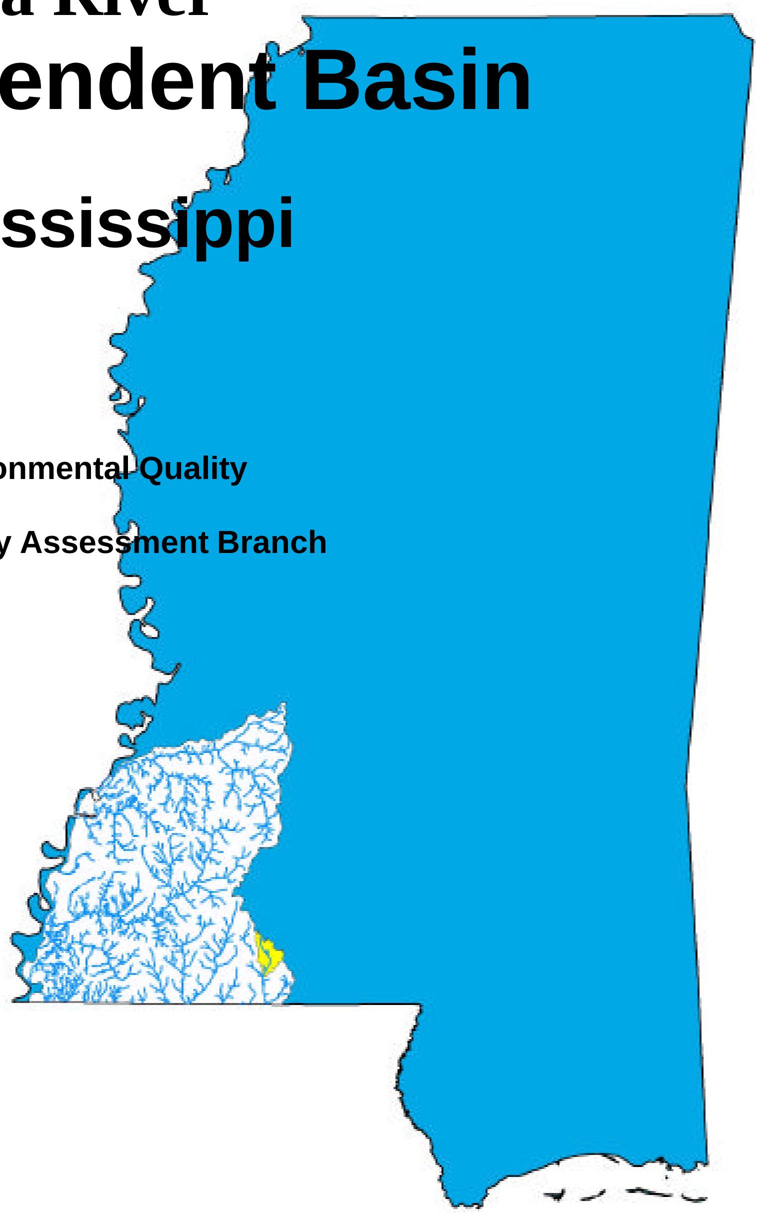
FINAL REPORT
July 2004

Phase 1
Total Maximum Daily Load
Organic Enrichment/Low Dissolved Oxygen and Ammonia Nitrogen

Little Tangipahoa River
South Independent Basin

Pike County 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 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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PHOTOS

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TMDL INFORMATION PAGE

i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Little Tangipahoa River	MS481M5	Pike	08070205	Biological Impairment	Monitored
Near Fernwood from Confluence of Town Creek to Confluence with Tangipahoa River.					

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	Permitted Discharge (MGD)	Receiving Water
MS0000141	Canadian National Railroad	Report	Town Creek
MS0050652	Eott Energy Operation LP, McComb Station	Report	Unnamed Tributary of Little Tangipahoa River
MS0044598	Fernwood Industries, LLC	0.14	Little Tangipahoa River
MS0026891	Magnolia POTW, North	0.387	Little Tangipahoa River
MS0026883	Magnolia POTW, South	0.381	Little Tangipahoa River
MS0025518	McComb POTW, West	0.95	Little Tangipahoa River
MS0025526	McComb POTW, East	2.7	Town Creek
MS0044199	Fernwood Water and Sewer Association	0.04	Unnamed Tributary thence Little Tangipahoa River
MS0050415	Fernwood Truck Stop	0.015	Minnehaha Creek
MS0038458	Haygood Trailer Park	0.018	Martin Creek Thence Little Tangipahoa River
MS0042528	Pike County Industrial Park	0.045	Little Tangipahoa River

iv. Phase 1 Total Maximum Daily Load for TBODu

WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
1,217	**105**	**Implicit**	**1,322**

EXECUTIVE SUMMARY

This TMDL has been developed for one segment of the Little Tangipahoa River that has been placed on the Mississippi 1998 Section 303(d) List of Water Bodies as an impaired water body segment, due to biological impairment. A stressor identification study has been developed for this waterbody. Based on the available information, it was determined that the biological impairment was most likely due to elevated ammonia nitrogen and nutrient enrichment. Secondary stressors were identified as dissolved solids and organic enrichment. Low dissolved oxygen was also identified as a likely stressor during the summer. Mississippi currently does not have standards for allowable nutrient concentrations, so a TMDL specifically for nutrients will not be developed. However, elevated levels of nutrients, ammonia nitrogen, organic material, and dissolved solids contribute to increased primary production and subsequent dissolved oxygen depletion through respiration. Thus, the TMDL developed for organic enrichment addresses the potential impact of these primary and secondary stressors in the Little Tangipahoa River.

The Little Tangipahoa River watershed is located in southern part of Mississippi in HUC 08070205. The headwaters of the river begin northwest of McComb, MS in Pike County. The Little Tangipahoa River flows in a southeastern direction for approximately 16 miles to its confluence with the Tangipahoa River. The Tangipahoa River continues south into the state of Louisiana and eventually empties into Lake Pontchartrain. The 303(d) listed segment of the Little Tangipahoa River Watershed begins south of McComb, at the confluence of Town Creek. Photo 1 shows The Little Tangipahoa River at Magnolia (Highway 48).

Photo 1. Little Tangipahoa River at Highway 48

The predictive model used to calculate this TMDL is based primarily on assumptions described in MDEQ Regulations. A modified Streeter-Phelps dissolved oxygen sag model was selected as the modeling framework for developing the TMDL allocations for this study. A mass-balance approach was used to ensure that the instream concentration of ammonia nitrogen (NH_3-N) did not exceed the water quality criteria. The critical modeling period was determined to occur during the hot, dry summer period.

The TMDL for organic enrichment was quantified in terms of total ultimate biochemical oxygen demand (TBODu). The model used in developing this TMDL included both nonpoint and point sources of TBODu in the Little Tangipahoa 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 estimated background concentration of TBODu in the stream. There are several NPDES Permitted discharges located in the watershed that are included as point sources in the model.

This report concludes that the Little Tangipahoa River does not have sufficient assimilative capacity for the current NPDES permitted facilities. Some upgrades to wastewater treatment need to be made. However, there were many uncertainties involved in developing the predictive model. Due to lack of data collected during the critical modeling period, the model was not calibrated, and is based primarily on assumed values. Thus, this TMDL has been prepared as a phased TMDL Report to indicate that more information and monitoring data about the Little Tangipahoa River watershed are needed.

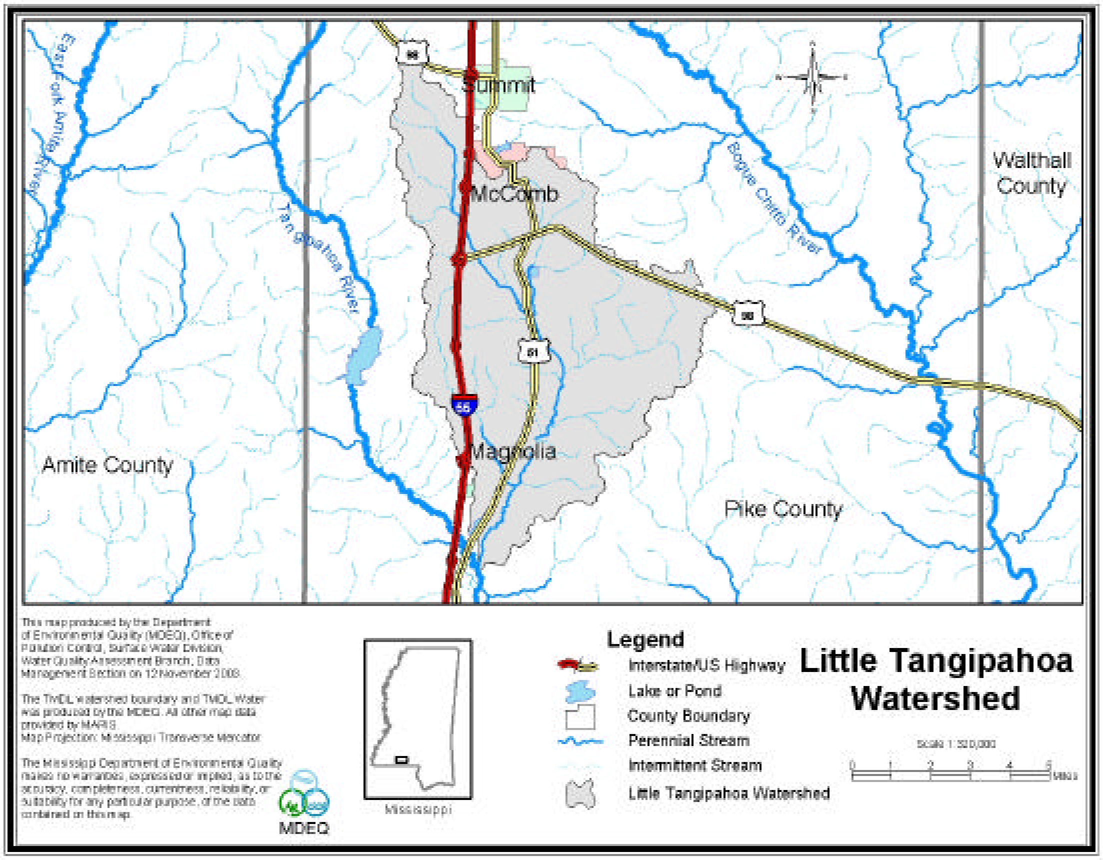


Figure 1. Little Tangipahoa River Watershed

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. This TMDL has been developed for the 303(d) listed segment shown in Figure 2.

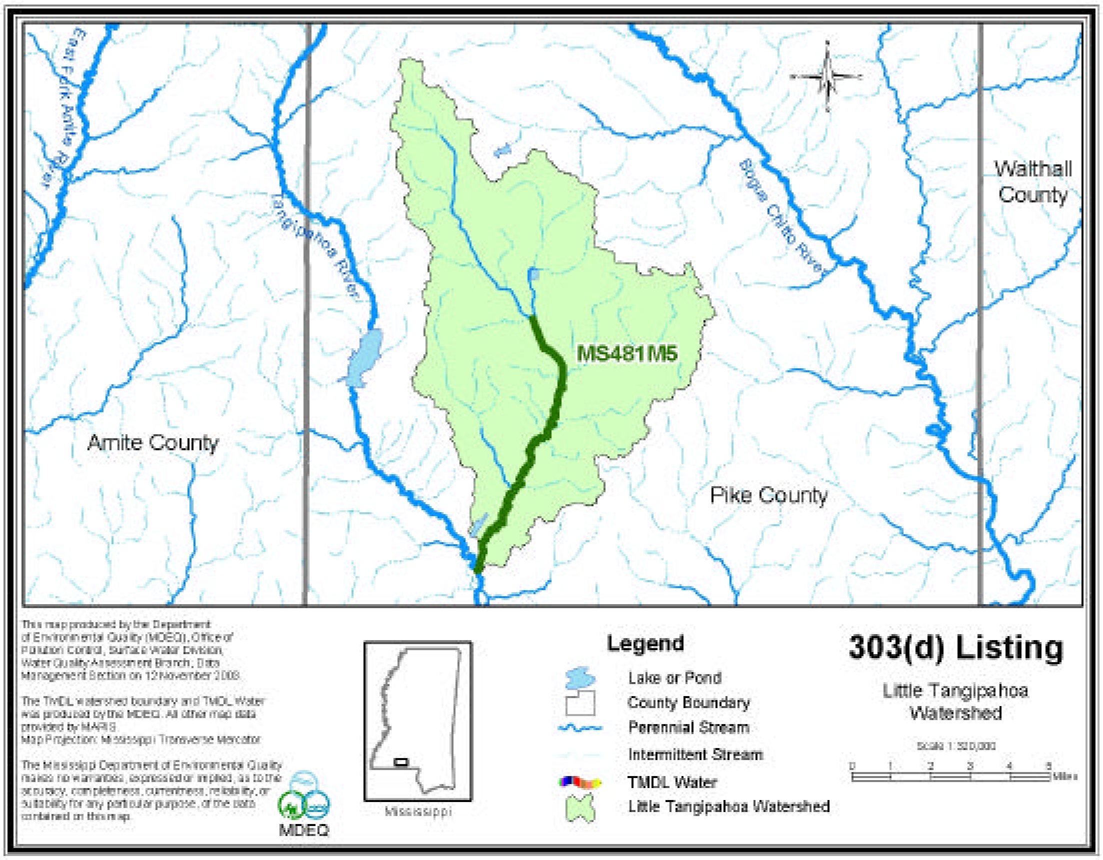


Figure 2. Little Tangipahoa River Watershed 303(d) Listed Segment

1.2 Stressor Identification

The impaired segment of the Little Tangipahoa River was listed due to failure to meet minimum water quality criteria for biological use support. Because of this, a detailed assessment of the watershed and potential pollutant sources, called a stressor identification report, was developed. The purpose of a stressor identification report is to identify the stressors and their sources most likely causing degradation of instream biological conditions. The stressor identification report was developed according to USEPA guidance (USEPA, 2000) for two sites that were included in the Mississippi Benthic Index of Stream Quality (M-BISQ) (MDEQ, 2003). Site 456 was located in the upper part of the Little Tangipahoa River watershed, at Highway 98 near McComb. This site was not impaired, but scored just above the minimum reference value for the bioregion in which it is located. Site 460, located at Highway 48 near Magnolia, in the lower part of the watershed, was impaired. The M-BISQ score was below the minimum reference value for its bioregion. Site 460 is located within the 303(d) listed segment of the Little Tangipahoa River. The locations of the two M-BISQ sites are shown on the map in Figure 3.

The stressor identification process consists of several steps including assessment of impairments, identification of candidate causes, evaluation of the relationships between stressors and biological impairment. The process also includes a strength of evidence analysis which was used to evaluate the candidate causes and prioritize them according to their likelihood of being the most important stressors. The stressor identification report used all available water quality data for the Little Tangipahoa River including data collected during the IBI project, historical water quality monitoring data, NPDES permit data, and watershed information. The primary stressors identified for site 460 were identified as elevated ammonia nitrogen and nutrient enrichment (nitrite-nitrate nitrogen, total Kjeldahl nitrogen, and total phosphorous). Several other candidate causes, solids (total dissolved solids, alkalinity, chlorides, specific conductance), organic enrichment (COD), and depressed dissolved oxygen were identified as secondary stressors.

Based on the results of the stressor identification, this TMDL has been developed for organic enrichment enrichment/low dissolved oxygen and ammonia nitrogen. Mississippi currently does not have water quality standards available for specific nutrient species including nitrite-nitrate nitrogen, total Kjeldahl nitrogen, and total phosphorous. Thus, a TMDL for these specific nutrient species cannot be developed at this time. However, elevated levels of these nutrients may contribute to increased primary production and respiration. Also, nutrient and organic enrichment are known to cause increased microbial respiration that lead to depressed levels of dissolved oxygen. The process of nitrification (oxidation of ammonia nitrogen to nitrate nitrogen) can also deplete instream dissolved oxygen levels. Increased dissolved solids and specific conductivity are likely linked to point source loads of the primary stressors. Reduction of organic material from point sources would likely result in commensurate reductions in these pollutants. Thus, the TMDL developed for dissolved oxygen includes the water quality impact of the primary stressors, ammonia nitrogen and nutrient enrichment, and secondary stressors, dissolved solids and organic enrichment.

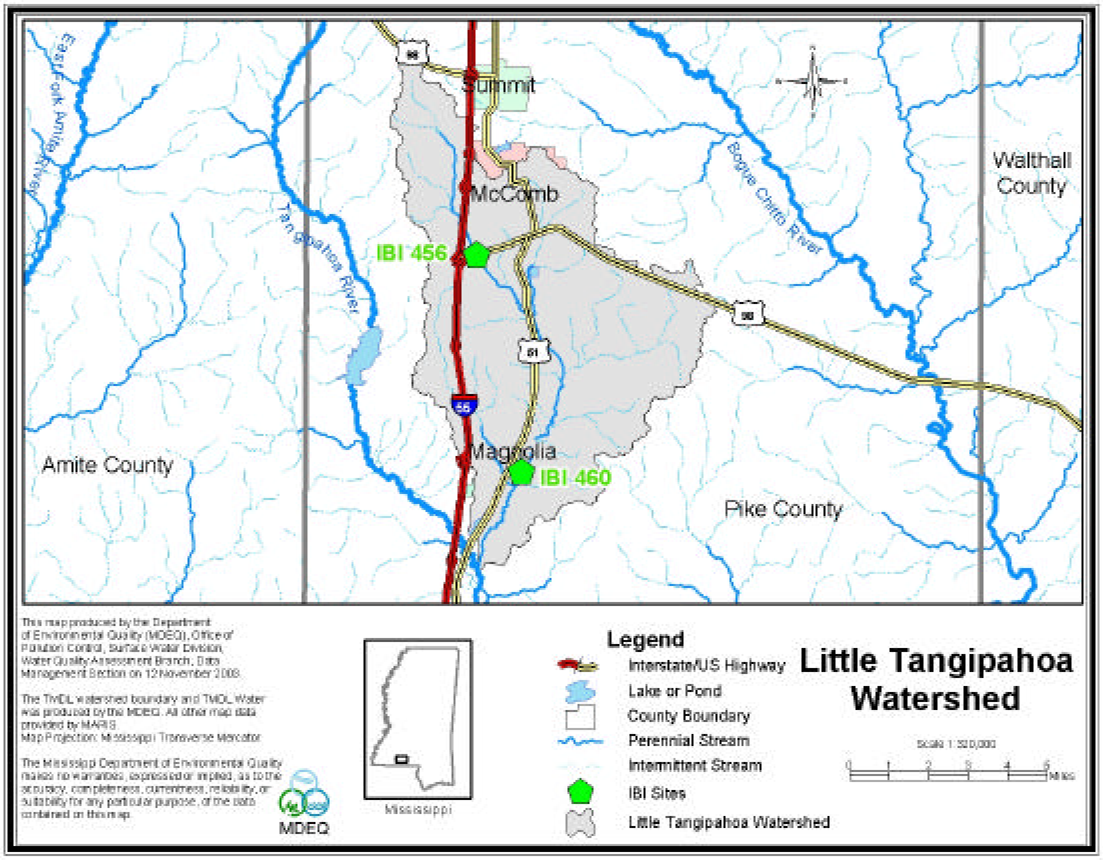


Figure 3. Location of the M-BISQ Stations

1.3 Applicable Water Body Segment Use

The water use classification for the listed segments of the Little Tangipahoa 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 Little Tangipahoa River and its tributaries are Secondary Contact and Aquatic Life Support.

1.4 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* (MDEQ, 2002). 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. This water quality standard will be used as a targeted endpoint to evaluate impairments and establish this TMDL.

The water quality standard for ammonia nitrogen toxicity is also included in this TMDL. 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.

1.5 Selection of a Critical Condition

Low DO typically occurs during seasonal low-flow, high-temperature periods 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. The low flow condition for the Little Tangipahoa River watershed was determined based on Techniques for Estimating 7-Day, 10-Year Low-Flow Characteristics on Streams in Mississippi (Telis, 1992). According to this repot, the 7Q10 flow at Magnolia, MS is 7.4 cfs.

1.6 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 protect 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.

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. The endpoint for this TMDL will be based on a daily average of not less than 5.0 mg/l at the DO sag during critical conditions.

The TMDL for DO will be quantified in terms of 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.

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

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 Little Tangipahoa River watershed. The potential point and nonpoint pollutant sources were characterized by the best available information, monitoring data, and literature values.

2.1 Discussion of Instream Water Quality Data

There are several sources of data available for the Little Tangipahoa River Watershed. Table 1 presents time series measurements from the Little Tangipahoa River at Fernwood. The time series measurements were recently collected by MDEQ in the summer of 2003 approximately 10 yards downstream of a County Road just north of Fernwood. The dissolved oxygen data have been plotted in Figure 4 below. As shown in the figure, the DO data show diurnal variation. The lowest values, measured in the morning hours before sunrise, are below the instantaneous water quality standard. Table 2 shows water chemistry measurements from sites upstream and downstream of the Fernwood POTW collected by MDEQ in 1999. The upstream site was located on Wardlaw Road near Fernwood. The downstream site was located at Magnolia. Samples at the upstream site were collected on July 27, 1999, while samples at the downstream site were collected on July 29, 1999. Table 3 and Table 4 contain data from three sites on the Little Tangipahoa River and one on Town Creek that were collected during a 1990 study of the Tangipahoa River watershed (U.S. Department of Agriculture et al, 1991). Station 4 is located on the Little Tangipahoa River approximately 100 yards downstream of Highway 48 at Magnolia. Station 5 is located on the Little Tangipahoa River approximately 10 yards downstream of a County Road, 0.3 miles northeast of Fernwood. Station 6 is located on Town Creek approximately 15 yards downstream of a County Road, 1.2 miles north of Fernwood. Station 7 is on the Little Tangipahoa River immediately downstream of a County Road, 1.2 miles north of Fernwood. As shown in the tables, each sample was not analyzed for all parameters.

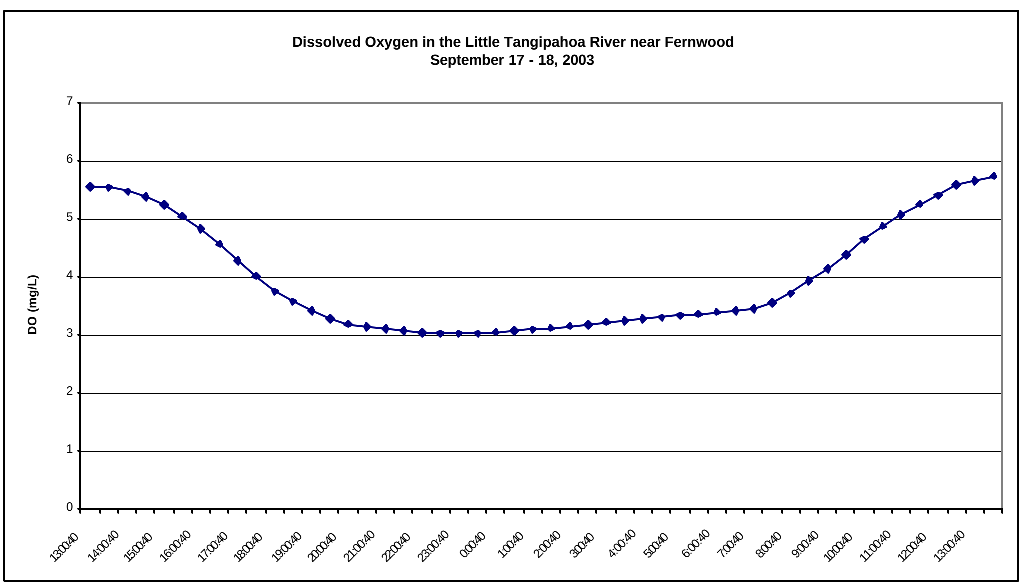


Figure 4. Time Series Data

Table 1. Time Series Data for Little Tangipahoa River at Fernwood

Date	Time	DO (mg/L)	Temperature (°C)	pH (SU)	Specific Conductivity (us/cm)	TDS (g/L)
9/17/2003	13:30:40	5.54	22.2	6.83	176	0.114
9/17/2003	14:00:40	5.53	22.4	6.84	175	0.114
9/17/2003	14:30:40	5.46	22.6	6.85	175	0.114
9/17/2003	15:00:40	5.37	22.7	6.84	175	0.114
9/17/2003	15:30:40	5.23	22.8	6.84	175	0.114
9/17/2003	16:00:40	5.04	22.9	6.83	174	0.113
9/17/2003	16:30:40	4.82	23.0	6.82	174	0.113
9/17/2003	17:00:40	4.55	23.0	6.81	174	0.113
9/17/2003	17:30:40	4.27	23.1	6.79	174	0.113
9/17/2003	18:00:40	4.00	23.2	6.78	174	0.113
9/17/2003	18:30:40	3.74	23.3	6.78	174	0.113
9/17/2003	19:00:40	3.56	23.3	6.77	174	0.113
9/17/2003	19:30:40	3.4	23.3	6.77	174	0.113
9/17/2003	20:00:40	3.27	23.3	6.76	174	0.113
9/17/2003	20:30:40	3.18	23.2	6.76	174	0.113
9/17/2003	21:00:40	3.13	23.2	6.76	174	0.113
9/17/2003	21:30:40	3.09	23.1	6.77	175	0.114
9/17/2003	22:00:40	3.06	23.0	6.77	175	0.114
9/17/2003	22:30:40	3.03	22.9	6.77	175	0.114
9/17/2003	23:00:40	3.02	22.7	6.77	176	0.114
9/17/2003	23:30:40	3.02	22.5	6.77	176	0.114
9/18/2003	0:00:40	3.02	22.4	6.78	176	0.115
9/18/2003	0:30:40	3.04	22.1	6.78	177	0.115
9/18/2003	1:00:40	3.06	21.9	6.78	177	0.115
9/18/2003	1:30:40	3.08	21.7	6.78	177	0.115
9/18/2003	2:00:40	3.11	21.5	6.79	178	0.115
9/18/2003	2:30:40	3.14	21.3	6.79	178	0.116
9/18/2003	3:00:40	3.17	21.1	6.79	178	0.116
9/18/2003	3:30:40	3.21	20.9	6.79	178	0.116
9/18/2003	4:00:40	3.23	20.8	6.79	178	0.116
9/18/2003	4:30:40	3.27	20.6	6.79	178	0.116
9/18/2003	5:00:40	3.29	20.5	6.79	178	0.116
9/18/2003	5:30:40	3.32	20.3	6.79	178	0.116
9/18/2003	6:00:40	3.35	20.2	6.79	178	0.116
9/18/2003	6:30:40	3.38	20.1	6.79	178	0.116
9/18/2003	7:00:40	3.40	20.0	6.79	179	0.116
9/18/2003	7:30:40	3.44	19.9	6.79	179	0.116
9/18/2003	8:00:40	3.54	19.9	6.79	179	0.116
9/18/2003	8:30:40	3.70	19.9	6.8	179	0.116
9/18/2003	9:00:40	3.92	20.0	6.8	179	0.116
9/18/2003	9:30:40	4.13	20.2	6.81	179	0.116
9/18/2003	10:00:40	4.37	20.4	6.82	179	0.117
9/18/2003	10:30:40	4.63	20.7	6.82	179	0.117
9/18/2003	11:00:40	4.86	21.1	6.83	179	0.117
9/18/2003	11:30:40	5.06	21.4	6.84	179	0.117
9/18/2003	12:00:40	5.25	21.8	6.84	179	0.117
9/18/2003	12:30:40	5.39	22.1	6.84	179	0.117
9/18/2003	13:00:40	5.58	22.4	6.85	179	0.117
9/18/2003	13:30:40	5.65	22.6	6.85	179	0.116
9/18/2003	14:00:40	5.73	22.8	6.85	179	0.116

Table 2. Water Quality Data Collected Near the Fernwood POTW in July 1999

Parameter	Upstream Site	Downstream Site
Alkalinity, Total (mg/L, as CaCO3)	16.7	30.2
Chloride, Total (mg/L)	5.7	11.7
Depth Sample, Max (ft)	0.2	0.2
Dissolved Oxygen, Analysis by probe (mg/L)	3.92	5.07
Fecal Coliform, MFC Both, MF(100ml)	350	80
Hardness, Total (mg/L) as CaCO3	11.6	19.4
Nitrogen, Ammonia (mg/L as N)	1.42	0.82
Nitrogen, Nitrate-Nitrite (mg/L as N)	0.78	1.66
Nitrogen, Total Kjeldahl (mg/L as N)	1.44	1.65
Oxygen Demand, Chemical (mg/L)	35	36
pH, Field (SU)	6.44	6.57
Phosphorus, Total (mg/L as P)	0.87	0.61
Solids Suspended, Total (mg/L)	13	18
Specific Conductance, Field (umhos/cm @25°C)	65.4	130.4
Temperature, Air (°C)	27	25.7
Temperature, Water (°C)	24.6	25.3
Turbidity, Lab (NTU)	No data	16

Table 3. Water Quality Data for the Little Tangipahoa River Stations 4 and 5

Site ID	Date	Time (Hrs.)	pH (SU)	Water Temp. (°C)	DO (mg/L)	Conduct. UMHOS/ cm	Total Solids (mg/L)	TSS (mg/L)	Turbidity (NTU)	TOC (mg/L)	Total Phosph. (mg/L)	TKN (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)
4	3/12/1990	8:32	6.57	19.7	7.70	72	63	9.80	3.10		0.20	0.97	0.16	0.55	0.054
4	4/10/1990	9:10	6.56	17.0	8.60	84	46	4.00	6.00	1.7	0.17	1.25	0.26	1.24	0.040
4	4/27/1990	11:34													
4	5/8/1990	8:55	6.64	18.8	8.37	71	77	11.40	8.40		0.17	0.84	0.32	0.22	0.015
4	5/22/1990	12:42													
4	6/12/1990	10:20	6.63	24.1	7.60	88	94	18.00	24.60	4.6	0.32	0.82	0.24	1.19	0.040
4	7/16/1990	8:20	6.74	22.6	6.55	110	130	7.80	6.40		0.67	2.63	0.86		0.008
4	8/14/1990	8:30	6.66	23.0	6.70	101	130	5.00	11.40	6.2	0.76	0.97	0.10		
4	9/18/1990	11:05	6.81	24.6	8.10	117									
4	10/9/1990	10:32	6.65	23.0	7.50	119									
4	11/13/1990	11:27	6.73	15.2	9.25	97									
4	12/3/1990	12:21													
4	12/11/1990	11:45	6.68	11.6	10.60	82									
5	3/12/1990	9:05	6.53	19.3	8.00	104	93	7.20	3.10		0.08	0.53	0.16	0.74	0.052
5	4/10/1990	9:10	6.67	17.5	8.30	113	24	3.00	8.00	2.4	0.29	0.29	0.23	1.24	0.040
5	4/27/1990	12:13													
5	5/8/1990	9:30	6.70	19.1	7.80	140	120	10.00	9.90		0.49	4.76	0.52	2.49	0.071
5	5/22/1990	13:09													
5	6/12/1990	10:55	6.74	24.8	7.72	123	128	38.00	27.80	3.6	2.15	1.24	0.21	1.12	0.040
5	7/16/1990	8:50	6.88	23.1	5.20	171	158	6.60	4.90		1.82	3.54	2.49		0.019
5	8/14/1990	9:05	6.76	23.7	6.40	188	1.69	9.00	13.00	6.9	1.48	2.37	0.68		
5	9/18/1990	9:25	6.80	26.0	6.10	181									
5	10/9/1990	9:08	6.78	22.8	6.00	193									
5	11/13/1990	10:05	6.84	14.3	8.20	135									
5	12/3/1990	11:21													
5	12/11/1990	10:30	6.69	10.8	9.62	110									

Table 4. Water Quality Data for Town Creek Station 6 and Little Tangipahoa River Station 7

Site ID	Date	Time (Hrs.)	pH (SU)	Water Temp. (°C)	DO (mg/L)	Conduct. UMHOS/cm	Total Solids (mg/L)	TSS (mg/L)	Turbidity (NTU)	TOC (mg/L)	Total Phosph. (mg/L)	TKN (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)
6	3/12/1990	9:35	6.80	19.6	8.10	148	117	5.20	4.80		0.07	0.87	0.13	1.21	0.042
6	4/10/1990	9:35	6.73	19.0	8.80	158	50	4.00	5.00	2.5	0.44	0.53	0.30	1.93	0.040
6	4/27/1990	12:25													
6	5/8/1990	10:00	6.74	21.1	7.72	182	150	10.40	7.10		0.94	1.40	0.61	2.73	0.133
6	5/22/1990	13:17													
6	6/12/1990	11:15	6.71	26.2	7.00	147	158	12.00	18.70	3.5	0.73	1.54	0.31	1.30	0.040
6	7/16/1990	9:15	7.02	25.0	5.70	238	223	7.60	5.00		2.27	2.74	1.50		0.019
6	8/14/1990	9:50	6.82	24.7	7.10	220	198	3.00	10.50	9.6	1.90	2.74	0.61		
6	9/18/1990	9:05	6.76	24.0	5.40	223									
6	10/9/1990	8:51	6.72	23.8	5.35	222									
6	11/13/1990	9:45	6.73	16.0	7.60	172									
6	12/3/1990	11:14													
6	12/11/1990	10:15	6.66	12.5	9.00	152									
7	3/12/1990	9:48	6.40	19.2	7.40	58	53	2.90	2.40		0.07	1.22	0.01	0.50	0.023
7	4/10/1990	9:52	6.48	17.1	8.30	71	48	1.00	14.00	3.6	0.34	0.58	0.10	0.60	0.040
7	4/27/1990	12:29													
7	5/8/1990	10:20	6.39	19.1	7.40	99	109	19.30	15.10		0.74	1.40	0.34	0.22	0.009
7	5/22/1990	13:23													
7	6/12/1990	11:35	6.60	23.5	6.60	83	116	14.00	20.80	5.1	0.39	0.90	0.10	0.26	0.040
7	7/16/1990	9:30	6.31	22.7	5.70	71	85	4.80	5.00		0.18	1.70	0.55		0.019
7	8/14/1990	10:00	6.36	23.2	6.10	72	90	12.00	14.80	3.2	0.24	0.89	0.10		
7	9/18/1990	8:35	6.65	24.1	3.45	169									
7	10/9/1990	8:35	6.53	22.6	3.92	147									
7	11/13/1990	9:15	6.35	13.8	6.22	67									
7	12/3/1990	11:01													
7	12/11/1990	9:50	6.53	10.0	8.50	85									

A site visit to the Little Tangipahoa River watershed was made prior to the development of the stressor identification and the TMDL. During the visit, visual observations of the river were made. As shown in Photo 2, the water has significant discoloration, and appears green in color below the confluence of Town Creek. This is most likely due to loading of organic material and nutrients, which increases algal growth downstream from the discharge points of wastewater treatment plants in McComb. The discoloration of the water is apparent when compared to Photo 1, which was taken upstream of the point sources.

Photo 2. Little Tangipahoa River South of McComb

2.2 Assessment of Point Sources

An important step in assessing pollutant sources in the Little Tangipahoa River watershed is locating the NPDES permitted sources. There are eleven facilities permitted to discharge into the Little Tangipahoa River or its tributaries. These facilities serve a variety of activities in the watershed, including municipalities, industries, and other businesses. The municipal facilities include POTWs for the towns of McComb, Fernwood, and Magnolia. The Eott Energy Operation LP, McComb Station has a stormwater discharge permit for two outfalls: 1) runoff collected in a tank impoundment, and 2) wash water and stormwater from an exterior truck washing pad. Fernwood Industries LLC is permitted to handle discharges into the Little Tangipahoa River from a pump-and-treat groundwater remediation operation that was conducted during the mid-to-late 1990s. The site, a former wood preserving plant, was the focus of a cleanup plan authorized under the Resource Conservation and Recovery Act (RCRA) in the mid-1990s. The facility's NPDES permit requires quarterly monitoring for acenapthene, fluoranthene, 2,4,6-trichlorophenol, naththalene, and pentachororphenol. All samples for these parameters have been below their minimum detection levels in DMR reports that were reviewed

(December 1997 to present). Canadian National Railroad is currently permitted to treat stromwater runoff. Haygood Trailer Park and Fernwood Truck Stop are the two commercial facilities located in the watershed. The treatment type used by each of these facilities is given in Table 5. Figure 5 shows the locations of these sources.

Table 5. NPDES Permitted Facilities Treatment Types

Name	NPDES Permit	Treatment Type
Canadian National Railroad	MS0000141	Oil/Water Separator and Stabilization Pond
Eott Energy Operation LP, McComb Station	MS0050652	Settling Pond
Fernwood Industries, LLC	MS0044598	Carbon Filter
Magnolia POTW, North	MS0026891	2-Celled Conventional Lagoon
Magnolia POTW, South	MS0026883	Aerated Lagoon
McComb POTW, West	MS0025518	Aerated Lagoon with Sand Filter
McComb POTW, East	MS0025526	Aerated Lagoon with Sand Filter
Fernwood Water and Sewer Association	MS0044199	2-Celled Conventional Lagoon
Fernwood Truck Stop	MS0050415	Activated Sludge Plant
Haygood Trailer Park	MS0038458	Conventional Lagoon
Pike County Industrial Park	MS0042528	Conventional Lagoon

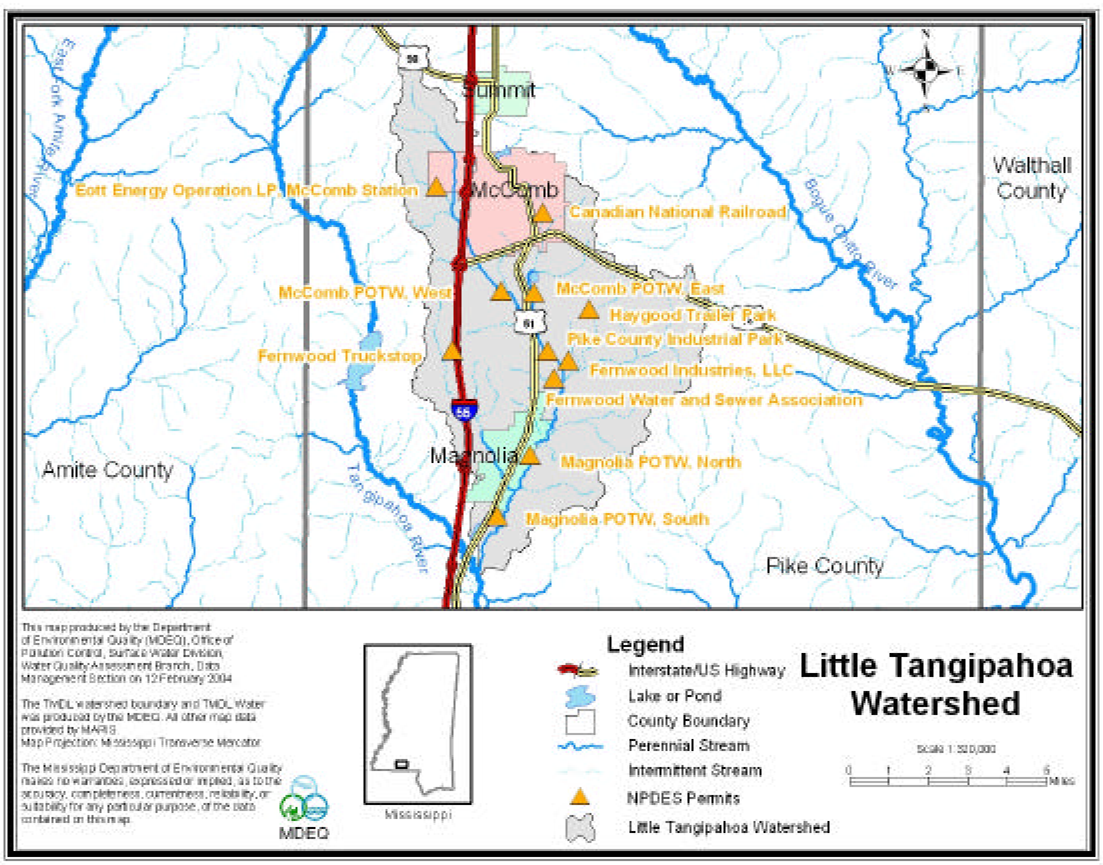


Figure 5. Point Source Location Map

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. The permit limits as well as the average flows and BOD_5 concentrations, as reported in available discharge monitoring reports (DMRs) for the past five years (1998 through 2003), are given in Table 6. Ammonia nitrogen permit limits and monitoring are not required for most of the facilities. As shown in Table 6, most facilities are currently discharging at average flows and average BOD_5 concentrations below their allowable permit limits. The McComb East facility is exceeding its BOD_5 limit of 10 mg/l. Also, there have been occasional monthly violations for several of the facilities. MDEQ inspectors have also noted that there have been several compliance problems at the McComb POTW East and West Facility. MDEQ has been working with the city of McComb to address these problems, and anticipates permit compliance in the future.

Table 6. Identified NPDES Permitted Facilities

Name	NPDES Permit	Permitted Discharge (MGD)	Actual Average Discharge (MGD)	Permitted Average BOD_5 (mg/L)	Actual Average BOD_5 (mg/L)
Canadian National Railroad	MS0000141	Report	0.06	N/A	N/A
Eott Energy Operation LP, McComb Station	MS0050652	Report	No discharge reported	N/A	N/A
Fernwood Industries, LLC	MS0044598	0.14	0.12	N/A	N/A
Magnolia POTW, North	MS0026891	0.387	0.21	40	21.0
Magnolia POTW, South	MS0026883	0.381	0.18	45	17.3
McComb POTW, West	MS0025518	0.95	0.70	18	14.0
McComb POTW, East	MS0025526	2.78	1.81	10	10.2
Fernwood Water and Sewer Association	MS0044199	0.04	0.01	45	19.9
Fernwood Truck Stop	MS0050415	0.015	0.01	30	11.2
Haygood Trailer Park	MS0038458	0.018	No discharge reported	30	No discharge reported
Pike County Industrial Park	MS0042528	0.045	0.03	30	23.5

2.3 Assessment of Nonpoint Sources

Nonpoint loading of nutrients and organic material in a water body results from the transport of the pollutants into receiving waters by overland surface runoff and groundwater infiltration. Nonpoint pollution sources of concern are storm sewer drainage from the Cities of McComb, Magnolia, and Fernwood and runoff from agricultural areas. Nonpoint loading of TBODu in a waterbody 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 agriculture, and urbanization contribute to nonpoint source loading.

The 33,152-acre drainage area of the Little Tangipahoa River contains many different landuse types, including urban, forest, cropland, pasture, water, 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. Agriculture is the dominant landuse within this watershed. The landuse distribution within the Little Tangipahoa River Watershed is shown in Table 7 and Figure 6.

Table 7. Landuse Distribution, Little Tangipahoa River Watershed

	Urban	Forest	Agriculture	Barren	Water	Wetlands	Total
Area (acres)	3,195	10,402	12,143	431	188	6,792	33,152
Percentage	10	31	37	1	1	20	100%

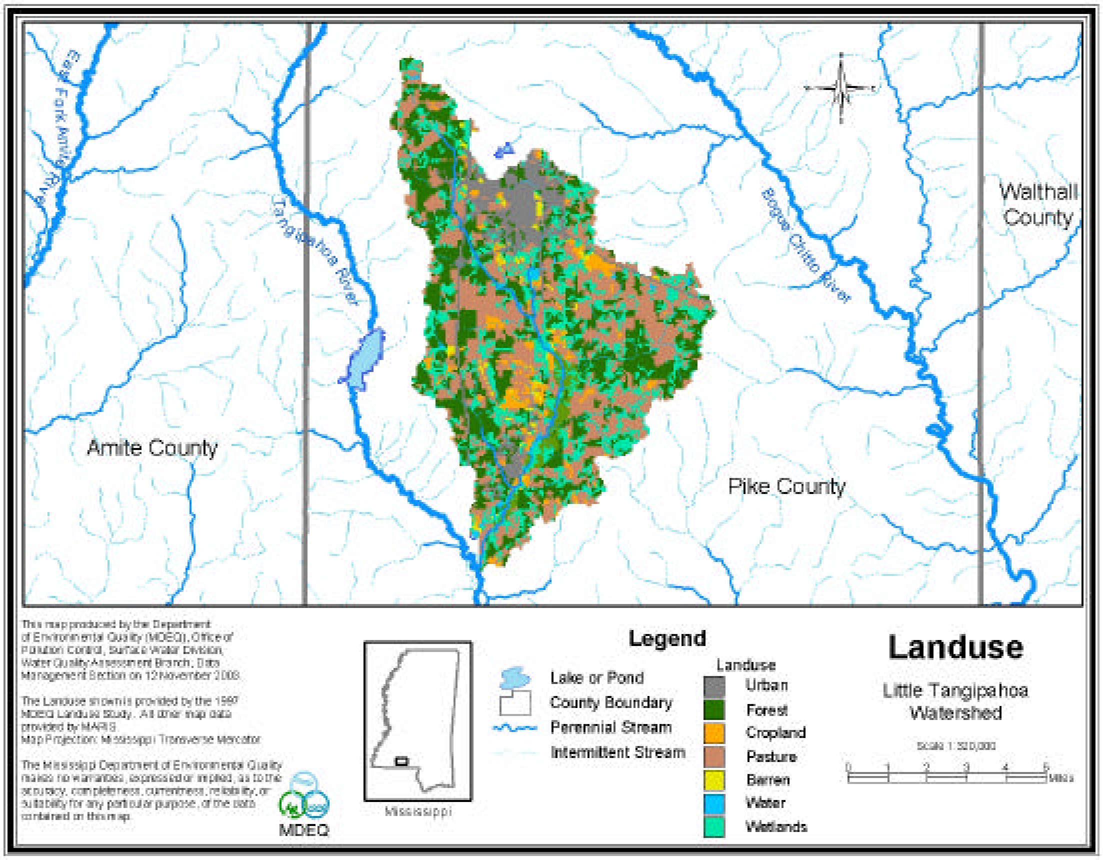


Figure 6. Landuse Distribution Map for the Little Tangipahoa River Watershed

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, STeady Riverine Environmental Assessment Model (STREAM), for DO distribution in freshwater streams was used for developing the TMDL. STREAM is an updated version of the AWFWUL1 model, which had been used by MDEQ for many years. 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 STREAM model in TMDL development is its ability to assess instream water quality conditions in response to point and nonpoint source loadings.

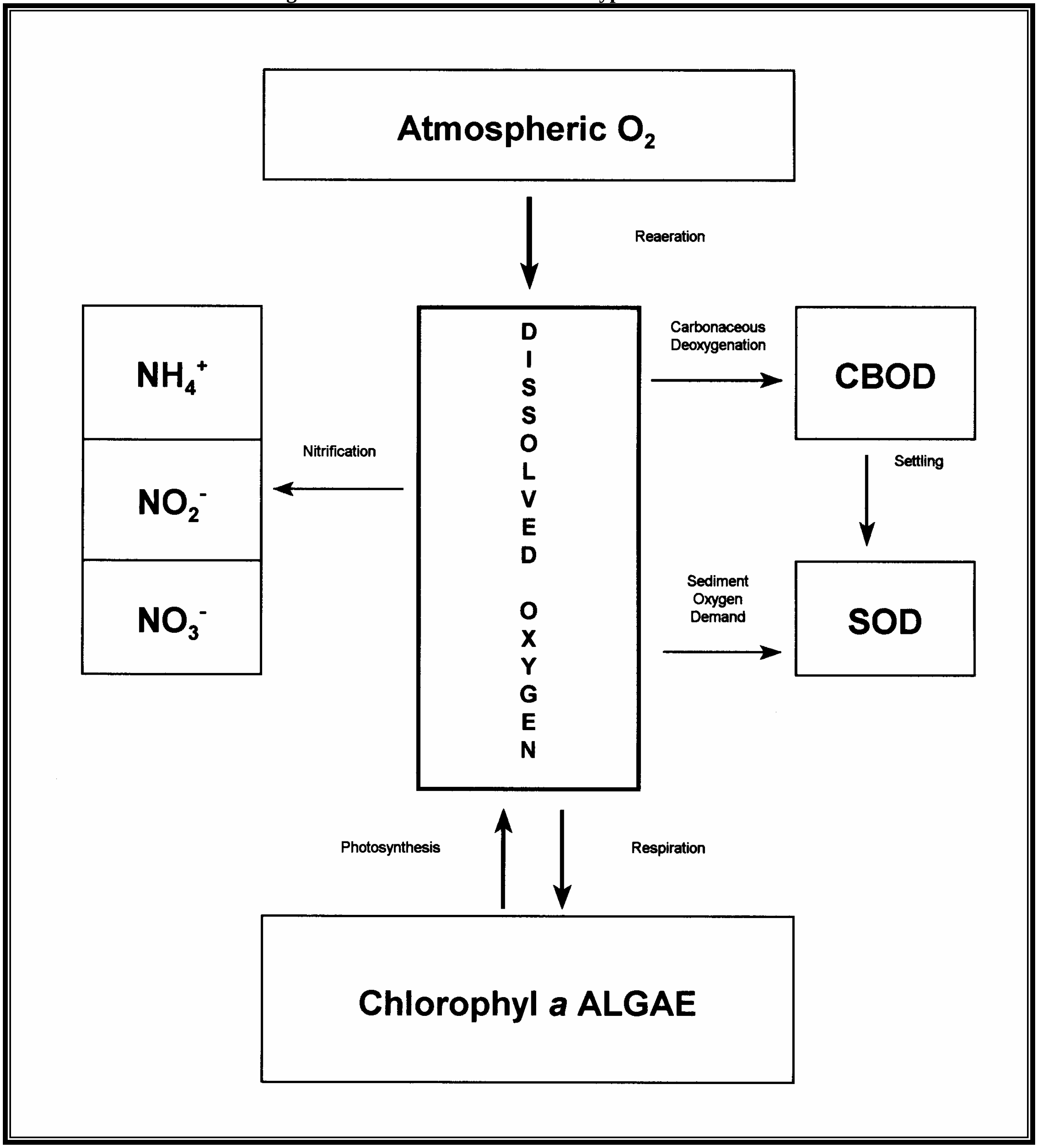
STREAM is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBODu decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 7 shows how these processes 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 Tsivoglou formulation. The Tsivoglou formulation calculates reaeration (Ka) within each reach according to Equation 2.

$$Ka = CSU \qquad \textbf{(Equation 2)}$$

S is the slope in ft/mile, U is the reach velocity in mile/day, and C is the escape coefficient, which is 0.11 for reaches with flow less than 10 cfs and 0.0597 for reaches with flow greater than 10 cfs. The slope of each reach was estimated from USGS quad maps and input into the model in units of feet/mile. Slopes for the Little Tangipahoa River averaged at approximately 10 ft/mile.

Figure 7. Instream Processes in a Typical DO Model



4.2 Model Setup

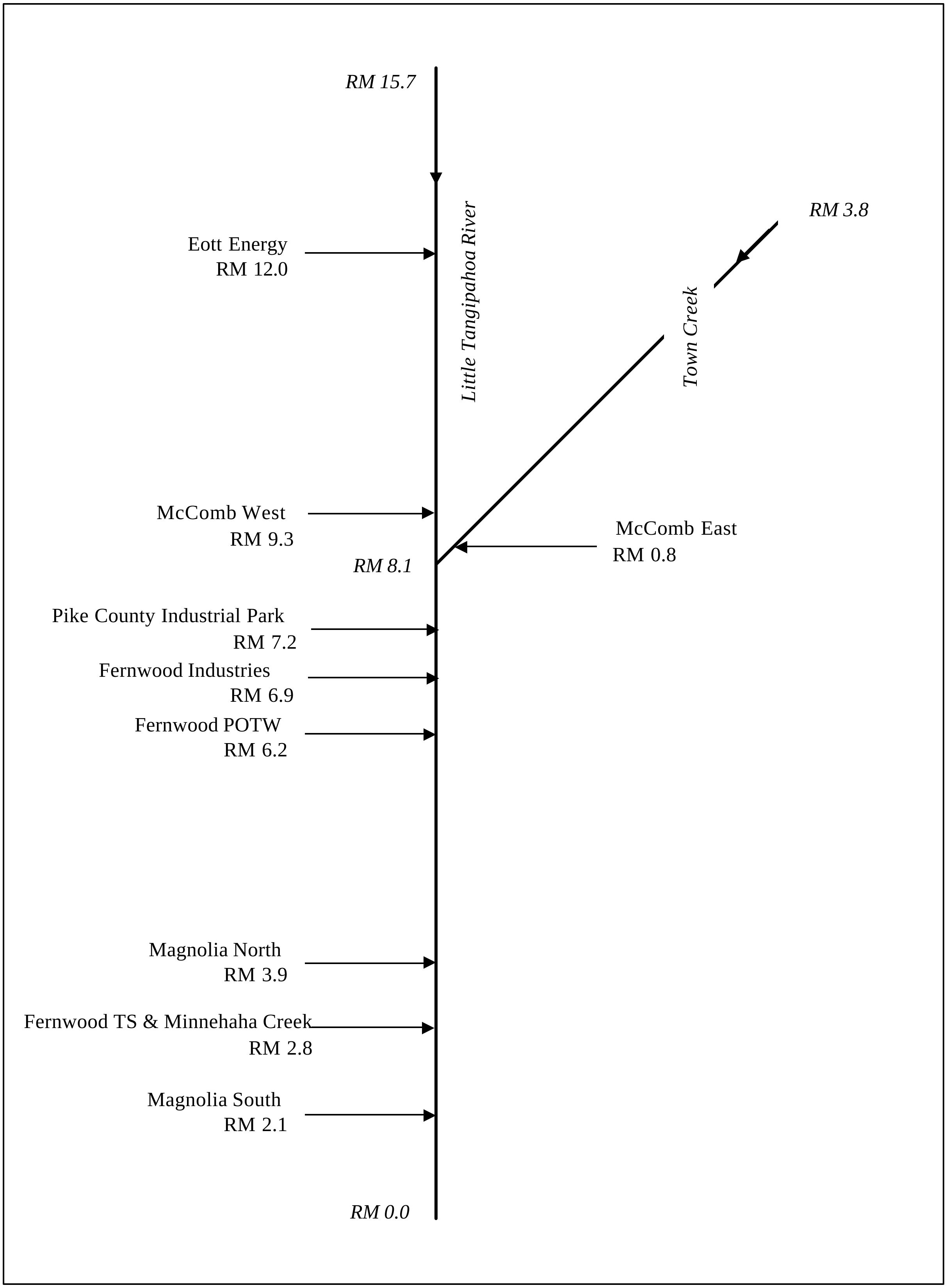
The Little Tangipahoa River TMDL model includes the 303(d) listed segment, from the confluence of Town Creek to the mouth at the Tangipahoa River. The headwaters of the Little Tangipahoa River and the tributary, Town Creek, are also included. Other tributaries including Minnehaha Creek were not modeled. The modeled water bodies were divided into reaches for input into the STREAM 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 8. The locations of the confluence of point sources and significant tributaries are shown. Arrows represent the direction of flow in each segment. The numbers on the figure represent approximate river miles. River miles are assigned to water bodies, beginning with zero at the mouth. Within each reach, the modeled segments were divided into computational elements of 0.1 mile. The simulated hydrological and water quality characteristics were calculated and output by the model for each computational element.

The model was setup to simulate flow and temperature conditions, which were 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.

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

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). Literature values were used to estimate values of sediment oxygen demand (Chapra, 1997). Based on visual observation of the Little Tangipahoa River and Town Creek, algal photosynthesis and respiration are likely to be significant processes in the oxygen balance. Because of this, values were also used to input the rates of photosynthesis and respiration into the model.

Figure 8. Little Tangipahoa River and Town Creek Model Setup (Note: Figure not to Scale)



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 concentration of $CBOD_5$ and ammonia nitrogen in mg/L. The facilities that do not discharge $CBOD_5$ and ammonia nitrogen (Eott Energy and Fernwood Industries) were included only as a contributor of flow. Canadian National Railroad was not included in the model because it does not discharge these parameters and has an insignificant flow. Also, the Haygood Trailer Park was not included in the baseline model because it has reported no discharge since 1998. Spatially distributed loads, which represent nonpoint sources of flow, $CBOD_5$, and ammonia nitrogen were distributed evenly into each computational element of the Little Tangipahoa River and Town Creek.

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 TMDLs are typically developed using CBODu, a ratio between the two terms is needed, Equation 4.

$$\textbf{CBODu} = \textbf{CBOD}_5 * \textbf{Ratio} \qquad \textbf{(Equation 4)}$$

The CBODu to $CBOD_5$ ratios are given in *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). 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. For secondary treatment systems (conventional and aerated lagoons), this ratio is 1.5. A CBODu to $CBOD_5$ ratio of 1.5 was used for all of the facilities in the Little Tangipahoa River watershed, with the exception of Fernwood Truck Stop. A ratio of 2.3 was used for this facility. MDEQ regulations specify that a ratio of 2.3 should be used for advanced treatment (activated sludge).

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. 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 maximum permitted loads of TBODu from each of the existing point sources are given in Table 8. Note that most of the permitted $CBOD_5$ concentrations are greater than the actual concentrations, as reported in the DMR data, Table 9. Magnolia North and the Pike County Industrial Park are the only facilities that report values for ammonia nitrogen. An assumed value of 2.0 mg/L was used to calculate the NBODu load for the facilities, with the exception McComb West. An ammonia nitrogen value of 5.0 mg/L was assumed for this facility. The Magnolia North facility has seasonal limits, and is allowed to discharge up to 45 mg/L BOD_5 in the winter months (October through April). The maximum allowable value for the summer months is included in the table below.

Table 8. Point Sources, Maximum Permitted Loads

Facility	Flow (MGD)	$CBOD_5$ (mg/l)	NH_3-N (mg/L)	$CBOD_u$:$CBOD_5$ Ratio	CBODu (lbs/day)	NH_3-N (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Magnolia POTW, North	0.387	40	2	1.5	193.7	6.5	29.5	223.2
Magnolia POTW, South	0.381	45	2	1.5	214.5	6.4	29.0	243.5
McComb POTW, West	0.95	18	5	1.5	213.9	39.6	181.0	395.0
McComb POTW, East	2.7	10	2	1.5	337.8	45.0	205.8	543.6
Fernwood Water and Sewer Association	0.04	45	2	1.5	22.5	0.7	3.0	25.6
Fernwood Truck Stop	0.015	30	2	2.3	8.6	0.3	1.1	9.8
Pike County Industrial Park	0.045	30	9	1.5	16.9	3.4	15.4	32.3
Haygood Trailer Park	0.015	30	2	1.5	6.8	0.3	1.4	8.2
					1,014.7	**102.1**	**466.4**	**1,481.0**

Table 9. Point Sources, Loads Based on Averages of DMR Data

Facility	Flow (MGD)	$CBOD_5$ (mg/l)	NH_3-N (mg/L)	$CBOD_u$:$CBOD_5$ Ratio	CBODu (lbs/day)	NH_3-N (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Magnolia POTW, North	0.214	21.0	2.35	1.5	56.2	4.2	19.1	75.3
Magnolia POTW, South	0.180	17.3	2.00	1.5	39.0	3.0	13.7	52.8
McComb POTW, West	0.705	14.0	5.00	1.5	123.0	29.4	134.3	257.3
McComb POTW, East	1.812	10.2	2.00	1.5	230.2	30.2	138.1	368.3
Fernwood Water and Sewer Association	0.014	19.9	2.00	1.5	3.5	0.2	1.1	4.5
Fernwood Truck Stop	0.005	11.2	2.00	2.3	1.1	0.1	0.4	1.5
Pike County Industrial Park	0.025	23.5	0.87	1.5	7.4	0.2	0.8	8.3
Haygood Trailer Park	0.0	No discharge	No discharge	1.5	0.0	0.0	0.0	0.0
					460.4	**67.3**	**307.6**	**768.0**

Direct measurements of nonpoint source loads of CBODu and NH_3-N were not available for the Little Tangipahoa River Watershed. The background contributions of CBODu and ammonia 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.

The background flows in the Little Tangipahoa River, Town Creek, and Minnehaha Creek were estimated based on USGS data for the 7Q10 flow condition. The 7Q10 flow of the Little Tangipahoa River at Magnolia is 7.4 cfs. The 7Q10 flow of Minnehaha Creek at Magnolia is 2.3 cfs (Telis, 1991). The 7Q10 flow of the Little Tangipahoa River was used to estimate the amount of background flow for the entire Little Tangipahoa River watershed using a drainage area ratio. The drainage area of the Little Tangipahoa River at Magnolia is 39.8 square miles. A drainage area ratio can be calculated from this information by dividing the 7Q10 flow by the drainage area (7.4 cfs/39.8 square miles = 0.186 cfs/square mile. It is assumed that this drainage area ratio can be applied to the entire watershed to estimate background flows at 7Q10 condition. The total drainage area of the Little Tangipahoa River watershed is 42.5 square miles. Thus a total flow of (0.186 cfs/square miles * 42.5 square miles) 7.9 cfs is expected. The estimated flows were multiplied by the background concentrations of CBODu and NH_3-N to calculate the nonpoint source loads going into the Little Tangipahoa River, Town Creek, and Minnehaha Creek, Table 10.

Table 10. Nonpoint Source Loads Input into the Model

Water Body	Flow (cfs)	$CBOD_u$ (mg/L)	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
Town Creek	1.1	2.0	11.9	0.1	2.7	14.6
Minnehaha Creek	2.3	2.0	24.8	0.1	5.7	30.5
Little Tangipahoa River	4.5	2.0	48.5	0.1	11.1	59.6
Total	**7.9**		**85.2**		**19.5**	**104.6**

4.4 Model Calibration

The model used to develop the TMDL was not calibrated due to lack of instream monitoring data collected during critical conditions. However, comparison of the available data shows that the predicted daily average dissolved oxygen and ammonia nitrogen levels are in the same range as recently collected data.

4.5 Model Results

Once the model setup was complete, the model was used to predict water quality conditions in the Little Tangipahoa River. The model was first run under baseline conditions. Under baseline conditions, the loads from NPDES permitted point sources were set at their existing loads as determined from the discharge monitoring reports, Table 9. Thus, baseline model runs reflect the current condition of the Little Tangipahoa River without any reduction of loads. The baseline condition model was run again with the permits set at the maximum loads allowed in the NPDES permits. The model was then run using a trial-and-error process to determine the maximum TBODu loads from the point source facilities which would not violate water quality standards for DO. The modeled loads from the NPDES permits were reduced during this process. These model runs are called maximum load scenarios.

4.5.1 Baseline Model Runs

The baseline model results for the Little Tangipahoa River and Town Creek are shown in Figures 9 and 10. The figures show the modeled daily average DO with the NPDES permits at their current loads based on DMR data. The red line represents the TMDL endpoint of 5.0 mg/l DO. Figure 9 shows the daily average instream DO concentrations, beginning with river mile 15.7 and ending with river mile 0.0 in the Little Tangipahoa River. The DO sag, or maximum DO deficit, occurs below the confluence of Town Creek, at river mile 8.2. As shown, the model does predict that the DO goes below the standard of 5.0 mg/l. As shown in Figure 10, the modeled DO is greater than the water quality standard in Town Creek.

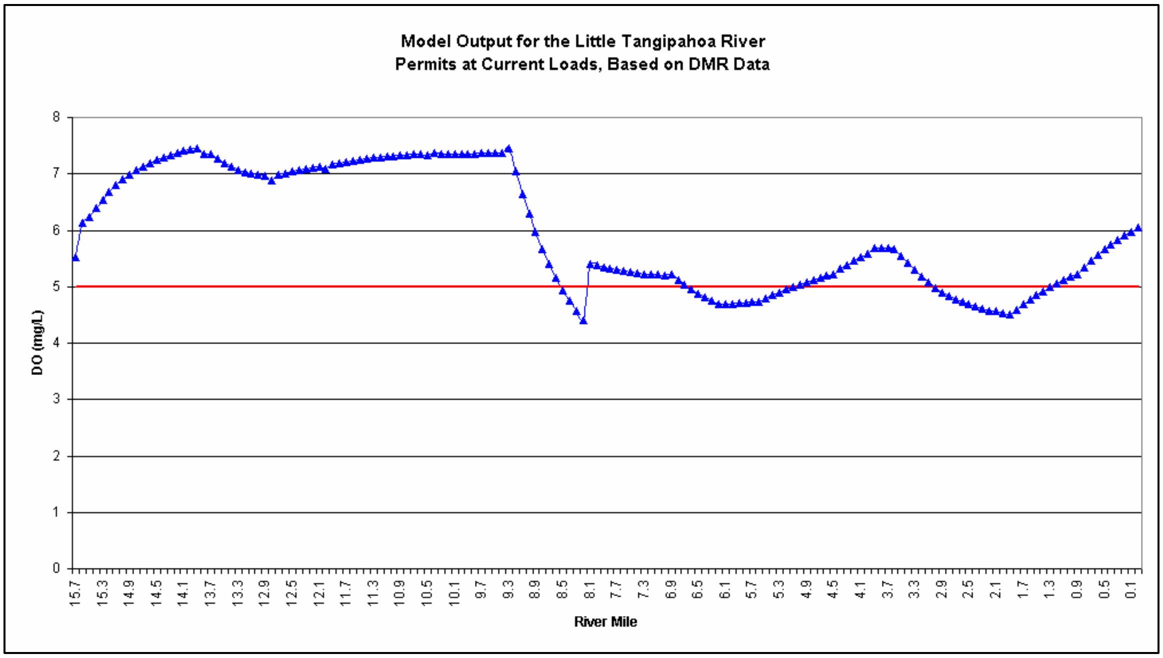


Figure 9. Baseline Model Output for the Little Tangipahoa River

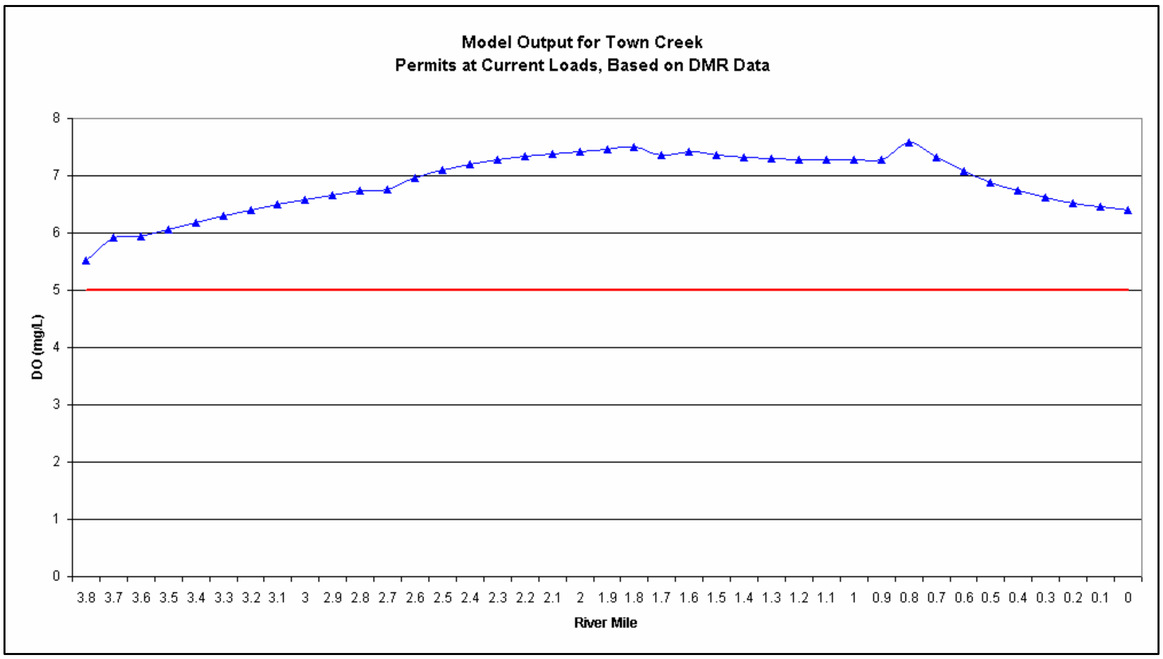


Figure 10. Baseline Model Output for Town Creek

A second model run was completed in order to predict the dissolved oxygen in the Little Tangipahoa River if the NPDES permits were discharging at their maximum permit limits. The results of this model run are shown in Figures 11. As shown, the modeled DO in the Little Tangipahoa River falls to 3.6 mg/l as a result of the increased point sources loads.

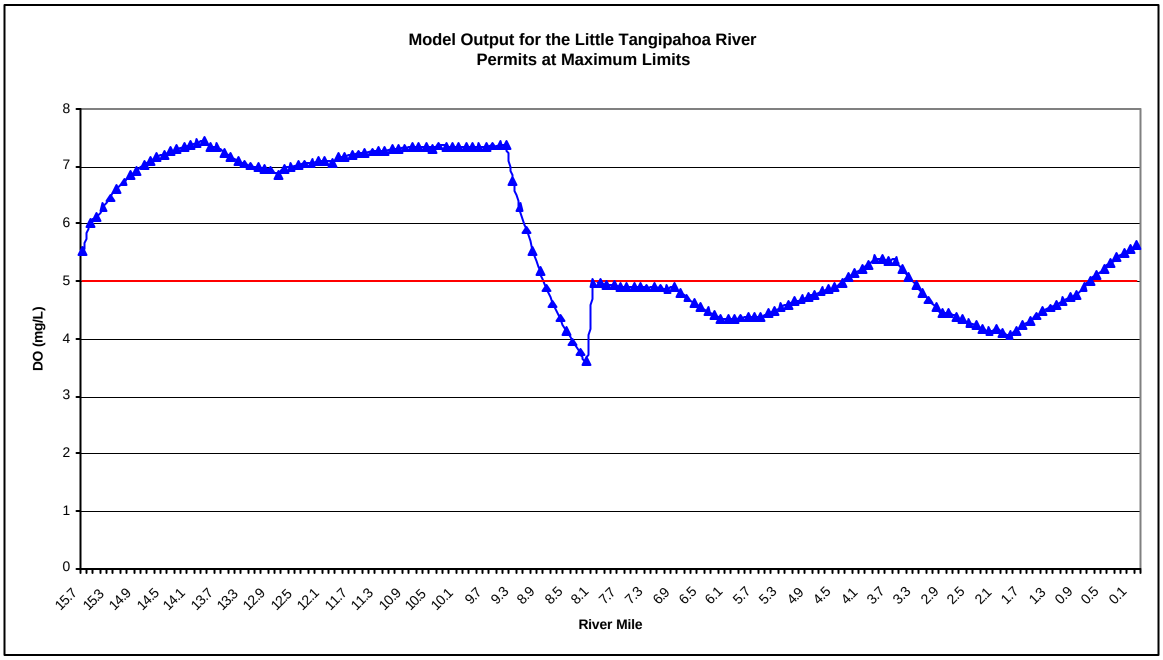


Figure 11. Model Output for the Little Tangipahoa River at Permitted Loads

4.5.2 Maximum Load Scenario

The graphs of baseline model output show that the predicted DO falls below the daily average DO standard in the Little Tangipahoa River during the simulated critical conditions. As a result, reductions from the baseline loads of TBODu are necessary in order to maintain a daily average DO of at least 5.0 mg/L.

The maximum load scenario involved running the model using a trial-and-error process. The maximum load that allowed the maintenance of water quality standards was selected and used to develop the waste load allocations proposed in this TMDL. The selected load reduction scenario involves proposed modifications to the wastewater treatment plants that serve the city of McComb. Specifically, the scenario involves the relocation of the discharge from the McComb West facility from the Little Tangipahoa River to Town Creek at the same location as the McComb East facility. Both facilities would be required to meet permit limits of 10 mg/l BOD_5, 2 mg/l ammonia nitrogen, and 6 mg/l DO at their combined discharge point. The Magnolia North POTW is also required to reduce the BOD_5 in its discharge to 30 mg/l for this load reduction scenario. Dissolved oxygen requirements will be added to the permits for Fernwood Water and Sewer Association and Fernwood Truck Stop, with the requirement that the DO is at least 6.0 mg/l in their effluents. Finally, the ammonia nitrogen permit limit will be reduced from 9.0 mg/l in the current permit to 2 mg/l for Pike County Industrial Park. All other NPDES permitted facilities will be required to remain in compliance with their current permit limits.

Figure 12 shows the modeled instream DO concentrations in the Little Tangipahoa River after application of the selected maximum load scenario at critical conditions. Figure 13 shows the modeled DO in Town Creek. The lowest DO concentrations in the Little Tangipahoa River, of approximately 5.0 mg/l, occur near river mile 5.6, just downstream from the town of Fernwood and at river mile 1.8, downstream of the city of Magnolia. As shown in Figure 13, the DO in Town Creek stays above 5.0 mg/l downstream of the McComb outfall.

The TBODu loads included in the maximum load scenario are given in Table 11. The overall percent reductions in Table 12 are based on a reduction from the maximum permitted loads and the current discharge monitoring data. The selected load reduction scenario was used to develop the waste load allocation proposed in this TMDL. However, it is important to note that the load reduction scenario is only one example of how the necessary reductions could be split among the permitted dischargers. Other reduction scenarios could be developed to suit the specific needs of individual dischargers, as long as the model shows that the scenario allows attainment of water quality standards in the receiving water bodies.

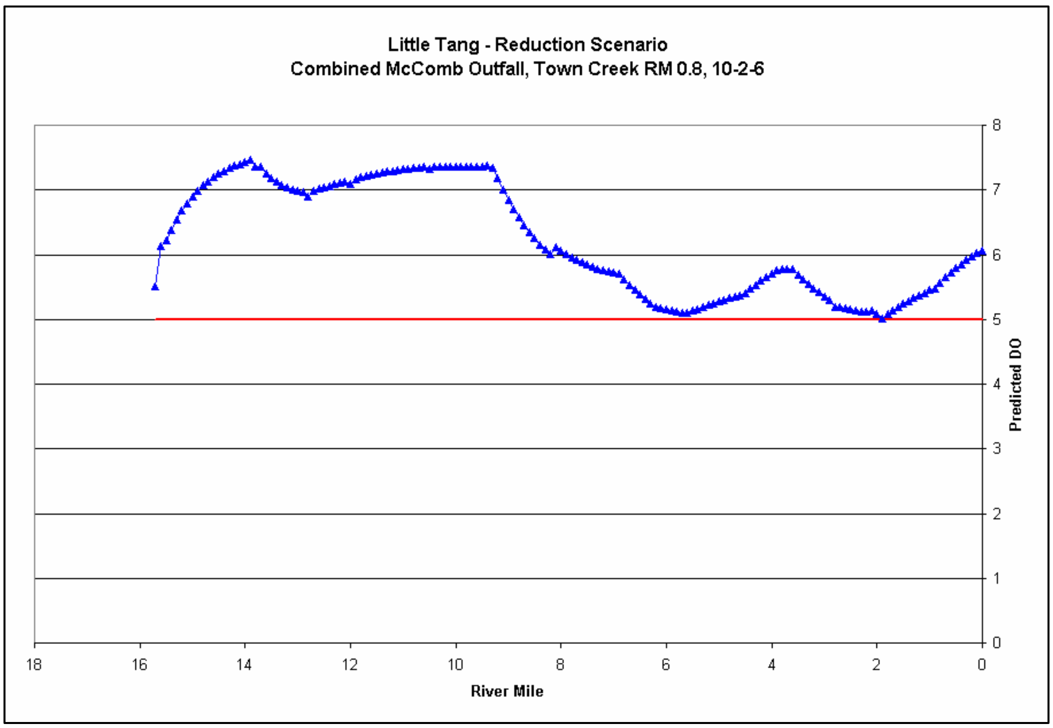


Figure 12. Model Output for the Little Tangipahoa River After Application of Maximum Load Scenario

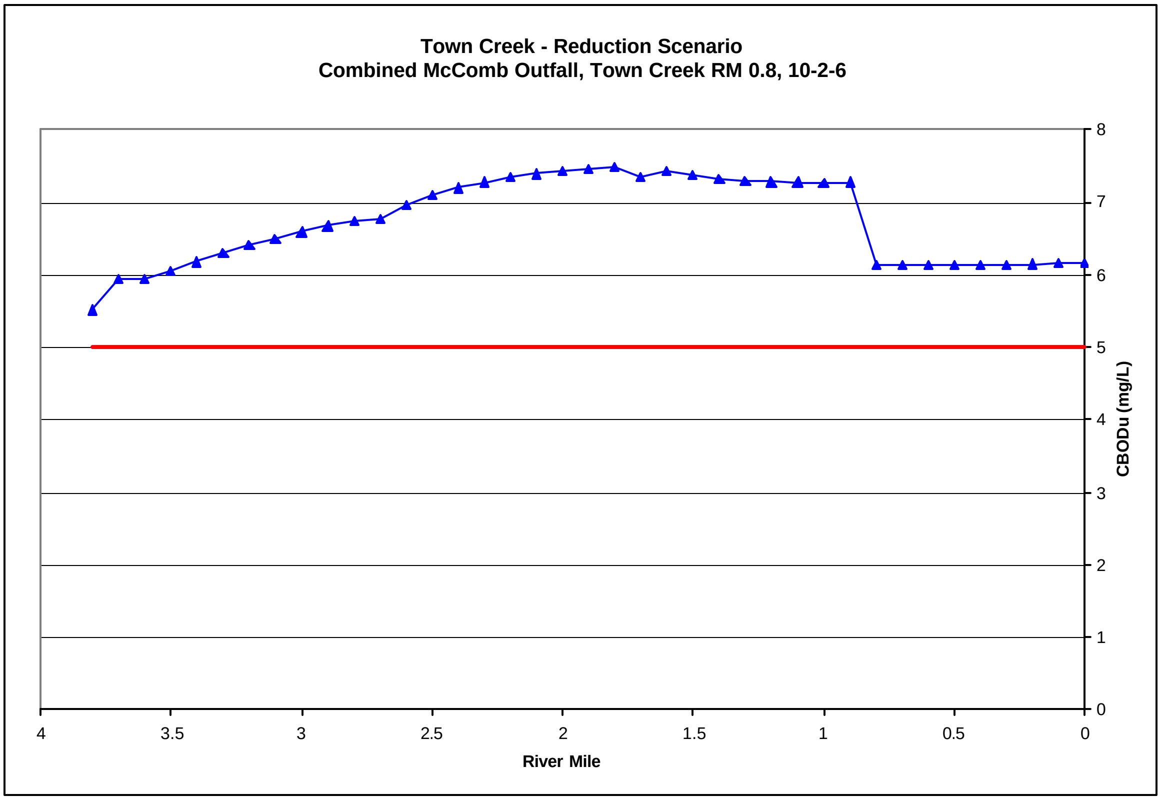


Figure 13. Model Output for Town Creek After Application of Maximum Load Scenario

Table 11. Maximum Load Scenario, Critical Conditions

Facility	Flow (MGD)	$CBOD_5$ (mg/l)	NH_3-N (mg/L)	$CBOD_u$:$CBOD_5$ Ratio	CBODu (lbs/day)	NH_3-N (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Magnolia POTW, North	0.387	30	2	1.5	145.2	6.5	29.5	174.7
Magnolia POTW, South	0.381	45	2	1.5	214.5	6.4	29.0	243.5
McComb POTW, West	0.95	10	2	1.5	118.8	15.8	72.4	191.3
McComb POTW, East	2.7	10	2	1.5	337.8	45.0	205.8	543.6
Fernwood Water and Sewer Association	0.04	45	2	1.5	22.5	0.7	3.0	25.6
Fernwood Truck Stop	0.015	30	2	2.3	8.6	0.3	1.1	9.8
Pike County Industrial Park	0.045	30	2	1.5	16.9	0.8	3.4	20.3
Haygood Trailer Park	0.018	30	2	1.5	6.8	0.3	1.4	8.1
Total					**871.1**	**75.7**	**345.8**	**1,216.9**

Table 12. Maximum Load Scenario, Percent Reductions

Facility	Percent Reduction from Current Permit Limits	Percent Reduction from Discharge Monitoring Data
Magnolia POTW, North	22%	0%
Magnolia POTW, South	0%	0%
McComb POTW, West	52%	26%
McComb POTW, East	0%	0%
Fernwood Water and Sewer Association	0%	0%
Fernwood Truck Stop	0%	0%
Pike County Industrial Park	37%	0%
Haygood Trailer Park	0%	0%
Total	18%	0%

4.6 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, Figures 14 and 15, this standard was not exceeded in the Little Tangipahoa River and Town Creek under the current NH_3-N loads. However, the instream ammonia nitrogen concentration was elevated below the city of McComb in Town Creek, where the instream levels approached the water quality standard. As previously mentioned, all of the model output is based on an assumed value for ammonia nitrogen in the effluent from point sources. If these assumed values were exceeded by a significant level, it would be possible for instream toxicity to occur due to ammonia nitrogen. For this reason, it is strongly recommended that ammonia nitrogen permit limits and monitoring requirements be added to the city of McComb East and West POTWs.

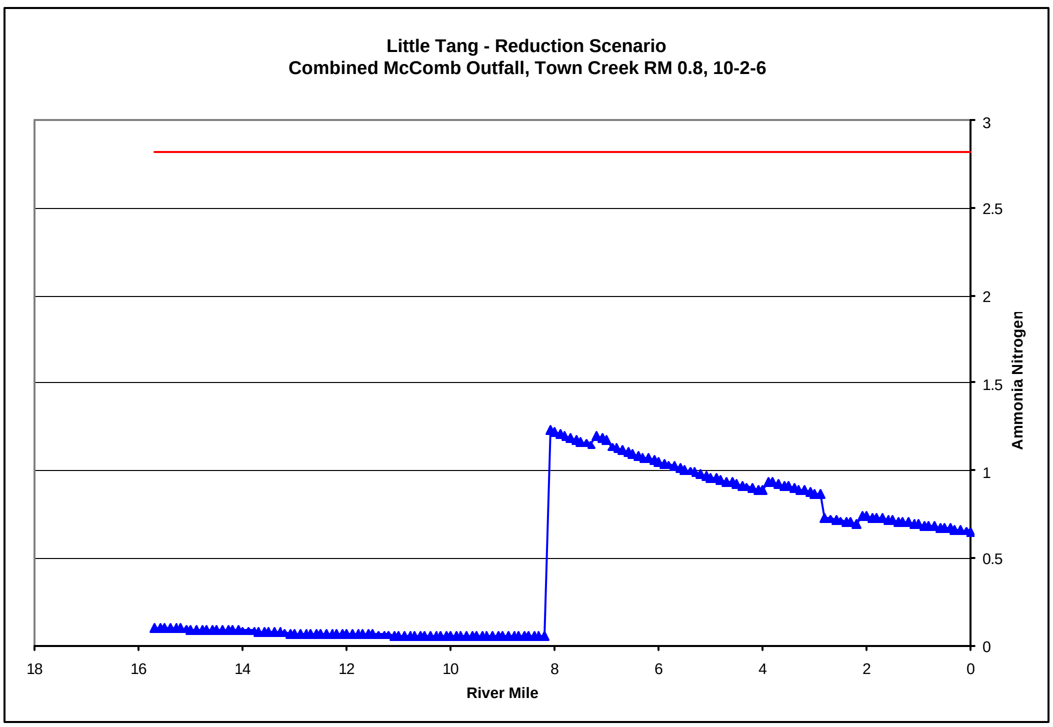


Figure 14. Model Output for Ammonia Nitrogen in Little Tangipahoa River

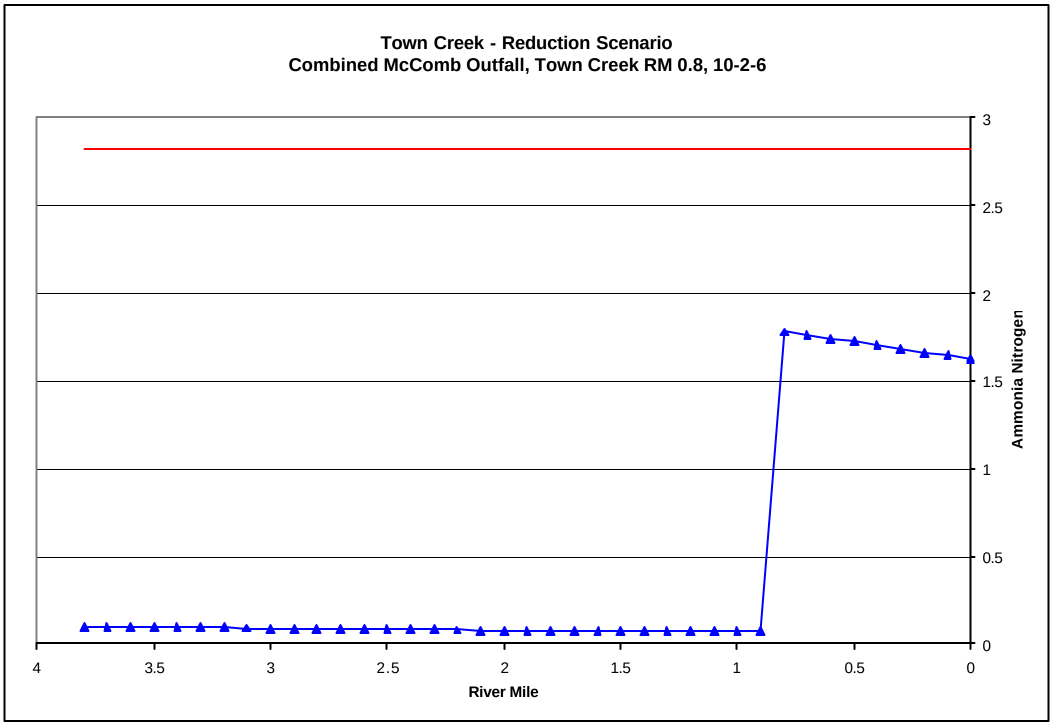


Figure 15. Model Output for Ammonia Nitrogen in Town Creek

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 the Little Tangipahoa River and Town Creek.

5.1 Wasteload Allocation

Federal regulations require that effluent limits developed to protect water quality criteria are consistent with the assumptions and requirements of any available wasteload allocation for the discharge prepared by the state and approved by EPA. Due to economic and environmental considerations in the watershed, MDEQ will stage the implementation of this TMDL. This TMDL recommends a 5-year compliance schedule be included in the NPDES permit of each NPDES Permitted facility in the watershed. The compliance schedule should require each facility to meet permit limits during the first four years of the permit. Prior to the end of the fifth year of the permit, the compliance schedule will require each facility to meet limits as determined by the state necessary to meet whatever applicable water quality standards that are in place at that time.

5.1.1 Wasteload Allocation for the TMDL

The NPDES Permitted facilities that discharge BOD_5 and ammonia nitrogen in the Little Tangipahoa River watershed are included in the wasteload allocation, Table 13. An overall reduction of 18% of the permitted TBODu load is needed in order for the model to show compliance with the TMDL endpoint.

5.1.2 Wasteload Allocation Implementation Plan

The loads given in Table 13 are equal to the wasteload allocation for the critical condition. Implementation of this wasteload allocation, through modification of NPDES permits, will be done as a multi-staged process. This is largely due to the uncertainties involved with the development of the model. At the present time, MDEQ recommends that the existing facilities take steps to ensure that they remain in compliance with their permit limits. In addition, no new facilities will be issued permits to discharge effluent that would increase the TBODu load going into the Little Tangipahoa River, Town Creek, or tributaries of these water bodies. More monitoring and model development is needed to improve the accuracy of the WLA calculations. The second phase of the implementation will require compliance with the approved WLA.

Table 13. Wasteload Allocation

Facility	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Magnolia POTW, North	145.2	29.5	174.7
Magnolia POTW, South	214.5	29.0	243.5
McComb POTW, West	118.8	72.4	191.3
McComb POTW, East	337.8	205.8	543.6
Fernwood Water and Sewer Association	22.5	3.0	25.6
Fernwood Truck Stop	8.6	1.1	9.8
Pike County Industrial Park	16.9	3.4	20.3
Haygood Trailer Park	6.8	1.4	8.1
	871.1	**345.8**	**1,216.9**

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 $CBOD_u$ concentration of 2.0 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 load allocations were calculated for each water body, Table 14. Because these are estimated loads, which are small in comparison to point source loads, reductions are not included in this TMDL.

Table 14. Load Allocation

Water Body	Flow (cfs)	$CBOD_u$ (mg/L)	CBODu (lbs/day)	NH_3-N (mg/L)	NBODu (lbs/day)	TBODu (lbs/day)
Town Creek	1.1	2.0	11.9	0.1	2.7	14.6
Minnehaha Creek	2.3	2.0	24.8	0.1	5.7	30.5
Little Tangipahoa River	4.5	2.0	48.5	0.1	11.1	59.6
Total	**7.9**		**85.2**		**19.5**	**104.7**

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 represented by the low-flow, high-temperature condition. Modeling the water body at this flow provides protection during the worst-case scenario.

5.4 Seasonality

Seasonal variation may be addressed in the TMDL by using seasonal water quality standards or developing model scenarios 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. This 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.

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

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 phase 1 TMDL for TBODu was calculated based on the maximum allowable loading of pollutant in the Little Tangipahoa River, according to the model. The TMDL calculations are shown in Table 15. 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 background and nonpoint sources of TBODu and NH_3-N 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 15. Phase 1 TMDL for TBODu in the Little Tangipahoa River Watershed

	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
CBODu	871.1	85.2	Implicit	**956.3**
NBODu	345.8	19.5	Implicit	**365.3**
TBODu	**1,216.9**	**104.7**	**Implicit**	**1,321.6**

The TMDL presented in this report represents the maximum daily load of a pollutant allowed in a water body. Although it has been developed for critical conditions in the water body, the allowable load is not tied to any particular combination of point and nonpoint source loads. The LA given in the TMDL applies to all nonpoint sources, and does not assign loads to specific sources. Also, the WLA does not dictate a specific distribution of the loads among individual point sources.

This report includes one allocation scenario that could be used to divide the total allowable load among the point and nonpoint sources in the Little Tangipahoa River. This scenario, however, represents only one of many possible options for dividing the allowable load among all sources. Other scenarios could be considered as long as the total load contributed by the various sources does not exceed the TMDL. MDEQ may implement an allocation scenario that is different than the scenario presented in this TMDL as long as this condition is met. Pollutant trading among the permitted point sources could be used to develop alternate WLA scenarios, as long as the alternate WLA does not exceed the allowable load. Trading between the loads included in the LA (nonpoint sources) and WLA (point sources) is also acceptable. However, a reduction in the LA may be used to increase the allowable WLA only if BMPs or other nonpoint source pollution controls make reductions in the LA practicable. In this situation reasonable assurance that the nonpoint source reductions will occur before the increased WLA is allowed will be required.

CONCLUSION

This Phase 1 TMDL is based on a desktop model using MDEQ's regulatory assumptions and literature values in place of actual field data. The model results and limited water quality monitoring data indicate impairment in the stream at the present loading of TBODu. This TMDL recommends that no additional NPDES permit be issued for the Little Tangipahoa River or its tributaries, unless it can be shown that the facilities do not further degrade water quality. 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.

According to the model, an 18% overall reduction from the current point source loads and relocation of the discharge point of the McComb West POTW would be needed to eliminate the standards violation in the stream during critical conditions. The current model used for these calculations does not have adequate data to support all of the assumptions used, however, it is clear that the stream occasionally does not meet water quality standards. The TMDL therefore recommends the following:

1. No increases in TBODu load allowed for the Little Tangipahoa River Watershed;
2. MDEQ will continue to monitor the biology and water quality condition at the M-BISQ Site 460 on the Little Tangipahoa River
3. EPA and MDEQ schedule intensive monitoring to refine the model;
4. The facilities or EPA may request a Use Attainability Analysis (UAA) based on the modeling results; and
5. NPDES Permits will be modified with a schedule of compliance.

6.1 Future Monitoring

Additional monitoring needed for model refinement needs to be prioritized by the local stakeholders, MDEQ, and EPA. 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 Southern Independent Basin, the Little Tangipahoa River Watershed may receive additional monitoring to identify any change in water quality.

Additional monitoring may also be conducted in the Little Tangipahoa River in order to provide a data set for calibration of the water quality model used to develop the 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 accuracy of model results. 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 the phase 1 model were not accurate, the model and the TMDL will be updated.

6.2 Public Participation

MDEQ will hold meetings with the cities of McComb and Magnolia to present and discuss the results of this TMDL report. 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

MDEQ. 2003. Development and Application of the Mississippi Benthic Index of Stream Quality (M-BISQ). June 30, 2003. Prepared by Tetra Tech, Inc., Owings Mills, MD, for the Mississippi Department of Environmental Quality, Office of Pollution Control, Jackson, MS. (*For further information on this document, contact Randy Reed [601-961-5158*).

MDEQ. 2002. *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Office of Pollution Control.

MDEQ. 1998. *Mississippi List of Water bodies, Pursuant to Section 303(d) of the Clean Water Act*. Office of Pollution Control.

MDEQ. 1998. *Mississippi 1998 Water Quality Assessment, Pursuant to Section 305(b) of the Clean Water Act*. Office of Pollution Control.

MDEQ. 1994. *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.* Office of Pollution Control.

Metcalf and Eddy, Inc. 1991. *Wastewater Engineering: Treatment, Disposal, and Reuse 3rd ed.* New York: McGraw-Hill.

Telis, Pamela A. 1992. *Techniques for Estimating 7-Day, 10-Year Low Flow Characteristics for Ungaged Sites on Streams in Mississippi*. U.S. Geological Survey, Water Resources Investigations Report 91-4130.

U.S. Environmental Protection Agency. 2000. Stressor identification guidance document. EPA/822/B-00/025. Office of Water, Washington, DC.

USEPA. 1997. *Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2: Streams and Rivers, Part 1: Biochemical Oxygen Demand/Dissolved Oxygen and Nutrients/ Eutrophication*. United States Environmental Protection Agency, Office of Water, Washington, D.C. EPA 823-B-97-002.

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, macroinvertebrates, 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 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; silviculture; 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

POTW ....Public Owned Treatment Works

RBA ....Rapid Biological Assessment

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