FINAL REPORT
June 2003
ID: 903062401

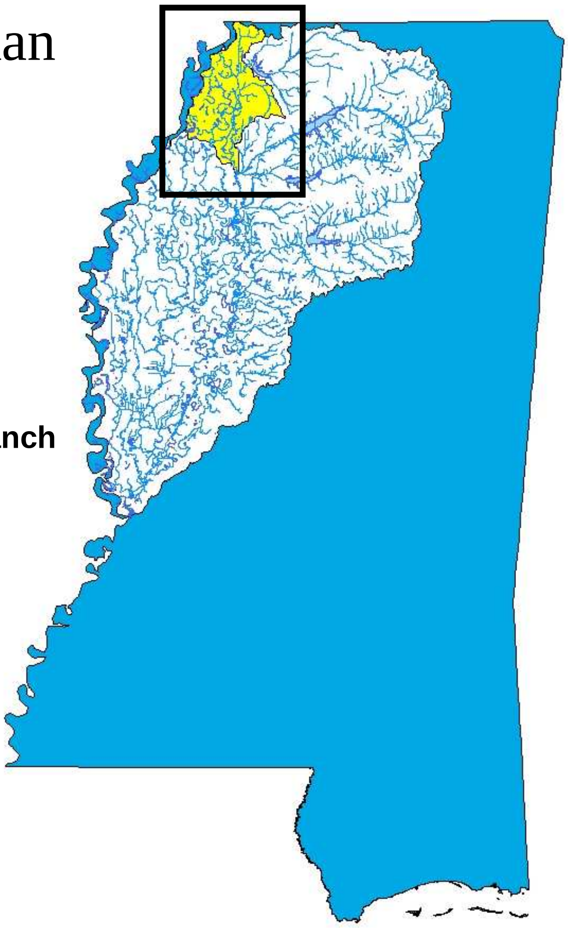
Total Maximum Daily Load

For Organic Enrichment/Low DO and Nutrients for

The Coldwater River

Yazoo River Basin

Desoto, Tate, Tunica, and Quitman Counties, Mississippi



Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Section/Water Quality Assessment Branch

MDEQ
PO Box 10385
Jackson, MS 39289-0385
(601) 961-5171
www.deq.state.ms.us

Mississippi Department
of Environmental Quality

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 water body segments found on Mississippi's 1996 Section 303(d) List of Impaired Water Bodies. 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

i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Coldwater River	MSCOLDR2M2	Desoto, Tate, and Tunica	08030204	Organic Enrichment–Low DO, nutrients	E
At Prichard: From Confluence with Cub Lake Bayou to split with Pompey Ditch Above Sara (Below Savage)					
Coldwater River	MSCOLDR2E	Tate and Tunica	08030204	Organic Enrichment–Low DO, nutrients	E
At Coldwater River: From Spillway of Arkabutla Reservoir to confluence with Pompey Ditch					
Coldwater River	MSCOLDR1E	Quitman	08030204	Organic Enrichment–Low DO, nutrients	E
At Coldwater River: From confluence with Pompey Ditch near Darling to confluence with Old Little Tallahatchie					
Pompey Ditch	MSPOMPEYE	Tunica and Quitman	08030204	Organic Enrichment–Low DO, nutrients	E
From Confluence of Coldwater River North of Sarah to Southern terminus near Darling					

ii. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Dissolved Oxygen	Aquatic Life Support	DO concentrations shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l

iii. NPDES Facilities

NPDES ID	Facility Name	Subwatershed	Receiving Water
MS0049123	Buck Island Bayou MHP	08030204014	Buck Island Bayou
MS0020656	USACOE Arklabutla N Abutment	08030204014	Spillway Channel
MS0051934	Austin Trailer Park	08030204037	Beaverdam Bayou
MS0034188	Lake Forest S/D	08030204037	Johnson Creek
MS0037925	Skylane Trailer Park	08030204037	Big Six Creek
MS0022543	Twin Lakes #1	08030204037	Johnson Creek
MS0029467	Twin Lakes #2	08030204037	Johnson Creek
MS0053830	Wilson Mill Subdivision	08030204037	Jackson Creek
MS0030104	Como POTW	08030204012	Porter Creek
MS0045055	Sam Minor Headstart	08030204012	Arkabutla Creek
MS0035181	Strayhorn Elementary School	08030204011	Strayhorn Creek
MS0039802	Pride of the Pond, 001	08030204039	White Oak Bayou
MS0039802	Pride of the Pond, 002	08030204039	White Oak Bayou
MS0032786	Tunica Industrial Park	08030204039	White Oak Bayou
MS0042323	Tunica POTW	08030204039	Ephimeral stream to White Oak Bayou
MS0024261	Westgate Utilities-White Oak	08030204039	White Oak Bayou
MS0054798	Dundee School	08030204039	Unnamed branch of 6Philips Bayou

iii. NPDES Facilities, continued

NPDES ID	Facility Name	Subwatershed	Receiving Water
MS0026930	Crenshaw POTW	08030204006	Unnamed ditch to David Bayou
MS0021016	Sledge POTW	08030204007	David Bayou
MS0024660	Marks POTW	08030204001	Coldwater River
MS0025151	Lula POTW	08030204007	Muddy Bayou
MS0036731	Falcon POTW	08030204007	Burrell Bayou to Coldwater River

iv. Total Maximum Daily Load

	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
CBODu	2566.86	1731.53	Implicit	4298.39
NBODu	329.04	396.67	Implicit	725.71
TBODu	**2895.90**	**2128.3**	**Implicit**	**5024.1**

EXECUTIVE SUMMARY

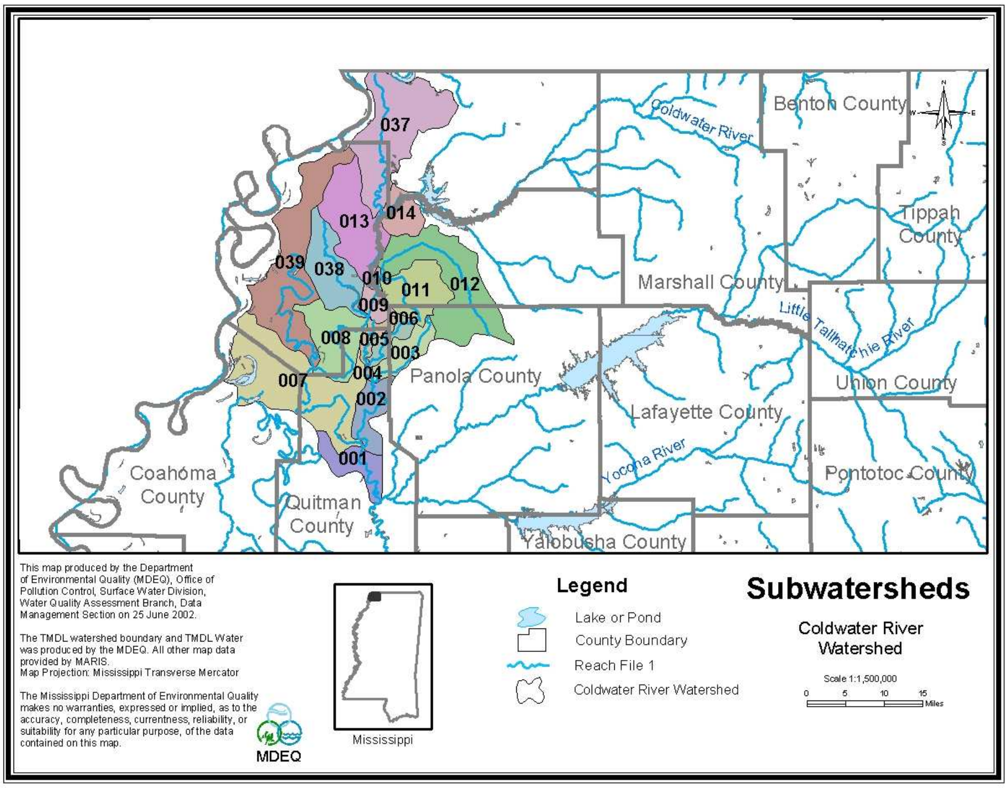
Segments of the Coldwater River have been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as evaluated water body segments, due to organic enrichment/low dissolved oxygen and nutrients. The applicable state standard specifies that the DO concentrations shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l. The Coldwater River is a water body in the Yazoo River Basin. Mississippi currently does not have standards for allowable nutrient concentrations, so a TMDL specifically for nutrients will not be developed. However, since elevated levels of nutrients may cause low levels of dissolved oxygen, the TMDL developed for dissolved oxygen also addresses the potential impact of elevated nutrients in the Coldwater River.

The Coldwater River, photo 1, flows in a southwestern direction from its headwaters near Hudsonville, Mississippi into Arkabutla Lake. Coldwater River then flows from Arkabutla Lake to the Little Tallahatchie River. This TMDL has been developed for three evaluated segments of the Coldwater River, and the evaluated segment of the Pompey Ditch. The first evaluated segment of the Coldwater River (MSCOLDR2M2) is found in Desoto, Tate, and Tunica Counties. It begins just below Arkabutla Dam, at the confluence of Cub Lake. This segment ends at the split with Pompey Ditch which is above Sarah. The second evaluated segment (MSCOLDR2E) is found in Desoto, Tate, Tunica, and Quitman Counties. It begins at the spillway of the Arkabutla Reservoir and continues to the confluence with Pompey Ditch near Darling. The third evaluated segment (MSCOLDR1E) lies completely in Quitman County. It begins at the confluence of Pompey Ditch and ends at the confluence with Old Little Tallahatchie Creek. The evaluated segment of Pompey Ditch is found in Tunica and Quitman Counties. It begins at the split with the Coldwater River, which is north of Sarah. The evaluated segment of the Pompey Ditch ends at its southern terminus near Darling.

Photo 1. Coldwater River

The predictive model used to calculate this TMDL is based primarily on assumptions described in MDEQ Regulations. A modified Streeter-Phelps DO sag model was selected as the modeling framework for performing the TMDL allocations for this study. The model was developed to account for seasonal variations in stream temperature, dissolved oxygen saturation, and carbonaceous biochemical oxygen demand (CBODu) decay rate. A mass-balance approach was used to ensure that the instream concentration of total ammonia (NH_3) did not exceed the water quality criteria for toxicity. In order to find the low-flow condition at the mouth of the watershed the drainage area ratio method was applied from *Techniques for Estimating 7-Day, 10-Year Low Flow Characteristics for Ungaged Sites on Streams in Mississippi* using station 07273500 (Tallahatchie River at Batesville) The low-flow condition was estimated to be 161 cfs. This station was selected because it has characteristics that are similar to the Coldwater River including size as well as having a dam located above it. The model used in developing this TMDL included both nonpoint and point sources of total ultimate biochemical oxygen demand (TBODu) in the Coldwater River Watershed. The location of the watershed is shown in Figure 1. TBODu loading from nonpoint sources in the watershed was accounted for by using an assumed background concentration of TBODu in the stream as directed in MDEQ Regulations. The background concentration was determined based on *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1995). There are 22 NPDES Permitted discharges located in the watershed that are included as point sources in the model.

Figure 1. Coldwater River Watershed



INTRODUCTION

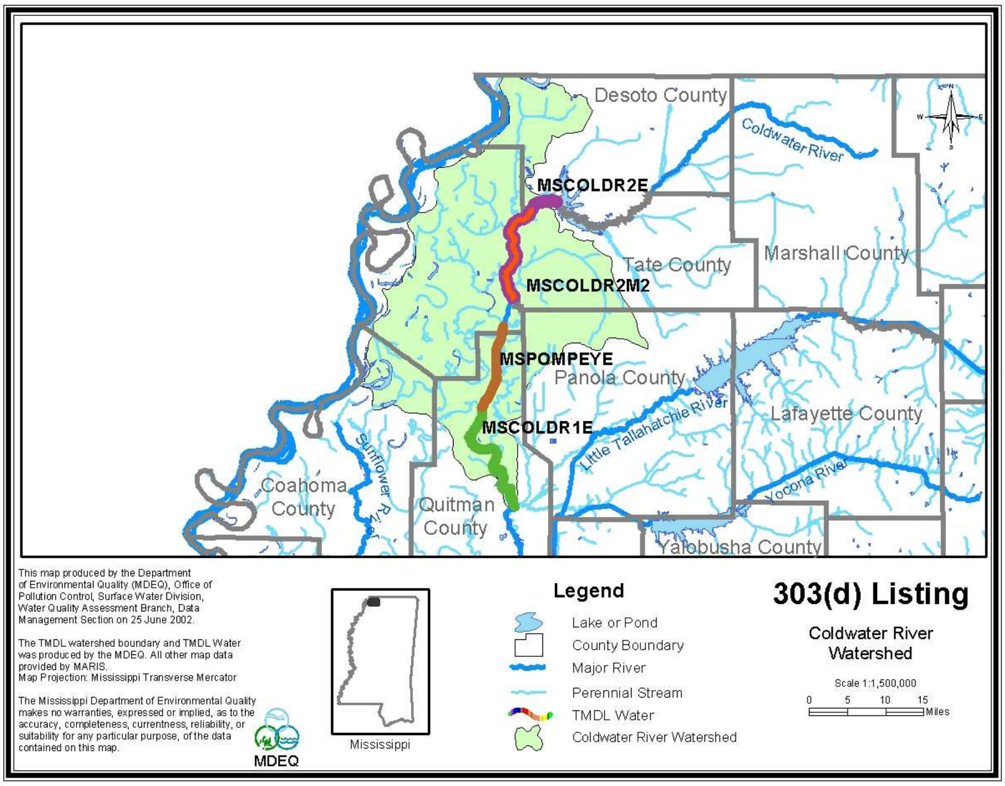
1.1 Background

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 impairment is caused by reduced levels of dissolved oxygen (DO) in the creek due to oxidation of organic material. Thus, this TMDL has been developed for organic enrichment.

Organic enrichment is measured in terms of total ultimate biochemical oxygen demand (TBODu). TBODu represents the oxygen consumed by microorganisms while stabilizing or degrading carbonaceous and nitrogenous compounds under aerobic conditions over an extended time period. The carbonaceous compounds are referred to as CBODu, and the nitrogenous compounds are referred to as NBODu. TBODu is equal to the sum of NBODu and CBODu, Equation 1. This TMDL was developed for the 303(d) listed segments shown in Figure 2.

$$\mathbf{TBODu = CBODu + NBODu} \qquad \textbf{(Equation 1)}$$

Figure 2. Coldwater River Watershed 303(d) Listed Segments



1.2 Applicable Water Body Segment Use

Designated beneficial uses and water quality standards are established by the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations. The designated use for the Coldwater River and Pompey Ditch as defined by the regulations is Fish and Wildlife.

1.3 Applicable Water Body 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*. The applicable standard specifies that the dissolved oxygen (DO) concentrations shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l. These water quality standards will be used as targeted endpoints to evaluate impairments and establish this TMDL.

1.4 Selection of a Critical Condition

Low DO typically occurs during seasonal low-flow, high-temperature periods that occur during the late summer and early fall. Elevated oxygen demand is of primary concern during low-flow periods because the effects of minimum dilution and high temperatures combine to produce the worst-case potential effect on water quality (USEPA, 1997). The flow at critical conditions is typically defined as the 7Q10 flow, which is the lowest flow for seven consecutive days expected during a 10-year period. 7Q10 flows, however, have not been established for streams in the Mississippi Alluvial Plain. Because of this a low-flow condition, instead of a 7Q10 flow, is used to define the critical condition for streams in this area.

1.5 Selection of a TMDL Endpoint

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 meeting the load and wasteload allocations specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream DO target for this TMDL is a daily average of not less than 5.0 mg/l. The instantaneous minimum portion of the DO standard was considered when establishing the instream target for this TMDL. However, it was determined that using the daily average standard with the conservative modeling assumptions would be sufficiently protective of the instantaneous minimum standard. The daily average choice is supported by the use of the existing modeling tools in a desktop modeling exercise such as this. More specific modeling and calibration is needed in order to obtain diurnal oxygen levels with any expectation of accuracy. Therefore, based on the limited data available and the relative un-sophistication of the model, the daily average target is sufficient.

Low DO typically occurs during seasonal low-flow periods of late summer and early fall. Elevated oxygen demand is of primary concern during low-flow periods because the effects of minimum dilution and high temperatures combine to produce the worst-case potential effect on water quality (USEPA, 1997). The low-flow, high-temperature period is referred to as the critical condition. The maximum impact of oxidation of organic material is generally not at the location of the sources, but at some distance downstream, where the maximum DO deficit occurs. The DO deficit is defined as the difference between the DO concentration at 100% saturation and the actual DO. The point of maximum DO deficit, also called the DO sag, will be used to define the endpoint required for this TMDL.

WATER BODY ASSESSMENT

This TMDL report includes an analysis of available water quality data and the identification of all known potential pollutant sources in the Coldwater River watershed. The potential point and nonpoint pollutant sources were characterized by the best available information, monitoring data, and literature values. This section documents the available information for Coldwater River.

2.1 Discussion of Instream Water Quality Data

The State's 1998 Section 305(b) Water Quality Assessment Report was reviewed to assess water quality conditions and data available for the watershed. Limited water quality data are available for the listed segments of Coldwater River. According to the 1998 303(d) List of Water Bodies Report, segments of the Coldwater River and Pompey Ditch are listed on the evaluated portion of the list for having possible impairments of the aquatic life use support as a result of low dissolved oxygen/organic enrichment and nutrients. Segment MSCOLDR2M2 of the Coldwater River was originally listed on the 1996 303(d) List of Waterbodies as impaired but was moved to the evaluated section of the list due to the old age and limited nature of this data. The original conclusions were based on instantaneous water chemistry data conducted at stations A0128 and A0728 collected by the Corps of Engineers from 1990-1992. Additional monitoring data were available from station 07279300 collected by MDEQ from 1990 to 1993. Data from the stations are in Tables 1-3.

Table 1. Water Quality Data for Coldwater River at Prichard, Station A1028

Date	DO (mg/L)
3-Jan-90	5.53
16-Jan-90	5.37
30-Jan-90	5.04
14-Feb-90	3.13*
12-Mar-90	4.31*
27-Mar-90	8.93
10-Apr-90	6.64
24-Apr-90	9.04
8-May-90	3.71*
19-Jul-91	5.95
31-Jul-91	6.55
14-Aug-91	2.83*
29-Aug-91	6.64

Table 1. Water Quality Data for Coldwater River at Prichard, Station A1028, continued

Date	DO (mg/L)
11-Sep-91	5.76
25-Sep-91	8.38
8-Oct-91	7.23
21-Oct-91	7.69
4-Nov-91	9.12
20-Nov-91	7.72
2-Dec-91	10.56
6-Jan-92	9.53
21-Jan-92	11.11
4-Feb-92	7.84
17-Feb-92	8.23
2-Mar-92	7.89

* DO Violations

Table 2. Water Quality Data for Coldwater River, Station A7028

Date	DO (mg/L)
8-Jan-90	5.21
23-Jan-90	5.72
6-Feb-90	5.46
20-Feb-90	4.69*
6-Mar-90	6.46
20-Mar-90	6.93
3-Apr-90	7.52
17-Apr-90	8.71
1-May-90	6.08
15-May-90	3.18*
6-Aug-91	3.00*
4-Sep-91	6.83
2-Oct-91	5.75
11-Nov-91	7.99
10-Dec-91	8.04
15-Jan-92	10.12
10-Feb-92	7.93
9-Mar-92	7.18
15-Apr-92	8.85
12-May-92	5.52
9-Jun-92	6.74

* Do Violations

Table 3. Water Quality Data for Coldwater River at Prichard, Station 07279300

Date	Time	Flow (cfs)	DO (mg/L)
8-Jan-90	11:15	2400	13.20
5-Mar-90	9:45	3600	12.80
1-May-90	12:00	2250	7.70
4-Sep-90	13:45	1630	11.60
5-Nov-90	11:50	510	6.67
7-Jan-91	10:00	3900	8.40
4-Mar-91	10:15	260.00	12.00
6-May-91	10:30	5400	11.20
9-Sep-91	10:00	2450	7.20
4-Nov-91	11:45	1570	8.70
6-Jan-92	10:25	1690	10.20
3-Mar-92	10:00	1610	12.00
4-May-92	10:00	330	11.50
13-Jul-92	13:10	1370	8.80
-Sep-92	13:20	1760	8.50
2-Nov-92	14:15	1020	8.00
12-Jan-93	9:25	2800	8.50
9-Mar-93	10:30	838	9.00
3-May-93	10:15	3100	7.00
12-Jul-93	11:00	877	8.00
13-Sep-93	11:30	1400	6.90
2-Nov-93	10:35	620	7.90

2.2 Assessment of Point Sources

The first step in assessing pollutant sources in the Coldwater River Watershed was locating the NPDES permitted sources. There are 22 NPDES sources permitted to discharge into Coldwater River, Table 4. The effluent from each facility was characterized based on all available data including information on each facility's wastewater treatment system, permit limits, and discharge monitoring reports. Discharge monitoring data are vital to characterizing effluent from each facility.

Table 4. Identified NPDES Permitted Facilities

Name	NPDES Permit	Permitted Discharge (cfs)	Actual Average Discharge (cfs)	Actual Average BOD_5 (mg/L)	Permitted BOD_5 (mg/L)	Actual NH_3-N (mg/L)	Permitted NH_3-N (mg/L)
Buck Island Bayou MHP	MS0049123	0.063	0.029	5.33	30	NA	NR
USACOE Arklabutla N Abutment	MS0020656	0.021	0.002	2.0	30	NA	NR
Austin Trailer Park	MS0051934	0.009	0.009	2.8	30	NA	NR
Lake Forest S/D	MS0034188	1.547	0.147	6.07	30	NA	NR
Skylane Trailer Park	MS0037925	0.034	0.027	17.3	30	NA	NR
Twin Lakes #1	MS0022543	0.232	0.151	7.07	30	NA	NR
Twin Lakes #2	MS0029467	0.201	0.169	5.61	30	NA	NR
Wilson Mill Subdivision	MS0053830	0.019	0.002	5.0	30	NA	NR
Como POTW	MS0030104	0.387	0.165	2.4	10	0.15	NR
Sam Minor Headstart	MS0045055	0.002	0.003	34.5	30	NA	NR
Strayhorn Elementary School	MS0035181	0.012	0.005	8	30	NA	NR
Pride of the Pond, 001	MS0039802	1.076	0.185	34.14	75	NA	NR
Pride of the Pond, 002	MS0039802	1.076	0.630	9.87	30	NA	NR
Tunica Industrial Park	MS0032786	0.093	0.211	11.7	30	2.3	2

Table 4. Identified NPDES Permitted Facilities, continued

Name	NPDES Permit	Permitted Discharge (cfs)	Actual Average Discharge (cfs)	Actual Average BOD_5 (mg/L)	Permitted BOD_5 (mg/L)	Actual NH_3-N (mg/L)	Permitted NH_3-N (mg/L)
Tunica POTW	MS0042323	0.680	0.330	26.4	30	NA	NR
Westgate Utilities-White Oak	MS0024261	0.081	0.074	33.56	30	NA	NR
Dundee School	MS0054798	0.015	0.211	8.06	10	NA	NR
Crenshaw POTW	MS0026930	0.320	0.131	26.4	30	NA	NR
Sledge POTW	MS0021016	0.340	0.400	22	30	NA	NR
Marks POTW	MS0024660	1.020	0.297	27.2	30	NA	NR
Lula POTW	MS0025151	0.068	0.046	23.3	30	2.54	2
Falcon POTW	MS0036731	0.035	0.012	11.7	30	NA	NR

2.3 Assessment of Nonpoint Sources

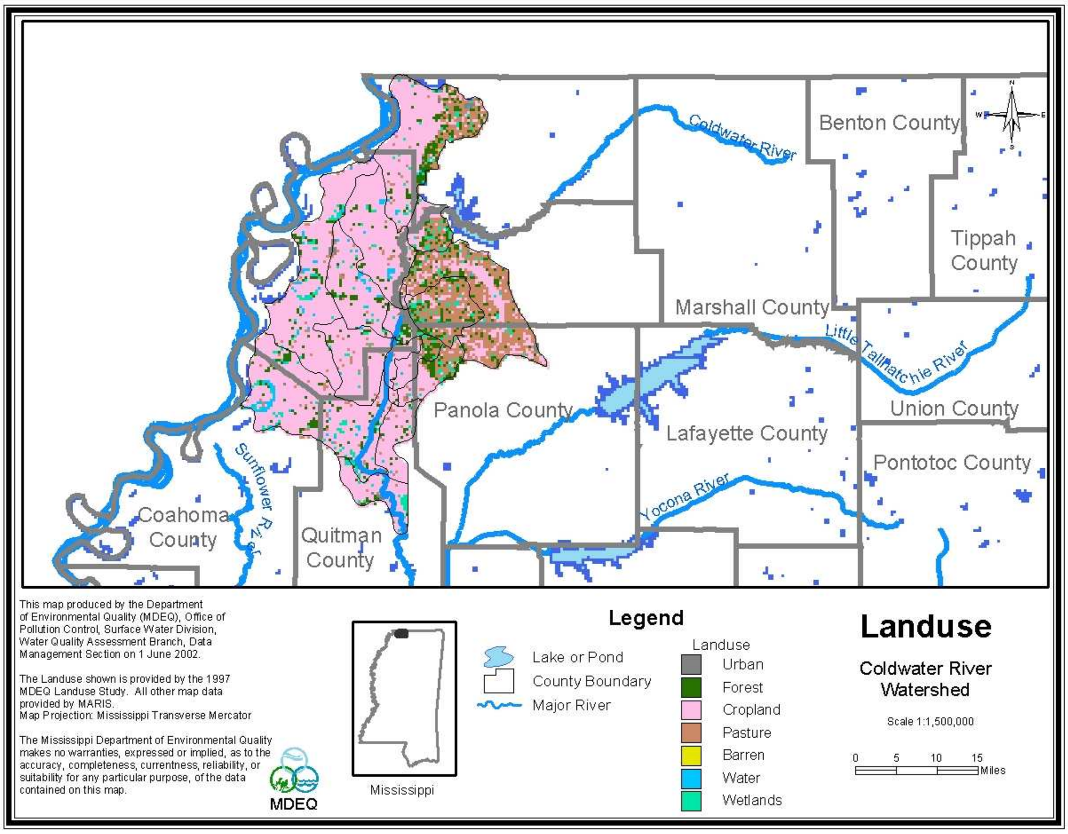
Nonpoint loading of TBODu in a water body results from the transport of the pollutants into receiving waters by overland surface runoff and groundwater infiltration. Landuse activities within the drainage basin, such as cropland and urbanization contribute to nonpoint source loading. Other nonpoint pollution sources include atmospheric deposition and natural weathering of rocks and soil.

The 590,893 drainage area of Coldwater River contains many different landuse types, including urban, forest, cropland, pasture, barren, water, aquaculture, and wetlands. The landuse information is based on data collected by the State of Mississippi's Automated Resource Information System (MARIS) 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. Cropland and pasture are the dominant landuses within this watershed. The landuse distribution within the Coldwater River Watershed is shown in Table 5 and Figure 3.

Table 5. Landuse Distribution

	Urban	Forest	Cropland	Pasture	Barren	Wetland	Aquaculture	Water	Total
Area (acres)	3,540	30,139	400,588	109,012	160	37,261	2,903	7,290	590,893
% Area	1%	5%	68%	18%	0%	6%	0%	1%	100%

Figure 3. Landuse Distribution Map for Coldwater River Watershed



MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

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. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain water body 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 mathematical model, named AWFWUL1, for DO distribution in freshwater streams was used for developing the TMDL. The use of AWFWUL1 is promulgated in the *Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification* (MDEQ, 1994). This model has been approved by EPA and has been used extensively at MDEQ. A key reason for using the AWFWUL1 model in TMDL development is its ability to assess instream water quality conditions in response to point and nonpoint source loadings.

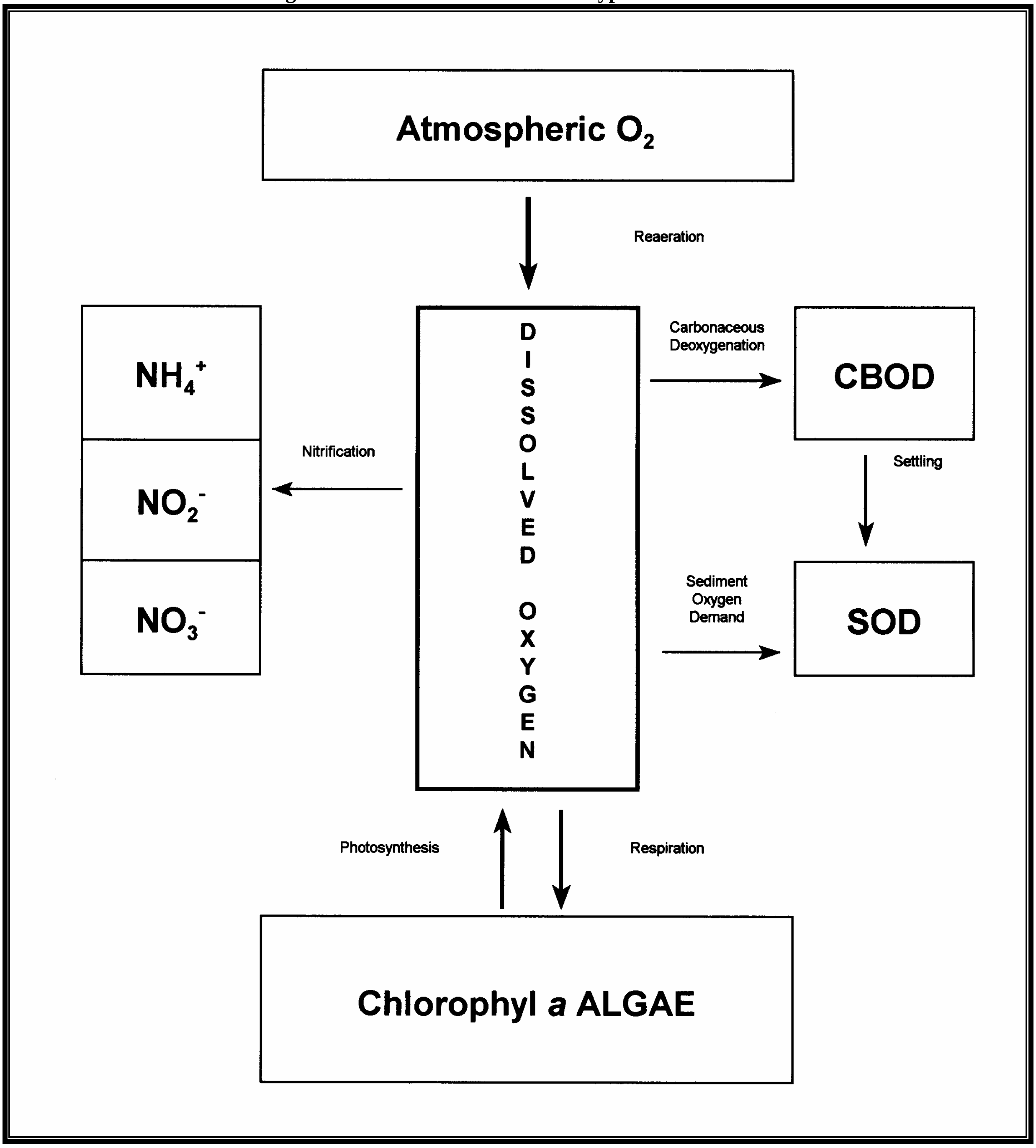
The model is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBODu decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 4 shows how these processes are related in a typical DO model. Reaction rates for the instream processes are input by the user and corrected for temperature by the model. The model output includes water quality conditions in each computational element for DO, CBODu, and NH_3-N concentrations. The hydrological processes simulated by the model include stream velocity and flow from point sources and spatially distributed inputs.

The model was set up to calculate reaeration within each reach using the O'Connor Dobbins formulation. The O'Connor Dobbins formulation calculates reaeration (Ka) within each reach according to Equation 2.

$$Ka = \frac{12.9\,U^{0.5}}{D^{1.5}} \qquad \textbf{(Equation 2)}$$

where U is the reach velocity in ft/s, and D is the Depth in ft estimated to be 5 or greater.

Figure 4. Instream Processes in a Typical DO Model



4.2 Model Setup

The Coldwater River TMDL model includes the 303(d) listed portions of Coldwater River, from the spillway of Arkabutla Reservoir to confluence of Old Little Tallahatchie River. The modeled water bodies were divided into reaches for input into the AWFWUL1 model. Reach divisions were made at any major change in the hydrology of the water body, such as a significant change in slope or the confluence of a tributary or point source discharge. The watershed was modeled according to the diagram shown in Figure 5. As shown in Figure 5, there are 22 NPDES

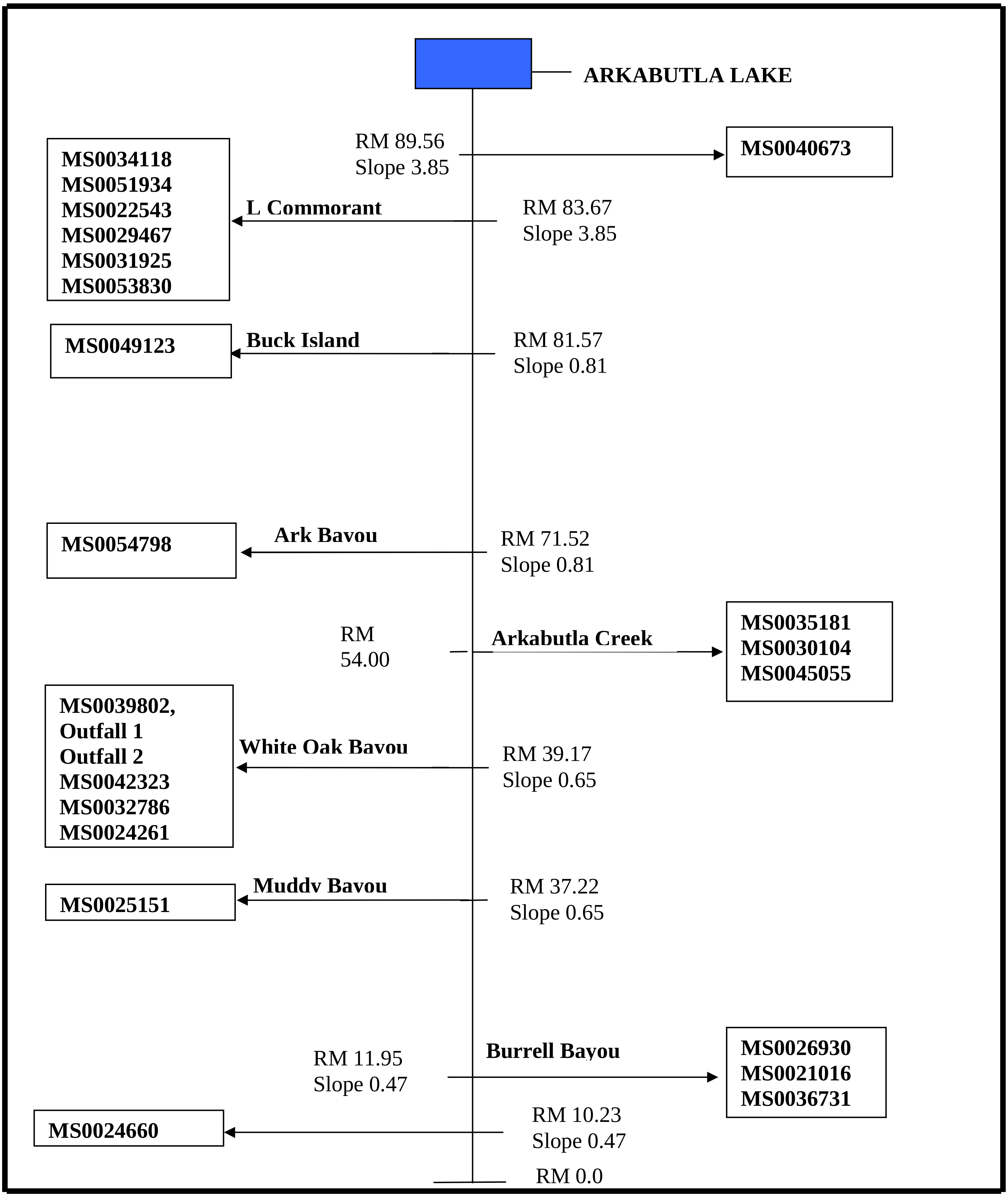


Figure 5. Simplified Coldwater River Model Setup (Note: Figure not to Scale)

permitted point sources that discharge into the Coldwater River Watershed. The numbers on the figure represent river miles at which point sources discharges or confluence of the creeks are located. River miles are assigned to water bodies, beginning with zero at the mouth. The slope of each reach was estimated from USGS quad maps and input into the model in units of feet/mile. Within each reach, the modeled segments were divided into computational elements of 0.1 mile. The hydrological and water quality characteristics are calculated and output by the model for each computational element.

The model was setup to simulate low-flow, high-temperature conditions, which was determined to be the critical condition for this TMDL. The temperature used in the model is 26°C. The headwater instream DO was assumed to be 85% of saturation at the stream temperature. The instream CBODu decay rate is dependent on temperature, according to Equation 3.

$$\mathbf{Kd_{(T)} = Kd_{(20°C)}(1.047)^{T-20}} \qquad \textbf{(Equation 3)}$$

Where Kd is the CBODu decay rate and T is the assumed instream temperature. The assumptions regarding the instream temperatures, background DO saturation, and CBODu decay rate are required by the *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994).

4.3 Source Representation

Both point and nonpoint sources were represented in the model. The loads from NPDES permitted sources were added as direct inputs into the appropriate reach of the water body as a flow in cfs and a load of CBODu and ammonia nitrogen in lbs/day. Spatially distributed loads, which represent nonpoint sources of flow, CBODu, and ammonia nitrogen were distributed evenly into each computational element of the Coldwater River and its tributaries.

Organic material discharged to a stream from an NPDES permitted point source is typically quantified as 5-day biochemical oxygen demand (BOD_5). BOD_5 is a measure of the oxidation of carbonaceous and nitrogenous material over a 5-day incubation period. However, oxidation of nitrogenous material, called nitrification, usually does not take place within the 5-day period because the bacteria that are responsible for nitrification are normally not present in large numbers and have slow reproduction rates (Metcalf and Eddy, 1991). Thus, BOD_5 is generally considered equal to $CBOD_5$. Because permits for point source facilities are written in terms of BOD_5 while predictive models used for TMDL development are typically developed using CBODu, a ratio between the two terms is needed, Equation 4.

$$\mathbf{CBODu = CBOD_5 * Ratio} \qquad \textbf{(Equation 4)}$$

The CBODu to $CBOD_5$ ratios are given in *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1995). These values are recommended for use by MDEQ regulations when actual field data are not available. The value of the ratio depends on the treatment type.

In order to convert the ammonia nitrogen (NH_3-N) loads to an oxygen demand, a factor of 4.57 pounds of oxygen per pound of ammonia nitrogen (NH_3-N) oxidized to nitrate (NO_3) was used. Using this factor is a conservative modeling assumption because it assumes that all of the ammonia is converted to nitrate through nitrification, which is not necessarily accurate. The oxygen demand caused by nitrification of ammonia is equal to the NBODu load. The sum of CBODu and NBODu is equal to the point source load of TBODu. The loads of TBODu from each of the existing point sources are given in Table 6. The loads were based on the maximum allowable loads according to NPDES permits and data from discharge monitoring reports, which represents another conservative assumption.

Table 6. Point Source Loads as Input into the Model (Existing DMR Data)

Facility	Flow (cfs)	$CBOD_5$ (mg/l)	$CBOD_u$:$CBOD_5$ Ratio	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
Lake Forest Subdivision	0.147	6.07	1.5	7.22	2	7.24	14.46
Austin Trailer Park	0.009	2.8	1.5	0.21	2	0.46	0.67
Twin Lakes #1	0.151	7.07	1.5	8.63	2	7.44	16.07
Twin Lakes #2	0.169	5.61	1.5	7.67	2	8.33	16
Skylane Trailer Park	0.027	17.3	1.5	3.75	2	1.32	5.07
Wilson Mill Subdivision	0.002	5.0	1.5	0.06	2	0.07	0.13
Buck Island Bayou	0.030	5.33	1.5	1.25	2	1.43	2.68
Dundee School	0.211	8.06	1.5	13.75	2	10.40	24.15
Pride of the Pond, 001	0.185	34.1	2.5	85.12	2	9.12	94.24
Pride of the Pond, 002	0.630	9.87	2.5	83.81	2	31.04	114.85
Tunica Industrial Park	0.211	11.7	1.5	19.96	2	10.40	30.36
Tunica POTW	0.330	26.4	1.5	70.45	2.3	18.70	89.15
Westgate Utilities	0.074	33.5	1.5	20.08	2	3.65	23.73
Como POTW	0.165	2.38	1.5	3.17	0.15	0.61	3.78
Strayhorn Elementary	0.005	8	1.5	0.29	2	0.22	0.51
Sam Minor Headstart	0.003	34.5	1.5	0.84	2	0.15	0.99
Lula POTW	0.046	23.3	1.5	8.67	2.54	2.88	11.55
Crenshaw POTW	0.131	26.4	1.5	27.97	2	6.45	34.42
Sledge POTW	0.400	22	1.5	71.16	2	19.71	90.87
Falcon POTW	0.012	24.9	1.5	2.42	2	0.59	3.01
Tunica Industrial Park	0.211	11.7	1.5	19.96	2	10.40	30.36
Arkabutla Abutment	0.002	2	1.5	0.04	2	0.12	0.16
Marks POTW	0.297	27.2	1.5	65.24	2	14.61	79.85
Total				**521.72**		**165.3**	**687.1**

Direct measurements of nonpoint source loads of CBODu and NH_3-N were not available for the Coldwater River Watershed. The background contributions of CBODu and total ammonia as nitrogen (NH_3–N) were estimated based on *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). According to these regulations, the background concentrations used in modeling are CBODu = 2.0 mg/l and NH_3-N = 0.1 mg/l.

Due to lack of data, the nonpoint source flows in Coldwater River were also estimated. According to *Techniques for Estimating 7-Day, 10-Year Low Flow Characteristics for Ungaged Sites on Streams in Mississippi*, the estimated low-flow condition for the Coldwater River

Watershed is 161 cfs. After determining the drainage area of the Coldwater River Watershed, the estimated low-flow condition (flow value in cfs) was used to estimate the amount of water draining into the Coldwater River and its tributaries during low-flow conditions. The estimated flows were multiplied by the background concentrations of CBODu and NH_3-N to calculate the nonpoint source loads in the model, Table 7.

Table 7. NonPoint Source Loads as Input into the Model (Existing)

Source	Flow (cfs)	$CBOD_5$ (mg/l)	$CBOD_u$:$CBOD_5$ Ratio	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
Spatial	2.34	1.33	1.5	25.13	0.1	5.76	30.9
Spatial	8.25	1.33	1.5	88.74	0.1	20.33	109.10
Spatial	0.45	1.33	1.5	4.83	0.1	1.11	5.94
Spatial	3.33	1.33	1.5	35.77	0.1	8.19	44.0
Spatial	18.06	1.33	1.5	194.3	0.1	44.51	238.8
Spatial	5.41	1.33	1.5	58.2	0.1	13.33	71.50
Spatial	14.52	1.33	1.5	156.2	0.1	35.79	192.0
Spatial	7.51	1.33	1.5	80.81	0.1	18.51	99.3
Spatial	4.05	1.33	1.5	43.50	0.1	9.97	53.50
Spatial	3.04	1.33	1.5	32.67	0.1	7.48	40.2
Spatial	13.8	1.33	1.5	148.29	0.1	33.97	182.3
Spatial	9.83	1.33	1.5	105.76	0.1	24.23	130.0
Spatial	3.51	1.33	1.5	37.70	0.1	8.64	46.3
Spatial	1.19	1.33	1.5	12.76	0.1	2.92	15.7
Spatial	14.17	1.33	1.5	152.36	0.1	34.90	187.3
Spatial	14.15	1.33	1.5	152.16	0.1	34.86	187.0
Spatial	5.07	1.33	1.5	54.52	0.1	12.49	67.0
Spatial	10.89	1.33	1.5	116.78	0.1	26.75	143.5
Spatial	3.09	1.33	1.5	33.26	0.1	7.62	40.9
Spatial	18.39	1.33	1.5	197.79	0.1	45.31	243.1
Total				**1731.53**		**396.67**	**2128.3**

4.4 Model Results

Once the model setup was complete, the model was used to predict water quality conditions in Coldwater River and its tributaries. The model was first run under baseline conditions. Under baseline conditions, the loads from NPDES permitted point sources were set at their existing load scenarios as determined from the discharge monitoring reports. Thus, baseline model runs reflect the current condition of Coldwater River without any reduction of TBODu loads.

4.4.1 Baseline Model Runs

The model results from the baseline model run are shown in Figure 6. The figure shows the modeled daily average DO in the Coldwater River. The red line represents the DO standard of 5.0 mg/l. Figure 6 shows the daily average instream DO concentrations in the Coldwater River under existing summer conditions, beginning with river mile 89.5 and ending with river mile 0.0 (the mouth of Coldwater at Little Tallahatchie). The DO sag, or maximum DO deficit, occurs around river mile 81.5. The data show that the DO standard is not violated using the existing DMR data.

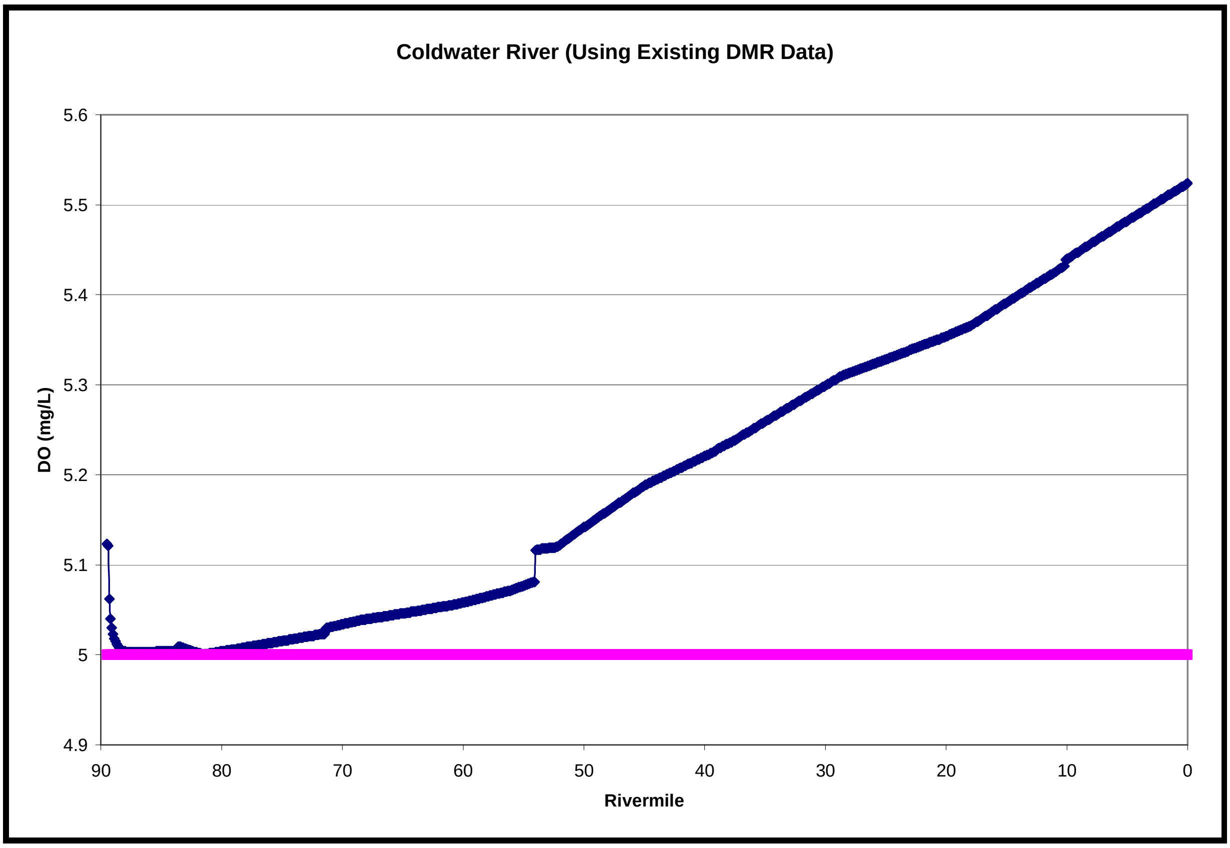


Figure 6. Baseline Model Output for Coldwater River (Using Existing DMR Data)

4.4.2 Model Results Using Permit Limits

The graph of data using permit limits show that the predicted DO falls below the DO standard in the Coldwater River during critical conditions. The model results using the permit are shown in Figure 7. The DO sag, or maximum DO deficit, occurs around river mile 60.4. The data show that the DO standard is violated using the permit limits. As a result, reductions from these loads of TBODu are necessary in order to maintain a daily average DO of at least 5.0 mg/l. The loads of TBODu from each of the point sources are given in Table 8. The loads were based on the maximum allowable loads according to NPDES permits.

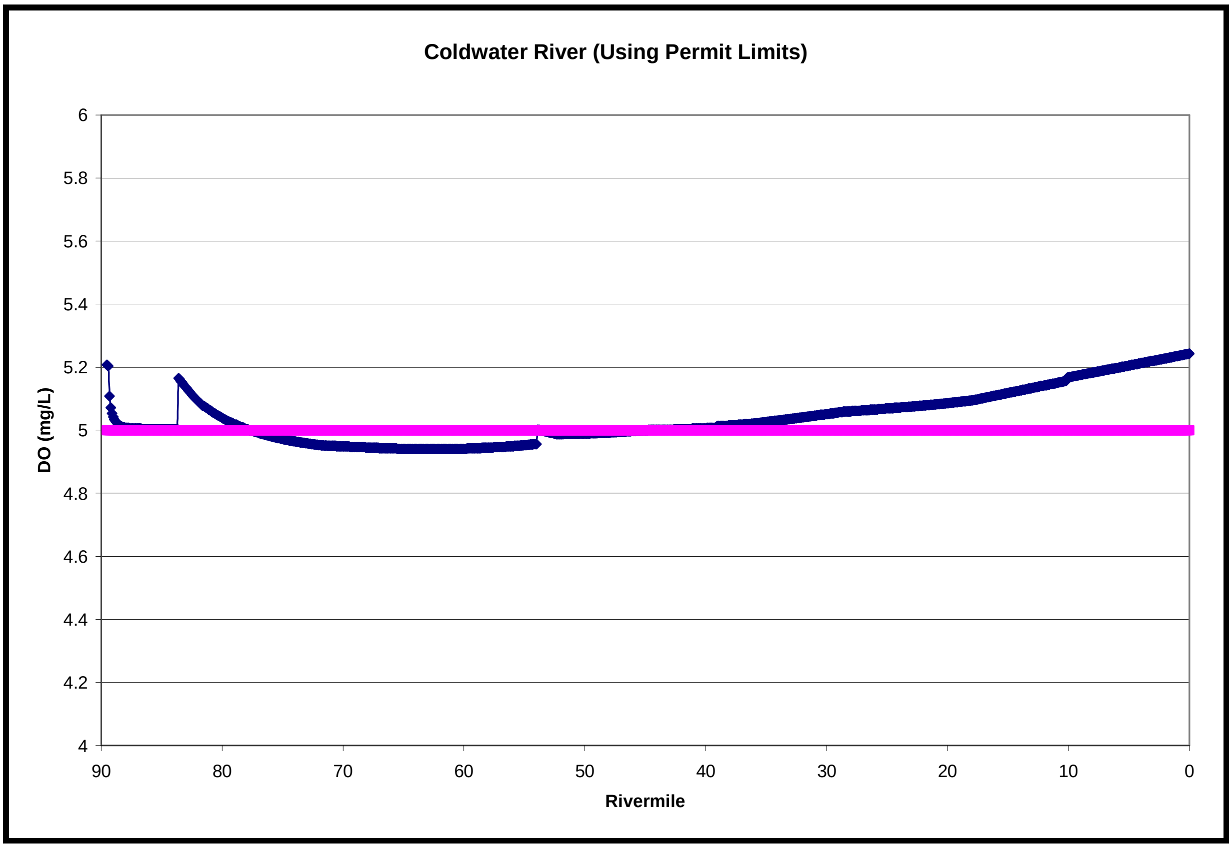


Figure 7. Model Output for Coldwater River (Using Permit Limits)

Table 8. Wasteload Allocation at Maximum Permit Limits

Facility	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Lake Forest Subdivision	375.30	76.23	451.53
Austin Trailer Park	2.26	0.46	2.72
Twin Lakes #1	56.28	11.43	67.71
Twin Lakes #2	48.76	9.90	58.66
Skylane Trailer Park	8.25	1.68	9.93
Wilson Mill Subdivision	4.51	0.92	5.43
Buck Island Bayou	15.28	3.10	18.38
Dundee School	1.21	0.74	1.95
Pride of the Pond, 001	1087.7	53.02	1140.72
Pride of the Pond, 002	435.0	53.02	488.02
Tunica Industrial Park	22.56	4.58	27.14
Tunica POTW	164.97	33.51	198.48
Westgate Utilities	19.65	3.99	23.64
Como POTW	31.30	19.07	50.37
Strayhorn Elementary	2.91	0.59	3.5
Sam Minor Headstart	0.36	0.07	0.43
Lula POTW	16.50	3.35	19.85
Crenshaw POTW	77.63	15.77	93.4
Sledge POTW	82.48	16.75	99.23
Falcon POTW	8.49	1.72	10.21
Arkabutla Abutment	5.09	1.03	6.12
Marks POTW	247.45	50.26	297.71
Total	**2713.94**	**361.19**	**3075.13**

4.4.3 Maximum Load Scenarios

The maximum load scenarios involved running the model using a trial-and-error process. The maximum load, that allowed the maintenance of water quality standards, was selected. The maximum load was used to develop a waste load allocation shown in this TMDL. Figure 8 shows the daily average instream DO concentrations in the Coldwater River after application of the selected maximum load scenario for the critical condition. The lowest DO concentration in the creek, approximately 5.0 mg/l occurs near river mile 61.5. The TBODu loads included in the maximum load scenario are given in Table 9.

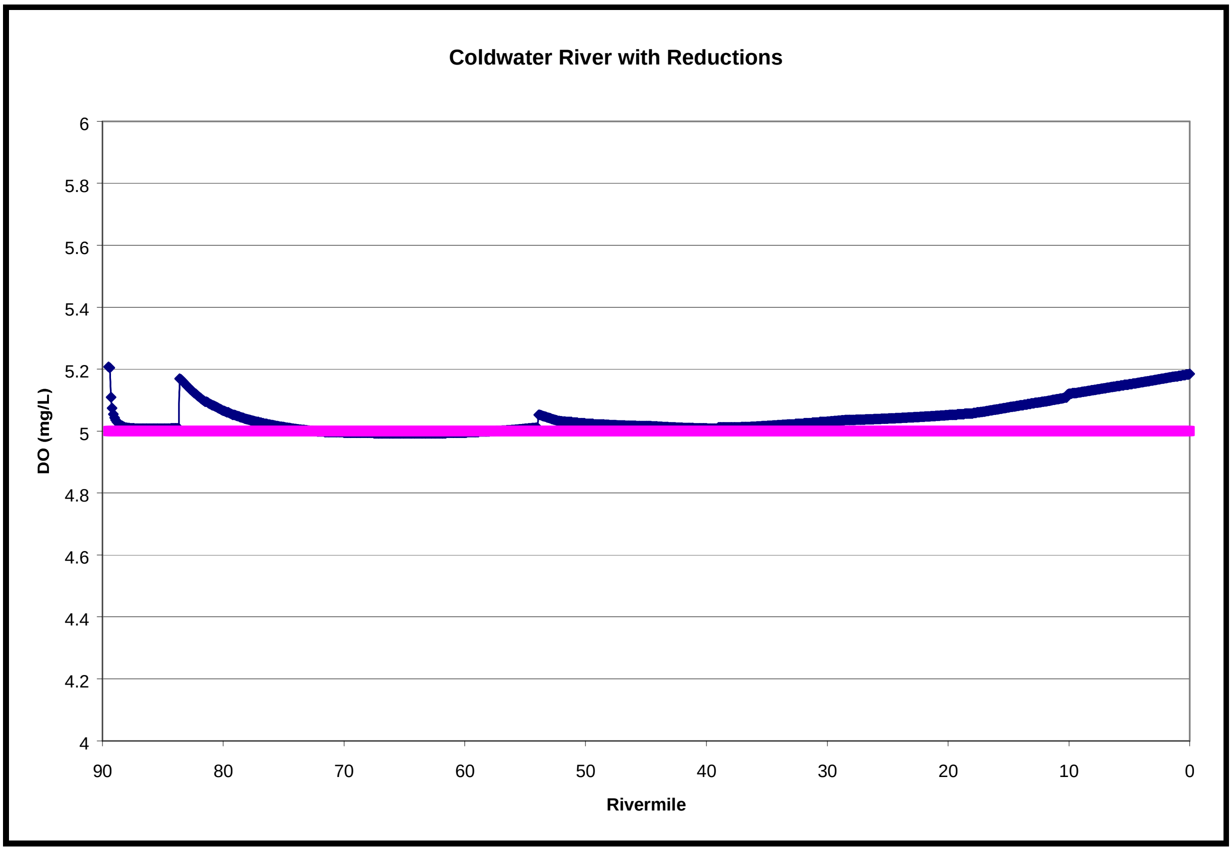


Figure 8. Model Output for Coldwater River after Application of Maximum Load Scenario

Table 9. Maximum Load Scenario, Critical Conditions

Source	Flow (cfs)	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)	Overall Percent Reduction
Point Source	7.3	2566.86	329.04	2895.9	**5.8%**
Nonpont Source	161.0	1731.53	396.67	2128.3	**0%**
Total	**168.3**	**4298.39**	**725.71**	**5024.20**	**3.4%**

4.5 Evaluation of Ammonia Toxicity

Ammonia must not only be considered due to its effect on dissolved oxygen in the receiving water, but also its toxicity potential. Ammonia nitrogen concentrations can be evaluated using the criteria given in 1999 Update of Ambient Water Quality Criteria for Ammonia (EPA-822-R-99-014). The maximum allowable instream ammonia nitrogen (NH_3-N) concentration at a pH of 7.0 and stream temperature of 26°C is 2.82 mg/l. Based on the model results, this criteria was not exceeded in the Coldwater River under the current NH_3-N loads.

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of water quality standards in segments MSCOLDR2M2, MSCOLDR1E, MSCOLDR2E, and MSPOMPEYE.

5.1 Wasteload Allocation

Twenty-two NPDES Permitted facilities in the Coldwater River watershed are included in the wasteload allocation, Table 10. The loads given in Table 10 are equal to the load reduction scenario used for the critical condition. As discussed in Section 4.4.3, an overall reduction of 5.8% of the permitted TBODu load is needed to show compliance with the TMDL endpoint. Table 10 shows a percent reduction for the Lake Forest Subdivision only. The NPDES permit for the Lake Forest Subdivision is written to accommodate a 1.0 MGD load. The Lake Forest Subdivision currently averages approximately a 0.15 MGD load which is only a 15% utilization of the permitted load. Therefore, the reduction will be taken from this facility based upon the significant difference in what the permit is written for versus what this facility is actually discharging.

Additionally, the DeSoto County Utility Authority is responsible for wastewater treatment in DeSoto County. As explained in the 201 facilities plan, the facilities located in Desoto county listed in this TMDL should connect to the regional treatment plant soon after it comes online. This action should restore water quality in this area. However, until the regional treatment plant is completed, implementation of this wasteload allocation, through modification of NPDES permits, will be completed by MDEQ during reissuance of the individual permits.

Table 10. Wasteload Allocation with Percent Reduction

Facility	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)	%Reduction
Lake Forest Subdivision*	228.93	46.5	275.43	39%
Austin Trailer Park	2.26	0.46	2.72	0%
Twin Lakes #1	56.28	11.43	67.71	0%
Twin Lakes #2	48.76	8.52	57.28	0%
Skylane Trailer Park	8.25	1.44	9.69	0%
Wilson Mill Subdivision	4.51	0.79	5.3	0%
Buck Island Bayou	15.28	2.67	17.95	0%
Dundee School	1.21	0.64	1.85	0%
Pride of the Pond, 001	1087.7	53.02	1140.72	0%
Pride of the Pond, 002	435	53.02	488.02	0%
Tunica Industrial Park	22.56	4.58	27.14	0%
Tunica POTW	164.97	33.51	198.48	0%
Westgate Utilities	19.65	3.99	23.64	0%
Como POTW	31.3	19.07	50.37	0%
Strayhorn Elementary	2.91	0.59	3.5	0%
Sam Minor Headstart	0.36	0.07	0.43	0%
Lula POTW	16.5	3.35	19.85	0%
Crenshaw POTW	77.63	15.77	93.4	0%
Sledge POTW	82.48	16.75	99.23	0%
Falcon POTW	8.49	1.72	10.21	0%

Table 10 cont. Wasteload Allocation with Percent Reduction

Facility	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)	%Reduction
Arkabutla Abutment	4.38	0.89	5.27	0%
Marks POTW	247.45	50.26	297.71	0%
Total	**2566.86**	**329.04**	**2895.9**	**5.8%**

* Facilities requiring reductions

5.2 Load Allocation

The headwater and spatially distributed loads are included in the load allocation. The TBODu concentrations of these loads were determined by using an assumed $CBOD_5$ concentration of 1.33 mg/l and an NH_3-N concentration of 0.1 mg/l. These concentrations should be assumed when reliable field data are not available, according to *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). The headwater and spatially distributed flows were calculated for the Coldwater River Watershed by delineating the drainage area into subwatersheds. Flows from each subwatershed were based on the 7Q10 flow coefficient for the watershed and the watershed size. Then, the load allocations were calculated to determine the CBODu and NBODu loads in lbs/day, Table 11.

Table 11. Load Allocations with Percent Reduction

Source	Flow (cfs)	$CBOD_5$ (mg/l)	$CBOD_u$:$CBOD_5$ Ratio	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
Spatial	2.34	1.33	1.5	25.13	0.1	5.76	30.9
Spatial	8.25	1.33	1.5	88.74	0.1	20.33	109.10
Spatial	0.45	1.33	1.5	4.83	0.1	1.11	5.94
Spatial	3.33	1.33	1.5	35.77	0.1	8.19	44.0
Spatial	18.06	1.33	1.5	194.3	0.1	44.51	238.8
Spatial	5.41	1.33	1.5	58.2	0.1	13.33	71.50
Spatial	14.52	1.33	1.5	156.2	0.1	35.79	192.0
Spatial	7.51	1.33	1.5	80.81	0.1	18.51	99.3
Spatial	4.05	1.33	1.5	43.50	0.1	9.97	53.50
Spatial	3.04	1.33	1.5	32.67	0.1	7.48	40.2
Spatial	13.8	1.33	1.5	148.29	0.1	33.97	182.3
Spatial	9.83	1.33	1.5	105.76	0.1	24.23	130.0
Spatial	3.51	1.33	1.5	37.70	0.1	8.64	46.3
Spatial	1.19	1.33	1.5	12.76	0.1	2.92	15.7
Spatial	14.17	1.33	1.5	152.36	0.1	34.90	187.3
Spatial	14.15	1.33	1.5	152.16	0.1	34.86	187.0
Spatial	5.07	1.33	1.5	54.52	0.1	12.49	67.0
Spatial	10.89	1.33	1.5	116.78	0.1	26.75	143.5
Spatial	3.09	1.33	1.5	33.26	0.1	7.62	40.9
Spatial	18.39	1.33	1.5	197.79	0.1	45.31	243.1
Total				**1731.53**		**396.67**	**2128.3**

5.3 Incorporation of a Margin of Safety

The margin of safety is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving water body. The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this model is implicit.

Conservative assumptions which place a higher demand of DO on the water body than may actually be present are considered part of the margin of safety. The assumption that all of the ammonia nitrogen present in the water body is oxidized to nitrate nitrogen, for example, is a conservative assumption. In addition, the TMDL is based on the critical condition of the water body which is represented by the estimated low-flow condition. Therefore, modeling the water body at this flow provides protection in the worst-case scenario.

5.4 Seasonality

Seasonal variation may be addressed in the TMDL by using seasonal water quality standards or developing model runs to reflect seasonal variations in temperature and other parameters. Mississippi's water quality standards for dissolved oxygen, however, do not vary according to the seasons. The model was set up to simulate dissolved oxygen during the critical condition period, the low-flow, high-temperature period that typically occurs during the summer season. Since the critical condition represents the worst-case scenario, the TMDL developed for critical conditions is protective of the water body at all times. Thus, this TMDL will ensure attainment of water quality standards for each season.

5.5 Calculation of the TMDL

The TMDL was calculated based on Equation 5.

$$\mathbf{TMDL = WLA + LA + MOS} \qquad \textbf{(Equation 5)}$$

Where WLA is the wasteload allocation, LA is the load allocation, and MOS is the margin of safety. All units are in lbs/day of TBODu. The TMDL for TBODu was calculated based on the maximum allowable loading of the pollutants in Coldwater River and its tributaries, according to the model. The TMDL calculations are shown in Table 12. As shown in the table, TBODu is the sum of CBODu and NBODu. The wasteload allocations incorporate the CBODu and NH_3-N contributions from identified NPDES Permitted facilities. The load allocations include the headwaters and spatially distributed TBODu and NH_3-N contributions from surface runoff and groundwater infiltration. The implicit margin of safety for this TMDL is derived from the conservative assumptions used in setting up the model.

Table 12. TMDL for TBODu, for Critical Conditions in the Coldwater River

	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
CBODu	2566.86	1731.53	Implicit	4298.39
NBODu	329.04	396.67	Implicit	725.71
TBODu	**2895.90**	**2128.3**	**Implicit**	**5024.1**

CONCLUSION

This TMDL is based on a desktop model using MDEQ's regulatory assumptions and literature values in place of actual field data. The model results indicate impairment in the stream at the maximum permitted loading of TBODu. This TMDL recommends that no additional NPDES permit be issued for this segment of the Coldwater River. Also no increase in the current loadings specified in the existing permits will be allowed. Further steps are needed to ensure that the overall loads of TBODu placed in this water body from point and nonpoint sources do not exceed the water body's assimilative capacity. The maximum load of TBODu, as determined by this TMDL, is 5024.1 lbs/day. In order to achieve this load, a 39% reduction is required by Lake Forest Subdivision, and overall, a 3.4% reduction is needed from both nonpoint and point sources.

As previously mentioned, the DeSoto County Utility Authority is responsible for wastewater treatment in DeSoto County. As explained in the 201 facilities plan, the facilities located in Desoto county listed in this TMDL should connect to the regional treatment plant soon after it comes online. This action should restore water quality in this area.

6.1 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 year-long cycle, MDEQ's resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Yazoo Basin, the Coldwater River Watershed may receive additional monitoring to identify any change in water quality.

Additional monitoring may also be conducted on the Coldwater River in order to provide a data set for calibration of the water quality model used to develop this TMDL. Parameters such as flow, water velocity, and background concentrations of CBODu and NH_3-N during the critical modeling period would be beneficial. Also, measurements of rates of CBODu decay, algal photosynthesis and respiration, and sediment oxygen demand would allow for a more accurate model. Finally, additional characterization of the effluent from point source facilities, such as determinations of CBODu to $CBOD_5$ ratios, would increase the model's accuracy. The additional monitoring would allow confirmation of the assumptions used in the model used for calculating the TMDL. If additional data show that the assumptions used in this model were not accurate, the model and the TMDL will be updated. Future work may also include the development of a more complex model, which could more accurately represent the Coldwater River Watershed..

6.2 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. 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 become a member of 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 hearing. If a public hearing is deemed appropriate, the public will be given a 30-day notice of the hearing to be held at a location near the watershed. That public hearing would be an official hearing of the Mississippi Commission on Environmental Quality, and would be transcribed.

All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the submission of this TMDL to EPA Region 4 for final approval.

REFERENCES

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DEFINITIONS

5-Day Biochemical Oxygen Demand: Also called BOD_5, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous or nitrogenous compounds under aerobic conditions over a period of 5 days.

Activated Sludge: A secondary wastewater treatment process that removes organic matter by mixing air and recycled sludge bacteria with sewage to promote decomposition

Aerated Lagoon: A relatively deep body of water contained in an earthen basin of controlled shape which is equipped with a mechanical source of oxygen and is designed for the purpose of treating wastewater.

Ammonia: Inorganic form of nitrogen (NH_3); product of hydrolysis of organic nitrogen and denitrification. Ammonia is preferentially used by phytoplankton over nitrate for uptake of inorganic nitrogen.

Ammonia Nitrogen: The measured ammonia concentration reported in terms of equivalent ammonia concentration; also called total ammonia as nitrogen (NH_3-N)

Ammonia Toxicity: Under specific conditions of temperature and pH, the unionized component of ammonia can be toxic to aquatic life. The unionized component of ammonia increases with pH and temperature.

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 water body may be based upon a similar, unaltered or least impaired, water body or on historical pre-alteration data.

Biological Impairment: Condition in which at least one biological assemblages (e.g. , fish, macroinvertabrates, or algae) indicates less than full support with moderate to severe modification of biological community noted.

Carbonaceous Biochemical Oxygen Demand: Also called CBODu, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous compounds under aerobic conditions over an extended time period.

Calibrated Model: A model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving water body.

Conventional Lagoon: An un-aerated, relatively shallow body of water contained in an earthen basin of controlled shape and designed for the purpose of treating water.

Critical Condition: Hydrologic and atmospheric conditions in which the pollutants causing impairment of a water body 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 water body or segment regardless of actual attainment.

Discharge Monitoring Report: Report of effluent characteristics submitted by a NPDES Permitted facility.

Dissolved Oxygen: The amount of oxygen dissolved in water. It also refers to a measure of the amount of oxygen that is available for biochemical activity in a water body. The maximum concentration of dissolved oxygen in a water body depends on temperature, atmospheric pressure, and dissolved solids.

Dissolved Oxygen Deficit: The saturation dissolved oxygen concentration minus the actual dissolved oxygen concentration.

DO Sag: Longitudinal variation of dissolved oxygen representing the oxygen depletion and recovery following a waste load discharge into a receiving water.

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.

First Order Kinetics: Describes a reaction in which the rate of transformation of a pollutant is proportional to the amount of that pollutant in the environmental system.

Groundwater: Subsurface water in the zone of saturation. Groundwater infiltration describes the rate and amount of movement of water from a saturated formation.

Impaired Water Body: Any water body 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

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

Mass Balance: An equation that accounts for the flux of mass going into a defined area and the flux of mass leaving a defined area, the flux in must equal the flux out.

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; silvaculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

Nitrification: The oxidation of ammonium salts to nitrites via *Nitrosomonas* bacteria and the further oxidation of nitrite to nitrate via *Nitrobacter* bacteria.

Nitrogenous Biochemical Oxygen Demand: Also called NBODu, the amount of oxygen consumed by microorganisms while stabilizing or degrading nitrogenous compounds under aerobic conditions over an extended time period.

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.

Photosynthesis: The biochemical synthesis of carbohydrate based organic compounds from water and carbon dioxide using light energy in the presence of chlorophyll.

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.

Reaeration: The net flux of oxygen occurring from the atmosphere to a body of water across the water surface.

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.

Respiration: The biochemical process by means of which cellular fuels are oxidized with the aid of oxygen to permit the release of energy required to sustain life. During respiration, oxygen is consumed and carbon dioxide is released.

Sediment Oxygen Demand: The solids discharged to a receiving water are partly organics, which upon settling to the bottom decompose aerobically, removing oxygen from the surrounding water column.

Storm Runoff: Rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate than rainfall intensity, but instead flows into adjacent land or water bodies or is routed into a drain or sewer system.

Streeter-Phelps DO Sag Equation: An equation which uses a mass balance approach to determine the DO concentration in a water body downstream of a point source discharge. The equation assumes that the stream flow is constant and that CBODu exertion is the only source of DO deficit while reaeration is the only sink of DO deficit.

Total Ultimate Biochemical Oxygen Demand: Also called TBODu, the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous or nitrogenous compounds under aerobic conditions over an extended time period.

Total Kjeldahl Nitrogen: Also called TKN, organic nitrogen plus ammonia nitrogen.

Total Maximum Daily Load or TMDL: The calculated maximum permissible pollutant loading to a water body 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.

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
$CBOD_5$	5-Day Carbonaceous Biochemical Oxygen Demand
CBODu	Carbonaceous Ultimate Biochemical Oxygen Demand
CWA	Clean Water Act
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MARIS	Mississippi Automated Resource Information System
MDEQ	Mississippi Department of Environmental Quality
MGD	Million Gallons per Day
MOS	Margin of Safety
NBODu	Nitrogenous Ultimate Biochemical Oxygen Demand
NH_3	Total Ammonia
NH_3-N	Total Ammonia as Nitrogen
NO_2+ NO_3	Nitrite Plus Nitrate
NPDES	National Pollution Discharge Elimination System
RBA	Rapid Biological Assessment

$TBOD_5$ .... 5-Day Total Biochemical Oxygen Demand

TBODu .... Total Ultimate Biochemical Oxygen Demand

TKN .... Total Kjeldahl Nitrogen

TN .... Total Nitrogen

TOC .... Total Organic Carbon

TP .... Total Phosphorous

USGS .... United States Geological Survey

WLA .... Waste Load Allocation

WWTP .... Wastewater Treatment Plant