FINAL REPORT
June 2007
ID: 807062601

Total Maximum Daily Load

Nutrients

For
Tibbee and Chuquatonchee Creeks

Tombigbee River Basin

Clay and Monroe Counties, Mississippi

Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Branch

MDEQ
PO Box 10385
Jackson, MS 39289-0385
(601) 961-5171
www.deq.state.ms.us

Mississippi Department of

FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. The report contains one or more Total Maximum Daily Loads (TMDLs) for water body segments found on Mississippi's 1996 Section 303(d) List of Impaired Water bodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach. The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Conversion Factors

To convert from	To	Multiply by	To convert from	To	Multiply by
mile2	acre	640	acre	ft2	43560
km2	acre	247.1	days	seconds	86400
m3	ft3	35.3	meters	feet	3.28
ft3	gallons	7.48	ft3	gallons	7.48
ft3	liters	28.3	hectares	acres	2.47
cfs	gal/min	448.8	miles	meters	1609.3
cfs	MGD	0.646	tonnes	tons	1.1
m3	gallons	264.2	µg/l * cfs	gm/day	2.45
m3	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	102	hecto	h
10-3	milli	m	103	kilo	k
10-6	micro	:	106	mega	M
10-9	nano	n	109	giga	G
10-12	pico	p	1012	tera	T
10-15	femto	f	1015	peta	P
10-18	atto	a	1018	exa	E

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Table 1. Listing Information

Water Body ID	Name	County	Cause	HUC	Monitored/Evaluated
MS022E	Chuquatonchee Creek	Monroe, Clay	Nutrients	03160104	Evaluated
Location: Near Siloam from confluence of Houlka Creek and Chuquatonchee River to mouth at Tibbee Creek					
MSTIBBEE	Tibbee Creek	Clay	Nutrients	03160104	Evaluated
Location: From Headwaters at confluence of Line and Chuquatonchee Creeks to the Tenn-Tom Waterway					

Table 2. Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
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.

Table 3. Total Maximum Daily Loads

Waterbody	**Nutrients**	**WLA (lbs/day)**	**LA (lbs/day)**	**MOS**	**TMDL (lbs/day)**	**Percent Reduction**
Tibbee Creek	TN	376.36	5291.22 – 6235.82	implicit	5567.58 – 6612.18	0 - 43%
	TP	170.13	396.63 – 774.47	implicit	566.76 – 944.60	26 – 36%
Chuquatonchee Creek	TN	113.09	2513.90 – 2951.73	implicit	2626.99 – 3064.82	37 - 47%
	TP	48.26	214.44 – 389.57	implicit	262.70 – 437.83	0- 45%

Table 4. NPDES Permitted Facilities

Name	NPDES Permit	Watershed
Adams Trailer Park	MS0046281	Tibbee
Alexander High School	MS0038598	Tibbee
Atkinson Laundry and Carwash	MS0049239	Chuquatonchee
Boatman Trailer Park	MS0051446	Tibbee
Camp Tik A Witha	MS0029882	Chuquatonchee
Cantrells Personal Care Home	MS0046787	Tibbee
Community Counseling Services, Opportunity House	MS0049131	Chuquatonchee
Davis Meats Inc	MS0037788	Chuquatonchee
Houston POTW	MS0025071	Chuquatonchee
Josey Creek Missionary Baptist Church	MS0055727	Tibbee
New Houlka POTW, West	MS0025216	Chuquatonchee
Oktibbeha County Lake	MS0021717	Tibbee
Ridge Lakes Apartments	MS0054917	Tibbee
West Clay County School	MS0029459	Tibbee
West Point POTW, Lone Oak	M50033740	Chuquatonchee
West Point POTW, West	M50020788	Tibbee
Youngs Fish and Steak House	MS0045705	Chuquatonchee

EXECUTIVE SUMMARY

This TMDL has been developed for Tibbee and Chuquatonchee Creeks which were placed on the Mississippi 1996 Section 303(d) List of Impaired Water Bodies due to evaluated causes of pesticides, siltation, nutrients, and organic enrichment - low dissolved oxygen. The Mississippi Department of Environmental Quality (MDEQ) completed TMDLs for the pesticides and siltation causes. The nutrients and organic enrichment - low dissolved oxygen causes remained on the evaluated list. Recent monitoring was conducted and the organic enrichment - low dissolved oxygen causes have been delisted. This TMDL will provide an estimate of the total nitrogen (TN) and total phosphorus (TP) loadings allowable in the stream.

Mississippi does not have water quality standards for allowable nutrient concentrations. MDEQ currently has a Nutrient Task Force working on the development of criteria for nutrients. An annual concentration range of 0.6 to 0.7 mg/L is an applicable target for TN and 0.06 to 0.10 mg/L for TP for water bodies located in Ecoregion *65*. MDEQ is presenting these ranges as preliminary target values for TMDL development which is subject to revision after the development of numeric nutrient criteria. The nutrient data and estimated ecoregion concentrations indicate reductions of nutrients are needed.

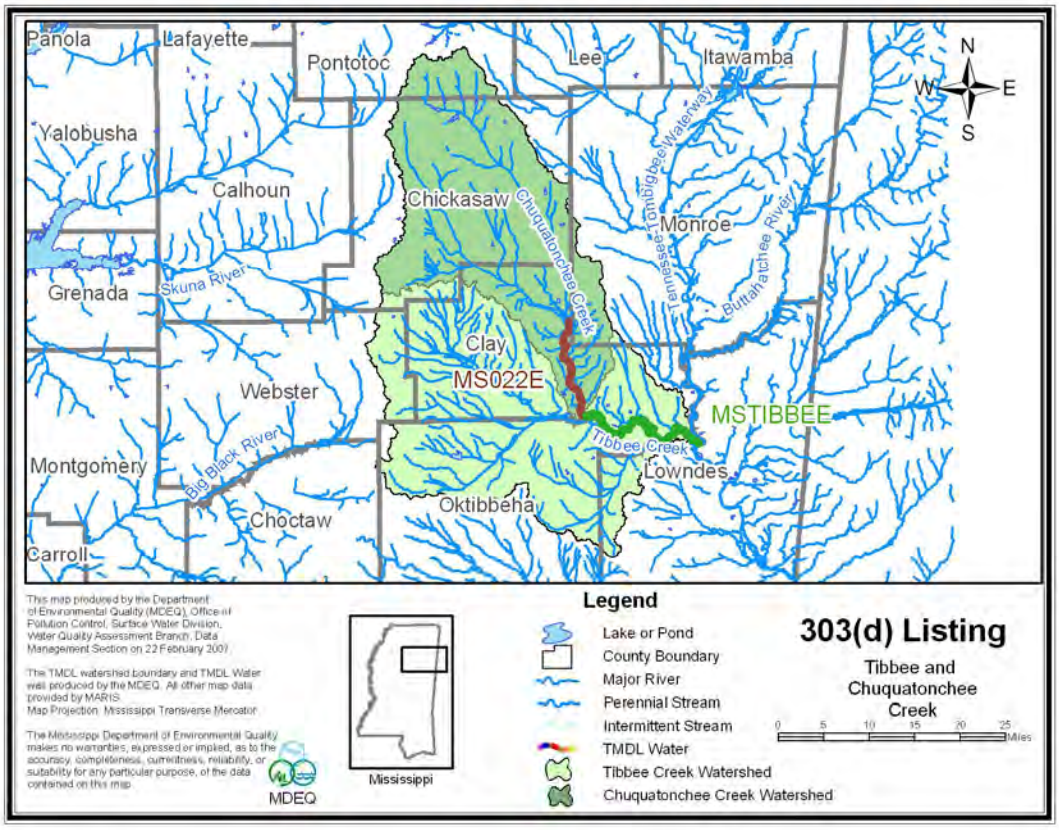
The Tibbee Creek Watershed contains the Chuquatonchee Creek Watershed and is the entire HUC 03160104 near West Point in Clay, Chickasaw, Lowndes, and Oktibbeha Counties. Tibbee Creek flows for 24 miles in a southeast direction from the confluence of Chuquatonchee and Line Creeks to the confluence with the Tenn-Tom Waterway. The Chuquatonchee Creek Watershed is located in HUC 03160104 near Siloam in Monroe and Clay Counties (shown in Figure 1). The impaired segment of Chuquatonchee Creek flows for 15 miles in a southerly direction. Chuquatonchee Creek begins from intermittent headwaters in Chickasaw County and flows to the confluence with Tibbee Creek.

INTRODUCTION

1.1 Background

The identification of water bodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those water bodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired water bodies through the establishment of pollutant specific allowable loads. This TMDL has been developed for the 2006 §303(d) listed segments shown in Figure 1.

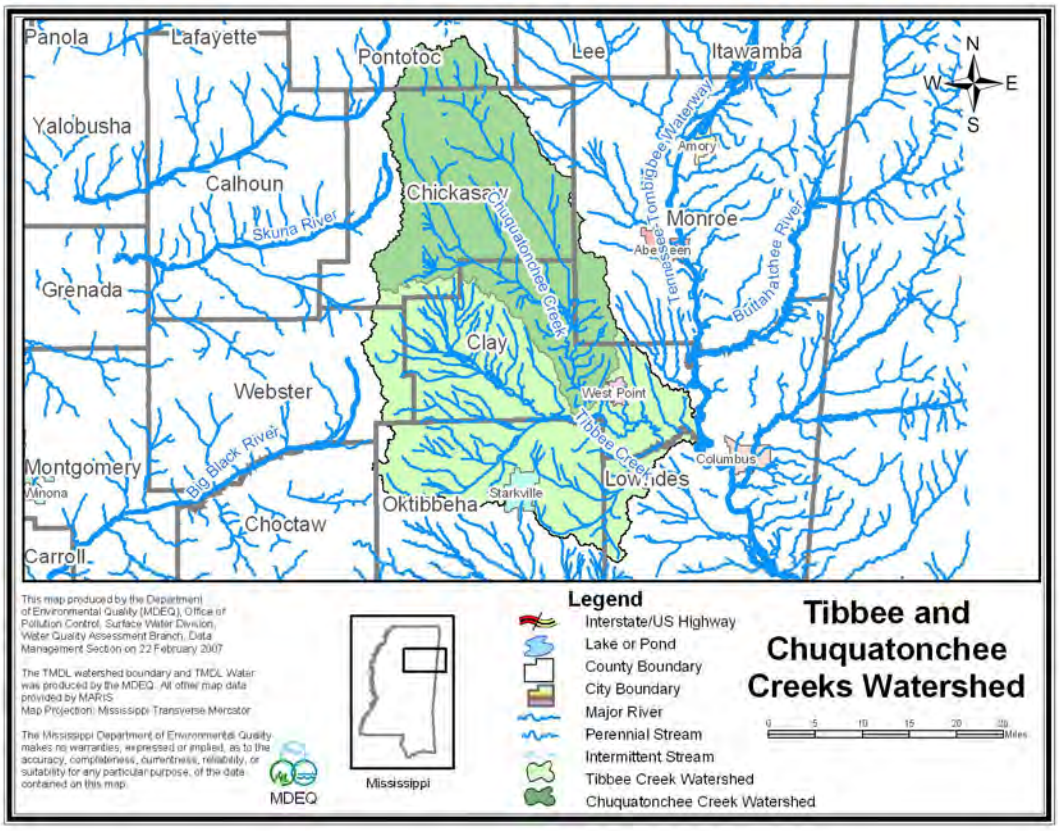
Figure 1. Tibbee and Chuquatonchee Creeks §303(d) Segments



The original listing for Chuquatonchee Creek was for the Spring Creek Drainage Area (MS022E). In 1998, MDEQ changed the practice of listing drainage areas. There were no monitoring data, so the streams remained on the evaluated portion of Mississippi's §303(d) list. The impaired segment of Chuquatonchee Creek flows for 15 miles in a southerly direction. Chuquatonchee Creek begins from intermittent headwaters in Chickasaw County and flows to the confluence with Tibbee Creek. The Chuquatonchee Creek Watershed is located in HUC 03160104 near Siloam in Monroe and Clay Counties (shown in Figure 1). The Tibbee Creek Watershed contains the Chuquatonchee Creek Watershed and is the entire HUC 03160104 near West Point in Clay, Chickasaw, Lowndes, and Oktibbeha Counties (shown in Figure 2). Tibbee Creek flows for 24 miles

in a southeast direction from the confluence of Chuquatonchee and Line Creeks to the confluence with the Tenn-Tom Waterway.

Figure 2. Tibbee and Chuquatonchee Creeks Watersheds



1.2 Preliminary Nutrient Criteria

There are no state criteria in Mississippi for nutrients. These criteria are currently being developed by the Mississippi Nutrient Task Force (NTF) in coordination with EPA Region 4. MDEQ proposed a work plan for nutrient criteria development that has been approved by EPA and is on schedule according to the approved plan in development of nutrient criteria (MDEQ, 2004). Data were collected for wadeable streams to calculate the nutrient criteria. For this TMDL, MDEQ is presenting preliminary target ranges for Total Nitrogen (TN) and Total Phosphorus (TP). The limited data available are greater than these ranges for TN and TP. An annual concentration range of 0.6 to 0.7 mg/L is an applicable target for TN and 0.06 to 0.10 mg/L for TP for water bodies located in Ecoregion 65. However, MDEQ is presenting these ranges as preliminary target values for TMDL development which is subject to revision after the development of nutrient criteria, when the work of the NTF is complete.

1.3 Pollutants of Concern: Total Nitrogen and Total Phosphorus

The following is an adaptation of the State of Washington Department of Ecology's *Citizen's Guide to Understanding and Monitoring in Streams and Lakes* and provides a brief description and basic understanding of the pollutants of concern for this TMDL report:

The two primary nutrients of concern are nitrogen and phosphorus. Both elements commonly are measured in several forms. Phosphorus can be reported as total phosphorus (TP), which includes a particulate form and soluble reactive phosphate (SRP) (also sometimes called phosphate (PO_4^{-3}) or orthophosphate (ortho-P). The latter two are different terms used to describe the fraction of TP that is soluble, and therefore more immediately available to organisms for growth.

Nitrogen can be measured as total nitrogen (TN), total Kjeldahl nitrogen (TKN), nitrite-nitrogen (NO_2^-), nitrate-nitrogen (NO_3^-), or ammonia-nitrogen (NH_3 or NH_4^+) [NO_2^- is usually measured as nitrate-nitrite-nitrogen ($NO_3^- – NO_2^-$)]. As is the case with TP, there are fractions of TN that are more bioavailable. TKN includes the organic form of TN, which is less bioavailable for growth versus the more readily available component of TKN, which is NH_3 or NH_4^+. The fractions of NO_2^--NO_3^- and NH_3 or NH_4^+ represent forms of nitrogen that are more immediately available for growth.

Organically bound TP and TN, while not immediately available, can be converted to bioavailable forms at predictable rates; and may be significant drivers of primary productivity. One chemical form of an element can be converted into another, and the conditions under which the conversion occurs are influenced by many factors; such as pH, temperature, oxygen concentration, and biological activity. The original form of the nutrient and physical conditions will determine if an increase in total nutrient concentrations will result in higher available nutrient concentrations and therefore, a corresponding immediate increase in growth or productivity. If nutrients enter as organic matter that first needs to be decomposed before it can be utilized for growth, temperature becomes important due to its effect on the rate of decomposition. (During warmer month, nutrients entering the system, as intact organic matter would be decomposed relatively quickly as compared to cold, wet-weather months when decomposition is slow).

These dynamics are further complicated by the fact that increased growth leads to greater numbers of organisms that need even more nutrients. So, as nutrients become available they are immediately utilized.

Increased nutrient concentrations are almost always an impact of pollution. Municipal and industrial discharges usually contain nutrients, and overland flow from developed watersheds contains nutrients from lawn and garden fertilizers as well as the additional organic debris so easily washed from urban surfaces. Agricultural areas also contribute to nutrient increases through poor manure and fertilizing practices and increased erosion from plowed surfaces.

Nutrient loading can typically result in increased algae growth. In flowing stream segments where conditions are right, algae take the form of an attached growth – called periphyton –on rocks, logs, and other substrate. Phytoplankton growth is also a concern in slower flowing streams. Excessive growths of algae can result in exaggerated fluctuations of normal dissolved oxygen cycles and eventually create a dissolved oxygen crash. In addition, unsightly conditions, odors, and poor habitat conditions for aquatic organisms can also be attributed to excessive algae (WDOE, 1994).

1.4 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 listed segments is fish and wildlife.

1.5 Applicable Water Body Segment Standard

The water quality standard applicable to the use of the water body and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* (MDEQ, 2003). Mississippi's current standards contain a narrative criteria that can be applied to nutrients which states "*Waters shall be free from materials attributable to municipal, industrial, agricultural, or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation, or to aquatic life and wildlife, or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use* (MDEQ, 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 professional judgment." MDEQ believes the most economical and scientifically defensible method for use in Mississippi is a comparison between similar but unimpaired waters within the same region. This method is dependent on adequate data which are being collected in accordance with the EPA approved plan. The initial phase of the data collection process for wadeable streams is complete.

1.6 Nutrient Target Development

Nutrient data were collected quarterly at 99 discrete sampling stations state wide where biological data already existed. These stations were identified and used to represent a range of stream reaches according to biological health status, geographic location (selected to account for ecoregion, bioregion, basin and geologic variability) and streams that potentially receive non-point source pollution from urban, agricultural, and silviculture lands as well as point source pollution from NPDES permitted facilities.

Nutrient concentration data were not normally distributed; therefore, data were log transformed for statistical analyses. Data were evaluated for distinct patterns of various data groupings (stratification) according to natural variability. Only stations that were characterized as "least disturbed" through a defined process in the Mississippi Benthic Index of Stream Quality (M-BISQ) process or stations that resulted in a biological impairment rating of "fully attaining" were used to evaluate natural variability of the data set (MDEQ, 2003).

The M-BISQ, a regionally calibrated benthic index of biotic integrity, was developed through a partnership between MDEQ and Tetra Tech, Inc. in 2001 from 434 wadeable (perennial, 1st-4th order streams) in the state excluding the Yazoo Delta. This index defined five bioregions for the state, and established the 25th percentile of the least disturbed condition for each bioregion as the threshold of impairment of the state of Mississippi's wadeable streams. Since Tibbee and Chuquatonchee are non-wadeable

streams, MDEQ was unable to use the M-BISQ methodology and perform a biological assessment. Therefore, these water bodies did not have stressor identification reports completed and remain evaluated listings for nutrients.

Each of the two groups—"least disturbed sites" and "fully attaining sites"—was evaluated separately. Some stations were used in both sets, in other words, they were considered "least disturbed" and "fully attaining". The number of stations considered "least disturbed" was 30 of 99, and the number of stations considered "fully attaining" was 53 of 99.

Several analysis techniques were used to evaluate nutrient data. Graphical analyses were used as the primary evaluation tool. Specific analyses used included; scatter plots, box plots, Pearson's correlation, and general descriptive statistics.

In general, natural nutrient variability was not apparent based on box plot analyses according to the four stratification scenarios. Bioregions were selected as the stratification scheme to use for TMDLs in the Pascagoula Basin. However, this was not appropriate for some water bodies in smaller bioregions. Therefore, MDEQ now uses ecoregions as a stratification scheme for the water bodies in the remainder of the state.

In order to use the data set to determine possible nutrient thresholds, nutrient concentrations were evaluated as to their correlation with biological metrics. That thorough evaluation was completed prior to the Pascagoula River Basin TMDLs. The methodology and approach were verified. The same methodology was applied to the subsequent ecoregions.

For the preliminary target concentration range the means of the data at each of the nutrient sites were taken. Then the 75th and percentiles of the means were taken of the nutrient sites in that ecoregion that are fully supporting for aquatic life support according to the M-BISQ scores. For the estimate of the existing concentrations the median was taken of the data from the sites that were not attaining and had nutrient concentrations greater than the target.

2.0 WATER BODY ASSESSMENT

2.1 Tibbee and Chuquatonchee Creeks Water Quality Data

Nutrient data for the Tibbee and Chuquatonchee Creeks Watershed were gathered and reviewed. The data are given in Table 5 and Table 6. Data exist for the § 303(d)-listed segment of Tibbee Creek based on samples collected at ambient station #2440950 from 1996 to 2001. Additionally, in 2006, nutrient data were collected at two special study stations, #303DF62 on Tibbee Creek and #A0250007 on Chuquatonchee Creek. The locations of the water quality monitoring stations are shown in Figure 3.

Figure 3. Tibbee and Chuquatonchee Creeks Water Quality Monitoring Stations

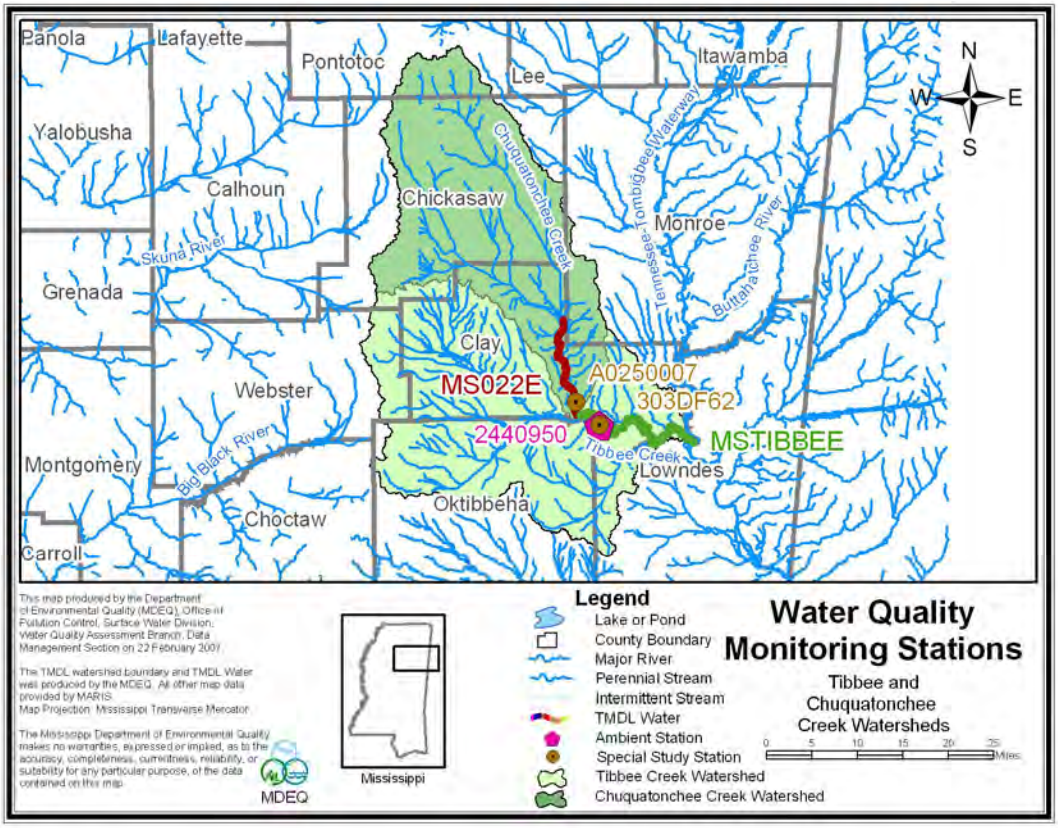


Table 5: Nutrient Data from 1996-2001 on Tibbee Creek

Station ID	Program	Water Body	Date	Time	TP (mg/l)	TN(mg/l)
2440950	Ambient	Tibbee Creek	12/4/1996	13:30	0.27	0.87
			1/22/1997	9:30	0.10	0.60
			2/12/1997	8:45	0.14	0.22
			3/5/1997	11:00	0.13	0.89
			4/3/1997	13:30	0.05	0.49
			5/5/1997	12:00	0.11	1.49
			6/10/1997	11:40	0.17	0.82
			7/1/1997	12:30	0.30	1.11
			8/4/1997	12:15	0.12	0.79
			9/9/1997	12:15	0.03	0.45
			10/13/1997	12:30	0.07	0.60
			11/18/1997	11:50	0.07	0.54
			12/9/1997	12:05	0.08	0.41
			1/7/1998	12:15	0.25	1.78
			2/26/1998	11:55	0.16	0.78
			3/4/1998	11:30	0.13	0.50
			5/27/1998	10:30	0.09	0.80
			6/9/1998	11:35	0.11	0.75
			7/14/1998	12:10	0.46	2.20
			8/13/1998	12:30	0.92	2.92
			9/30/1998	8:30	0.09	0.86
			10/26/1998	11:35	0.11	1.26
			12/9/1998	10:06	0.13	0.34
			1/11/1999	11:30	0.16	0.77
			2/16/1999	11:31	0.10	0.76
			3/2/1999	12:30	0.16	0.92
			3/30/1999	11:30	0.06	0.44
			5/5/1999	11:20	0.31	0.77
			6/3/1999	12:00	0.10	0.55
			7/1/1999	12:50	0.13	0.87
			8/11/1999	12:00	0.08	0.82
			9/16/1999	11:15	0.10	1.34
			10/27/1999	10:30	0.13	0.58
			11/8/1999	13:00	0.06	0.70
			12/14/1999	12:20	0.09	0.46
			1/19/2000	13:10	0.09	0.56
			2/24/2000	12:25	0.12	0.82
			4/10/2000	11:15	0.17	0.85
			5/3/2000	9:10	0.08	0.62
			6/9/2000	14:20	0.20	1.49
			7/13/2000	13:35	0.06	0.57
			11/28/2000	10:44	0.23	2.84
			11/28/2000	10:44	0.32	1.78
			4/10/2001	13:15	0.11	0.66
			5/21/2001	12:25	0.15	0.62
			6/20/2001	11:05	0.28	0.76
			7/18/2001	11:25	0.13	0.87
			9/18/2001	11:10	0.14	0.79
			10/22/2001	10:45	0.08	0.66
			11/6/2001	9:50	0.07	0.30
			12/11/2001	10:05	0.11	0.67
			Average		**0.16**	**0.89**

Table 6. Nutrient data collected for Special Studies on Tibbee and Chuquatonchee Creeks

Station ID	Program	Water Body	Date	Time	TP (mg/l)	TN (mg/l)
A0250007	Special Study	Chuquatonchee Creek	9/7/2006	7:06	0.06	0.96
			9/18/2006	11:00	0.10	1.33
			9/27/2006	12:30	0.14	1.00
			Average		**0.10**	**1.10**
303DF62	Special Study	Tibbee Creek	9/6/2006	11:45	0.04	1.14
			9/18/2006	10:05	0.09	1.35
			9/27/2006	11:15	0.13	1.17
			Average		**0.09**	**1.22**

2.2 Assessment of Point Sources

An important step in assessing pollutant sources in the Tibbee and Chuquatonchee Creeks Watershed is locating the NPDES permitted sources. There are 17 active facilities permitted to discharge organic material into the Tibbee and Chuquatonchee Creeks watersheds, which are presented in Table 7. The effluent from the facilities was characterized based on all available data including information on its wastewater treatment system, permit limits, and discharge monitoring reports. Bryan Foods Inc. (MS0001783) has shut down its facility as of March 30, 2007 and is currently in negotiations with MDEQ to close out their NPDES permit. The facility discharged into an unnamed tributary of Town Creek, which then discharged into Tibbee Creek. The impairment assessment for Tibbee Creek was made when Bryan Foods was an active permitted discharger to the water body. Given that Bryan Foods was only removed in March 2007, it is appropriate to include Bryan Foods in the existing point source assessment in order to demonstrate the relative impact Bryan Foods versus the remaining dischargers to the Tibbee-Chuquatonchee watersheds. Information on Bryan Foods is presented in Table 8.

Table 7. Active NPDES Permitted Facilities in the Watersheds

Name	NPDES Permit	Treatment Type	Permitted Discharge (MGD)	Watershed
Adams Trailer Park	MS0046281	Aerobic treatment unit	0.001	Tibbee
Alexander High School	MS0038598	Conventional lagoon	0.015	Tibbee
Atkinson Laundry and Carwash	MS0049239	Septic tank and sand filter	0.002	Chuquatonchee
Boatman Trailer Park	MS0051446	Activated sludge system	0.002	Tibbee
Camp Tik A Witha	MS0029882	Septic tank and sand filter	0.001	Chuquatonchee
Cantrells Personal Care Home	MS0046487	Aerobic treatment unit	0.001	Chuquatonchee
Community Counseling Services, Opportunity House	MS0049131	Aerated treatment unit	0.002	Tibbee
Davis Meats, Inc.	MS0037788	Septic tank into 2 lagoons	0.00	Chuquatonchee
Houston POTW	MS0025071	Oxidation ditch and UV disinfection	0.990	Chuquatonchee
Josey Creek Missionary Baptist Church	MS0055727	Aerated treatment unit	0.001	Tibbee
New Houlka POTW, West	MS0025216	Conventional lagoon, disinfection	0.200	Tibbee
Oktibbeha County Lake	MS0021717	Conventional lagoon	0.008	Tibbee
Ridge Lakes Apartments	MS0054917	Conventional lagoon, disinfection	0.096	Tibbee
West Clay County School	MS0029459	Activated sludge system	0.012	Tibbee
West Point POTW, Lone Oak	MS0033740	Aerated lagoon, disinfection	0.085	Tibbee
West Point POTW, West	MS0020788	Aerated lagoon, sand filtration	3.500	Tibbee
Youngs Fish and Steak House	MS0045705	Conventional lagoon	0.003	Chuquatonchee
Total Point Source Flow for Existing Dischargers (MGD) for Tibbee Creek: 3.92 MGD				
Total Point Source Flow for Existing Dischargers (MGD) for Chuquatonchee Creek: 1.0 MGD				

Table 8. Information for Bryan Foods, Inc., which was taken offline in March 2007

Name	NPDES Permit	Treatment Type	Permitted Discharge (MGD)	Watershed
Bryan Foods, Inc	MS0001783	Anaerobic lagoon, two stage activated sludge plant	3.0—Maximum permitted discharge 1.91—Actual Average annual flow for 2002-2006	Town Creek, thence into Tibbee Creek

2.3 Assessment of Non-Point Sources

Non-point loading of nutrients and organic material in a water body results from the transport of the pollutants into receiving waters by overland surface runoff, groundwater infiltration, and atmospheric deposition. The two primary nutrients of concern are nitrogen and phosphorus. TN is a combination of many forms of nitrogen found in the environment. Inorganic nitrogen can be transported in particulate and dissolved phases in surface runoff. Dissolved inorganic nitrogen can be transported in groundwater and may enter a stream from groundwater infiltration. Finally, atmospheric gaseous nitrogen may enter a stream from atmospheric deposition.

Unlike nitrogen, phosphorus is primarily transported in surface runoff when it has been sorbed by eroding sediment. Phosphorus may also be associated with fine-grained particulate matter in the atmosphere and can enter streams as a result of dry fallout and rainfall (USEPA, 1999). However, phosphorus is typically not readily available from the atmosphere or the natural water supply (Davis and Cornwell, 1988). As a result, phosphorus is typically the limiting nutrient in most non-point source dominated rivers and streams, with the exception of watersheds which are dominated by agriculture and have high concentrations of phosphorus contained in the surface runoff due to fertilizers and animal excrement or watersheds with naturally occurring soils which are rich in phosphorus (Thomann and Mueller, 1987). Table 9 presents typical nutrient loading ranges for various land uses.

Table 9. Nutrient Loadings for Various Land Uses

Landuse	Total Phosphorus (lbs/acre-y)			Total Nitrogen (lbs/acre-y)		
	Maximum	Median	Minimum	Maximum	Median	Minimum
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

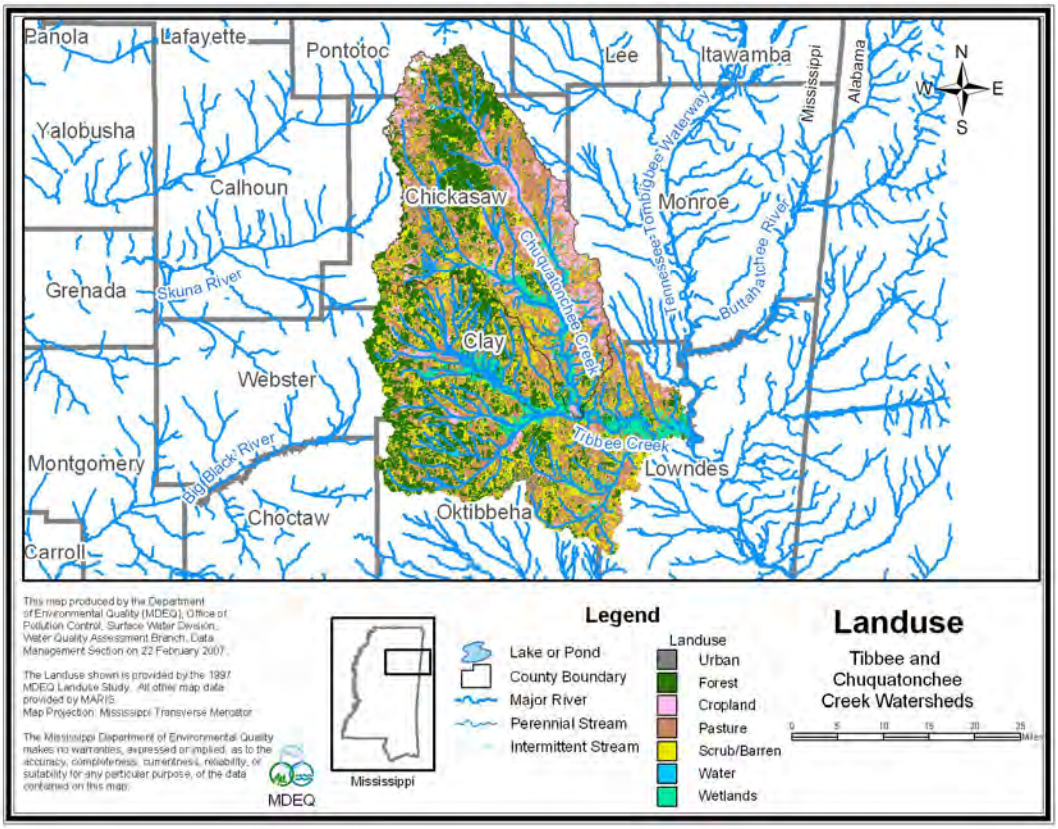
Source: Homer et al., 1994 in Protocol for Developing Nutrient TMDLs (USEPA 1999)

The drainage area of Chuquatonchee Creek is approximately 517 square miles and the drainage area of Tibbee Creek is approximately 1,117 square miles. The watershed contains many different landuse types, including forest, cropland, pasture, water, and wetlands. The landuse information given below is based on data collected by the State of Mississippi's Automated Resource Information System (MARIS) 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. Forest and pasture are the dominant landuses within this watershed. The landuse distribution for Tibbee and Chuquatonchee Creeks is shown in Table 10 and Figure 4.

Table 10. Landuse Distributions in the Tibbee Creek and Chuquatonchee Creek Watershed

In Acres	Urban	Forest	Cropland	Pasture	Scrub/Barren	Water	Wetlands
Tibbee Creek	4,915	193,170	57,090	234,687	161,977	5,357	55,692
Percentage	1	27	8	33	22	1	8
Chuquatonchee Creek	1,655	81,616	43,327	118,617	61,674	1,531	20,548
Percentage	1	25	13	36	19	0	6

Figure 4: Landuse in the Tibbee Creek and Chuquatonchee Creek Watershed



2.4 Estimated Existing Loads for Total Nitrogen

In Ecoregion 65, the estimated TN concentration based on the median TN concentrations measured in wadeable streams with impaired biology and elevated nutrients is 1.38 mg/L. The concentration found in Tibbee Creek during the ambient monitoring is generally below this level, with an average of 0.89 mg/L. The special study total nitrogen data has

an average of 1.22 mg/L for Tibbee Creek. By averaging the two studies, the TN average for Tibbee Creek is 1.06 mg/L. The average TN concentration found in Chuquatonchee Creek was 1.10 mg/L. Existing TN loads in both Tibbee and Chuquatonchee Creeks are based on the average TN concentration data collected during these water quality studies.

To convert the estimated existing TN concentration to a TN load, the average annual flow for Tibbee and Chuquatonchee Creeks was estimated based on U.S. Geological Survey (USGS) monitoring station 02440500 on Chuquatonchee Creek near West Point, Mississippi. The annual average flow for Chuquatonchee Creek at the USGS gage is 791 cfs, with a drainage area of 505 square miles. To estimate the amount of flow in Tibbee and Chuquatonchee Creeks, a drainage area ratio for the 02440500 gage watershed was calculated (791 cfs/505 square miles= 1.57 cfs/square miles). The ratio was then multiplied by the drainage areas in square miles of the impaired segments. Thus, the annual average flow in Tibbee Creek is estimated as 1754.2 cfs and Chuquatonchee Creek is estimated as 811.7 cfs (Table 11).

Table 11. Estimated annual flows for Tibbee and Chuquatonchee Creeks

Watershed	Drainage Area Ratio (cfs/square miles)	Drainage Area (square miles)	Estimated Annual Average Flow (cfs)
Tibbee Creek	1.57	1117.32	1754.2
Chuquatonchee Creek		517.00	811.7

Existing nutrient loads are calculated using the relationship described in Equation 1 and are shown in Table 12. The existing TN loads shown in this table consists of both point source and non-point source loads.

Load (lb/day) = Flow (cfs) * 5.394 (conversion factor)* Concentration (mg/L) (Eq. 1)

Table 12. Estimated Existing Total TN Loads

Stream	Area (sq miles)	Average Annual Flow (cfs)	TN (mg/L)	TN (lbs/day)
Tibbee Creek	1,117	1,751.2	1.06	10,012.73
Chuquatonchee Creek	517	811.7	1.10	4,816.14

2.5 Existing Point Source Loads for TN

Existing TN load for point sources are calculated based on facility design flow and an estimate of TN concentration in the facility effluent (see Equation 2). Since many treatment facilities in Mississippi do not have permit limits for TN, nor are many currently required to report effluent nitrogen concentrations, MDEQ used estimated effluent concentrations based on literature values for different treatment types. Table 13 shows the median effluent nutrient concentrations for four conventional treatment processes. The appropriate concentration for the type of treatment currently used at each of the facilities was used to estimate the total TN load from the point sources.

Load (lbs/day) = Flow (MGD) * 8.34 (conversion factor) * Concentration (mg/L) (Eq. 2)

Table 13. Median Nutrient Concentrations in Wastewater Effluents

	Treatment Type			
	Primary	Trickling Filter	Activated Sludge	Stabilization Pond
Number of plants sampled	55	244	244	149
TN (mg/L)	22.4 ± 1.30	16.4 ± 0.54	13.54 ± 0.62	11.5 ± 0.84
TP (mg/L)	6.6 ± 0.66	6.9 ± 0.28	5.8 ± 0.29	5.2 ± 0.45

Source: Ketchum, 1982 in EPA 823-397-002 (USEPA, 1997)

Estimated median TN concentrations and loads for the NPDES facilities discharging into Tibbee and Chuquatonchee Creeks are presented in Table 14. There are 11 active NPDES facilities discharging into Tibbee Creek. The total TN load from these 11 active facilities is 376.36 lbs/day. There are six active facilities permitted to discharge into Chuquatonchee Creek. The total TN load from these six facilities is 113.09 lbs/day.

Bryan Foods, Inc. (MS001783) had effluent permit limits and reporting requirements for TN until it stopped discharging in April 2007. Tibbee Creek was the outfall location for effluent from Bryan Foods. The TN loads for Bryan Foods is included in the existing point source loads for Tibbee Creek as effluent from the facility flowed into Tibbee Creek during the time period when monitoring data were collected in the creek. EPA's Permit Compliance System has TN data for Bryan Foods available only from 2006-2007. The average annual TN load and flow discharging from Bryan Foods for this time period is shown in Table 14. Effluent TN concentration based on these values is approximately 74.81 mg/L. The TN load for both active and inactive facilities (i.e., Bryan Foods) is estimated to be 1568.22 lbs/day. Therefore, Bryan Foods was approximately 76% of the total point source load flowing into Tibbee Creek.

Table 14. Estimated TN Concentration and TN Loads for Bryan Foods

Bryan Foods, Inc.	Flow (MGD)	Estimated TN Concentration (mg/L)	Conversion Factor	Average TN Load (lb/day)
	1.91	74.81	8.34	1191.86

Table 15. TN Concentration and Loads for NPDES Facilities in Tibbee and Chuquatonchee Creeks

Facility Name	NPDES	Treatment Type	Receiving Stream	Permitted Discharge (MGD)	TN concentration (mg/I)	TN Load estimate (lbs/day)
Adams Trailer Park	MS0046281	aerobic treatment unit	Tibbee	0.001	13.6	0.11
Alexander High School	MS0038598	conventional lagoon	Tibbee	0.015	11.5	1.44
Atkinson Laundry and Carwash	MS0049239	septic tank and sand filter	Chuquatonchee	0.002	11.5	0.19
Boatman Trailer Park	MS0051446	activated sludge system	Tibbee	0.002	13.6	0.23
Camp Tik A Witha	MS0029882	septic tank and sand filter	Chuquatonchee	0.001	11.5	0.10
Cantrells Personal Care Home	MS0046787	aerated treatment unit	Chuquatonchee	0.002	13.6	0.23
Community Counseling Services, Opportunity House	MS0049131	aerobic treatment unit	Tibbee	0.001	13.6	0.11
Davis Meats Inc	MS0037788	septic tank into 2 lagoons	Chuquatonchee	0.000	11.5	0.00
Houston POTW	MS0025071	oxidation ditch and UV disinfection	Chuquatonchee	0.990	13.6	112.29
Josey Creek Missionary Baptist Church	MS0055727	aerated treatment unit	Tibbee	0.001	13.6	0.11
New Houlka POTW, West	MS0025216	conventional lagoon, disinfection	Tibbee	0.200	11.5	19.18
Oktibbeha County Lake	MS0021717	conventional lagoon	Tibbee	0.008	11.5	0.77
Ridge Lakes Apartments	MS0054917	conventional lagoon, disinfection	Tibbee	0.096	11.5	9.21
West Clay County School	MS0029459	activated sludge system	Tibbee	0.012	13.6	1.36
West Point POTW, Lone Oak	MS0033740	aerated lagoon, disinfection	Tibbee	0.085	11.5	8.15
West Point POTW, West	MS0020788	aerated lagoon, sand filtration	Tibbee	3.500	11.5	335.69
Youngs Fish and Steak House	MS0045705	conventional lagoon	Chuquatonchee	0.003	11.5	0.29

2.6 Estimated Existing Point Source Loads for Total Phosphorus

In Ecoregion 65 the estimated TP concentration based on the median TP concentrations measured in wadeable streams with impaired biology and elevated nutrients is 0.18 mg/L. The concentration found in Tibbee Creek during ambient monitoring is slightly below this level, with an average of 0.16 mg/L. The special study TP data has an average of 0.09 mg/L for Tibbee Creek. The average TP concentration of these two studies in Tibbee Creek is 0.13 mg/L. The average TP concentration found in Chuquatonchee Creek was 0.10 mg/L. Existing loads in both Tibbee and Chuquatonchee Creeks are based on the average TP concentration data collected during the water quality studies.

To convert the estimated existing TP concentration to a TP load, the average annual flow for Tibbee and Chuquatonchee Creeks was estimated based on USGS monitoring station 02440500 on Chuquatonchee Creek near West Point, Mississippi. As previously described, the annual average flow in Tibbee Creek is estimated as 1754.2 cfs and Chuquatonchee Creek is estimated as 811.7 cfs. The existing TP load was calculated using Equation 1 and shown in Table 16. Existing TP loads shown in this table consists of both point source and non-point source loads.

Table 16. Estimated Existing Total TP Load

Stream	Area (sq. miles)	Average Annual Flow (cfs)	TP (mg/L)	TP (lbs/day)
Tibbee Creek	1,117	1,751.2	0.13	1227.98
Chuquatonchee Creek	517	811.7	0.10	437.83

The estimated existing TP loads for NPDES facilities were calculated using Equation 2. Since many treatment facilities in Mississippi do not have permit limits for TP, nor are many currently required to report effluent nitrogen concentrations, MDEQ used estimated effluent concentrations based on literature values for different treatment types (see Table 13). The appropriate concentration for the type of treatment currently used at each of the facilities was used to estimate the TP load from each point source.

Estimated median TP concentrations and loads for the NPDES facilities are presented in Table 17. There are 11 active NPDES facilities discharging into Tibbee Creek. The total TP load from these 11 active facilities is 170.13 lbs/day. There are six active facilities permitted to discharge into Chuquatonchee Creek. The total TP load from these six facilities is 48.26 lbs/day.

Table 17. TP Concentration and Loads from NPDES Facilities in Tibbee and Chuquatonchee Creeks

Facility Name	NPDES	Treatment Type	Receiving Stream	Permitted Discharge (MGD)	TP Concentration Estimate (mg/L)	TP Load Estimate (lbs/day)
Adams Trailer Park	MS0046281	aerobic treatment unit	Tibbee	0.001	5.8	0.05
Alexander High School	MS0038598	conventional lagoon	Tibbee	0.0 15	5.2	0.65
Atkinson Laundry and Carwash	MS0049239	septic tank and sand filter	Chuquatonchee	0.002	5.2	0.09
Boatman Trailer Park	MS001446	activated sludge system	Tibbee	0.002	5.8	0.10
Camp Tik A Witha	MS0029882	septic tank and sand filter	Chuquatonchee	0.001	5.2	0.04
Cantrells Personal Care Home	MS0046787	aerated treatment unit	Chuquatonchee	0.002	5.8	0.10
Community Counseling Services, Opportunity House	MS0049131	aerobic treatment unit	Tibbee	0.001	5.8	0.05
Davis Meats Inc	M50037788	septic tank into 2 lagoons	Chuquatonchee	0.000	5.2	0.00
Houston POTW	MS0025071	oxidation ditch and UV disinfection	Chuquatonchee	0.990	5.8	47.89
Josey Creek Missionary Baptist Church	MS0055727	aerated treatment unit	Tibbee	0.001	5.8	0.05
New Houlka POTW, West	M50025216	conventional lagoon, disinfection	Tibbee	0.200	5.2	8.67
Oktibbeha County Lake	MS0021717	conventional lagoon	Tibbee	0.008	5.2	0.35
Ridge Lakes Apartments	MS0054917	conventional lagoon, disinfection	Tibbee	0.096	5.2	4.16
West Clay County School	MS0029459	activated sludge system	Tibbee	0.012	5.8	0.58
West Point POTW, Lone Oak	M50033740	aerated lagoon disinfection	Tibbee	0.085	5.2	3.69
West Point POTW, West	MS0020788	aerated lagoon, sand filtration	Tibbee	3.500	5.2	151.79
Youngs Fish and Steak House	MS0045705	conventional lagoon	Chuquatonchee	0.003	5.2	0.13

Bryan Foods, Inc. (MS001783) did not have permit limits for TP. The permit application for Bryan Foods projected an effluent TP concentration of 23.0 mg/L. Based on this concentration and an annual average flow of 1.91 MGD, the TP load from Bryan Foods was 365.74 lbs/day (see Table 18). Therefore, the existing TP load from all NPDES facilities active at the time of the water quality studies in Tibbee Creek is estimated to be 535.87 lbs/day. Effluent from Bryan Foods accounted for approximately 68% of the TP load from point sources discharging into Tibbee Creek.

Table 18. Estimated TP Concentration and TP Loads for Bryan Foods

Bryan Foods, Inc.	Flow (MGD)	Estimated TP Concentration (mg/L)	Conversion Factor	Average TP Load (lbs/day)
	1.91	23	8.34	365.74

2.7 Existing Non-Point Source TN and TP Loads

In order to obtain the contribution from non-point sources, the existing point source load was subtracted from the total load for each waterbody, as shown in Equation 3. Table 19 and Table 20 provide a summary of existing TN and TP loads for both waterbodies, respectively. Existing TN and TP loads in Tibbee Creek include contributions from Bryan Foods as the facility was discharging into the creek during the time of the water quality studies.

Non-point Source Load = Total Load – Total Point Source Load (Equation 3)

Based on Equation 3, the TN load from non-point sources discharging into Tibbee Creek is estimated to be 8,444.51 lbs/day. Non-point sources account for about 84% of the total load. The non-point source contribution of TN load into Chuquatonchee Creek is estimated to be 4,703.05 lbs/day and this is about 98% of the total load.

Table 19. Existing Point and Non-point Source TN Loads for Tibbee and Chuquatonchee Creeks

Waterbody	Total Load (lbs/day)	Point Source Load (lbs/day)	Non-point Source Load (lbs/day)	Percent of non-point source load contribution relative to total load
Tibbee Creek	10,012.73	1568.22	8444.51	84.33%
Chuquatonchee Creek	4,816.14	113.09	4703.05	97.65%

Using Equation 3, the TP load from non-point sources discharging into Tibbee Creek is about 692.11 lb/day. Non-point sources contribute about 56% of the total load of TP in Tibbee Creek. The non-point source contribution of TP load into Chuquatonchee Creek is about 389.57 lbs/day, and this accounts for about 89% of the total load.

Table 20. Existing Point and Non-point Source TP Loads for Tibbee and Chuquatonchee Creeks

Waterbody	Total Load (lbs/day)	Point Source Load (lbs/day)	Non-point Source Load (lbs/day)	Percent of non-point source load contribution relative to total load
Tibbee Creek	1227.98	535.87	692.11	56.36%
Chuquatonchee Creek	437.83	48.26	389.57	88.98%

2.8 Analysis of the Removal of Bryan Foods on the Existing Nutrient Loads

As previously discussed, the total estimated nutrient loads for Tibbee and Chuquatonchee Creeks included contributions from both point and non-point sources. Therefore, by removing Bryan Foods from the Tibbee Creek watershed, the total existing nutrient loads for Tibbee Creek would be less. Consequently, the non-point source nutrient loads would also be decreased as the non-point source loads are derived from the total load. Since the effluent from Bryan Foods only impacted Tibbee Creek, the Chuquatonchee loads would remain unchanged by the removal of Bryan Foods.

The estimated nutrient loads in Tibbee Creek without Bryan Foods would be 862.24 lbs/day of TP (see Table 21) and 8,820.87 lbs/day of TN (see Table 22). As shown in Table 21, the contribution of point sources to the overall TP load in Tibbee Creek is reduced by 80% with the removal of Bryan Foods. The contribution of TN from point sources is reduced about 96% with the removal of Bryan Foods from the system.

Table 21. Analysis of Bryan Foods TP Contributions to Tibbee Creek

Estimated Total TP Load Tibbee Creek (lbs/day) without Bryan Foods	**Estimated Total TP Point Source Load (lbs/day)**		**Non-Point Source Load without Bryan Foods (lbs/day)**	**TP Percent contribution of Bryan Foods to total PS Load**	**Percent reduction with Bryan Foods removed from Total TP Loads**
862.24	Tibbee Creek point sources not including Bryan Foods	170.13	692.11	68.25%	80%
	Bryan Foods Loads	365.74			
	Total Load	535.87			

Table 22. Analysis of Bryan Foods TN Contributions to Tibbee Creek

Estimated Total TN Load Tibbee Creek (lbs/day) without Bryan Foods	Estimated Total TN Point Source Load (lbs/day)		Non-Point Source Load without Bryan Foods (lbs/day)	TN Percent contribution of Bryan Foods to total PS Load	Percent reduction with Bryan Foods removed from Total TN Loads
8,820.87	Tibbee Creek point sources not including Bryan Foods	376.36	8,444.51	76%	96%
	Bryan Foods Loads	1191.86			
	Total Load	1568.22			

3.0 ALLOCATIONS

The allocation for this TMDL involves a wasteload allocation (WLA) and a load allocation (LA) for non-point sources necessary for attainment of water quality standards in Tibbee and Chuquatonchee Creeks. The nutrient portion of this TMDL is addressed through initial estimates of the existing and target TN and TP concentrations.

3.1 Wasteload Allocations

There are currently 17 active NPDES permits issued for the Tibbee and Chuquatonchee Creeks watersheds. The NPDES permit, for Bryan Foods, Inc., which discharges to Tibbee Creek, is no longer active as of April 2007. As shown in the previous section, the nutrient loadings from Bryan Foods comprised a significant portion of the nutrient loadings from all point sources in the Tibbee Creek watershed. After removing the Bryan Foods outfall pipe, the majority of the nutrient loadings into Tibbee Creek are coming from non-point sources. Therefore, this TMDL does not recommend further reduction to point sources at this time for Tibbee Creek. However, MDEQ is recommending quarterly nutrient monitoring and reporting for all of these facilities. The WLAs for the Tibbee Creek dischargers are presented in Table 23.

Table 23. WLA for NPDES discharges to Tibbee Creek

Facility	Receiving Stream	Permitted discharge (MGD)	TP estimate (mg/L)	TP WLA (lbs/day)	TN estimate	TN WLA (lbs/day)
Adams Trailer Park	Tibbee	0.001	5.8	0.05	13.6	0.11
Alexander High School	Tibbee	0.015	5.2	0.65	13.6	1.44
Boatman Trailer Park	Tibbee	0.002	5.8	0.10	13.6	0.23
Community Counseling Services, Opportunity House	Tibbee	0.001	5.8	0.05	13.6	0.11
Josey Creek Missionary Baptist Church	Tibbee	0.001	5.8	0.05	11.5	0.11
New Houlka POTW, West	Tibbee	0.2	5.2	8.67	11.5	19.18
Oktibbeha County Lake	Tibbee	0.008	5.2	0.35	11.5	0.77
Ridge Lakes Apartments	Tibbee	0.096	5.2	4.16	13.6	9.21
West Clay County School	Tibbee	0.012	5.8	0.58	11.5	1.36
West Point POTW, Lone Oak	Tibbee	0.085	5.2	3.69	11.5	8.15
West Point POTW, West	Tibbee	3.5	5.2	151.79	13.6	335.69
TOTAL LOADS				**170.13**		**376.36**
TN and TP Point Source Loads as a percentage of the Total TN and TP Loads (does not include Bryan Foods)				**80%**		**96%**

There are six point sources permitted to discharge to Chuquatonchee Creek. The total point source discharge flowing into Chuquatonchee Creek is approximately 1.0 MGD. The combined WLA of all facilities is 48.26 lbs/day for TP and 113.09 lbs/day for TN (see Table 24). Given that non-point source contributions of TN and TP to Chuquatonchee comprise the majority of the nutrient contributions to the creek, no reductions to the point sources discharging to Chuquatonchee Creek are necessary. However, MDEQ is recommending quarterly nutrient monitoring and reporting for these facilities. The WLAs for the individual facilities discharging into Chuquatonchee Creek are presented in Table 24.

Table 24. WLA for NPDES Discharges to Chuquatonchee Creek

Facility	Receiving Stream	Permitted discharge (MGD)	TP estimate (mg/L)	TP WLA (lbs/day)	TN estimate (mg/L)	TN WLA (lbs/day)
Atkinson Laundry and Carwash	Chuquatonchee Creek	0.002	11.5	0.09	5.8	0.19
Camp Tik A Witha	Chuquatonchee Creek	0.001	11.5	0.04	5.2	0.10
Cantrells Personal Care Home	Chuquatonchee Creek	0.002	13.6	0.10	5.8	0.23
Davis Meats Inc	Chuquatonchee Creek	0	11.5	0.00	5.8	0.00
Houston POTW	Chuquatonchee Creek	0.99	13.6	47.89	5.8	112.29
Youngs Fish and Steak House	Chuquatonchee Creek	0.003	11.5	0.13	5.2	0.29
TOTAL LOADS				**48.25**		**113.09**
TN and TP Point Source Loads as a percentage of the Total TN and TP Loads				**1%**		**2%**

3.2 Load Allocation

The non-point source LA for TN and TP are presented in Table 25 and Table 26. The LA values are expressed as a range representing the 75^{th} and 90^{th} percentile TN and TP concentrations in Ecoregion 65. The LA values were calculated using Equation 3. The target load was estimated by multiplying the target concentration and the estimated flow in the water bodies. The existing non-point source loads (see Table 19 and Table 20) were compared to the LA values and the percent reduction necessary to achieve the LA values, if any, were calculated using the relationship described in Equation 4.

$$\% \text{ Reduction} = (\text{existing load} - \text{LA})/(\text{existing load}) * 100 \quad \text{(Equation 4)}$$

Table 25. Load Allocations for TN in Tibbee and Chuquatonchee Creeks

Waterbody	Average Annual Flow (cfs)	Target Concentration (mg/L)	TP Target Load (lbs/day)	TP LA Loads (lbs/day)	Percent Reduction Needed
Tibbee Creek	1,751.20	0.6-0.7	5667.58 – 6612.18	5291.22 – 6235.82	26%-36%
Chuquatonchee Creek	811.7	0.6-0.7	2626.99 – 3064.82	2513.90 – 2951.73	37%-47%

Table 26. Load Allocations for TP in Tibbee and Chuquatonchee Creeks

Waterbody	Average Annual Flow (cfs)	Target Concentration (mg/L)	TP Target Load (lbs/day)	TP LA Loads (lbs/day)	Percent Reduction Needed
Tibbee Creek	1,751.20	0.06-0.10	566.76 - 944.60	396.63- 774.47	0% - 43%
Chuquatonchee Creek	811.7	0.06-0.10	262.70 - 437.83	214.44- 389.57	0% - 45%

Given that the majority of the nutrient loads into the Tibbee and Chuquatonchee creeks are coming from non-point sources, best management practices (BMPs) are recommended in these watersheds to reduce TN and TP loads. These watersheds should be considered a priority for riparian buffer zone restoration and 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.

3.3 Incorporation of a Margin of Safety

The margin of safety (MOS) 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 TMDL is implicit. An implicit MOS is appropriate as only non-impaired streams in Ecoregion 65 for TN and TP were used for the development of nutrient targets.

3.4 Calculation of the TMDL

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (WLA), non-point source loads (LA), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS \quad \text{(Equation 5)}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and WQS achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measures. The TMDLs for Tibbee Creek and Chuquatonchee Creek are expressed as daily load values given in pounds per day. TMDL components for TN and TP are provided in Table 27.

Table 27. TMDL Summary for Tibbee and Chuquatonchee Creeks

Waterbody	Parameter	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
Tibbee	TN	376.36	5291.22 – 6235.82	implicit	5567.58 – 6612.18
	TP	170.13	396.63 – 774.47	implicit	566.76 – 944.60
Chuquatonchee	TN	113.09	2513.90 – 2951.73	implicit	2626.99 – 3064.82
	TP	48.26	214.44 – 389.57	implicit	262.70 – 437.83

3.5 Seasonality and Critical Condition

This TMDL accounts for seasonal variability by requiring allocations that ensure year-round protection of water quality standards, including during critical conditions. In addition, the targets for TP and TN that were used to calculate the necessary percent reductions were developed based on the average annual TP and TN concentrations determined to be typical of non-impaired wadeable streams in the bioregion for all seasons of the calendar year. Due to these reasons, the TMDL is protective of the waterbody during all seasons.

4.0 CONCLUSION

Nutrients were addressed through an estimate of preliminary TN and TP concentration target ranges. The estimated existing TN concentration indicates needed reductions of 0% to 43% in Tibbee Creek and 37% to 47% in Chuquatonchee Creek. The estimated existing TP concentration indicates needed reductions of 26% to 36% in Tibbee Creek and 0% to 45% in Chuquatonchee Creek. Because the majority of the existing TN and TP loads for Tibbee and Chuquatonchee Creeks are due to non-point sources and the fact that a major point source discharger was removed from the Tibbee Creek watershed, this TMDL does not recommend reductions from active NPDES facilities. However, this TMDL does recommend nutrient monitoring and reporting of all active NPDES facilities. It is also recommended that the Tibbee and Chuquatonchee Creeks watershed be considered as a priority watershed for riparian buffer zone restoration and any nutrient reduction BMPs. The implementation of these BMP activities should reduce the nutrient load entering the creeks from non-point sources. These activities will provide improved water quality for the support of aquatic life in the water bodies and will result in the attainment of the applicable water quality standards.

4.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each year long cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Tombigbee River Basin, Tibbee and Chuquatonchee Creeks may receive additional monitoring to identify any change in water quality. MDEQ produced guidance for future Section 319 project funding will encourage NPS restoration projects that attempt to address TMDL related issues within Section 303(d)/TMDL watersheds in Mississippi.

4.2 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper. The public will be given an opportunity to review the TMDLs and submit comments. MDEQ also distributes all TMDLs at the beginning of the public notice to those members of the public who have requested to be included on a TMDL mailing list. Anyone wishing to become a member of the TMDL mailing list should contact Kay Whittington at Kay_Whittington@deq.state.ms.us.

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

REFERENCES

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DEFINITIONS

Allocations: That portion of a receiving water's loading capacity that is attributed to one of its existing or future pollution sources (non-point or point) or to natural background sources.

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.

Anthropogenic: Pertains to the [environmental] influence of human activities.

Assimilative Capacity: The amount of contaminant load that can be discharged to a specific stream or river without violating the provisions of the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality* regulations. Assimilative capacity is the extent to which a body of water can receive wastes without significant deterioration of beneficial uses.

Background: Ambient pollutant concentrations due to natural sources, nearby sources other than the one currently under consideration, and unidentified anthropogenic sources.

Background Levels: Levels representing the chemical, physical, and biological conditions that would result from natural geomorphological processes such as weathering or dissolution.

Best Management Practices (BMPs): (1) The methods, measures, or practices selected by an agency to meet its non-point source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during, or after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. (2) Methods have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources.

Critical Condition: The critical condition can be thought of as the "worst case" scenario of environmental conditions in the water body in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence.

Cross-Sectional Area: Wet area of a waterbody normal to the longitudinal component of the flow.

Daily Discharge: The discharge of a pollutant measured during a 24-hour period that reasonably represents the 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 discharge is calculated as the average measurement of the pollutant over the day.

Designated Use: (1) Those uses specified in water quality standards for each water body or segment whether or not they are being attained. (2) Those water uses identified in state water quality standards which must be achieved and maintained as required under the Clean Water Act.

Discharge Monitoring Report: Report of effluent characteristics submitted by a NPDES permitted facility.

Ecoregion: A physical region that is defined by its ecology, which includes meteorological factors, elevation, plant and animal speciation, landscape position, and soils.

Effluent: (1) Any solid, liquid, or gas which enters the environment as a by-product of a man-oriented process. The substances that flow out of a designated source. Effluent, effluence, and efflux have the same meaning. (2) Wastewater – treated or untreated – that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

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.

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.

Surface Runoff: Precipitation, snow melt, or irrigation in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter or non-point source pollutants.

Load Allocation (LA): The portion of a receiving water's loading capacity attributed either to one of its existing or future non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and non-point source loads should be distinguished.

Loading: The portion of a receiving water's loading capacity attributed either to one of its existing or future non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and non-point source loads should be distinguished.

NPDES Permit: An individual or general permit issued by the MDEQ Permit Board pursuant to regulations adopted by the Commission under Mississippi Code Annotated (as amended) § 49-17-17 and § 49-17-29 for discharges into State waters.

Narrative Criteria: Nonquantitative guidelines that describe the desired water quality goals.

Natural Waters: Flowing water within a physical system that has developed without human intervention, in which natural processes continue to take place.

Non-point Source: The pollution from sources which generally are not controlled by establishing effluent limitations under sections 301, 302, and 402. Non-point source pollutants are not traceable to a discrete identifiable origin, but generally result from land runoff, precipitation, drainage, or seepage. This 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.

Numeric Target: A measurable value determined for the pollutant of concern which, if achieved, is expected to result in the attainment of water quality standards in the listed water body.

Phased Approach: Under the phased approach to TMDL development, load allocations and wasteload allocations are calculated using the best available data and information recognizing the need for additional monitoring data to accurately characterize sources and loadings. The phased approach is typically employed when non-point sources dominate. It provides for the implementation of load reduction strategies while collecting additional data.

Point Source: Pollution from a stationary location or fixed facility from which pollutants are discharged or emitted. Pollution from any single identifiable source, e.g., a pipe, ditch, ship, ore pit, or factory smokestack.

Pollutant: Includes, but not limited to, any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may be reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical

deformations, in such organisms or their offspring; except that the term pollutant or contaminant shall not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of paragraph (14) and shall not include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas).

Pollution: Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as man-made or man-induced alteration of the physical, biological, and radiological integrity of water. Other pollution related terms include: agricultural pollution, air pollution, indoor air pollution, industrial waste pollution, manmade air pollution, natural pollution, noise pollution, oil pollution, sewage pollution, soil pollution, thermal pollution, water pollution, and wood burning stove pollution.

Reference Sites: Water bodies that are representative of the characteristics of the region and subject to minimal human disturbance.

Stream Restoration: Various techniques used to replicate the hydrological, morphological, and ecological features that have been lost in a stream due to urbanization, farming, or other disturbance.

Surface Runoff: Precipitation, snow melt, or irrigation in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter or non-point source pollutants.

Total Maximum Daily Load or TMDL: (1) The total allowable pollutant load to a receiving water such that any additional loading will produce a violation of water quality standards. (2) The sum of the individual waste load allocations and load allocations. A margin of safety is included with the two types of allocations so that any additional loading, regardless of source, would not produce a violation of water quality standards.

Wasteload Allocation (WLA): (1) The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality based effluent limitation. (2) The portion of a receiving water's total maximum daily load that is allocated to one of its existing or future point sources of pollution. (3) The maximum load of pollutants each discharger of waste is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being, or expected to be, violated. The portion of a stream's total assimilative capacity assigned to an individual discharge.

Water Quality Criteria: Specific levels of water quality which, if reached, are expected to render a body of water suitable for its designated use. The 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. Water quality criteria are comprised of numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or States for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal.

Water Quality Standards: (1) Provisions of State or Federal law which consist of a designated use or uses for the water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water, and serve the purposes of the Clean Water Act. (2) A law or regulation that consists of the beneficial designated use or uses of a water body, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and an antidegradation statement. (3) 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.

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: (1) The land area that drains (contributes runoff) into a stream. (2) 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 delivery point.

ABBREVIATIONS

ARS	Agricultural Research Service
BMP	Best Management Practice
CWA	Clean Water Act
CWPRU	Channel and Watershed Processes Research Unit
EPA	Environmental Protection Agency
HUC	Hydrologic Unit Code
LA	Load Allocation
MARIS	Mississippi Automated Resource Information Service
MDEQ	Mississippi Department of Environmental Quality
MFC	Mississippi Forestry Commission
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resource Conservation Service
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WLA	Wasteload Allocation
WWTP	Wastewater Treatment Plant