

FINAL REPORT
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Fecal Coliform TMDL for the Coldwater River

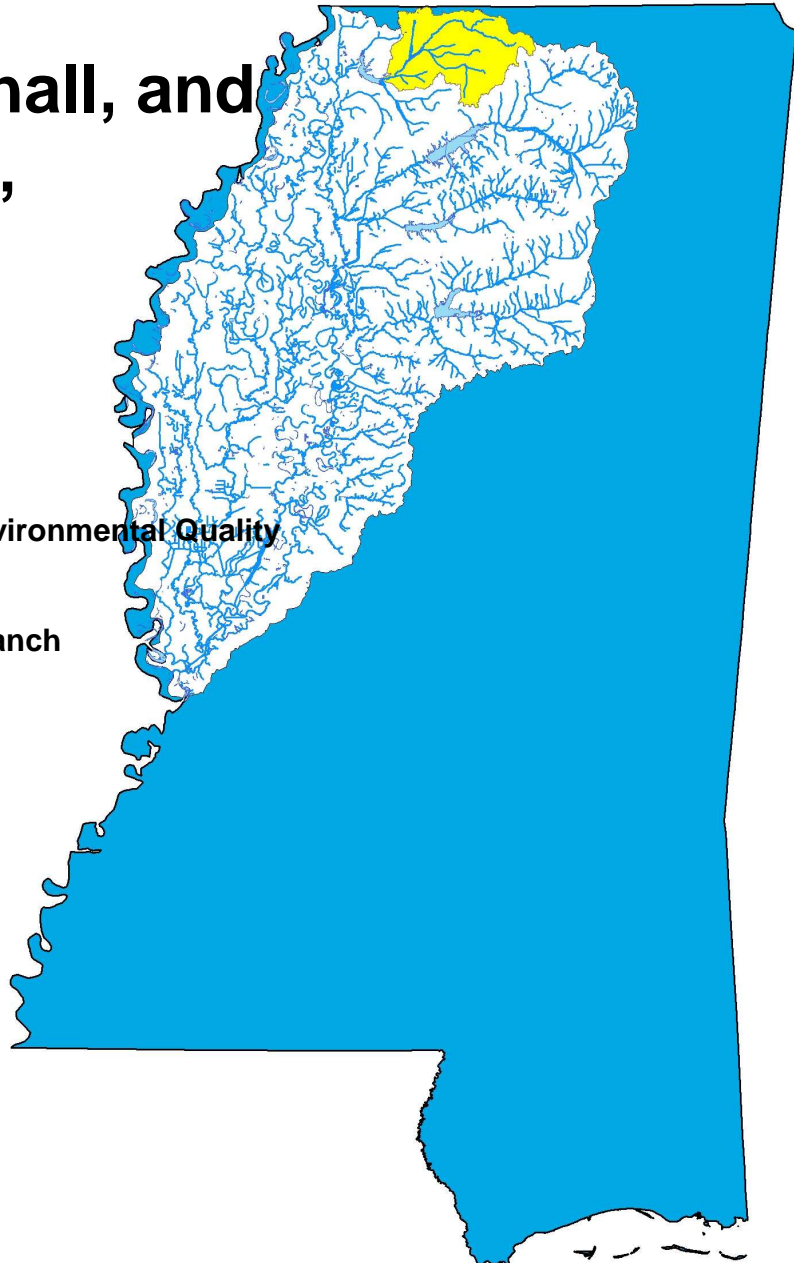
Yazoo River Basin

DeSoto, Marshall, and Tate Counties, Mississippi

Prepared By

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FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. The report contains one or more Total Maximum Daily Loads (TMDLs) for waterbody segments found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10 ⁻¹	deci	d	10	deka	da
10 ⁻²	centi	c	10 ²	hecto	h
10 ⁻³	milli	m	10 ³	kilo	k
10 ⁻⁶	micro	μ	10 ⁶	mega	M
10 ⁻⁹	nano	n	10 ⁹	giga	G
10 ⁻¹²	pico	p	10 ¹²	tera	T
10 ⁻¹⁵	femto	f	10 ¹⁵	peta	P
10 ⁻¹⁸	atto	a	10 ¹⁸	exa	E

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.0015625	Days	Seconds	86400
Cubic feet	Cu. Meter	0.028316847	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805195	Gallons	Cu feet	0.133680555
Cubic feet	Liters	28.316847	Hectares	Acres	2.4710538
cfs	Gal/min	448.83117	Miles	Meters	1609.344
cfs	MGD	.6463168	Mg/l	ppm	1
Cubic meters	Gallons	264.17205	μg/l * cfs	Gm/day	2.45

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TMDL INFORMATION PAGE

Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Coldwater River	MS296E	DeSoto and Marshall	08030204	Pathogens	Evaluated
Near Alpha: From Headwaters to confluence with Camp Creek Canal					
Coldwater River	MSYZ303R00_010	DeSoto and Tate	08030204	Pathogens	Monitored
From the confluence with Campcreek Canal to Arkabutla Lake					

Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Fecal Coliform	Secondary Contact	<p>May - October: Fecal coliform colony counts not to exceed a geometric mean of 200 per 100ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100ml more than 10 percent of the time.</p> <p>November – April: Fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than 10 percent of the time.</p>

NPDES Facilities

NPDES ID	Facility Name	Receiving Water
MS0056375	Belmore Lakes Subdivision	Tributary of Camp Creek
MS0043869	Briarwood Court Mobile Home Park	Sticky Creek
MS0028185	Bridgetown Subdivision	Bean Patch Creek
MS0049280	Brigadoon Farm Retreat	Pigeon Roost Creek
MS0052477	Byhalia POTW	Byhalia Creek
MS0044911	C Ws Laundry	Camp Creek Canal
MS0055280	Carters Plantation Subdivision	Tributary of Camp Creek
MS0053155	City of Olive Branch	Tributary of Coldwater River
MS0053155	City of Olive Branch, Braybourne Subdivision	Coldwater River
MS0024678	Coldwater POTW, Southwest	Coldwater River
MS0038938	Crestfield Subdivision	Coldwater River
MS0050962	Cypress Creek Plantation	Coldwater River
MS0049646	Dye Cat and Cow Vet Clinic	Coldwater River
MS0055000	Evening Shade Subdivision	Tributary of Coldwater River
MS0034584	Galena Attendance Center	Cuffawa Creek
MS0055441	Grove of Cayce Mobile Home Park, The	Shell Creek
MS0052272	Hamilton Self Storage Facility	Tributary of Nolehoe Creek
MS0025313	Holly Springs POTW, Number 1	Pigeon Roost Creek
MS0053635	Lewisburg Steak House	Short Creek
MS0024481	MDOT	Cane Creek
MS0024490	MDOT	Camp Creek
MS0051764	North Mississippi Utility Company, College Hill Subdivision	Camp Creek
MS0029513	Olive Branch POTW, Ross Road	Camp Creek
MS0048038	Pincrest Sewer Company, Forest Hill Subdivision	Coldwater River
MS0048780	Pinehurst Subdivision	Bean Patch Creek
MS0043753	Southern Baptist Education Center	Nolehole Creek
MS0048470	Summers Place Subdivision	Bean Patch Creek
MS0040673	US Army COE, Bayou Point, Arkabutla Lake	Coldwater River
MS0050091	Village of Ceder View	Turkey Creek

Fecal Coliform TMDL for the Coldwater River

Total Maximum Daily Load for Segment MS296E

Season	WLA (counts per day)	LA (counts per day)	MOS	Total TMDL (counts per day)	TMDL Percent Reduction
Summer	9.01E+10	Varies with Flow	Explicit	Varies with Flow	47
Winter	4.99E+11	Varies with Flow	Explicit	Varies with Flow	37

Total Maximum Daily Load for Segment MSYZ303R00_010

Season	WLA (counts per 30 days)	LA (counts per 30 days)	MOS (counts per 30 days)	Total TMDL (counts per day)	TMDL Percent Reduction
Summer	1.40E+12	7.95E+13	8.99E+12	8.99E+13	27
Winter	7.91E+12	2.02E+14	2.33E+13	2.33E+14	0

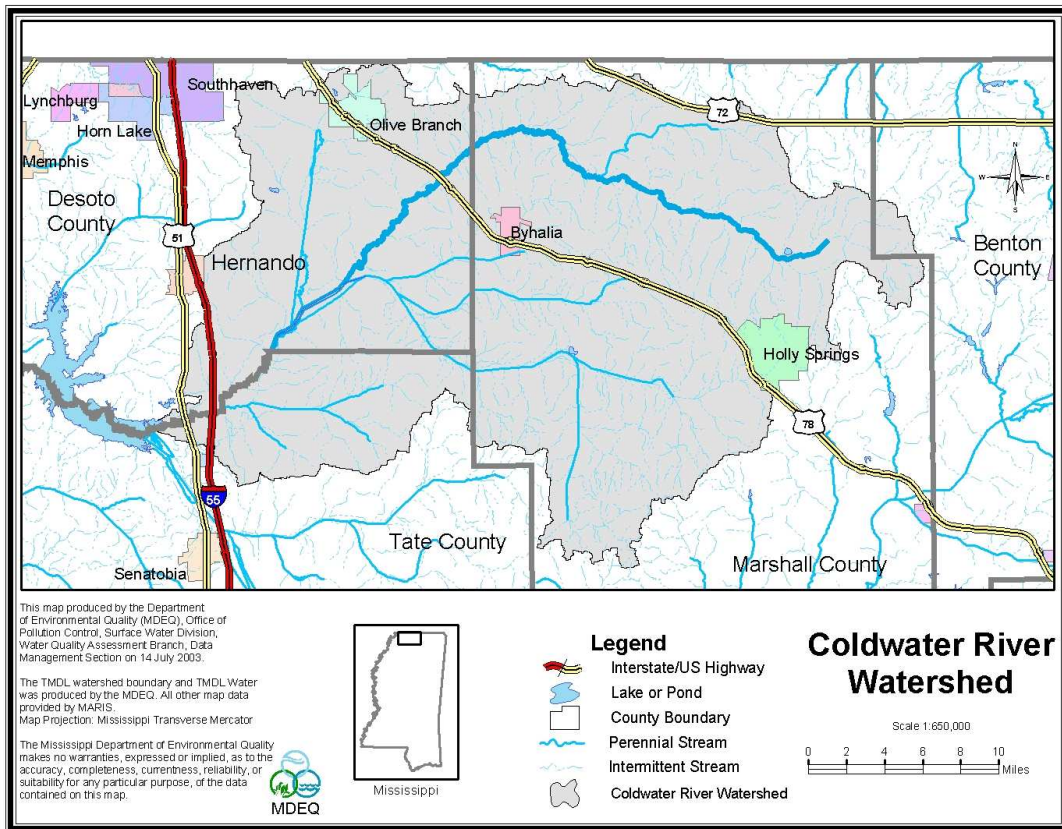
EXECUTIVE SUMMARY

A pathogen TMDL has been developed for one evaluated water body segment of the Coldwater River, MS296E, on the Mississippi 1998 Section 303(d) List of Water Bodies. A pathogen TMDL has also been developed for an additional water body segment of the Coldwater River, MSYZ303R00_010. MDEQ selected fecal coliform as an indicator organism for pathogenic bacteria. The applicable state standard specifies that for the months of May through October, the maximum allowable level of fecal coliform shall not exceed a geometric mean of 200 colonies per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed a colony count of 400 per 100 ml more than 10 percent of the time. For the months of November through April, the maximum allowable level of fecal coliform shall not exceed a geometric mean of 2000 colonies per 100 ml, based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed a colony count of 4000 per 100 ml more than 10 percent of the time.

The Coldwater River, Figure 1, flows in a southwesterly direction from its headwaters near Hudsonville, MS to the Tallahatchie River in Quitman County. The Coldwater River is one of the larger streams flowing through the Yazoo River Basin. This TMDL has been developed for two segments of the Coldwater River. Due to both limited flow data and limited fecal coliform data, the Loading Simulation Program C++ (LSPC) was inappropriate as the modeling framework for performing the TMDL allocations for this study. Load duration curves, which compare the water quality data against a flow-varying allowable load, were used to determine the TMDL for segment MS296E, and a mass balance approach was used to develop the TMDL for segment MSYZ303R00_010.

Although fecal coliform loadings from point and nonpoint sources in the watershed were not explicitly represented with a model, a source assessment was conducted for the Coldwater River Watershed. Nonpoint sources considered include wildlife, livestock, and urban development. Also considered were the nonpoint sources such as failing septic systems and other direct inputs to tributaries of the Coldwater River. There are 29 NPDES Permitted discharges included as point sources in the waste load allocation (WLA).

Figure 1. Location of the Coldwater River Watershed



Most of the permitted facilities currently have requirements in their NPDES Permits that require disinfection to meet water quality standards for pathogens at the end of pipe. Therefore, no changes are required for those existing NPDES permits. However, this TMDL recommends that upon permit reissuance the other NPDES Permits be modified to require disinfection. Monitoring of the permitted facilities in the Coldwater River Watershed should continue to ensure that compliance with permit limits is consistently attained.

The seasonal variations in hydrology, climatic conditions, and watershed activities are represented through the use of a continuous gage to develop the acceptable load curve and the use of water quality data collected throughout the year. The critical period was determined to be the summer season of May through October. An explicit 50 percent margin of safety (MOS) was used to account for uncertainty in the load duration curve method. An explicit 10 percent MOS was used in the mass balance method.

Water quality data indicate violations of the fecal coliform standard in the waterbody. The load duration curves provide a data-based method to estimate the reductions required to meet water quality standards in the Coldwater River. Load duration curves and TMDLs were computed at one location corresponding to the listed segment of the Coldwater River. The estimated summer reduction of fecal coliform bacteria required for segment MS296E is 47% and 27% for segment MSYZ303R00_010.

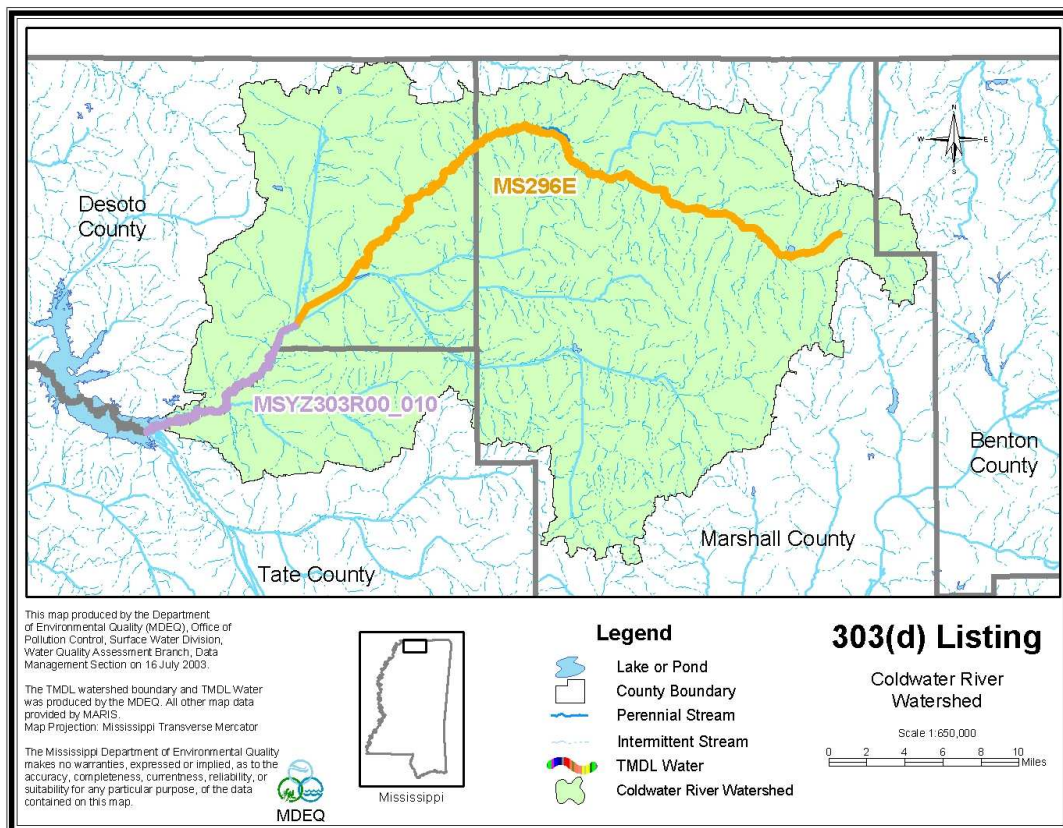
INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency’s (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is fecal coliform. Fecal coliform bacteria are used as indicator organisms. They are readily identifiable and indicate the possible presence of other pathogenic organisms in the waterbody. The TMDL process can be used to establish water quality based controls to reduce pollution from nonpoint sources, maintain permit requirements for point sources, and restore and maintain the quality of water resources.

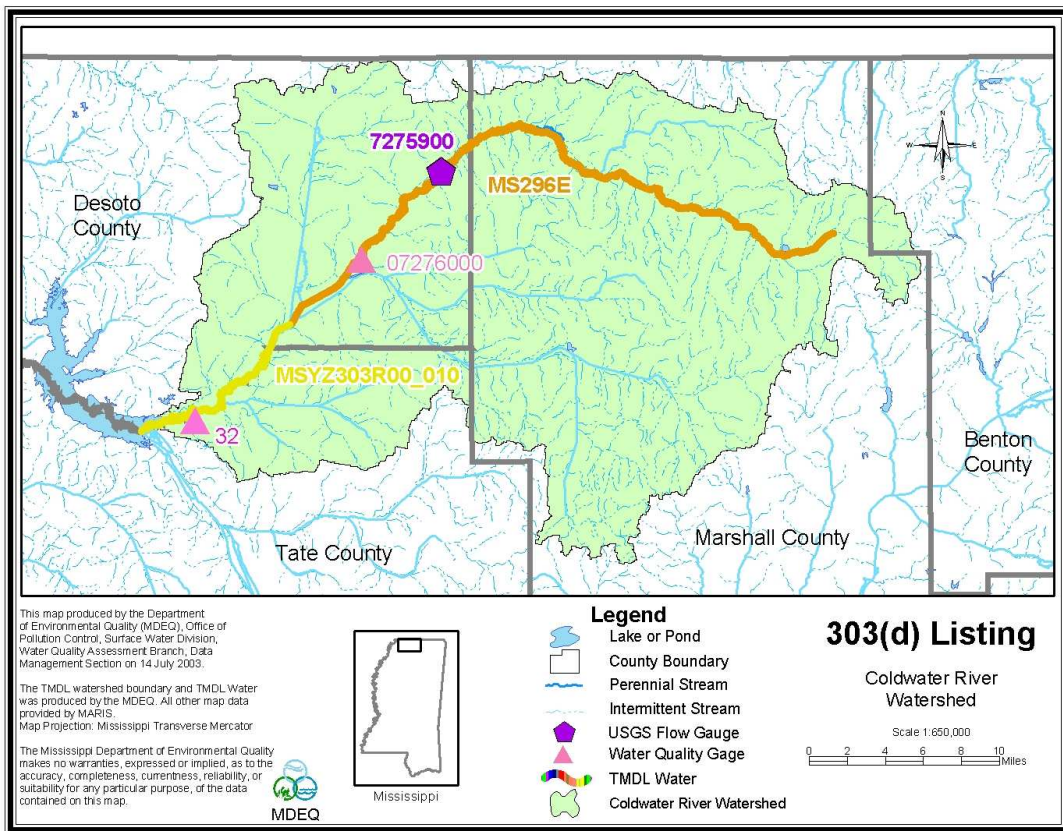
One segment, MS296E, of the Coldwater River on the evaluated section of the Mississippi 1998 Section 303(d) List of Waterbodies for pathogen impairment has had a TMDL developed. Segment MS296E was listed based on anecdotal information. Segment MSYZ303R00_010 had data collected in 2001 that indicated impairment. The segments are shown in Figure 2.

Figure 2. Coldwater River Watershed Segments



Load duration curves are developed using water quality monitoring data along with long-term flow monitoring data, typically from the station where the sampling data were collected. However, when flow data are not available at the monitoring station, a nearby station can be used. The mass balance method is used when the water quality data is collected in a manner consistent with the water quality standards, that is at least 5 samples collected within a 30 day period. The water body segments along with the location of the water quality gages and flow gage is shown in Figure 3. The TMDL for segment MS296E was developed with one load duration curve based on water quality data from station 07276000 and flow data from the station 07275900. The TMDL for segment MSYZ303R00_010 was developed using the mass balance method and station 32.

Figure 3. Coldwater River Segments with Water Quality and Flow Gages



The Coldwater River segments are in the Yazoo River Basin Hydrologic Unit Code (HUC) 08030204 in northwest Mississippi. The watershed is approximately 472,000 acres. The watershed is primarily rural, but includes many small municipalities. Pasture is the dominant landuse within the watershed as shown by the land distribution summary in Table 1.

Table 1. Landuse Distribution for the Coldwater River Watershed

	Urban	Forest	Agriculture	Barren	Wetland	Water	Total
Area (acres)	5,667	149,059	248,512	174	66,564	2,777	472,753
% Area	1%	31%	53%	0%	14%	1%	100%

1.2 Applicable Waterbody Segment Use

The water use classification for the listed segments of the Coldwater River, as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulation, is Fish and Wildlife Support. The designated beneficial uses for the Coldwater River are Secondary Contact and Aquatic Life Support.

1.3 Applicable Waterbody Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (2002). The standard states that for the summer months the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 400 per 100 ml more than 10 percent of the time. For the winter months, the maximum allowable level of fecal coliform shall not exceed a geometric mean of 2000 colonies per 100 ml, based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples, nor shall the samples examined during a 30-day period exceed 4000 per 100 ml more than 10 percent of the time. The water quality standard was used to assess the data to determine impairment in the waterbody.

TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. Recently, MDEQ established a revision to the fecal coliform standard that allows for a statistical review of any fecal coliform data set. There are two tests that the data set must pass to show non-impairment.

The first test states that for the summer the fecal coliform colony count shall not exceed a geometric mean of 200 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples and for the winter the fecal coliform colony count shall not exceed a geometric mean of 2000 per 100 ml based on a minimum of 5 samples taken over a 30-day period with no less than 12 hours between individual samples. The second test states that for the summer the samples examined during a 30-day period shall not exceed a count of 400 per 100 ml more than 10 percent of the time and for the winter the samples examined during a 30-day period shall not exceed a count of 4000 per 100 ml more than 10 percent of the time.

2.1.1 Discussion of the Geometric Mean Test

The level of fecal coliform found in a natural water body varies greatly depending on several independent factors such as temperature, flow, or distance from the source. This variability is accentuated by the standard test used to measure fecal coliform levels in the water. The membrane filtration or MF method uses a direct count of bacteria colonies on a nutrient medium to estimate the fecal level. The fecal coliform colony count per 100 ml is determined using an equation that incorporates the dilution and volume to the sample filtered.

To account for this variability the dual test standard was established. The geometric mean test is used to dampen the impact of the large numbers when there are smaller numbers in the data set. The geometric mean is calculated by multiplying all of the data values together and taking the root of that number based on the number of samples in the data set.

$$G = \sqrt[n]{s1 * s2 * s3 * s4 * s5 * sn}$$

The standard requires a minimum of 5 samples be used to determine the geometric mean. MDEQ routinely gathers 6 samples within a 30-day period in case there is a problem with one of the samples. It is conceivable that there would be more samples available in an intensive survey, but typically each data set will contain 6 samples therefore, n would equal 6. For the data set to indicate no impairment, the result must be less than or equal to 200 in summer and 2000 in winter.

2.1.2 Discussion of the 10% Test

The other test looks at the data set as representing the 30 days for 100% of the time. The data points are sorted from the lowest to the highest and each value then represents a point on the curve from 0% to 100% or from day 1 to day 30. The lowest value becomes the 1st data point and the highest data point becomes the nth data point. The standard requires that 90% of the time, the counts of fecal coliform in the stream be less than or equal to 400 counts per 100 ml in summer and 4000 counts per 100 ml in winter.

By calculating a concentration of fecal coliform for every percentile point based on the data set, it is possible to determine a curve that represents the percentile ranking of the data set. Once the 90th percentile of the data set has been determined, it may be compared to the standard of 400 counts per 100 ml. If the 90th percentile of the data is greater than 400 then the stream will be considered impaired. This can be used not only to assess actual water quality data, but also computer generated model results. Actual water quality data will typically have 5 or 6 values in the data set, and computer generated model results would have 30 values.

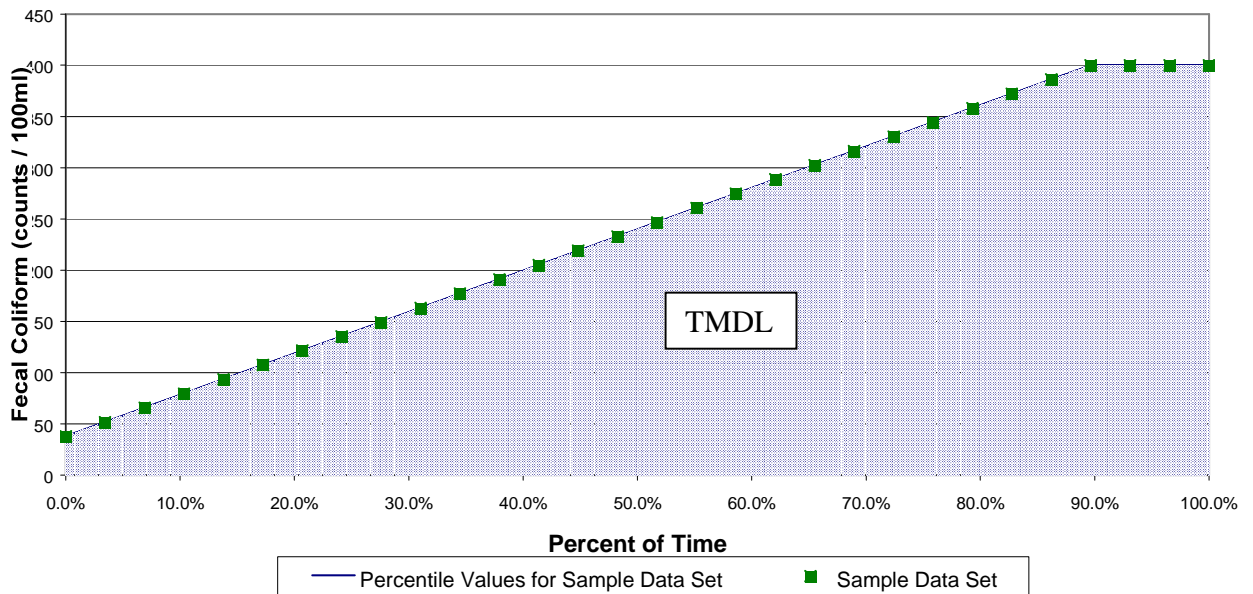
2.1.3 Discussion of Combining the Tests

MDEQ determined a curve that meets both portions of the standard and is indicative of possible water quality conditions. The integral of this curve represents the mass balance TMDL. That is, the maximum amount of fecal coliform in the water body either based on actual data sets or on computer generated values. By multiplying the integral of the 30-sample data set curve by the flow in the stream, the mass balance TMDL can be calculated. It is not possible to combine both tests for a load duration curve TMDL.

Table 2. 30 point data set

Fecal Coliform (counts/100ml)	Percentile Ranking
37.82	0.0%
51.75	3.4%
65.68	6.9%
79.61	10.3%
93.54	13.8%
107.47	17.2%
121.4	20.7%
135.33	24.1%
149.26	27.6%
163.19	31.0%
177.12	34.5%
191.05	37.9%
204.98	41.4%
218.91	44.8%
232.84	48.3%
246.77	51.7%
260.7	55.2%
274.63	58.6%
288.56	62.1%
302.49	65.5%
316.42	69.0%
330.35	72.4%
344.28	75.9%
358.21	79.3%
372.14	82.8%
386.07	86.2%
400	89.7%
400	93.1%
400	96.6%
400	100.0%

Figure 3. 30 point data set curve



2.1.4 Discussion of the Targeted Endpoint

While the endpoint of a TMDL calculation is similar to a standard for a pollutant, the endpoint is not the standard. For a mass balance TMDL, the endpoint selected is 200 counts per 100 ml for any given sample. If all of the data points are less than or equal to 200 then the water body will automatically pass both tests and not be considered impaired. Meeting the geometric mean test and applying the 10% test to the data sets apply both parts of the standard when applied to an actual data set or when considering a computer generated data set. It is therefore appropriate to select 200 colony counts per 100 ml as the targeted endpoint for the mass balance TMDL. For a load duration curve TMDL, MDEQ considered the 10% test instantaneous portion of the standard when looking at the data for assessment of impairment, setting the target, and calculating the TMDL. The instream fecal coliform target for the load duration curve TMDL is 400 colony counts per 100 ml with an explicit MOS of 50 percent, which reduces the target to 200 colony counts per 100 ml.

2.1.5 Discussion of the Critical Condition for Fecal Coliform

Critical conditions for waters impaired by nonpoint sources generally occur during periods of wet-weather and high surface runoff. But, critical conditions for point source dominated systems generally occur during periods of low-flow, low-dilution conditions. Therefore a careful examination of the data is needed to determine the critical 30-day period to be used for the TMDL.

2.2 Discussion of Instream Water Quality

MDEQ collected data at one station (07276000) in segment MS296E during the evaluation period. This data was collected on a semi-monthly basis from December 1996 through December 2000. Monitoring was performed in a manner consistent with the water quality standards, at least 5 samples in a 30-day period, at station 32 in segment MSYZ303R00_010 during the summer season of 2001 and the winter season of 2001.

2.2.1 Inventory of Available Water Quality Monitoring Data

The data collected at station 07276000 is provided in Table 3. Data collected from station 32 is presented in Tables 4 and 5.

Table 3. Fecal Coliform Data at Station 07276000

Date	Time	Flow (cfs)	Fecal Coliform (counts/100ml)
12/3/96	13:00		100
1/23/97	11:00		1060
2/24/97	9:45		10
3/13/97	9:50		140
4/2/97	13:00		50
5/14/97	12:45		80
7/8/97	13:40		4700
8/19/97	13:15		260
9/11/97	13:50		860
10/1/97	12:37		148
11/19/97	12:30		210
1/15/98	12:18	540	90
2/24/98	13:50	179	50
3/18/98	9:05	276	670
5/21/98	11:50	68	60
7/7/98	12:50	69	200
12/16/98	12:30	145	240
1/25/99	12:40	1620	750
2/3/99	13:01	859	120
3/2/99	14:05	104	40
3/31/99	13:30	269	2900
5/4/99	12:10	101	220
6/9/99	13:00	59	40
6/30/99	12:30	189	500
8/10/99	13:15	59	60
8/31/99	14:04	48	120
10/26/99	13:45	52	120
11/16/99	14:20	69	200
12/1/99	13:00	71	130
1/6/00	10:45	98	210
2/24/00	13:15	119	260
4/4/00	13:35	569	2200
5/15/00	15:40	65	144
6/6/00	16:55	59	73
12/11/00	11:00	36	48

Table 4. Fecal Coliform Data reported in Coldwater River, Station 32
October 2001

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90 th Percentile	90 th Percentile Violation
10/2/2001	380	304	Yes	530	Yes
10/8/2001	250				
10/10/2001	150				
10/17/2001	630				
10/23/2001	290				

Table 5. Fecal Coliform Data reported in Coldwater River, Station 32
November and December 2001

Date	Fecal Coliform (counts/100ml)	Geometric Mean	Geometric Mean Violation	90 th Percentile	90 th Percentile Violation
11/13/2001	100	237	No	1150	No
11/19/2001	140				
11/26/2001	1200				
11/28/2001	1100				
12/5/2001	200				
12/10/2001	48				

2.2.2 Analysis of Instream Water Quality Monitoring Data

For segment MS296E, figure 5 shows the water quality data and the corresponding precipitation data for Station 07276000. The critical condition appears to be summer. For segment MSYZ303R00_010, the data collected at station 32 during the summer season indicate violation of the geometric mean portion of the standard and the percent of time in exceedence portion of the standard. The 90th percentile of the data set is 530, which is greater than the 400 necessary to meet the standard. A graphical representation can be seen in Figure 6 below. A line has been added to the graph representing 400 counts/100 ml and showing that this occurs less than 90% of the time, meaning that the counts of fecal coliform in the stream is greater than 400 more than 10% of the time. However, the data collected during November and December 2001 indicated no violations of either portion of the standard. Therefore, the summer season is considered the critical period for the Coldwater River. Figure 7 shows the water quality data and the corresponding precipitation data for Station 32. Based on the summer season being in violation and Figure 7, the critical period appears to be both summer and wet weather driven.

Figure 5. Water Quality Data from Station 07276000 and Rainfall

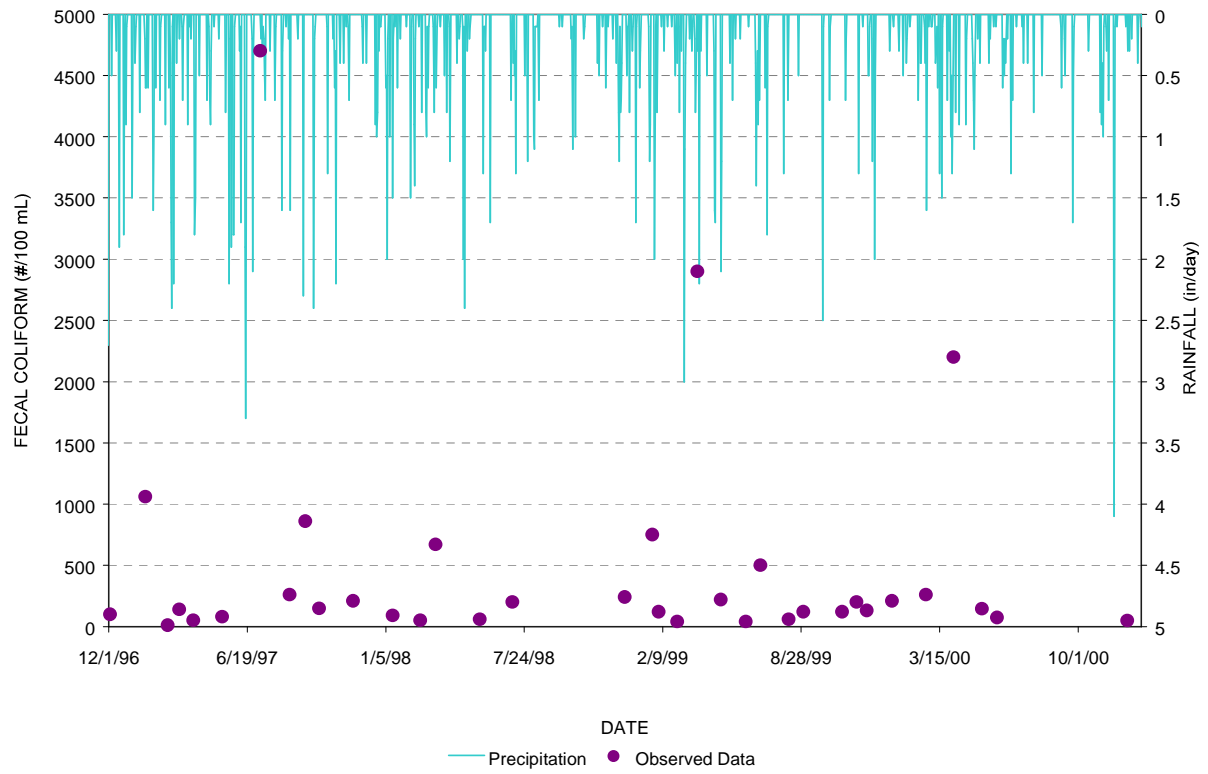


Figure 6. Statistical Representation of Water Quality Data for Station 32, Summer 2001

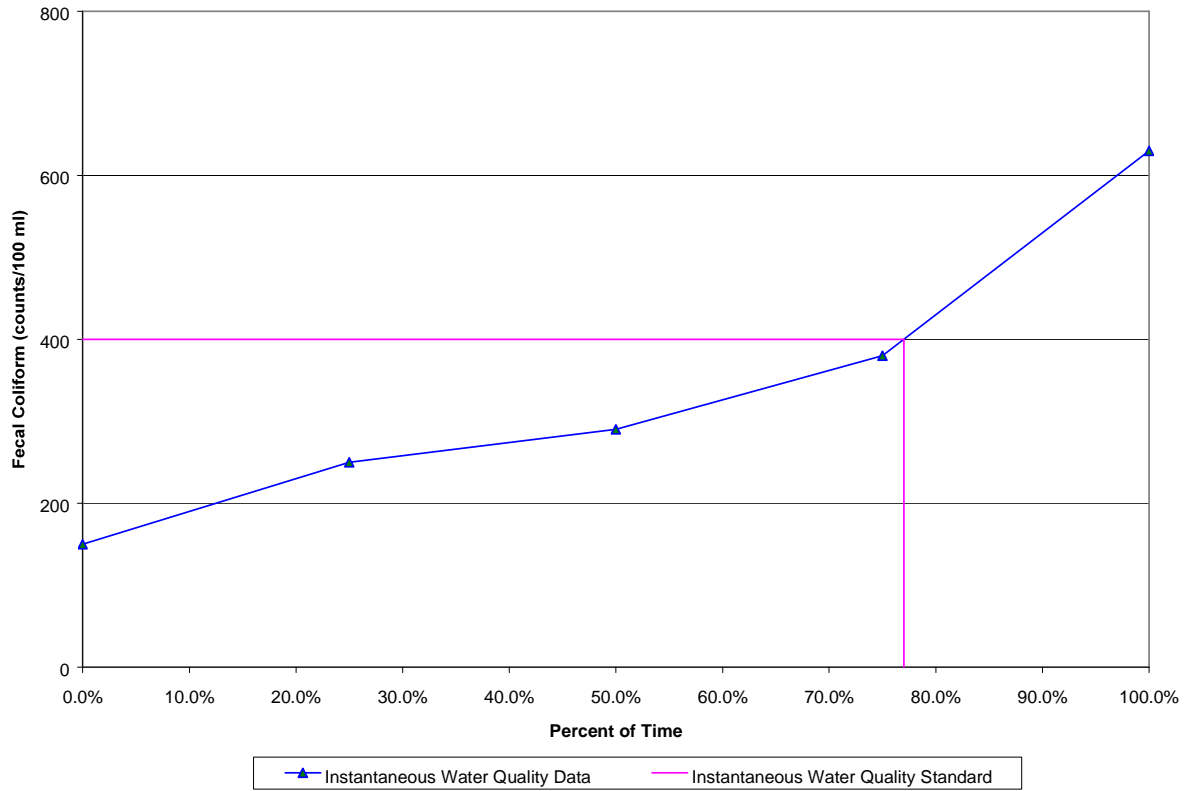
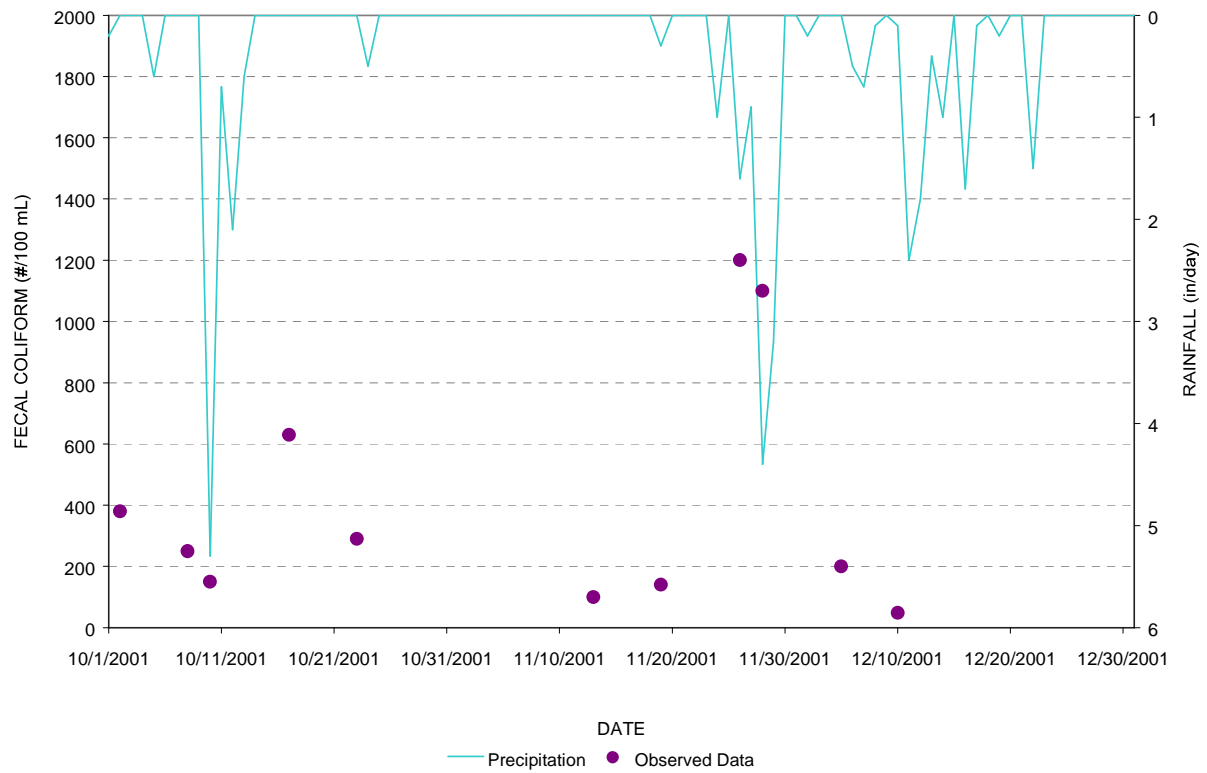


Figure 7. Water Quality Data from Station 32 and Rainfall



SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Coldwater River Watershed. In evaluation of the sources, loads were characterized by the best available information, monitoring data, literature values, and local management activities. This section documents the available information and interpretation for the analysis.

3.1 Assessment of Point Sources

Point sources of fecal coliform bacteria have their greatest potential impact on water quality during periods of low flow. Thus, a careful evaluation of point sources that discharge fecal coliform bacteria was necessary in order to quantify the degree of impairment present during the low-flow, critical condition period

Once the permitted dischargers were located, the effluent was characterized based on all available monitoring data including permit limits, discharge monitoring reports, and information on treatment types. Discharge monitoring reports (DMRs) were the best data source for characterizing effluents because they report measurements of flow and fecal coliform present in effluent samples. If evidence of insufficient treatment existed or when data were not available, professional judgement was used to estimate a fecal coliform loading rate for the calculations. The facilities are shown in Table 6.

Table 6. Inventory of Point Source Dischargers

NPDES ID	Facility Name	Receiving Water	Design Flow (MGD)
MS0056375	Belmore Lakes Subdivision	Tributary of Camp Creek	0.08
MS0043869	Briarwood Court Mobile Home Park	Sticky Creek	0.0164
MS0028185	Bridgetown Subdivision	Bean Patch Creek	0.264
MS0049280	Brigadoon Farm Retreat	Pigeon Roost Creek	0.0015
MS0052477	Byhalia POTW	Byhalia Creek	0.6
MS0044911	C Ws Laundry	Camp Creek Canal	0.0027
MS0055280	Carters Plantation Subdivision	Tributary of Camp Creek	0.02
MS0053155	City of Olive Branch	Tributary of Coldwater River	0.19
MS0053155	City of Olive Branch, Braybourne Subdivision	Coldwater River	0.19
MS0024678	Coldwater POTW, Southwest	Coldwater River	0.18
MS0038938	Crestfield Subdivision	Coldwater River	0.011
MS0050962	Cypress Creek Plantation	Coldwater River	0.05
MS0049646	Dye Cat and Cow Vet Clinic	Coldwater River	0.001
MS0055000	Evening Shade Subdivision	Tributary of Coldwater River	0.028
MS0034584	Galena Attendance Center	Cuffawa Creek	0.005
MS0055441	Grove of Cayce Mobile Home Park, The	Shell Creek	0.09
MS0052272	Hamilton Self Storage Facility	Tributary of Nolehole Creek	0.003
MS0025313	Holly Springs POTW, Number 1	Pigeon Roost Creek	0.99
MS0053635	Lewisburg Steak House	Short Creek	0.0015
MS0024481	MDOT	Cane Creek	0.025
MS0024490	MDOT	Camp Creek	0.025
MS0051764	North Mississippi Utility Company, College Hill Subdivision	Camp Creek	0.138
MS0029513	Olive Branch POTW, Ross Road	Camp Creek	3.0
MS0048038	Pinecrest Sewer Company, Forest Hill Subdivision	Coldwater River	0.078
MS0048780	Pinehurst Subdivision	Bean Patch Creek	0.0825
MS0043753	Southern Baptist Education Center	Nolehole Creek	0.02
MS0048470	Summers Place Subdivision	Bean Patch Creek	0.023
MS0040673	US Army COE, Bayou Point, Arkabutla Lake	Coldwater River	0.014
MS0050091	Village of Ceder View	Turkey Creek	0.05

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for Coldwater River, including:

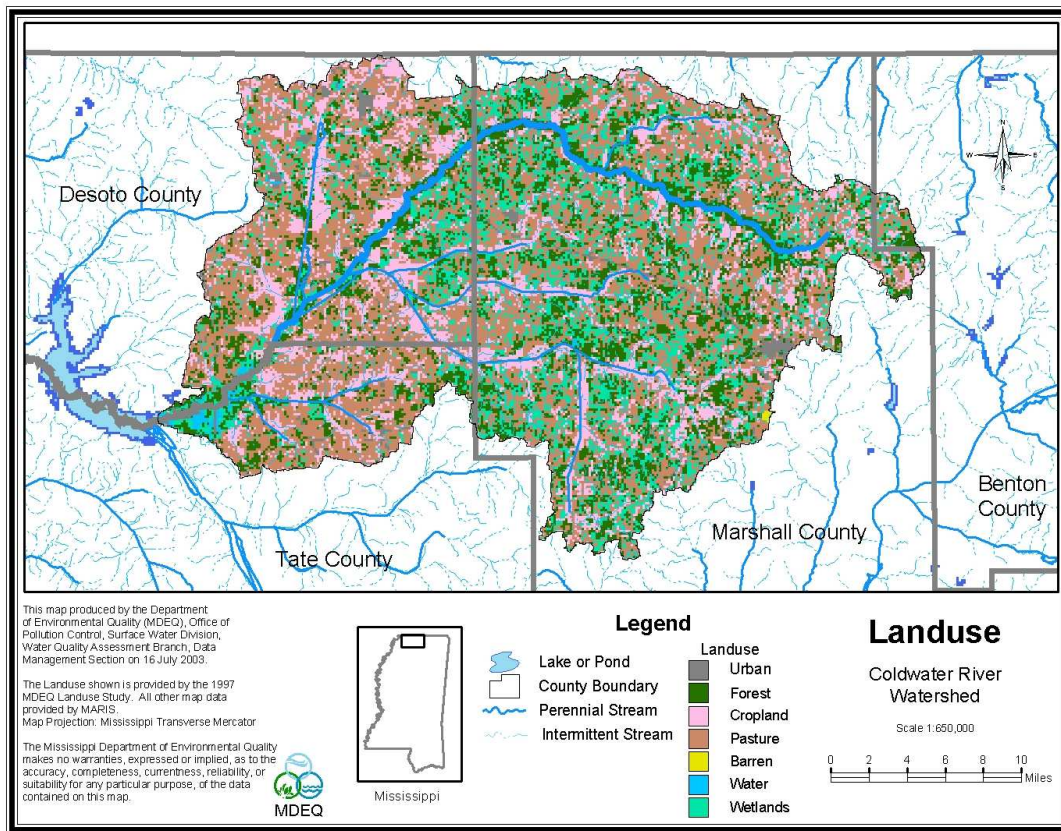
- ◆ Failing septic systems
- ◆ Wildlife
- ◆ Land application of hog and cattle manure
- ◆ Grazing animals
- ◆ Land application of poultry litter
- ◆ Other Direct Inputs
- ◆ Urban development

The 472,000 acre drainage area of the Coldwater River contains many different landuse types, including urban, forest, cropland, pasture, and wetlands. The landuse distribution for the watershed is provided in Table 7 and displayed in Figure 8. The landuse information for the watershed is based on the State of Mississippi's Automated Resource Information System (MARIS), 1997. This data set is based Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. The landuse categories were grouped into the landuses of urban, forest, cropland, pasture, barren, and wetlands.

Table 7. Landuse Distribution (acres)

	Urban	Forest	Agriculture	Barren	Wetland	Water	Total
Area (acres)	5,667	149,059	248,512	174	66,564	2,777	472,753
% Area	1%	31%	53%	0%	14%	1%	100%

Figure 8. Landuse Distribution Map for the Coldwater River Watershed



The MARIS landuse data for Mississippi was utilized by the Watershed Characterization System (WCS) to extract landuse sizes, populations, and agriculture census data. MDEQ contacted several agencies to refine the assumptions made in determining the fecal coliform loading. The Mississippi Department of Wildlife, Fisheries, and Parks provided information of wildlife density in the Magees Creek Watershed. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in this portion of the state. Mississippi State University researchers provided information on manure application practices and loading rates for hog farms, poultry farms, and beef and dairy operations. The Natural Resources Conservation Service gave MDEQ information on agricultural manure treatment practices and land application of manure.

3.2.1 Failing Septic Systems

Septic systems have a potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate, thence into underground absorption. The systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek.

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems may not receive the maintenance needed for proper, long-term operation. These systems require some sort of disinfection to properly operate. When this expense is ignored, the water does not receive adequate disinfection prior to release.

Septic systems have an impact on nonpoint source fecal coliform impairment in the Yazoo River Basin. The best management practices needed to reduce this pollutant load need to prioritize eliminating septic tank failures and improving maintenance and proper use of individual onsite treatment systems.

3.2.2 Wildlife

Wildlife present in the Coldwater River Watershed contributes to fecal coliform bacteria on the land surface. It was assumed that the wildlife population remained constant throughout the year, and that wildlife were present on all land classified as pastureland, cropland, and forest. It was also assumed that the manure produced by the wildlife was evenly distributed throughout these land types.

3.2.3 Land Application of Hog Manure

In the Yazoo River Basin processed manure from confined hog operations is collected in lagoons and routinely applied to pastureland during April through October. This manure is a potential contributor of bacteria to receiving water bodies due to runoff produced during a rain event. Hog farms in the Yazoo River Basin operate by keeping the animals confined at all times. The hog waste is collected in a lagoon and periodically sprayed on forage or cropland. The amount of the manure application is determined by the nitrogen uptake of the plant being sprayed. The frequency is determined by rain events so that the waste is not sprayed on saturated ground or just prior to a rain event to minimize runoff. Another factor in the application of the manure is pumping the lagoons often enough to avoid a lagoon overflow. Also, the waste is not land applied during the winter months when there is no forage or crop being grown. It was assumed that all of the hog manure produced was applied evenly to the available pastureland. Application rates of hog manure to pastureland from confined operations varied monthly according to management practices currently used in this area.

3.2.4 Beef and Dairy Cattle

Large dairy farms, over 200 head, typically confine the milking herd at all times. Smaller dairy farms confine the lactating cattle for a limited time during the day for milking and feeding. The manure collected during confinement is applied to the available pastureland in the watershed. Like the hog farms, application rates of dairy cow manure to pastureland vary monthly according to management practices currently used in this area.

Grazing cattle deposit manure on pastureland where it is available for wash-off and delivery to receiving water bodies. Beef cattle are assumed to have access to pastureland for grazing all of the time. For dairy cattle, the dry cattle and heifers are assumed to have access to pastureland for grazing all of the time. The small dairy farms, less than 200 head, in the Yazoo River Basin confine the lactating cattle for a limited time during the day. During all other times, the lactating cattle at small dairies are assumed to have access to pastureland for grazing. The milking herd is assumed to make up approximately 80% of the total herd. Manure produced by grazing beef and dairy cows is directly

deposited onto pastureland and is available for wash off.

The manure produced by confined dairy cows is collected in lagoons and spray applied to available pastureland in the watershed. Large dairy farms, more than 200 head, typically confine the milking herd at all times. Smaller dairy farms confine the lactating cattle for a limited time during the day for milking and feeding. Like the hog farms, application rates of dairy cow manure to pastureland vary monthly according to management practices currently used in this area.

3.2.5 Land Application of Poultry Litter

Predominantly, two kinds of chickens are raised on farms in the Yazoo River Basin, broilers and layers. For the broiler chickens, the amount of growth time from when the chicken is born to when it is sold off the farm is approximately 48 days or 1.6 months. Broiler chickens are confined in poultry houses all of the time. A pine shaving litter material is used to contain broiler chicken waste. This dry waste accumulates and breaks down in the poultry houses. The poultry litter is removed from the houses approximately every two years but may remain as long as seven years. The majority of the litter is used as a fertilizer on hay and row crops and may be used in areas of the state other than the location of the poultry houses. The litter is applied in the spring, summer, and early fall and rates are determined by a phosphorous index. A small amount of the litter may be mixed in with cattle feed and is not land applied.

Layer chickens are confined at all times and remain on farms for ten months or longer. The waste from small scale layer operations is treated in the same way as broiler operations. Large scale layer operations collect the chicken waste in a lagoon and periodically spray apply the waste to corn fields. The application rates vary monthly from the spring through the early fall.

3.2.6 Other Direct Inputs

Due to the general topography in the Yazoo River Watershed, it was assumed that land slopes in the watershed are such that unconfined animals are able to access the intermittent streams in the watershed. This direct input of cattle manure represents all animal access to streams (domestic and wild), illicit discharges of fecal coliform bacteria, human recreation, and leaking sewer collection lines.

3.2.7 Urban Development

Urban areas include land classified as urban and barren. Even though only a small percentage of the watershed is classified as urban, the contribution of the urban areas to fecal coliform loading in the Yazoo River was considered. Fecal coliform contributions from urban areas may come from storm water runoff, failing sewer pipes, and runoff contribution from improper disposal of materials such as litter.

MASS BALANCE PROCEDURE

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

4.1 Modeling Framework Selection

A mass balance approach was used to calculate the TMDL for segment MSYZ303R00_010. This method of analysis was selected due to the lack of long term fecal coliform data for the segment. The mass balance approach is suitable for this TMDL

4.2 Calculation of Load

The mass balance approach utilizes the conservation of mass principle. Loads can be calculated by multiplying the fecal coliform concentration in the water body for a 30-day period by the flow. The principle of the conservation of mass allows for the addition and subtraction of those loads to determine the appropriate numbers necessary for the TMDL. The loads can be calculated using the following relationship:

$$\text{Load (counts/30days)} = [\text{Concentration for 30 days (30 days*counts/ 100 ml)}] * [\text{Flow (cfs)}] * (\text{Conversion Factor})$$

$$\begin{aligned} \text{where (Conversion Factor)} &= [(28316.8 \text{ ml/1 ft}^3) * (1 (100 \text{ ml})/100 (1 \text{ ml})) * (60 \text{ s/1 min}) * \\ & (60 \text{ min/1 hour}) * (24 \text{ hour/1 day}) * (30 \text{ days/1 (30 days)/30 days)}] \\ &= 2.45 \text{ E+07 } ((100 \text{ ml} * \text{s})/(\text{ft}^3 * 30 \text{ days} * 30 \text{ days})) \end{aligned}$$

For the calculation of this TMDL, the concentration for 30 days used was the area under a curve that meets both portions of the standard with an assumed 30-sample data set. This value is 7129.425 (30days*counts/100 ml). USGS flow gage 07275900 was used to estimate the flow for segment MSYZ303R00_010. The average summer flow was estimated to be 514.59 cfs based on the average summer discharge at station 07275900 near Olive Branch, Mississippi. (Telis). This method was also used to calculate the average winter discharge.

$$\text{Avg Seasonal Discharge (cfs)} = \{ [\text{07275900 Avg Seasonal Discharge (cfs)}] / [\text{07275900 Drainage Area (square mile)}] \} * [\text{MSYZ303R00_010 Drainage Area (square mile)}]$$

$$\text{Avg Summer Discharge (cfs)} = \{ [\text{133 (cfs)}] / [\text{191 (square mile)}] \} * [\text{739 (square mile)}]$$

$$\text{Avg Summer Discharge (cfs)} = 514.59 \text{ cfs}$$

LOAD DURATION CURVE PROCEDURE

The methodology outlined in a paper completed to explore the use of load duration curves for data analysis applications for streams in the Yazoo River Basin in Mississippi was followed in the development of the load duration curves (Sheely, 2002). Load duration curves were developed as a method in which TMDLs applicable to all hydrological conditions could be calculated. Prior to the introduction of this method, many TMDLs were developed to address a single flow condition such as the 7Q10 (7-day, 10-year low flow) or average flow. This new method is innovative, because it allows for the development of TMDLs that addressed more than just a single flow condition. Because these curves include the entire range of flow conditions, pollutant sources of all types can be considered in the TMDLs. The methods used to develop both the flow and load duration curves will be described. A load duration curve approach was used to calculate the TMDL for segment MS296E.

5.1 Development of Flow Duration Curves

The first step in the development of load duration curves is to create flow duration curves using continuous flow or stage data. For segment MS296E, USGS continuous flow gage 07275900 was used with a drainage area weighting method.

The flow data are used to create flow duration curves, which display the cumulative frequency distribution of the daily flow data over the period of record. The flow duration curve relates flow values measured at the monitoring station to the percent of time that those values are met or exceeded. Flows are ranked from extremely low flows, which are exceeded nearly 100 percent of the time, to extremely high flows, which are rarely exceeded.

5.2 Development of Load Duration Curves

Flow duration curves are then transformed into load duration curves by multiplying the flow values along the curve by applicable water quality criteria values for pathogens and appropriate conversion factors. The load duration curves are conceptually similar to the flow duration curves, in that the x-axis represents the flow recurrence interval. The y-axis is transformed to represent the allowable load of the water quality parameter. The curve representing the allowable load of fecal coliform was calculated using the instantaneous, summer water quality criteria of 400 counts per 100 ml and the flow associated with each flow recurrence interval. Another load duration curve showing the target of 200 counts per 100 ml with a 50 percent MOS was also developed. The load duration curves developed for the three segments are included in Appendix A.

5.3 Comparison of Monitoring Data and Water Quality Criteria

The final step in the development of load duration curves was to add the monitoring data to the curves. Pollutant loads were estimated from the data as the product of the pollutant concentrations, instantaneous flows measured at the time of sample collection, and appropriate conversion factors. In order to identify the plotting position of each calculated load, the recurrence interval of each instantaneous flow measurement was defined. Water quality monitoring data are plotted on the same graph as the load duration curve. The load duration curves provide a graphical display of the water quality conditions in the waterbody. The monitoring data points that plot above the target line exceed the water quality target, while those that plot below meet the target.

5.4 Source Identification

The position at which the monitoring data exceed the target gives an indication of the potential sources and delivery mechanisms of the pollutants. Violations that occur on the right side of the curve, during low-flow conditions, indicate the presence of continuous pollutant sources, such as NPDES permitted discharges. Violations that occur on the left side of the curve, during higher flows, indicate intermittent sources that appear in response to rain events. Monitoring data that exceed water quality criteria in the mid-range flow indicate that pollutants are most likely due to a combination of these sources.

The load duration curves shown in Appendix A display only the water quality data points that exceed the target in each segment. The interpretation of those curves indicate that both point and nonpoint sources are present in the Coldwater River Watershed.

Using load duration curves for data analysis is different from the methods typically used for data analysis in that the frequency of attainment or violation of a particular water quality criteria is stressed rather than the absolute values of the monitoring data. One of the strengths of this method is that it can be used to interpret possible delivery mechanisms of pollutants. Load duration curves discussed have been shown to be influenced by the landuse distribution in their watersheds (Sheely, 2002). Because of this, load duration curves have the potential to be used as a method for targeting pollution reduction efforts in watersheds that are impaired and require TMDL development. Another strength of load duration curves is that they provide an understandable, graphical explanation of the data that are available for a monitoring station.

5.5 Selection of Representative Period

The period of record for flow data ranged from 1996 to 2002. The period of record for water quality data ranged from 1996 to 2000. Seasonality and critical conditions are accounted for during the time frame of the data represented in the load duration curves.

The critical condition for fecal coliform impairment from nonpoint source contributors occurs after a heavy rainfall that is preceded by several days of dry weather. The dry weather allows a build up of fecal coliform bacteria, which is then washed off the ground by a heavy rainfall. By using this time period, many such occurrences should be captured in the data results. Critical conditions for point sources, which occur during low-flow and low-dilution conditions, are considered as well.

5.6 Existing Loading

Appendix A includes graphs of the load duration curve showing the instream fecal coliform load for segment MS296E included in this TMDL. The graph shows a regression line through the data points that exceed the 200 counts per 100 ml target. The regression line represents the best fit of the existing loading in the Coldwater River.

ALLOCATION

In accordance with 40 CFR Section 130.2, which states, “TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure,” this TMDL is expressed as a percent reduction of load in order to retain the benefit of utilizing various flow conditions to develop the load duration curve. The use of a single TMDL number would effectively return to the choice of just one flow condition for TMDL development. This method uses the difference between the regression line through the exceeding points and the load duration target curve to calculate the appropriate percent reduction necessary for the TMDL. The only allocation included in this TMDL is the wasteload allocation for point sources.

6.1 Wasteload Allocations

The wasteload allocation is based on the existing point sources in the Coldwater River Watershed. The WLA for segment MS296E is represented on the Load Duration Curves in Appendix A as a horizontal line with a constant load appropriate for each segment. Due to the large number of point sources in the Coldwater River Watershed and the absence of the ability to represent die-off of fecal coliform using the load duration curve method, the WLA makes up a large percentage of the TMDL in this report. The point sources in segment MS296E and their allocated load are shown in Table 8. Additional point sources in segment MSYZ303R00_010 are shown in Table 9. The point sources that are recommended for permit modification to include fecal coliform limits and disinfection are also indicated in Tables 8 and 9.

Table 8. Wasteload Allocations for Segment MS296E

NPDES ID	Facility Name	Summer Allocated Load (counts/day)	Winter Allocated Load (counts/day)	Permit Modification Necessary
MS0056375	Belmore Lakes Subdivision	1.21E+09	1.21E+09	No
MS0043869	Briarwood Court Mobile Home Park	2.48E+08	2.48E+08	No
MS0028185	Bridgetown Subdivision	4.00E+09	4.00E+09	No
MS0049280	Brigadoon Farm Retreat	2.27E+07	2.27E+07	No
MS0052477	Byhalia POTW	9.09E+09	9.09E+09	No
MS0044911	C Ws Laundry	4.09E+07	4.09E+07	Yes
MS0055280	Carters Plantation Subdivision	3.03E+08	3.03E+08	No
MS0053155	City of Olive Branch	2.88E+09	2.88E+09	No
MS0053155	City of Olive Branch, Braybourne Subdivision	2.88E+09	2.88E+09	No
MS0050962	Cypress Creek Plantation	7.57E+08	7.57E+08	No
MS0049646	Dye Cat and Cow Vet Clinic	1.51E+07	1.51E+07	No
MS0055000	Evening Shade Subdivision	4.24E+08	4.24E+08	No
MS0034584	Galena Attendance Center	7.57E+07	7.57E+07	No
MS0055441	Grove of Cayce Mobile Home Park, The	1.36E+09	1.36E+09	No
MS0052272	Hamilton Self Storage Facility	4.54E+07	4.54E+07	No
MS0025313	Holly Springs POTW, Number 1	1.50E+10	1.50E+10	Yes
MS0053635	Lewisburg Steak House	2.27E+07	2.27E+07	Yes
MS0024490	MDOT	3.79E+08	3.79E+08	No
MS0051764	North Mississippi Utility Company, College Hill Subdivision	2.09E+09	2.09E+09	No
MS0029513	Olive Branch POTW, Ross Road	4.54E+10	4.54E+11	No
MS0048038	Pinecrest Sewer Company, Forest Hill Subdivision	1.18E+09	1.18E+09	No
MS0048780	Pinehurst Subdivision	1.25E+09	1.25E+09	No
MS0043753	Southern Baptist Education Center	3.03E+08	3.03E+08	No
MS0048470	Summers Place Subdivision	3.48E+08	3.48E+08	No
MS0050091	Village of Ceder View	7.57E+08	7.57E+08	No
Total		9.01E+10	4.99E+11	

Table 9. Wasteload Allocations for Segment MSYZ303R00_010

NPDES ID	Facility Name	Summer Allocated Load (counts/30 days)	Winter Allocated Load (counts/30 days)	Permit Modification Necessary
MS0056375	Belmore Lakes Subdivision	1.82E+10	1.82E+10	No
MS0043869	Briarwood Court Mobile Home Park	3.73E+09	3.73E+09	No
MS0028185	Bridgetown Subdivision	6.00E+10	6.00E+10	No
MS0049280	Brigadoon Farm Retreat	3.41E+08	3.41E+08	No
MS0052477	Byhalia POTW	1.36E+11	1.36E+11	No
MS0044911	C Ws Laundry	6.14E+08	6.14E+08	Yes
MS0055280	Carters Plantation Subdivision	4.54E+09	4.54E+09	No
MS0053155	City of Olive Branch	4.32E+10	4.32E+10	No
MS0053155	City of Olive Branch, Braybourne Subdivision	4.32E+10	4.32E+10	No
MS0024678	Coldwater POTW, Southwest	4.09E+10	4.09E+11	No
MS0038938	Crestfield Subdivision	2.50E+09	2.50E+09	No
MS0050962	Cypress Creek Plantation	1.14E+10	1.14E+10	No
MS0049646	Dye Cat and Cow Vet Clinic	2.27E+08	2.27E+08	No
MS0055000	Evening Shade Subdivision	6.36E+09	6.36E+09	No
MS0034584	Galena Attendance Center	1.14E+09	1.14E+09	No
MS0055441	Grove of Cayce Mobile Home Park	2.05E+10	2.05E+10	No
MS0052272	Hamilton Self Storage Facility	6.82E+08	6.82E+08	No
MS0025313	Holly Springs POTW, Number 1	2.25E+11	2.25E+11	Yes
MS0053635	Lewisburg Steak House	3.41E+08	3.41E+08	Yes
MS0024481	MDOT	5.68E+09	5.68E+09	No
MS0024490	MDOT	5.68E+09	5.68E+09	No
MS0051764	North Mississippi Utility Company, College Hill Subdivision	3.14E+10	3.14E+10	No
MS0029513	Olive Branch POTW, Ross Road	6.82E+11	6.82E+12	No
MS0048038	Pinecrest Sewer Company, Forest Hill Subdivision	1.77E+10	1.77E+10	No
MS0048780	Pinehurst Subdivision	1.87E+10	1.87E+10	No
MS0043753	Southern Baptist Education Center	4.54E+09	4.54E+09	No
MS0048470	Summers Place Subdivision	5.23E+09	5.23E+09	No
MS0040673	US Army COE, Bayou Point, Arkabutla Lake	3.18E+09	3.18E+09	No
MS0050091	Village of Ceder View	1.14E+10	1.14E+10	No
Total		1.40E+12	7.91E+12	

6.2 Load Allocations

The load allocation for segment MS296E varies according to the flow conditions as represented graphically for the segment in Figures 9 and 10. The load allocation for segment MSYZ303R00_010 is calculated using the water quality criterion and the estimated critical flow. In calculating the LA

component, the total TMDL for the water body is reduced by a 10 percent MOS. For this TMDL, the summer load is based on a fecal coliform concentration for 30 days determined by the area under a curve that meets both portions of the standards for a 30 sample data set and the average summer flow of 514.59 cfs. The resulting summer LA is estimated to be 7.95E+13 counts/30 days. The resulting winter LA is estimated to be 2.02E+14 counts/30 days using the average winter flow.

Summer

$$LA = 0.9 * (7129.425(30 \text{ days} * \text{counts}/100\text{ml}) * 514.59(\text{cfs}) * 2.45\text{E}+07((100\text{ml} * \text{s}) / (\text{ft}^3 * 30 \text{ days} * 30 \text{ days}))) - 1.40\text{E}+12(\text{counts for 30 days})$$

$$LA = 7.95\text{E}+13 \text{ counts for 30 days}$$

Winter

$$LA = 0.9 * (7129.425(30 \text{ days} * \text{counts}/100\text{ml}) * 1334.20(\text{cfs}) * 2.45\text{E}+07((100\text{ml} * \text{s}) / (\text{ft}^3 * 30 \text{ days} * 30 \text{ days}))) - 7.91\text{E}+12(\text{counts for 30 days})$$

$$LA = 2.02\text{E}+13 \text{ counts for 30 days}$$

6.3 Incorporation of a Margin of Safety (MOS)

The two types of MOS development are to implicitly incorporate the MOS using conservative assumptions or to explicitly specify a portion of the total TMDL as the MOS. For segment MS296E, the MOS is an explicit 50 percent reduction of the criteria of 400 counts per 100 ml to a target of 200 counts per 100 ml. For segment MSYZ303R00_010, reducing the TMDL by 10 percent explicitly specifies the MOS. Assuming the average summer flow, the resulting load attributed to the MOS for the summer is 8.99E+12 counts/30 days.

Summer

$$\text{MOS} = 0.1 * (7129.425(30 \text{ days} * \text{counts}/100\text{ml}) * 514.59(\text{cfs}) * 2.45\text{E}+07((100\text{ml} * \text{s}) / (\text{ft}^3 * 30 \text{ days} * 30 \text{ days})))$$

$$\text{MOS} = 8.99\text{E}+12 \text{ counts for 30 days}$$

Winter

$$\text{MOS} = 0.1 * (7129.425(30 \text{ days} * \text{counts}/100\text{ml}) * 1334.20(\text{cfs}) * 2.45\text{E}+07((100\text{ml} * \text{s}) / (\text{ft}^3 * 30 \text{ days} * 30 \text{ days})))$$

$$\text{MOS} = 2.33\text{E}+13 \text{ counts for 30 days}$$

6.4 Calculation of the TMDL

Because the TMDL for segment MS296E is variable depending on the recurrence interval of the appropriate flow, the TMDL is expressed as an average percent reduction of the load. The percent reduction necessary for the TMDL is the average of the differences between the existing load line and the target load curve at each recurrence interval. The regression line through the exceeding points represents the existing load. The target curve represents the 200 counts per 100 ml at the various flows. Graph A-1 graphically represents the variable TMDL and LA, WLA and MOS for each segment. The percent reduction of fecal coliform bacteria recommended for segment MS296E in this TMDL is shown in Table 10. The units of counts per day are appropriate for this TMDL due to the use of the instantaneous standard as opposed to units of counts/per 30 days that are used in conjunction with the use of the geometric mean standard.

Table 10. TMDL Percent Reduction for Segment MS296E

Season	WLA (counts/day)	MOS	TMDL Percent Reduction
Summer	9.01E+10	Explicit	47
Winter	4.99E+11	Explicit	37

The TMDL for segment MSYZ303R00_010 is calculated based on the following equation:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

where WLA is the Waste Load Allocation, LA is the Load Allocation, and MOS is the Margin of Safety.

WLA = NPDES Permitted Facilities

LA = Surface Runoff + Other Direct Inputs

MOS = explicit

The summer TMDL for segment MSYZ303R00_010 was calculated based on the average summer flow of the watershed, and a fecal coliform concentration for 30 days determined by the area under a curve that meets both portions of the standards for a 30-sample data set and resulted in a 27% reduction of fecal coliform for the segment. The winter TMDL was calculated based on the average winter flow of the watershed, and a fecal coliform concentration for 30 days determined by the area under a curve that meets both portions of the standards for a 30-sample data set.

Summer

$$\text{TMDL} = (7129.425(30 \text{ days} \cdot \text{counts}/100\text{ml}) * 514.59(\text{cfs}) * 2.45\text{E}+07((100\text{ml} \cdot \text{s})/(\text{ft}^3 * 30 \text{ days} * 30 \text{ days})))$$

$$\text{TMDL} = 8.99\text{E}+13 \text{ counts for 30 days}$$

Winter

$$\text{TMDL} = (7129.425(30 \text{ days} * \text{counts}/100\text{ml}) * 1334.20(\text{cfs}) * 2.45\text{E}+07((100\text{ml}*s)/(\text{ft}^3*30 \text{ days}*30 \text{ days})))$$

$$\text{TMDL} = 2.33\text{E}+14 \text{ counts for 30 days}$$

Table 11. TMDL Summary for Segment MSYZ303R00_010 (counts/30 days)

	Summer	Winter
WLA	1.40E+12	7.91E+12
LA	7.95E+13	2.02E+14
MOS	8.99E+12	2.33E+13
TMDL = WLA + LA +MOS	8.99E+13	2.33E+14

6.5 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. This stream is designated for the use of secondary contact. For this use, the pollutant standard is seasonal. The criteria for the most critical season, which is the summer for the Coldwater River as shown in Figures 5 and 7, was used as the target for this TMDL.

For segment MS296E, data were used throughout the year for several years, therefore seasonality was addressed. The extended period of record for the flow information allowed for representation of many different flow conditions, which is also relevant to seasonality.

For segment MSYZ303R00_010, MDEQ used the average summer flow for calculating the summer TMDL and the average winter flow for calculating the winter TMDL; therefore, the season differences are incorporated in the seasonal average flow values. Additionally, MDEQ selected the summer values as the target for the TMDL, which are more stringent

6.6 Reasonable Assurance

This component of TMDL development does not apply to this TMDL Report. There are no point sources (WLA) requesting a reduction based on promised Load Allocation components and reductions. This TMDL will recommend that all point sources discharge treated and disinfected effluent that will be below the 200 colony counts per 100-ml. target at the end of the pipe.

CONCLUSION

The fecal coliform reduction scenario used in this TMDL included requiring all NPDES Permitted dischargers of bacteria to meet water standards for fecal coliform.

The TMDL will not impact existing or future NPDES Permits as long as the effluent is disinfected to meet water quality standards for fecal coliform. MDEQ will not approve any NPDES Permit application that does not plan to meet water quality standards for disinfection. Education projects that teach best management practices should be used as a tool for reducing nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants.

7.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each yearlong cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Yazoo River Basin, the Coldwater River may receive additional monitoring to identify any change in water quality. MDEQ produced guidance for future Section 319 project funding will encourage NPS restoration projects that attempt to address TMDL related issues within Section 303(d)/TMDL watersheds in Mississippi.

The Mississippi State Department of Health under contract with MDEQ will be conducting surveys for failing or inadequate septic systems in the Coldwater River Watershed attempting to identify the sources of the violations.

7.2 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper and a newspaper in the area of the watershed. The public will be given an opportunity to review the TMDL and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. TMDL mailing list members may request to receive the TMDL reports through either, email or the postal service. Anyone wishing to be included on the TMDL mailing list should contact Greg Jackson at (601) 961-5098 or Greg_Jackson@deq.state.ms.us. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public meeting. All written comments received during the public notice period and at any public meeting become a part of the record of this TMDL. All comments will be considered in the ultimate completion of this TMDL for submission of this TMDL to EPA Region 4 for final approval.

DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered waterbody may be based upon a similar, unaltered or least impaired, waterbody or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving waterbody.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a waterbody have their greatest potential for adverse effects.

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: use specified in water quality standards for each waterbody or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Fecal coliform bacteria: a group of bacteria that normally live within the intestines of mammals, including humans. Fecal coliform bacteria are used as an indicator of the presence of pathogenic organisms in natural water.

Geometric mean: the n th root of the product of n numbers. A 30-day geometric mean is the 30th root of the product of 30 numbers.

Impaired Waterbody: any waterbody that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant. The load allocation is the value assigned to the summation of all direct sources and land applied fecal coliform that enter a receiving waterbody. It also contains a portion of the contribution from septic tanks.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

NPDES permit: an individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): a waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Regression Coefficient: an expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: $4.16 \times 10^{(+b)}$ and $4.16 \times 10^{(-b)}$ [same as $4.16E4$ or $4.16E-4$]. In this case, b is always a positive, real number. The $10^{(+b)}$ tells us that the decimal point is b places to the right of where it is shown. The $10^{(-b)}$ tells us that the decimal point is b places to the left of where it is shown.

For example: $2.7 \times 10^4 = 2.7E+4 = 27000$ and $2.7 \times 10^{-4} = 2.7E-4 = 0.00027$.

Sigma (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, (d_1 , d_2 , d_3) respectively could be shown as:

$$\sum_{i=1}^3 d_i = d_1 + d_2 + d_3 = 24 + 123 + 16 = 163$$

Total Maximum Daily Load or TMDL: the calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained.

Waste: sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload allocation (WLA): the portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant. It also contains a portion of the contribution from septic tanks.

Water Quality Standards: the criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10.....	Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period
BASINS	Better Assessment Science Integrating Point and Nonpoint Sources
BMP	Best Management Practice
CWA	Clean Water Act
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MARIS.....	State of Mississippi Automated Information System
MDEQ.....	Mississippi Department of Environmental Quality
MOS	Margin of Safety
NRCS	National Resource Conservation Service
NPDES.....	National Pollution Discharge Elimination System
NPSM.....	Nonpoint Source Model
RF3.....	Reach File 3
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WLA	Waste Load Allocation

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APPENDIX A

This appendix contains the load duration curves for segment MS296E included in this TMDL. Figure 9 shows the summer load duration curve near Lewisburg for Station 07276000. Figure 10 shows the winter load duration curve near Lewisburg for Station 07276000.

Figure 9

Coldwater River Segment MS296E Summer

Load Duration Curve for Fecal Coliform Bacteria

USGS Flow Gage 07275900

Monitoring Data from Station 07276000

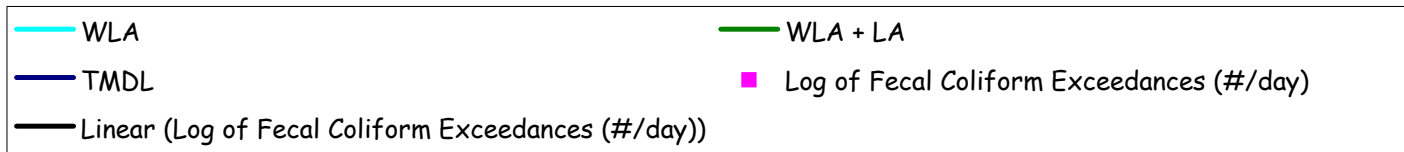
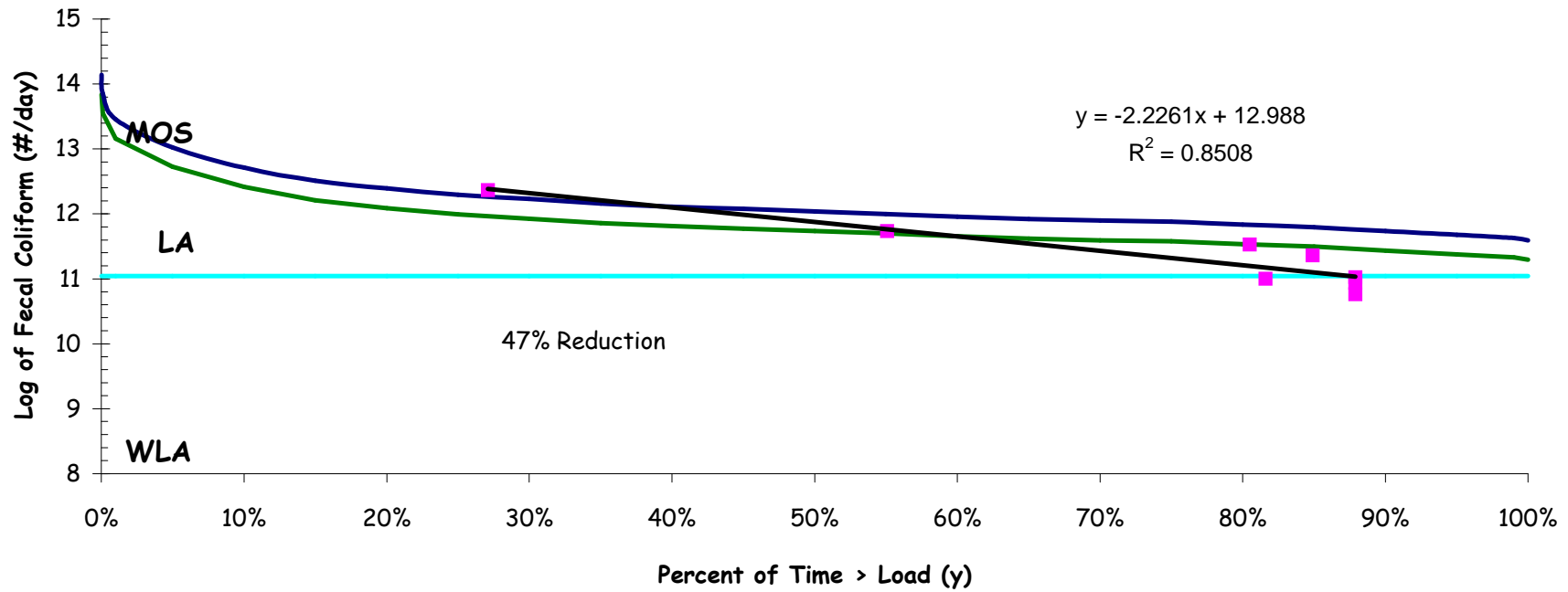


Figure 10

Coldwater River Segment MS296E Winter

Load Duration Curve for Fecal Coliform Bacteria

USGS Flow Gage 07275900

Monitoring Data from Station 07276000

