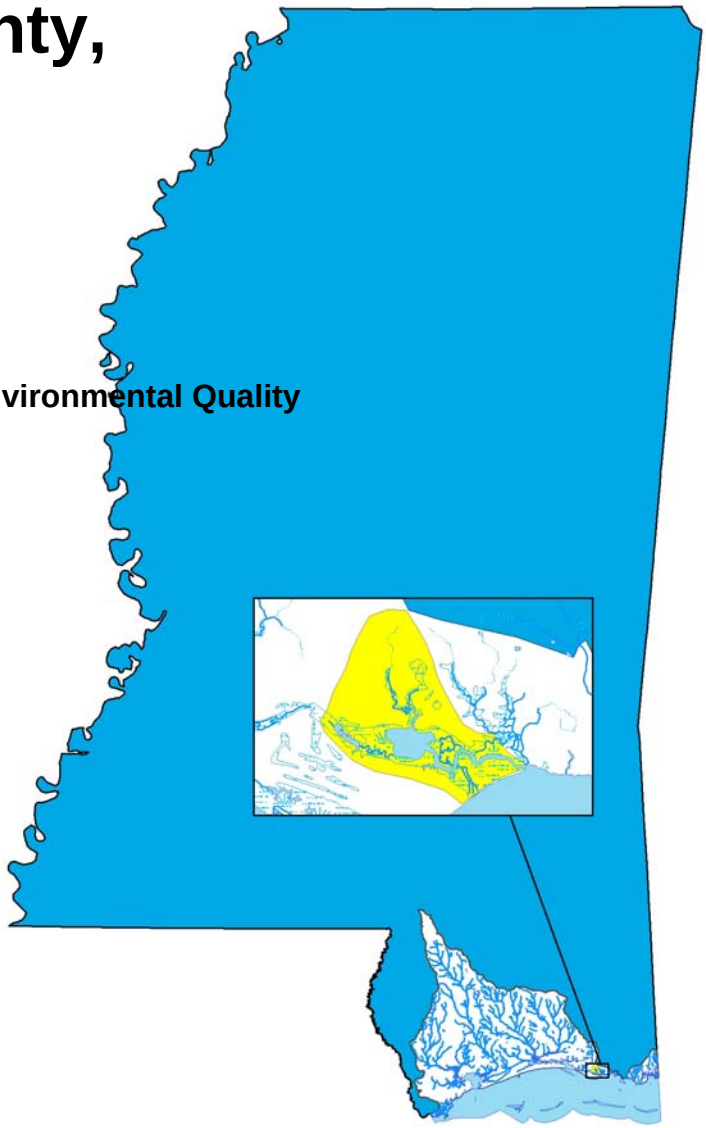
FINAL REPORT
November 2005
ID:205110401

Phase One Fecal Coliform TMDL for Graveline Bayou Watershed

Coastal Streams Basin

Jackson County, 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

MDEQ

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 waterbody 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'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.

Prefixes for fractions and multiples of SI units

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

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.00156	Days	Seconds	86400
Cubic feet	Cu. Meter	0.02832	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805	Gallons	Cu feet	0.13368
Cubic feet	Liters	28.316	Hectares	Acres	2.4711
cfs	Gal/min	448.83	Miles	Meters	1609.34
cfs	MGD	0.64632	Mg/l	ppm	1
Cubic meters	Gallons	264.173	μg/l * cfs	Gm/day	2.45

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TMDL INFORMATION PAGE

Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Graveline Bayou	MS118GBE	Jackson	03170009	Fecal Coliform	Monitored
Near Camp Lamotte from and including Graveline Bay to the Mississippi Sound					

Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Fecal Coliform	Shellfishing	The meadian fecal coliform MPN (Most Probable Number) of the water shall not exceed 14 per 100 ml, and not more than ten percent (10%) of the samples shall ordinarily exceed an MPN of 43 per 100 ml in those portions or areas most probably exposed to fecal contamination during most unfavorable hydrographic and pollutional conditions.

Total Maximum Daily Load for Segment MS118GBE

WLA (counts per day)	LA (counts per day)	MOS (counts per day)	Total TMDL (counts per day)	TMDL Percent Reduction
0.00	2.10E+13	6.99E+12	2.80E+13	82%

EXECUTIVE SUMMARY

A fecal coliform TMDL has been developed for the Graveline Bayou Watershed, MS118GBE, on the Mississippi 2002 Section 303(d) List of Water Bodies. This water body was listed due to monitoring data collected for shellfish harvesting.

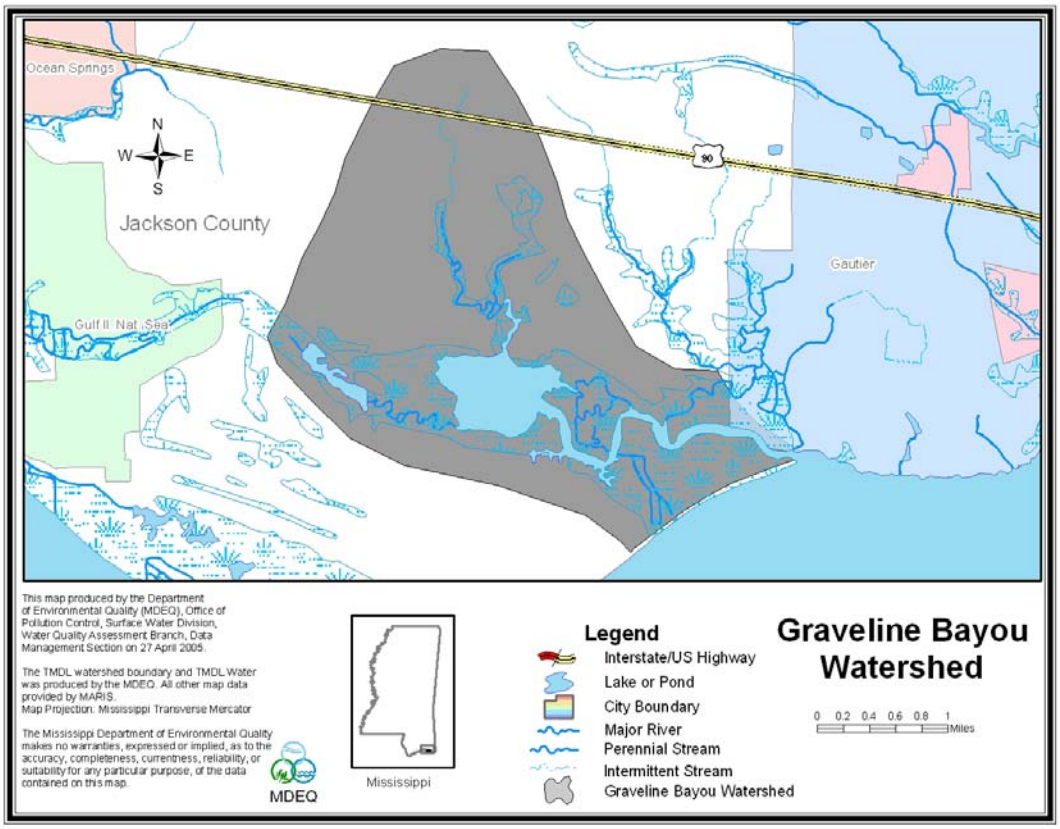
Graveline Bayou, Figure 1, flows in a easterly direction from Graveline Bay to the Mississippi Sound in southern Jackson County. This TMDL has been developed for Graveline Bayou from and including Graveline Bay to the Mississippi Sound. Due to data limitations, complex dynamic modeling was inappropriate for performing the TMDL allocations for this study. Load duration curves were also inappropriate. Therefore, a mass balance approach was used to develop the TMDL for this water body.

Although fecal coliform loadings from point and nonpoint sources in the watershed were not explicitly represented with a model, a source assessment was conducted for the Graveline Bayou Watershed. Nonpoint sources of fecal coliform include wildlife, and urban development. Also considered were the nonpoint sources such as failing septic systems and other direct inputs to Graveline Bayou. There are no NPDES Permitted discharges included as point sources in the waste load allocation (WLA).

The seasonal and tidal variations in hydrology, climatic conditions, and watershed activities could not be represented with a mass balance approach. The TMDL was based on the estimated volume of water at mean lower low water which is a conservative assumption. An explicit 10% margin of safety (MOS) was used in the mass balance method to account for uncertainty.

Water quality data indicate violations of the shellfish fecal coliform standard in the waterbody. The estimated reduction of fecal coliform bacteria recommended for segment MS118GBE is 82%.

Figure 1. Location of the Graveline Bayou Watershed



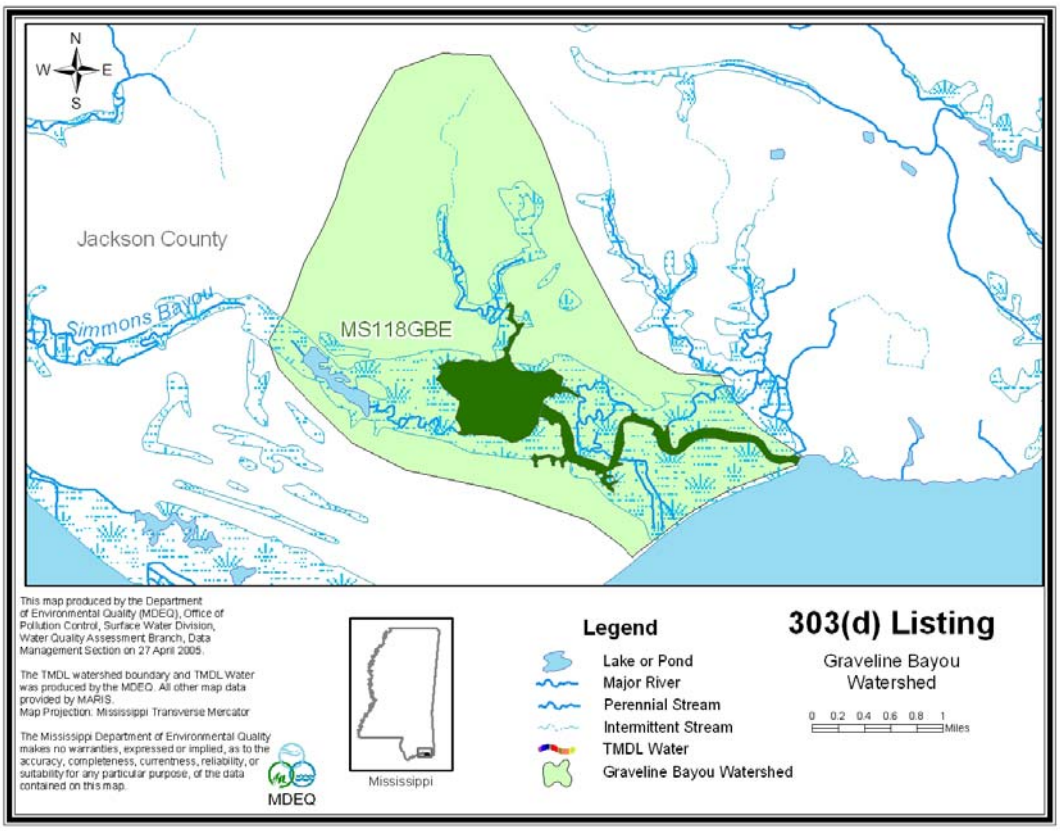
INTRODUCTION

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. The pollutant of concern for this TMDL is fecal coliform. Fecal coliform bacteria are used as indicator organisms because they are readily identifiable and indicate the possible presence of pathogenic organisms in the water body. The TMDL process can be used to establish water quality based controls to reduce pollution from nonpoint sources, maintain permit requirements for point sources, and restore and maintain the quality of water resources.

A TMDL has been developed for segment MS118GBE, Graveline Bayou, from and including Graveline Bay to the Mississippi Sound as shown in Figure 2. Segment MS118GBE was originally listed based on shellfish monitoring data. This segment has had data collected by the Mississippi Department of Marine Resources that confirmed impairment and is listed on the monitored section of the Mississippi 2002 Section 303(d) List of Water Bodies for fecal coliform. The data are listed in Section 2.2.

Figure 2. Graveline Bayou Watershed Segment



The mass balance method is an applicable method for TMDL development with limited data in complex watersheds that are tidally influenced. The TMDL for segment MS118GBE was developed using a mass balance method with the shellfish harvesting water quality standard and an estimated volume of water at mean lower low water, which is the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.

The Graveline Bayou segment is in Hydrologic Unit Code (HUC) 03170009 in southern Mississippi. The watershed is approximately 4,900 acres. The land area immediately adjacent to Graveline Bayou and Graveline Bay is one of Mississippi's Gulf Ecological Management Sites Coastal Preserves. The 2,339 acre Graveline Bay Coastal Preserve is one of the few relatively undisturbed estuarine bays and small tidal creeks in Mississippi. The area has salt marshes and brackish marshes and several oyster beds. The land area south of Graveline Bayou and Graveline Bay is a residential area. The headwaters of the watershed include the Fontainbleau area of Jackson County. Recent urban development in the watershed includes residential subdivisions and construction of the Graveline Causeway which opened in July 2004 restoring tidal flow to the upper reaches of the bayou. Forest and wetlands are the other dominant landuses within the watershed. This fecal coliform TMDL is for the entire Graveline Bayou Watershed.

1.2 Applicable Waterbody Segment Use

The water use classification for the listed segment of Graveline Bayou, as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulation, is Shellfish Harvesting. The designated beneficial uses for Graveline Bayou and Graveline Bay are Shellfish Harvesting. The Mississippi Department of Marine Resources currently classifies Graveline Bayou and Graveline Bay as prohibited for shellfish harvesting. Previously, in the 1980's and 1990's, it was classified as conditionally approved, which meant shellfish could be harvested under certain precipitation and stage conditions. The approval classification was changed based on the water quality of Graveline Bayou and Graveline Bay.

1.3 Applicable Waterbody 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* (2002). The median fecal coliform MPN (Most Probable Number) of the water shall not exceed 14 per 100 ml, and not more than ten percent (10%) of the samples shall ordinarily exceed an MPN of 43 per 100 ml in those portions or areas most probably exposed to fecal coliform contamination during most unfavorable hydrographic and pollutional conditions. The Interstate Shellfish Sanitation Conference (ISSC) gives guidance on assessment of fecal coliform water quality data in the National Shellfish Sanitation Program (NSSP) Model Ordinance. The shellfish harvesting water quality standard was used to assess the data to determine impairment in the water body.

TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* requires that the fecal coliform median MPN of the water sample results shall not exceed 14 counts per 100ml, and not more than 10% of the samples shall exceed an MPN of 43 counts per 100ml. The NSSP Model Ordinance states that a minimum of 2 samples shall be collected annually and that the most recent 15 samples collected shall be used to calculate the median and percentage values.

2.1.4 Discussion of the Targeted Endpoint

While the endpoint of a TMDL calculation is similar to a standard for a pollutant, the endpoint is not the standard. For this mass balance TMDL, the endpoint selected is the median portion of the standard, that is the median of the most recent 15 data points shall not exceed 14 counts per 100ml.

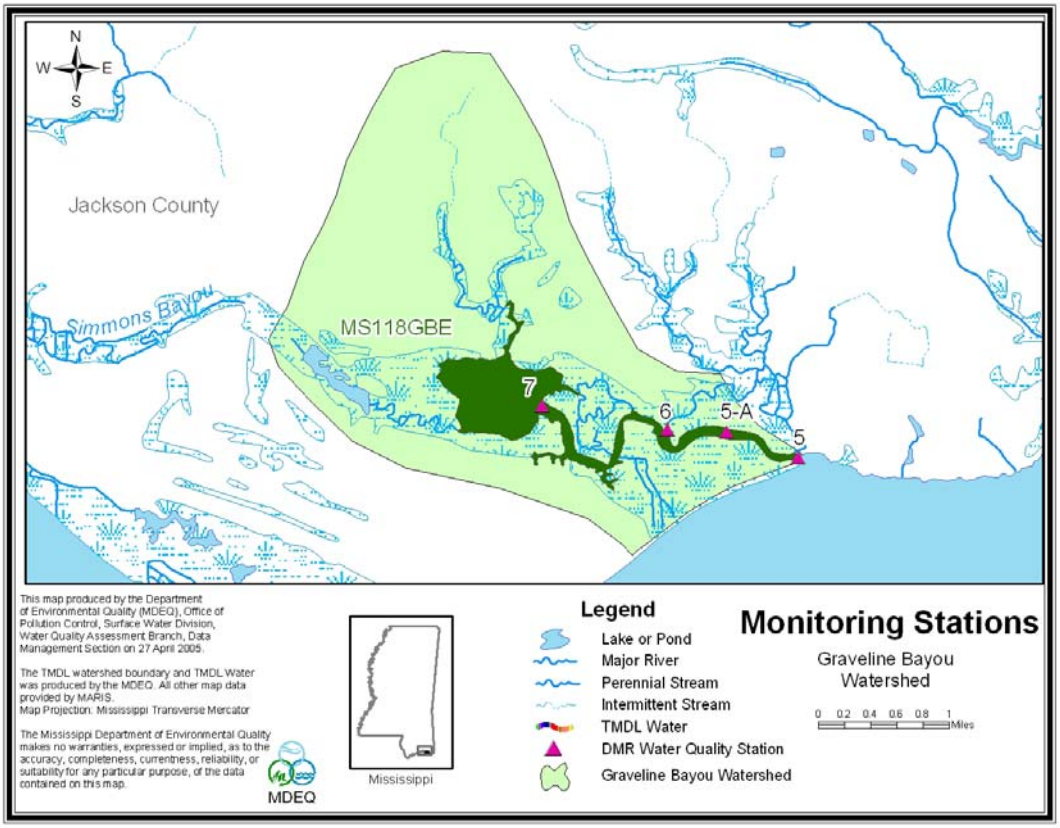
2.1.5 Discussion of the Critical Condition for Fecal Coliform

Critical conditions for waters impaired by nonpoint sources generally occur during periods of wet-weather and high surface runoff. But, critical conditions for point source dominated systems generally occur during periods of low-flow, low-dilution conditions. Therefore, a careful examination of the data is needed to determine the critical period to be used for the TMDL.

2.2 Discussion of Instream Water Quality

Monitoring was performed by the Mississippi Department of Marine Resources in a manner consistent with the ISSP NSSP Model Ordinance. Historical water quality data are given for 4 stations in Graveline Bayou from 1995 through 1999. More recent water quality data is given for 3 stations in Graveline Bayou from 2000 through 2004 along with the total rainfall for the 5 days leading up to the water quality data collection. The rainfall station is located at Pascagoula, MS. The water body segment along with the location of the water quality gages are shown in Figure 3.

Figure 3. Graveline Bayou Segment with Water Quality Gages



2.2.1 Inventory of Available Water Quality Monitoring Data

The historical water quality data collected at stations 5, 5-A, 6, and 7 is provided in Table 1.

Table 1. Fecal Coliform Data reported in Graveline Bayou, 1995-1999

DATE	Station 5 (counts/100ml)	Station 5A (counts/100ml)	Station 6 (counts/100ml)	Station 7 (counts/100ml)
4-Jan-95	33	33	17	6.8
10-Jan-95	6.8	4	79	2
12-Jan-95	33	170	79	46
10-Apr-95	4.5	17	23	2
18-Apr-95	79	79	240	-
20-Apr-95	33	49	49	49
2-May-95	49	17	17	33
5-Sep-95	13	4.5	11	1
19-Sep-95	7.8	-	7.8	1
26-Sep-95	1	2	2	2
10-Oct-95	6.8	14	11	11
13-Oct-95	13	27	33	14
18-Oct-95	2	13	46	2
20-Oct-95	7.8	2	17	2
23-Oct-95	7.8	13	27	17
25-Oct-95	17	4.5	13	4.5

Table 1 cont. Fecal Coliform Data reported in Graveline Bayou, 1995-1999

DATE	Station 5 (counts/100ml)	Station 5A (counts/100ml)	Station 6 (counts/100ml)	Station 7 (counts/100ml)
1-Nov-95	49	33	49	17
27-Nov-95	33	49	79	1
29-Nov-95	27	23	46	13
4-Dec-95	49	130	350	49
15-Dec-95	23	49	79	4.5
27-Dec-95	46	33	110	33
29-Dec-95	-	22	23	17
9-Jan-96	28	34	79	79
18-Jan-96	33	-	33	79
7-Feb-96	350	240	240	170
21-Feb-96	49	33	13	7.8
26-Feb-96	22	49	79	79
17-Apr-96	-	920	1600	920
7-May-96	17	79	33	70
17-Sep-96	11	13	23	22
23-Oct-96	1	1	2	23
28-Oct-96	7.8	33	7.8	7.8
30-Oct-96	33	9.3	17	17
21-Nov-96	13	-	11	9.3
11-Dec-96	-	22	79	46
7-Jan-97	540	350	350	23
14-Jan-97	17	11	17	13
6-Feb-97	130	-	46	49
11-Feb-97	11	-	33	13
25-Feb-97	350	-	1600	350
12-Mar-97	7.8	23	13	13
25-Mar-97	79	6.8	33	33
3-Apr-97	46	23	79	17
8-Apr-97	33	70	23	4.5
16-Apr-97	46	17	13	26
18-Apr-97	1	4.5	1	4.5
21-Apr-97	2	6.8	6.8	2
1-May-97	33	70	9.3	14
9-Oct-97	17	4.5	9.3	6.8
21-Oct-97	-	4.5	13	4
23-Oct-97	17	11	6.8	7.8
28-Oct-97	4.5	2	17	4.5
30-Oct-97	23	-	13	13
31-Oct-97	-	6.1	-	-
4-Nov-97	23	13	13	17
6-Nov-97	130	23	49	14
4-Mar-98	130	130	49	4.5
25-Mar-98	22	23	17	11
15-Apr-98	49	-	17	13
21-Apr-98	7.8	-	11	13
18-Nov-99	23.0	2.0	2.0	1.7
14-Dec-99	23.0	33.0	49.0	22.0

The more recent water quality data collected at stations 5, 6, and 7 along with the total rainfall for the 5 days leading up to the water quality data collection is provided in Table 2.

Table 2. Fecal Coliform Data reported in Graveline Bayou, 2000-2004

DATE	5 Day Rainfall (inches)	Station 5 (counts/100ml)	Station 6 (counts/100ml)	Station 7 (counts/100ml)
13-Jan-00	0.1	17.0	33.0	7.8
3-Feb-00	0.05	2.0	4.5	2.0
25-May-00	0.91	1.7	1.7	4.5
8-Jun-00	0.25	4.5	7.8	1.7
20-Jun-00	1.79	2.0	2.0	17.0
25-Jul-00	0.28	11.0	4.5	2.0
31-Jul-00	0.01	1.7	1.7	1.7
14-Aug-00	1.6	2.0	2.0	1.7
22-Aug-00	0.96	1.7	2.0	1.7
7-Dec-00	0	2.0	2.0	6.8
21-May-01	0.24	1.7	1.7	1.7
28-Jun-01	0.19	7.8	7.8	23.0
17-Jul-01	1.17	2.0	4.5	7.8
24-Jul-01	2.2	1.7	7.8	2.0
23-Aug-01	0.71	2.0	2.0	1.7
27-Aug-01	0	2.0	7.8	2.0
31-Oct-01	0	13.0	79.0	33.0
8-Nov-01	0	79.0	49.0	4.5
23-Jan-02	0.03	70.0	23.0	49.0
23-Apr-02	0	13.0	17.0	6.8
28-May-02	0	4.5	4.5	2.0
18-Jun-02	0	1.7	1.7	1.7
15-Jul-02	1.45	17.0	11.0	13.0
14-Aug-02	0	4.5	4.0	4.0
18-Sep-02	0.52	1.7	1.7	1.7
10-Jun-03	2.69	22.0	13.0	6.8
28-Aug-03	1.2	23.0	23.0	33.0
31-Mar-04	0.08	23.0	23.0	23.0
14-Apr-04	0.3	22.0	11.0	33.0

2.2.2 Analysis of Instream Water Quality Monitoring Data

For segment MS118GBE, the data collected at the three stations from 2000 through 2004 do not indicate a correlation between rainfall and violations of the shellfish harvesting standard. The 2000 through 2004 data did violate the median portion of the standard at all three stations when examining a running 15 sample median. The ten percent portion of the standard was only violated at stations 5 and 6 during 2000 through 2004 sampling period when examining running 15 sample data sets.

SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Graveline Bayou Watershed. Sources were characterized by the best available information, monitoring data, literature values, and local management activities. Under the CWA, sources are broadly classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point sources can be described by two broad categories: 1) NPDES regulated municipal and industrial wastewater treatment plants (WWTPs) and 2) NPDES regulated industrial activities (which include construction activities) and municipal stormwater discharges (Municipal Separate Storm Sewer Systems [MS4s]). For the purposes of this TMDL, all sources of fecal coliform loading not regulated by NPDES permits are considered nonpoint sources.

3.1 Assessment of Point Sources

Point sources of fecal coliform bacteria have their greatest potential impact on water quality during periods of low flow. No NPDES permitted dischargers are currently located within the Graveline Bayou Watershed. Jackson County has a Municipal Separate Storm Sewer System (MS4) which does not include Graveline Bayou or Graveline Bay.

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for Graveline Bayou and Graveline Bay, including:

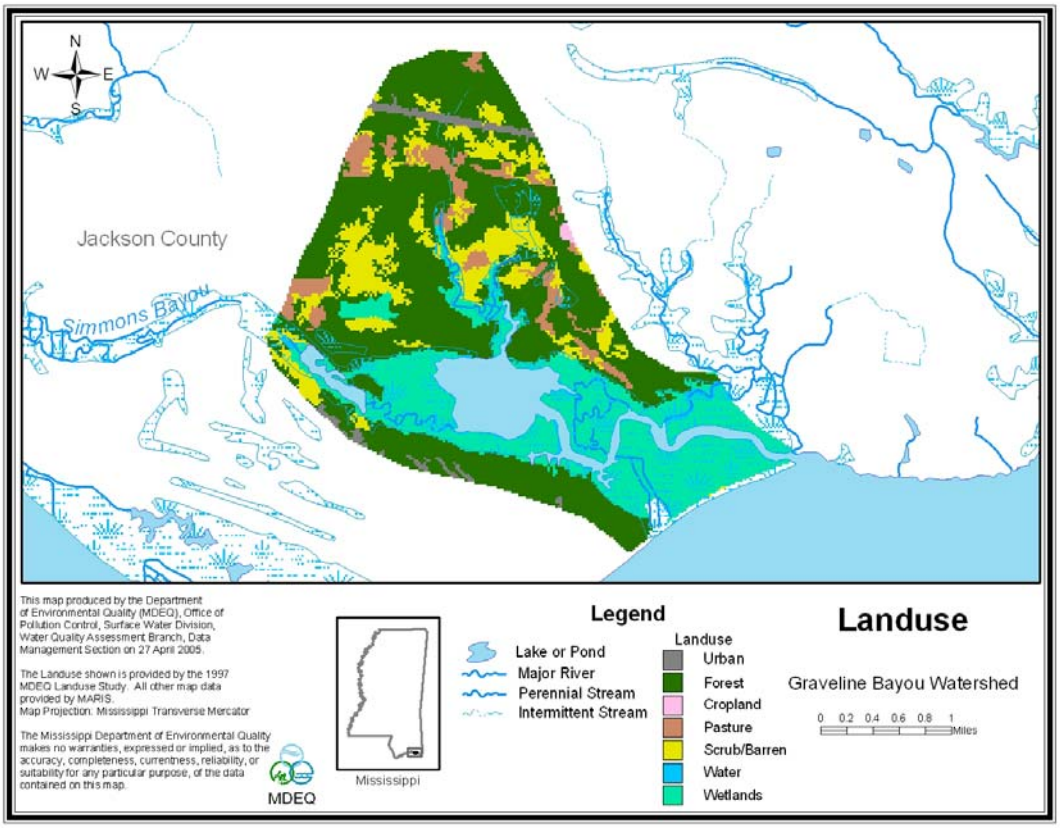
- Failing septic systems
- Wildlife
- Other Direct Inputs
- Urban development

The 4,900 acre drainage area of Graveline Bayou contains many different landuse types, including urban, forest, pasture, scrub / barren, and wetlands. The watershed is predominantly forest and wetlands. The landuse distribution for the watershed is provided in Table 3 and displayed in Figure 4. The landuse information for the watershed is based on the State of Mississippi's Automated Resource Information System (MARIS), 1997. This data set is based Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. The landuse categories were grouped into the landuses of urban, forest, cropland, pasture, scrub/barren, wetlands, and water.

Table 3. Landuse Distribution (acres)

	Urban	Forest	Cropland	Pasture	Scrub/Barren	Wetland	Water	Total
Area (acres)	83	2,243	8	251	577	1,282	429	4,873
% Area	2%	46%	0%	5%	12%	26%	9%	100%

Figure 4. Landuse Distribution Map for the Graveline Bayou Watershed



MDEQ contacted several agencies to refine the information concerning nonpoint sources of fecal coliform bacteria. The Mississippi Department of Wildlife, Fisheries, and Parks provided information of wildlife density in the Graveline Bayou Watershed. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in this portion of the state. The Mississippi Department of Marine Resources was contacted concerning shellfish harvesting closures. The Natural Resources Conservation Service gave MDEQ information on possible nonpoint sources of fecal coliform bacteria specific to the watershed. The 2002 Census of Agriculture produced by the National Agriculture Statistics Service was used to estimate agricultural animal populations in the watershed. Cattle, hog, and poultry populations are not considered significant in the Graveline Bayou Watershed.

3.2.1 Failing Septic Systems

Septic systems have a potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate, thence into underground absorption. The systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A

failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek.

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems may not receive the maintenance needed for proper, long-term operation. These systems require some sort of disinfection to properly operate. When this expense is ignored, the water does not receive adequate disinfection prior to release.

Septic systems have an impact on nonpoint source fecal coliform impairment in the Coastal Basin. The best management practices needed to reduce this pollutant load need to prioritize eliminating septic tank failures and improving maintenance and proper use of individual onsite treatment systems.

The Graveline Bayou Watershed is located in Jackson County, which has a wastewater ordinance. A wastewater ordinance requires that the wastewater treatment and disposal system used be certified as sufficient. It also ensures that electricity, water, or natural gas will not be made available without written approval from the Jackson County Health Department that the wastewater treatment and disposal system used is sufficient.

3.2.2 Wildlife

Wildlife present in the Graveline Bayou Watershed contributes to fecal coliform bacteria on the land surface which is then available for wash-off and delivery to receiving water bodies. Some form of wildlife may be present on all land uses within the watershed. Also, wildlife is present throughout the year. The Graveline Bay Coastal Preserve is an important landing area for neotropical migratory birds which are a source of fecal coliform to the water body.

3.2.3 Other Direct Inputs

Other direct inputs of fecal coliform bacteria to water bodies in the Graveline Bayou Watershed include illicit discharges, human recreation, leaking sewer collection lines, and access of both domestic and wild animals to the stream. Due to the general topography in the Graveline Bayou Watershed, land slopes in the watershed are such that unconfined animals are able to access some intermittent streams in the watershed.

3.2.4 Urban Development

Urban areas include land classified as urban and barren. Even though a small percentage of the entire watershed is classified as urban, there has been and continues to be urban growth within the Graveline Bayou Watershed. Fecal coliform contributions from urban areas may come from storm water runoff and runoff contribution from improper disposal of materials such as pet waste and litter.

MASS BALANCE PROCEDURE

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain water body responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

4.1 Modeling Framework Selection

A mass balance approach was used to calculate the TMDL for segment MS118GBE. This method of analysis was selected because data limitations precluded the use of more complex methods. The mass balance approach utilizes the conservation of mass principle. Loads can be calculated by multiplying the fecal coliform concentration in the water body by a quantity of water. The principle of the conservation of mass allows for the addition and subtraction of those loads to determine the appropriate numbers necessary for the TMDL. The mass balance approach is suitable for this TMDL.

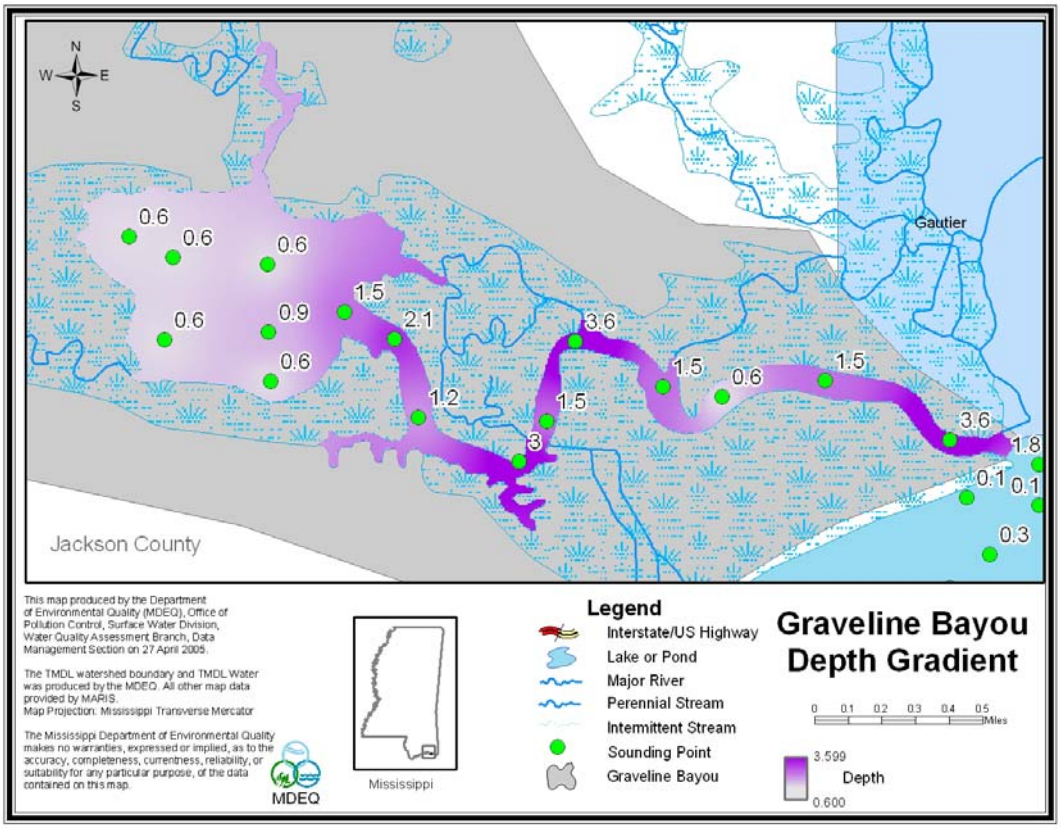
4.2 Calculation of Allowable Load

For Graveline Bayou and Graveline Bay, both of which are tidally influenced, the volume of water was estimated for the mass balance calculation. Navigational charts which show soundings, or the depth in meters of the water body at certain locations, were used to estimate the depth gradient of Graveline Bayou and Graveline Bay. The depth gradient estimation was done using an ArcGIS format that interpolated the depth between the sounding points. The resulting depth gradient was used to calculate the volume of water in Graveline Bayou and Graveline Bay. The datum for the soundings is the mean lower low water, giving a conservative estimate of the water volume. Figure 5 shows the depth gradient and the sounding points in meters. The loads can be calculated using the following relationship:

Load (counts/day) = [**Concentration** (counts/ 100 ml)] * [**Volume at Mean Lower Low Water** (m^3/day)] * (Conversion Factor)

where (Conversion Factor) = 1,000,000 ml/m^3

Figure 5. Depth Gradient Map for Graveline Bayou and Graveline Bay



4.3 Calculation of Existing Load

For the calculation of the existing load, the volume of water at mean lower low tide was multiplied by the maximum fecal coliform concentration of 79 counts / 100ml for the data collected from 2000 through 2004. The maximum fecal coliform concentration was used as a conservative assumption of existing water quality for calculation of a percent reduction. This existing load was determined to be 1.58E+12 counts/day.

ALLOCATION

The allocation for this TMDL includes a wasteload allocation (WLA) for point sources, a load allocation (LA) for nonpoint sources, and a margin of safety (MOS).

5.1 Wasteload Allocations

There are no point sources currently within the Graveline Bayou Watershed. This is not a suitable water body for NPDES permitted discharges.

5.2 Load Allocations

The load allocation for segment MS118GBE is calculated using the water quality criteria and the estimated volume at mean lower low water. The load allocation is assumed to represent nonpoint sources as described in section 3.2. In calculating the LA component, the total TMDL for the water body is reduced by a 25% MOS. The resulting LA is estimated to be 2.10E+11 counts/day.

LA = 0.75*14(counts/100ml)* 1,996,531(m^3/day) * 1,000,000 ml/m^3 – 0(counts/day)

LA = 2.10E+11 (counts/day)

5.3 Incorporation of a Margin of Safety (MOS)

The two types of MOS development are to implicitly incorporate the MOS using conservative assumptions or to explicitly specify a portion of the total TMDL as the MOS. For segment MS118GBE, reducing the TMDL by 25% explicitly specifies the MOS. The resulting load attributed to the MOS for the critical condition of summer is 6.99E+10 counts/day.

MOS = 0.25*14(counts/100ml)* 1,996,531(m^3/day) * 1,000,000 ml/m^3

MOS = 6.99E+10 (counts/day)

5.4 Calculation of the TMDL

The TMDL for segment MS118GBE is calculated based on the following equation:

TMDL = WLA + LA + MOS

where WLA is the Waste Load Allocation, LA is the Load Allocation, and MOS is the Margin of Safety.

WLA = NPDES Permitted Facilities

LA = Surface Runoff + Other Direct Inputs

MOS = 25% explicit

The TMDL for segment MS118GBE was calculated based on the estimated volume of water in Graveline Bayou and Graveline Bay at mean lower low water and a fecal coliform concentration of 14 counts/100ml. The fecal coliform percent reduction calculated is 82%.

TMDL = 14(counts/100ml)* 1,996,531(m^3/day) * 1,000,000 ml/m^3

TMDL = 2.80E+11 (counts/day)

Table 4. TMDL Summary for Segment MS118GBE (counts/day)

WLA	0.00
LA	2.10E+11
MOS	6.99E+10
TMDL = WLA + LA +MOS	**2.80E+11**

5.5 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. This stream is designated for the use of shellfish harvesting. For this use, the fecal coliform standard is not seasonal. This TMDL is appropriate for all seasons.

5.6 Reasonable Assurance

This component of TMDL development does not apply to this TMDL Report. There is no WLA reduction request based on promised LA components and reductions. This TMDL will recommend that no point sources discharge into the water body as it is not a suitable water body for NPDES permitted discharges.

CONCLUSION

MDEQ will not approve any NPDES Permit application as the water body is not appropriate for discharge. Education projects that teach best management practices should be used as a tool for reducing nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants.

6.1 Future Monitoring

Graveline Bayou will receive ongoing monitoring by the Mississippi Department of Marine Resources 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.

6.2 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 and a newspaper in the area of the watershed. The public will be given an opportunity to review the TMDL and submit comments. MDEQ also distributes all TMDLs prior to the beginning of the public notice to those members of the public who have requested to be included on a TMDL email list. Anyone wishing to be included on the TMDL email list should contact Greg Jackson at (601) 961-5098 or Greg_Jackson@deq.state.ms.us. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public meeting. All written comments received during the public notice period and at any public meeting become a part of the record of this TMDL. All comments will be considered in the ultimate completion of this TMDL for submission of this TMDL to EPA Region 4 for final approval.

DEFINITIONS

Adverse pollution condition: state or situation caused by meteorological, hydrological or seasonal events or point source discharges that has historically resulted in elevated fecal coliform levels in a particular growing area.

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 natural body of water to receive wastewaters or toxic materials without deleterious effects and without damage to aquatic life or humans who use the water.

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.

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.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a waterbody have their greatest potential for adverse effects.

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 Uses: (1) those uses specified in the 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. Uses can include public water supply, recreation, etc.

Discharge monitoring report (DMR): the EPA uniform national form, including any subsequent additions, revisions, or modifications for the reporting of self-monitoring results by permittees.

Effluent: wastewater – treated or untreated – that flows out of a treatment plant or industrial outfall. Generally refers to wastes discharged into surface waters.

Effluent limitation: (1) any restriction established by a State or the Administrator on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean, including schedules of compliance. (2) restrictions established by a State or EPA on quantities, rates, and concentrations in wastewater discharges.

Effluent standard: any effluent standard or limitation, which may include a prohibition of any discharge, established or proposed to be established for any toxic pollutant under section 307(a) of the Act.

Fecal Coliform Bacteria: (1) those organisms associated with the intestines of warm-blooded animals that are commonly used to indicate the presence of fecal material and the potential presence of organisms capable of causing human disease. (2) bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

Geometric mean: the *n*th root of the production of n factors. A 30-day geometric mean is the 30^{th} root of the product of 30 numbers.

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 nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint 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 nonpoint source loads should be distinguished.

Loading: the introduction of waste into a waste management unit but not necessarily to complete capacity.

Lower Low Water: the lowest of the low waters (or single low water) of any specified tidal day due to the declination effects of the Moon and Sun.

Mass Balance: a concept based on a fundamental law of physical science (conservation of mass) which says that matter can not be created or destroyed. It is used to calculate all input and output streams of a given substance in a system.

Mean Lower Low Water: the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.

Model: a quantitative or mathematical representation or computer simulation which attempts to describe the characteristics or relationships of physical events.

National pollutant discharge elimination system (NPDES): the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under section 307, 402, 318, and 405 of the Clean Water Act.

National Tidal Datum Epoch: the specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values for tidal datums.

Nonpoint Source: the pollution sources which generally are not controlled by establishing effluent limitations under section 301, 302, and 402 of the Clean Water Act. Nonpoint source pollutants are not traceable to a discrete identifiable origin, but generally result from land runoff, precipitation, drainage, or seepage.

Outfall: the point where an effluent is discharges into receiving waters

Point Source: a stationery location or fixed facility from which pollutants are discharges or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Pollution: generally, the presence of matter or energy whose nature, location or quanitity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, and radiological integrity of water.

Publicly Owned Treatment Works (POTW): the treatment works treating domestic sewage that is owned by a municipality or State.

Regression: a relationship of y and x in a finction of y = f(x), where: y is the expected value of an independent random variable x. The parameters in the function f(x) are determined by the method of least squares. When f(x) is a linear function of x, the term linear regression is used.

Regression Coefficient: a quantity that describes the slope and intercept of a regression line.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.

For example: $2.7X10^{4}$ = 2.7E+4 =27000 and $2.7X10^{-4}$ = 2.7E-4=0.00027.

Sigma (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d}_1$, $\mathbf{d}_2$, $\mathbf{d}_3$) respectively could be shown as:

$$\sum_{i=1}^{3} d_i = d_1+d_2+d_3 = 24 + 123 + 16 = 163$$

Tidal Day: the time of the rotation of the earth with respect to the moon, approximately 24 hours and 50 minutes, same as lunar day.

Total Maximum Daily Load or TMDL: (1) the calculated maximum permissible pollutant loading introduced to a water body 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.

Waste: (1) useless, unwanted or discarded material resulting form (agricultural, commercial, community and industrial) activities. Wastes include solids, liquids, and gases. (2) any liquid resulting from industrial, commercial, mining, or agricultural operations, or from community activities that is discarded or is being accumulated, stored, or physically, chemically, or biologically treated prior to being discarded or recycled.

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 source of pollution. (3) the maximum load of pollutants each discharger of waste is allowed to release into a particulat 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 Standards: State-adopted and EPA-approved regulations mandated by the Clean Water Act and specified in 40 CFR 131 that describe the designated uses of a water body, the numeric and narrative water quality criteria designed to protect those uses, and an antidegredation statement to protect existing levels of water quality. Standards are designed to safeguard the public health and welfare, enhance the quality of water and serve the purposes of the Clean Water Act.

Water quality criteria: numeric water quality values and narrative statements which are derived to protect designated uses. 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. Ambient waters that meet applicable water quality criteria are considered to support their 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

7Q10 ..... Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period

BASINS ..... Better Assessment Science Integrating Point and Nonpoint Sources

BMP ..... Best Management Practice

CWA ..... Clean Water Act

DMR ..... Discharge Monitoring Report

EPA ..... Environmental Protection Agency

GIS ..... Geographic Information System

HUC ..... Hydrologic Unit Code

ISSC ..... Interstate Shellfish Sanitation Conference

LA ..... Load Allocation

MARIS ..... State of Mississippi Automated Information System

MDEQ ..... Mississippi Department of Environmental Quality

MOS ..... Margin of Safety

NOAA ..... National Oceanic and Atmospheric Administration

NPDES ..... National Pollution Discharge Elimination System

NPSM ..... Nonpoint Source Model

NRCS ..... National Resource Conservation Service

NSSP ..... National Shellfish Sanitation Program

RF3 ..... Reach File 3

USACOE ..... United States Army Corps of Engineers

USGS ..... United States Geological Survey

USM ..... University of Southern Mississippi

WLA ..... Waste Load Allocation

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