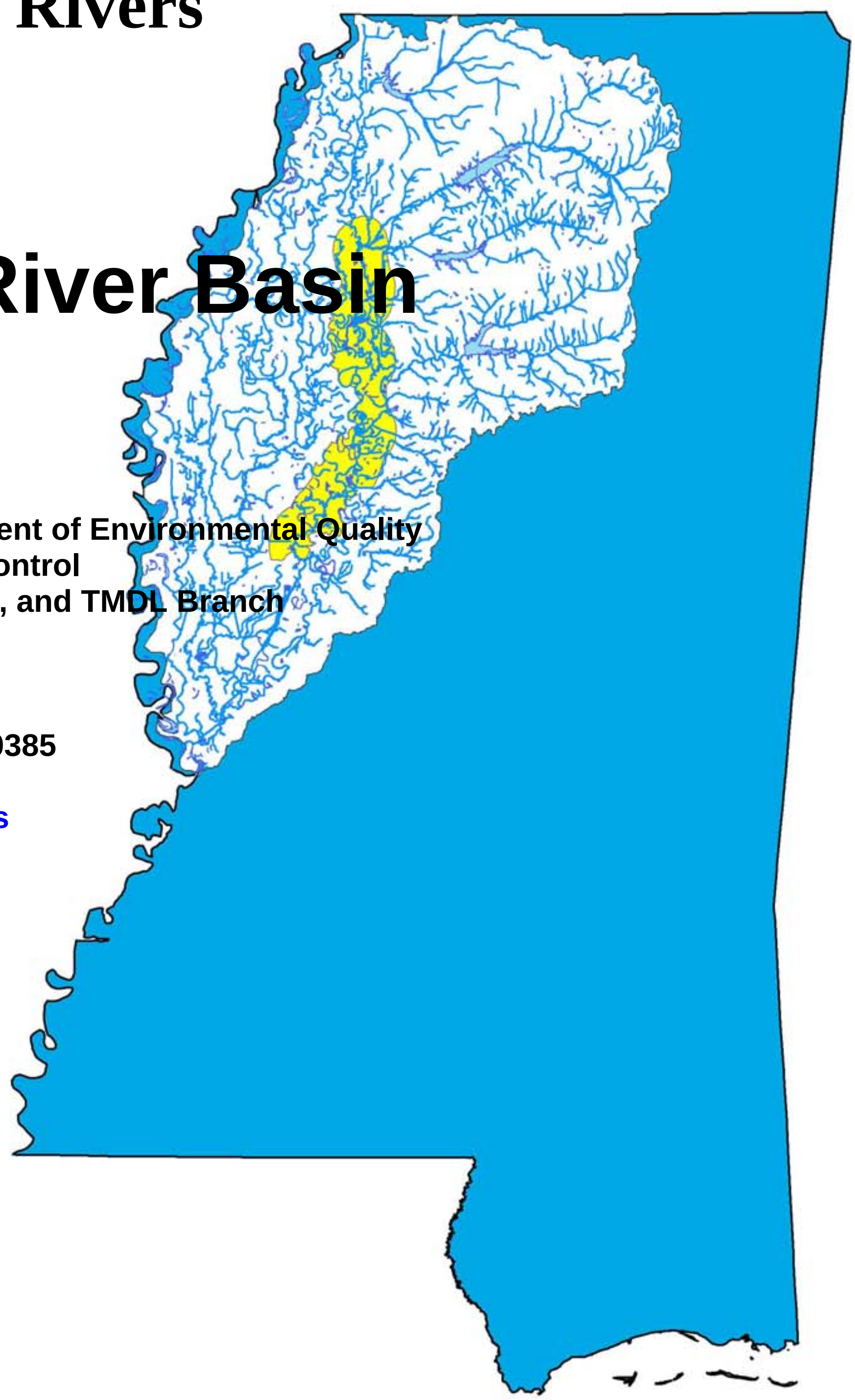
PROPOSED REPORT
April 2008

Total Maximum Daily Load
For Organic Enrichment / Low Dissolved Oxygen in the Tallahatchie and Yazoo Rivers



Yazoo River Basin

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.

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	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

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Table 1. Listing Information

Name	ID	County	HUC	Impaired Use	Causes
Tallahatchie River	MSUTALARE	Quitman, Tallahatchie	08030202	Aquatic Life Support	Organic Enrichment / Low Dissolved Oxygen
From confluence of Coldwater River and Old Little Tallahatchie to confluence with southern end of Panola Quitman Floodway					
Tallahatchie River	MSTALARE	Tallahatchie	08030202	Aquatic Life Support	Organic Enrichment / Low Dissolved Oxygen
From confluence at south end of Panola Quitman Floodway to confluence with the Yalobusha River					
Yazoo River	MSYAZR3E	Leflore, Humphreys	08030206	Aquatic Life Support	Organic Enrichment / Low Dissolved Oxygen
From confluence of Yalobusha River and Tallahatchie River to confluence with north end of the Lower Auxiliary Channel					

Table 2. Water Quality Standards

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

Table 3. Total Maximum Daily Load for the Tallahatchie River (MSUTALARE)

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
TBODu	855.4	3,231.8	1,332.8	5,420.0

Table 4. Total Maximum Daily Load for the Tallahatchie River (MSTALARE)

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
TBODu	454.9	132,864.9	127,162.7	260,482.5

Table 5. Total Maximum Daily Load for the Yazoo River (MSYAZR3E)

	WLA Lbs/day	LA lbs/day	MOS	TMDL lbs/day
TBODu	10,188.4	155,816.8	152,904.2	318,909.4

Table 6. Identified NPDES Permitted Facilities

Name	NPDES Permit	Permitted Discharge (MGD)	Receiving Water
Belzoni POTW	MS0020371	1.3	Yazoo River
Bunge North America, Incorporate	MS0000752	0.091	Coldwater River
Charleston POTW	MS0044083	0.516	Tillatoba Creek
Confish Inc	MS0043346	0.174	Yazoo River
Crowder POTW	MS0034304	0.16	Panola Quitman Floodway
Cruger POTW	MS0042315	0.21	Abiaca Creek
Delta Pride Catfish Inc, 001	MS0043826	0.5	Yazoo River
Delta Pride Catfish Inc, 002	MS0043826	0.3	Unnamed Ditch thence Yazoo River
East Leflore County Water and	MS0040185	0.02	Jennings Bayou

Name	NPDES Permit	Permitted Discharge (MGD)	Receiving Water
Sewer District POTW, Chapman Subdivision			
East Leflore County Water and Sewer District POTW, Rising Sun Subdivision	MS0022705	0.16	Pelucia Creek
Florewood State Park	MS0029203	0.01	Yazoo River
Freshwater Farms Products LLC	MS0048551	0.28*	Yazoo River
Glendora POTW	MS0048356	0.02	Black Bayou
Greenwood POTW	MS0023833	6.32	Yazoo River
Humphreys Academy	MS0048003	0.008	Ditch Number 26
Lambert POTW	MS0020231	0.75	Unnamed Ditch thence Muddy Bayou
Malouf Trailer Park	MS0034169	0.04	Pelucia Canal
Marks POTW	MS0024660	0.66	Coldwater River
Miles Homes Subdivision	MS0032701	0.01	Unnamed Bayou thence Tallahatchie River
Minter City Water and Sewer Dist	MS0049905	0.1	Tallahatchie River
Morgan City Water and Sewer Association	MS0024716	0.075	Unnamed Creek thence Yazoo River
Phillip Water and Sewer Association	MS0055361	0.08	Tallahatchie River
PYCO Industries Inc	MS0001317	0.132	Yazoo River
Quitman County Residential Treatment Facility	MS0043281	0.001	Tributary of the Tallahatchie River
Sidon POTW	MS0024724	0.06	Sidon Cutoff thence Old Yazoo River
Silver City POTW	MS0044709	0.06	Yazoo River
T T and W Farm Products Inc	MS0051098	0.954	Yazoo River
Tepper Headstart	MS0043982	0.005	Little Jackson Bayou
Three Forks LLC	MS0059552	0.003	Tallahatchie River

* Long term average discharge

EXECUTIVE SUMMARY

This TMDL has been developed for two segments of the Tallahatchie River and one segment of the Yazoo River which were placed on the Mississippi 2006 Section 303(d) List of Impaired Water Bodies due to evaluated causes of organic enrichment/low dissolved oxygen. These segments have never been monitored, therefore, there is no data corresponding to these sites. This TMDL addresses organic enrichment/low DO. Nutrients will be addressed through a separate TMDL report.

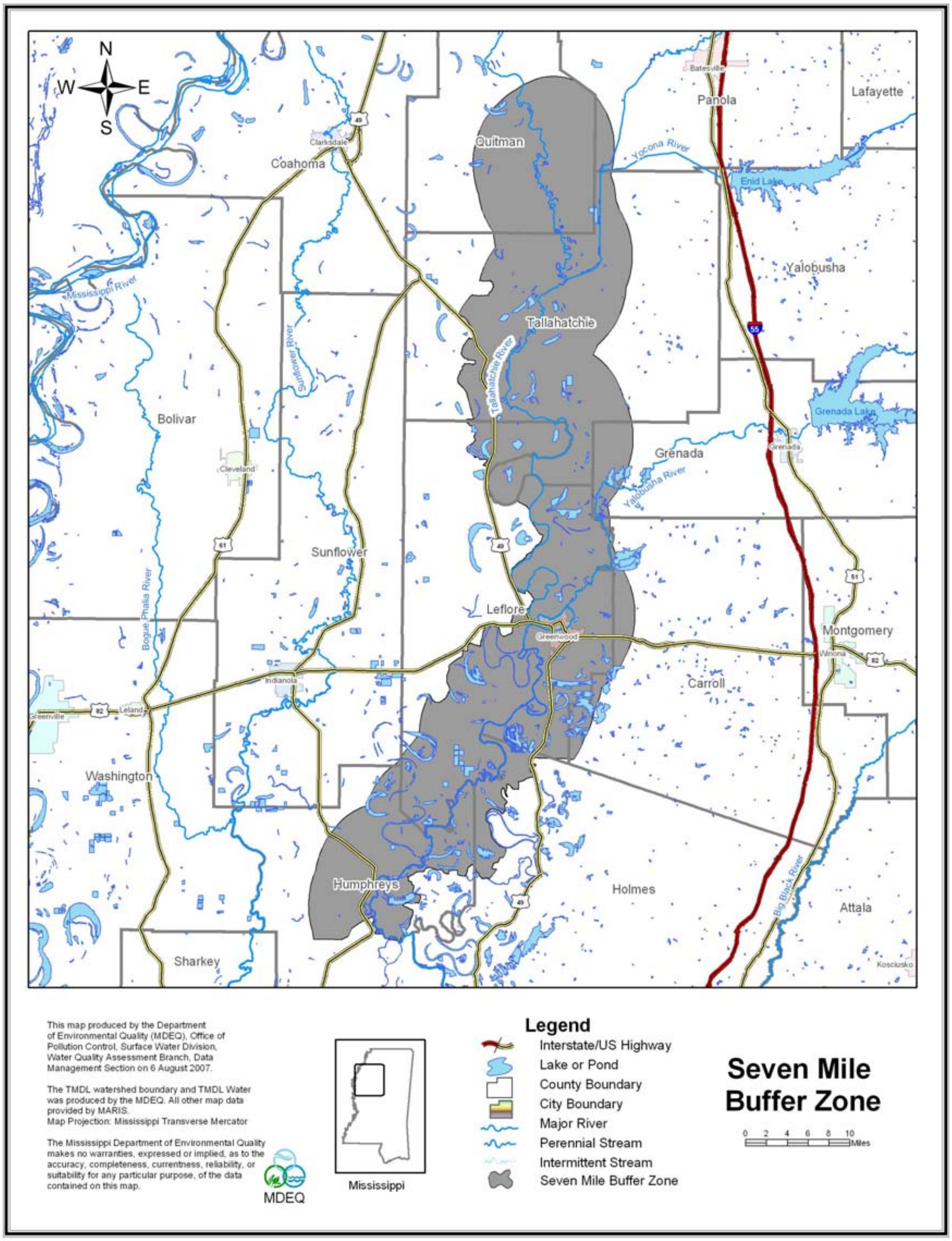
The Tallahatchie and Yazoo River watersheds are located in the Yazoo River Basin. Segment MSUTALARE of the Tallahatchie River starts at the confluence of the Coldwater River and the Old Little Tallahatchie River and ends at the confluence with the southern end of Panola Quitman Floodway. Segment MSTALARE of the Tallahatchie River starts at the confluence with the south end of Panola Quitman Floodway and ends at the confluence with the Yalobusha River in Leflore County. Segment MSYAZR3E of the Yazoo River starts at the confluence of the Yalobusha and Tallahatchie Rivers in Leflore County and ends at the confluence with the north end of the Lower Auxiliary Channel in Humphreys County.

It was determined that a buffer zone was the best way to obtain a watershed for this TMDL. Attempts at delineating a watershed using conventional techniques resulted in the watershed and model becoming extremely large with far field areas of the watershed having virtually no effect on the TMDL. MDEQ reviewed several different size buffer zones including 3-mile, 5-mile, and 7-mile buffer zones from the main stem of the TMDL segments. After reviewing the different options MDEQ determined the most reasonable size buffer zone was the 7-mile buffer. This was based on the fact that the 7 mile zone extended all the way to the edge or beyond the edge of the actual watershed in the majority of the Delta and it encompassed all nearby towns and industries. There are also no major point sources in close proximity to the outside of the buffer zone that would have an impact on the TMDL model. The watersheds shown in Figure 1 illustrate this 7-mile buffer distance from the main stem of the TMDL water bodies.

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. The critical modeling period occurs 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 non-point and point sources of TBODu in the Tallahatchie and Yazoo Rivers Watershed. TBODu loading from background and non-point sources in the buffer zone was accounted for by using an estimated concentration of TBODu and flows based on the critical flow conditions. There are twenty eight NPDES permitted dischargers located in the buffer zone that are included as point sources in the TMDL.

According to the model, the current TBODu load in the water body does not exceed the assimilative capacity of the Tallahatchie and Yazoo Rivers for organic material at the critical conditions.

Figure 1. Tallahatchie and Yazoo Rivers

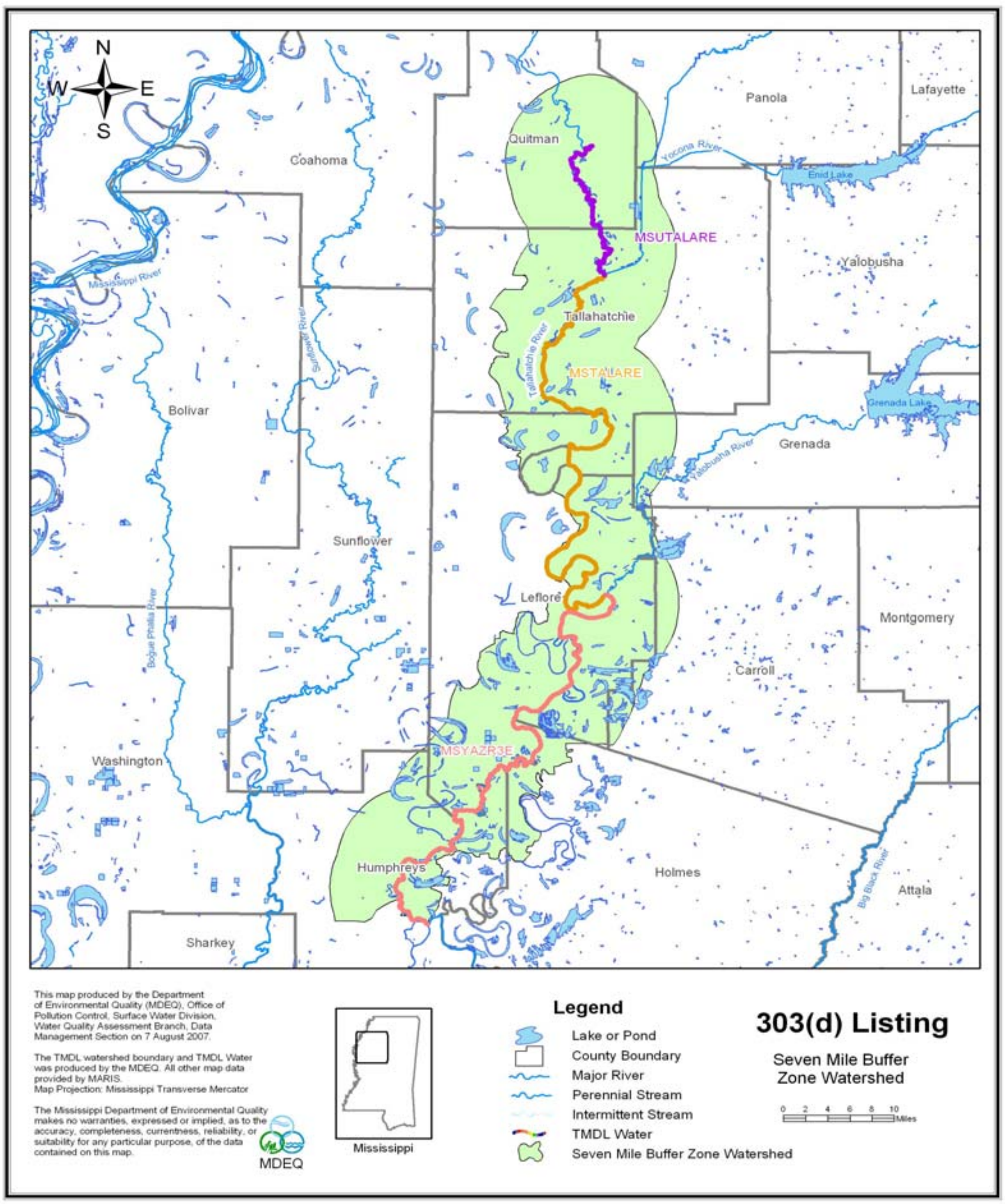


INTRODUCTION

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 2006 §303(d) listed segments shown in Figure 2. These segments include two segments of the Tallahatchie River (MSUTALARE and MSTALARE) and one segment of the Yazoo River (MSYAZR3E)

Figure 2. Tallahatchie and Yazoo Rivers §303(d) Listed Segments



1.2 Applicable Water Body Segment Use

The water use classifications are established by the State of Mississippi in the document *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007). The designated beneficial use for the listed segments is Fish and Wildlife.

1.3 Applicable Water Body Segment Standard

The water quality standard applicable to the use of these water bodies and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2007).

1.4 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 only flow gage on these three segments is gage 07287000 on the Yazoo River at Greenwood, MS with a 7Q10 of 720 cfs. The 7Q10 flow at the headwaters of segment MSUTALARE was obtained by subtracting out the non-point source flows coming from the hills regions of the Yazoo River basin from the 720 cfs based on *Techniques for Estimating 7-Day, 10-Year Low-Flow Characteristics on Streams in Mississippi* (Telis, 1992).This resulted in a 7Q10 flow of 614.8cfs. The 7Q10 flows downstream of Greenwood were obtained in the same manner by adding the non-point source flows. This resulted in a 7Q10 flow of 741.7 cfs.

1.5 Selection of a TMDL Endpoint

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by meeting the load and wasteload allocations specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream DO target for this TMDL is a daily average of not less than 5.0 mg/l. The instantaneous minimum portion of the DO standard was considered when establishing the instream target for this TMDL. However, it was determined that using the daily average standard with the conservative modeling assumptions would 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 are needed in order to obtain accurate diurnal oxygen levels. Therefore, based on the limited data available and the relative simplicity of the model, the daily average target is appropriate.

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.

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

WATER BODY ASSESSMENT

2.1 Tallahatchie and Yazoo Rivers Water Quality Data

There are no diurnal DO monitoring data available for these segments of the Tallahatchie and Yazoo Rivers.

2.2 Assessment of Point Sources

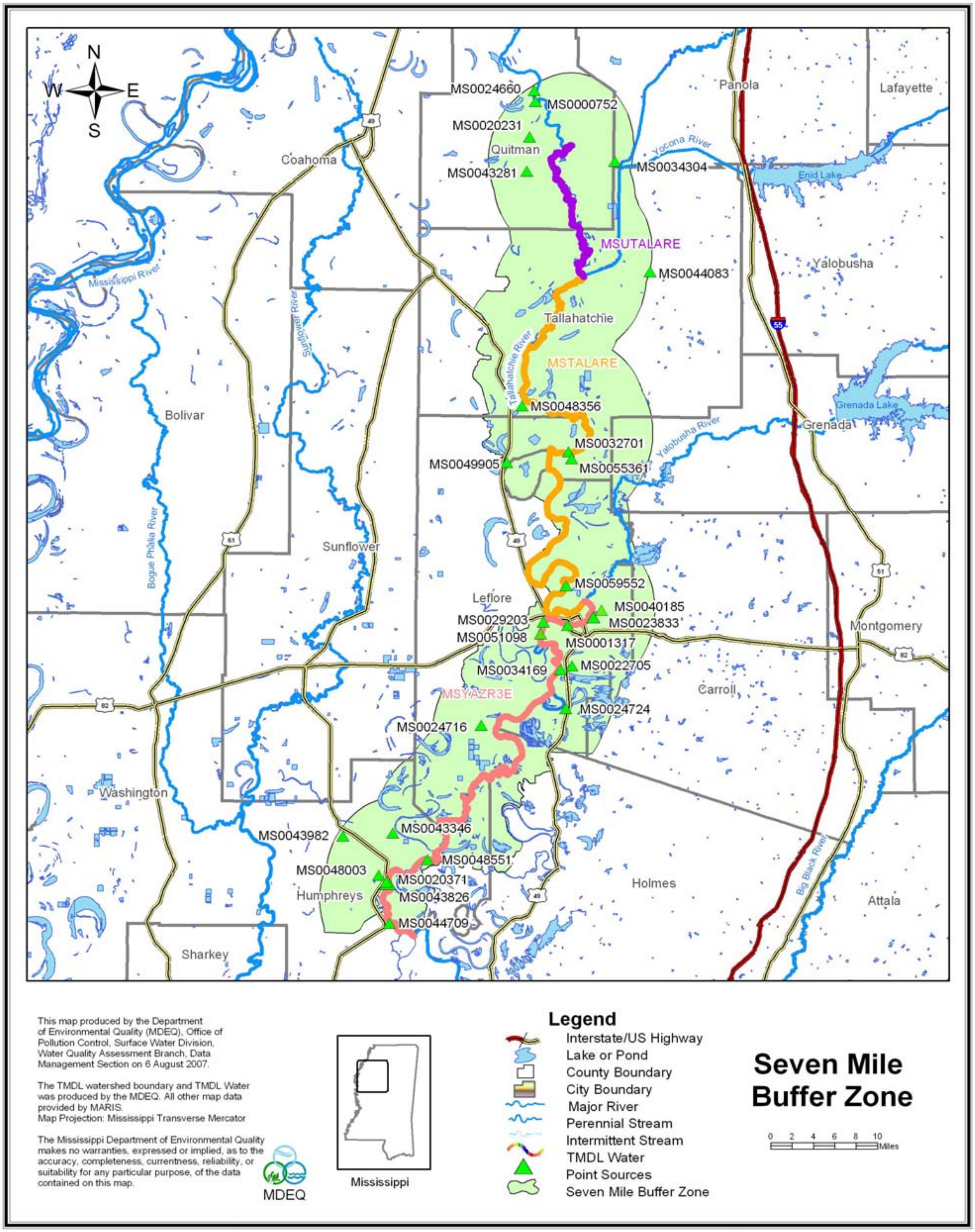
An important step in assessing pollutant sources in the Tallahatchie and Yazoo Rivers watershed is locating the NPDES permitted sources. There are twenty eight facilities permitted to discharge organic material into the buffer zone portion of the Tallahatchie and Yazoo River watershed, Table 7. The locations of these facilities are shown in Figure 3.

Table 7. NPDES Permitted Facilities Treatment Types

Name	NPDES Permit	Treatment Type
Belzoni POTW	MS0020371	Conventional Lagoon
Bunge North America, Incorporate	MS0000752	Skimming chamber, aerated lagoon, and settling basin
Charleston POTW	MS0044083	Conventional Lagoon
Confish Inc	MS0043346	Screening, anaerobic lagoon, and aerated lagoons
Crowder POTW	MS0034304	Aerated Lagoon
Cruger POTW	MS0042315	Conventional Lagoon
Delta Pride Catfish Inc, 001	MS0043826	Anaerobic Lagoon and Aerated Lagoon
Delta Pride Catfish Inc, 002	MS0043826	None
East Leflore County Water and Sewer District POTW, Chapman Subdivision	MS0040185	Conventional Lagoon
East Leflore County Water and Sewer District POTW, Chapman Subdivision	MS0022705	Conventional Lagoon
Florewood State Park	MS0029203	Activated Sludge
Freshwater Farms Products LLC	MS0048551	Screening, anaerobic, aerobic, and aerated lagoons
Glendora POTW	MS0048356	Conventional Lagoon
Greenwood POTW	MS0023833	Trickling Filter
Humphreys Academy	MS0048003	Sand Filter
Lambert POTW	MS0020231	Aerated Lagoon
Malouf Trailer Park	MS0034169	Aerated Lagoon
Marks POTW	MS0024660	Activated Sludge w/ Conventional Lagoon
Miles Homes Subdivision	MS0032701	Conventional Lagoon
Minter City Water and Sewer District	MS0049905	Aerated Lagoon
Morgan City Water and Sewer Association	MS0024716	Conventional Lagoon
Phillip Water and Sewer Association	MS0055361	Conventional Lagoon
PYCO Industries Inc	MS0001317	Neutralization, Oil/Water Separator, Primary Settling

Name	NPDES Permit	Treatment Type
Quitman County Residential Treatment Facility	MS0043281	Septic Tank w/ Rock Reed
Sidon POTW	MS0024724	Conventional Lagoon
Silver City POTW	MS0044709	Conventional Lagoon
T T and W Farm Products Inc	MS0051098	Anaerobic lagoons, aerated lagoon, facultative lagoons, and storage lagoons
Tepper Headstart	MS0043982	Activated Sludge
Three Forks LLC	MS0059552	Aerobic Treatment Unit

Figure 3. Tallahatchie and Yazoo Rivers Point Sources



The effluent from the facilities was characterized based on all available data including information on their wastewater treatment system, permit limits, and discharge monitoring reports. The permit limits are given in Table 8.

Table 8. Identified NPDES Permitted Facilities with Permit Limits

Name	NPDES Permit	Permitted Discharge (MGD)	NH_3-N (mg/l)	Permitted Average BOD_5 (mg/l)
Belzoni POTW	MS0020371	1.3	2*	45
Bunge North America, Incorporate	MS0000752	0.091	2*	75 lbs/day
Charleston POTW	MS0044083	0.516	2*	30
Confish Inc	MS0043346	0.174	0.44**	45
Crowder POTW	MS0034304	0.16	2*	30
Cruger POTW	MS0042315	0.21	2*	45
Delta Pride Catfish Inc, Belzoni	MS0043826	0.5	--	920 lbs/day
Delta Pride Catfish Inc, Belzoni	MS0043826	0.3	2	10
East Leflore County Water and Sewer District POTW, Chapman Subdivision	MS0040185	0.02	2*	30
East Leflore County Water and Sewer District, Rising Sun Subdivision	MS0022705	0.16	2*	30
Florewood State Park	MS0029203	0.01	2*	30
Freshwater Farms Products LLC	MS0048551	0.28***	10.7**	60
Glendora POTW	MS0048356	0.02	2*	30
Greenwood POTW	MS0023833	6.32	2*	30
Humphreys Academy	MS0048003	0.008	2*	30
Lambert POTW	MS0020231	0.75	2*	30
Malouf Trailer Park	MS0034169	0.04	2*	30
Marks POTW	MS0024660	0.66	2*	30
Miles Homes Subdivision	MS0032701	0.01	2*	30
Minter City Water and Sewer District	MS0049905	0.1	2*	45
Morgan City Water and Sewer Association	MS0024716	0.075	2*	45
Phillip Water and Sewer Association	MS0055361	0.08	2*	30
PYCO Industries Inc	MS0001317	0.132	2*	30
Quitman County Residential Treatment Facility	MS0043281	0.001	2*	30
Sidon POTW	MS0024724	0.06	2*	45
Silver City POTW	MS0044709	0.06	2*	45
T T and W Farm Products Inc	MS0051098	0.954	10	40
Tepper Headstart	MS0043982	0.005	2*	30
Three Forks LLC	MS0059552	0.003	2*	30

* Assumed Value
** Average Value based on monitoring data
*** Long term average discharge

2.3 Assessment of Non-Point Sources

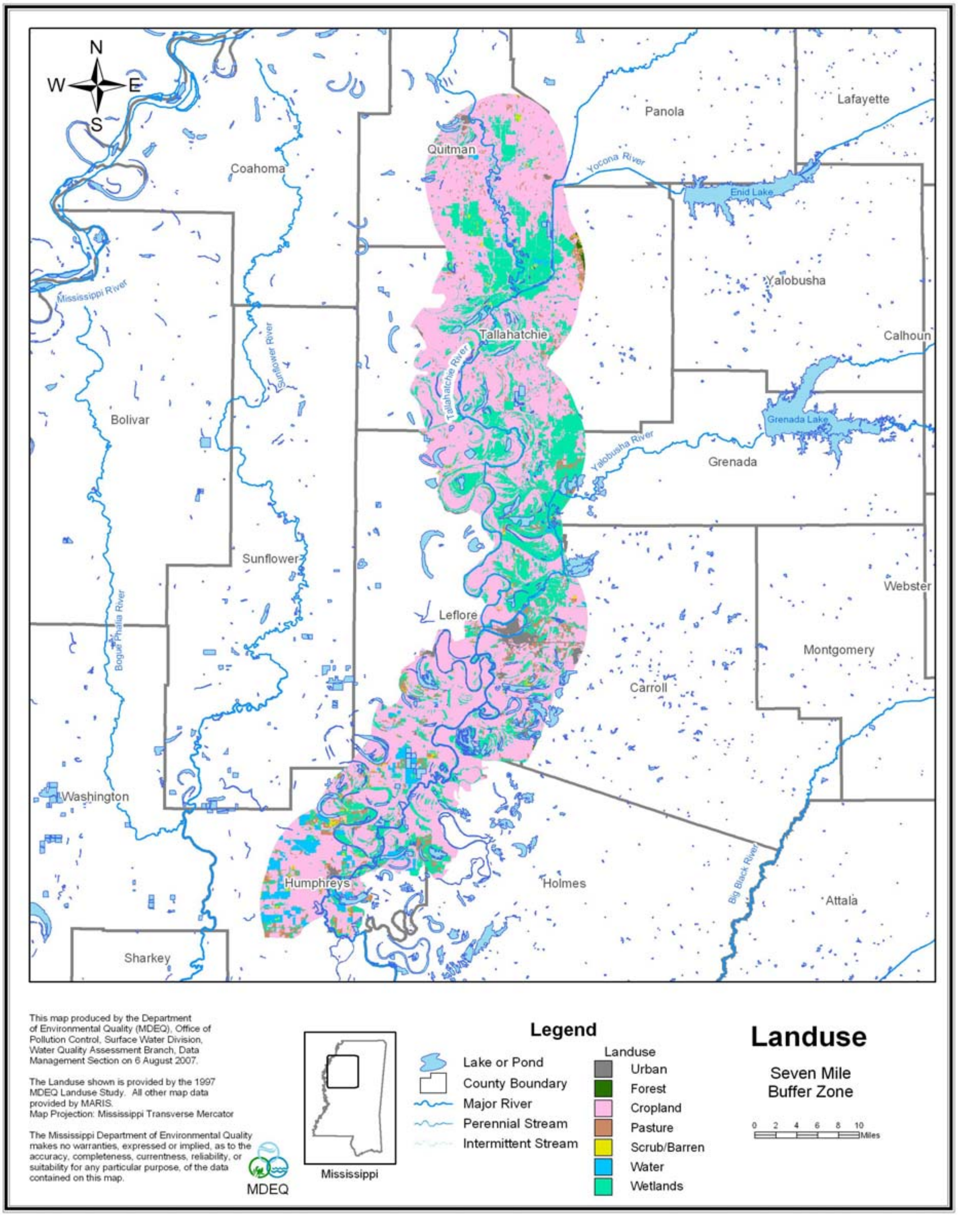
Non-point loading of organic material in a water body results from the transport of the pollutants into receiving waters by overland surface runoff and groundwater infiltration. Other land use activities within the drainage basin, such as agriculture and urbanization also contribute to non-point source loading. Overland surface runoff and groundwater infiltration results in the transport of TBODu into receiving waters. Since no data exist to determine the non-point 7Q10 flows in the Delta, they were conservatively assumed to equal zero. Thus, all non-point source flows come from the hills portion of the Yazoo River Basin and are added into the tributaries rather than being spatially distributed.

The drainage area of the Tallahatchie and Yazoo Rivers is approximately 685,225 acres or 1,070.7 square miles. The buffer zone contains many different landuse types, including urban, forest, cropland, pasture, and wetlands. The land use information for the buffer zone is based on the State of Mississippi's Automated Resource Information System (MARIS), 1997. This data set is based Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. The land use categories were grouped into the land uses of urban, forest, cropland, pasture, disturbed, wetlands, and water. Cropland is the dominant landuse within this buffer zone. The landuse distribution for the Tallahatchie and Yazoo Rivers buffer zone is shown in Table 9 and Figure 4.

Table 9. Landuse Distribution for the Tallahatchie and Yazoo Rivers Buffer Zone

In Acres	Urban	Forest	Cropland	Pasture	Scrub/Barren	Wetlands
Buffer Zone	7,008	634	425,793	29,716	5,836	186,987
Percentage	1.0%	0.1%	62.1%	4.3%	0.9%	27.3%

Figure 4. Tallahatchie and Yazoo Rivers Buffer Zone Landuse



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 6 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 when the stream flow was less than 280 cfs. The Tsivoglou formulation calculates the reaeration rate, K_a (day^{-1} base *e*), within each reach according to Equation 2.

$$K_a = C*S*U \qquad \textbf{(Eq. 2)}$$

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 and 0.0597 for stream flows equal to or greater than 10 cfs. Reach velocities were calculated using an equation based on slope. The slope of each reach was estimated electronically and input into the model in units of feet/mile.

When the stream flow was greater than 280 cfs the reaeration within each reach was calculated based on the O'Conner-Dobbins equation. The O'Conner-Dobbins formulation calculates the reaeration rate, K_a (day^{-1} base *e*), within each reach according to Equation 3 where U is the velocity and D is the stream depth.

$$\mathbf{K}_a = \frac{\mathbf{12.9U^{0.5}}}{\mathbf{D^{1.5}}} \qquad \textbf{(Eq. 3)}$$

The velocity was calculated based on MDEQ regulations and the depth was estimated based on the equation shown in Figure 5, which is a graph of the stage vs. discharge for a site on the Tallahatchie River.

Figure 5. Stage vs. Discharge Curve

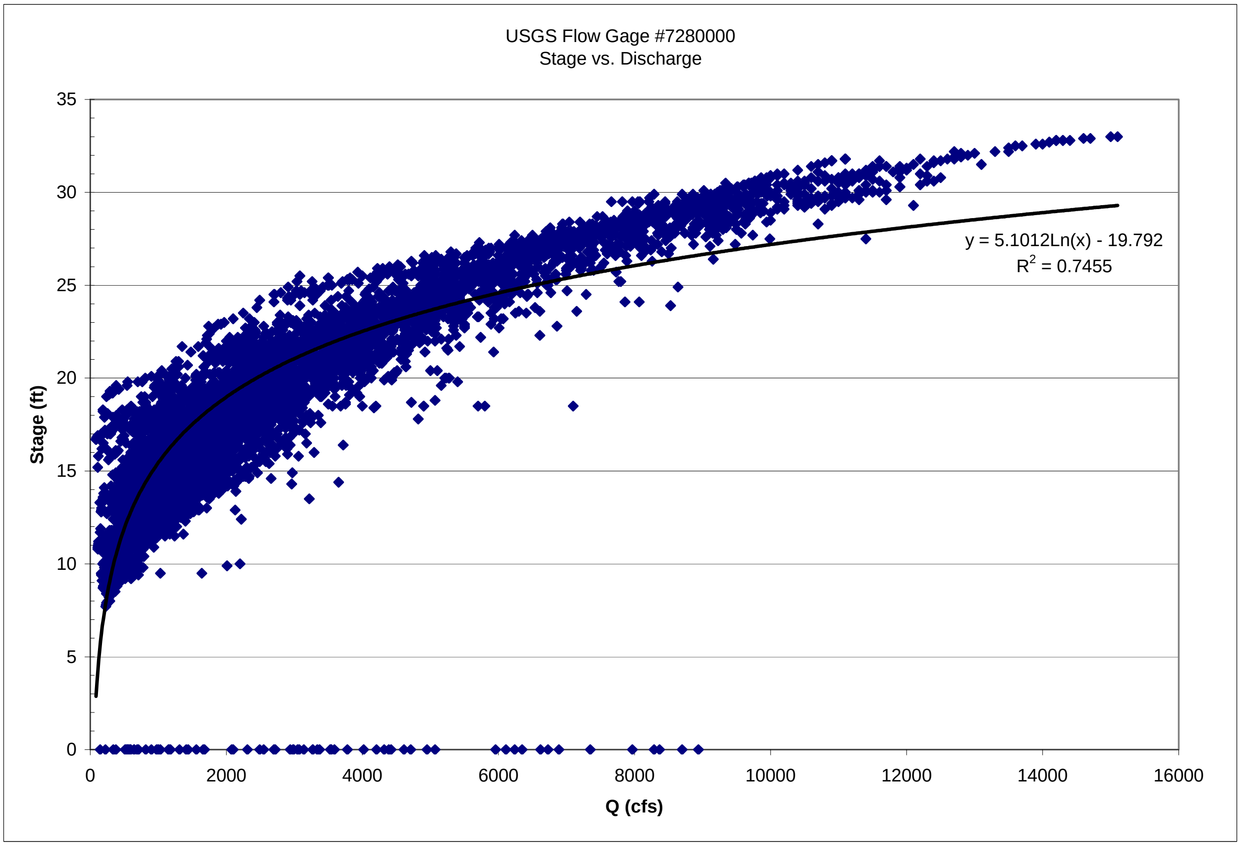
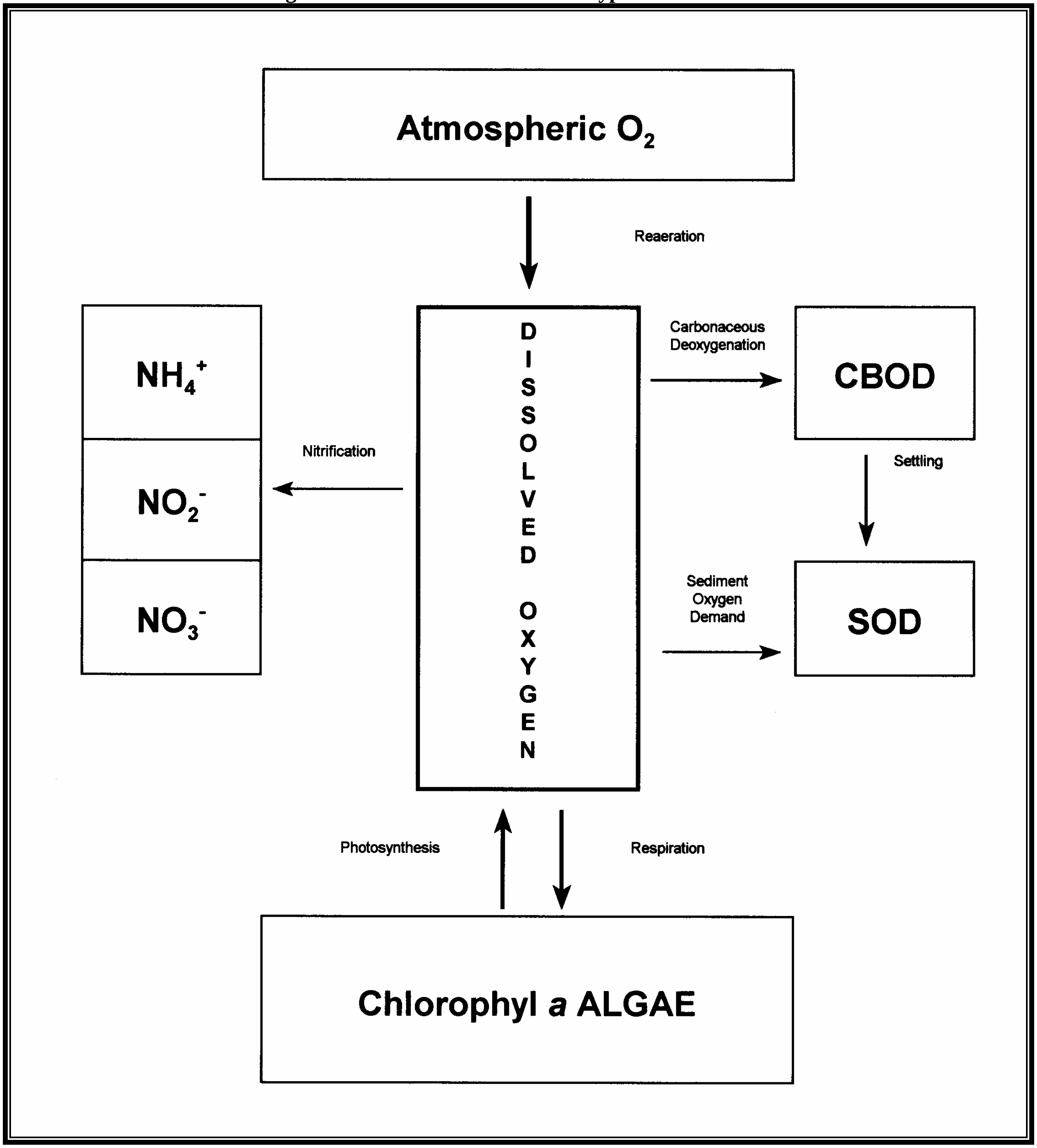


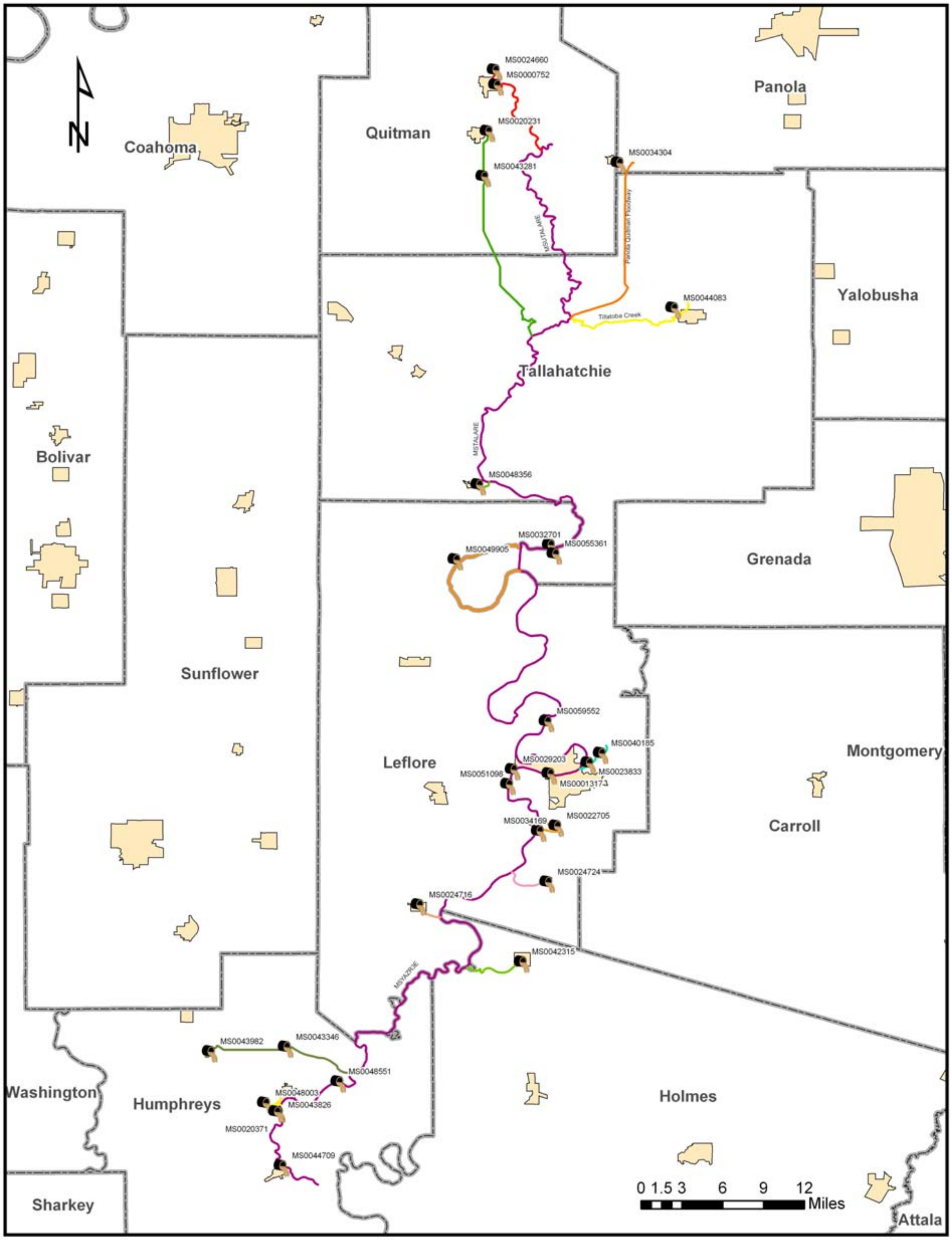
Figure 6. Instream Processes in a Typical DO Model



3.2 Model Setup

The model for this TMDL includes the §303(d) listed segments of the Tallahatchie and Yazoo Rivers. A diagram showing the model setup is shown in Figure 7.

Figure 7. Tallahatchie and Yazoo Rivers Model Setup



As can be seen by the diagram, the area in which point sources were considered was limited. This is due to the potential for the watersheds and model for this TMDL to become extremely large with far field areas of the watershed having virtually no effect on the TMDL segments and the fact that it is almost impossible to delineate a watershed in the MS Delta with any degree of accuracy. Thus, it was determined that a buffer zone was the most viable way to obtain a representative watershed for this TMDL. MDEQ reviewed several different size buffer zones including 3-mile, 5-mile, and 7-mile buffer zones from the main stem of the TMDL segments. After reviewing the different options MDEQ determined the most reasonable size buffer zone was the 7-mile buffer. This was based on the fact that the 7 mile zone extended all the way to the edge or beyond the edge of the actual watershed in the majority of the Delta and the fact that it encompassed all nearby towns and industries. There are also no major point sources beyond the buffer zone that would have an impact on the TMDL model.

The water bodies were 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. MDEQ Regulations state that the temperatures based on the stream flow should be used in modeling when insufficient data exist as shown in Table 10.

Table 10. MDEQ Regulations Flow and Temperature

Minimum Low Flows	Temperature
≥ 300 cfs	30 °C
≥50 cfs and < 300 cfs	28 °C
< 50 cfs	26 °C

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 4.

$$\mathbf{K_{d(T)} = K_{d(20°C)}(1.047)^{T-20}} \qquad \textbf{(Eq. 4)}$$

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 only flow gage on these three segments is gage 07287000 on the Yazoo River at Greenwood, MS with a 7Q10 of 720 cfs. The 7Q10 flow at the headwaters of segment MSUTALARE was obtained by subtracting out the non-point source flows coming from the hills regions of the Yazoo River basin from the 720 cfs based on *Techniques for Estimating 7-Day, 10-Year Low-Flow Characteristics on Streams in Mississippi* (Telis, 1992). This resulted in a 7Q10 flow of 614.8cfs. The 7Q10 flows downstream of Greenwood were obtained in the same manner by adding the non-point source flows. This resulted in a 7Q10 flow of 741.7 cfs.

3.3 Source Representation

Both point and non-point sources were represented in the model. The loads from the NPDES permitted point sources was added as a direct input into the appropriate reaches as a flow in MGD and concentration of $CBOD_5$ and ammonia nitrogen in mg/l. Non-point sources were accounted for by adding loads into the tributaries of the model at the appropriate locations based on USGS (Telis, 1991)

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 5.

$$\textbf{CBODu} = \textbf{CBOD}_5 * \textbf{Ratio} \qquad \textbf{(Eq. 5)}$$

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 wastewater treatment type.

In order to convert the ammonia nitrogen (NH_3-N) loads to an oxygen demand, a factor of 4.57 pounds of oxygen per pound of ammonia nitrogen (NH_3-N) oxidized to nitrate 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 the existing point sources is given in Table 11.

Table 11. Point Sources, Maximum Permitted Loads

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)
MS0020371	1.3	45	2*	1.5	732.4	21.70	99.2	831.5
MS0000752	0.091	--	2*	1.5	112.5	1.52	6.9	119.4
MS0044083	0.516	30	2*	1.5	193.8	8.61	39.4	233.2
MS0043346	0.174	45	0.44**	1.5	98.0	0.64	2.9	100.9
MS0034304	0.16	30	2*	1.5	60.1	2.67	12.2	72.3
MS0042315	0.21	45	2*	1.5	118.3	3.51	16.0	134.3

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)
MS0043826, 001	0.5	--	--	2.5	2300.0	434.0	1983.4	4283.4
MS0043826, 002	0.3	10	2	1.5	37.6	5.01	22.9	60.4
MS0040185	0.02	30	2*	1.5	7.5	0.33	1.5	9.0
MS0022705	0.16	30	2*	1.5	60.1	2.67	12.2	72.3
MS0029203	0.01	30	2*	2.3	5.8	0.17	0.8	6.5
MS0048551	0.28***	60	10.7**	2.5	350.5	25.00	114.3	464.8
MS0048356	0.02	30	2*	1.5	7.5	0.33	1.5	9.0
MS0023833	6.32	30	2*	1.5	2373.6	105.5	482.1	2855.7
MS0048003	0.008	30	2*	1.5	3.0	0.13	0.6	3.6
MS0020231	0.75	30	2*	1.5	281.7	12.52	57.2	338.9
MS0034169	0.04	30	2*	1.5	15.0	0.7	3.1	18.1
MS0024660	0.66	30	2*	2.3	380.1	11.02	50.3	430.4
MS0032701	0.01	30	2*	1.5	3.8	0.17	0.8	4.5
MS0049905	0.1	45	2*	1.5	56.3	1.67	7.6	64.0
MS0024716	0.075	45	2*	1.5	42.3	1.25	5.7	48.0
MS0055361	0.08	30	2*	1.5	30.0	1.34	6.1	36.1
MS0001317	0.132	30	2*	1.5	49.6	2.20	10.1	59.6
MS0043281	0.001	30	2*	1.5	0.4	0.02	0.1	0.5
MS0024724	0.06	45	2*	1.5	33.8	1.00	4.6	38.4
MS0044709	0.06	45	2*	1.5	33.8	1.00	4.6	38.4
MS0051098	0.954	40	10	2.5	796.2	79.6	363.9	1160.1
MS0043982	0.005	30	2*	2.3	2.9	0.08	0.4	3.3
MS0059552	0.003	30	2*	2.3	1.7	0.05	0.2	2.0

*Assumed Value
** Average Value based on monitoring data
*** Long term flow from permit rationale

Direct measurements of background concentrations of CBODu near the modeled flow rates were not available for the Tallahatchie and Yazoo Rivers. Because there were no data available, the background concentrations of CBODu and 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 concentration used in modeling for BOD_5 is 1.33 mg/l and for NH_3-N is 0.1 mg/l. These concentrations were also used as estimates for the CBODu and NH_3-N levels of water entering the water bodies through tributaries.

Non-point source flows were included in the model to account for water entering due to groundwater infiltration, overland flow, and small, unmeasured tributaries. These flows were estimated based on USGS data for the 7Q10 flow condition in the Tallahatchie and Yazoo Rivers watershed. They were then added into the tributaries of the model at the appropriate locations based on USGS (Telis, 1991). The background loads, Table 12, were determined by applying the mixing equation to the model output for the segments upstream of the TMDL segments. Therefore, these values represent the effects of point and non-point sources on the water bodies.

Table 12. Background Loads Input into the Model

Background Loads	Flow (cfs)	$CBOD_u$ (mg/l)	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
MSUTALARE	164.2	1.78	1,575.4	0.08	323.6	1,899.0
MSTALARE	615.1	1.40	4,641.6	0.07	1,060.6	5,702.2
MSYAZR3E	723.3	0.61	2,378.1	0.03	534.5	2,912.6

3.4 Model Calibration

The model used to develop the Tallahatchie and Yazoo Rivers TMDL was not calibrated due to lack of instream monitoring data collected during critical conditions. Future monitoring is needed 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 Tallahatchie and Yazoo Rivers. The model was first run under regulatory load conditions. Under regulatory load conditions, the load from the NPDES permitted point sources were set at their current location and maximum permit limits, Table 11.

3.5.1 Regulatory Load Scenario

The regulatory load scenario model results are shown in Figure 8. Figure 8 shows the modeled daily average DO with the NPDES permit at its maximum allowable loads and with estimated non-point source loads. The figure shows the daily average instream DO concentrations, beginning with the headwaters and ending at the downstream end of segment MSYAZR3E. 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.

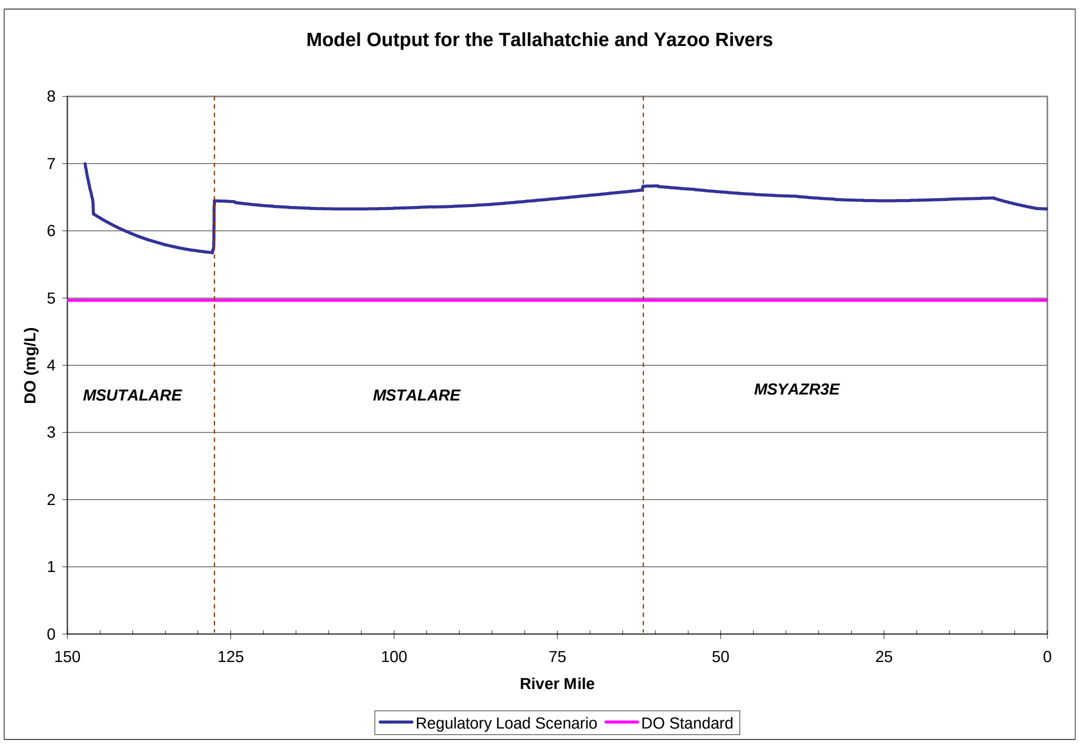


Figure 8. Model Output for the Tallahatchie and Yazoo Rivers for DO, Regulatory Load Scenario

3.5.2 Maximum Load Scenario

The graph of the regulatory load scenario output shows that the predicted DO does not fall below the DO standard in the Tallahatchie and Yazoo Rivers during critical conditions. Thus, reductions from the loads of TBODu are not necessary. Calculating the maximum allowable load of TBODu involved breaking the model into three separate models which began at the headwaters of each segment. The initial condition for each model was then calculated by using the mixing equation and the output of the upstream model. Since there was no non-point source loads the maximum allowable loads were calculated by increasing the mixing equation loads and running the model using a trial-and-error process until the modeled DO was just above 5.0 mg/l. The increased loads were used to develop the allowable maximum daily load for this report. The mixing equation loads were increased by a factor of 1.7 for MSUTALARE, 21 for MSTALARE, and 4.5 for MSYAZR3E. The model output for DO with the increased loads is shown in Figure 9.

Figure 9 shows the modeled instream DO concentrations in the Tallahatchie and Yazoo Rivers 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.

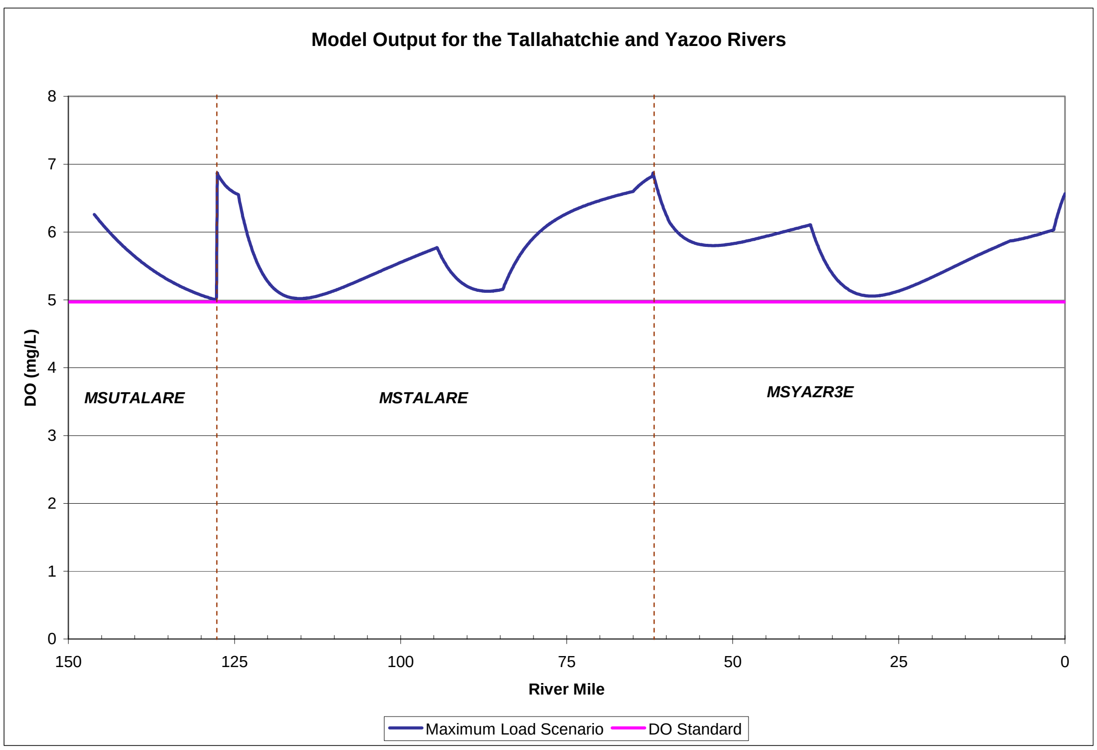


Figure 9. Model Output for the Tallahatchie and Yazoo Rivers for DO, Maximum Load Scenario

ALLOCATION

The allocation for this TMDL involves a wasteload allocation and a load allocation for non-point sources necessary for attainment of water quality standards in the Tallahatchie and Yazoo Rivers.

4.1 Wasteload Allocation

There are currently twenty eight NPDES permits issued for the buffer zone of the Tallahatchie and Yazoo Rivers. Although this wasteload allocation is based on the current condition of the Tallahatchie and Yazoo Rivers, it is not intended to prevent the issuance of permits for future facilities. Future permits will be considered in accordance with Mississippi's *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.* The NPDES permitted facilities included in the wasteload allocation are shown in Table 13 and the wasteload allocations for the segments is summarized in Table 14 based on which segment they discharge in as shown in the segment column of Table 13. The point sources in upstream segments are not included in the WLAs of the downstream segments because they are already accounted for in the mixing equation loads.

Table 13. Wasteload Allocation by Facility

Facility Name	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)	Segment
Belzoni POTW	732.4	99.2	831.5	MSYAZR3E
Bunge North America, Incorporate	112.5	6.9	119.4	MSUTALARE
Charleston POTW	193.8	39.4	233.2	MSUTALARE
Confish Inc	98.0	2.9	100.9	MSYAZR3E
Crowder POTW	60.1	12.2	72.3	MSUTALARE
Cruger POTW	118.3	16.0	134.3	MSYAZR3E
Delta Pride Catfish Inc, Belzoni	2300.0	1983.4	4283.4	MSYAZR3E
Delta Pride Catfish Inc, Belzoni	37.6	22.9	60.4	MSYAZR3E
East Leflore County Water and Sewer District POTW, Chapman Subdivision	7.5	1.5	9.0	MSYAZR3E
East Leflore County Water and Sewer District POTW, Rising Sun Subdivision	60.1	12.2	72.3	MSYAZR3E
Florewood State Park	5.8	0.8	6.5	MSYAZR3E
Freshwater Farms Products LLC	350.5	114.3	464.8	MSYAZR3E
Glendora POTW	7.5	1.5	9.0	MSTALARE
Greenwood POTW	2373.6	482.1	2855.7	MSYAZR3E
Humphreys Academy	3.0	0.6	3.6	MSYAZR3E
Lambert POTW	281.7	57.2	338.9	MSTALARE
Malouf Trailer Park	15.0	3.1	18.1	MSYAZR3E
Marks POTW	380.1	50.3	430.4	MSUTALARE
Miles Homes Subdivision	3.8	0.8	4.5	MSTALARE
Minter City Water and Sewer District	56.3	7.6	64.0	MSTALARE

Morgan City Water and Sewer Association	42.3	5.7	48.0	MSYAZR3E
Phillip Water and Sewer Association	30.0	6.1	36.1	MSTALARE
PYCO Industries Inc	49.6	10.1	59.6	MSYAZR3E
Quitman County Residential Treatment Facility	0.4	0.1	0.5	MSTALARE
Sidon POTW	33.8	4.6	38.4	MSYAZR3E
Silver City POTW	33.8	4.6	38.4	MSYAZR3E
T T and W Farm Products Inc	796.2	363.9	1160.1	MSYAZR3E
Tepper Headstart	2.9	0.4	3.3	MSYAZR3E
Three Forks LLC	1.7	0.2	2.0	MSTALARE
	8,188.2	**3,310.5**	**11,498.7**	

Table 14. Wasteload Allocation Summary Table

Segment	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
MSUTALARE	746.5	108.9	855.4
MSTALARE	381.4	73.5	454.9
MSYAZR3E	7,060.3	3,128.1	10,188.4

4.2 Load Allocation

The load allocation for this TMDL was determined as described in the Maximum Load Scenario, Section 3.5.2. This procedure involved increasing the mixing equation loads until the modeled DO was just above 5 mg/L. The mixing equation loads account for the effects of upstream point and non-point sources. This TMDL does not require a reduction of the load allocation, Table 15.

Table 15. Load Allocation, Maximum Scenario

Segment	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
MSUTALARE	2,681.9	549.9	3,231.8
MSTALARE	108,683.2	24,181.7	132,864.9
MSYAZR3E	127,417.9	28,398.9	155,816.8

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 for this TMDL 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 bodies represented by the low-flow, high-temperature 7Q10 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 background loads calculated in the maximum load scenario and the regulatory load scenario background loads. MDEQ set the explicit MOS as the difference in these loads. The calculated MOS is shown in Tables 16 through 18.

Table 16. Calculation of Explicit MOS, MSUTALARE

	Maximum Background Load	Regulatory Background Load	Margin of Safety	Future Development
CBODu (lbs/day)	2,681.9	1,575.4	276.6	829.9
NBODu (lbs/day)	549.9	323.6	56.6	169.7
TBODu (lbs/day)	3,231.8	1,899.0	333.2	999.6

Table 17. Calculation of Explicit MOS, MSTALARE

	Maximum Background Load	Regulatory Background Load	Margin of Safety	Future Development
CBODu (lbs/day)	108,683.2	4,641.6	26010.4	78031.2
NBODu (lbs/day)	24,181.7	1,060.6	5780.3	17340.8
TBODu (lbs/day)	132,864.9	5,702.2	31790.7	95372.0

Table 18. Calculation of Explicit MOS, MSYAZR3E

	Maximum Background Load	Regulatory Background Load	Margin of Safety	Future Development
CBODu (lbs/day)	127,417.9	2,378.1	31260.0	93779.8
NBODu (lbs/day)	28,398.9	534.5	6966.1	20898.3
TBODu (lbs/day)	155,816.8	2,912.6	38226.0	114678.2

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, known as the 7Q10 flow. 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 TMDL was calculated based on Equation 6.

TMDL = WLA + LA + MOS **(Eq. 6)**

The TMDL for TBODu was calculated based on the current loading of pollutant in the Tallahatchie and Yazoo Rivers, according to the model. The TMDL calculations are shown in Tables 19 through Table 21. As shown in the tables, the TBODu is the sum of CBODu and NBODu. The wasteload allocations incorporate the CBODu contributions from identified NPDES Permitted facilities. The load allocations include the background loads of TBODu from surface runoff and groundwater infiltration as well as the effects of upstream point sources as since the background conditions were determined by the mixing equation. The implicit margin of safety for this TMDL is derived from the conservative assumptions used in setting up the model, while the explicit margin of safety is calculated based on the maximum loads scenario explained in Section 3.5.2.

Table 19. TMDL for TBODu in the Tallahatchie River (MSUTALARE)

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
CBODu	746.5	2,681.9	1,106.5	4,534.9
NBODu	108.9	549.9	226.3	8,85.1
TBODu	855.4	3,231.8	1,332.8	5,420.0

Table 20. TMDL for TBODu in the Tallahatchie River (MSTALARE)

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
CBODu	381.4	108,683.2	104,041.6	213,106.2
NBODu	73.5	24,181.7	23,121.1	47,376.3
TBODu	454.9	132,864.9	127,162.7	260,482.5

Table 21. TMDL for TBODu in the Yazoo River (MSYAZR3E)

	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
CBODu	7,060.3	127,417.9	125,039.8	259,518.0
NBODu	3,128.1	28,398.9	27,864.4	59,391.4
TBODu	10,188.4	155,816.8	152,904.2	318,909.4

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 loads.

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 Tallahatchie and Yazoo Rivers are meeting water quality standards for dissolved oxygen at the present loading of TBODu. Therefore, no permit reductions are needed. Also, this TMDL does not limit the issuance of new permits in the watershed as long as new facilities do not cause impairment in the Tallahatchie or Yazoo Rivers.

5.1 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 TMDLs 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. Anyone wishing to become a member of the TMDL mailing list should contact Kay Whittington at Kay_Whittington@deq.state.ms.us.

All comments should be directed to Kay Whittington at Kay_Whittington@deq.state.ms.us or Kay Whittington, 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.

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