

# **Total Maximum Daily Load**

## **Nutrients and Organic Enrichment / Low**

### **Dissolved Oxygen For**

#### **Big Creek**

## **Pearl River Basin**

### **Hinds County,**

### **Mississippi**

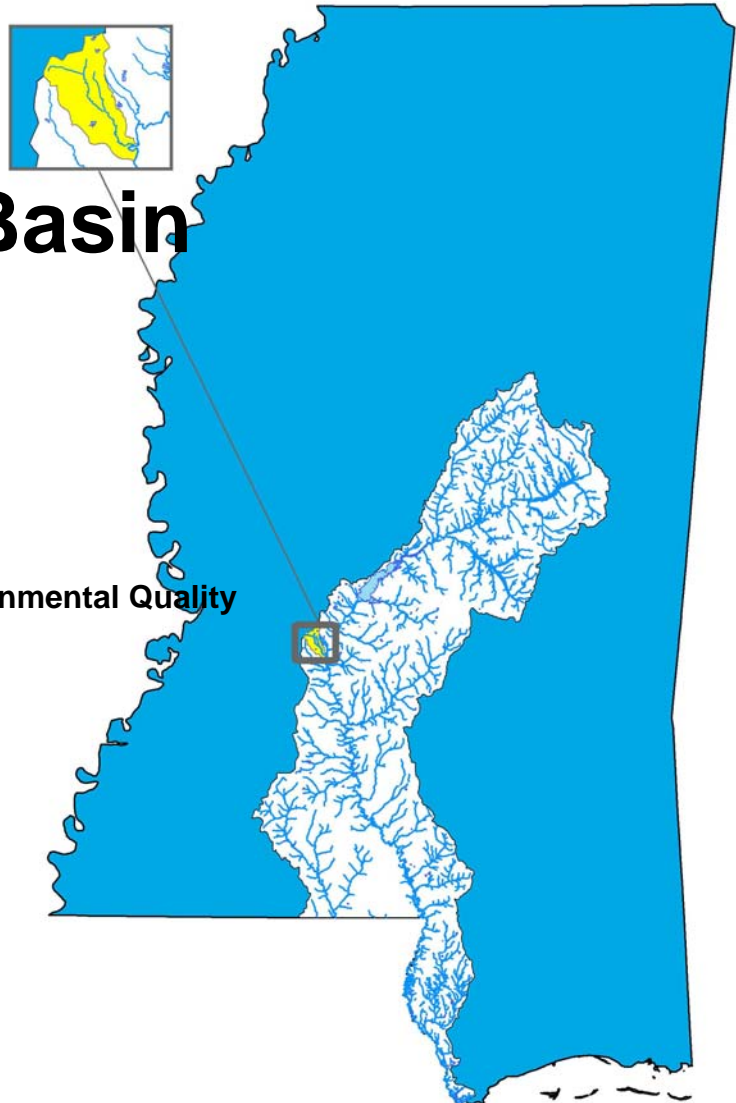
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## FOREWORD

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 <sup>2</sup>	acre	640	acre	ft <sup>2</sup>	43560
km <sup>2</sup>	acre	247.1	days	seconds	86400
m <sup>3</sup>	ft <sup>3</sup>	35.3	meters	feet	3.28
ft <sup>3</sup>	gallons	7.48	ft <sup>3</sup>	gallons	7.48
ft <sup>3</sup>	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 <sup>3</sup>	gallons	264.2	µg/l * cfs	gm/day	2.45
m <sup>3</sup>	liters	1000	µg/l * MGD	gm/day	3.79

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

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## TMDL INFORMATION PAGE

**Table 1. Listing Information**

Name	ID	County	HUC	Evaluated Cause
<b>Big Creek</b>	MS159E	Hinds	03180002	Nutrients and Organic Enrichment / Low DO
Near Byram from Headwaters to the Pearl River				

**Table 2. Water Quality Standards**

Parameter	Beneficial use	Water Quality Criteria
<b>Nutrients</b>	Aquatic Life Support	Waters shall be free from materials attributable to municipal, industrial, agricultural, or other dischargers 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 uses.
<b>Dissolved Oxygen</b>	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. Natural conditions are defined as background water quality conditions due only to non-anthropogenic sources. The criteria herein apply specifically with regard to substances attributed to sources (discharges, nonpoint sources, or instream activities) as opposed to natural phenomena. Waters may naturally have characteristics outside the limits established by these criteria. Therefore, naturally occurring conditions that fail to meet criteria should not be interpreted as violations of these criteria.

**Table 3. Total Maximum Daily Load for Big Creek**

	WLA lbs/day	LA lbs/day	MOS	TMDL lbs/day
Total Nitrogen	<b>14.82</b>	<b>133.91</b>	<b>Implicit</b>	<b>148.73</b>
Total Phosphorous	<b>6.70</b>	<b>14.55</b>	<b>Implicit</b>	<b>21.25</b>
TBODu	<b>1255.71</b>	<b>1.25</b>	<b>Implicit</b>	<b>1256.96</b>

**Table 4. Point Source Loads for Big Creek**

Permit	Facility	Flow MGD	TN Load lbs/day	TP Load lbs/day	TBODu lbs/day
MS0045837	Child Care Management Group	0.0015	0.14	0.07	0.98
MS0045161	The Child Development Center	0.001	0.10	0.04	0.65
MS0057819	David K. May Office	0.0005	0.06	0.02	0.33
MS0043541	Siwell Utilities	0.525	0.00	0.00	0.00
MS0042099	Gary Road Elementary	0.0139	1.33	0.60	2.80
MS0044059	Jackson Trahon POTW <sup>1</sup>	4.5	-	-	1206.21
MS0059323	Yates Construction	0.0006	0.06	0.03	0.39
MS0023469	Byram Attendance Center	0.0225	2.16	0.98	12.73
MS0044792	Red River Utility	0.1144	10.97	4.96	31.62
	<b>Total</b>		<b>14.82</b>	<b>6.70</b>	<b>1255.71</b>

<sup>1</sup> Refer to section 4.1: Wasteload Allocation

## EXECUTIVE SUMMARY

This TMDL has been developed for Big Creek which was placed on the Mississippi 2008 Section 303(d) List of Impaired Water Bodies. Big Creek was listed due to biological impairment. A stressor identification report indicated that organic enrichment / low dissolved oxygen, nutrients, and sediment were the primary probable stressors for the stream. Sediment will be addressed in a separate TMDL report. This TMDL will provide an estimate of the total biochemical oxygen demand (TBODu), total nitrogen (TN), and total phosphorus (TP) allowable in this water body.

Mississippi does not have water quality standards for allowable nutrient concentrations. MDEQ currently has a Nutrient Task Force (NTF) working on the development of criteria for nutrients. An annual concentration of 0.7 mg/l is an applicable target for TN and 0.10 mg/l for TP for water bodies located in ecoregion 65. MDEQ is presenting these preliminary target values for TMDL development which are subject to revision after the development of numeric nutrient criteria.

The Big Creek Watershed is located in HUC 03180002. The listed portion of Big Creek is near Byram from the headwaters to the Pearl River. The location of the watershed for the listed segment is shown in Figure 1.

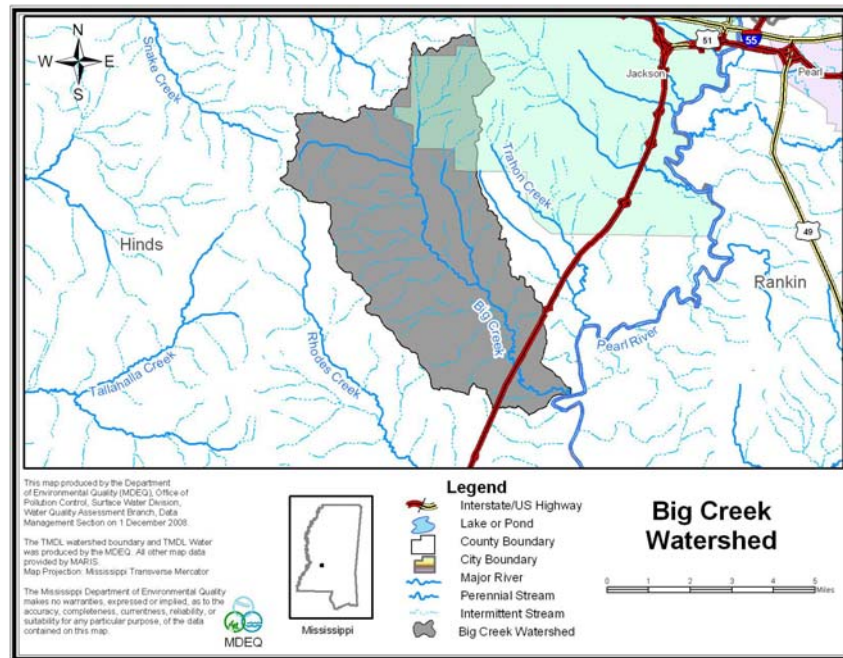


Figure 1. Big Creek

The Big Creek watershed mass balance calculations showed that the estimated existing TP and TN concentrations indicate reductions of nutrients are needed from both point sources and non-point sources. Additionally, according to the STREAM model, the current TBODu load in the water body exceeds the assimilative capacity of Big Creek for organic material at the critical conditions. Therefore, permit reductions are recommended in order to protect water quality. There are currently 9 facilities in the watershed. One facility's discharge (Siwell Utilites) will be taken offline and connected to the Jackson Trahon POTW. MDEQ believes that with the *Pearl River Basin*

elimination of this discharge and with the installation of best management practices, a significant reduction in TN, TP, and organic enrichment will allow the stream to meet water quality standards.



## 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 2008 §303(d) listed segment shown in Figure 2.

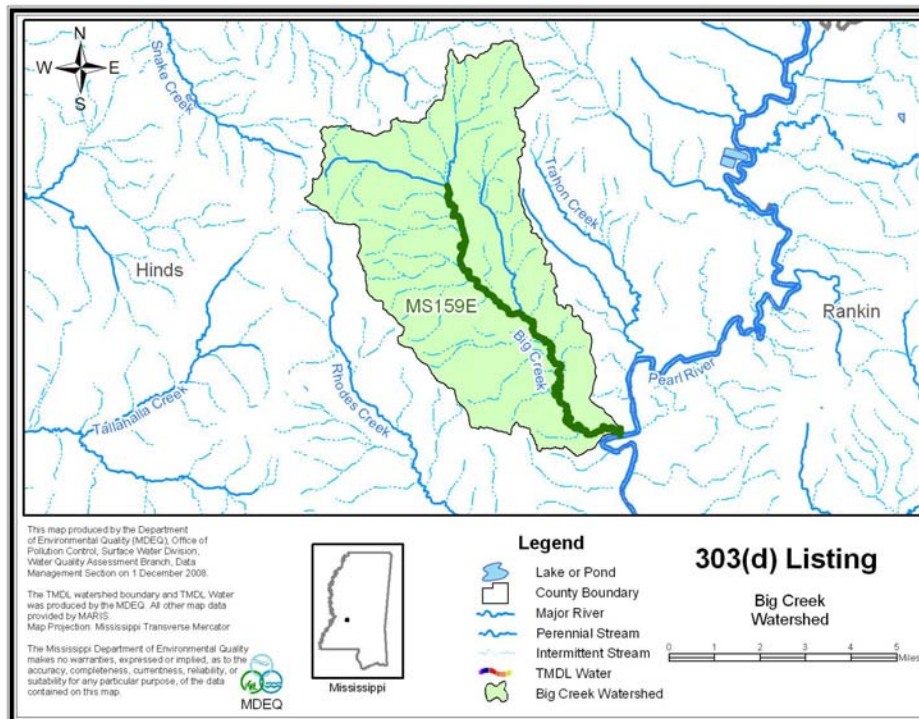


Figure 2. Big Creek §303(d) Listed Segment

### 1.2 Listing History

The impaired segment was monitored and found to be biologically impaired. In 2001, Big Creek was determined to be biologically impaired due to organic enrichment and nutrients. A stressor identification report was completed by MDEQ in 2006 and details the findings of the creek.

There are no state criteria in Mississippi for nutrients. These criteria are currently being developed by the Mississippi Nutrient Task Force in coordination with EPA Region 4. MDEQ proposed a work plan for nutrient criteria development that has been mutually agreed upon with EPA Region 4 and is on schedule according to the approved timeline for development of nutrient criteria (MDEQ, 2007).

### 1.3 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.

### 1.4 Applicable Water Body Segment Standards

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, 2007). Mississippi's current standards contain a narrative criteria that can be applied to nutrients which states “*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, 2007).”

The standard for dissolved oxygen states, “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.” In addition, the State water quality standard regulations include a natural condition clause which will be used to determine the appropriate DO for Big Creek under critical conditions. Natural conditions are defined as background water quality conditions due only to non-anthropogenic sources. The criteria herein apply specifically with regard to substances attributed to sources (discharges, nonpoint sources, or instream activities) as opposed to natural phenomena. Waters may naturally have characteristics outside the limits established by these criteria. Therefore, naturally occurring conditions that fail to meet criteria should not be interpreted as violations of these criteria.

### 1.5 Nutrient Target Development

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 professional judgment.*”

For this TMDL, MDEQ is presenting preliminary targets for TN and TP. An annual concentration 0.7 mg/l is an applicable target for TN and 0.1 mg/l for TP for water bodies located in ecoregion 65. However, MDEQ is presenting these preliminary target values for TMDL development which are subject to revision after the development of nutrient criteria, when the work of the NTF is complete.

## **WATER BODY ASSESSMENT**

### **2.1 Water Quality Data**

The impaired segment was monitored and found to be biologically impaired due to organic enrichment and nutrients. Data exist for IBI Site 305. Based upon this completed stressor identification report, the strength of evidence analysis showed low DO to be a primary probable cause of impairment. Some biological metrics also indicated altered food sources (nutrient enrichment). Physical/chemical data from M-BISQ and 2005 recon indicate low DO and DO% saturation measurements at one site. Nutrients were slightly elevated over the Least Disturbed (LD)/Site Specific Comparators (SSC) with TKN exceeding screening level. No historical data are available. A few potential sources exist in the watershed for this cause including urban runoff and chronic septic issues in the tributary above the IBI site, point source discharges with several lagoons, subdivision impoundments, and hydrologic alteration (ponding) enabling minimal reaeration.



**Figure 3. Dye Boat located on Big Creek**

## 2.2 Assessment of Point Sources

There are 9 NPDES point sources in the watershed included in the TMDL. Table 5 indicates the existing estimates of loads for the modeled outfalls at the maximum daily load scenario (See section 3.5.2).

**Table 5. Loads from Point Sources**

NPDES	Facility	Flow (MGD)	TN Load (lbs/day)	TP Load (lbs/day)	CBOD <sub>u</sub> (lbs/day)	NBOD <sub>u</sub> (lbs/day)	TBOD <sub>u</sub> (lbs/day)
MS0045837	Child Care Management Group	0.0015	0.14	0.07	0.86	0.11	0.98
MS0045161	The Child Development Center	0.001	0.10	0.04	0.58	0.08	0.65
MS0057819	David K. May Office	0.0005	0.06	0.02	0.29	0.04	0.33
MS0043541	Siwell Utilities	0.525	50.35	22.77	100.71	40.02	140.72
MS0042099	Gary Road Elementary	0.0139	1.33	0.60	5.22	2.65	7.87
MS0044059	Jackson Trahon POTW	4.5	510.41	217.67	863.19	343.02	1206.21
MS0059323	Yates Construction	0.0006	0.06	0.03	0.35	0.05	0.39
MS0023469	Byram Attendance Center	0.0225	2.16	0.98	8.44	4.29	12.73
MS0044792	Red River Utility	0.1144	10.97	4.96	42.93	21.80	64.74
	<b>Total</b>		<b>575.58</b>	<b>247.14</b>	<b>1022.56</b>	<b>412.06</b>	<b>1434.62</b>

## 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, groundwater infiltration, and atmospheric deposition. The two primary nutrients of concern are nitrogen and phosphorus. Total nitrogen is a combination of many forms of nitrogen found in the environment. Inorganic nitrogen can be transported in particulate and dissolved phases in surface runoff. Dissolved inorganic nitrogen can be transported in groundwater and may enter a water body from groundwater infiltration. Finally, atmospheric gaseous nitrogen may enter a water body from atmospheric deposition.

Unlike nitrogen, phosphorus is primarily transported in surface runoff when it has been sorbed by eroding sediment. Phosphorus may also be associated with fine-grained particulate matter in the atmosphere and can enter streams as a result of dry fallout and rainfall (USEPA, 1999). However, phosphorus is typically not readily available from the atmosphere or the natural water supply (Davis and Cornwell, 1988). As a result, phosphorus is typically the limiting nutrient in most non-point source dominated rivers and streams, with the exception of watersheds which are dominated by agriculture and have high concentrations of phosphorus contained in the surface



runoff due to fertilizers and animal excrement or watersheds with naturally occurring soils which are rich in phosphorus (Thomann and Mueller, 1987).

Watersheds with a large number of failing septic tanks may also deliver significant loadings of phosphorus to a water body. All domestic wastewater contains phosphorus which comes from humans and the use of phosphate containing detergents. Table 6 presents the estimated loads from various land use types in the Pearl Basin based on information from USDA ARS Sedimentation Laboratory. (Shields, et. al., 2008)

The watershed contains mainly forest land but also has different landuse types, including urban, water, and wetlands. The land use information for the watershed is based on the National Land Cover Database (NLCD). The landuse distribution for the Big Creek Watershed is shown in Table 6 and Figure 4. By multiplying the landuse category size by the estimated nutrient load, the watershed specific estimate can be calculated. Table 6 presents the estimated loads and the target loads to meet the TMDLs.

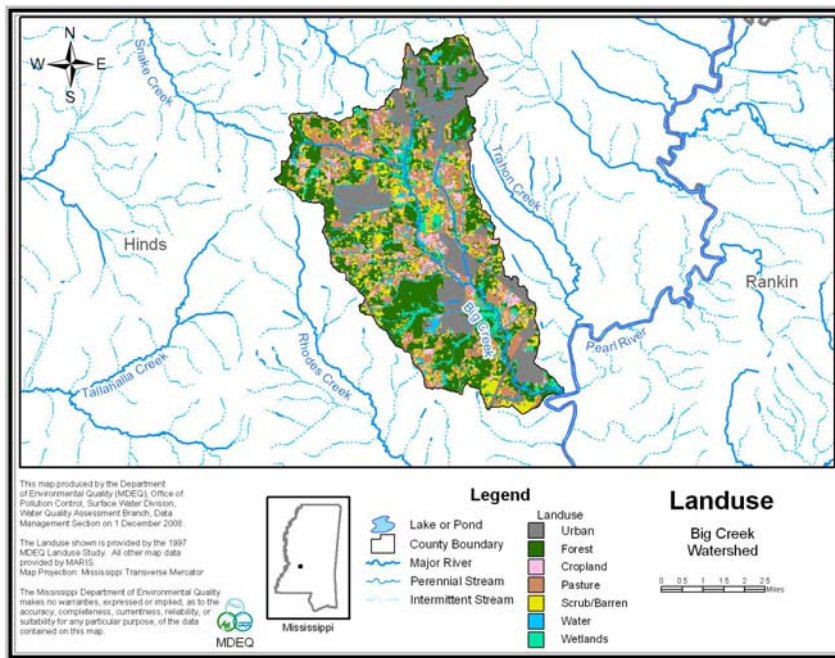


Figure 4. Big Creek Watershed Landuse

## 2.4 Estimated Existing Load for Total Nitrogen and Total Phosphorus

The average annual flow in the watershed was calculated by utilizing the flow vs. watershed area graph shown in Figure 5. All available gages were compared to the watershed size. A very strong correlation between flow and watershed size was developed for the Pearl and South Independent Streams Basins. The equation for the line that best fits the data was then used to estimate the annual average flow for the Big Creek watershed. The TMDL target TN and TP loads were then calculated, using Equation 1 and the results are shown in Table 6.

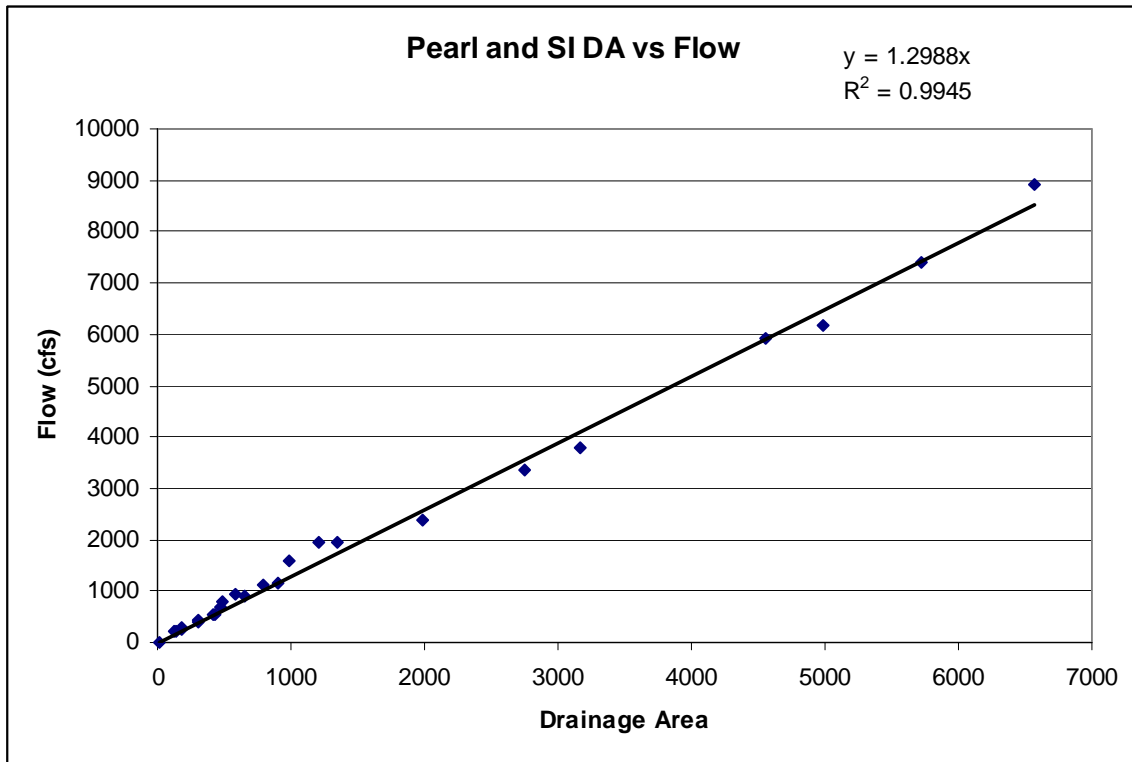


Figure 5. Pearl and South Independent Drainage Area to Flow Comparison

$$\text{Nutrient Load (lb/day)} = \text{Flow (cfs)} * 5.394 \text{ (conversion factor)} * \text{Nutrient Concentration (mg/L)}$$

(Equation 1)

**Table 6. TMDL Calculations and Watershed Sizes**

<b>Water body</b>	<b>Big Creek</b>		<b>Water</b>	<b>Urban</b>	<b>Scrub/Barren</b>	<b>Forest</b>	<b>Pasture/Grass</b>	<b>Cropland</b>	<b>Wetland</b>	<b>Total</b>	
		Acres	245.97	4453.68	2714.33	6015.56	3540.30	1067.94	1371.95	19409.73	
<b>Land Use</b>	<b>TN</b>										
	<b>kg/mile<sup>2</sup></b>	Percent	1.27	22.95	13.98	30.99	18.24	5.50	7.07	100.00	
Forest	111.3	Miles <sup>2</sup> in watershed	0.38	6.96	4.24	9.40	5.53	1.67	2.14	30.33	
Pasture	777.2	Flow in cfs based on area	39.39	cfs							
Cropland	5179.9										
Urban	296.4	TN Load kg/mi <sup>2</sup> annual avg	257.40	296.4	111.3	111.3	777.2	5179.9	265.2		
Water	257.4	TP Load kg/mi <sup>2</sup> annual avg	257.40	3.1	62.1	62.1	777.2	2589.9	265.2		
Wetland	265.2										
aquaculture	111.3	TN Load kg/day	0.27	5.65	1.29	2.87	11.78	23.68	1.56	47.10	kg/day
		TP Load kg/day	0.27	0.06	0.72	1.60	11.78	11.84	1.56	27.83	kg/day
<b>Land Use</b>	<b>TP</b>										
	<b>kg/mile<sup>2</sup></b>										
Forest	62.1	TN target concentration	0.70	mg/l							
Pasture	777.2	TP target concentration	0.10	mg/l							
Cropland	2589.9										
Urban	3.1	TN estimated concentration	0.49	mg/l							
Water	257.4	TP estimated concentration	0.29	mg/l							
Wetland	265.2										
aquaculture	62.1	TN target load	148.73	lbs/day							
		TP target load	21.25	lbs/day							
		TBODu target load	1255.53	lbs/day	based on STREAM model output						
		TN estimated load per day	103.84	lbs/day							
		TP estimated load per day	61.35	lbs/day							
		TBODu estimated load per day	1435.87	lbs/day							
		TN reduction needed	NA								
		TP reduction needed	65.4%								
		TBODu reduction needed	12.6%								

The land use calculations are based on 2004 data. The nutrient estimates are based on USDA ARS. The TMDL targets are based on EPA guidance for calculation of targets when considering all available data.

## 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 CBOD<sub>u</sub> 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, CBOD<sub>u</sub>, and NH<sub>3</sub>-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<sup>-1</sup> base  $e$ ), within each reach according to Equation 2.

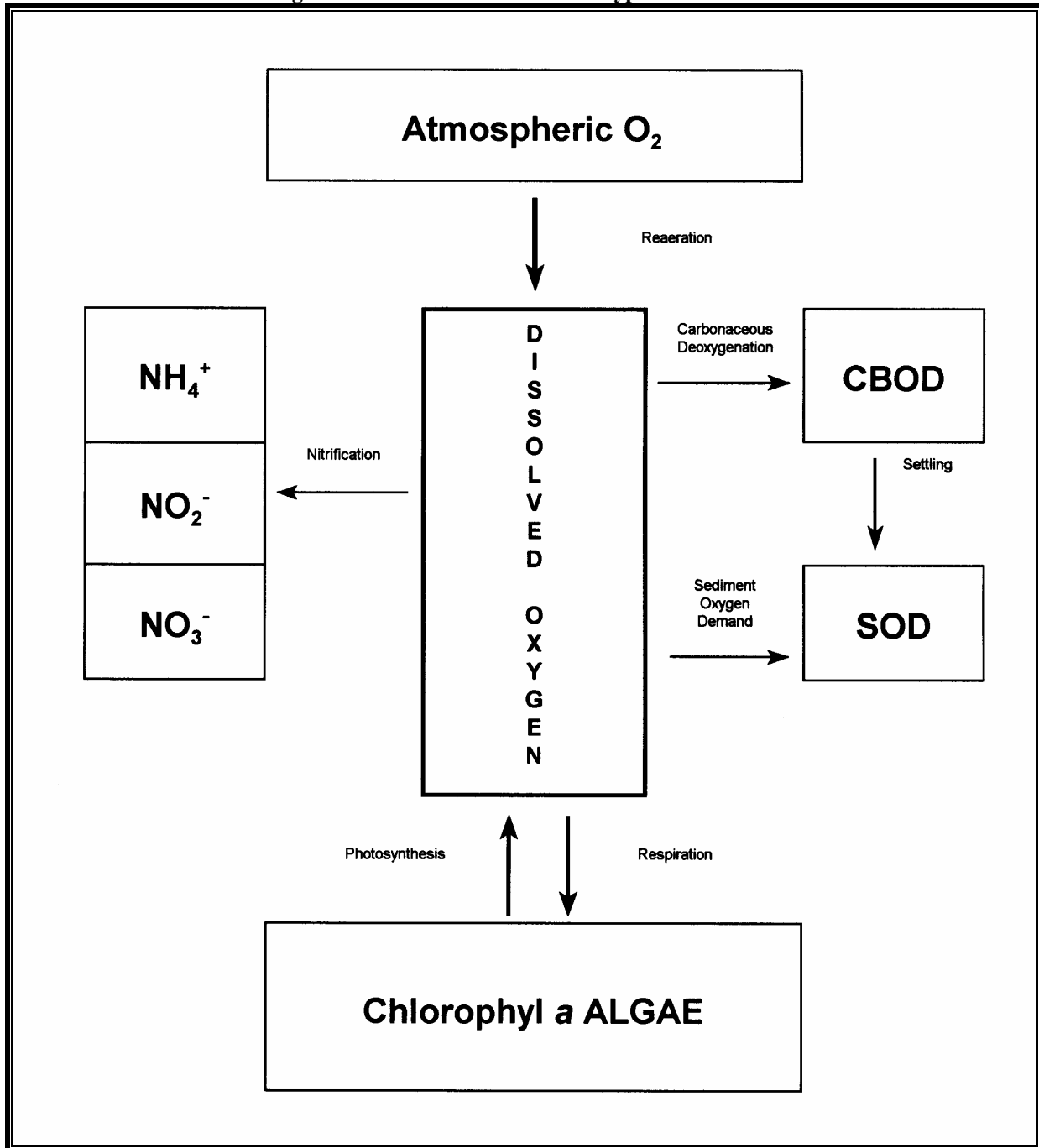
$$K_a = C*S*U \quad (\text{Eq. 2})$$

$C$  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 with the NHD Plus GIS coverage and input into the model in units of feet/mile.

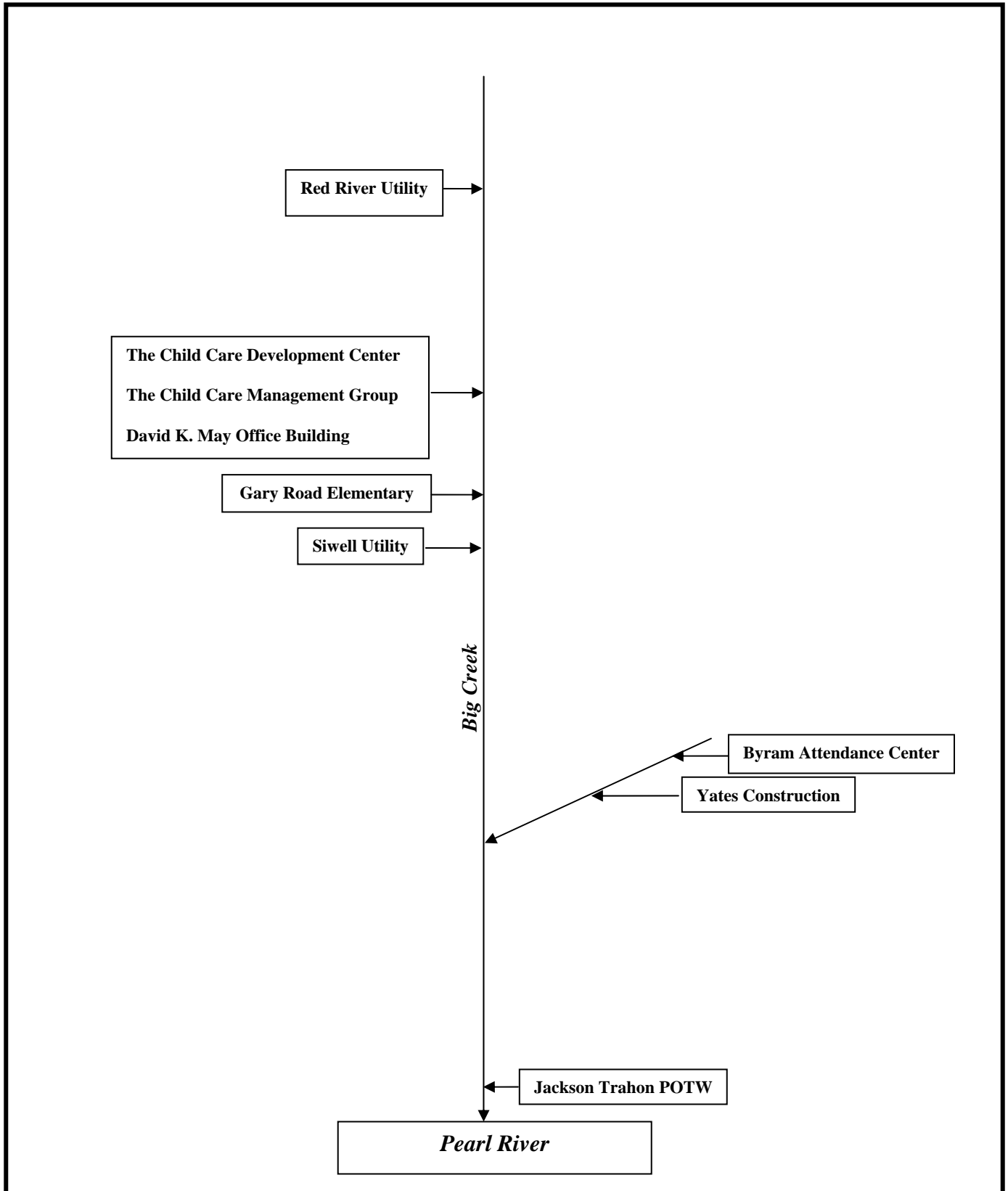
**Figure 6. Instream Processes in a Typical DO Model**



### 3.2 Model Setup

The model for this TMDL includes the §303(d) listed segment of Big Creek, beginning at the headwaters. A diagram showing the model setup is shown in Figure 7.

Figure 7. Big Creek 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. MDEQ Regulations state that when the flow in a water body is less than 50 cfs, the temperature used in the model is 26°C. The headwater instream DO was assumed to be 85% of saturation at the stream temperature. The instream CBOD<sub>u</sub> decay rate at  $K_d$  at 20°C was input as 0.3 day<sup>-1</sup> (base e) as specified in MDEQ regulations. The model adjusts the  $K_d$  rate based on temperature, according to Equation 3.

$$K_{d(T)} = K_{d(20^{\circ}\text{C})}(1.047)^{T-20} \quad (\text{Eq. 3})$$

Where  $K_d$  is the CBOD<sub>u</sub> decay rate and T is the assumed instream temperature. The assumptions regarding the instream temperatures, background DO saturation, and CBOD<sub>u</sub> 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.

Big Creek currently has a partial USGS flow gage. The flow in Big Creek watershed was modeled at critical conditions based on the 7Q10 from this gage which is listed in the USGS Water-Resources Investigation Report 90-4130 Low-Flow and Flow Duration Characteristics of Mississippi Streams (Telis, 1991).

### 3.3 Source Representation

Both point and non-point sources were represented in the model. The loads from the NPDES permitted point sources were added as direct inputs into the appropriate reaches as a flow in MGD and concentration of CBOD<sub>5</sub> and ammonia nitrogen in mg/l.

Organic material discharged to a stream from an NPDES permitted point source is typically quantified as 5-day biochemical oxygen demand (BOD<sub>5</sub>). BOD<sub>5</sub> 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<sub>5</sub> is generally considered equal to CBOD<sub>5</sub>. Because permits for point source facilities are written in terms of

CBOD<sub>5</sub> while TMDLs are typically developed using CBOD<sub>u</sub>, a ratio between the two terms is needed, Equation 4.

$$\text{CBOD}_u = \text{CBOD}_5 * \text{Ratio} \quad (\text{Eq. 4})$$

The CBOD<sub>u</sub> to CBOD<sub>5</sub> 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<sub>3</sub>-N) loads to an oxygen demand, a factor of 4.57 pounds of oxygen per pound of ammonia nitrogen (NH<sub>3</sub>-N) oxidized to nitrate nitrogen (NO<sub>3</sub>-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 NBOD<sub>u</sub> load. The sum of CBOD<sub>u</sub> and NBOD<sub>u</sub> is equal to the point source load of TBOD<sub>u</sub>. The permitted loads of TBOD<sub>u</sub> from the existing point sources to be used in the STREAM model are given in Table 7.

**Table 7. Point Sources, Maximum Permitted Model Inputs**

NPDES	Facility	Flow (MGD)	CBOD <sub>u</sub> (lbs/day)	NBOD <sub>u</sub> (lbs/day)	TBOD <sub>u</sub> (lbs/day)
MS0045837	Child Care Management Group*	0.0015	0.86	0.11	0.98
MS0045161	The Child Development Center*	0.001	0.58	0.08	0.65
MS0057819	David K. May Office*	0.0005	0.29	0.04	0.33
MS0043541	Siwell Utilities	0.525	100.71	40.02	140.72
MS0042099	Gary Road Elementary	0.0139	5.22	2.65	7.87
MS0044059	Jackson Trahon POTW	4.5	863.19	343.02	1206.21
MS0059323	Yates Construction*	0.0006	0.35	0.05	0.39
MS0023469	Byram Attendance Center	0.0225	8.44	4.29	12.73
MS0044792	Red River Utility	0.1144	42.93	21.80	64.74
			1022.56	412.06	1434.62

\*For modeling purposes, these point sources were determined to be insignificant.

Direct measurements of background concentrations of CBOD<sub>u</sub> were not available for Big Creek. Because there were no data available, the background concentrations of CBOD<sub>u</sub> and NH<sub>3</sub>-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<sub>5</sub> is 1.33 mg/l and for NH<sub>3</sub>-N is 0.1 mg/l. These concentrations were also used as estimates for the CBOD<sub>u</sub> and NH<sub>3</sub>-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 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 Big Creek watershed. The non-point source loads were assumed to be distributed evenly on a river mile basis throughout the modeled reaches.

### **3.4 Model Calibration**

The model used to develop the Big Creek TMDL was not calibrated due to the limited amount of instream monitoring data collected during critical conditions. Future monitoring would be necessary 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 Big Creek. The model was first run under regulatory load conditions. Under regulatory load conditions, the loads from the NPDES permitted point sources were based on their current location and loads shown in Table 7.

#### **3.5.1 Regulatory Load Scenario**

As shown in the figure, the model predicts that the DO does go below the standard of 5.0 mg/l using the permit based allowable loads, thus reductions are needed to meet the current TMDL. The regulatory load scenario model results are shown in Figure 8.

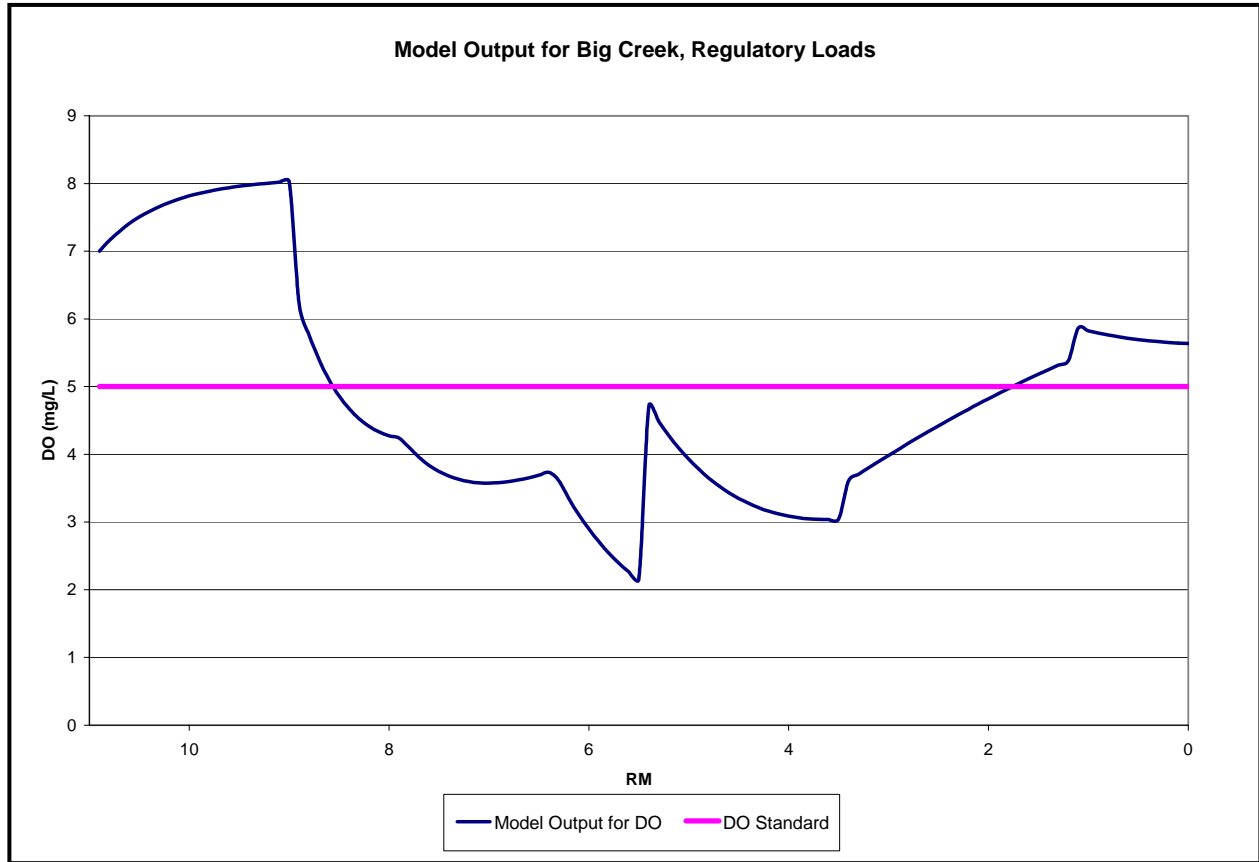
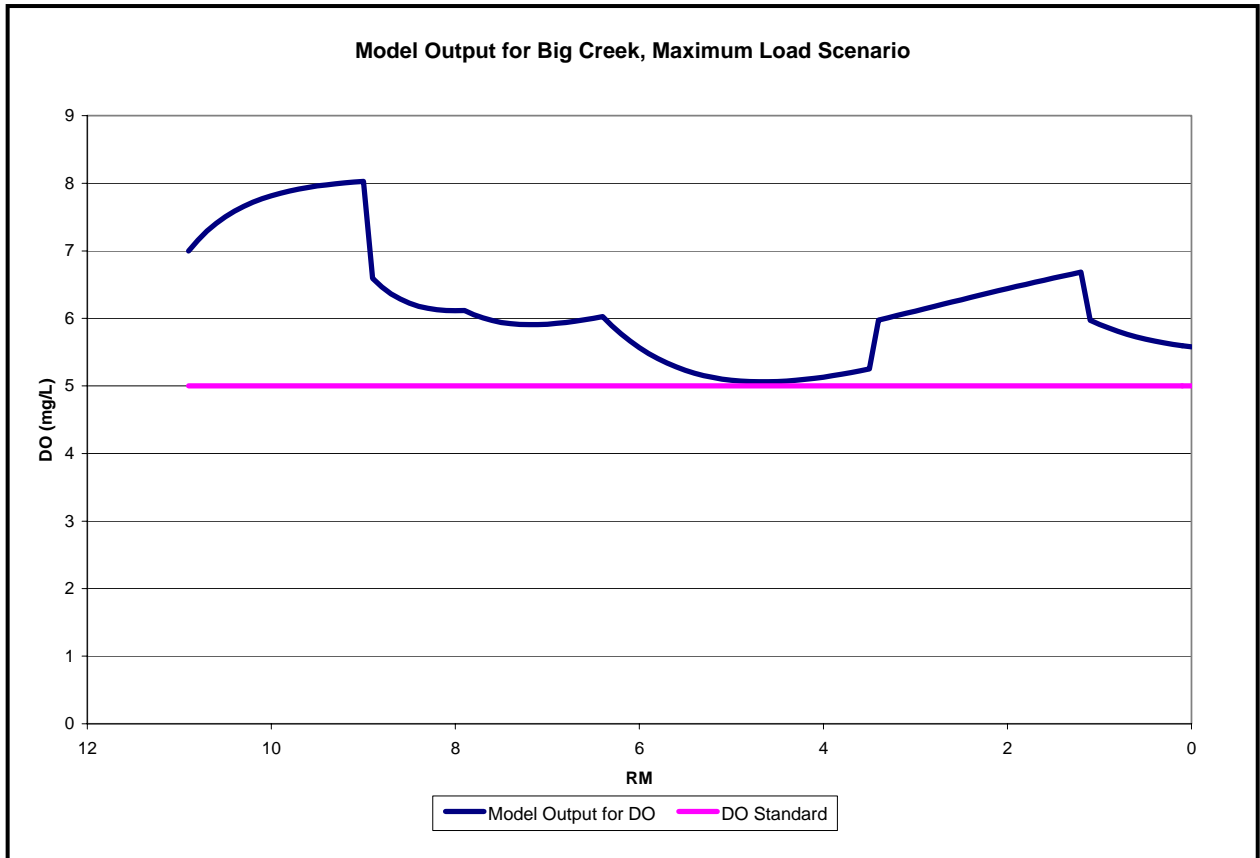


Figure 8. Model Output for DO in Big Creek, Regulatory Load Scenario

### 3.5.2 Maximum Load Scenario

The graph of the regulatory load scenario output shows that the predicted DO does fall below the DO standard in Big Creek during critical conditions. Thus, reductions of the loads of TBODu are necessary. It is noted that Siwell Utilities located at RM 5.5 will be taken offline and connected to the Jackson Trahon POTW. This discharge relocation helps reduce the DO violations downstream of RM 5.5. However, there are also violations upstream of this facility. Calculating the maximum allowable load of TBODu involved decreasing the model loads upstream of RM 5.5 until the modeled DO was above 5.0 mg/l. The non-point source loads in this model were already set at background conditions based on MDEQ regulations so no non-point source reductions were necessary. Thus, the permitted limits were decreased until the modeled DO was 5.0 mg/L. The decreased loads were then used to develop the allowable maximum daily load for this report. The maximum load scenario model results are shown in Figure 9.



**Figure 9. Model Output for DO in Big Creek, Maximum Load Scenario**

## ALLOCATION

### 4.1 Wasteload Allocation

The organic enrichment and nutrient TMDLs indicate that reductions are needed from the point sources to meet water quality standards.

It is noted that Siwell Utilities will be taken offline and connected to the Jackson Trahon POTW. MDEQ believes that the removal of this point source will have a significant impact on the water quality in the watershed, however, 2 point sources (MS0044792-Red River Utility and MS0042099-Gary Road Elementary) located above Siwell Utilities will also need reductions to help meet water quality standards.

The model results indicate that upon removal of the Siwell Utilities discharge, the nutrient portion of the TMDL does not indicate reductions are not needed from the remaining point sources. (For this report, only the point sources located above the Jackson Trahon POTW were used to calculate the point source nutrient load contribution.) The Jackson Trahon POTW is located approximately 0.8 miles from the confluence of Big Creek and the Pearl River. Therefore, it is believed that any effects of nutrients from this discharge will primarily be seen in the Pearl River. MDEQ recently completed a DRAFT nutrient TMDL report for the Pearl River. (MDEQ, 2008) This nutrient TMDL addresses the reductions that are necessary from the Jackson Trahon POTW in order to meet the nutrient targets. Tables 8 and 9 indicate the reduction scenario selected for this TMDL.

Table 8. TMDL Loads for TN and TP

Permit	Facility	Flow MGD	TN Load <sup>2</sup>	TP Load <sup>2</sup>
			lbs/day	lbs/day
MS0045837	The Child Care Management Group	0.0015	0.14	0.07
MS0045161	The Child Development Center	0.001	0.10	0.04
MS0057819	David K. May Office	0.0005	0.06	0.02
MS0043541	Siwell Utilities*	0.00	0.00	0.00
MS0042099	Gary Road Elementary	0.0139	1.33	0.60
MS0044059	Jackson Trahon POTW**	4.50	-	-
MS0059323	Yates Construction	0.0006	0.06	0.03
MS0023469	Byram Attendance Center	0.0225	2.16	0.98
MS0044792	Red River Utility	0.1144	10.97	4.96
	<b>Total</b>		<b>14.82</b>	<b>6.70</b>

\* Connecting to Jackson Trahon POTW, \*\* Refer to Pearl River Nutrient TMDL for nutrient allocations

<sup>2</sup> No reduction necessary after Siwell Utilities is taken offline



**Table 9. TMDL Loads for TBODu**

Permit	Facility	Flow MGD	CBOD <sub>5</sub> mg/L	CBOD <sub>u</sub> lbs/day	NH <sub>3</sub> -N mg/L	NBOD <sub>u</sub> lbs/day	TBOD <sub>u</sub> lbs/day	% reduction
MS0045837	The Child Care Management Group	0.0015	30	0.86	2	0.11	0.98	0%
MS0045161	The Child Development Center	0.001	30	0.58	2	0.08	0.65	0%
MS0057819	David K. May Office	0.0005	30	0.29	2	0.04	0.33	0%
MS0043541	Siwell Utilities*	0.00	0	0.00	0	0.00	0.00	100%
MS0042099	Gary Road Elementary	0.0139	10	1.74	2	1.06	2.80	64%
MS0044059	Jackson Trahon POTW**	4.50	10	863.19	2	343.02	1206.21	0%
MS0059323	Yates Construction	0.0006	30	0.35	2	0.05	0.39	0%
MS0023469	Byram Attendance Center	0.0225	30	8.44	5	4.29	12.73	0%
MS0044792	Red River Utility	0.1144	16	22.89	2	8.72	31.62	46.6%
	<b>Total</b>			<b>898.34</b>		<b>357.37</b>	<b>1255.71</b>	<b>12.5%</b>

\* Connecting to Jackson Trahon POTW, \*\* Refer to Pearl River Nutrient TMDL for nutrient allocations

<sup>2</sup> No reduction necessary after Siwell Utilities is taken offline

## 4.2 Load Allocation

Best management practices (BMPs) should be encouraged in the watersheds to reduce potential TBOD<sub>u</sub>, TN, and TP loads from non-point sources. The LA for TN and TP was calculated by subtracting the WLA from the TMDL. The LA for TBOD<sub>u</sub> is shown in Table 10. 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 10. Load Allocation**

	Flow (MGD)	CBOD <sub>u</sub> (mg/L)	CBOD <sub>u</sub> (lbs/day)	NH <sub>3</sub> -N (mg/L)	NBOD <sub>u</sub> (lbs/day)	TBOD <sub>u</sub> (lbs/day)
<b>Background Load</b>	<b>0.06</b>	<b>2</b>	<b>1.01</b>	<b>0.1</b>	<b>0.23</b>	<b>1.25</b>
<b>Total</b>			<b>1.01</b>		<b>0.23</b>	<b>1.25</b>

## 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.

#### 4.4 Calculation of the TMDL

Equation 1 was used to calculate the TMDL for TP and TN (see Table 6). The target concentration was used with the average flow for the watershed to determine the nutrient TMDLs. The STREAM model was used to calculate the TBODu TMDL. The allocations for TN, TP, and TBODu are given in Table 11. These allocations are established to attain the applicable water quality standards.

**Table 11. TMDL Loads**

	<b>WLA lbs/day</b>	<b>LA lbs/day</b>	<b>MOS</b>	<b>TMDL lbs/day</b>
Total Nitrogen	<b>14.82</b>	<b>133.91</b>	<b>Implicit</b>	<b>148.73</b>
Total Phosphorous	<b>6.70</b>	<b>14.55</b>	<b>Implicit</b>	<b>21.25</b>
TBODu	<b>1255.71</b>	<b>1.25</b>	<b>Implicit</b>	<b>1256.96</b>

The nutrient TMDL loads were compared to the estimated existing loads previously calculated. A 65.4% reduction in TP loading is recommended based on the Land Use Land Cover estimate provided in Table 6. A TN reduction is not indicated by the estimates in Table 6, however, the stressor data indicate a TN reduction is needed.

The TN calculations indicate a WLA of 65.17 lbs in Table 5 (excluding Jackson Trahon) and a LA of 103.84 lbs in Table 6. This sums to a load of 169.01 lbs/day. The TN TMDL target load is 148.73 which is a reduction of 20.28 lbs or 12.0%.

The TP calculations indicate a WLA of 29.47 lbs in Table 5 (excluding Jackson Trahon) and a LA of 61.35 lbs in Table 6. This sums to a load of 90.82 lbs/day. The TP TMDL target load is 21.25 lbs. which is a reduction of 69.57 lbs. or 76.6%.

Siwell Utilities is currently 77% of the TN and TP point source loads in the watershed. MDEQ believes that a significant reduction in the nutrient loads will occur when this point source is connected to the regional authority. MDEQ also believes that this reduction will address the elevated nutrient levels discussed in the stressor identification report. Upon relocation of the Siwell Utilities’s discharge, no further reductions are needed from the LA for TN. However, reductions will be necessary from the LA for TP. The TP LA will need to reduce from 61.35 lbs to 14.55 lbs which is a reduction of 76.3%.

### **3.5 Seasonality and Critical Condition**

This TMDL accounts for seasonal variability by requiring allocations that ensure year-round protection of water quality standards, including during critical conditions.

## CONCLUSION

The model results indicate that Big Creek is not meeting water quality standards for dissolved oxygen at the present loading of TBODu. A reduction from some of the facilities will be necessary to help meet water quality standards. Nutrients were addressed through an estimate of a preliminary TP concentration target and a preliminary TN concentration target.

For the TMDL for TN, an overall 12% reduction is needed to meet the TN target. For the TMDL for TP, an overall 76% reduction is needed to meet the TP target. One of the facilities, Siwell Utilities, is currently scheduled to connect to the Jackson Trahon POTW. MDEQ believes that this connection to this regional authority will have a significant reduction in the TN and TP load in Big Creek. In addition to the reduction from the point source, the LA will need to reduce its TP contribution by 76.3%. The implementation of BMP activities should reduce the nutrient loads entering the creek. Best management practices are encouraged in this watershed to reduce the nonpoint nutrient loads.

### 4.1 Next Steps

MDEQ's Basin Management Approach and Nonpoint Source Program emphasize restoration of impaired waters with developed TMDLs. During the watershed prioritization process to be conducted by the Pearl River Basin Team, this TMDL will be considered as a basis for implementing possible restoration projects. The basin team is made up of state and federal resource agencies and stakeholder organizations and provides the opportunity for these entities to work with local stakeholders to achieve quantifiable improvements in water quality. Together, basin team members work to understand water quality conditions, determine causes and sources of problems, prioritize watersheds for potential water quality restoration and protection activities, and identify collaboration and leveraging opportunities. The Basin Management Approach and the Nonpoint Source Program work together to facilitate and support these activities.

The Nonpoint Source Program provides financial incentives to eligible parties to implement appropriate restoration and protection projects through the Clean Water Act's Section 319 Nonpoint Source (NPS) Grant Program. This program makes available around \$1.6M each grant year for restoration and protections efforts by providing a 60% cost share for eligible projects.

Mississippi Soil and Water Conservation Commission (MSWCC) is the lead agency responsible for abatement of agricultural NPS pollution through training, promotion, and installation of BMPs on agricultural lands. USDA Natural Resource Conservation Service (NRCS) provides technical assistance to MSWCC through its conservation districts located in each county. NRCS assists animal producers in developing nutrient management plans and grazing management plans. MDEQ, MSWCC, NRCS, and other governmental and nongovernmental organizations work closely together to reduce agricultural runoff through the Section 319 NPS Program.

Mississippi Forestry Commission (MFC), in cooperation with the Mississippi Forestry Association (MFA) and Mississippi State University (MSU), have taken a leadership role in the development and promotion of the forestry industry Best Management Practices (BMPs) in Mississippi. MDEQ is designated as the lead agency for implementing an urban polluted runoff control program through its Stormwater Program. Through this program, MDEQ regulates most

construction activities. Mississippi Department of Transportation (MDOT) is responsible for implementation of erosion and sediment control practices on highway construction.

Due to this TMDL, projects within this watershed will receive a higher score and ranking for funding through the basin team process and Nonpoint Source Program described above.

## **4.2 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 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](mailto:Kay_Whittington@deq.state.ms.us).

All comments should be directed to [Kay\\_Whittington@deq.state.ms.us](mailto:Kay_Whittington@deq.state.ms.us) or Kay Whittington, MDEQ, PO Box 2261, Jackson, MS 39225. 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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