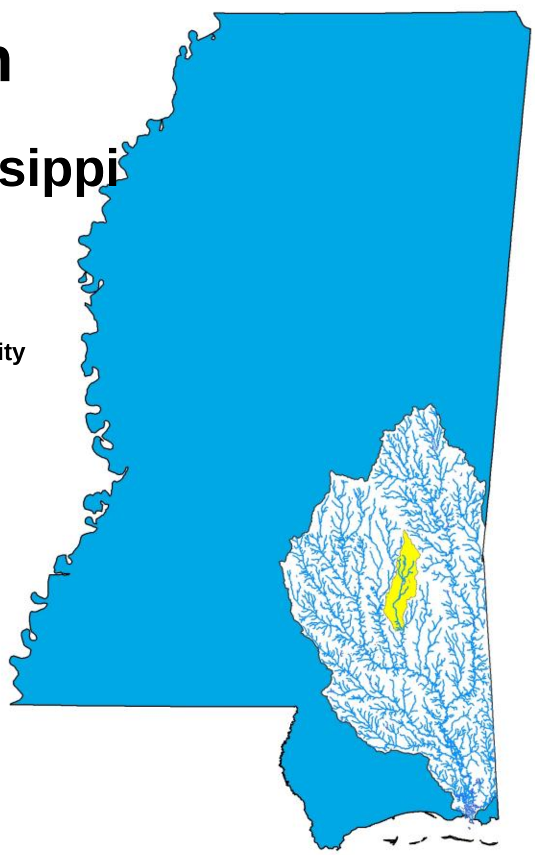
PROPOSEDFINALDR
AFT REPORT
JuneMay 2005

Phase 1
Total Maximum Daily Load
Biological Impairment Due to Organic Enrichment/Low Dissolved Oxygen and Nutrients

The Bogue Homo River
Pascagoula Basin

Jones County, Mississippi



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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.

Conversion Factors

To convert from	To	Multiply by	To convert from	To	Multiply by
$mile^2$	acre	640	acre	ft^2	43560
km^2	acre	247.1	days	seconds	86400
m^3	ft^3	35.3	meters	feet	3.28
ft^3	gallons	7.48	ft^3	gallons	7.48
ft^3	liters	28.3	hectares	acres	2.47
cfs	gal/min	448.8	miles	meters	1609.3
cfs	MGD	0.646	tonnes	tons	1.1
m^3	gallons	264.2	µg/l * cfs	gm/day	2.45
m^3	liters	1000	µg/l * MGD	gm/day	3.79

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	:	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

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TMDL INFORMATION PAGE

i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Bogue Homo River	MS091E	Jones	03170006	Biological Impairment	M
Near Ovett: From mouth of Lake Bogue Homo to confluence with Tiger Creek.					

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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
Nutrients	Aquatic Life Support	Waters shall be free from materials attributable to municipal, industrial, agricultural, or other dischargers producing color, odor, taste, total suspended solids, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated uses.

iii. NPDES Facilities

NPDES ID	Facility Name	Permitted Discharge (MGD)	Receiving Water
MS0038105	Lees Packing	0.0006	Bogue Homo
MS0035629	Dixie Hills	0.04	Channel Branch
MS0031267	Jones County Schools, Glade Elementary	0.015	Unnamed Thence Bogue Homo
MS0032042	Dixie Electric Power Association	0.015	Dry Swamp Creek
MS0049514	United Parcel	0.001	Dry Swamp Creek
MS0031283	Jones County School, Northeast Jones High School	0.048	Blacksnake Creek
MS0055115	Howse Implement Corporation	0.002	Dry Swamp Creek

iv. Phase 1 Total Maximum Daily Load for TBODu

WLA (lbs/day)	Baseline LA (lbs/day)	MOS	TMDL (lbs/day)
55.99	**94.43**	**191.95**	**342.37**

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v. Total Estimated Maximum Daily Load for TP*

WLA lbs/day	LA lbs/day	MOS lbs/day	TMDL lbs/day
5.3*	**151.7 to 241.4***	**Implicit**	**157.0 to 246.7***

* Due to the lack of nutrient water quality criteria these Phase 1 TMDL allocations are estimates based on literature assumptions and projected targets. The State of Mississippi is in the process of developing numeric nutrient criteria in accordance with an EPA approved work plan for nutrient criteria development. This TMDL recommends quarterly monitoring of nutrients for NPDES facilities. MDEQ's calculations of the annual average load indicate that the majority of the estimated nutrient load is from non-point sources. Therefore, the State will focus on striving to attain the goal set by the LA portion of the TMDL.

EXECUTIVE SUMMARY

This TMDL has been developed for a segment of the Bogue Homo River placed on the Mississippi 2002 Section 303(d) List of Water Bodies due to Biological Impairment. A Stressor Identification Report which indicates the predominant stressors to the water body has been developed. Based on the available information, it was determined that the biological impairment is most likely due to nutrients, organic enrichment/low dissolved oxygen, and sediment. Sediment will be addressed in a separate TMDL report. The applicable state standard specifies that the dissolved oxygen 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. Ammonia nitrogen levels will also be evaluated in this TMDL using criteria established for ammonia nitrogen toxicity.

Additionally, this TMDL will provide an estimate of the total phosphorous (TP) in the stream and a preliminary breakdown of the TP load between point and non-point sources. Currently, Mississippi does not have numeric water quality standards for allowable nutrient concentrations. MDEQ currently has a Nutrient Task Force (NTF) working on the development of numeric criteria for nutrients.

For TMDL development, TP was used as the nutrient of concern because phosphorus is typically the limiting nutrient in most rivers and streams (Thomann and Mueller, 1987). A preliminary analysis of the total phosphorus data measured for non-impaired wadeable streams in the East Bioregion was completed to find a range of appropriate TP loading. The range selected in the East Bioregion is 0.07 to 0.11 mg/L of total phosphorus. ~~reveals that an annual concentration range of 0.07 to 0.11 mg/l is an applicable target for total phosphorus for water bodies which are located in the East Bioregion.~~ MDEQ is presenting this range as a preliminary ~~target~~ value for TMDL development which is subject to revision after the development of nutrient criteria, when the work of the NTF is complete. This TMDL has been developed as a Phase 1 TMDL so nutrients may be further evaluated when more data are available and nutrient criteria are developed.

The Bogue Homo River Watershed is located in southeastern Mississippi in HUC 03170005. The headwaters of the Bogue Homo River begin north of Heildelberg, MS in Jasper County. The §303(d) listed segment of the Bogue Homo River begins near Cleo, MS below Lake Bogue Homo and ends at the confluence with Tiger Creek near Ovett, MS. The segment flows for approximately 51 miles. Photo 1 shows the Bogue Homo River near Ovett. The location of the watershed is shown in Figure 1.

Photo 1. The Bogue Homo River near Ovett

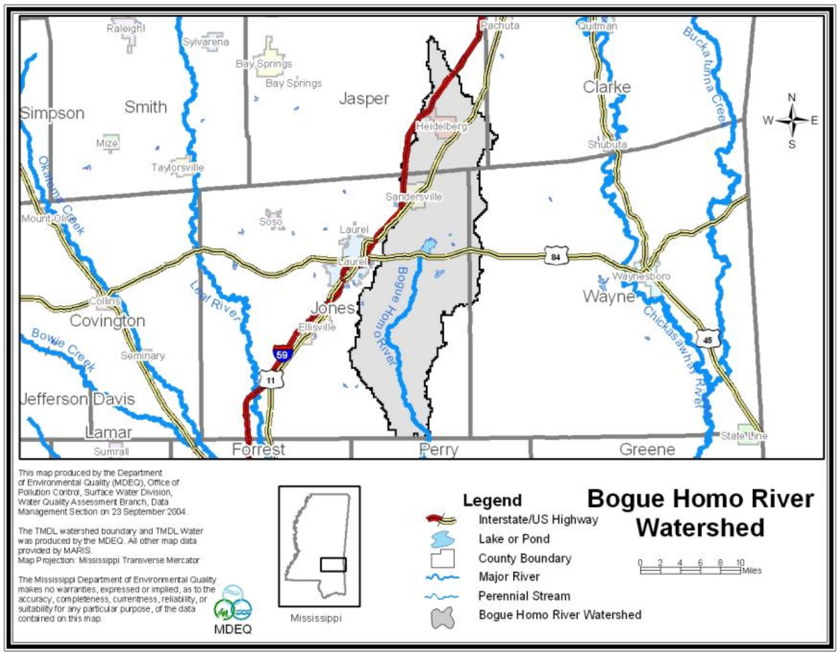


Figure 1. The Bogue Homo River Watershed

The predictive model used to calculate the dissolved oxygen 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. The critical modeling period was determined to occur during the hot, dry summer period. A mass-balance approach was used to ensure that the instream concentration of ammonia nitrogen (NH_3-N) does not exceed the water quality criteria. MDEQ also used the mass balance approach to estimate total phosphorous contributions from point and non-point sources.

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 non-point and point sources of TBODu in the Bogue Homo River Watershed. TBODu loading from background and non-point sources in the watershed was accounted for by using an estimated concentration of TBODu and flows based on 7Q10 conditions. There are 7 NPDES Permitted dischargers located in the watershed that are included as point sources in the model.

According to the model, the current load in the water body does not exceed the assimilative capacity of the Bogue Homo River for organic material and ammonia nitrogen. ~~Additionally, mass balance calculations showed that the phosphorus levels are predominantly from non-point sources.~~ This WLA, however, will not limit expansion of existing facilities or construction of new facilities in the Bogue Homo watershed because modeling shows there is additional assimilative capacity in the water body. Future NPDES permits in this section of the Leaf River will be analyzed on a case-by-case basis. Therefore, no reductions in the current loading of organic material are needed for this TMDL report in order to meet water quality limits.

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 2002 §303(d) listed segment shown in Figure 2.

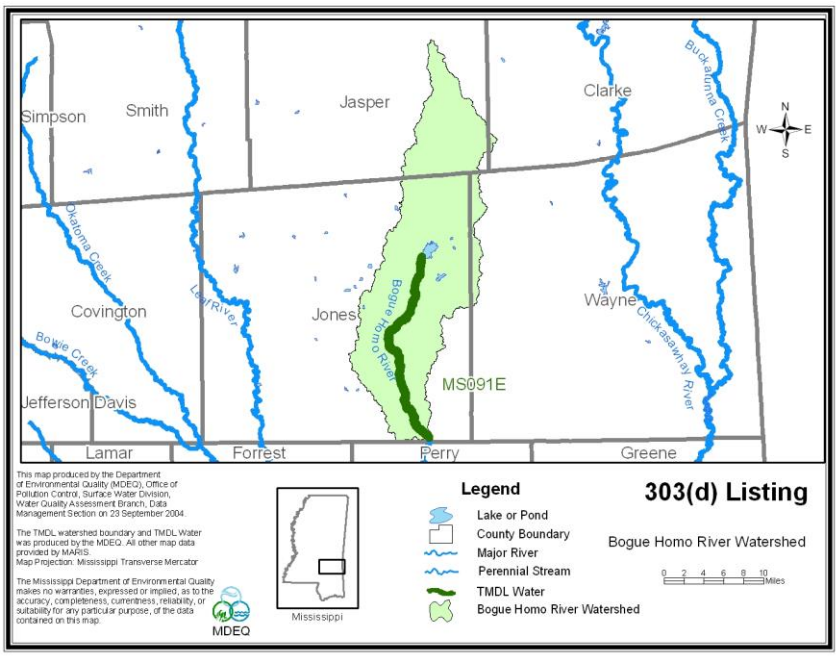


Figure 2. The Bogue Homo River §303(d) Listed Segment

1.2 Stressor Identification

The impaired segment of the Bogue Homo River was listed due to failure to meet minimum water quality criteria for biological use support based on biological sampling conducted in 2001 (MDEQ, 2003). Because of the 2001 sampling results, 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 report indicated that nutrients, organic enrichment/low dissolved oxygen, and sediment were the most likely stressors (MDEQ, 2004). Sediment will be addressed in a separate TMDL report.

There are no state criteria in Mississippi for nutrients. These criteria are currently being developed by the Mississippi Nutrient Task Force in agreement with EPA Region 4. MDEQ proposed a work plan for nutrient criteria development that has been approved by EPA and is on schedule according to the approved plan in development of nutrient criteria (MDEQ, 2004). Data have been collected for wadeable streams to be used to calculate the criteria. For this TMDL, MDEQ chose total phosphorus as the limiting nutrient. The management of phosphorus will also control other nutrients. Preliminary analysis of the data reveals that an annual concentration range of 0.07 to 0.11 mg/l is an applicable target for total phosphorus for water bodies located in the East Bioregion. However, MDEQ is presenting this range as a preliminary target value for TMDL development which is subject to revision after the development of nutrient criteria, when the work of the NTF is complete.

1.3 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in the document *Water Quality Criteria for Intrastate, Interstate and Coastal Waters*. The designated beneficial use for the listed segment of the Bogue Homo River is fish and wildlife 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. Thise daily average water quality standard will be used as a targeted endpoint to evaluate impairments and establish this TBODu 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.

Mississippi's NTF is currently developing numeric criteria for nutrients. The current standards only contain a narrative criteria that can be applied to nutrients which states that "Waters shall be free from materials attributable to municipal, industrial, agricultural, or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use (MDEQ, 2002)."

In the 1999 Protocol for Developing Nutrient TMDLs, EPA suggests several methods for the development of numeric criteria for nutrients (USEPA, 1999). In accordance with the 1999 Protocol, "The target value for the chosen indicator can be based on: comparison to similar but unimpaired waters; user surveys; empirical data summarized in classification systems; literature values; or best professional judgment." MDEQ believes the most economical and scientifically defensible method for use in Mississippi is a comparison between similar but unimpaired waters within the same region. This method is dependent on adequate data which are being collected in accordance with the EPA approved plan. The initial phase of the data collection process for wadeable streams has been completed. Preliminary analysis of the available data reveals that an annual concentration range of 0.07 to 0.11 mg/l is an applicable TMDL target for total phosphorus for water bodies located in the East Bioregion. However, MDEQ is presenting this as a preliminary target value for TMDL development which will be subject to revision after the development of nutrient criteria, when the work of the NTF is complete.

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 Bogue Homo River was determined based on *Techniques for Estimating 7-Day, 10-Year Low-Flow Characteristics on Streams in Mississippi* (Telis, 1992).

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 simplicity 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.

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

The TMDL for nutrients will be quantified in terms of an annual average concentration range for TP. TP was used as the nutrient of concern because phosphorus is typically the limiting nutrient in most rivers and streams (Thomann and Mueller, 1987). A preliminary analysis of the total phosphorus data measured for non-impaired wadeable streams in the East Bioregion was completed to transform the narrative criteria for nutrients into a preliminary numeric range for use in TMDL development. Streams were classified as non-impaired based on biological sampling which was conducted as part of Mississippi's Benthix Index of Stream Quality (MBISQ) project. A non-impaired wadeable stream is one which supports the designated aquatic life use which is defined by the State of Mississippi's *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* (MDEQ, 2002) and one which also satisfies all other conditions of the narrative criteria. The annual concentration range for this TMDL and all other wadeable streams which are located in the East Bioregion is 0.07 to 0.11 mg/L of total phosphorus. These values may be subject to revision as the nutrient criteria development process continues.

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 Bogue Homo River Watershed. The potential point and non-point pollutant sources were characterized by the best available information, monitoring data, and literature values.

2.1 Discussion of Instream Water Quality Data

There were very limited data available for the Bogue Homo River. The available data collected by MDEQ were at station 02474595. This station is located at Ovett. The data for dissolved oxygen, ammonia nitrogen, and total phosphorus are given in Table 1.

Table 1. Water Quality Data Collected at the Bogue Homo River near Ovett (02474595)

Sample Date	Time	Dissolved Oxygen (mg/l)	Ammonia Nitrogen (mg/l)	Total Phosphorus (mg/L)
9-Jul-97	10:37	5.5	0.14	0.07
10-Dec-97	12:10	9.7	0.21	0.01

2.2 Assessment of Point Sources

An important step in assessing pollutant sources in the Bogue Homo River watershed is locating the NPDES permitted sources. There are 7 facilities permitted to discharge organic material into this segment of the Bogue Homo River or its tributaries, Table 2. These facilities serve a variety of activities in the watershed, including municipalities, industries, and other businesses. The location of the facilities is shown in Figure 3.

Table 2. NPDES Permitted Facilities Treatment Types

Name	NPDES Permit	Treatment Type
Lees Packing	MS0038105	Conventional Lagoon
Dixie Hills Utility SD	MS0035629	Aerated Lagoon
Jones County Schools	MS0031267	Conventional Lagoon
Dixie Electric Power Association	MS0032042	Conventional Lagoon
United Parcel	MS0049514	Conventional Lagoon
Jones County School	MS0031283	Aerated Lagoon
Howse Implement Corporation	MS0055115	Conventional Lagoon

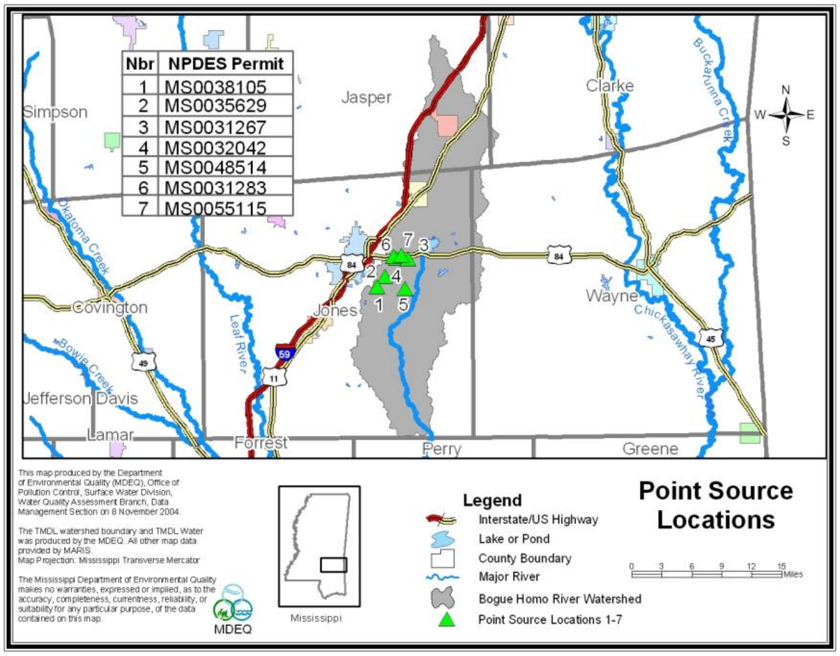


Figure 3. Bogue Homo River Point Sources

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 recent years are given in Table 3. Ammonia nitrogen permit limits and monitoring are not required for most of the facilities. All of the facilities are discharging well below their maximum permitted levels.

Table 3. 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)	Actual Average CBODu (lbs/day)
Lees Packing	MS0038105	0.0006	No discharge	45	No discharge	No discharge
Dixie Hills Utility SD	MS0035629	0.04	0.036	30	25.9*	11.67
Jones County Schools	MS0031267	0.015	0.005	30	25.5	1.60
Dixie Electric Power Association	MS0032042	0.015	0.004	30	10	1.88
United Parcel	MS0049514	0.001	0.00082	report	87.48	0.90
Jones County School	MS0031283	0.048	.021	30	14	3.68
Howse Implement Corporation	MS0055115	0.002	0.0004	30	40	0.20

* based on one measurement

2.3 Assessment of Non-Point Sources

Non-point 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. Phosphorus is typically seen as the limiting nutrient in most rivers and streams (Thomann and Mueller, 1987). Therefore, this TMDL will address total phosphorus. Phosphorus is primarily transported by runoff when it has been sorbed by eroding sediment. Phosphorous may not be immediately released from sediment and can sometimes reenter the water column from deposited sediment. Most non-point sources of phosphorous will build up and then wash off during rain events. Table 4 presents typical nutrient loading ranges for various land uses.

Table 4. Nutrient Loadings for Various Land Uses

Landuse	Total Phosphorus [lb/acre-y]			Total Nitrogen [lb/acre-y]		
	Minimum	Maximum	Median	Minimum	Maximum	Median
Roadway	0.53	1.34	0.98	1.2	3.1	2.1
Commercial	0.61	0.81	0.71	1.4	7.8	4.6
Single Family-Low Density	0.41	0.57	0.49	2.9	4.2	3.6
Single Family-High Density	0.48	0.68	0.58	3.6	5.0	5.2
Multifamily Residential	0.53	0.72	0.62	4.2	5.9	5.0
Forest	0.09	0.12	0.10	1.0	2.5	1.8
Grass	0.01	0.22	0.12	1.1	6.3	3.7
Pasture	0.01	0.22	0.12	1.1	6.3	3.7

Source: Horner et al., 1994 in Protocol for Developing Nutrient TMDLs (USEPA 1999)

Non-point pollution sources of concern are drainage from agricultural areas. The drainage area of this section of the Bogue Homo River is approximately 177,988 acres (278 square miles). The watershed contains many different landuse types, including urban, forest, cropland, pasture, water, and wetlands. The landuse information given below 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. Forest is the dominant landuse within this watershed. The landuse distribution is shown in Table 5 and Figure 4.

Table 5. Landuse Distribution, Bogue Homo River Watershed

	Urban	Forest	Cropland	Pasture	Scrub/Barren	Water	Wetlands
Area (acres)	1139.7	98568.2	3137.9	38134.6	30839.0	1771.0	4397.7
Percentage	0.64%	55.38%	1.76%	21.43%	17.33%	1%	2.47%

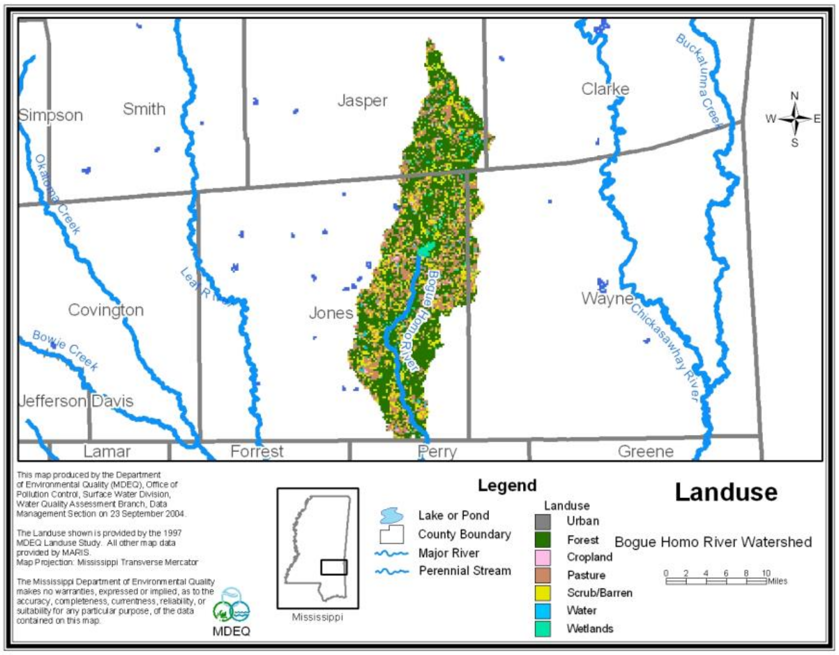


Figure 4. Landuse Distribution for the Bogue Homo River Watershed

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.

3.1 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 non-point source loadings.

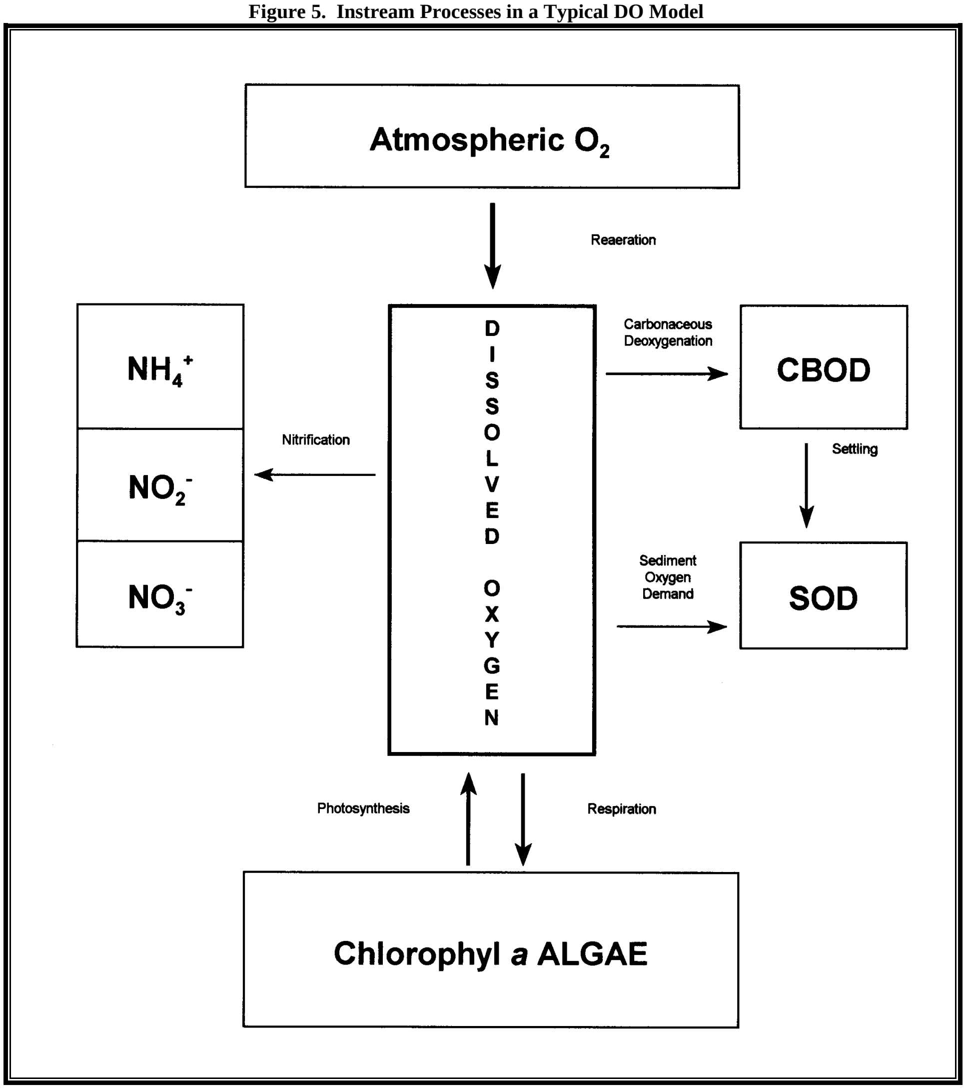
STREAM is a steady-state, daily average computer model that utilizes a modified Streeter-Phelps DO sag equation. Instream processes simulated by the model include CBODu decay, nitrification, reaeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 5 shows how these processes 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 the reaeration rate, K_a (day^{-1} base *e*), within each reach according to Equation 2.

$$\mathbf{K_a = C*S*U} \qquad \textbf{(Equation 2)}$$

C is the escape coefficient, U is the reach velocity in mile/day, and S is the average reach slope in ft/mile. The value of the escape coefficient is assumed to be 0.11 for streams with flows less than 10 cfs. Reach velocities were calculated using an equation based on slope. The slope of each reach was estimated from USGS quad maps and input into the model in units of feet/mile.

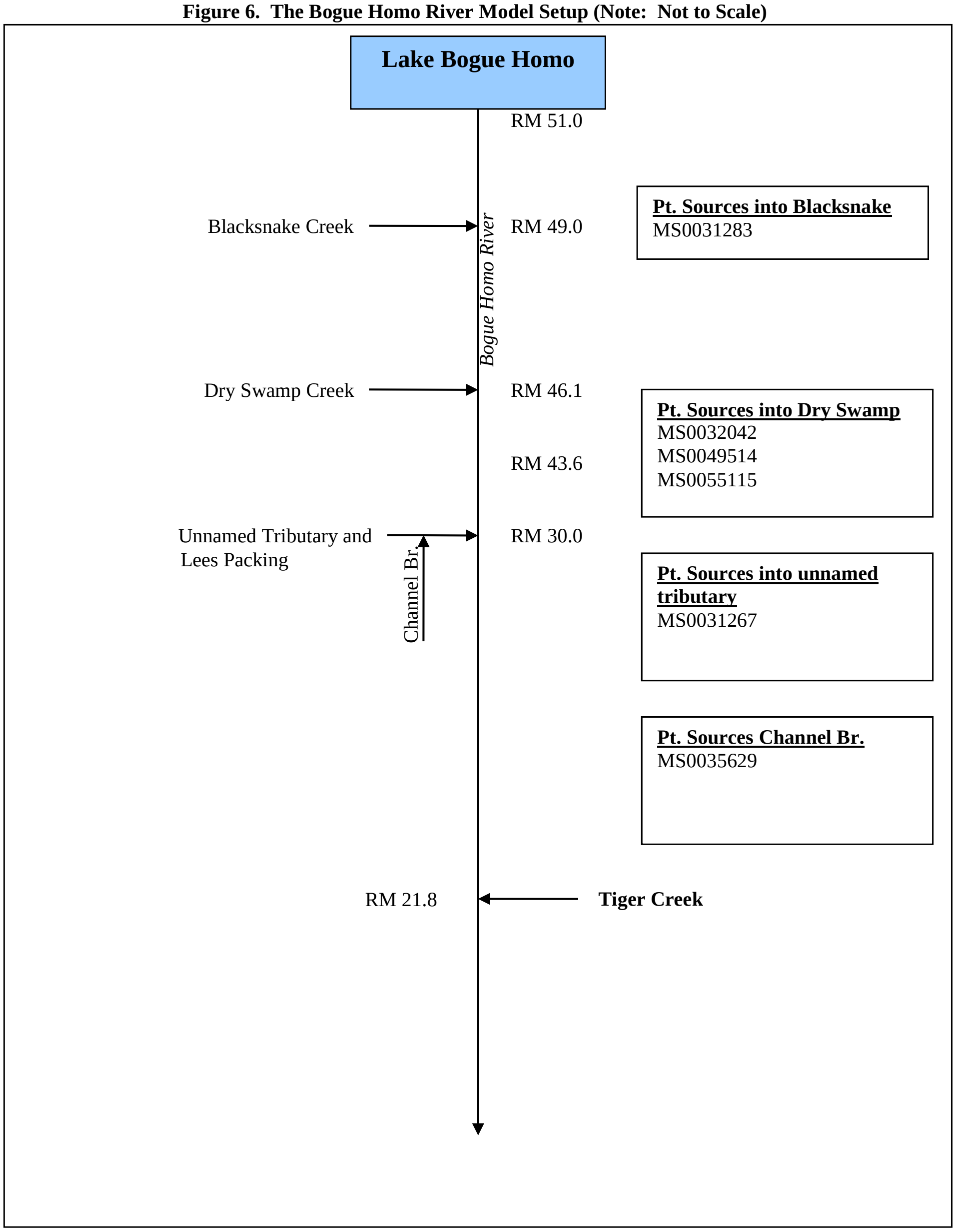
Figure 5. Instream Processes in a Typical DO Model



3.2 Model Setup

The model for this TMDL includes the §303(d) listed segment of the Bogue Homo River, beginning at mouth of Lake Bogue Homo and ending at the confluence with Tiger Creek. A diagram showing the model setup is shown in Figure 6. 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 (RM). River miles are assigned to water bodies, beginning with zero at the mouth.

Figure 6. The Bogue Homo River Model Setup (Note: Not to Scale)



The water body was divided into reaches for modeling purposes. Reach divisions were made at locations where there is a significant change in hydrological and water quality characteristics, such as the confluence of a point source or tributary. 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 STREAM model was setup to simulate flow and temperature conditions, which were determined to be the critical condition for this TMDL. In accordance with MDEQ regulations, the temperature was 26°C because the flow is less than 50 cfs. The headwater instream DO was assumed to be 85% of saturation at the stream temperature. The instream CBODu decay rate at K_d at 20°C was input as 0.3 day^{-1} (base e) as specified in MDEQ regulations. The model adjusts the K_d rate based on temperature, according to Equation 3.

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

Where K_d 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). Also based on MDEQ Regulations, the rates for photosynthesis, respiration, and sediment oxygen demand were set to zero because data for these model parameters are not available.

The flow in the Bogue Homo River watershed was modeled at 7Q10 condition based on data available from the USGS (Telis, 1992). There is a flow gauging station (02474600) located on the Bogue Homo River at Richton. The 7Q10 flow at this station is 5.7 cfs with a drainage area of 344 square miles.

3.3 Source Representation

Both point and non-point sources were represented in the model. The loads from NPDES permitted sources were added as direct inputs into the appropriate reach of the Bogue Homo River as a flow in MGD and concentration of $CBOD_5$ and ammonia nitrogen in mg/L. Spatially distributed loads, which represent non-point sources of flow, $CBOD_5$, and ammonia nitrogen were distributed evenly into each computational element of the modeled water body.

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.

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

The CBODu to $CBOD_5$ ratios are given in *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 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 of wastewater. For secondary treatment systems (conventional and aerated lagoons), this ratio is 1.5. A CBODu to $CBOD_5$ ratio of 1.5 is appropriate for all of the facilities in the Bogue Homo River Watershed, with the exception of Lees Packing. A ratio of 2.5 was used for this facility. MDEQ regulations specify that a ratio of 2.5 should be used for all meat facilities.

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 nitrogen (NO_3-N) 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 6. Because the facilities do not have permit limits for NH_3-N an assumed value of 2.0 mg/L was used to calculate the NBODu load for the facilities.

Table 6. Point Sources, Maximum Permitted Loads

Facility	NPDES	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)
Lees Packing	MS0038105	0.0006	45	2	2.5	0.56	0.01	0.05	0.61
Dixie Hills Utility SD	MS0035629	0.04	30	2	1.5	15.02	0.67	3.05	18.07
Jones County Schools	MS0031267	0.015	30	2	1.5	5.63	0.25	1.14	6.77
Dixie Electric Power Association	MS0032042	0.015	30	2	1.5	5.63	0.25	1.14	6.77
United Parcel	MS0049514	0.001	87.48*	2	1.5	1.10	0.02	0.08	1.18
Jones County School	MS0031283	0.048	30	2	1.5	18.03	0.80	3.66	21.69
Howse Implement Corporation	MS0055115	0.002	30	2	1.5	0.75	0.03	0.15	0.90
						46.72		**9.27**	**55.99**

*The maximum $CBOD_5$ was obtained from the 95th percentile of available DMR data through June 2003.

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Direct measurements of background concentrations of CBODu were not available for the Bogue Homo River. Because there were no data available, the background concentrations of CBODu were estimated based on *Empirical Stream Model Assumptions for Conventional Pollutants and Conventional Water Quality Models* (MDEQ, 1994). The NH_3-N concentration was obtained from the biological monitoring site. According to these regulations, the background concentrations used in modeling for BOD_5 = 1.33 mg/L. The NH_3-N at the monitoring site was 0.3 mg/l. These concentrations were used as estimates for the CBODu and NH_3-N levels of water entering the water bodies through non-point source flow and tributaries.

Non-point source flows were included in the model to account for the background flow and water entering due to groundwater infiltration, overland flow, and small, unmeasured tributaries. These flows were estimated based on USGS data. Using the Ungaged Site on a Gaged Stream method (Telis, 1992), a 7Q10 flow of 4.61 cfs was calculated for the Bogue Homo River at the confluence with Tiger Creek. This flow was used to determine the spatial flows entering into the Bogue Homo River watershed. It was assumed that the flows were evenly distributed throughout the creek. The flows were multiplied by the background concentrations of $CBOD_5$ and NH_3-N to calculate the non-point source loads going into each reach of the Bogue Homo River, Table 7. For the nonpoint source loads, 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 nitrogen (NO_3-N) was used.

Table 7. Non-Point Source Loads Input into the Model

	Flow (cfs)	$CBOD_5$ (mg/L)	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
Background Loads	0.50	1.33	5.38	0.3	3.70	9.08
RM 51.0 – RM 49	0.30	1.33	3.23	0.3	2.22	5.45
RM 49.0 – RM 46.1	0.50	1.33	5.38	0.3	3.70	9.08
RM 46.1 – RM 43.6	0.40	1.33	4.31	0.3	2.96	7.26
RM 43.6 – RM 30.0	2.20	1.33	23.68	0.3	16.26	39.94
RM 30.0 – RM 21.8	1.30	1.33	14.0	0.3	9.61	23.60
			55.98		**38.45**	**94.43**

3.4 Model Calibration

The model used to develop the Bogue Homo River TMDL was not calibrated due to lack of instream monitoring data collected during critical conditions. Future monitoring is essential to improve the accuracy of the model and the results.

3.5 Model Results

Once the model setup was complete, the model was used to predict water quality conditions in the Bogue Homo River. The model was first run under baseline conditions. Under baseline conditions, the loads from NPDES permitted point sources were set at their current location and their maximum permit limits, Table 6. The model was run again to reflect an increase in the load. This set of model results is called the maximum load scenario.

3.5.1 Baseline Model Runs

The baseline model results are shown in Figure 7. Figure 7 shows the modeled daily average DO with the NPDES permits at their maximum allowable loads. The figure shows the daily average instream DO concentrations, beginning with river mile 51.0 and ending with river mile 21.8 of the Bogue Homo River. As shown in the figure, the model does not predict that the DO goes below the standard of 5.0 mg/l using the maximum allowable loads.

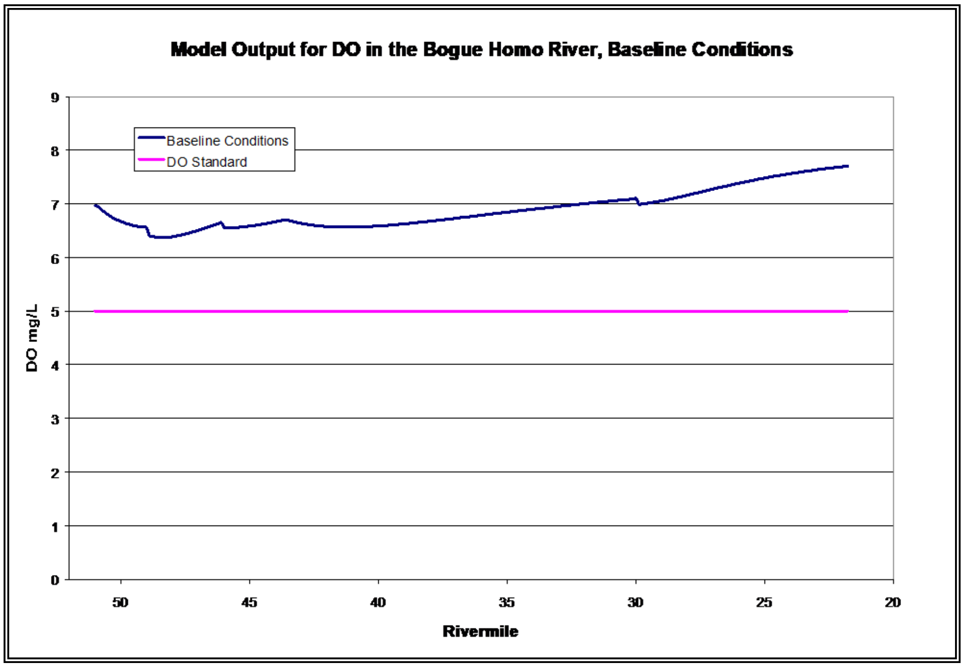

Figure 7. Model Output for DO in the Bogue Homo River, Baseline Conditions

3.5.2 Maximum Load Scenario

The graph of the baseline model output shows that the predicted DO does not fall below the DO standard in the Bogue Homo River during critical conditions. Thus, reductions from the baseline loads of TBODu are not necessary. Calculating maximum allowable load of TBODu involved increasing the loads and running the model using a trial-and-error process until the modeled DO was just above 5.0 mg/l. The baseline non-point source loads were increased by a factor of 3.25 in this process. The increased loads were used to develop the allowable maximum daily load for this report. The model output for DO with the increased loads is shown in Figure 8.

Figure 8 shows the modeled instream DO concentrations in the Bogue Homo River after application of the selected maximum load scenario at critical conditions. The model results for the maximum load scenario show that the water body does have additional assimilative capacity.

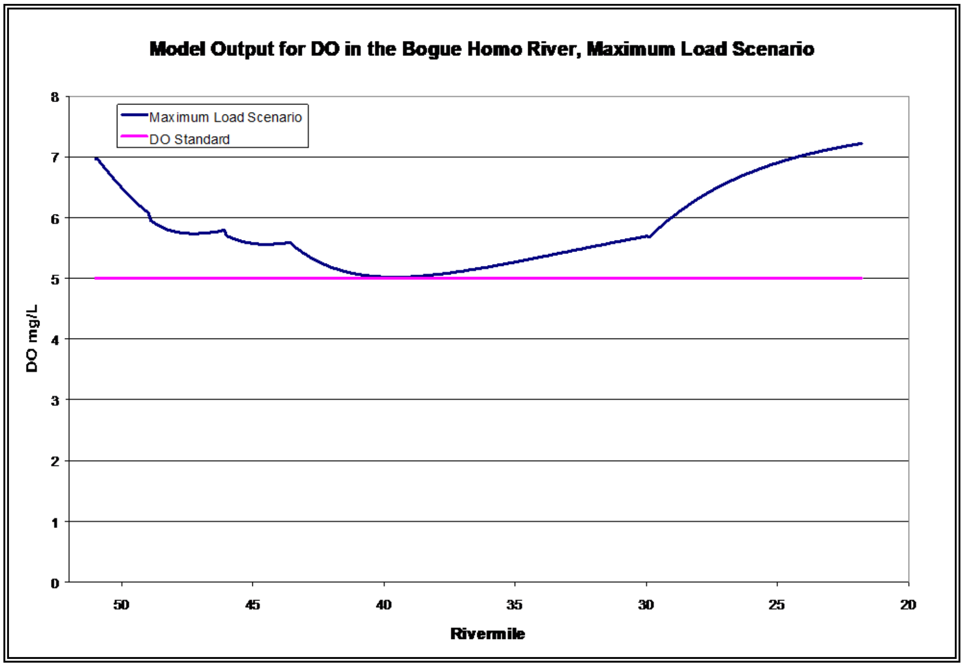

Figure 8. Model Output for the Bogue Homo River for DO, Maximum Load Scenario

Table 8. Maximum Load Scenario

Facility	NPDES	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)
Lees Packing	MS0038105	0.0006	45	2	2.5	0.56	0.01	0.05	0.61
Dixie Hills Utility SD	MS0035629	0.04	30	2	1.5	15.02	0.67	3.05	18.07
Jones County Schools	MS0031267	0.015	30	2	1.5	5.63	0.25	1.14	6.77
Dixie Electric Power Association	MS0032042	0.015	30	2	1.5	5.63	0.25	1.14	6.77
United Parcel	MS0049514	0.001	87.48*	2	1.5	1.10	0.02	0.08	1.18
Jones County School	MS0031283	0.048	30	2	1.5	18.03	0.80	3.66	21.69
Howse Implement Corporation	MS0055115	0.002	30	2	1.5	0.75	0.03	0.15	0.90
						46.72		**9.27**	**55.99**

*The maximum $CBOD_5$ was obtained from the 95th percentile of available DMR data through June 2003.

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3.6 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, Figure 9, the NH_3-N concentration is well below the water quality standard under the current NH_3-N loads.

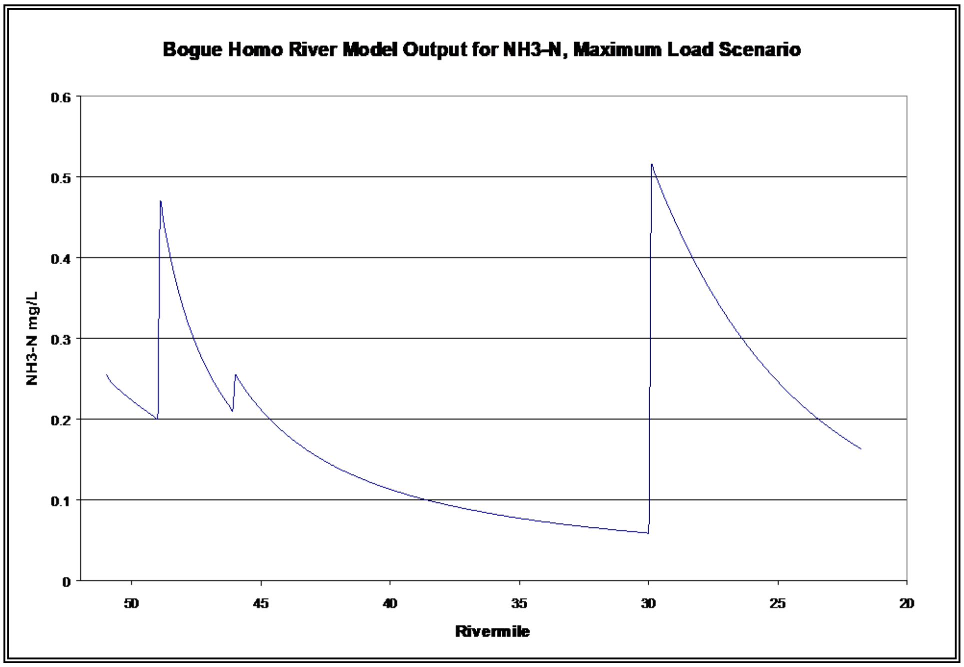

Figure 9. Model Output for NH3-N in the Bogue Homo River, Maximum Load Scenario

3.7 Total Phosphorus Estimates

The primary data available for the Bogue Homo River were collected as part of the M-BISQ project. As a result, the §303(d) listing for the Bogue Homo River was changed to biological impairment and a Stressor Identification Report was prepared by MDEQ in 2004. The stressor identification process determined that the biological impairment in the Bogue Homo River was most likely due to organic enrichment/low dissolved oxygen, nutrients, and sediment. Sediment will be addressed in a separate TMDL report.

Due to the limited amount of total phosphorus data available for the Bogue Homo River, the estimated existing total phosphorus concentration is based on the median total phosphorus concentrations measured in wadeable streams in the East Bioregion with impaired biology and elevated nutrients. For wadeable streams in the East Bioregion, the estimated existing total phosphorus concentration from sites with impaired biology and elevated nutrients is 0.22 mg/l.

A mass balance approach was used to convert the annual average concentration to a load. The mass balance approach was used only to get an initial estimate of the difference betweenrelative contribution of point and non-point loads. To convert the estimated existing total phosphorus concentration to a total phosphorus load, the average annual flow for the Bogue Homo River was estimated based on USGS monitoring data. The annual average flow for the Bogue Homo River near Richton (02474600) is 515 cfs, with a drainage area of 344 square miles. This flow monitoring station is located on the Bogue Homo River downstream of the impaired segment. To estimate the amount of flow in the Bogue Homo River within the segment, a drainage area ratio was calculated (515 cfs/344 square miles = 1.50 cfs/square mile). The ratio was then multiplied by the drainage area of the modeled segment, 278 square miles (1.50 cfs/square mile * 278 square miles = 416 cfs). Thus, the annual average flow in the Bogue Homo River is estimated as 416 cfs (269 MGD).

The existing TP load was then calculated, using Equation 5 as shown below, to be 493.4 lbs/day. The existing total phosphorous load consists of both point and non-point components. Since many treatment facilities in Mississippi do not have permit limits for phosphorous, nor are they currently required to report effluent phosphorous concentrations, MDEQ used an estimated effluent concentration based on literature values for different treatment types. Table 9 shows the median effluent phosphorus concentrations for four conventional treatment processes. The appropriate concentration for each of the facilities was then used in Equation 5 to estimate the total phosphorus load from point sources.

TP Load (lb/day) = Flow(MGD) *8.34 (conversion factor)* TP Concentration (mg/L) (Eq. 5)

Table 9. Median Phosphorous Concentrations in Wastewater Effluents

	Treatment Type			
	Primary	Trickling Filter	Activated Sludge	Stabilization Pond
No. of plants sampled	55	244	244	149
Total P (mg/L)	6.6 ± 0.66	6.9 ± 0.28	5.8 ± 0.29	5.2 ± 0.45

Source: After Ketchum, 1982 in EPA 823-B-97-002 (USEPA, 1997)

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Table 10. NPDES Permitted Facilities Treatment Types with Phosphorus Estimates

Facility Name	NPDES	Treatment Type	Permitted Discharge (MGD)	TP concentration estimate (mg/l)	TP Load estimate (lbs/day)
Lees Packing	MS0038105	Conventional Lagoon	0.0006	5.2	0.03
Dixie Hills Utility SD	MS0035629	Aerated Lagoon	0.04	5.2	1.73
Jones County Schools	MS0031267	Conventional Lagoon	0.015	5.2	0.65
Dixie Electric Power Association	MS0032042	Conventional Lagoon	0.015	5.2	0.65
United Parcel	MS0049514	Conventional Lagoon	0.001	5.2	0.04
Jones County School	MS0031283	Aerated Lagoon	0.048	5.2	2.08
Howse Implement Corporation	MS0055115	Conventional Lagoon	0.002	5.2	0.09
Total			~~0.1216~~0.1216		5.3

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The average TP point source load is estimated to be 5.3 pounds per day. The annual average total load based on the estimated total phosphorus concentration of 0.22 mg/L and an annual average flow of 269 MGD is 493.4 pounds per day. The point source load is 1.1% of the total load. Therefore, 98.9% of the estimated existing total load is from non-point sources.

The ~~target~~ annual total phosphorus concentration range for this TMDL is 0.07 to 0.11 mg/L based on total phosphorus concentrations measured for non-impaired wadeable streams in the East Bioregion. The existing concentration was assumed to be 0.22 mg/L based on total phosphorus concentrations measured for wadeable streams in the East Bioregion with impaired biology and elevated nutrients. This indicates than an estimated percent reduction of 50 to 68% of estimated instream total phosphorus concentration is needed in the Bogue Homo River to meet the ~~target~~ concentration range for non-impaired wadeable streams in the East Bioregion.

ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for non-point sources necessary for attainment of water quality standards in the Bogue Homo River, MS091E.

The nutrient portion of this TMDL is addressed through initial estimates of the existing and target total phosphorus concentrations. In agreement with EPA Region 4 MDEQ is continuing work on a six year plan to establish criteria for nutrients in wadeable streams, non-wadeable rivers, lakes, and estuaries. The target for this TMDL is only preliminary and will be subject to revision as the work of the NTF continues. When water quality standards and additional information become available, a Phase 2 TMDL may be developed for the Bogue Homo River that includes a modified nutrient target and reduction scenario.

4.1 Wasteload Allocation

There are currently 7 NPDES permits issued for this section of the Bogue Homo River. Although this wasteload allocation is based on the current condition of the Bogue Homo River, it is not intended to prevent the issuance of permits for future facilities or expansion of these facilities. This is because the model results show that the Bogue Homo River has additional assimilative capacity for organic material. Future permits will be considered on a case-by-case basis as long as they are within the maximum allowable load given in this TMDL.

The NPDES Permitted facilities that discharge BOD_5 and ammonia nitrogen in the modeled segment of the Bogue Homo River or tributaries of the Bogue Homo River are included in the wasteload allocation, Table 11. The estimated load of total phosphorus from the seven point sources shown in Table 12 is 1.1% of the estimated existing average annual load of total phosphorus in the Bogue Homo River, as described in Section 3.7. Because this estimate is based on literature values this TMDL recommends quarterly nutrient monitoring for all facilities.

Table 1111. Wasteload Allocation

Facility	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Lees Packing	0.56	0.05	0.61
Dixie Hills Utility SD	15.02	3.05	18.07
Jones County Schools	5.63	1.14	6.77
Dixie Electric Power Association	5.63	1.14	6.77
United Parcel	1.10	0.08	1.18
Jones County School	18.03	3.66	21.69
Howse Implement Corporation	0.75	0.15	0.90
	46.72	**9.27**	**55.99**

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Table 12. Wasteload Allocation TP*

Facility	Existing Estimated TP Point Source Concentration (mg/l)	Permitted Discharge (MGD))	Existing Estimated TP Point Source Load (lbs/day)	Allocated Average TP Point Source Load (lbs/day)	Percent Reduction
Lees Packing	5.2	0.0006	0.03	0.03	0
Dixie Hills Utility SD	5.2	0.04	1.73	1.73	0
Jones County Schools	5.2	0.015	0.65	0.65	0
Dixie Electric Power Association	5.2	0.015	0.65	0.65	0
United Parcel	5.2	0.001	0.04	0.04	0
Jones County School	5.2	0.048	2.08	2.08	0
Howse Implement Corporation	5.2	0.002	0.09	0.09	0
	5.2	0.1216	5.3	5.3*	0

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* Due to the lack of nutrient water quality criteria these Phase 1 TMDL allocations are estimates based on literature assumptions and projected targets. The State of Mississippi is in the process of developing numeric nutrient criteria in accordance with an EPA approved work plan for nutrient criteria development. This TMDL recommends quarterly monitoring of nutrients for NPDES facilities. MDEQ's calculations of the annual average load indicate that the majority of the estimated nutrient load is from non-point sources. Therefore, the State will focus on striving to attain the goal set by the LA portion of the TMDL.

4.2 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 BOD_u concentration of 1.33 mg/L and an NH_3-N concentration of 0.3 mg/l. This TMDL does not require a reduction of the load allocation for organic enrichment, but does recommend reduction of the nonpoint source contribution of total phosphorus. In Table 123, the load allocation is shown as the non-point sources (the spatially distributed flow entering each reach in the model).

Table 123. Load Allocation, Maximum Scenario

	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Background	5.38	3.70	9.08
Non-Point Source	164.44	112.90	277.34
	169.82	**116.60**	**286.42**

Based on initial estimates in Section 3.7, approximately 98.9% of the total phosphorus load in this watershed comes from non-point sources. Therefore, best management practices (BMPs) should be encouraged in the watershed to reduce potential total phosphorus loads from non-point sources. The Bogue Homo River watershed should be considered a priority for riparian buffer zone restoration and any nutrient reduction BMPs. For land disturbing activities related to silviculture, construction, and agriculture, it is recommended that practices, as outlined in "Mississippi's BMPs: Best Management Practices for Forestry in Mississippi" (MFC, 2000), "Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater" (MDEQ, et. al, 1994), and "Field Office Technical Guide" (NRCS, 2000), be followed, respectively. Table 14 shows the load allocation for Total Phosphorus based on the estimates given in Section 3.7.

Table 14. Load Allocation for Estimated Total Phosphorus

Existing Estimated TP Nonpoint Source Load (lbs/day)	Allocated Average TP Nonpoint Source Load (lbs/day)	Percent Reduction
488.1	151.7 to 241.4	51% to 69%

4.3 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 and explicit.

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.

The explicit MOS for this report is the difference between the non-point loads calculated in the maximum load scenario and the baseline non-point loads. The baseline non-point source loads represent an approximation of the loads currently going into the Bogue Homo River at the critical conditions. The maximum non-point source loads are the maximum TBODu loads with a 3.25 increase that allow maintenance of water quality standards. MDEQ has set the MOS as the difference in these loads to account for the uncertainty in the desktop model that was used to develop this TMDL. Many assumptions based on regulations and literature values were used. The rate of sediment oxygen demand, for example, was set to zero due to lack of monitoring data. Sediment oxygen demand, however, can be a significant factor in the DO balance of a large water body. The STREAM model is a steady state, daily average model that assumes complete mixing throughout the water column. Due to the uncertainty in the model, MDEQ set a large, explicit MOS instead of increasing either the WLA or LA to express the maximum assimilative capacity determined for the water body. The calculated MOS is in Table 135.

Table 135. Calculation of Explicit MOS

	Maximum Non-Point Load	Baseline Non-Point Load	Margin of Safety
CBODu (lbs/day)	169.82	55.98	113.80
NBODu (lbs/day)	116.60	38.45	78.15
TBODu (lbs/day)	**286.42**	**94.43**	**192.0**

The total phosphorus allocations incorporate an implicit margin of safety in the estimation of the allocations using annual average flow estimates and literature values for loading based on facility

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4.4 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.

4.5 Calculation of the TMDL

The TMDLs wasere calculated based on Equation 6.

$$\textbf{TMDL} = \textbf{WLA} + \textbf{LA} + \textbf{MOS} \qquad \textbf{(Equation 6)}$$

Where WLA is the wasteload allocation, LA is the load allocation (baseline LA for this report), 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 current loading of pollutant in the Bogue Homo River, according to the model. The TMDL calculations are shown in Tables 146 and 17. As shown in the tTable 16, 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 non-point sources of TBODu and NH_3-N from surface runoff and groundwater infiltration. The implicit and explicit margin of safety for this TMDL is derived from the conservative assumptions used in setting up the model.

Table 146. TMDL for TBODu in the Bogue Homo River Watershed

	WLA (lbs/day)	Baseline LA (lbs/day)	MOS	TMDL (lbs/day)
CBODu	46.72	55.98	113.80	216.5
NBODu	9.27	38.45	78.15	125.87
TBODu	**55.99**	**94.43**	**191.95**	**342.37**

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Table 17. Phase 1, TMDL for TP* in the Bogue Homo Watershed

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
TP	**5.3***	**151.7 to 241.4***	**Implicit**	**157.0 to 246.7***

* Due to the lack of nutrient water quality criteria these Phase 1 TMDL allocations are estimates based on literature assumptions and projected targets. The State of Mississippi is in the process of developing numeric nutrient criteria in accordance with an EPA approved work plan for nutrient criteria development. This TMDL recommends quarterly monitoring of nutrients for NPDES facilities. MDEQ's calculations of the annual average load indicate

that the majority of the estimated nutrient load is from non-point sources. Therefore, the State will focus on striving to attain the goal set by the LA portion of the TMDL.

The TMDL presented in this report represents the current load of a pollutant allowed in the 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 non-point source loads. The LA given in the TMDL applies to all non-point sources, and does not assign loads to specific sources.

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BMPs, as outlined in "Mississippi's BMPs: Best Management Practices for Forestry in Mississippi" (MFC, 2000), "Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater" (MDEQ, et. al, 1994), and "Field Office Technical Guide" (NRCS, 2000), are an effective means of reducing the sediment load from a majority of potential upland sources. While these BMPs address the issue of sediment control, it is believed that these BMP's would also help alleviate any non-point source runoff that would contribute to organic enrichment and nutrient loading in Bogue Homo. The adoption of numeric nutrient criteria will be reflected in the Phase 2 TMDL that will be completed using data based allocations in lieu of the literature based allocations included in this TMDL. MDEQ's calculations of the annual average load indicate that the majority of the estimated nutrient load is from non-point sources. Therefore, the State will focus on striving to attain the goal set by the LA portion of the TMDL.

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4.6. Reasonable Assurance

This component of TMDL development does not apply to this TMDL Report. There are no point sources (WLA) requesting a reduction based on promised LA components and reductions.

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. Each TMDL is evaluated through the Basin Team for prioritization and targeting of implementation activities.

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 that the Bogue Homo River is meeting the water quality standard for dissolved oxygen at the present loading of TBODu. Thus, this TMDL does not limit the issuance of new permits in the watershed as long as new facilities do not cause impairment in the Bogue Homo River. Nutrients were addressed through an estimate of a preliminary total phosphorus concentration target range. This TMDL has been developed as a Phase 1 TMDL so that TBOD and/or nutrients may be further evaluated when more data are available or when numeric water quality standards are finalized for nutrients.

In lieu of state water quality standards for nitrogen and phosphorus, MDEQ developed this estimated TMDL for total phosphorus based on various assumptions. The ~~Based on the estimated existing and target total phosphorus concentrations, this~~ TMDL recommends a 50 to 68% reduction of the nutrient concentrations~~loads entering~~ in the Bogue Homo River to meet the preliminary ~~target~~ range of 0.07 to 0.11 mg/l. Because~~,~~ 98.9% of the existing total phosphorus load is estimated to be due to non-point sources, the State will focus on striving to attain the goal set by the LA portion of the TMDL~~this recommended percent reduction should not impact current or future NPDES permits~~. This TMDL recommends quarterly nutrient monitoring for the facilities shown in Table 12. Additionally, i~~I~~t is recommended that the Bogue Homo River watershed be considered as a priority watershed for riparian buffer zone restoration and any nutrient reduction BMPs. The implementation of these BMP activities should reduce the nutrient load entering the Bogue Homo River. This will provide improved water quality for the support of aquatic life in the water body and will result in the attainment of the applicable water quality standards.

5.1 Additional Monitoring

Additional monitoring needed for model refinement may 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 Pascagoula Basin, the Bogue Homo River Watershed may receive additional monitoring to identify any change in water quality.

5.2 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.

All comments should be directed to Greg Jackson at Greg_Jackson@deq.state.ms.us or Greg Jackson, MDEQ, PO Box 10385, Jackson, MS 39289. All comments received during the public notice period and at any public hearings become a part of the record of this TMDL and will be considered in the submission of this TMDL to EPA Region 4 for final approval.

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.

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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, 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 non-point 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 non-point 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.

Non-Point 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.

Technology based effluent limitation (TBEL): A minimum waste treatment requirement, established by the Department, based on treatment technology. The minimum treatment requirements may be set at levels more stringent than that which is necessary to meet water quality standards of the receiving water body.

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

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

NTF .... Nutrient Task Force

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