for the single sample criterion and the geometric mean criterion for Chandelower Creek. Table 1.4 lists the TMDL, defined as the maximum allowable *E. coli* loading under critical conditions, for Chandelower Creek.

Table 1.3: Chandelower Creek - *E. coli* Loads and Required Reductions

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	5.15E+11	5.71E+10	4.58E+11	89%
Geometric Mean Load	3.15E+09	2.77E+09	3.77E+08	12%

Table 1.4: *E. coli* TMDL for Chandelower 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
6.34E+11	6.34E+10	N/A	N/A	0	5.71E+10	89%

Note: N/A = not applicable
a. There are no CAFOs in the Chandelower Creek 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.

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 Rock Creek and Chandelower Creek watersheds. 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).

2.2 Problem Definition

Waterbody Impaired:	Rock Creek – from Bear Creek to its source
Assessment Unit ID:	AL06030006-0304-500
Impaired Reach Length:	20.74 miles
Impaired Drainage Area:	53.5 sq. miles
Water Quality Standard Violation:	Pathogens (Single Sample Maximum, Geometric Mean)
Pollutant of Concern:	Pathogens (*E. coli*)
Water Use Classification:	Fish and Wildlife

Waterbody Impaired:	Chandelower Creek – from Rock Creek to its source
Assessment Unit ID:	AL06030005-0301-200
Impaired Reach Length:	5.95 miles
Impaired Drainage Area:	8.95 sq. miles
Water Quality Standard Violation:	Pathogens (Single Sample Maximum, Geometric Mean)
Pollutant of Concern:	Pathogens (*E. coli*)
Water Use Classification:	Fish and Wildlife

Usage Related to Classification:

The impaired stream segments are both 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.

<u>Rock Creek - Criteria Exceeded:</u>

Rock Creek was placed on the Department's 2018 §303(d) list for pathogens based upon data collected during 2016 at station RCKC-1. The basis for the addition to the list was that the geometric mean *E. coli* criterion was exceeded. The table below illustrates the 2016 *E. coli* data for RCKC-1.

Table 2.2.1: Rock Creek - Data for §303(d) Listing - Ambient Monitoring (2016)

Station	Date_Time	Flow cfs	E. coli (MPN/DL)	Calculated Geometric mean (MPN/DL)	Geometric mean Criterion (MPN/DL)
RCKC-1	3/15/2016 11:00		325.5		
RCKC-1	4/12/2016 11:00		1046.2		
RCKC-1	5/10/2016 10:30	16.8	275.5		
RCKC-1	6/20/2016 10:00	5.6	150		
RCKC-1	7/11/2016 10:45		228.2	150.49	126.00
RCKC-1	7/14/2016 10:45	2.1	115.3		
RCKC-1	7/18/2016 10:30	6.1	214.2		
RCKC-1	7/20/2016 10:15	3.1	155.3		
RCKC-1	7/25/2016 10:30		88.2		
RCKC-1	8/11/2016 10:20	23.1	191.8		
RCKC-1	9/1/2016 10:00	3.7	179.3	203.75	126.00
RCKC-1	9/12/2016 10:00	1	275.5		
RCKC-1	9/15/2016 10:45	1.5	125		
RCKC-1	9/19/2016 10:15	2.1	206.4		
RCKC-1	9/26/2016 10:30	0.7	275.5		

Chandelower Creek - Criteria Exceeded:

Chandelower Creek was placed on the Department's 2018 §303(d) list for pathogens based upon data collected during 2013 and 2016 at station CHLC-1. The basis for the addition to the list was that the *E. coli* criterion was exceeded in 4 out of 19 samples. In addition, the *E. coli* geometric mean criterion was exceeded in 2016. The table below illustrates the 2013 and 2016 *E. coli* data for CHLC-1.

Table 2.2.2: Chandelower Creek - Data for §303(d) Listing - Ambient Monitoring (2013, 2016)

STATION	Date_Time	Flow cfs	E. coli (MPN/DL) mpn/dl	Calculated Geometric mean (MPN/DL)	Geometric mean Criterion(MPN/DL)	Single Sample Max Criterion (MPN/DL)	DET_COND - E. coli (MPN/DL)
CHLC-1	4/9/2013 10:26	10.2	325.5			2507	
CHLC-1	6/11/2013 17:13	4.5	**1413.6**			298	H
CHLC-1	10/16/2013 14:53	2.3	**1046.2**			298	H
CHLC-1	3/15/2016 11:45	41.3	261.3			2507	
CHLC-1	4/12/2016 11:45	66	307.6			2507	
CHLC-1	5/10/2016 11:35	8.7	**2419.6**			298	G
CHLC-1	6/20/2016 11:30	0.7	119.8			298	
CHLC-1	7/11/2016 12:45	1.2	166.4			298	
CHLC-1	7/14/2016 12:15		42.6			298	
CHLC-1	7/18/2016 11:45	0.8	248.1			298	
CHLC-1	7/20/2016 11:30	0.5	123.6	**128.81**	126.00	298	
CHLC-1	7/25/2016 11:30		93.3			298	
CHLC-1	8/11/2016 11:30	1.7	290.9			298	
CHLC-1	9/1/2016 11:00	0.5	167			298	
CHLC-1	9/12/2016 11:30	0.1	88.6			298	
CHLC-1	9/15/2016 12:00	0.1	121.1	115.68	126.00	298	
CHLC-1	9/19/2016 11:30	0.3	59.1			298	
CHLC-1	9/26/2016 11:40		195.6			298	
CHLC-1	10/13/2016 11:45		**613.1**			298	

G – The analyte is present, but the amount of the analyte is determined to be above an acceptable level for quantitation.
H – The analytical holding times for analysis are exceeded.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

For the purpose 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

Currently, there are no NPDES regulated continuous point source discharges located within the Rock Creek watershed or the Chandelower Creek watershed.

3.2.2 Non-Continuous Point Sources

Currently, there are no NPDES regulated non-continuous point source discharges located within the Rock Creek watershed or the Chandelower Creek watershed.

3.2.3 Municipal Separate Storm Sewer Systems (MS4s)

Currently, there are no urban areas designated as Municipal Separate Storm Sewer System (MS4) regulated areas located within the Rock Creek watershed or the Chandelower Creek watershed.

3.2.4 Animal Feeding Operation/Concentrated Animal Feeding Operation (AFO/CAFO)

Currently, there are no Animal Feeding Operations/Concentrated Animal Feeding Operations (AFOs/CAFOs) located within the Rock Creek watershed or the Chandelower Creek 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 discharger that is considered by the Department to be a pathogen source will be required to demonstrate consistency with the assumptions and requirements of this TMDL.

3.2.5 Nonpoint Sources

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 stormwater 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.

The nature and extent of bacteria sources in the watershed will be identified more specifically during the implementation phase of the TMDL.

3.3 Land Use Assessment

Land use percentages for the Rock Creek watershed were determined from the 2019 National Land Cover Dataset (NLCD). The total drainage area of the Rock Creek watershed is approximately 53.5 square miles. Table 3.3.1 lists the various land uses and their associated percentages for the Rock Creek watershed. A pie chart illustrating the major cumulative land use types for the Rock Creek watershed is shown in Figure 3.3.1.

Table 3.3.1: Rock Creek Watershed Land Use (2019 NLCD)

2019 NLCD Land Cover	NLCD Legend	Area (square miles)	%
Open Water	11	0.01	0.03%
Developed, Open Space	21	0.71	1.33%
Developed, Low Intensity	22	0.34	0.64%
Developed, Medium Intensity	23	0.03	0.06%
Developed, High Intensity	24	0.00	0.00%
Barren Land	31	0.01	0.01%
Deciduous Forest	41	29.00	54.23%
Evergreen Forest	42	12.60	23.57%
Mixed Forest	43	3.04	5.68%
Shrub/Scrub	52	2.65	4.96%
Herbaceuous	71	0.70	1.31%
Hay/Pasture	81	2.96	5.54%
Cultivated Crops	82	0.02	0.04%
Woody Wetlands	90	1.37	2.55%
Emergent Herbaceuous Wetlands	95	0.03	0.06%

Cumalative Land Cover	NLCD Legend	Area (square miles)	%
Open Water	11	0.00	0.00%
Developed	21,22,23,24	1.09	2.03%
Barren Land	31	0.01	0.01%
Forested	41,42,43	44.64	83.48%
Grassland/Shrub	52,71	3.35	6.26%
Agriculture	81,82	2.98	5.57%
Wetlands	90,95	1.40	2.61%

Figure 3.3.1: Rock Creek Watershed Cumulative Land Use Distribution

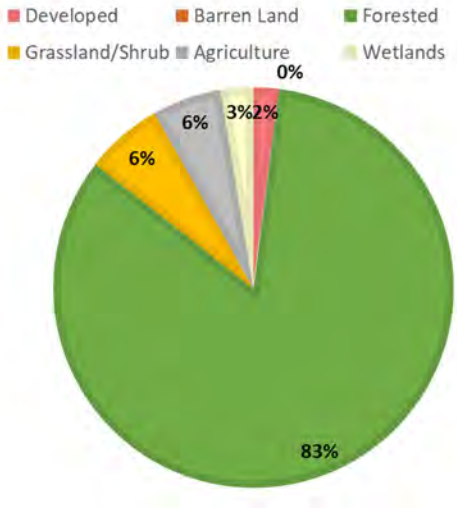
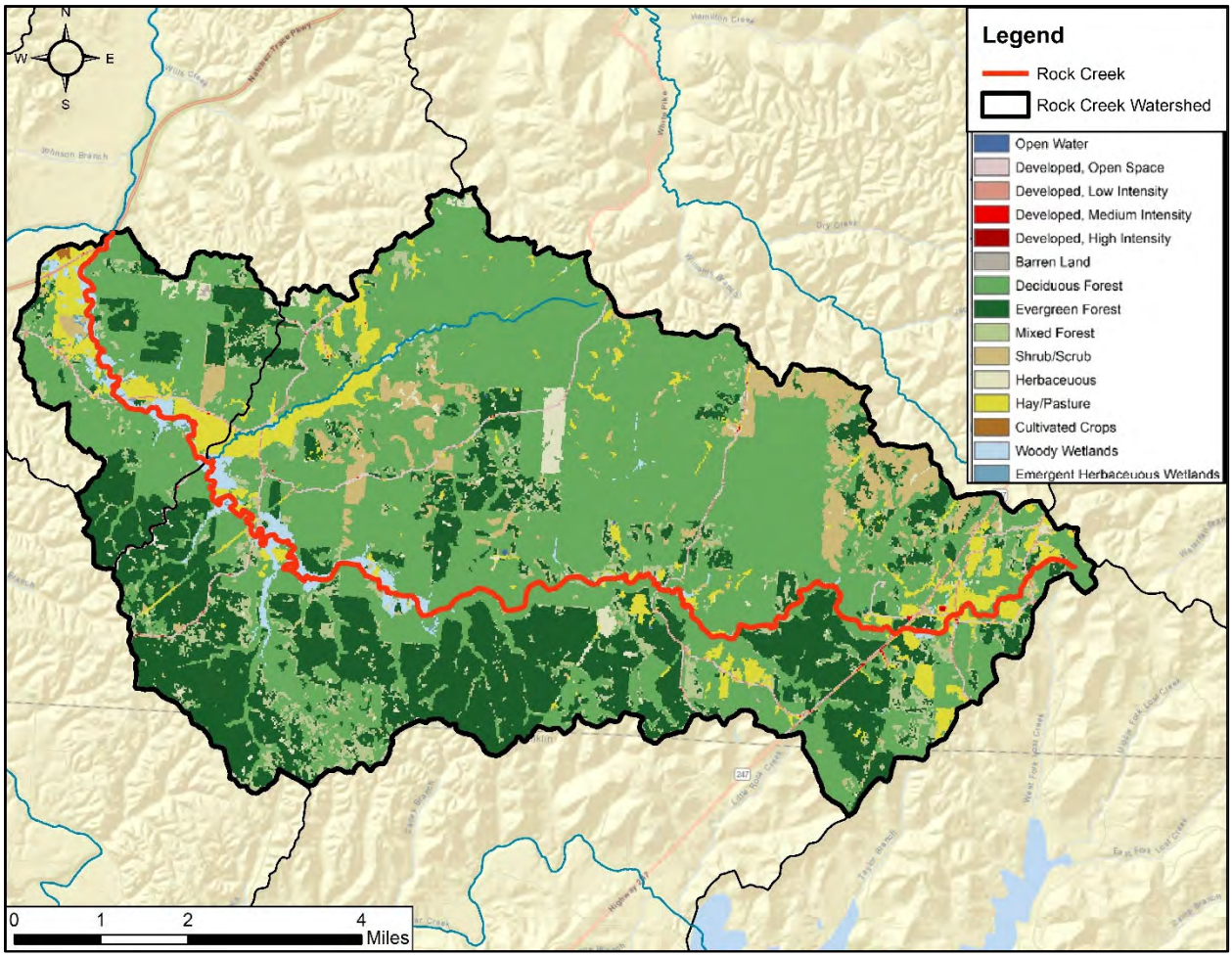


Figure 3.3.2: 2019 NLCD Map of the Rock Creek Watershed



Land use percentages for the Chandelower Creek watershed were also determined from the 2019 NLCD. The total drainage area of the Chandelower Creek watershed is approximately 8.95 square miles. Table 3.3.2 lists the various land uses and their associated percentages for the Chandelower Creek watershed. A pie chart illustrating the major cumulative land use types for the Chandelower Creek watershed is shown in Figure 3.3.3.

Table 3.3.2: Chandelower Creek Watershed Land Use (2019 NLCD)

2019 NLCD Land Cover	NLCD Legend	Area (square miles)	%
Open Water	11	0.00	0.03%
Developed, Open Space	21	0.17	1.89%
Developed, Low Intensity	22	0.05	0.50%
Developed, Medium Intensity	23	0.00	0.05%
Deciduous Forest	41	6.62	73.95%
Evergreen Forest	42	0.30	3.39%
Mixed Forest	43	0.24	2.63%
Shrub/Scrub	52	0.50	5.59%
Herbaceuous	71	0.20	2.24%
Hay/Pasture	81	0.78	8.72%
Woody Wetlands	90	0.09	1.00%
Emergent Herbaceuous Wetlands	95	0.00	0.01%

Cumalative Land Cover	NLCD Legend	Area (square miles)	%
Open Water	11	0.00	0.00%
Developed	21,22,23,24	0.22	2.44%
Forested	41,42,43	7.16	79.97%
Grassland/Shrub	52,71	0.70	7.83%
Agriculture	81,82	0.78	8.72%
Wetlands	90,95	0.09	1.01%

Figure 3.3.3: Chandelower Creek Watershed Cumulative Land Use Distribution

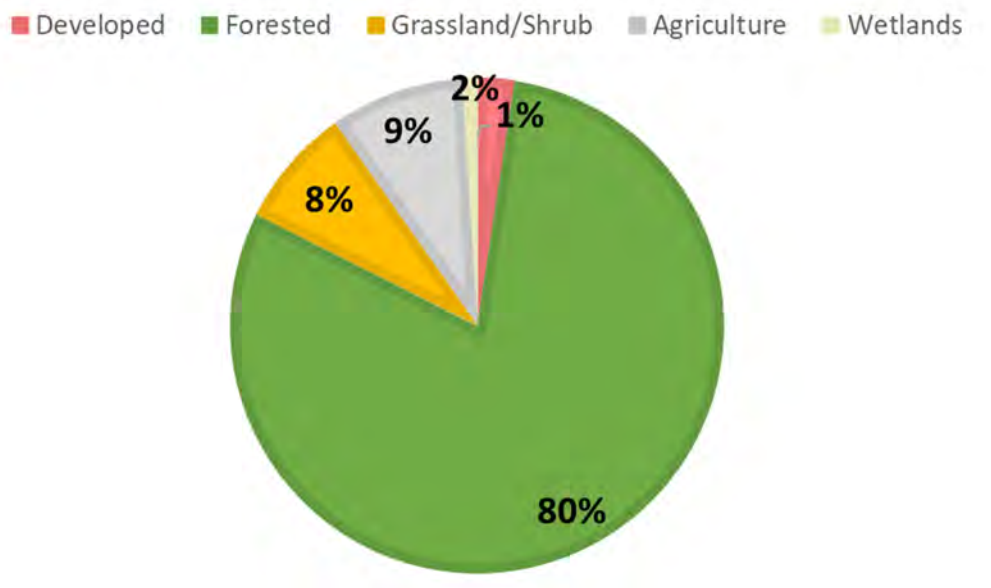
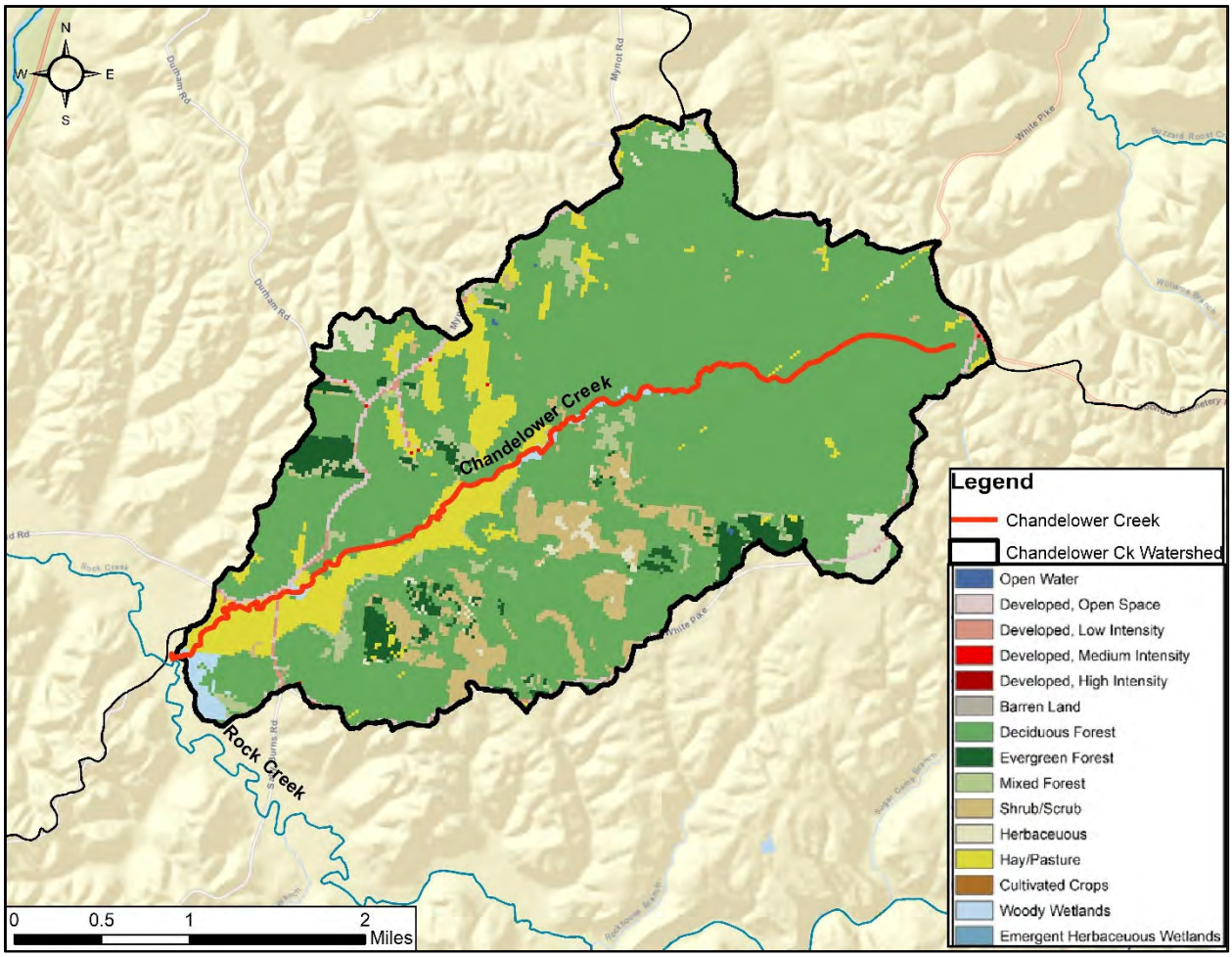


Figure 3.3.4: 2019 NLCD Map of the Chandelower Creek Watershed



3.4 Linkage between Numeric Targets and Sources

The predominant land use in both the Rock Creek watershed and the Chandelower Creek 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 are from the agricultural land uses. 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

In 2016, ADEM collected monthly (March – October) *E. coli* samples in Rock Creek at stations RCKC-1 and RCKC-2. Two intensive bacteria studies (July and September) were also conducted at stations RCKC-1 and RCKC-2 during 2016. Each intensive bacteria study consisted of collecting 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. In 2017, ADEM also collected monthly samples (March – October) at station RCKC-1. In 2018, water quality samples were collected three times (May, July and September) at station RCKC-1.

A total of twenty-seven *E. coli* samples were collected at station RCKC-1 during 2016-2018. Of the twenty-seven total *E. coli* samples, one sample exceeded the single sample summer maximum criterion of 298 colonies/100 ml. Intensive bacteria studies were performed during the months of July and September in 2016. Both the July and September *E. coli* geometric means violated the geometric mean criterion of 126 colonies/100 ml. A summary of the *E. coli* results is provided below in Table 3.5.1. All *E. coli* criteria exceedances are highlighted in red.

A total of fourteen *E. coli* samples were collected at station RCKC-2 during 2016. Of the fourteen total *E. coli* samples, one sample exceeded the single sample summer maximum criterion of 298 colonies/100 ml. Intensive bacteria studies were performed during the months of July and September in 2016. Both the July and September *E. coli* geometric means were below the geometric mean criterion of 126 colonies/100 ml. A summary of the *E. coli* results is provided below in Table 3.5.1. All *E. coli* criteria exceedances are highlighted in red.

Table 3.5.1: *E. coli* Data for Rock Creek

Station	Date_Time	Flow cfs	E. coli (MPN/DL)	Single Sample Max Criteron (MPN/DL)	Calculated Geometric mean (MPN/DL)	Geometric mean Criterion (MPN/DL)	DET_COND - E. coli (MPN/DL)
RCKC-1	3/15/2016 11:00		325.5	2507			
RCKC-1	4/12/2016 11:00		1046.2	2507			
RCKC-1	5/10/2016 10:30	16.8	275.5	298			
RCKC-1	6/20/2016 10:00	5.6	150	298			
RCKC-1	7/11/2016 10:45		228.2	298			
RCKC-1	7/14/2016 10:45	2.1	115.3	298			
RCKC-1	7/18/2016 10:30	6.1	214.2	298	150.5	126	
RCKC-1	7/20/2016 10:15	3.1	155.3	298			
RCKC-1	7/25/2016 10:30		88.2	298			
RCKC-1	8/11/2016 10:20	23.1	191.8	298			
RCKC-1	9/1/2016 10:00	3.7	179.3	298			
RCKC-1	9/12/2016 10:00	1	275.5	298			
RCKC-1	9/15/2016 10:45	1.5	125	298	203.7	126	
RCKC-1	9/19/2016 10:15	2.1	206.4	298			
RCKC-1	9/26/2016 10:30	0.7	275.5	298			
RCKC-1	10/13/2016 10:30		108.6	298			
RCKC-1	3/15/2017 10:20		228.2	2507			
RCKC-1	4/10/2017 10:30		111.9	2507			
RCKC-1	5/2/2017 11:30		275.5	298			
RCKC-1	6/13/2017 11:30		53.8	298			
RCKC-1	7/11/2017 11:00	4.8	191.8	298			
RCKC-1	8/15/2017 10:45	45.9	488.4	298			
RCKC-1	9/26/2017 11:15	4.4	108.1	298			
RCKC-1	10/17/2017 10:30	4	93.3	298			
RCKC-1	5/16/2018 11:45	17.8	191.8	298			
RCKC-1	7/10/2018 11:00	7.5	109.2	298			
RCKC-1	9/11/2018 12:00	2.7	74.4	298			
RCKC-2	3/15/2016 12:15		119.8	2507			
RCKC-2	4/12/2016 12:20		517.2	2507			
RCKC-2	5/10/2016 12:30	13.9	727	298			
RCKC-2	6/20/2016 12:45	2.9	21.8	298			
RCKC-2	7/11/2016 11:40	4.9	55.6	298			
RCKC-2	7/14/2016 12:45	0.9	44.1	298			
RCKC-2	7/18/2016 12:45	2.3	36.4	298	49.2	126	
RCKC-2	7/20/2016 12:15	1.1	26.5	298			
RCKC-2	8/11/2016 12:45	13.2	122.3	298			
RCKC-2	9/1/2016 12:00	2.2	104.6	298			
RCKC-2	9/12/2016 12:30	1.2	48.1	298			
RCKC-2	9/15/2016 13:00	0.3	143.9	298	63.1	126	
RCKC-2	9/19/2016 12:15	1.6	51.2	298			
RCKC-2	9/26/2016 12:30		26.9	298			

In 2016, ADEM collected monthly (March – October) *E. coli* bacteria samples in Chandelower Creek at station CHLC-1. Two intensive bacteria studies were also conducted at station CHLC-1 during 2016. Each intensive bacteria study consisted of collecting 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.

A total of sixteen *E. coli* samples were collected at station CHLC-1 in 2016. Of the sixteen total *E. coli* samples, two samples exceeded the single sample summer maximum criterion of 298 colonies/100 ml. Intensive bacteria studies were performed during the months of July and September in 2016. The July *E. coli* geometric mean violated the geometric mean criterion of 126 colonies/100 ml. A summary of the *E. coli* results is provided below in Table 3.5.2. All *E. coli* criteria exceedances are highlighted in red.

Table 3.5.2: *E. coli* Data for Chandelower Creek

STATION	Date_Time	Flow cfs	E. coli (MPN/DL)	Single Sample Max Criterion (MPN/DL)	Calculated Geometric mean (MPN/DL)	Geometric mean Criterion (MPN/DL)	DET_COND - E. coli (MPN/DL)
CHLC-1	3/15/2016 11:45	41.3	261.3	2507			
CHLC-1	4/12/2016 11:45	66	307.6	2507			
CHLC-1	5/10/2016 11:35	8.7	2419.6	298			G
CHLC-1	6/20/2016 11:30	0.7	119.8	298			
CHLC-1	7/11/2016 12:45	1.2	166.4	298			
CHLC-1	7/14/2016 12:15		42.6	298			
CHLC-1	7/18/2016 11:45	0.8	248.1	298			
CHLC-1	7/20/2016 11:30	0.5	123.6	298	128.8	126	
CHLC-1	7/25/2016 11:30		93.3	298			
CHLC-1	8/11/2016 11:30	1.7	290.9	298			
CHLC-1	9/1/2016 11:00	0.5	167	298			
CHLC-1	9/12/2016 11:30	0.1	88.6	298			
CHLC-1	9/15/2016 12:00	0.1	121.1	298	115.7	126	
CHLC-1	9/19/2016 11:30	0.3	59.1	298			
CHLC-1	9/26/2016 11:40		195.6	298			
CHLC-1	10/13/2016 11:45		613.1	298			

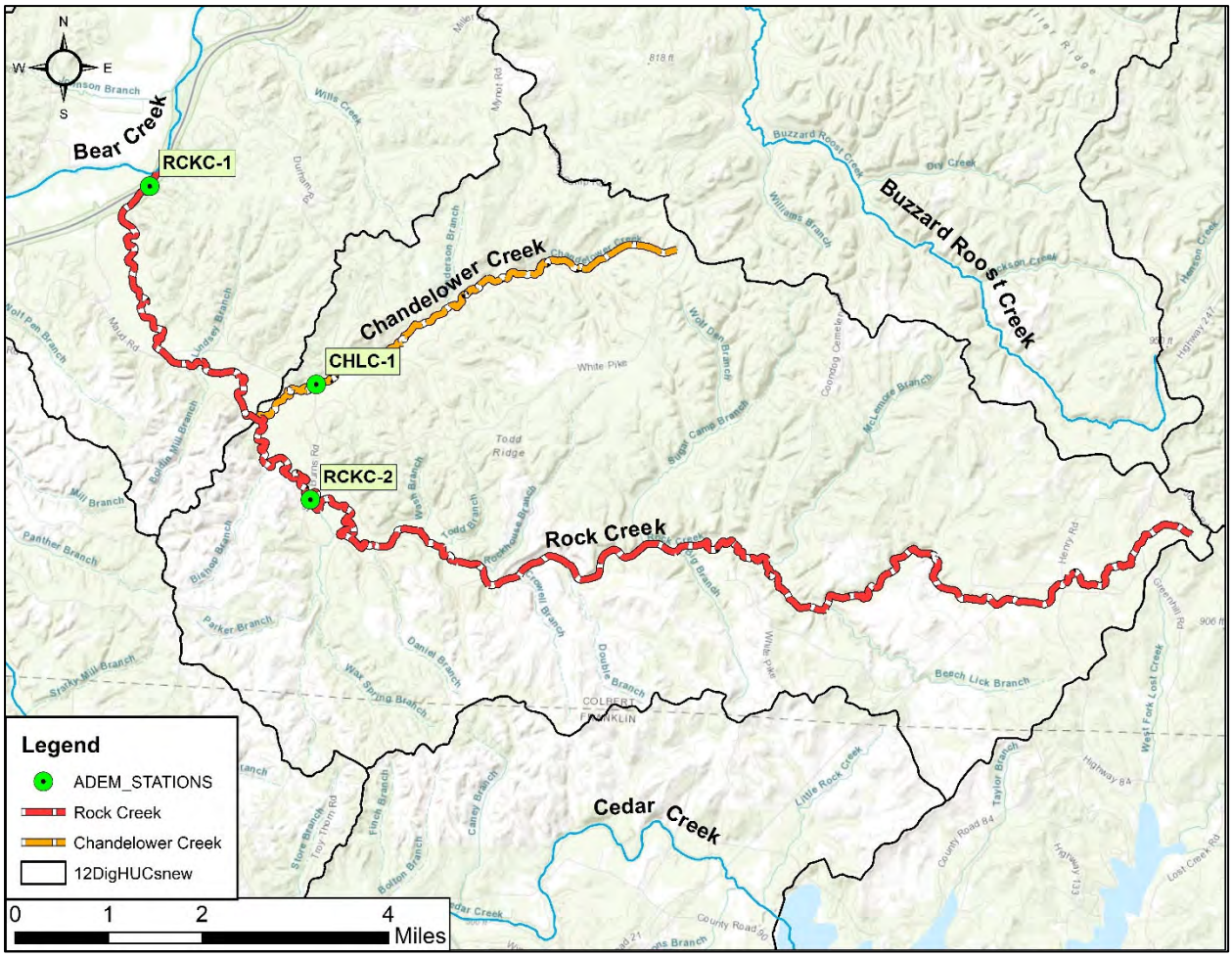
G - The analyte is present, but the amount of the analyte is determined to be above an acceptable level for quantitation

The water quality data collected in the Rock Creek and Chandelower Creek watersheds during the 2016 to 2018 time frame illustrated in the tables above reflects the most recent data available. The Department believes that this data is still representative of current conditions since the predominant land use coverages in these watersheds have remain unchanged since 2016.

Table 3.5.3: Station Descriptions

Station	Latitude	Longitude	Description
RCKC-1	34.6579	-88.09412	Rock Creek at Natchez Trace Road
RCKC-2	34.6093	-88.06323	Rock Creek at Colbert Co. Rd. 7 (Sally Burns Rd)
CHLC-1	34.627362	-88.062380	Chandelower Cr @ Sally Burns Rd

Figure 3.5.1: ADEM sampling stations in the Rock Creek watershed



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.

For Rock Creek, the single sample maximum concentration of 727 colonies/100 ml collected on May 10, 2016 at station RCKC-2 will be used to estimate the TMDL pathogen loadings in Rock Creek under critical conditions. A streamflow of 13.9 cfs was measured at station RCKC-2 during this sampling event.

For Chandelower Creek, the single sample maximum concentration of 2419 colonies/100 ml collected on May 10, 2016 at station CHLC-1 will be used to estimate the TMDL pathogen loadings

in Chandelower Creek under critical conditions. A streamflow of 8.7 cfs was measured at station CHLC-1 during this sampling event.

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 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 Rock Creek and Chandelower 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 of 298 col/100 ml and the geometric mean

criterion of 126 col/100 ml. 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 be the single sample or geometric mean.

4.2.1 Rock Creek - Existing Conditions

The **single sample** mass loading was calculated by multiplying the highest *E. coli* single sample exceedance concentration of 727 colonies/100 ml by the measured flow on the day of the exceedance. The calculation for the existing condition was based on the measurement at RCKC-2 on May 10, 2016, which can be found above in Table 3.5.1. The product of the concentration, measured flow, and a conversion factor gives the total mass loading (colonies per day) of *E. coli* in Rock Creek under the single sample exceedance condition.

$$\frac{13.9\ \text{ft}^3}{\text{s}} \times \frac{727\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{2.47 \times 10^{11}\text{colonies}}{\text{day}}$$

The **geometric mean** mass loading was calculated by multiplying the highest geometric mean exceedance concentration of 203.7 colonies/100 ml times the average of the five measured daily streamflows. This concentration was calculated based on measurements at RCKC-1 between September 1, 2016, and September 25, 2016, and can be found above in Table 3.5.1. The average stream flow was calculated to be 1.80 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of *E. coli* in Rock Creek under the geometric mean exceedance condition.

$$\frac{1.8\text{ft}^3}{\text{s}} \times \frac{203.7\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{8.97 \times 10^{9}\text{colonies}}{\text{day}}$$

4.2.2 Rock Creek - 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:

$$\frac{13.9\ \text{ft}^3}{\text{s}} \times \frac{268.2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{9.12 \times 10^{10}\text{colonies}}{\text{day}}$$

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

$$\frac{13.9\ \text{ft}^3}{\text{s}} \times \frac{29.8\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{1.01 \times 10^{10} \text{colonies}}{\text{day}}$$

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

$$\frac{1.8\ ft^3}{s} \times \frac{113.4\ colonies}{100\ mL} \times \frac{24{,}465{,}755 * 100 mL * s}{ft^3 * day} = \frac{4.99 \times 10^9 colonies}{day}$$

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

$$\frac{1.8\ ft^3}{s} \times \frac{12.6\ colonies}{100\ mL} \times \frac{24{,}465{,}755 * 100\ mL * s}{ft^3 * day} = \frac{5.55 \times 10^8 colonies}{day}$$

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 in Rock Creek. Table 4.2.1 below depicts the existing and allowable *E. coli* loads and required reductions for the Rock Creek watershed.

Table 4.2.1: Rock Creek - *E. coli* Loads and Required Reductions

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	2.47E+11	9.12E+10	1.56E+11	63%
Geometric Mean Load	8.97E+09	4.99E+09	3.98E+09	44%

From Table 4.2.1, compliance with the single sample maximum criterion of 298 colonies/100 ml requires a reduction of 63% in the *E. coli* load. The TMDL, WLA, LA and MOS values necessary to achieve the applicable *E. coli* criteria are provided in Table 4.2.2 below.

Table 4.2.2: *E. coli* TMDL for Rock 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
1.01E+11	1.01E+10	N/A	N/A	0	9.12E+10	63%

Note: N/A = not applicable
a. There are no CAFOs in the Rock Creek 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.

4.2.3 Chandelower Creek - Existing Conditions

The **single sample** mass loading was calculated by multiplying the highest *E. coli* single sample exceedance concentration of 2419.6 colonies/100 ml by the measured flow on the day of the exceedance. The calculation for the existing condition was based on the measurement at CHLC-1 on May 10, 2016, which can be found above in Table 3.5.2. The product of the concentration, measured flow, and a conversion factor gives the total mass loading (colonies per day) of *E. coli* in Chandelower Creek under the single sample exceedance condition.

$$\frac{8.7\ \text{ft}^3}{\text{s}} \times \frac{2419.6\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.15 \times 10^{11}\text{colonies}}{\text{day}}$$

The **geometric mean** mass loading was calculated by multiplying the highest geometric mean exceedance concentration of 128.8 colonies/100 ml times the average of the five measured daily streamflows. This concentration was calculated based on measurements at CHLC-1 between July 14, 2016, and August 11, 2016, and can be found above in Table 3.5.2. The average stream flow was calculated to be 1.00 cfs. The product of these two values times the conversion factor gives the total mass loading (colonies per day) of *E. coli* in Chandelower Creek under the geometric mean exceedance condition.

$$\frac{1.00\ \text{ft}^3}{\text{s}} \times \frac{128.8\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{3.15 \times 10^{9}\text{colonies}}{\text{day}}$$

4.2.4 Chandelower Creek - 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:

$$\frac{8.7\ \text{ft}^3}{\text{s}} \times \frac{268.2\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{5.71 \times 10^{10}\text{colonies}}{\text{day}}$$

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

$$\frac{8.7\ \text{ft}^3}{\text{s}} \times \frac{29.8\ \text{colonies}}{100\ \text{ml}} \times \frac{24{,}465{,}755 * 100\ \text{ml} * \text{s}}{\text{ft}^3 * \text{day}} = \frac{6.34 \times 10^{9}\text{colonies}}{\text{day}}$$

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

$$\frac{1.00\ ft^3}{s} \times \frac{113.4\ colonies}{100\ mL} \times \frac{24{,}465{,}755 * 100 mL * s}{ft^3 * day} = \frac{2.77 \times 10^{9} colonies}{day}$$

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

$$\frac{1.00\ ft^3}{s} \times \frac{12.6\ colonies}{100\ mL} \times \frac{24{,}465{,}755 * 100\ mL * s}{ft^3 * day} = \frac{3.08 \times 10^{8} colonies}{day}$$

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 in Chandelower Creek. Table 4.2.3 below depicts the existing and allowable *E. coli* loads and required reductions for the Chandelower Creek watershed.

Table 4.2.3: Chandelower Creek - *E. coli* Loads and Required Reductions

Source	Existing Load (colonies/day)	Allowable Load (colonies/day)	Required Reduction (colonies/day)	% Reduction
Single Sample Load	5.15E+11	5.71E+10	4.58E+11	89%
Geometric Mean Load	3.15E+09	2.77E+09	3.77E+08	12%

From Table 4.2.3, compliance with the single sample maximum criterion of 298 colonies/100 ml requires a reduction of 89% in the *E. coli* load. The TMDL, WLA, LA and MOS values necessary to achieve the applicable *E. coli* criteria are provided in Table 4.2.4 below.

Table 4.2.4: *E. coli* TMDL for Chandelower 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
6.34E+10	6.34E+9	N/A	N/A	0	5.71E+10	89%

Note: NA = not applicable
a. There are no CAFOs in the Chandelower Creek 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.

4.3 TMDL Summary

Rock Creek was placed on Alabama's §303(d) list in 2018 based on data collected in 2016 at station RCKC-1. A mass balance approach was used to calculate the *E. coli* TMDL for Rock Creek. Based on the TMDL analysis, it was determined that a 63% reduction in *E. coli* loading was necessary to achieve compliance with applicable water quality standards.

Chandelower Creek was placed on Alabama's §303(d) list in 2018 based on data collected in 2016 at station CHLC-1. A mass balance approach was used to calculate the *E. coli* TMDL for Chandelower Creek. Based on the TMDL analysis, it was determined that an 89% 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. 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 9.

Table 5.1: 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 Department of Environmental Management (ADEM), *Alabama's Water Quality Assessment and Listing Methodology*, 2022.

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

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 Rock Creek Watershed Photos

Figure 7.2.1: At Station RCKC-1: Upstream View (7/11/2016)

Figure 7.2.2: At Station RCKC-1: Downstream View (7/11/2016)

Figure 7.2.3: At Station RCKC-1: Upstream View (9/1/2016)

Figure 7.2.4: At Station RCKC-1: Downstream View (9/1/2016)

Figure 7.2.5: At Station RCKC-2: Upstream View (5/10/2016)

Figure 7.2.6: At Station RCKC-2: Downstream View (5/10/2016)

7.3 Chandelower Creek Watershed Photos

Figure 7.3.1: At Station CHLC-1: Upstream View (5/10/2016)

Figure 7.3.2: At Station CHLC-1: Downstream View (5/10/2016)

Figure 7.3.3: At Station CHLC-1: Upstream View (8/11/2016)

Figure 7.3.4: At Station CHLC-1: Downstream (8/11/2016)

Figure 7.2.5: At Station CHLC-1: Upstream View (10/13/2016)

Figure 7.2.6: At Station CHLC-1 Downstream View (10/13/2016)