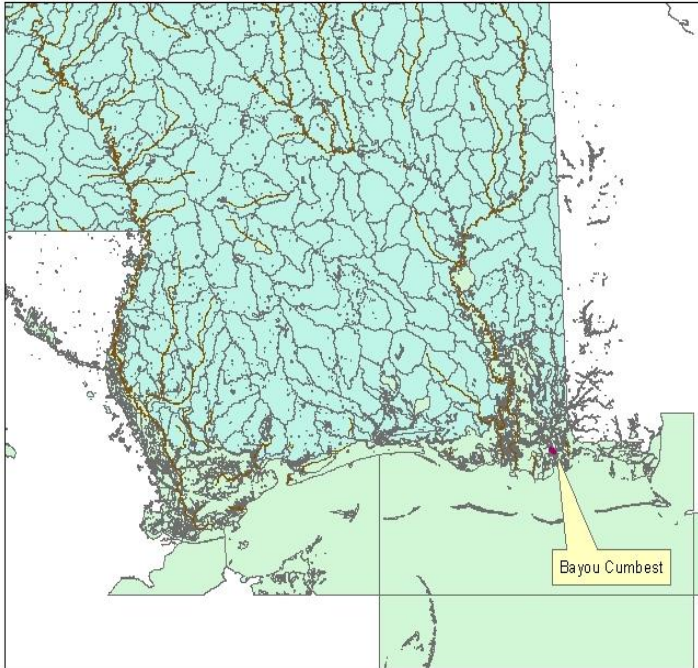


Total Maximum Daily Load (TMDL)

The Bayou Cumbest Watershed

To address Impairment due to Nutrients
In the Coastal Streams Basin of Mississippi



Prepared by:

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FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. In February 2006, EPA filed a motion with the Court for an extension of time to complete TMDLs in the Coastal Streams Basin, to allow EPA and MDEQ to address the significant impacts of Hurricane Katrina on Mississippi coastal waters. On February 28, 2006, the Court granted the motion, providing that EPA shall have up to June 30, 2007 to propose TMDLs for evaluated waters in the Coastal Basin as required by Paragraph V. of the Consent Decree.

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 in the Coastal Streams Basin. 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 TMDL 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 TMDL may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Conversion Factors

To convert from	To	Multiply by	To convert from	To	Multiply by
mile ²	acre	640	acre	ft ²	43560
km ²	acre	247.1	days	seconds	86400
m ³	ft ³	35.3	meters	feet	3.28
ft ³	gallons	7.48	ft ³	gallons	7.48
ft ³	liters	28.3	hectares	acres	2.47
cfs	gal/min	448.8	miles	meters	1609.3
cfs	MGD	0.646	tonnes	tons	1.1
m ³	gallons	264.2	µg/l * cfs	gm/day	2.45
m ³	liters	1000	µg/l * MGD	gm/day	3.79

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

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TMDL INFORMATION PAGE

Table i. Listing Information

ID	Name	County	Cause	Mon/Eval
MS109BCUE	Bayou Cumbest	Jackson	Nutrients	Evaluated
Near Lakeshore: From headwaters to mouth at Mississippi Sound				

Table ii. Water Quality Standard

Parameter	Beneficial use	Narrative Water Quality Criteria
Nutrients	Aquatic Life Support	Mississippi’s current standards contain a narrative criteria that can be applied to nutrients which states “ <i>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).</i> ”

Table iii. Total Maximum Daily Load

Nutrient	WLA (lbs/day)	LA (lbs/day)	MOS	TMDL (lbs/day)
TP	0.0	1.02	implicit	1.02
TN	0.0	5.2	implicit	5.2

EXECUTIVE SUMMARY

Bayou Cumbest (MS109BCUE) is on the Mississippi 2006 Section 303(d) List of Water Bodies as an evaluated ~~waterbody~~water body that is impaired due to nutrients (MDEQ, 2006). This TMDL addresses the nutrients impairment. An evaluated category indicates that the water body was listed based on anecdotal information and no additional monitoring data ~~is~~are available.

This TMDL addresses nutrients and will provide an estimate of the total nitrogen (TN) and total phosphorus (TP) in the stream. Mississippi does not have water quality standards for allowable nutrient concentrations. The Mississippi Department of Environmental Quality (MDEQ) currently has a Nutrient Task Force (NTF) working on the development of criteria for nutrients. ~~MDEQ is presenting the target nutrient ranges for TP and TN as preliminary target values for TMDL development which is subject to revision after the development of numeric nutrient criteria by the NTF.~~

The water body included in this TMDL is located within United States Geological Survey (USGS) Hydrologic Unit Code (HUC) 03170009. HUC 03170009 is located in Jackson County and in the Coastal Streams Basin in Mississippi.

Average annual loads of nutrients were estimated using a spreadsheet based on EPA's Simple Method formula from the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) Pollutant Loading (PLOAD) model (USEPA, 2001). The PLOAD model was used to estimate nutrient to the estuary based on existing land use conditions and least disturbed conditions. Loadings resulting from the least disturbed condition represent the TMDL.

For the TMDL analysis, existing "disturbed" land use were changed to wetlands and forest for purposes of representing least disturbed or "natural" conditions for the Bayou Cumbest watershed. In the analysis disturbed lands were assumed to be all land use categories with the exception of forests, water and wetlands. The percent reductions in pollutant loadings necessary to achieve "natural" conditions were calculated by subtracting the TMDL load from the existing load and dividing the difference by the existing load.

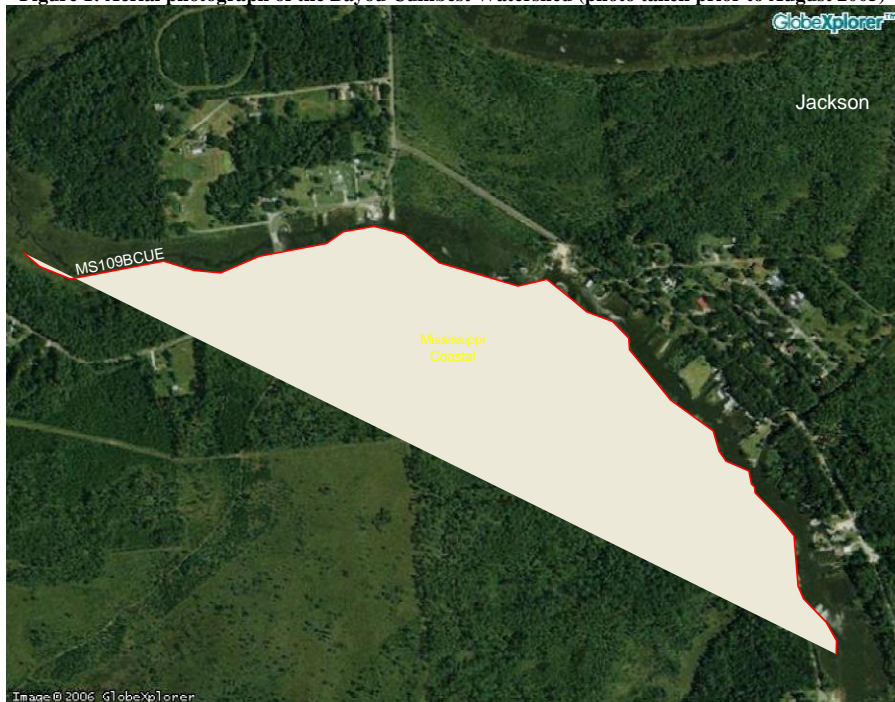
~~Nutrients were addressed through an estimate of a preliminary TP and TN concentration target ranges.~~—The TMDL for TN is 5.12 lbs/day and the TMDL for TP is 1.02 lbs/day. It is recommended that the Bayou Cumbest watershed be considered as a priority watershed for wetlands restoration, riparian buffer zone restoration and any nutrient reduction BMPs. The implementation of these BMP activities should reduce the nutrient load entering Bayou Cumbest. This will provide improved water quality for the support of aquatic life in Bayou Cumbest and will result in the attainment of the applicable water quality standards.

1.0 INTRODUCTION

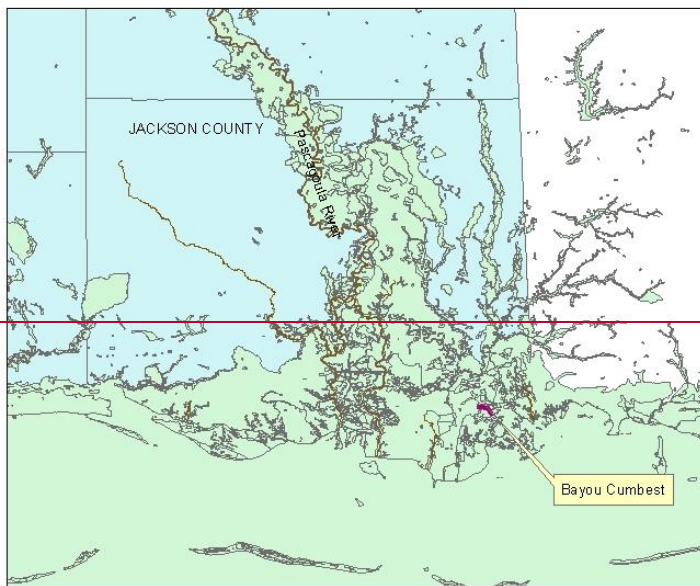
1.1 Background

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 (CWA) 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 nutrients.

Figure 1: Aerial photograph of the Bayou Cumbest Watershed (photo taken prior to August 2005)



Bayou Cumbest is within United States Geological Survey (USGS) Hydrologic Unit Code (HUC) 03170009. The Bayou Cumbest watershed is located in Jackson County (Figure 1) in Mississippi's Coastal Streams Basin. The entire watershed is 2951.67 acres and contains many landuse types including forest, pastureland, and wetland areas. However, the dominant landuse within the watershed is wetlands. The location of the §303(d) listed segment is also shown in Figure 21.

Figure 2. Bayou Cumbest Watershed 303(d) Listed Segment

1.2 Applicable Water Body Segment Use

The water use classification for the listed segment of Bayou Cumbest, as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulation, is Fish and Wildlife Support (MDEQ, 2002b). Waters with this classification are intended for fishing and propagation of fish, aquatic life, and wildlife. Waters that meet the Fish and Wildlife Support criteria should also be suitable for secondary contact, which is defined as incidental contact with water including wading and occasional swimming.

1.3 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’s methodology 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 in Mississippi is complete.~~

1.4 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 M-BISQ process (M-BISQ 2003) or stations that resulted in a biological impairment rating of “fully attaining” were used to evaluate natural variability of the data set.~~

~~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.~~

~~Each of these two groups was evaluated separately (“least disturbed sites” and “fully attaining sites”). 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.~~

~~MDEQ's current approach, as described above, to using nutrient targets for inland streams TMDLs is not applicable for this TMDL. As Bayou Cumbest is a tidally influenced estuarine stream, different targets will need to be used. MDEQ is working with a contractor, FTN & Associates, LTD, to develop nutrient criteria for estuaries and coastal waters. FTN conducted an extensive literature search on the effects of nutrients on estuarine systems and used existing water quality data available for some of Mississippi's coastal estuaries to develop draft nutrient targets for water bodies in the Coastal Streams Basin that still require TMDLs.~~ As described in Section 3.0, EPA is using the Simple Method formula from the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) Pollutant Loading (PLOAD) model (USEPA, 2001) to determine the appropriate TN and TP targets for the Bayou Cumbest watershed.

1.5 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 understanding of the pollutants of concern for this TMDL report:

The two primary nutrients of concern are nitrogen and phosphorus. Both elements are measured in several forms. Phosphorus can be reported as total phosphorus (TP) and is found in particulate forms and soluble reactive phosphate (SRP) (also sometimes called phosphate (PO_4^{3-}) or orthophosphate (ortho-P)). The latter represent 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), nitrate-nitrogen (NO_3^-), nitrite-nitrogen (NO_2^-) [NO_2^- is usually measured as nitrate-nitrite-nitrogen ($\text{NO}_3^-/\text{NO}_2^-$)], or ammonia-nitrogen (NH_3 or NH_4). As with the case of TP, there are fractions of TN that are more bioavailable. TKN is the organic form of TN, which is less bioavailable for growth versus the readily available component of TKN, which is NH_4 . The fractions of $\text{NO}_3^-/\text{NO}_2^-$ 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 at predictable rates; and maybe significant drivers of primary productivity. One chemical

form of an element can be converted into another. 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 months, 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).

The nutrient dynamics in the estuarine system greatly differs from the nutrient dynamics in inland water bodies, which was described above. In U.S. coastal waters, nutrient over-enrichment is a common thread that ties together a diverse suite of coastal problems such as red tides, fish kills, some marine mammal deaths, outbreaks of shellfish poisonings, loss of seagrass and bottom shellfish habitats, coral reef destruction, and hypoxia and anoxia now experienced as the Gulf of Mexico's "dead zone" (NRC 2000, Rabalais et al. 1991 taken from EPA, 2001).

2.0 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 target endpoints, which are used to evaluate the attainment of acceptable water quality. Target endpoints, therefore, represent the water quality goals that are to be achieved by meeting the load and wasteload allocations specified in the TMDL. The endpoints allow for a comparison between observed conditions and conditions that are expected to restore designated uses. The TMDL is based on landuse and pollutant loadings of TP and TN that provide for the attainment of water quality standards in Bayou Cumbest. This nutrient TMDL will be expressed as a daily maximum loads of TN and TP for Bayou Cumbest.

2.2 Source Assessment and Load Estimation

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of nutrients in the watershed and the amount of pollutant loading contributed by each of these sources. Under the CWA, sources are broadly classified as either point or non-point 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.

2.3 Assessment of Point Sources

There are no point sources that currently discharge into Bayou Cumbest. A wasteload allocation (WLA) is given to all NPDES facilities in the watershed permitted to discharge to surface waters. Under the NPDES program, permits for wastewater facilities may authorize a discharge only if the applicant provides reasonable assurance that the discharge will not cause or contribute to violations of the water quality criteria. There are no wastewater or industrial NPDES facilities in the Bayou Cumbest watershed permitted to discharge to surface waters.

Municipal Separate Storm Sewer Systems (MS4s) may also discharge to water bodies in response to storm events. Large and medium MS4s serving populations greater than 100,000 people are required to obtain a NPDES storm water permit under the Phase I storm water regulations. After March 2003, small MS4s serving urbanized areas were required to obtain a permit under the Phase II storm water regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile. There are no municipalities in the watershed of sufficient population or density requiring MS4 permits.

2.4 Assessment of Nonpoint Sources

The two primary nutrients of concern are nitrogen and phosphorus. Total nitrogen is a combination of many forms of nitrogen found in the environment. Inorganic nitrogen can be transported in particulate and dissolved phases in surface runoff. Dissolved inorganic nitrogen can be transported in groundwater and may enter a stream from groundwater infiltration. In agricultural areas, studies have indicated that human activities have

increased nitrate concentrations in ground water. In urban areas, it is likely that nitrogen sources are relatively localized when compared with the generally more intensive and widespread use of fertilizers on cropland. The greater the percentage of impervious surfaces in a watershed (usually more predominant in urban areas) generally results in surface runoff of nutrient-laden water, rather than seepage to ground water (USGS, 1999). 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 may be a limiting nutrient in 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 3-1 presents an estimate of typical nutrient loading ranges associated with various land uses.

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Table 1. Nutrient Loadings for Various Land Uses

Landuse	Total Phosphorus [lb/acre-y]			Total Nitrogen [lb/acre-y]		
	Minimum	Maximum	Median	Minimum	Maximum	Median
Roadway	0.53	1.34	0.98	1.2	3.1	2.1
Commercial	0.61	0.81	0.71	1.4	7.8	4.6
Single Family-Low Density	0.41	0.57	0.49	2.9	4.2	3.6
Single Family-High Density	0.48	0.68	0.58	3.6	5.0	5.2
Multifamily Residential	0.53	0.72	0.62	4.2	5.9	5.0
Forest	0.09	0.12	0.10	1.0	2.5	1.8
Grass	0.01	0.22	0.12	1.1	6.3	3.7
Pasture	0.01	0.22	0.12	1.1	6.3	3.7

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

The 2,951.67 acre drainage area of the Bayou Cumbest watershed contains many different landuse types, including forest, cropland, pasture, barren, and wetlands as shown in Table 4-2 and Figure 3. The dominant landuse within the watershed is wetlands. The landuse information for the watershed is based on the National Land Cover Dataset, which is based on digital images taken between 1992 and 1993.

Table 2. Bayou Cumbest Watershed Landuse Distribution

	Urban	Forest	Cropland	Pasture/ Grass	Transitional	Water/ Wetland	Grassland	Total
Acres	9	1213	25	106	14	1568	12	2947
Percentage	0.3	41.2	0.8	3.6	0.5	53.2	0.4	100.0%

2.5 Effects of Hurricanes Katrina and Rita

Hurricane Katrina and Hurricane Rita struck the U.S. Gulf Coast on August 29, and September 24, 2005, respectively. U.S. Geological Survey (USGS) real-time instruments

in Gautier, Mississippi recorded wind speeds up to 140 miles per hour and rainfall totals of approximately two feet (USEPA, October 2005). Tidal surges in nearby Bayou Casotte were reported to be as high as 20 feet during Hurricane Katrina. The land on the Mississippi coast was cleared of most vegetation and structures due to the storm surge and wind gusts. The current landuses that have recovered and are coming back post Hurricanes Katrina and Rita are difficult to predict as no site assessment was completed at Bayou Cumbest. Best professional judgment suggests that most of the land use types would have reverted back to wetlands and that existing wetlands impacted by the hurricanes will recover over time. Re-development efforts in Jackson County are underway. Efforts are being made to protect existing marshlands and greenways in the watershed as redevelopment continues along the Mississippi Coastline.

3.0 ANALYTICAL APPROACH

Average annual loads of nutrients were estimated using a spreadsheet based on EPA's Simple Method formula from the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) Pollutant Loading (PLOAD) model (USEPA, 2001):

$$LP = \sum_u (P * PJ * RV_u * C_u * A_u * 2.72 / 12)$$

Where: LP = Pollutant load, lbs

P = Precipitation, inches/year

PJ = Ratio of storms producing runoff (default = 0.9)

RV_u = Runoff Coefficient for land use type u, inches of runoff/inches of rain

RV_u = 0.05 + (0.009 * I_u); I_u = percent imperviousness

C_u = Event Mean Concentration for land use type u, milligrams/liter

A_u = Area of land use type u, acres.

The PLOAD model was used to estimate nutrient loadings to the estuary based on existing land use conditions and least disturbed conditions. Loadings resulting from the least disturbed condition represent the TMDL. Given the impacts of the hurricanes on the water body and watershed, EPA is using the 1999 NLCD dataset to reflect the existing land use conditions in Bayou Cumbest.

The PLOAD model uses average annual rainfall and event mean concentrations (EMCs) to estimate pollutant loading transported off a particular land use. The EMC is the measure of pollutant levels during a runoff event, and is expressed as the loading for a specific constituent divided by the stormwater volume in the runoff event. The model assumes all lands are connected to the stream, resulting in a conservative estimate of average annual loads. An annual average rainfall of approximately 60.5 inches was assumed to fall on the impaired watershed, and this is based on a meteorological data collected by Hancock County, Mississippi. The default ratio of 0.9 for storms producing runoff was assumed in the model. Land use data entered into the spreadsheet for existing conditions were based on the 1999 land use/cover features categorized according to the National Land Cover Data (NLCD) (see Table 2). EMC values assumed for the various land uses are default values contained in the BASINS PLOAD model (USEPA, 2001).

For the TMDL analysis, existing "disturbed" land use were changed to wetlands and forest for purposes of representing least disturbed or "natural" conditions for the Bayou Cumbest watershed. In the analysis disturbed lands were assumed to be all land use categories with the exception of forests, water and wetlands. Model results for existing and TMDL "unimpacted" conditions are shown in [Table 3](#). The percent reductions in pollutant loadings necessary to achieve "natural" conditions were calculated using the following equation and are presented in [Table 3](#).

$$\text{Percent Reduction} = (\text{existing load} - \text{TMDL load}) / \text{existing load} * 100$$

Table 3. Overall Percent Reductions Required to Achieve "Unimpacted" landuse conditions

Condition	Total Annual Load (lbs/year)	
	TN	TP
Existing	1920.974	389.404
Least Disturbed	1868.877	373.775
Percent Reduction	3%	4%

4.0 Development of the TMDL

The TMDL process quantifies the amount of a pollutant that can be assimilated in a ~~waterbody~~water body, 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), nonpoint 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:

$$\text{TMDL} = \Sigma \text{WLAs} + \Sigma \text{LAs} + \text{MOS}$$

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. TMDLs for Bayou Cumbest are expressed as a percent reduction of the estimated annual average loads, which are then converted into daily load values.

4.1 Wasteload Allocation

There are no point sources that are currently discharging into Bayou Cumbest. Therefore, the waste load allocations for TP and TN have been set to zero. This TMDL would need to be revised to allow for any additional allocations for future point sources prior to the issuance of NPDES permits.

4.2 Load Allocation

Best management practices (BMPs) should be encouraged in the watershed to reduce potential TN and TP loads from non-point sources. The watershed should be considered a priority for wetlands restoration, riparian buffer zone restoration and any nutrient reduction BMPs. For land disturbing activities related to silviculture, construction, and agriculture, it is recommended that practices, as outlined in ‘Mississippi’s BMPs: Best Management Practices for Forestry in Mississippi’ (MFC, 2000), ‘Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater’ (MDEQ, et. al, 1994), and ‘Field Office Technical Guide’ (NRCS, 2000), be followed, respectively.

4.3 Critical Conditions

The critical condition for non-point source loadings is typically an extended dry period followed by a rainfall runoff event. During the dry weather period, pollutants build up on the land surface, and are washed off by rainfall. Expression of a nutrient impairment (e.g. algal blooms) is more likely to occur during warmer months. However, because nutrients (especially phosphorus) can accumulate, nutrient loadings are usually considered over longer periods (e.g. annual averages).

There were no water quality data collected in Bayou Cumbest. Therefore, EPA is unable to cross-reference rainfall events and pollutant loadings. Critical conditions and seasonal

variation were incorporated into the TMDL development by using EMCs in a National dataset in BASINS, which would be representative of the Bayou Cumbest watershed. EPA used pollutant loadings during “undisturbed” conditions of wetlands and forests to determine annual average loads (expressed in daily terms). Wetlands, if restored and functioning well, will provide for retention and uptake of nutrients after a rainfall event and before excess nutrients can be flushed into Bayou Cumbest. Therefore, BMPs for wetland restoration, riparian restoration and nutrient reduction will be critical to achieving the reductions called for in this TMDL.

4.4 Margin of Safety

TMDLs shall include a margin of safety (MOS) that takes into account any lack of knowledge about the pollutant loading and in-stream water quality. ~~In this case the measured water quality was used directly to determine the reduction to meet the water quality standard. In this case the lack of knowledge concerns the data, and how well it represents the true water quality.~~ There are two methods for incorporating a MOS in the analysis: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. An implicit MOS was used in these TMDLs by targeting background loadings based on a least disturbed land cover and assuming all landuses are connected directly to the stream.

4.5 Determination of TMDL Components

The TMDL components are expressed as annual averages, which have been converted into daily loadings of TN and TP necessary for the stream to maintain water quality standards. The percent reductions necessary to achieve the TMDL values are very low; as a small percentage of the 1999 landuse is classified as disturbed (see ~~Error! Reference source not found, Table 2~~). The BMPs used to implement the TMDL should result in meeting water quality standards on a daily basis. EPA believes that the annual average loads will more effectively facilitate the implementation of the TMDL and the attainment of water quality standards in Bayou Cumbest. The TMDL components for Bayou Cumbest are summarized in ~~Table 4~~ Table 4.

Table 4. Summary of TMDL Components

Parameter	WLA (lbs/day)	LA (lbs/day)	TMDL (lbs/day)
TN	0.0	5.12	5.12
TP	0.0	1.02	1.02

4.6 Seasonal Variation

Seasonal variation is considered in the TMDL to ensure that WQS will be met during all seasons of the year. Seasonal variation was considered in the analysis through the use of average annual rainfall data collected over several seasons.

5.0 ALLOCATION

Nutrients were addressed through an estimate of a preliminary total phosphorous and total nitrogen concentration target range. The TMDL for TN is 5.12lbs/day and the TMDL for TP is 1.02 lbs/day. It is recommended that the Bayou Cumbest watershed be considered as a priority watershed for wetlands restoration, riparian buffer zone restoration and any nutrient reduction BMPs. The implementation of these BMP activities should reduce the nutrient load entering the creeks. This 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.

5.1 Public Participation

This draft TMDL is being proposed for public review and comment for a 30-day period. The EPA is notifying the public by publishing a notice of the TMDL through a legal ad in the statewide newspaper, the *Clarion-Ledger*. The public notice will also appear in the local newspaper, the *Mississippi Sun Herald*. EPA is also providing notice to members of the public through e-mail who have requested that MDEQ include them on a TMDL mailing list. The TMDL is also available for review and comment on EPA Region 4's website:

(<http://www.epa.gov/Region4/water/tmdl/mississippi/>).

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

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

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

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DEFINITIONS

Aggradation: The raising of the bed of a watercourse by the deposition of sediment.

Allocations: That portion of a receiving water's loading capacity that is attributed to one of its existing or future pollution sources (nonpoint 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.

Bank Full Stage: Stage of flow at which a stream fills its channel up to level of its bank. Recurrence interval averages 1.5 to 2 years.

Bedload Sediment: Portion of sediment load transported downstream by sliding, rolling, bouncing along the channel bottom. Generally consists of particles >1 mm.

Best Management Practices (BMPs): (1) The methods, measures, or practices selected by an agency to meet its nonpoint 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 nonpoint sources.

Calibration: Testing and tuning of a model to a set of field data. Also includes minimization of deviations between measured field conditions and output of a model by selecting appropriate model coefficients.

Channel: (1) A natural stream that conveys water; a ditch or channel excavated for the flow of water. (2) The water-filled groove through which runoff water flows. In a narrow valley the channel may include the entire valley floor, but ordinarily it occupies only a small fraction of the valley.

Channel Improvement: The improvement of the flow characteristics of a channel by clearing, excavation, realignment, lining, or other means in order to increase its capacity. Sometimes used to connote channel stabilization.

Channel Stabilization: Erosion prevention and stabilization of velocity distribution in a channel using jetties, drops, revetments, vegetation, and other measures.

Channelization: Straightening and deepening streams so that water will move faster, a marsh-drainage tactic that can interfere with waste assimilation capacity, disturb fish and wildlife habitats, and aggravate flooding.

Clean Sediment: Sediment that is not contaminated by chemical substances. Pollution caused by clean sediment refers to the quantity of sediment, as opposed to the presence of pollutant-contaminated sediment.

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~~water body 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.

Dissolved Solids: (1) The total amount of dissolved materials, organic and inorganic, contained in water or wastes. Excessive dissolved solids can make water unsuitable for industrial uses, unpalatable for drinking, and even cathartic. Potable water supplies must have dissolved solid content from 20 to 1000 mg/l, but sources which have more than 500 mg/l are not recommended by the U.S. Public Health Service. (2) Disintegrated organic and inorganic material in water. Excessive amounts make water unfit to drink or use in industrial processes.

Diurnal: Recurring daily. Diurnal indicates variations following a distinctive pattern and recurring from day to day.

Dynamic Model: A mathematical formulation describing and simulating the physical behavior of a system or a process and its temporal variability.

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

Effective Discharge: The channel-forming discharge or discharge which moves the most sediment. This value is obtained by combining flow frequency data with sediment transport data.

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.

Flood Plain: (1) The lowland and relatively flat areas adjoining inland and coastal waters and other floodprone areas such as offshore islands, including at a minimum, the area subject to a one percent or greater chance of flooding in any given year. The base floodplain shall be used to designate the 100-year floodplain (one percent chance floodplain). The critical action floodplain is defined as the 500-year floodplain (0.2 percent chance floodplain). (2) The portion of a river valley that becomes covered with water when the river overflows its banks at flood stage. (3) The flat or nearly flat land along a river or stream or in a tidal area that is covered by water during a flood.

Fluvial Geomorphology: The study of landforms and processes associated with rivers.

Geomorphology: The study of the Earth's landscapes and landforms, the processes by which the landforms originated, their age, and the nature of the materials underlying them.

Gully Erosion: (1) Severe erosion in which trenches are cut to a depth greater than 30 centimeters (1 ft). Generally, ditches deep enough to cross with farm equipment are considered gullies. (2) The widening, deepening, and cutting back of small channels and waterways due to erosion.

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 nonpoint source pollutants.

Load Allocation (LA): The portion of a receiving water's loading capacity 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 portion of a receiving water's loading capacity 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.

Mass Wasting: Downslope transport of soil and rocks due to gravitational stress.

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.

Nonpoint Source: The pollution from sources which generally are not controlled by establishing effluent limitations under sections 301, 302, and 402. Nonpoint 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 nonpoint 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.

Scouring: The removal of earth or rock by the action of running water or of a glacier.

Sediment: (1) The unconsolidated inorganic and organic material that is suspended in and being transported by surface water, or has settled out and deposited into beds. (2) Soil, sand, and minerals washed from land into water, usually after rain. They pile up in reservoirs, rivers, and harbors, destroying fish and wildlife habitat, and clouding the water so that sunlight cannot reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to wash off the land after rainfall.

Sediment Delivery: Contribution of transported sediment to a particular location or part of a landscape.

Sediment Production: Delivery of colluvium or bedrock from hillslope to stream channel. The production rate is evaluated as the sum of the rates of colluvial bank erosion and sediment transport across channel banks.

Sediment Yield: The quantity of sediment arriving at a specific location.

Sedimentation: Process of deposition of waterborne or windborne sediment or other material; also refers to the infilling of bottom substrate in a ~~waterbody~~water body by sediment (siltation).

Sheet Erosion: Also Sheetwash. Erosion of the ground surface by unconcentrated (i.e. not in rills) overland flow.

Sheetwash: Also Sheet Erosion. Erosion of the ground surface by unconcentrated (i.e. not in rills) overland flow.

Stage: The height of a water surface above an established datum plane.

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 nonpoint source pollutants.

Suspended Solids: Organic and inorganic particles (sediment) suspended in and carried by a fluid (water). The suspension is governed by the upward components of turbulence, currents, or colloidal suspension. Suspended-sediment usually consists of particles <0.1 mm, although size may vary according to current hydrological conditions. Particles between 0.1 mm and 1 mm may move as suspended or be deposited (bedload).

Thalweg: Deepest part of a stream channel.

Topography: The physical features of a geographic surface area including relative elevations and the positions of natural and man-made features.

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.

Turbidity: (1) A measure of opacity of a substance; the degree to which light is scattered or absorbed by a fluid. (2) A cloudy condition in water due to suspended silt or organic matter.

Waste: Useless, unwanted, or discarded material resulting from (agricultural, commercial, community, and industrial) activities. Wastes include solids, liquids, and gases.

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