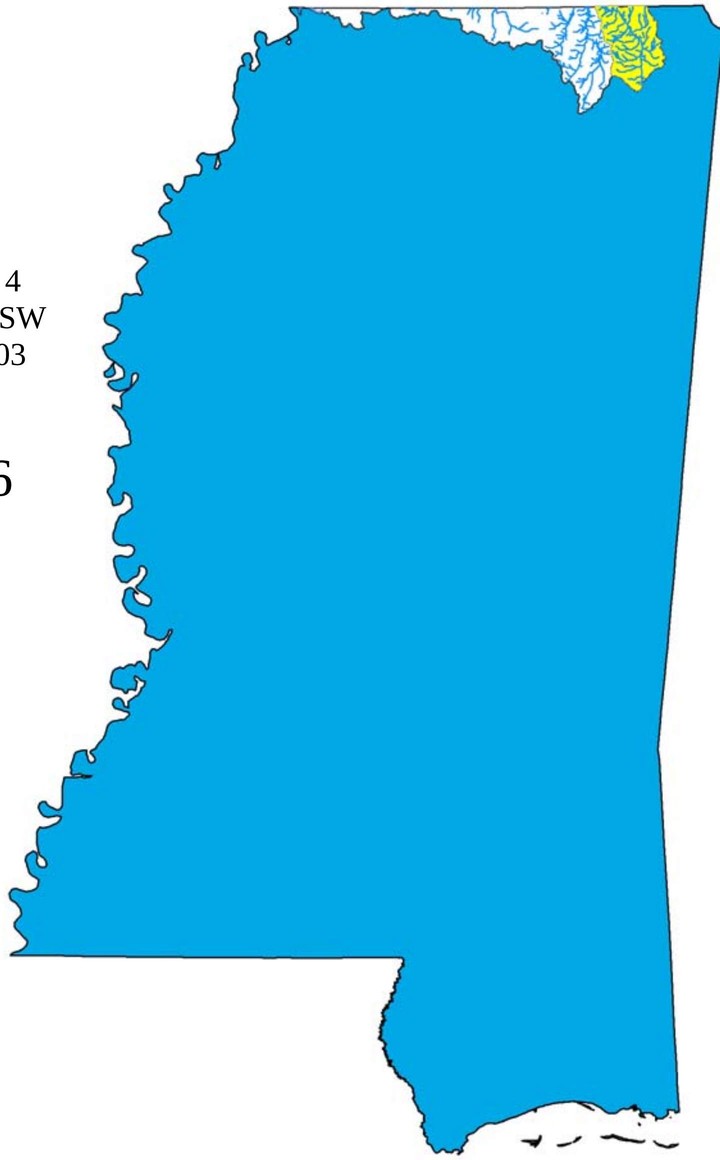
Draft Total Maximum Daily Load (TMDL)

TUSCUMBIA RIVER CANAL
BRIDGE CREEK
ELAM CREEK

IN THE NORTH INDEPENDENT STREAMS BASIN OF MISSISSIPPI
ALCORN AND PRENTISS COUNTIES, MISSISSIPPI

BIOLOGICAL IMPAIRMENT DUE TO NUTRIENTS AND ORGANIC ENRICHMENT/LOW DISSOLVED OXYGEN



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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 three Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State of Mississippi'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	Tones	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

TABLE OF CONTENTS

INDEX OF PHOTOS

INDEX OF TABLES

INDEX OF FIGURES

DRAFT TMDL INFORMATION PAGE

i. Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Tuscumbia River Canal	MS203TE	Alcorn, Prentiss	08010207	Biological Impairment	Monitored
Near Cuba from headwaters to Tennessee State Line					
Bridge Creek	MS203BE	Alcorn	08010207	Biological Impairment	Monitored
At Corinth from headwaters to confluence with Tuscumbia River Canal					
Elam Creek	MS204E	Alcorn	08010207	Biological Impairment	Monitored
Near Corinth from headwaters to confluence with Bridge Creek					

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."* As part of the TMDL development process, EPA is proposing a numeric translation of the above narrative criteria with respect to nutrients. A total phosphorus (TP) concentration target of 0.06 mg/l is being proposed to represent a level of protection which is sufficient to fully support designated uses for aquatic life for the waters subject to the TMDL. This concentration represents the 75th percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within Mississippi that have been determined by the State to fully support designated uses as confirmed by the State of Mississippi's rigorous biological assessment methodology. In recognition of the absence of numeric nutrient criteria for these waters, EPA is also accepting comments on an alternative TP concentration target of 0.10 mg/l, which represents a level of protection that is sufficient to fully support designated uses. This concentration represents the 90th percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within Mississippi that have been determined by the State to fully support designated uses as confirmed by the State of Mississippi's rigorous biological assessment methodology.

iii. NPDES Facilities

NPDES ID	Facility Name	Flowrate (MGD)	Receiving Water
MS0042030	Booneville POTW	2.0	Tuscumbia River Canal
MS0033961	Rienzi POTW	0.06	Tuscumbia River Canal
MS0037214	Suitor Meat Company	0.003	Bynum Creek
MS0030589	Biggersville School	0.015	Unnamed thence Parmicha Creek
MS0029084	Kossuth High School	0.0225	Unnamed thence McElroy
MS0057673	Giving Tree Learning Center and Daycare	0.001	Unnamed thence Clear Creek
MS0021652	Corinth POTW	4.7	Elam Creek

iv. Total Maximum Daily Load for TBODu

Waterbody	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
Tuscumbia River Canal	439.65	97.6	Implicit	537.25
Bridge Creek and Elam Creek	1007.76	12.42	Implicit	1020.18

v. Individual TBODu Wasteload Allocations for each NPDES Facility

NPDES ID	Facility Name	WLA		
		TBODu (lbs/day)	BOD_5 (mg/l)	NH_3-N (mg/l)
MS0042030	Booneville POTW	402.32	8.5	1.0
MS0033961	Rienzi POTW	22.38	15	5.0
MS0037214	Suitor Meat Company	0.073	Not Applicable	2.0
MS0030589	Biggersville School	5.78	30	2.0
MS0029084	Kossuth High School	8.62	30	2.0
MS0057673	Giving Tree Learning Center and Daycare	0.47	30	2.0
MS0021652	Corinth POTW	1007.76	10	2.0

vi. Total Estimated Maximum Daily Load based on a Total Phosphorus target of 0.06 mg/L

Waterbody	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
Tuscumbia River Canal	26.79	128.68	Implicit	155.47
Bridge Creek and Elam Creek	5.32	14.81	Implicit	20.13

vii. Individual TP wasteload allocation for each NPDES Facility (based on a target of 0.06 mg/l)

NPDES ID	Facility Name	WLA	
		TP (lbs/day)	TP (mg/l)
MS0042030	Booneville POTW	**21.9**	**1.31**
MS0033961	Rienzi POTW	**2.9**	**5.8**
MS0037214	Suitor Meat Company	**0.13**	**5.2**
MS0030589	Biggersville School	**0.73**	**5.8**
MS0029084	Kossuth High School	**1.09**	**5.8**
MS0057673	Giving Tree Learning Center and Daycare	**0.04**	**5.2**
MS0021652	Corinth POTW	**5.32**	**0.14**

viii. EPA is also asking for comments on an alternate set of allocations based on a TP target of 0.10 mg/L

Waterbody	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
Tuscumbia River Canal	101.69	128.68	Implicit	230.37
Bridge Creek and Elam Creek	18.73	14.81	Implicit	33.55

ix. Individual TP wasteload allocation for each NPDES Facility (based on a target of 0.10 mg/l)

NPDES ID	Facility Name	WLA	
		TP (lbs/day)	TP (mg/l)
MS0042030	Booneville POTW	**96.80**	**5.8**
MS0033961	Rienzi POTW	**2.90**	**5.8**
MS0037214	Suitor Meat Company	**0.13**	**5.2**
MS0030589	Biggersville School	**0.73**	**5.8**
MS0029084	Kossuth High School	**1.09**	**5.8**
MS0057673	Giving Tree Learning Center and Daycare	**0.04**	**5.2**
MS0021652	Corinth POTW	**18.73**	**0.48**

EXECUTIVE SUMMARY

These TMDLs have been developed for the portion of the Tuscumbia River Canal, Bridge Creek and Elam Creek located within Mississippi. Tuscumbia River Canal, Bridge Creek and Elam Creek were placed on the Mississippi 2004 Section 303(d) List of Impaired Waterbodies due to Biological Impairment. Stressor Identification Reports, which indicate the predominant stressors to the waterbodies, have been developed by the Mississippi Department of Environmental Quality (MDEQ). Based on the available information, it was determined that the biological impairment is most likely due to organic enrichment/low dissolved oxygen and nutrients. Sediment was also identified as a potential stressor to the Tuscumbia River Canal and was addressed in a separate TMDL report, which was proposed by Mississippi and approved by EPA. 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.

Mississippi does not have explicit numeric water quality standards for allowable nutrient concentrations. MDEQ currently has a Nutrient Task Force (NTF) that is working on the development of criteria for nutrients. As part of the TMDL development process, EPA is proposing a numeric translation of Mississippi's narrative nutrient criteria with respect to nutrients. A total phosphorus (TP) concentration target of 0.06 mg/L is being proposed to represent a level of protection which is sufficient to fully support designated uses for aquatic life for the waters subject to the TMDL. This concentration represents the 75th percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within Mississippi that have been determined by the State to fully support designated uses as confirmed by the State's rigorous biological assessment methodology. Targeting reductions in phosphorus is based on the assumption that the Elam/Bridge/Tuscumbia watershed will be driven to phosphorus limitation. In addition, there are no known immediate downstream impacts associated with any potential excess nitrogen from this watershed. Therefore, nitrogen reductions are not targeted in this TMDL.

In recognition of the absence of numeric nutrient criteria for these waters, EPA is also accepting comments on an alternative TP concentration target of 0.10 mg/L, which represents a level of protection that is sufficient to fully support designated uses. This concentration represents the 90th percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within Mississippi that have been determined by the State to fully support designated uses as confirmed by the State of Mississippi's rigorous biological assessment methodology. These TMDLs have been developed recognizing that appropriate nutrient targets may be further evaluated when more data are available. Water quality and wasteload allocation studies are being considered by EPA and MDEQ to better understand the influences of nutrients on the water quality of these systems.

The Tuscumbia River Canal (Photo 1) flows for approximately 43 miles until its confluence with the Hatchie River in Tennessee. Almost 33 miles of the Tuscumbia River Canal lies within Alcorn and Prentiss counties in Mississippi. The Tuscumbia River Canal watershed is shown in Figure 1. Elam Creek (Photo 2) flows for a distance of approximately 4.5 miles until its confluence with Bridge Creek. Bridge Creek (Photo 3) flows for a distance of approximately 11.6 miles until its confluence with the Tuscumbia River Canal. Both water bodies are located in Alcorn County. The Bridge and Elam Creeks watershed is shown in Figure 2. The figures and pictures provided in this report have been provided to EPA by courtesy of MDEQ. There are seven point sources that are permitted to discharge to the Elam/Bridge/Tuscumbia watershed

including two major point sources [i.e., Corinth and Booneville Publicly Owned Treatment Works (POTW)].

Photo 1: Tuscumbia River Canal at IBI Site 548

Photo 2. Elam Creek at Highway 72

Photo 3: Bridge Creek at IBI Station 161

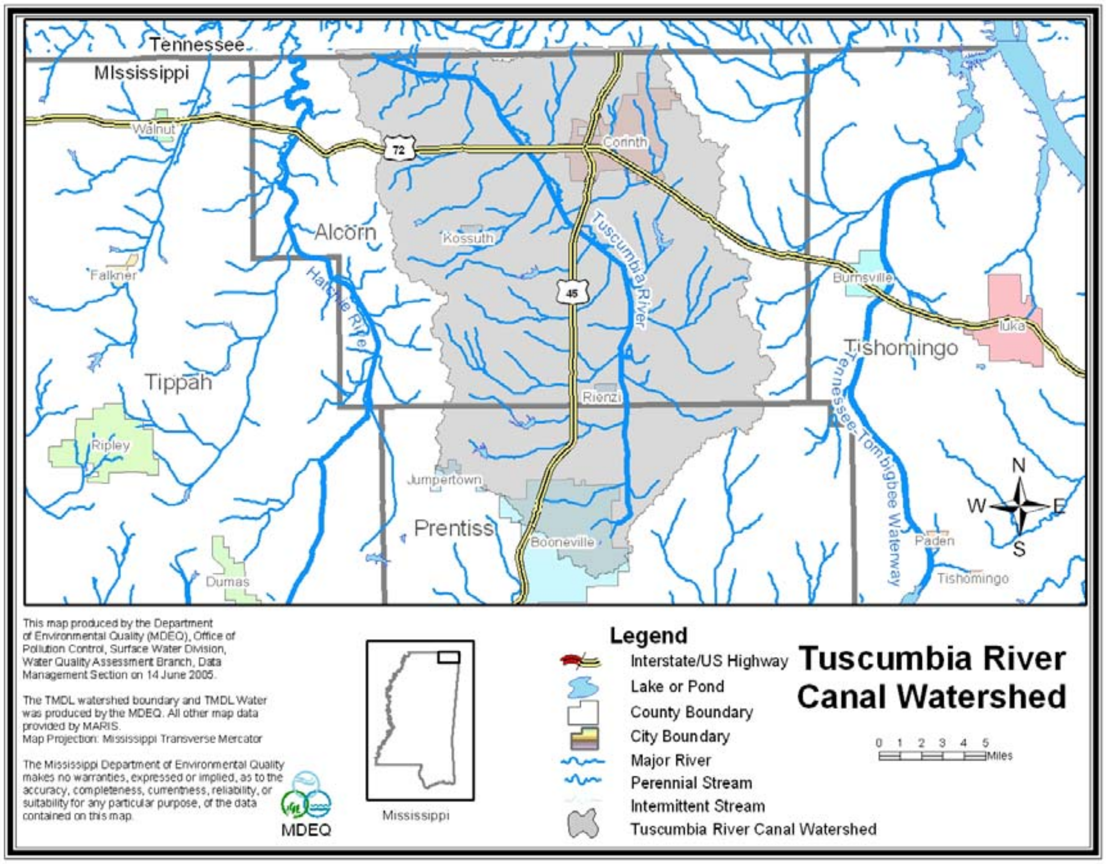

Figure 1. Tuscumbia River Canal Watershed (figure courtesy of MDEQ)

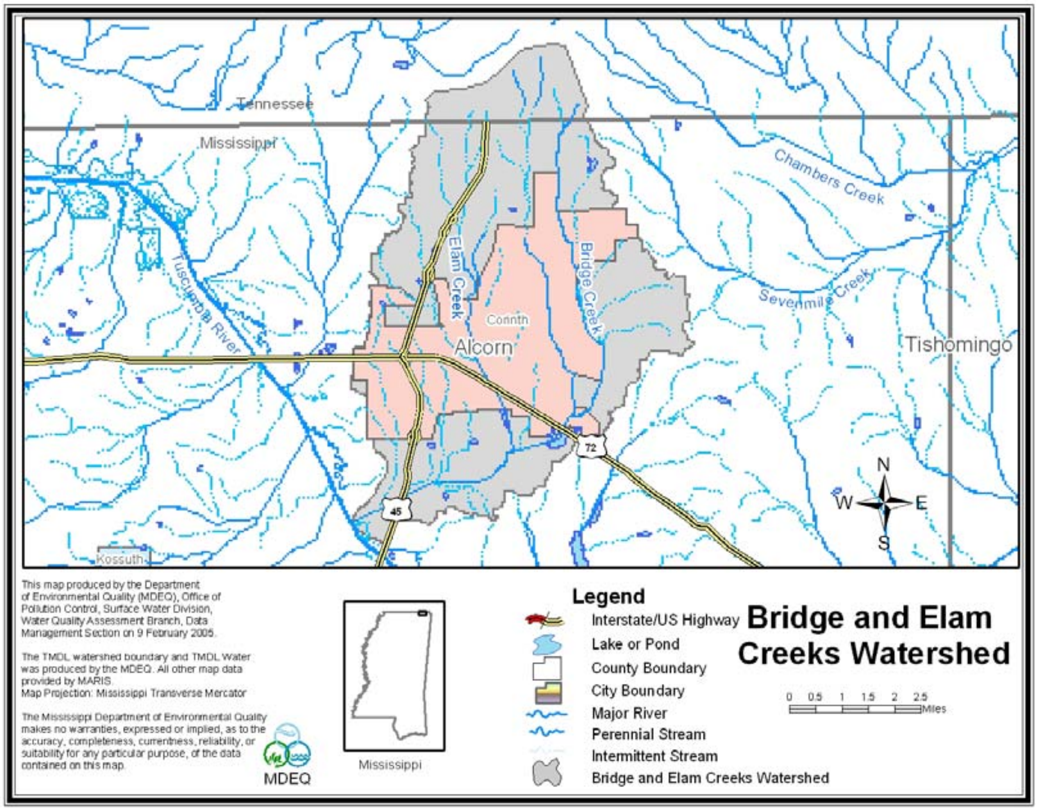

Figure 2. Bridge and Elam Creeks Watersheds (figure courtesy of MDEQ)

According to the model used to represent the processes affecting dissolved oxygen (DO) in these streams, the current loads in the waterbodies do not cause excursions of the dissolved oxygen criteria in the Bridge Creek and Elam Creek watersheds. However, the model results for Tuscumbia River Canal indicate excursions of the DO criteria during critical conditions. Therefore, permit reductions will be required for Booneville POTW, the largest point source (in terms of oxygen consuming loads) that discharges to Tuscumbia River Canal.

Based on the phosphorus targets used in the TMDL, significant phosphorus reductions are anticipated to be required for Elam Creek, Bridge Creek, and Tuscumbia River Canal. In consideration that phosphorus loads from the point sources dominate the system; reductions from the Corinth POTW and Booneville POTW are proposed in order to attain 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 waterbodies 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. These TMDLs have been developed for the 2004 §303(d) listed segments shown in Figures 3 and 4.

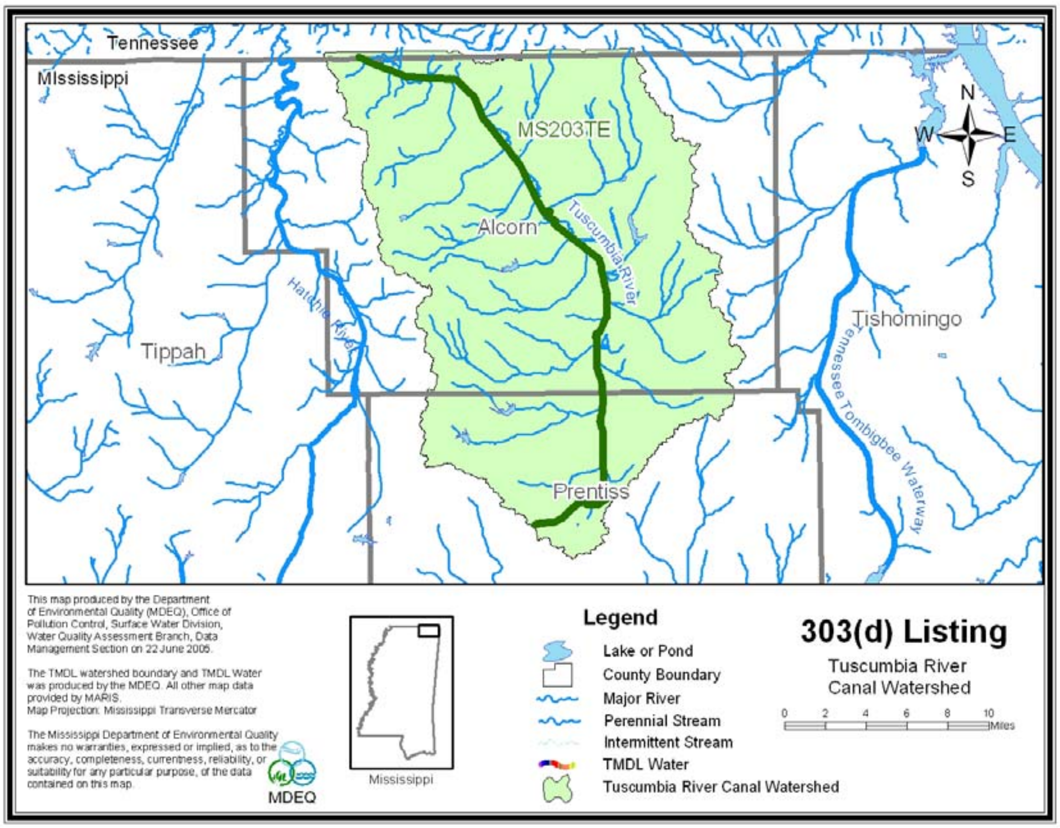

Figure 3. Tuscumbia River Canal §303(d) Listed Segment (figure courtesy of MDEQ)

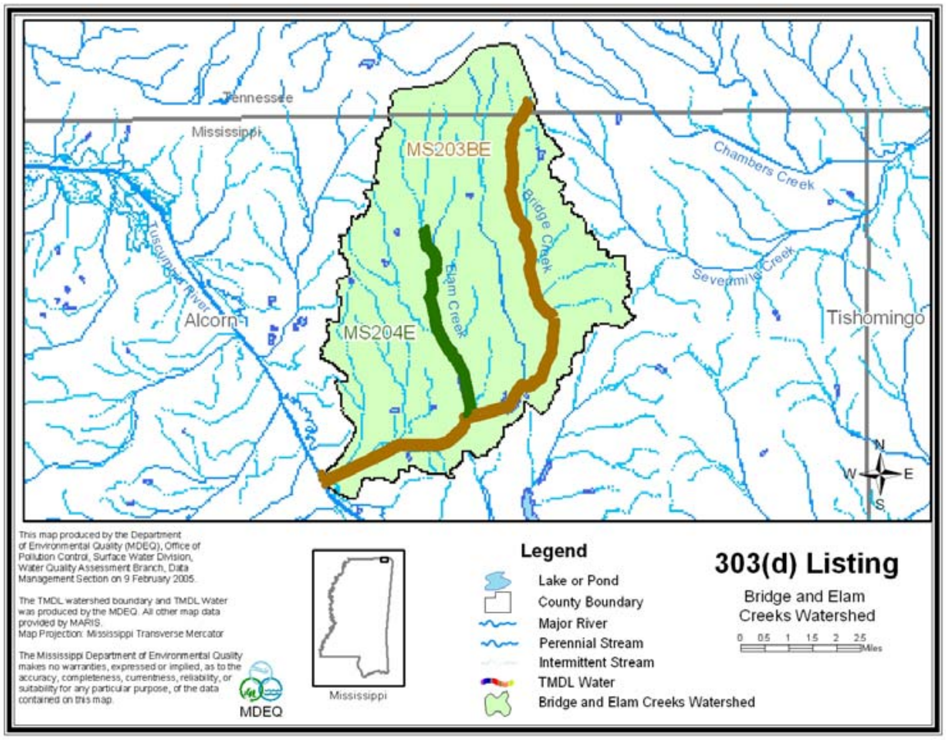

Figure 4. Bridge and Elam Creeks §303(d) Listed Segments (figure courtesy of MDEQ)

1.2 Stressor Identifications

Tuscumbia River Canal, Bridge Creek, and Elam Creek were 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, detailed assessments of the watersheds and potential pollutant sources, called stressor identification reports, were developed. The purpose of a stressor identification report is to identify the stressors and their sources most likely causing degradation of in-stream biological conditions. The reports indicated that nutrients and organic enrichment/low dissolved oxygen were the most likely stressors for all three waterbodies (MDEQ, 2004 and 2005). Sediment was also identified as a potential stressor to the Tuscumbia River Canal and was addressed in a separate TMDL report that was proposed by MDEQ and approved by EPA.

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, 2003)*. The designated beneficial use for the Tuscumbia River Canal, Bridge Creek, and Elam Creek is fish and wildlife support.

1.4 Applicable Water Body Segment Standard

The water quality standard applicable to the uses of the waterbodies and the pollutants of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (*MDEQ, 2003*). The applicable standard specifies that the dissolved oxygen (DO) concentrations shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l. This water quality standard will be used as a targeted endpoint to evaluate impairments and establish the TBODu TMDLs.

Mississippi does not have explicit numeric water quality standards for allowable nutrient concentrations. The Mississippi Department of Environmental Quality (MDEQ) currently has a Nutrient Task Force (NTF) that is working on the development of 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." The initial phase of the data collection process for wadeable streams has been completed.

As part of the TMDL development process, EPA is proposing a numeric translation of Mississippi's narrative nutrient criteria to address the nutrient impairment in the waterbodies. A TP concentration target of 0.06 mg/L is being proposed to represent a level of protection which is sufficient to fully support designated uses for aquatic life for the waters subject to the TMDL. This concentration represents the 75^{th} percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within Mississippi that have been determined by the State to fully support designated uses as confirmed by the State's rigorous biological assessment methodology. Targeting reductions in phosphorus is based on the assumption that the Elam/Bridge/Tuscumbia watersheds will be driven to phosphorus limitation. In addition, there are no known downstream impacts associated with any potential excess nitrogen from this watershed. Therefore, nitrogen reductions are not targeted in this TMDL.

In recognition of the absence of numeric nutrient criteria for these waters, EPA is also accepting comments on an alternative TP concentration target of 0.10 mg/L as representing a level of protection which is sufficient to fully support designated uses. This concentration represents the 90^{th} percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within Mississippi that have been determined by the State to fully support designated uses as confirmed by the State of Mississippi's rigorous biological assessment methodology. These TMDLs have been developed with recognition that appropriate nutrient targets may be further evaluated when more data are available. Water quality and wasteload allocation studies are being considered by EPA and MDEQ to better understand the influences of nutrients on the water quality of these systems.

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 Tuscumbia River Canal was determined based on the *Techniques for Estimating 7-Day, 10-Year Low-Flow Characteristics on Streams in Mississippi* (Telis, 1992). There was no 7Q10 flow available for Bridge and Elam Creeks. However, a wasteload allocation (WLA) study was conducted during the summer of 1998. The low flow condition measured during this study was used as the low flow condition for this report.

The total phosphorus targets were derived from datasets comprised of median phosphorus concentrations at several stations in Ecoregion 65 within the State of Mississippi. In order to attain the applicable water quality standards in the Elam/Bridge/Tuscumbia watersheds, it is expected that the target concentrations will need to be achieved on a long-term average basis. Therefore, the critical conditions for the phosphorus TMDL are based on annual average flows in these waters.

1.6 Selection of a TMDL Endpoint

One of the major components of a TMDL is the establishment of in-stream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. In-stream 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 in-stream conditions and conditions that are expected to restore designated uses. The in-stream DO target for these TMDLs 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 in-stream target for these TMDLs. 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 the desktop modeling exercise used in these TMDLs. 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 the 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.

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

The proposed TMDL target for TP is an annual concentration of 0.06 mg/l. EPA is also presenting and requesting public comment on an alternative target concentration of 0.10 mg/L. These values may be subject to revision as the State's 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 Tuscumbia River Canal, Bridge Creek, and Elam Creek Watersheds. 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 are data available at four stations on the Tuscumbia River Canal. The stations are 07029300, 07029310, 07029276.85, and IBI 548. MDEQ collected the most recent data at stations 07029300 and IBI 548. Both of these stations are located near the city of Corinth at Highway 72. The locations of the monitoring stations are shown in Figure 3. The data for each station are listed in Tables 1-4. Additional data from Elam Creek (MS204E) and Bridge Creek (MS203BE), shown in Figure 5, are available. Data for Bridge and Elam Creeks was gathered from MDEQ databases and the EPA Legacy STORET database. Samples were collected from Bridge and Elam Creeks in the winter of 2001 by MDEQ during the §303(d)/M-BISQ monitoring project. These sites are identified as Bridge Creek at Corinth at U.S. Highway 45 (M-BISQ Site # 61) and Elam Creek at Corinth at U.S. Highway 72 (M-BISQ Site # 62). Limited chemical data were also collected in 1998 at Elam Creek at Highway 72 as part of MDEQ’s Basin Monitoring Network component of the Surface Water Monitoring Program (SWMP). In addition, other historical physical and chemical data are available for several locations in both Elam Creek and Bridge Creek collected during an MDEQ intensive synoptic survey in the fall of 1988 to support WLA model development for the city of Corinth Publicly Owned Treatment Works (POTW). For this model study, numerous sites were located, for Elam Creek, from approximately one half mile downstream of the M-BISQ site at Highway 72 to the confluence with Bridge Creek and, for Bridge Creek, from immediately upstream of the confluence with Elam Creek to the confluence with the Tuscumbia River Canal downstream of Highway 45. However, use of this data for this report is limited since the Corinth Publicly Owned Treatment Works (POTW) was significantly upgraded by replacing a lagoon with an oxidation ditch treatment system following this study and no follow-up survey data are available.

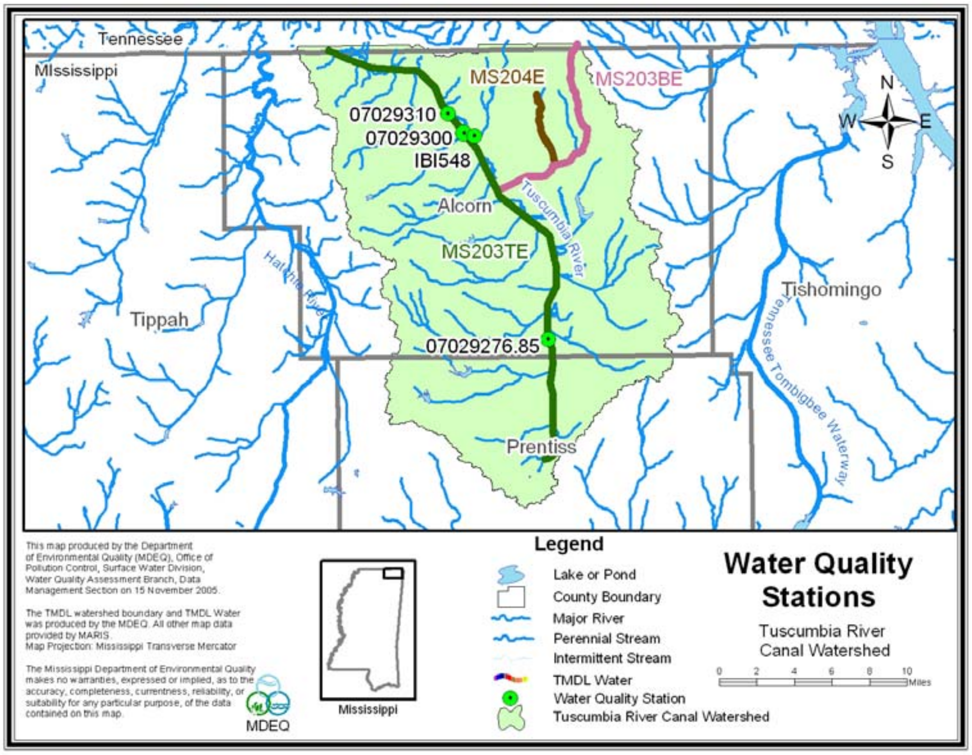

Figure 5. Tuscumbia River Canal Monitoring Station (figure courtesy of MDEQ)

Table 1. Water Quality Data Collected at the Tuscumbia River Canal, 07029300

Sample Date	Time	DO (mg/L)	NH_3-N (mg/L)	$NO_2 + NO_3$ (mg/L)	TKN (mg/L)	Total Phosphorus (mg/L)
12/05/96	9:45	11.6	0.17	0.37	0.74	0.22
01/09/97	10:30	10.1	0.10	0.21	1.01	0.17
02/26/97	9:45	10.8	0.10	0.38	0.49	0.06
03/12/97	10:30	9.0	0.19	0.24	0.49	0.06
04/09/97	9:45	9.6	0.19	0.30	0.57	0.05
05/14/97	11:10	10.2	0.16	0.82	0.52	0.07
06/05/97	10:50	8.2	0.10	0.31	0.39	0.07
07/08/97	11:30	8.7	0.11	0.42	0.46	0.10
08/19/97	11:20	7.2	0.17	0.83	0.62	0.10
09/11/97	11:50	11.8	0.61	0.45	0.61	0.10
10/13/97	13:40	7.9	0.27	0.61	1.21	0.23
11/19/97	11:00	12.0	0.10	0.66	0.56	0.08
01/13/98	7:30	10.2	0.27	0.13	1.31	0.01
02/04/98	11:50	13.1	0.25	0.45	0.62	0.09
03/18/98	10:26	10.4	0.31	0.25	0.82	0.09
06/04/98	11:00	6.3	0.12	0.59	0.49	0.14
07/07/98	11:00	7.8	0.17	0.94	0.78	0.16
08/12/98	18:00	**3.6**	0.15	0.25	1.55	0.27
09/03/98	14:00	9.2	0.10	1.84	0.50	0.16
10/14/98	14:54	9.6	0.14	1.72	0.14	0.23
12/16/98	10:55	11.5	0.24	0.39	0.55	0.09
01/25/99	11:00	8.8	0.25	0.10	0.67	0.09
02/03/99	11:03	11.7	0.36	0.26	1.53	0.12
03/02/99	12:28	11.2	0.20	0.24	0.33	0.08
03/31/99	11:47	9.7	0.22	0.47	0.90	0.16
05/04/99	10:40	9.0	0.14	0.51	0.92	0.08
06/09/99	11:30	**4.6**	0.10	1.23	0.49	0.13
06/30/99	11:00	7.0	0.28	0.36	0.54	0.14
08/10/99	11:48	**4.7**	0.48	2.58	1.05	0.15
08/31/99	12:40	8.4	0.53	2.84	1.45	0.55
10/13/99	15:38	7.0	0.77	0.53	1.08	0.28
11/16/99	13:00	11.2	0.71	1.09	1.61	0.18
12/01/99	11:20	10.7	0.89	0.53	1.06	0.09
01/05/00	14:35	11.2	0.25	1.57	1.52	0.16
02/23/00	11:10	10.5	0.21	0.50	0.63	0.18
04/04/00	11:30	7.1	0.13	0.11	0.98	0.14
05/15/00	13:45	8.9	0.32	0.74	0.61	0.10
06/06/00	15:05	9.7	0.27	2.02	0.61	0.09
04/09/01	12:05	7.1	0.20	0.38	0.66	0.10
05/22/01	11:30	5.7	0.58	0.56	1.99	0.50
06/19/01	11:47	7.6	0.10	0.61	0.56	0.17
07/09/01	11:51	6.8	0.10	-	0.60	0.12
09/19/01	11:23	7.6	0.10	1.10	0.71	0.14
10/08/01	11:30	8.6	0.18	0.82	0.47	0.16
11/05/01	11:13	8.6	0.10	0.70	0.61	0.08
12/05/01	12:00	10.2	0.10	0.08	0.73	0.12

Table 2. Water Quality Data Collected at the Tuscumbia River Canal, Station 07029310

Sample Date	Time	DO (mg/L)	$NO_2 + NO_3$ (mg/L)	TKN (mg/L)	Total Phosphorus (mg/L)
03/04/91	11:15	9.6	0.17	0.62	0.06
05/06/91	11:00	5.6	0.05	0.33	0.06
07/08/91	11:00	6.8	1.18	0.8	0.24
09/09/91	11:30	6.7	1.91	0.38	0.3
11/04/91	10:15	12.5	1.36	0.83	0.22
01/06/92	11:45	12.0	0.44	2.6	0.12
03/03/92	10:30	9.0	0.37	0.26	0.07
05/04/92	11:30	8.5	1.08	0.87	0.1
07/13/92	11:00	6.2	0.80	0.78	0.42
09/14/92	11:15	7.0	0.72	0.72	0.25
11/02/92	11:00	11.5	0.28	0.79	0.27
01/12/93	9:30	13.0	0.19	0.59	0.16
03/08/93	11:00	13.5	0.29	0.38	0.12
05/03/93	11:00	10.2	0.04	1.11	0.2
07/12/93	11:00	7.5	0.81	0.74	0.15
09/14/93	10:00	8.5	0.69	0.57	0.45
11/01/93	12:20	9.4	0.44	0.47	0.14
01/11/94	10:30	17.5	0.31	0.1	0.07
03/07/94	10:00	13.8	0.27	0.5	0.07
05/02/94	11:00	8.6	0.23	0.48	0.27
06/20/94	11:15	9.1	0.72	0.56	0.14
08/22/94	10:30	6.0	0.48	0.73	0.13
11/07/94	11:00	8.0	0.07	0.89	0.2
03/07/95	10:30	7.0	0.08	0.92	0.21
04/17/95	11:15	6.4	0.62	0.35	0.01
07/12/95	10:00	6.8	0.57	0.71	0.14
09/11/95	11:30	8.0	2.90	0.72	0.24
11/07/95	12:30	12.8	0.38	1.24	0.59
01/08/96	11:00	12.0	0.27	0.77	0.07
03/04/96	10:00	8.2	0.04	0.73	0.03
05/06/96	11:00	7.7	0.27	3.36	0.08
07/09/96	11:00	7.5	0.51	3.69	0.42
09/09/96	12:15	5.6	4.40	0.86	0.27

Table 3. Water Quality Data Collected at the Tuscumbia River Canal, Station 07029276.85

Sample Date	Time	DO (mg/l)	NH_3-N (mg/l)	$NO_2 + NO_3$ (mg/L)	TKN (mg/l)	Total Phosphorus (mg/L)
02/4/98	11:30	11.7	0.23	0.36	0.64	0.08
07/21/98	14:25	-	0.32	1.19	0.45	0.07

Table 4. Water Quality Data Collected at the Tuscumbia River Canal, Station IBI 548

Sample Date	Time	DO (mg/l)	NH_3-N (mg/l)	$NO_2 + NO_3$ (mg/L)	TKN (mg/l)	Total Phosphorus (mg/L)
02/06/01	11:10	12.6	0.1	0.48	0.86	0.1

2.1.1 Monitoring Data for Bridge and Elam Creeks

DO and percent DO saturation concentrations at both of the M-BISQ sites during 2001 were comparable to the least disturbed conditions (LD) and most Site Specific Comparator (SSC) station values. However, historical data show susceptibility to potential depressed DO as indicated by super-saturated conditions in 1998 with likely corresponding diel fluctuations to possibly low levels. Severe diel DO deficits were indicated as a problem in both creeks in 1988 prior to the construction of the present Corinth POTW. Values of total Kjeldahl nitrogen (TKN), ammonia, nitrite and nitrate at both sites and phosphorus at Bridge Creek were substantially higher than reference conditions and all SSC sites. In addition, significant algal growth was observed in 2005 below the Elam Creek site. Nutrients were also considerably elevated in 1998 in both streams. Nutrients and BOD were also major problems back in 1988 for these streams before the new wastewater treatment facility was constructed. More recently, a chronic sewer bypass occurred at the Corinth POTW into Bridge Creek from 2000 to 2001 due to a toluene discharge from a pre-treatment industrial facility. Based on the weight of evidence including presence of potential sources (cattle, major municipal point source, urban and residential runoff, un-sewered areas, and bypasses of the point source), highly elevated nutrients, susceptibility to super-saturated DO conditions, and biological metric analysis results, decreased dissolved oxygen and/or altered food sources as well as their associated pathway cause (organic and nutrient enrichment) are indicated as a primary cause of biological impairment (MDEQ, 2005).

2.2 Assessment of Point Sources

An important step in assessing pollutant sources in a watershed is locating the NPDES permitted sources. There are 7 facilities permitted to discharge organic material into the Tuscumbia River Canal, Bridge Creek and Elam Creek watersheds (Table 5). The locations of the facilities are shown in Figure 6.

Table 5. NPDES Permitted Facilities by Treatment Type

Name	NPDES Permit	Treatment Type
Booneville POTW	MS0042030	Oxidation Ditch
Rienzi POTW	MS0033961	Activated Sludge
Suitor Meat Company	MS0037214	Conventional Lagoon
Biggersville School	MS0030589	Activated Sludge
Kossuth High School	MS0029084	Activated Sludge
Giving Tree Learning Center and Daycare	MS0057673	Aerobic Treatment Unit
Corinth POTW	MS0021652	Oxidation Ditch

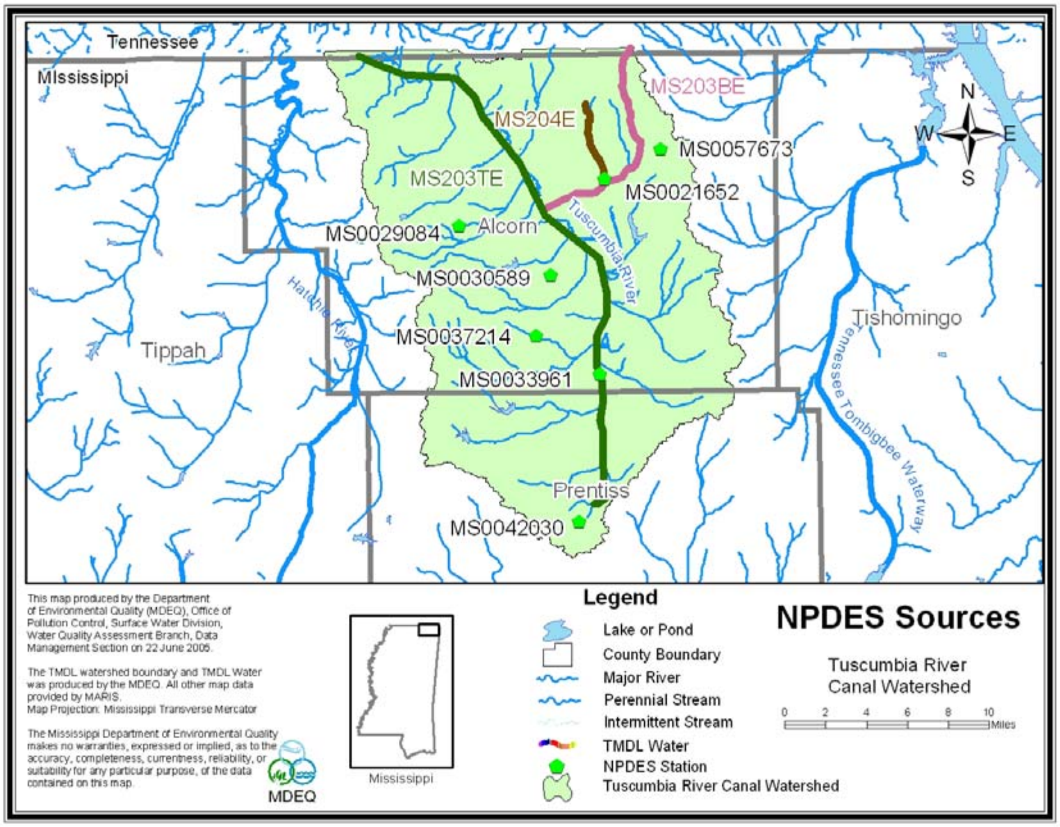

Figure 6. Point Sources in the Tuscumbia River Canal, Bridge and Elam Creeks Watersheds (figure courtesy of MDEQ)

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 as well as the average flows and BOD_5 concentrations, as reported in available discharge monitoring reports (DMRs) for the past five years (1999 through 2004) are given in Table 6. There are no concentrations given for Suitor Meat Company because this facility reports in units of lbs/day. In absence effluent permit limits or DMR data for ammonia nitrogen, an assumed value of 2.0 mg/L was used to calculate the NBODu loads. There were no monitoring data available for the Giving Tree Learning Center and Daycare (MS0057673). In this case, the maximum permit limits were used to estimate the actual loads.

Table 6. Identified NPDES Permitted Facilities

Name	NPDES Permit	Permitted Discharge (MGD)	Actual Average Discharge (MGD)	Permitted Average BOD_5 (mg/L)	Actual Average BOD_5 (mg/L)	Permitted NH_3-N (mg/L)	Actual Average NH_3-N (mg/L)
Booneville POTW	MS0042030	2.0	1.8	10	3.0	2	0.72
Rienzi POTW	MS0033961	0.06	0.137	15	10.6	5	0.98
Suitor Meat Company	MS0037214	0.003	No Discharge	0.25 lbs/day	No Discharge	-	No Discharge
Biggersville School	MS0030589	0.015	0.002*	30	17.6*	-	-
Kossuth High School	MS0029084	0.0225	0.002*	30	18.1*	-	-
Giving Tree Learning Center and Daycare	MS0057673	0.001	No DMR Data	30	No DMR Data	-	No DMR Data
Corinth POTW	MS0021652	4.7	3.44	10	9.9	2	0.82

**Based on one reported 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). EPA believes that TP is the nutrient of concern for these TMDLs. By controlling for TP, the waterbodies will achieve water quality standards for nutrients. 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. Small amounts of phosphorous may also enter a water body through atmospheric deposition. Phosphorus is present in almost all land uses. However, as shown by Table 7, human impacts on TP loads are significant.

Table 7. 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 the Tuscumbia River Canal Watershed is approximately 206,668 acres (323 square miles).

The watershed contains many different landuse types, including urban, forest, cropland, pasture, water, and wetlands. Forest is the dominant landuse within the Tuscumbia River watershed. The landuse distribution is shown in Table 8 and Figure 7. The drainage area of the Bridge Creek and Elam Creek watershed is approximately 23,687 acres (37 square miles). The watershed contains many different landuse types, including urban, forest, cropland, pasture, water, and wetlands. Forest is the dominant landuse within the Bridge Creek and Elam Creek watershed. The landuse distribution is shown in Table 9 and Figure 8. The landuse information given below for both watersheds 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.

Table 8. Landuse Distribution, Tuscumbia River Canal Watershed

	Urban	Forest	Cropland	Pasture	Scrub/Barren	Wetlands	Water	Total
Area (acres)	18,499	73,134	32,067	33,477	22,545	23,434	3512	206,668
% Area	9.0%	35.4%	15.5%	16.2%	10.9%	11.3%	1.7%	100%

Table 9. Landuse Distribution, Bridge and Elam Creeks Watershed

	Urban	Forest	Cropland	Pasture	Scrub/Barren	Wetlands	Water	Total
Area (acres)	6,323	5,340	3,169	4,753	2,236	1,665	202	23,687
% Area	27%	23%	13.3%	20%	9.4%	7%	0.85%	100%

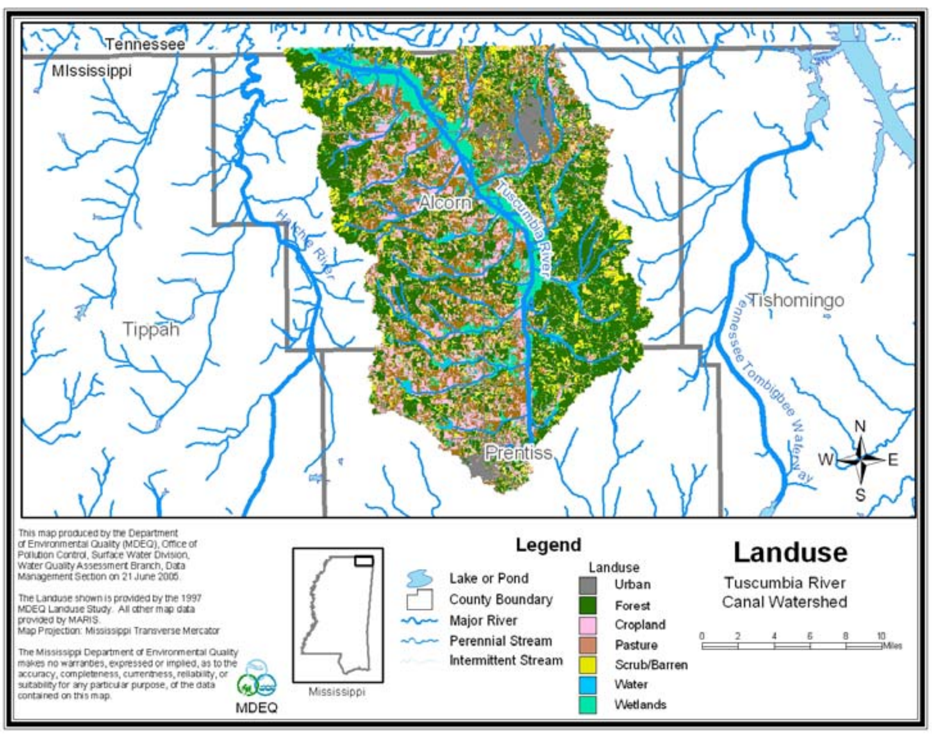

Figure 7. Landuse Distribution for the Tuscumbia River Canal Watershed (figure courtesy of MDEQ)

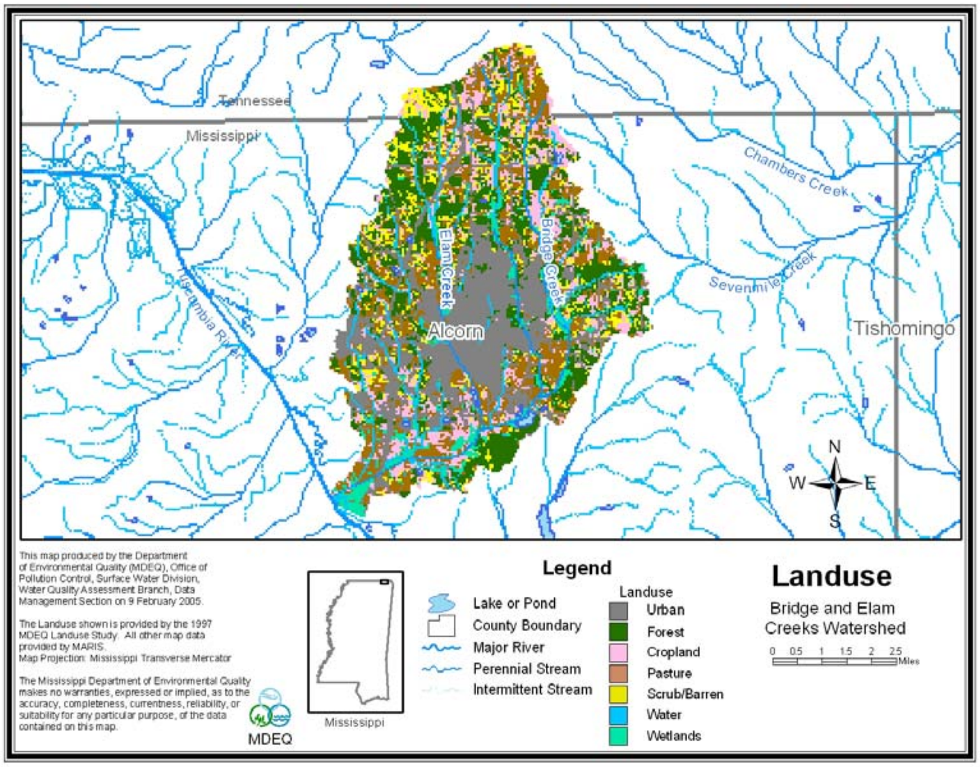

Figure 8. Landuse Distribution for the Bridge Creek and Elam Creek Watershed (figure courtesy of MDEQ)

2.3.1 Sewer Bypasses

In the past several years, there have been multiple bypasses of the city of Corinth's sewer collection system in the areas of Elam Creek and the unnamed tributary to Bridge Creek due to corrosion of the sewer lines. The city of Corinth has filed a complaint in U.S. District Court against the entity suspected of causing the problems. Repairs and court actions against illegal bypasses to the sewer system may help alleviate future water quality violations.

MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

Establishing the relationship between the in-stream 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 association of 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). A key reason for using the STREAM model in TMDL development is its ability to assess in-stream 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. In-stream processes simulated by the model include CBODu decay, nitrification, re-aeration, sediment oxygen demand, and respiration and photosynthesis of algae. Figure 9 shows how these processes are related in a typical DO model. Reaction rates for the in-stream 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 re-aeration within each reach using the Tsivoglou formulation. The Tsivoglou formulation calculates the re-aeration 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 cubic feet per second (cfs). Reach velocities were calculated using an equation based on slope. The slope of each reach was estimated from U.S. Geological Survey (USGS) quad maps and input into the model in units of feet per mile.

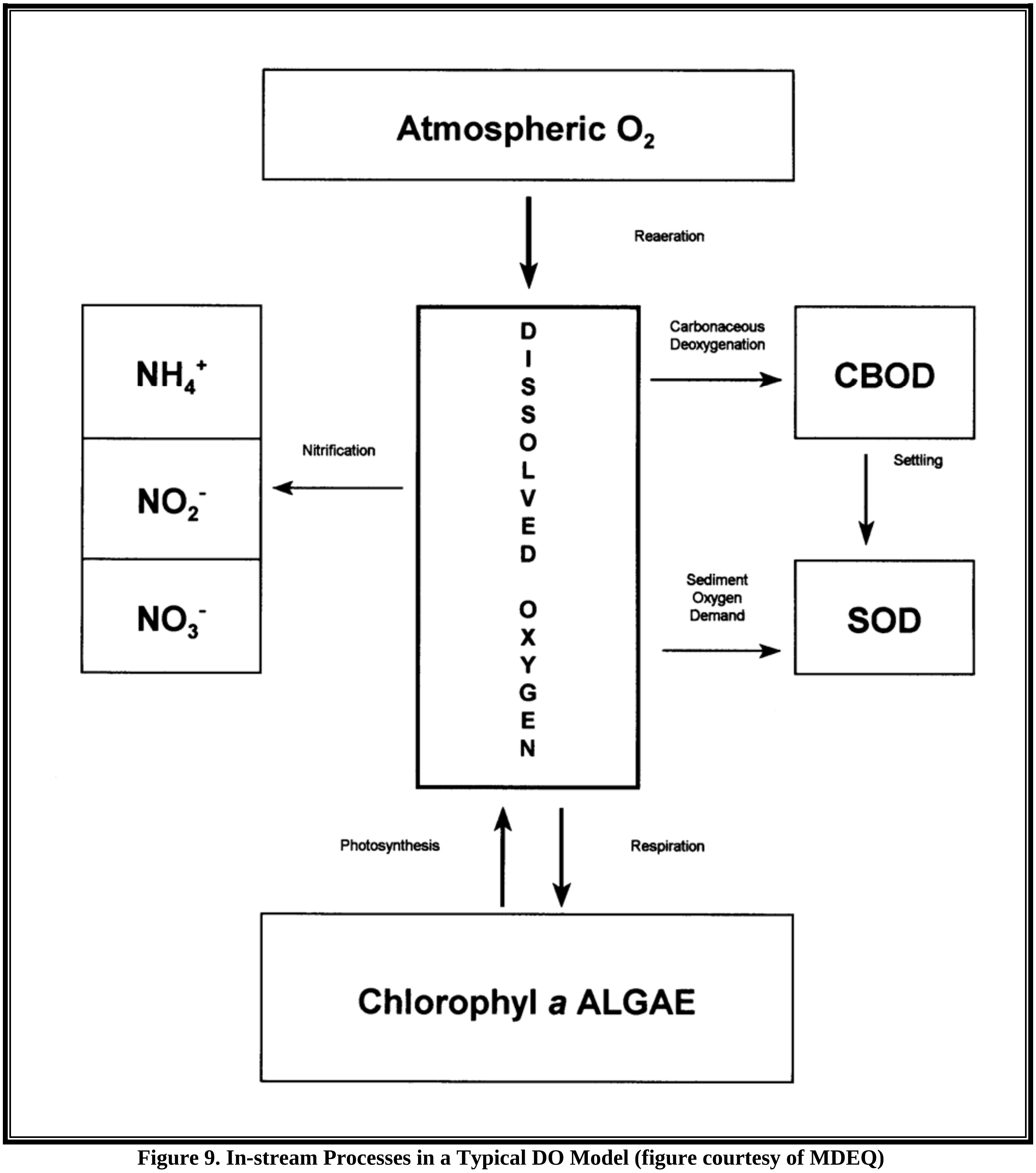

Figure 9. In-stream Processes in a Typical DO Model (figure courtesy of MDEQ)

3.2 Model Setup

The model for the Tuscumbia River Canal was developed beginning with its headwaters near Booneville to the point at which it crosses the state line in Alcorn County. A diagram showing the model setup is shown in Figure 10. A diagram showing the model setup for Bridge Creek and Elam Creek is shown in Figure 11. The locations of the confluence of point sources and significant tributaries are shown in both figures. 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.

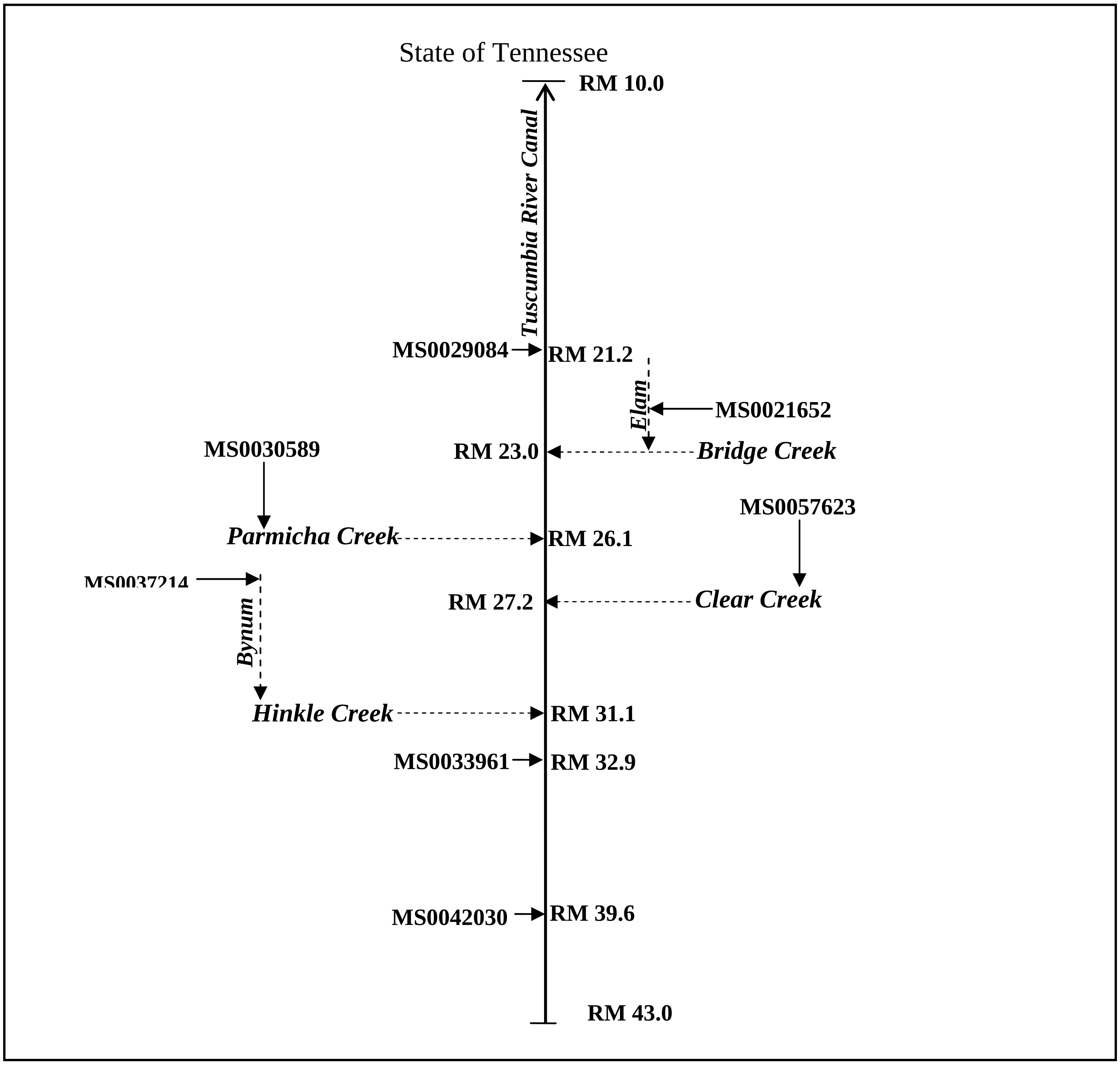

Figure 10. Tuscumbia River Canal Model Setup (Note: Not to Scale) (figure courtesy of MDEQ)

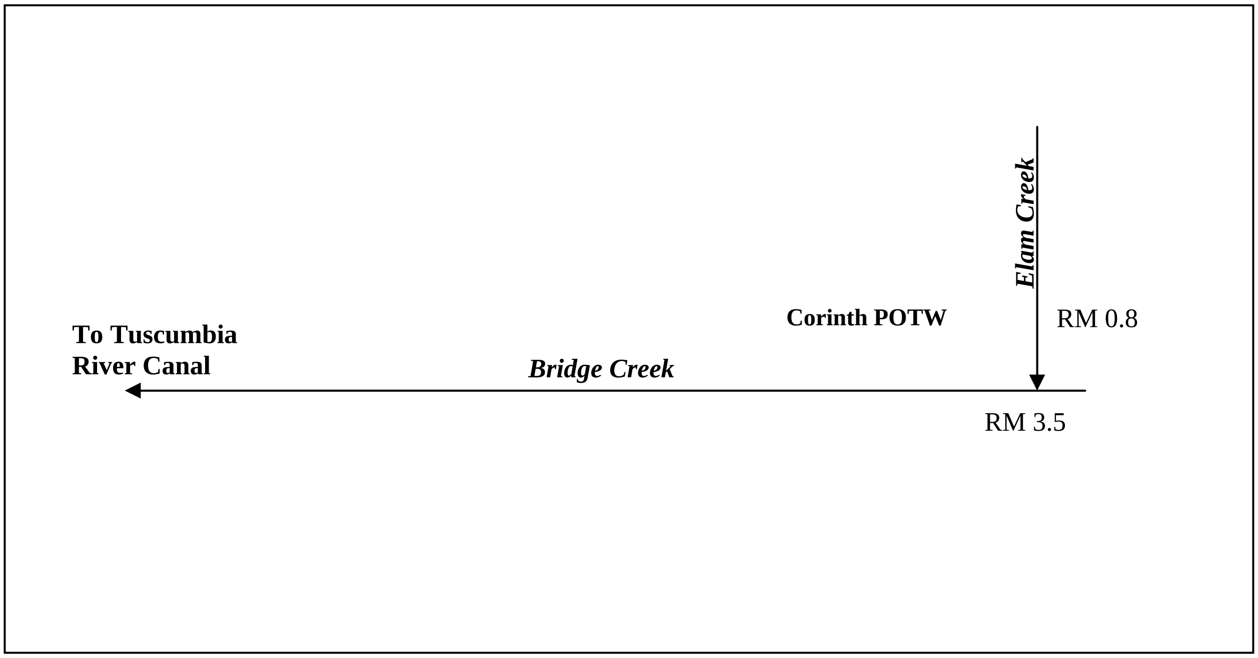

Figure 11. Bridge and Elam Creeks Model Setup (Note: not to scale) (figure courtesy of MDEQ)

The waterbodies 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 conditions for these TMDLs. 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 in-stream temperature. The assumptions regarding the in-stream 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 Tuscumbia River Canal watershed was modeled at 7Q10 conditions based on data available from the USGS (Telis, 1992). There are several partial record flow gauging stations located in the Tuscumbia River Canal Watershed. The stations and their 7Q10 flows are given in Table 10 and are represented in Figure 12. The critical condition model was set up so that the modeled flow was approximately equal to the 7Q10 flow at monitoring locations in the system. The flows in Bridge and Elam Creeks were modeled at flow conditions obtained from a 1998 WLA study.

Table 10. 7Q10 Flow Data for the Tuscumbia River Canal Watershed

Station	Location	Drainage Area (square miles)	7Q10 Flow (cfs)
07029278	Tuscumbia River Canal near Biggersville	248	5.0
07029300	Tuscumbia River Canal near Corinth	278	5.8
07029277	Hinkle Creek near Rienzi	15.2	0
07029279	Mays Creek near Biggersville	7.21	0

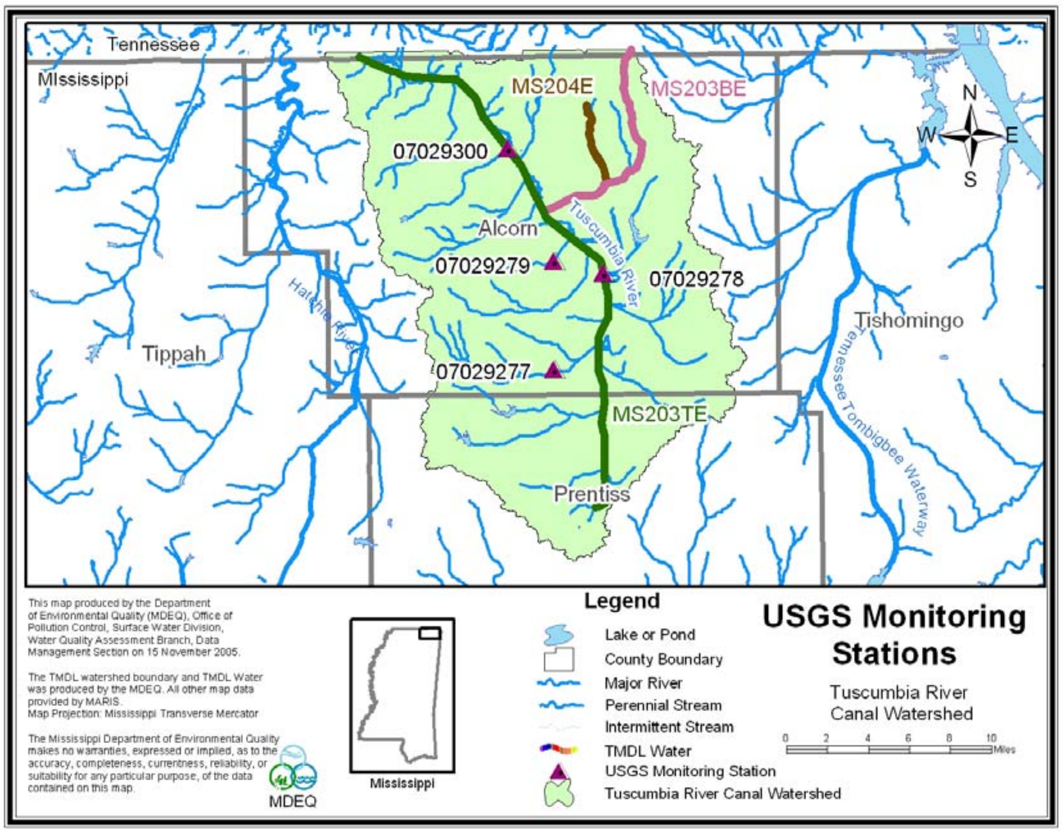

Figure 12. Gages for the Tuscumbia River Canal Watershed (figure courtesy of MDEQ)

3.3 Source Representation

Both point and non-point sources were represented in the corresponding models for the waterbodies. The loads from the NPDES permitted sources were added as direct inputs into the appropriate reaches as a flow in million gallons per day (MGD) and concentration of $CBOD_5$ and ammonia nitrogen in milligrams per liter. 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, which is described in Equation 4.

CBODu = $CBOD_5$ * Ratio*Flow*Conversion Factor (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. Secondary treatment systems (conventional and aerated lagoons) use a ratio of 1.5. A ratio of 2.3 was assumed for facilities with treatment systems using activated sludge and oxidation ditches.

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 are given in Table 13. A comparison of Tables 11 and 12 shows the maximum permitted load versus that of the actual TBODu load.

Table 11. Point Sources, Loads Based on Averages of DMR Data

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)
Booneville POTW	MS0042030	1.83	3.0	0.72	2.3	105.3	10.99	50.22	155.52
Rienzi POTW	MS0033961	0.137	10.6	0.98	2.3	27.9	1.12	5.12	33.02
Suitor Meat Company	MS0037214	No Discharge	No Discharge	No Discharge	-	No Discharge	No Discharge	No Discharge	No Discharge
Biggersville School	MS0030589	0.002*	17.6*	2	1.5	0.44	0.03	0.15	0.59
Kossuth High School	MS0029084	0.0023*	18.1*	2	1.5	0.52	0.04	0.18	0.7
Giving Tree Learning Center and Daycare	MS0057673	0.001**	30**	2	1.5	0.37	0.02	0.09	.46
Corinth POTW	MS0021652	3.44	9.9	0.81	2.3	653.26	23.24	106.21	759.47
						787.76		**162.0**	**949.76**

[*]Based on one reported measurement
[**]Permitted value was used because no DMR data are available

Table 12. 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)
Booneville POTW	MS0042030	2.0	10	2	2.3	383.64	33.36	152.46	536.1
Rienzi POTW	MS0033961	0.06	15	5	2.3	17.26	2.50	11.43	28.69
Suitor Meat Company	MS0037214	0.003	--	2	-	-	0.05	0.23	0.23
Biggersville School	MS0030589	0.015	30	2	1.5	5.63	0.25	1.14	6.77
Kossuth High School	MS0029084	0.0225	30	2	1.5	8.44	0.38	1.72	10.16
Giving Tree Learning Center and Daycare	MS0057673	0.001	30	2	1.5	0.36	0.02	0.08	0.44
Corinth POTW	MS0021652	4.7	10	2	2.3	901.55	78.40	358.27	1259.82
						1316.91		**525.3**	**1842.21**

Direct measurements of background concentrations of CBODu were not available for the Tuscumbia River Canal, Bridge Creek, and Elam Creek watersheds. Because there were no data available for CBODu and very limited data for NH_3-N, 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 concentrations used in modeling for BOD_5 = 1.33 mg/L and NH_3-N = 0.1 mg/l. These concentrations were used as estimates for the CBODu and NH_3-N levels of water entering the waterbodies 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 conditions in the Tuscumbia River Canal Watershed. The flows for Bridge and Elam Creeks were measured by MDEQ in 1998. The low-flow condition in Bridge Creek and Elam Creek watershed was determined to be 0.84 cfs. The flows for the respective watersheds were then multiplied by the concentrations of CBODu and NH_3-N to calculate the non-point source loads in the Tuscumbia River Canal, Bridge Creek and Elam Creek (Tables 13-15). It was assumed that the non-point source loads were distributed evenly throughout the modeled reaches.

Table 13. Non-Point Source Loads Input into the Model for Tuscumbia River Canal

	Flow (cfs)	$CBOD_5$ (mg/L)	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
Background Loads	0.010	1.33	0.11	0.1	0.02	0.13
RM 43.0 – RM 39.6	1.0874	1.33	11.70	0.1	2.68	14.38
RM 39.6 – RM 32.9	2.1365	1.33	22.98	0.1	5.26	28.24
RM 32.9 – RM 31.1	0.5740	1.33	6.17	0.1	1.41	7.58
RM 31.1 – RM 27.3	1.2022	1.33	12.93	0.1	2.96	15.89
RM 27.3 – RM 27.2	0.0118	1.33	0.13	0.1	0.03	0.16
RM 27.2 – RM 26.1	0.01	1.33	0.11	0.1	0.02	0.13
RM 26.1 – RM 23.1	0.01	1.33	0.11	0.1	0.02	0.13
RM 23.1 – RM 21.2	0.83	1.33	8.93	0.1	2.04	10.97
RM 21.2 – RM 19.2	0.01	1.33	0.11	0.1	0.02	0.13
RM 19.2 – RM 10.0	1.5000	1.33	16.13	0.1	3.70	19.83
			79.4		**18.2**	**97.6**

Table 14. Non-Point Source Loads Input into the Model for Bridge Creek

Bridge Creek	Flow (cfs)	CBODu (mg/L)	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
RM 3.5 – RM 1.7	0.44	2	4.73	0.1	1.08	5.81
RM 1.7 – RM 0.0	0.40	2	4.31	0.1	0.99	5.30
			9.04		**2.07**	**11.1**

Table 15. Non-Point Source Loads Input into the Model for Elam Creek

Elam Creek	Flow (cfs)	CBODu (mg/L)	CBODu (lbs/day)	NH_3-N (mg/l)	NBODu (lbs/day)	TBODu (lbs/day)
RM 2.74 – RM 0.0	0.10	2	1.07	0.1	0.25	1.32
			1.07		**0.25**	**1.32**

3.4 Model Calibration

There are not sufficient data available to calibrate the STREAM models of the Tuscumbia River Canal, Bridge Creek and Elam Creek. The model was run with the loads from NPDES permitted point sources set at their current loads as determined from the discharge monitoring reports, presented in Table 11. With additional data, it will be possible to calibrate a WASP model for the waterbodies that will more accurately reflect the aquatic health of the waterbodies. WASP is a dynamic model for aquatic systems that allows users to investigate 1, 2 and 3 dimensional systems for a variety of pollutant types.

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3.5 Model Results

Once the STREAM model setup was complete, the model was used to predict water quality conditions in the Tuscumbia River Canal, Bridge Creek and Elam Creek. The models were first run under routine conditions. Under routine conditions for Tuscumbia River Canal, the loads from NPDES permitted point sources were set at their average loads as determined from the discharge monitoring reports (Figure 13). Thus, routine model runs reflect the current conditions of the waterbodies. Figures 14-15 show the maximum condition models with the permits set at the maximum loads allowed in the NPDES permits for Bridge Creek and Elam Creek. Model runs at the maximum permit limits were equal to the assimilative capacities of the waterbodies. Thus, the model runs at maximum permit limits are considered the maximum load scenario. Model runs with permits at both average loads and maximum permitted loads showed that the water quality standard for dissolved oxygen was not violated at any point in the Bridge Creek and Elam Creek. In the Tuscumbia River Canal, the water quality standards for DO were violated when the model runs were set at the maximum permitted loads for dischargers to the Tuscumbia River Canal (shown in Figure 16).

3.5.1 Routine Model Results

Figure 13 shows the daily average in-stream DO concentrations, beginning with river mile 43.0 and ending with river mile 10.0 in the Tuscumbia River Canal. As shown, the model predicts that the DO stays above the standard of 5.0 mg/l.

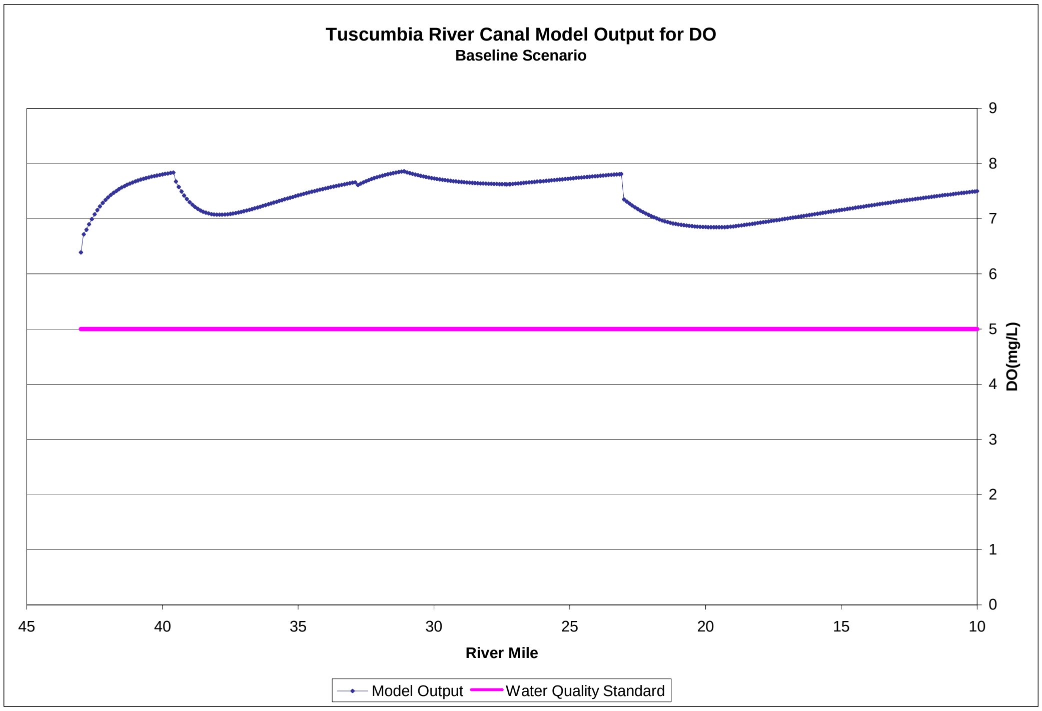

Figure 13. Model Output for DO in Tuscumbia River Canal—Routine Conditions (figure courtesy of MDEQ)

The maximum condition model results, with the maximum permit limits for NPDES dischargers to Bridge Creek and Elam Creek, are presented in Figures 14-15. As shown in Figures 14-15, the model does not predict that the DO goes below the standard of 5.0 mg/l using the maximum allowable loads for either of the waterbodies.

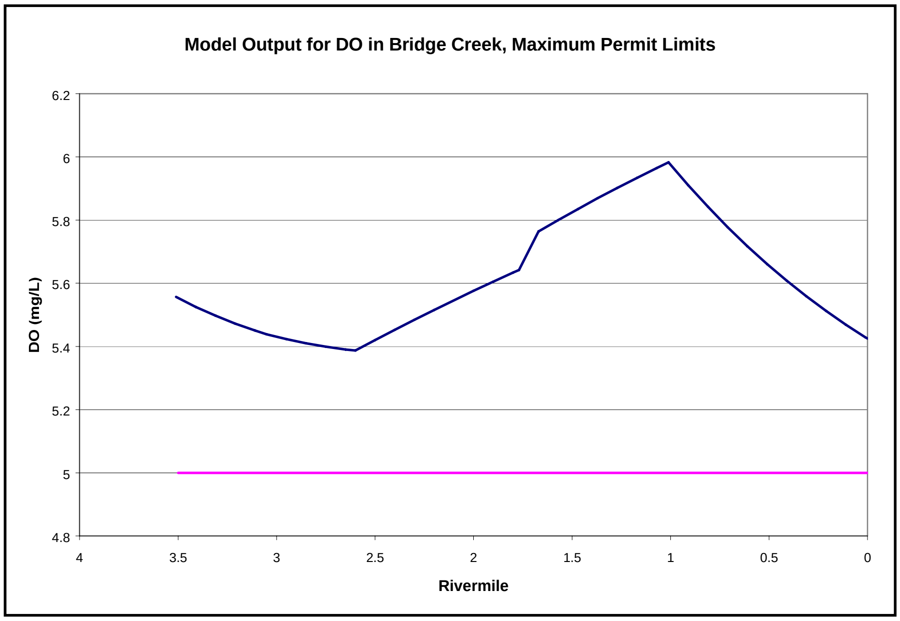

Figure 14. Model Output for DO in Bridge Creek, Maximum Conditions (figure courtesy of MDEQ)

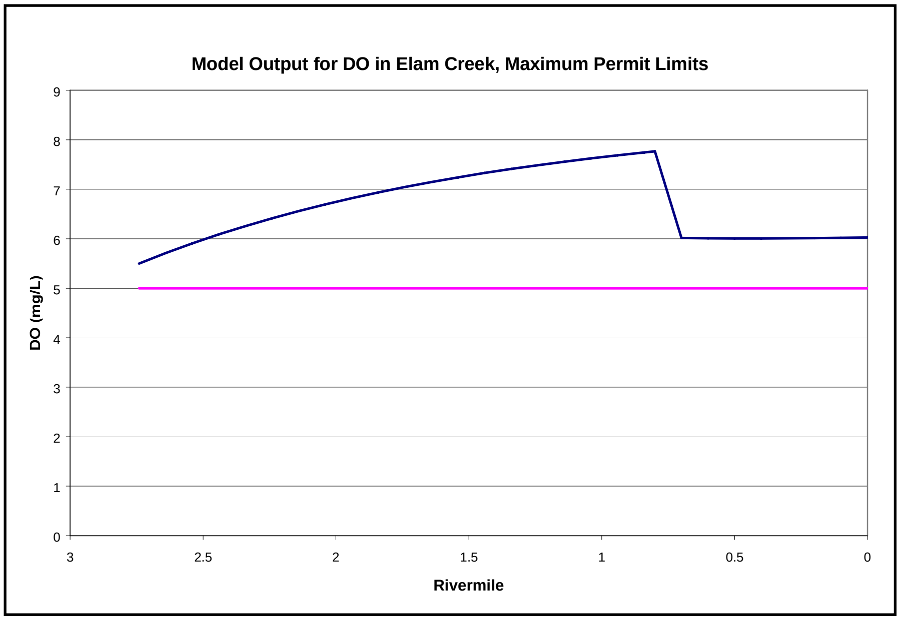

Figure 15 Model Output for DO in Elam Creek, Maximum Conditions (figure courtesy of MDEQ)

3.5.2 Model Results at NPDES Permit Maximum Limits

A second model run was completed in order to predict the dissolved oxygen in the Tuscumbia River Canal if the NPDES permits were discharging at their maximum permit limits, shown in Figure 16. The red line on the graph represents the daily average DO water quality standard of 5.0 mg/l. When the model is run with the maximum permit limits, the DO goes below the DO standard of 5.0 mg/L. The DO sag is 4.13 mg/L, which occurs approximately at RM 38. When the permitted load discharged by Booneville POTW is reduced by 24.95% (largest discharger by effluent volume to the Tuscumbia River Canal), the waterbody does attain water quality standards for DO. This is demonstrated in Figure 17.

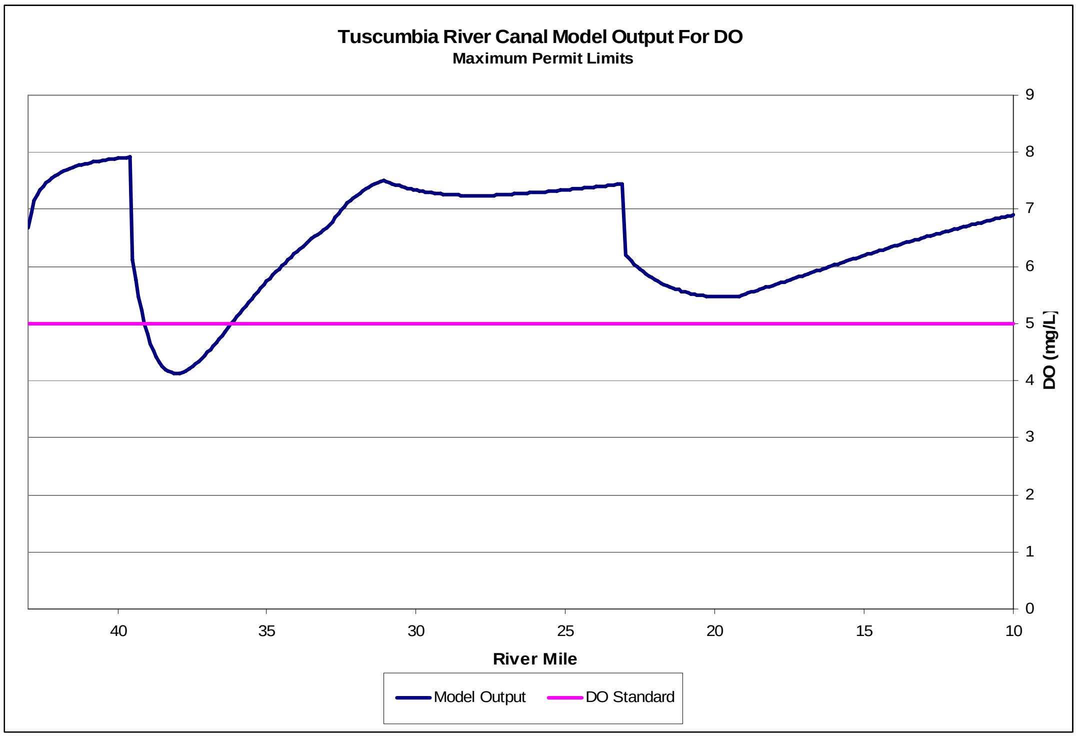

Figure 16. Model Output set at maximum permitted loads in Tuscumbia River Canal demonstrating water quality violations of the DO standard (figure courtesy of MDEQ)

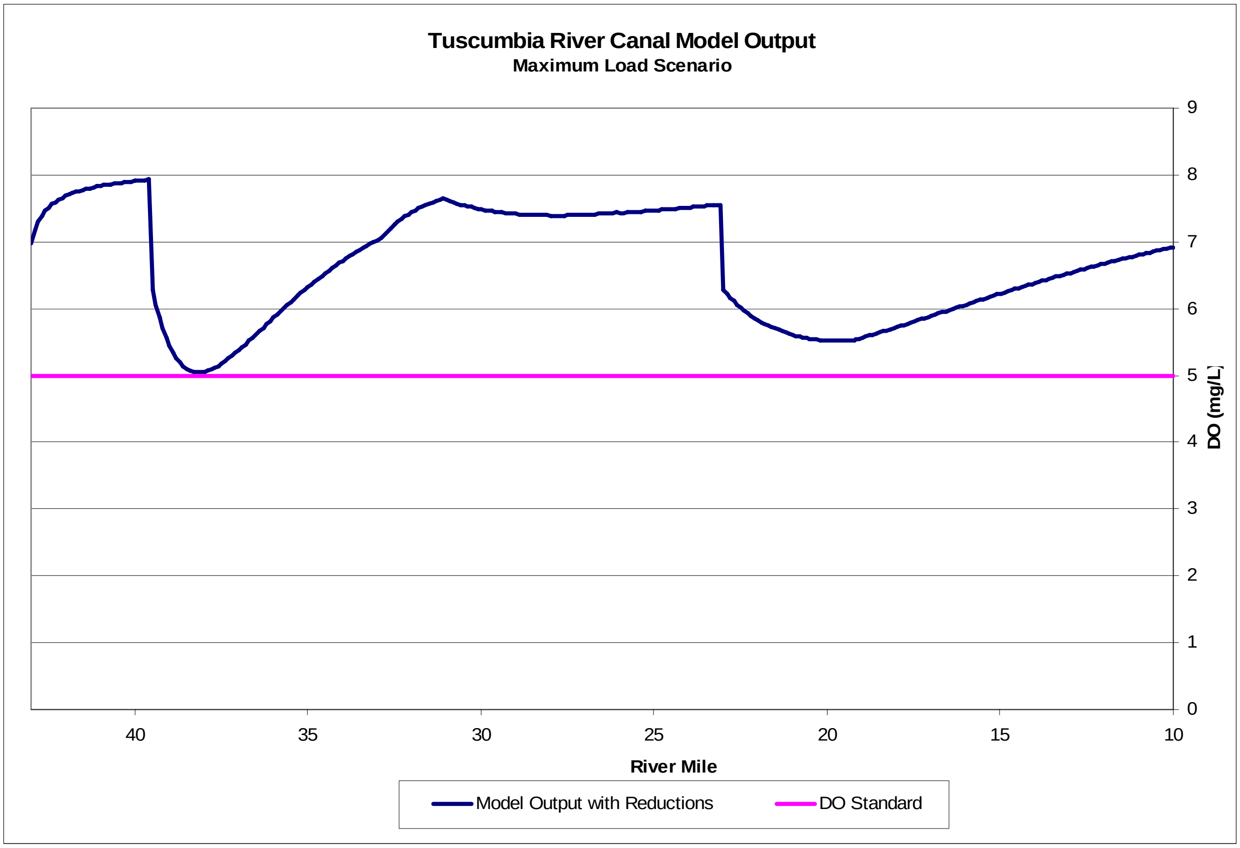

Figure 17. Model Output set at maximum permitted loads with permit reductions in Tuscumbia River Canal demonstrating attainment of the DO water quality (figure courtesy of MDEQ)

The graphs of the routine model outputs for Bridge Creek and Elam Creek, presented in Figures 14-15, show that the predicted DO does not fall below the DO standard in either of the modeled waterbodies during critical conditions. Thus, reductions from the routine loads of TBODu are not necessary. In order to calculate the available assimilative capacity with respect to oxygen consuming wastes, the model was run to increase non-point source loads through a trial-and-error process until the modeled DO was just above 5.0 mg/L. Only the routine non-point source loads in Bridge and Elam Creeks were increased. The baseline non-point source loads in Elam Creek were increased by a factor of 17.0 in this process. The baseline non-point source loads in Bridge Creek were increased by a factor of 38.0 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 Figures 18-19. It is noted that in Figure 18, the model output for the Bridge Creek DO, maximum load scenario, illustrates that the DO concentration is approximately 5.0 mg/l at the mouth of Bridge Creek, which is approximately RM 23.1 of the Tuscumbia River Canal.

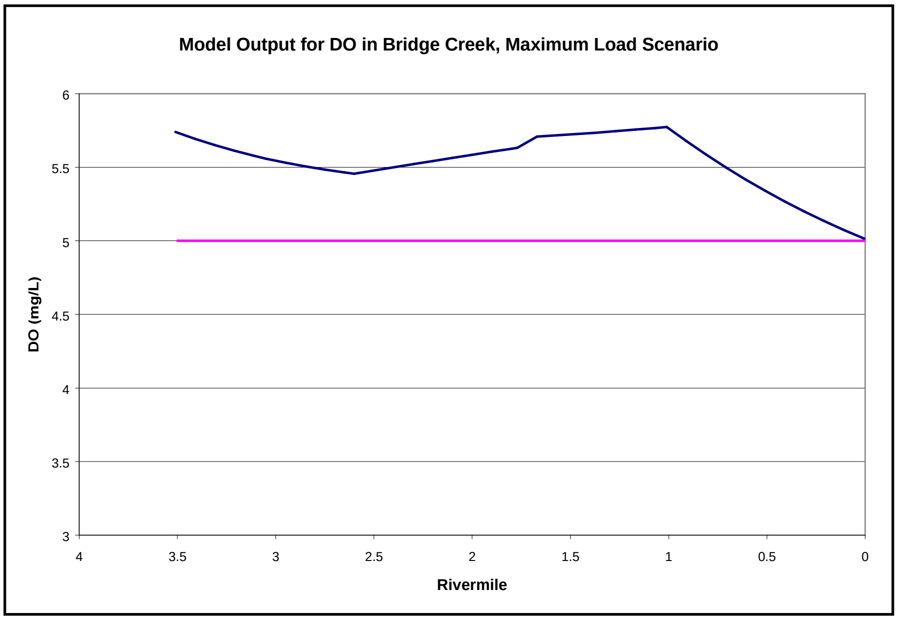

Figure 18. Output for Bridge Creek for DO, based on increasing TBODu loads by a factor of 38 (figure courtesy of MDEQ)

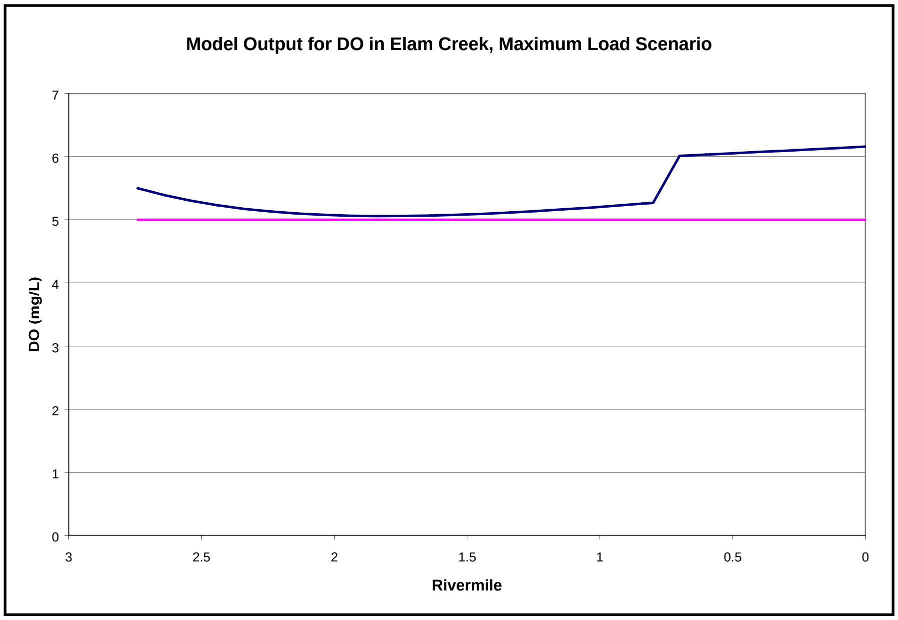

Figure 19. Model Output for Elam Creek for DO, based on increasing TBODu loads by a factor of 17 (figure courtesy of MDEQ)

3.6 Total Phosphorus Estimates

Based on the data available for the Tuscumbia River Canal, the estimated existing TP concentration is calculated as the average annual TP concentration measured over an 11 year period at stations 07029310 and station 07029030, which are located in close proximity to one another in the downstream reaches of the Tuscumbia River Canal, Figure 3. The estimating existing TP concentration is 0.17 mg/L, which is the annual average over the 11 year period of record for the two stations combined. This value is slightly below the value of 0.20 mg/L measured for wadeable streams in Ecoregion 65 with impaired biology and elevated nutrients. TP data are not available for Bridge and Elam Creeks.

Table 16. Average Annual TP Loads

Station	Year	Samples Collected	Annual Average TP mg/l
07029310	1991	5	0.18
	1992	6	0.21
	1993	6	0.20
	1994	6	0.15
	1995	5	0.24
	1996	5	0.17
070290300	1997	11	0.10
	1998	9	0.14
	1999	12	0.17
	2000	5	0.13
	2001	8	0.17
TOTAL	**-**	**78**	**0.17**

A mass balance approach was used to convert the annual average concentration to a load. A flow gage with an average annual flow was not available for the Tuscumbia River Canal Watershed. Therefore, in order to convert the estimated existing total phosphorus concentration to a total phosphorus load, the average annual flow for the Tuscumbia River Canal was estimated based on USGS monitoring data from the Hatchie River. The annual average flow for the Hatchie River near Bolivar, Tennessee (07029500) is 2,492 cfs, with a drainage area of 1480 square miles. To estimate the amount of flow in the Tuscumbia River watershed, a drainage area ratio was calculated (2,492 cfs/1,480 square miles = 1.68 cfs/square mile). The ratio was then multiplied by the drainage area for Bridge and Elam Creeks and the Tuscumbia River Canal, which was 37 and 323 square miles respectively. Thus, the annual average flow for the watershed is estimated in Table 17.

Table 17. Estimated Annual Average Flows

Watershed	Drainage Area Ratio (cfs/square miles)	Drainage Area (square miles)	Estimated Annual Average Flow (cfs)	Estimated Annual Average Flow (MGD)
Bridge Creek and Elam Creek	1.68	37	62.2	40.2
Tuscumbia River Canal	1.68	323	542.6	350.7

The non-point source TP concentration is assumed to be an annual average of 0.07 mg/l. The NPS annual average TP load contribution for Bridge Creek and Elam Creek is 20.7 lbs/day. The NPS annual average TP load contribution for the Tuscumbia River Canal is 180.2 lbs/day. The annual average TP loads were calculated based on the 0.07 mg/l background concentration multiplied by the conversion factor and the estimated annual average flows of the waterbodies.

Since many treatment facilities in Mississippi do not have permit limits for phosphorous, nor are they currently required to report on effluent phosphorous concentrations, EPA used an estimated effluent concentration based on literature values for different treatment types. Table 18 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 TP load from point sources, which is presented in Table 19.

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

Table 18. 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)

Table 19. 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)
Booneville POTW	MS0042030	Oxidation Ditch	2.0	5.8	96.80
Rienzi POTW	MS0033961	Activated Sludge	0.06	5.8	2.90
Suitor Meat Company	MS0037214	Conventional Lagoon	0.003	5.2	0.13
Biggersville School	MS0030589	Activated Sludge	0.015	5.8	0.73
Kossuth High School	MS0029084	Activated Sludge	0.0225	5.8	1.09
Giving Tree Learning Center and Daycare	MS0057673	Aerobic Treatment Unit	0.001	5.2	0.04
Corinth POTW	MS0021652	Oxidation Ditch	4.7	5.8	227.48
		Total	**6.8**	**-**	**329.18**

The average total TP point source load is estimated to be 329.18 lbs/day in the Tuscumbia River Canal, Bridge Creek and Elam Creek. Corinth POTW and Booneville POTW represent 98.5% of the total point source TP loads to the watersheds.

The existing TP loads for Tuscumbia River Canal and Bridge and Elam Creeks is provided for in Table 20, including point sources and non-point sources contributions. For the purposes of calculating the TMDLs, Corinth POTW contributions were accounted for in the Bridge Creek and Elam Creek load calculations and were subtracted from the rest of the point source loads in Tuscumbia River Canal. The existing TP load consists of both point and non-point components. The Tuscumbia River Canal existing load estimate takes into account the existing point-source load from Bridge Creek and Elam Creek.

Table 20. Estimated Annual Average Flows

Watershed	Estimated Annual Average Flow (MGD)	Existing Point Source Load at Maximum Flow Capacity (lbs/day)	Existing Non-Point Source TP Load (lbs/day)
Bridge Creek and Elam Creek	40.2	227.48	20.7
Tuscumbia River Canal	350.7	*101.7	*180.2

** These loads do not reflect the loads from the Bridge Creek and Elam Creek watersheds*

As part of the TMDL development process, EPA is proposing a TP concentration target of 0.06 mg/l to represent a level of protection which is sufficient to fully support designated uses for aquatic life and to provide for an adequate margin of safety for the waterbodies. This concentration represents the 75th percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within Mississippi that have been determined by the State to fully support designated uses as confirmed by the State of Mississippi's rigorous biological assessment methodology.

In recognition of the absence of numeric nutrient criteria for these waters, EPA is also accepting comments on an alternative TP concentration target of 0.10 mg/l as representing a level of protection which is sufficient to fully support designated uses. This concentration represents the 90th percentile of TP concentrations in a dataset comprised solely of waters within Ecoregion 65. Using the target concentrations and the annual average flows, the target loads necessary to attain water quality standards are presented in Table 21.

Table 21. Annual TP Target Loads based on respective TP Targets of 0.06 and 0.10 mg/l

WATERSHED	Pounds/Day and required concentration to meet the target concentration	
	Target Loads (based on TP = 0.06 mg/L)	Target Loads (based on TP = 0.10 mg/L)
Tuscumbia River Canal	175.6 lbs/day	292.7 lbs/day
Bridge and Elam Creeks	20.1 lbs/day	33.5 lbs/day

ALLOCATIONS

The allocations for this TMDL involve a wasteload allocation for point sources and a load allocation for non-point sources necessary for attainment of water quality standards in the Tuscumbia River Canal, Bridge Creek and Elam Creek.

4.1 Allocations for TBODu

The NPDES Permitted facilities that discharge BOD_5 and ammonia nitrogen in the Tuscumbia River Canal, Bridge Creek, and Elam Creek watersheds are included in the wasteload allocations, presented in Table 22. No reductions of the current point source loads are needed for attainment of the DO water quality standard in Bridge Creek and Elam Creek. Reductions in point source loads are needed for the attainment of the DO water quality standard in the Tuscumbia River Canal. The Booneville POTW will need to reduce its maximum permitted load contribution to the Tuscumbia River Canal to 402.32 pounds per day from 536.1 pounds per day, which represents a 24.95% reduction in maximum permitted discharges. The new allocation of 402.32 pounds per day is above the current average loads being discharged by Booneville POTW, which are 155.5 pounds per day.

Table 22. Wasteload Allocation for TBODu

NPDES ID	Facility Name	WLA		
		TBODu (lbs/day)	BOD_5 (mg/l)	NH_3-N (mg/l)
MS0042030	Booneville POTW	402.32	8.5	1.0
MS0033961	Rienzi POTW	22.38	15	5.0
MS0037214	Suitor Meat Company	0.073	Not Applicable	2.0
MS0030589	Biggersville School	5.78	30	2.0
MS0029084	Kossuth High School	8.62	30	2.0
MS0057673	Giving Tree Learning Center and Daycare	0.47	30	2.0
MS0021652	Corinth POTW	1007.76	10	2.0

The headwater and spatially distributed non-point source loads for the Tuscumbia River Canal are included in the load allocation, presented in Table 23. The TBODu concentrations of these loads were determined by using an assumed BOD_5 concentration of 1.33 mg/L and an NH_3-N concentration of 0.1 mg/l.

Table 23. Load Allocation, Maximum Scenario, Tuscumbia River Canal

	Flow (cfs)	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Background Loads	0.010	0.11	0.02	0.13
RM 43.0 – RM 39.6	1.0874	11.70	2.68	14.38
RM 39.6 – RM 32.9	2.1365	22.98	5.26	28.24
RM 32.9 – RM 31.1	0.5740	6.17	1.41	7.58
RM 31.1 – RM 27.3	1.2022	12.93	2.96	15.89
RM 27.3 – RM 27.2	0.0118	0.13	0.03	0.16
RM 27.2 – RM 26.1	0.01	0.11	0.02	0.13
RM 26.1 – RM 23.1	0.01	0.11	0.02	0.13
RM 23.1 – RM 21.2	0.83	8.93	2.04	10.97
RM 21.2 – RM 19.2	0.01	0.11	0.02	0.13
RM 19.2 – RM 10.0	1.5000	16.13	3.70	19.83
		79.4	**18.2**	**97.6**

Best management practices (BMPs) should be encouraged and implemented in the watershed to reduce potential TP loads from non-point sources. The Tuscumbia River Canal 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.

The headwater and spatially distributed loads for Bridge and Elam Creeks 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 0.1 mg/l. The load allocations for Bridge and Elam Creeks are shown in Tables 24-25. This TMDL does not require a reduction of the load allocations.

Table 24. Load Allocation for Bridge Creek, Maximum Scenario

Source	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Non-Point	9.04	2.07	11.1

Table 25. Load Allocation for Elam Creek, Maximum Scenario

Source	CBODu (lbs/day)	NBODu (lbs/day)	TBODu (lbs/day)
Non-Point	1.07	0.25	1.32

4.2 Proposed Allocations for TP

Attainment of the TP target concentration of 0.06 mg/l on an annual average basis requires that phosphorus loads do not exceed those presented in Table 26**.** These allowable loads represent the TMDL for these waters. In light of the effluent-dominated nature of the Elam/Bridge/Tuscumbia watersheds and the significant reductions required to achieve the TP TMDL target, EPA's next step in the TP TMDL development process was to determine the maximum nonpoint source reductions that could practically be achieved. Considering that nutrients are a natural and necessary substance in aquatic ecosystems, EPA understands that a portion of the loads to the Elam/Bridge/Tuscumbia watersheds are natural (i.e., do not originate from point or nonpoint sources) and that reductions to such natural background loads would not be possible. The estimated existing average annual concentration of TP based on both the nonpoint sources and natural background sources is 0.07 mg/l. However, there is insufficient information available to quantify the natural background phosphorus contribution. As part of the TMDL development process, EPA is assuming that concentrations associated with phosphorus loads from nonpoint sources can be reduced to achieve a level of 0.05 mg/l. The load allocations which are based on this assumption are presented in Table 26. The remaining phosphorus loads that could be assimilated by the Elam/Bridge/Tuscumbia watersheds are being allocated to the point sources, which are also presented in Table 26.

Table 26. Total Estimated Maximum Daily Load based on a Total Phosphorus target of 0.06 mg/L

Waterbody	WLA		LA		TMDL (lbs/day)
	(lbs/day)	% reduction	(lbs/day)	% reduction	
Tuscumbia River Canal	26.79	98%	128.68	29%	155.47
Bridge Creek and Elam Creek	5.32	74%	14.81	29%	20.13

In order for Bridge Creek and Elam Creek to attain the applicable water quality standards for nutrients; based on a TP target concentration of 0.06 mg/l, the Corinth POTW must significantly reduce its effluent phosphorus levels. These reductions will improve the water quality in the Tuscumbia River Canal; however, additional reductions in phosphorus from point sources and nonpoint sources affecting Tuscumbia River Canal will be necessary. In order to achieve the wasteload allocation for Tuscumbia River Canal, EPA is proposing reductions on the discharge from Booneville POTW. The current estimated phosphorus loads from the Booneville POTW currently comprise more than 95% of the total loads discharged from the point sources in this watershed, and therefore any load reductions from the minor point sources discharging to this watershed would have an insignificant impact on water quality. The individual wasteload allocations and percent reductions for the point sources discharging to Bridge Creek, Elam Creek and Tuscumbia River Canal are presented in Table 27 below.

Table 27: Wasteload allocations for NPDES dischargers to Tuscumbia River Canal, Bridge Creek and Elam Creek with a Target TP concentration of 0.06 mg/L

Facility	Permitted Discharge (MGD)	Existing Estimated TP Point Source Load and Concentration		Allocated Average TP Point Source Load and Concentration		Percent Reduction
		Lbs/day	Mg/L	Lbs/day	Mg/L	
Booneville POTW	2.0	96.74	5.8	**21.9**	**1.31**	77%
Rienzi POTW	0.06	2.9	5.8	**2.9**	**5.8**	0%
Suitor Meat Company	0.003	0.13	5.2	**0.13**	**5.2**	0%
Biggersville School	0.015	0.73	5.8	**0.73**	**5.8**	0%
Kossuth High School	0.0225	1.09	5.8	**1.09**	**5.8**	0%
Giving Tree Learning Center and Daycare	0.001	0.04	5.2	**0.04**	**5.2**	0%
Corinth POTW	4.7	227.34	5.8	**5.32**	**0.14**	98%

4.3 Alternate Allocations for TP

In recognition of the absence of numeric nutrient criteria for these waters, EPA is also accepting comments on an alternative TP concentration target of 0.10 mg/l as representing a level of protection that is sufficient to fully support designated uses. This concentration represents the 90th percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within the State of Mississippi that have been determined by the State to fully support designated uses. Attainment of the TP target concentration of 0.10 mg/l on an annual average basis requires that phosphorus loads do not exceed those presented in Table 28**.** These allowable loads represent the TMDL for these waters based on an alternate total phosphorus target concentration of 0.10 mg/l. The TMDLs, including the wasteload allocation and load allocation based on this alternate target are presented in Table 28.

Table 28. Total Estimated Maximum Daily Load based on a Total Phosphorus target of 0.10 mg/L

Waterbody	WLA		LA		TMDL (lbs/day)
	(lbs/day)	% reduction	(lbs/day)	% reduction	
Tuscumbia River Canal	26.79	98%	128.68	29%	292.7
Bridge Creek and Elam Creek	5.32	74%	14.81	29%	33.5

In order for Bridge Creek and Elam Creek to attain the applicable water quality standards for nutrients; which are based on a TP target concentration of 0.10 mg/l, the Corinth POTW must significantly reduce its effluent phosphorus levels. These reductions will improve the water quality in the Tuscumbia River Canal; however, additional reductions in phosphorus from pollutant sources affecting Tuscumbia River Canal will be necessary. However, reductions to the nonpoint sources in Tuscumbia River Canal combined with the phosphorus reductions from the Bridge/Elam Creek watersheds is expected to be sufficient to result in the attainment of the alternate TP target of 0.10 mg/l. Therefore, no reductions would be necessary from the Booneville POTW or the minor point sources discharges. The individual wasteload allocations for the point sources discharging to Bridge Creek, Elam Creek, and Tuscumbia River Canal are presented in Table 29. There are no TP data available from the Booneville and Corinth POTWs to calculate the current TP loads being discharged from the facilities. Therefore, TP monitoring at the facilities is necessary to better characterize the effluent and to more accurately predict the TP percent reductions needed from the facilities.

Table 29: Wasteload allocations for NPDES dischargers to Tuscumbia River Canal, Bridge Creek and Elam Creek with a Target TP concentration of 0.10 mg/L

Facility	Permitted Discharge (MGD)	Existing Estimated TP Point Source Load and Concentration		Allocated Average TP Point Source Load and Concentration		Percent Reduction
		Lbs/day	Mg/L	Lbs/day	Mg/L	
Booneville POTW	2.0	96.74	5.8	**96.80**	**5.8**	0%
Rienzi POTW	0.06	2.9	5.8	**2.90**	**5.8**	0%
Suitor Meat Company	0.003	0.13	5.2	**0.13**	**5.2**	0%
Biggersville School	0.015	0.73	5.8	**0.73**	**5.8**	0%
Kossuth High School	0.0225	1.09	5.8	**1.09**	**5.8**	0%
Giving Tree Learning Center and Daycare	0.001	0.04	5.2	**0.04**	**5.2**	0%
Corinth POTW	4.7	227.34	5.8	**18.73**	**0.48**	92%

4.4 Margin of Safety

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

Conservative assumptions, which place a higher demand of DO on the waterbody than may actually be present, are considered part of the margin of safety. The assumption that all of the ammonia nitrogen present in the water body is oxidized to nitrate nitrogen, for example, is a conservative assumption. In addition, the TMDL is based on the critical condition of the water body, which is represented by the 7Q10 flow. Therefore, modeling the water body at this flow provides protection in the worst-case scenario. In addition, the available assimilative capacity with respect to oxygen consuming wastes in Bridge Creek and Elam Creek provides an additional MOS for these waters.

The TP allocations for Tuscumbia River Canal, Elam Creek, and Bridge Creek incorporate an implicit margin of safety based on the conservative approach used in the nutrient target development. The TP TMDL target represents the 75th percentile of TP concentrations in a dataset comprised solely of waters in Ecoregion 65 within the State of Mississippi that have been determined by the State to fully support designated uses as confirmed by the State's rigorous biological assessment methodology. The MOS is further enhanced by using a TP value that corresponds to the 75th percentile of a distribution of streams fully supporting their uses based on their IBI scores. Thus, 25 percent of the fully supporting streams could have TP values above this conservative target.

4.5 Seasonal Variability

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, however, do not vary according to the seasons. The TMDL development approach used to establish allocations for TBODu and total phosphorus ensure that water quality standards will be protected throughout the year, including during critical conditions.

4.6 Potential Future Studies

MDEQ has expressed interest in conducting a water quality and wasteload allocation study of the Elam/Bridge/Tuscumbia watersheds during the early fall of 2006 in an effort to better understand how nutrients impact this system. The State has also requested EPA's technical assistance with this effort. Any data collected during that timeframe is expected to be available prior to the finalization of the TMDLs and would be fully considered as part of the TMDL development process.

4.7 Public Participation

These draft TMDLs are being proposed for public review and comment during a 60-day period. The EPA is notifying the public by publishing a notice of the TMDLs through a legal ad in the statewide newspaper, the *Clarion-Ledger*. The public notice will also appear in the local newspaper. EPA is also providing notice to members of the public through e-mail who have requested that MDEQ include them on a TMDL mailing list. The TMDL is also available for review and comment on EPA Region 4's website:
(http://www.epa.gov/Region4/water/tmdl/mississippi/).

The public may request to receive the TMDL report through the mail by addressing their comments to:

Attention: Ms Sibyl Cole,
U.S. EPA Region 4, Water Management Division
61 Forsyth Street, S.W.
Atlanta, Georgia 30303

The public may also submit comments by email at cole.sibyl@epa.gov or by phone at 404-562-9437. All comments received during the public notice period will become a part of the public record for these TMDLs.

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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 assemblage (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: A provision of the Clean Water Act which prohibits discharge of pollutants into waters of the United States unless a special permit is issued by EPA, a state, or, where delegated, a tribal government on an Indian reservation.

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: State-adopted and EPA-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Water Quality Criteria: Levels of water quality expected to render a body of water suitable for its designated use. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

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 land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

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

CFS .... Cubic Feet per Second

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

Mg/L .... Milligrams per Liter

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