DRAFT
TMDL for Dissolved Oxygen for Ponchatoula Creek and Ponchatoula River (Subsegment 040505) in the Lake Pontchartrain Basin, Louisiana

Prepared for:

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Executive Summary

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (at Title 40 of the *Code of Federal Regulations* [CFR] section 130.7) require TMDLs for waterbody-pollutant pairs apply to the approved 303(d) impaired waters list even if pollutant sources have implemented technology-based controls. A total maximum daily load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can assimilate while still meeting the water quality standard for that pollutant. TMDLs provide the scientific basis for a state to establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA 1991).

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality, and it may include a future growth (FG) component. The components of the TMDL calculation are illustrated using the following equation:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS + FG$$

The area for this TMDL includes Arnold's Creek, Ponchatoula Creek, and Ponchatoula River. Ponchatoula Creek, Arnold's Creek, and Yellow Water River are tributary streams within the Tickfaw River watershed that coalesce to form the Ponchatoula River. Ponchatoula Creek is entirely within Tangipahoa Parish. The predominant land use within the impaired subsegment is developed land (33.2 percent), followed by wetlands (31.2 percent).

The Louisiana Department of Environmental Quality (LDEQ) has included Ponchatoula Creek and Ponchatoula River (subsegment 040505) on the state's 2010 section 303(d) list of impaired waterbodies (*Draft 2010 Integrated Report*) (Table ES-1). The subsegment is listed for low dissolved oxygen (DO), phosphorus, and fecal coliform impairments. The impaired designated uses for the subsegment are primary contact recreation (PCR) and secondary contact recreation (SCR), and fish and wildlife propagation (FWP). Additional impairments for mercury in fish tissue, nitrate+nitrite, and total dissolved solids were included on the state's 2008 section 303(d) list (*Final 2008 Integrated Report*) and will be covered in separate TMDL documents.

Table ES-1. Excerpt from *Draft 2010 Integrated Report*

Subsegment	Subsegment name	Designated use		
		primary contact recreation	secondary contact recreation	fish and wildlife propagation
040505	Ponchatoula Creek and Ponchatoula River	Not supporting	Not supporting	Not supporting

Source: LDEQ 2010a

A water quality model (LA-QUAL) was set up to simulate DO, carbonaceous biochemical oxygen demand (CBOD), ammonia nitrogen, and nitrate+nitrite. The model was calibrated using data from fieldwork conducted in August 2009. The projection simulation was conducted at critical flows and temperatures to address seasonality, as the Clean Water Act requires. Reductions of existing point source and nonpoint source loads were required for the projection simulation to meet the DO standard of 5 milligrams per liter (mg/L). In general, the modeling for this TMDL was consistent with guidance in the Louisiana TMDL technical procedures manual (LDEQ 2010b).

TMDLs for CBOD, ammonia, organic nitrogen, and sediment oxygen demand (SOD) were calculated using the projection simulation. In developing the TMDL, allowable loads from all pollutant sources that cumulatively amount to no more than the TMDL must be established, thereby providing the basis for establishing water quality-based controls. WLAs were assigned to permitted point source discharges, including regulated stormwater. The LAs include background loadings and human-induced nonpoint sources. A MOS of 10 percent and a FG component of 10 percent were also included.

This TMDL establishes load limitations for oxygen-demanding substances. The numeric DO water quality criterion for subsegment 040505 (5 mg/L) was used to calculate the total allowable load in summer and winter scenarios. Loadings from point sources needed to be reduced in the summer to meet DO criterion. Point sources loadings in the winter did not need to be reduced. Table ES-2 summarizes the TMDLs for subsegment 040505.

Table ES-2. Summary of TMDLs, WLAs, LAs, MOSs, and FGs

Season	Loadings (lb/d)							
Summer	SOD		$CBOD_u$		Ammonia as N		Organic N as N	
	Baseline	TMDL	Baseline	TMDL	Baseline	TMDL	Baseline	TMDL
WLA	641.2	351.4	1,099.6	327.7	41.46	12.45	49.39	14.77
LA	1,106.2	606.2	1,474.3	439.3	10.26	3.22	54.57	16.35
MOS	218.4	119.7	321.7	95.9	6.46	1.96	12.99	3.89
FG	218.4	119.7	321.7	95.9	6.46	1.96	12.99	3.89
TMDL	2,184.3	1,196.9	3,217.4	958.8	64.65	19.60	129.94	38.90
Percent reduction	45%		70%		70%		70%	
Season	Loadings (lb/d)							
Winter	SOD		$CBOD_u$		Ammonia as N		Organic N as N	
	Baseline	TMDL	Baseline	TMDL	Baseline	TMDL	Baseline	TMDL
WLA	328.5	328.5	1,209.3	1,209.3	43.03	43.03	60.11	60.11
LA	566.8	566.8	1,663.5	1,663.5	12.96	12.96	73.07	73.07
MOS	111.9	111.9	359.1	359.1	7.00	7.00	16.65	16.65
FG	111.9	111.9	359.1	359.1	7.00	7.00	16.65	16.65
TMDL	1,119.1	1,119.1	3,591.0	3,591.0	69.99	69.99	166.47	166.47
Percent reduction	0%		0%		0%		0%	

Implementing the DO TMDL through future wastewater discharge permits, if required, along with implementing best management practices (BMPs) to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources within the watershed, should reduce the nutrient loading from those sources.

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1. Introduction

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (at Title 40 of the *Code of Federal Regulations* [CFR] section 130.7) require TMDLs for waterbody-pollutant pairs apply to the approved 303(d) impaired waters list even if pollutant sources have implemented technology-based controls. A total maximum daily load (TMDL) is a calculation of the maximum allowable load (in mass per unit time) of a pollutant that a waterbody is able to assimilate while still supporting its designated uses. The maximum allowable load is determined on the basis of the relationship between pollutant sources and in-stream water quality. A TMDL provides the scientific basis for a state to establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA 1991).

The text of 40 CFR 130.7 has been affected by several Federal District Court suits, appeals rulings, and a Supreme Court ruling mandating that TMDL must be described in terms of mass per day. According to 40 CFR 130.7, if EPA does not approve a TMDL submitted by a state, EPA is responsible for developing a TMDL. In a District Court case regarding the TMDL program in Louisiana (*Sierra Club and Louisiana Environmental Action Network, Inc. v. EPA*, Civil Action Number: 96-0527), EPA was listed as the sole defendant. That case resulted in the April 1, 2002, consent decree approved by the judge. A consent decree is a negotiated set of actions to satisfy the plaintiff. In many situations, the actions are more stringent than the established regulation. For example, most consent decrees require an annual report to the plaintiff summarizing the work done in the year; that is not required by any regulation and will cease when the consent decree is closed.

The 2002 consent decree between EPA and the plaintiffs establishes a fixed set of waterbody-pollutant pairs for which TMDLs are to be established or approved, and it establishes a timeline for each set of TMDLs. Each set is determined to be complete when every waterbody-pollutant pair either has a TMDL established or approved, or a subsequent approved 303(d) list has removed the waterbody-pollutant pair. The TMDLs in this report are part of that consent decree. Because the original court suit was initiated because of a lack of progress in establishing TMDLs, the date when a TMDL is established or approved is not easy to extend, and an extension would require another agreement with the plaintiffs.

In most circumstances, a variety of scientifically acceptable methods can be used for developing a TMDL, wasteload allocation (WLA), and load allocation (LA). For these TMDLs, the LA-QUAL model was used. It should be noted that because some acceptable TMDL calculation methods appear simple, that does not imply their results are not valid. Models vary in the amount of necessary resources (e.g. training, setup/computational time, personnel, expense), required input and background data, questions answered, and output capability (e.g., charts, tables, data files). The final result of these TMDLs (and any TMDL) is a plan adopted into the Water Quality Management Plan (WQMP) to achieve the TMDL. Stakeholder involvement and additional information, such as monitoring data, might lead to an update of the WQMP and in turn a proposal for a different plan to meet water quality objectives. Such a WQMP update receives the same public participation as the original TMDL and WQMP review and approval.

For the TMDL discussed in this report, monitoring data collected by the Louisiana Department of Environmental Quality (LDEQ) indicate that observed dissolved oxygen (DO) levels sometimes do not meet the state's water quality criteria for Ponchatoula Creek and Ponchatoula River (subsegment 040505) within the Lake Pontchartrain Basin. The impaired designated uses for the subsegments are primary and secondary contact recreation, and fish and wildlife propagation. The subsegment is listed as not supporting the designated uses in Louisiana's 2010 section 303(d) list (as included in the *Draft 2010 Integrated Report*). The suspected cause of the DO impairment is *residential districts*.

Oxygen concentrations in bodies of water fluctuate naturally; however, depletion of DO can be caused by human activities or natural sources. Temperature and salinity also have an effect on DO. For example, during extended hot weather, the subsequent warmer water can result in fish kills from lower DO in the water column because of decreased gas solubility compared to cooler water (Scorecard 2005). Chemical reactions can generate a chemical oxygen demand on receiving waters and further lower DO. Human activities, such as lawn mowing and fertilizing, can contribute large amounts of biodegradable organic matter or nutrients through stormwater and, over time, lead to eutrophication (Scorecard 2005). Natural sources can also add organic material to a waterbody. Forests add leaves and woody debris, whereas wetlands have large algal masses that can be carried over into the waterbody. In streams with significant amounts of organic matter, bacterial degradation can result in a net reduction of oxygen in the water column.

Other factors that affect DO concentrations include the following (Murphy 2005):

- Volume and velocity of water flowing in the waterbody
- Climate and season
- The type and number of organisms in the waterbody
- Altitude
- Dissolved or suspended solids
- Amount of nutrients in the water
- Organic waste
- Riparian vegetation
- Groundwater inflow.

2. Background Information

2.1 General Description

The Lake Pontchartrain Basin is in southeastern Louisiana and is primarily comprised of the rivers and bayous that drain into Lake Pontchartrain. The basin is bordered by the Pearl River Basin to the east, by Breton and Chandeleur Sound to the southeast, and by the Mississippi River Levee to the south and west. The northern portion of the Lake Pontchartrain Basin consists of forests, pines and hardwoods, pastures, and dairies. The southern portion consists of cypress-tupelo swamps and lowlands, and brackish and saline marshes. Elevations within the basin range from minus 5 feet at New Orleans to greater than 200 feet near the Mississippi River (LDEQ 2010c). Subsegment 040505 (Ponchatoula Creek and Ponchatoula River) is in Tangipahoa Parish and encompasses 56.6 square miles (146.6 square kilometers) (Figure 2-1).

Ponchatoula Creek and Yellow Water River are tributary streams that combine to form the Ponchatoula River. The Ponchatoula River flows south to the Natalbany River, which is the largest tributary of the Tickfaw River. The surface waters in the Tickfaw River watershed are characterized by low dissolved salt contents, which increase near Lake Pontchartrain due to mixing with the brackish waters (Bourgeois-Calvin 2008).

2.2 Land Use

Land use data were obtained from the 2006 U.S. Geological Survey (USGS) National Land Cover Dataset (NLCD) (Table 2-1 and Figure 2-2). The predominant land use within subsegment 040505 is developed land (33.2 percent), followed by wetlands (31.2 percent), forest (14 percent), grassland/shrub (10 percent), and pasture/hay (9.5 percent). Other land uses within subsegment 040505 take up only about 2 percent of its total area.

Table 2-1. Land uses percentages for subsegment 040505

Land use	Percent of total area
Water	0.9%
Developed	33.2%
Barren	0.6%
Forest	14.0%
Grassland/shrub	10.0%
Pasture/hay	9.5%
Cultivated crops	0.6%
Wetlands	31.2%
TOTAL	100.00%

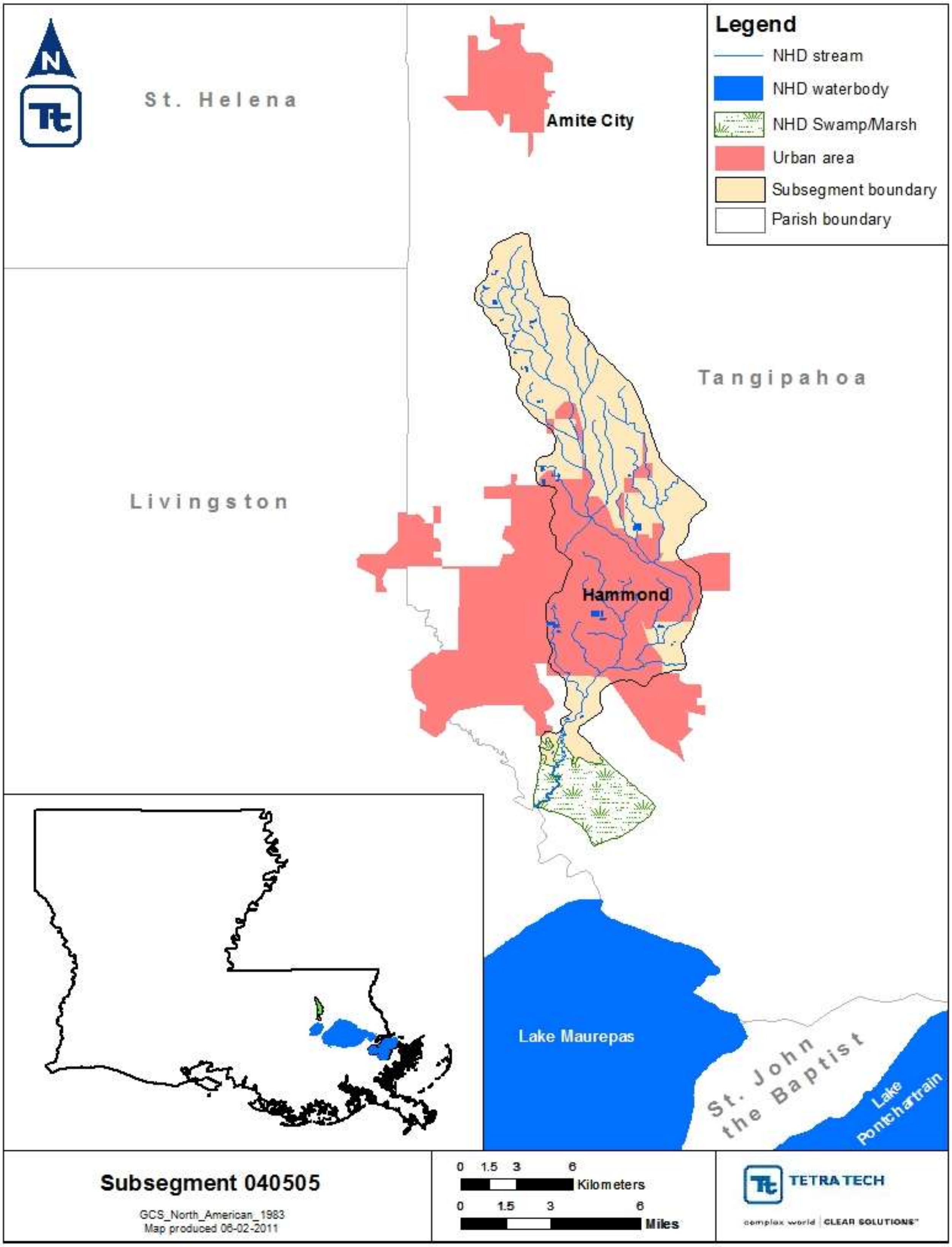

Figure 2-1. Location of subsegment 040505.

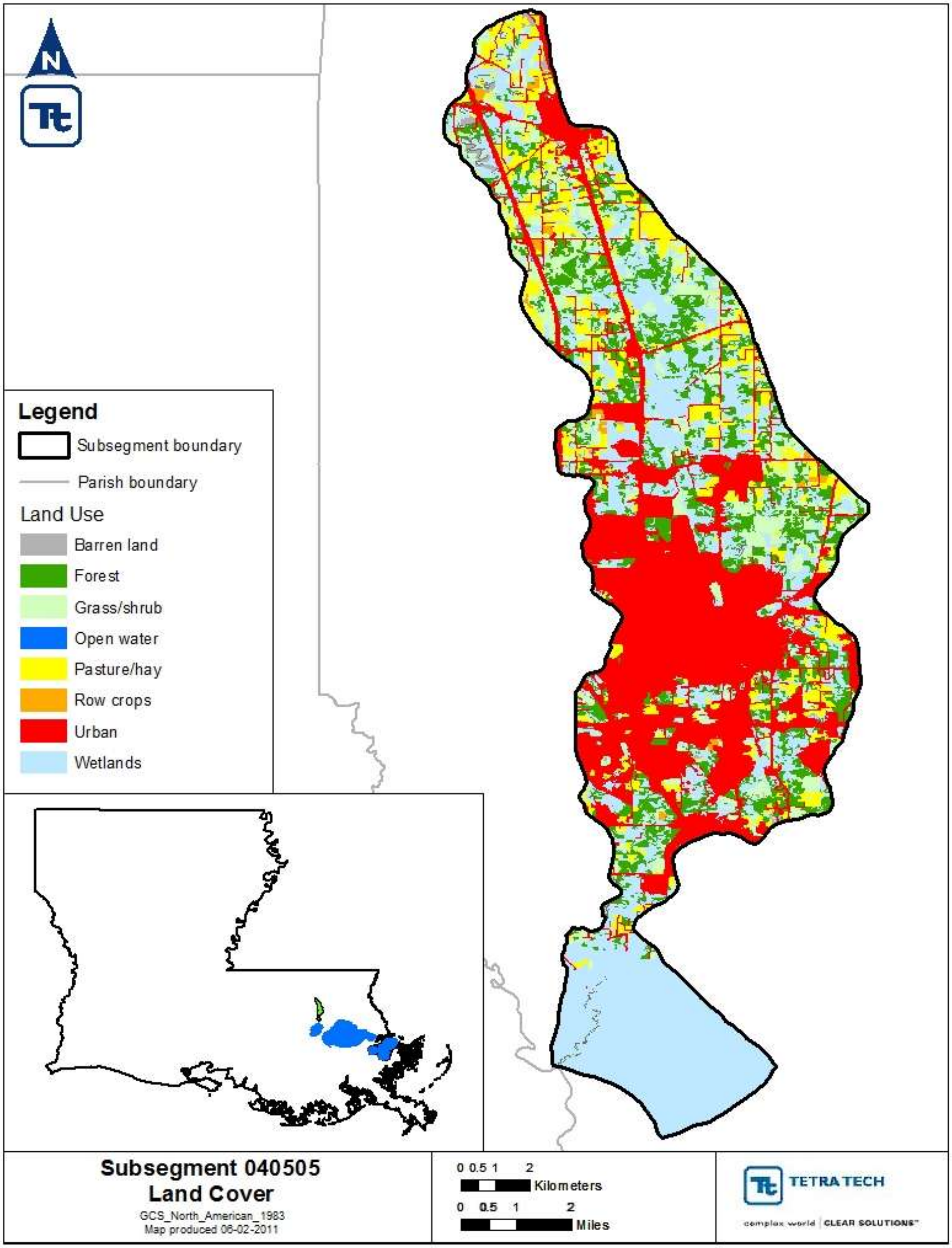

Figure 2-2. Land use in subsegment 040505.

2.3 Hydrologic Setting

Ponchatoula Creek lies between the Natalbany and Tangipahoa Rivers and north of Hammond, LA. The creek has undergone several modifications. The first modification—channel straightening and excavation—occurred in the 1920s or early 1930s. Prior to the 1950s, the area drained east of Hammond to the Natalbany River; however, in the early 1950s, a flood diversion canal (Yellow Water River Canal) was created northwest of Hammond to connect Ponchatoula Creek with the headwaters of the Yellow Water River. This canal was to divert 70 percent of the high water flow of Ponchatoula Creek westward through the canal to decrease flooding in the area around Hammond. As a result of the low lying earthen dam, 100 percent of the northern portion of Ponchatoula Creek flows through the canal to Yellow Water River during low flow (Shaw Environmental, Inc. 2004). Also in the 1950s, the creek was dredged and excavated upstream of US Highway 51. In 1981, Ponchatoula Creek was rehabilitated from Lake Maurepas to Highway 22. In 1983, Ponchatoula Creek was rehabilitated farther upstream to Highway 190 east of Hammond. In 1985, Ponchatoula Creek was rehabilitated from Highway 190 to the Independence area (Forbes 1998).

The USGS online hydrology database (NWISWeb) includes seven gages for subsegment 040505, which is impaired for DO (Table 2-2). None of these stations furnishes current flow information. Flow in Ponchatoula Creek and the Yellow Water River is believed to be tidal south of US 61 (Max Forbes, LDEQ, personal communication, May 31, 2011).

Table 2-2. USGS gage information for subsegment 040505

Station number	Station location
07376600	Ponchatoula Creek at Natalbany, LA
07376602	Ponchatoula Creek East of Natalbany, LA
07376610	Ponchatoula Creek East of Hammond, LA
07376614	Ponchatoula Creek North of Ponchatoula, LA
07376615	Ponchatoula Creek South of Hammond, LA
07376620	Yellow Water River Canal Near Hammond, LA
07376630	Ponchatoula Creek near Wadesboro, LA

2.4 Designated Uses and Water Quality Criteria

Louisiana's 2010 section 303(d) list (as included in the *Draft 2010 Integrated Report*) indicates that designated uses of the subsegment are primary contact recreation (PCR) and secondary contact recreation (SCR), and fish and wildlife propagation (FWP). PCR includes any recreational or other water contact involving full-body exposure to water and a considerable probability of ingesting water. Examples of this use are swimming and water skiing. SCR involves activities like fishing, wading, or boating, whereby water contact is accidental or incidental, and the chance of ingesting appreciable amounts of water is minimal. FWP includes use of water for aquatic habitat, food, resting, reproduction, cover, or travel corridors by any indigenous wildlife and aquatic life species associated with the aquatic environment.

The assessment methodology presented in LDEQ's 305(b) report (LDEQ 2010a) specifies that PCR, SCR, and FWP uses are to be fully supported. The DO criterion for this subsegment is 5 milligrams per liter (mg/L) year-round.

The Louisiana water quality standards also include an antidegradation policy (*Louisiana Administrative Code* [LAC] Title 33, Part IX, Section 1109.A), which specifies that state waters exhibiting high water quality should be maintained at that high level of water quality. If that is not possible, water quality at a level that supports the designated uses of the waterbody should be maintained. The designated uses of a waterbody may be changed to allow a lower level of water quality only through a use attainability study.

2.5 Identification of Sources

2.5.1 Point Sources

LDEQ stores permit information using internal databases. LDEQ generated a list of point source discharges within the subsegment by using the TEMPO database. Information on point source discharges to the listed subsegments was obtained from the Integrated Compliance Information System - National Pollutant Discharge Elimination System (ICIS-NPDES) and Louisiana's Electronic Document Management System (EDMS). Data were pulled from ICIS for the list of permits generated by LDEQ, and those data were confirmed through EDMS. Subsegment 040505 contains 121 permitted point source discharges (Figure 2-3). Because of the large number of permits, they are listed in Appendix A. Each facility was evaluated on the basis of its discharges and permit limits to determine whether the facility should be used in developing the TMDLs (Section 4.9).

Phase I and II stormwater systems are additional possible point source contributors in the Lake Pontchartrain Basin. Stormwater discharges are generated by runoff from urban land and impervious areas such as paved streets, parking lots, and rooftops during precipitation events. These discharges often contain high concentrations of pollutants that can eventually enter nearby waterbodies. Most stormwater discharges are considered point sources and require coverage by a National Pollutant Discharge Elimination System (NPDES) permit.

Under the NPDES stormwater program, operators of large, medium, and regulated small municipal separate storm sewer systems (MS4s) must obtain authorization to discharge pollutants. The Stormwater Phase I Rule (55 *Federal Register* 47990, November 16, 1990) requires all operators of medium and large MS4s to obtain an NPDES permit and develop a stormwater management program. Medium and large MS4s are defined by the size of the population within the MS4 area, not including the population served by combined sewer systems. A medium MS4 has a population between 100,000 and 249,999; a large MS4 has a population of 250,000 or more.

Phase II requires a select subset of small MS4s to obtain an NPDES stormwater permit. A small MS4 is any MS4 not already covered by the Phase I program as a medium or large MS4. The Phase II rule automatically covers all small MS4s in urbanized areas (UAs), as defined by the Bureau of the Census, and also includes small MS4s outside an UA that are so designated by NPDES permitting authorities, case by case (USEPA 2000).

In Louisiana, there are two ways that an MS4 can be identified as a regulated, small MS4. This category includes all cities within UAs and any small MS4 area outside UAs with a population of at least 10,000 and a population density of at least 1,000 people per square mile (LDEQ 2002). In subsegment 040505, there is one Phase II (small) MS4—City of Hammond (Table 2-3). The urban area of the MS4 covers 20.8 square miles of subsegment 040505.

Table 2-3. MS4 information for subsegment 040505

Agency interest (AI) #	Permit #	Facility name	Expiration date	Receiving waterbodies
104053	LAR041030	Hammond, City of - Municipal Separate Storm Sewer System MS4	12/4/12	Ponchatoula Creek and Ponchatoula River

2.5.2 Nonpoint Sources

Louisiana's section 303(d) list identifies the suspected cause of the DO impairment within subsegment 040505 of the Lake Pontchartrain Basin as *residential districts*. Areas where zoning laws may limit high-density building or commercial centers, but where residential housing is located, can still include significant amounts of impervious surfaces. During urbanization, pervious spaces (including vegetated and open forest areas) are converted to land uses that usually increase areas of impervious surface, resulting in increased runoff volumes and pollutant loadings. As impervious area increases, changes to the natural hydrology of an area are inevitable. Most problematic are greatly increased runoff volumes and velocity, as well as increased frequency and severity of flooding. Urban development also increases pollutant loadings including sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, pathogenic bacteria, and viruses (USEPA 1992).

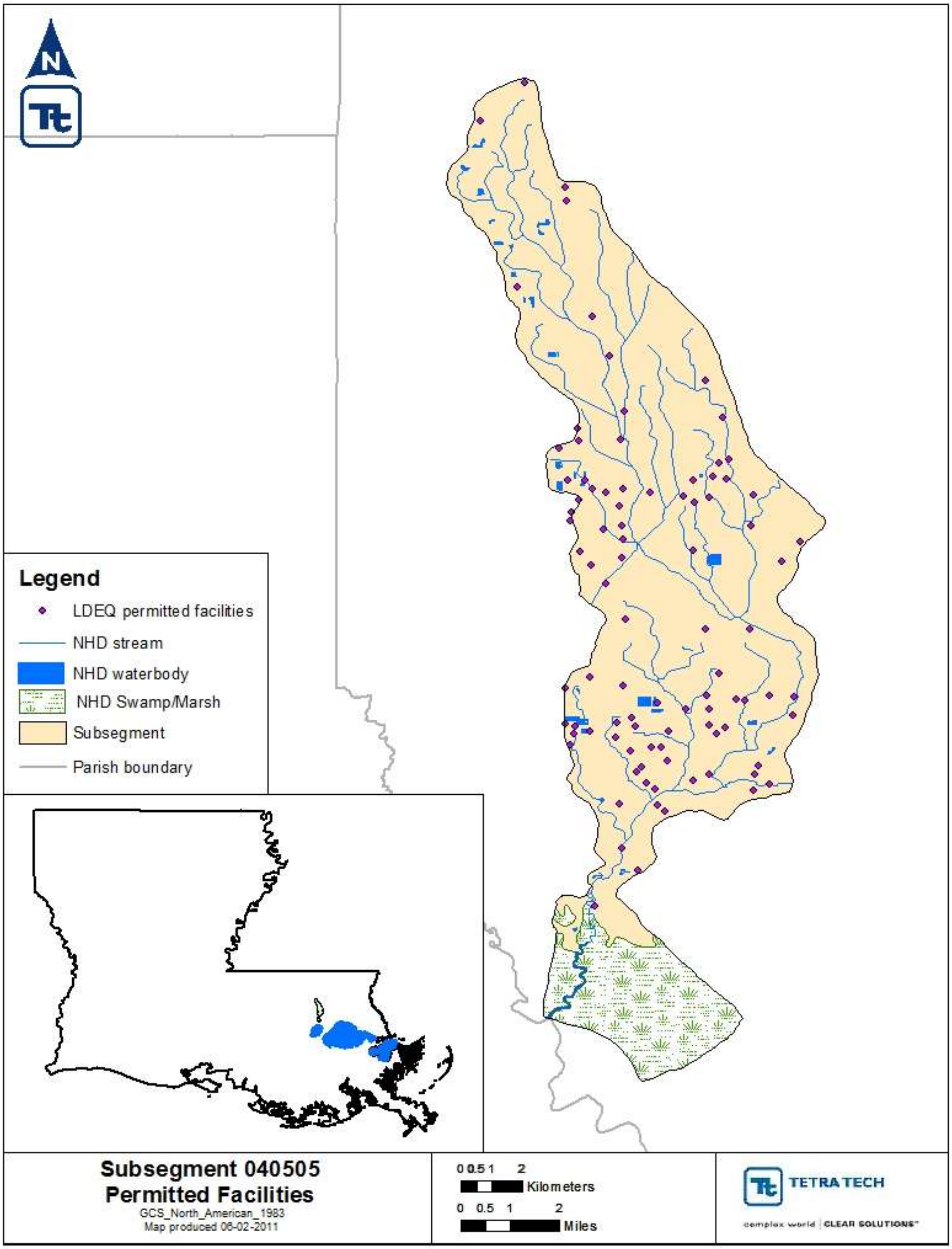

Figure 2-3. Permitted facilities within subsegment 040505 of the Lake Pontchartrain Basin.

3. Characterization of Existing Water Quality

3.1 Water Quality Data

Water quality data were obtained from LDEQ's routine ambient water quality monitoring program. Additional environmental data were obtained from a monitoring event conducted by FTN Associates (FTN) from August 5 through August 8, 2009. Figure 3-1 shows the locations of the LDEQ and FTN sampling sites. Data obtained during the 2009 field study included in situ measurements of temperature, DO, pH, specific conductivity, and Secchi depth, in addition to sampling data for total phosphorus (TP), ortho-phosphorus (OP), chlorophyll *a*, total suspended solids (TSS), ammonia nitrogen, total Kjeldahl nitrogen (TKN), nitrate plus nitrite nitrogen (NO_3+NO_2), total organic carbon (TOC), and carbonaceous biochemical oxygen demand (CBOD) time series, which used a nitrogen suppressant. The CBOD time-series data were obtained on days 2, 5, 9, 14, 20, and 27 of the analysis. Tables B-1 through B-7 in Appendix B summarize the water quality data for the section 303(d)-listed constituents, along with additional constituents used in the TMDL development process. Appendix B contains summaries of the DO and nutrient data. Appendix C presents the Field Survey Notes.

Measured water temperatures were all above 25 degrees Celsius (°C), with a median value of 29.8°C for all 35 sites. These temperatures are considered representative of summer critical conditions for DO TMDL development.

Additional water quality data were obtained as part of a University of New Orleans graduate project and dissertation (Bourgeois-Calvin 2008). Data (provided by Andrea Bourgeois-Calvin of the Lake Pontchartrain Basin Foundation) were collected generally monthly between June 2006 and March 2010 at four locations along Ponchatoula Creek (Figure 3-1). Eighty-five (22 percent) of the DO concentration measurements were below the 5 mg/L water quality criterion (Table B-5, Appendix B).

3.2 Comparison of Obtained Data to Criteria

Table B-1 in Appendix B summarizes the August 2009 DO data for eight stations within subsegment 040505. One observation is listed for each station. One of the eight stations indicated DO levels below the water quality criterion of 5 mg/L. This station is at the outfall of the Village of Tickfaw wastewater treatment plant (WWTP). Figures B-1 and B-2 in Appendix B show the LDEQ DO and other continuous monitoring data obtained at stations PON-4 (Ponchatoula Creek at LA Hwy 190) and PON-9 (Ponchatoula Creek at LA Hwy 22).

Table B-4 in Appendix B summarizes 35 DO observations at LDEQ station 1112 (Ponchatoula Creek at Hwy. 22). Twenty-five (71 percent) of the DO concentration measurements were below the 5 mg/L water quality criterion. Figures 3-2 and 3-3 show the DO data obtained at station 1112 plotted over time and season. As expected, DO levels were lower during the hotter summer months.

Louisiana does not have numeric nutrient criteria. The original nutrient impairment for this waterbody was not based on a quantitative assessment of historical nutrient data. The impairment was based on an evaluative assessment that might have included DO. LDEQ and EPA plan to reevaluate the previous nutrient impairments for this waterbody. As a result, both EPA and LDEQ expect the nutrient impairment to change from category 5 (impairment exists; TMDL required) to category 3 (insufficient data) for the 2010 Integrated Report. A TMDL for DO should adequately address any potential nutrient impairment, in the absence of numeric nutrient criteria and a quantitative assessment.

LDEQ is developing numeric nutrient criteria for waterbody types on the basis of ecoregions in accordance with LDEQ's plan *Developing Nutrient Criteria for Louisiana 2006.*[1] Waterbody types for nutrient criteria

[1] http://www.deq.louisiana.gov/portal/Portals/0/planning/LA%20Nutrient%20Strategy%20Plan%20Final%20FOR%20WEB.pdf. Accessed January 11, 2011.

development in Louisiana are (1) inland rivers and streams; (2) freshwater wetlands; (3) freshwater lakes and reservoirs; (4) big rivers and floodplains/boundary rivers and associated water bodies; and 5() estuarine and coastal waters, including up to Louisiana's 3-mile boundary in the Gulf of Mexico. Proposed approaches for nutrient criteria development are under review by LDEQ and EPA. Nutrient criteria can be implemented upon state promulgation and EPA approval per 40 CFR 131.21.

After nutrient criteria have been developed, a subsequent quantitative assessment of the waterbodies, and the development of full nutrient models, nutrient limits may be established for all facilities discharging to impaired waterbodies in Lake Pontchartrain Basin. LDEQ recommends that all facilities discharging to this subsegment take a proactive approach and prepare to receive nutrient limitations in the near future. Such a proactive approach should include nutrient monitoring and documentation through facility Discharge Monitoring Reports (DMRs) to assess their nutrient loads and the need to modify their treatment processes for nutrient removal.

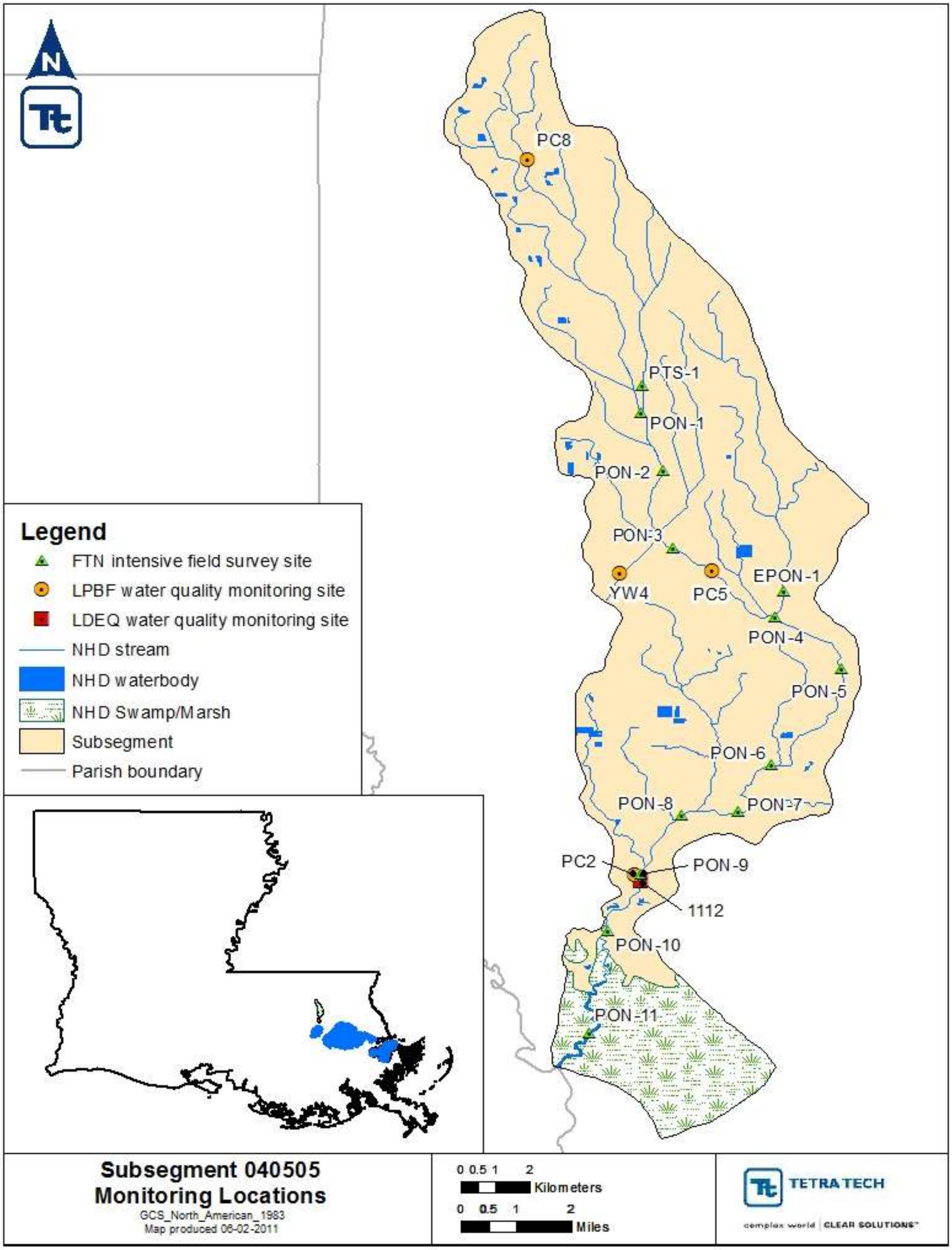

Figure 3-1. Monitoring locations within subsegment 040505 of the Lake Pontchartrain Basin.

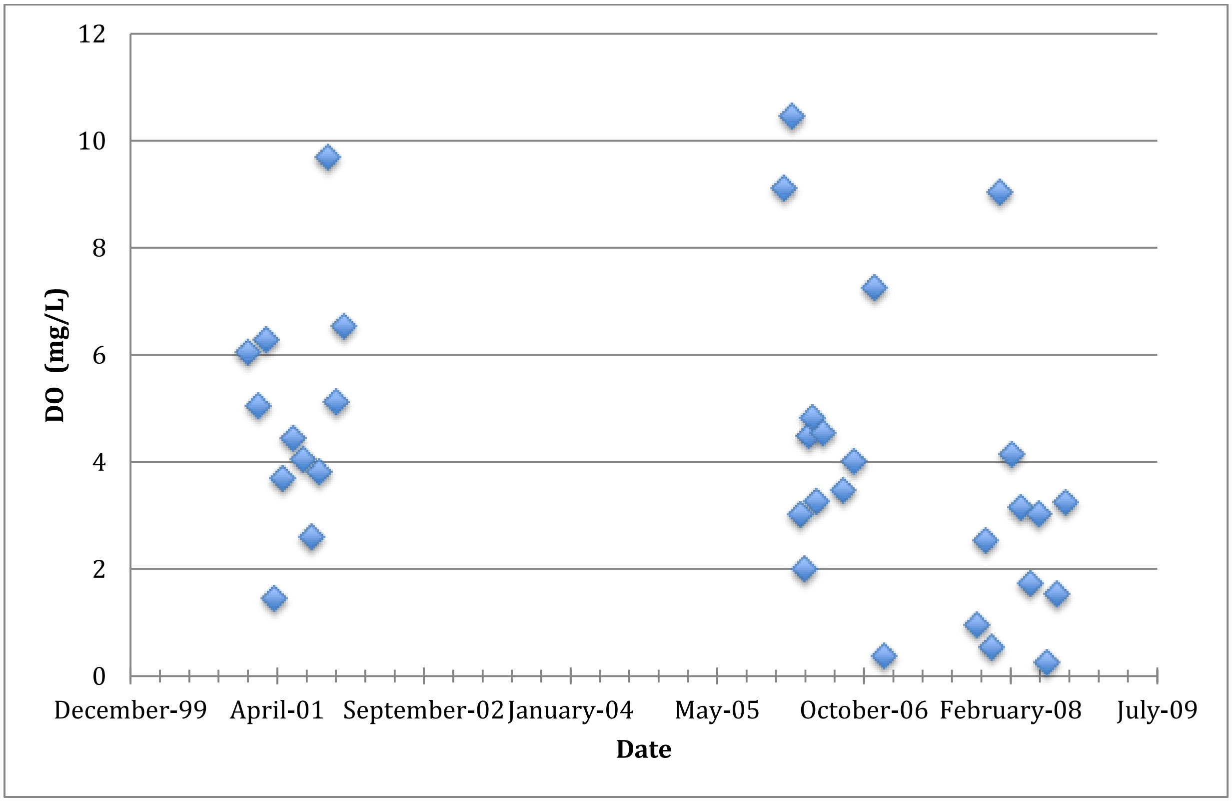

Figure 3-2. DO concentrations over time at station 1112.

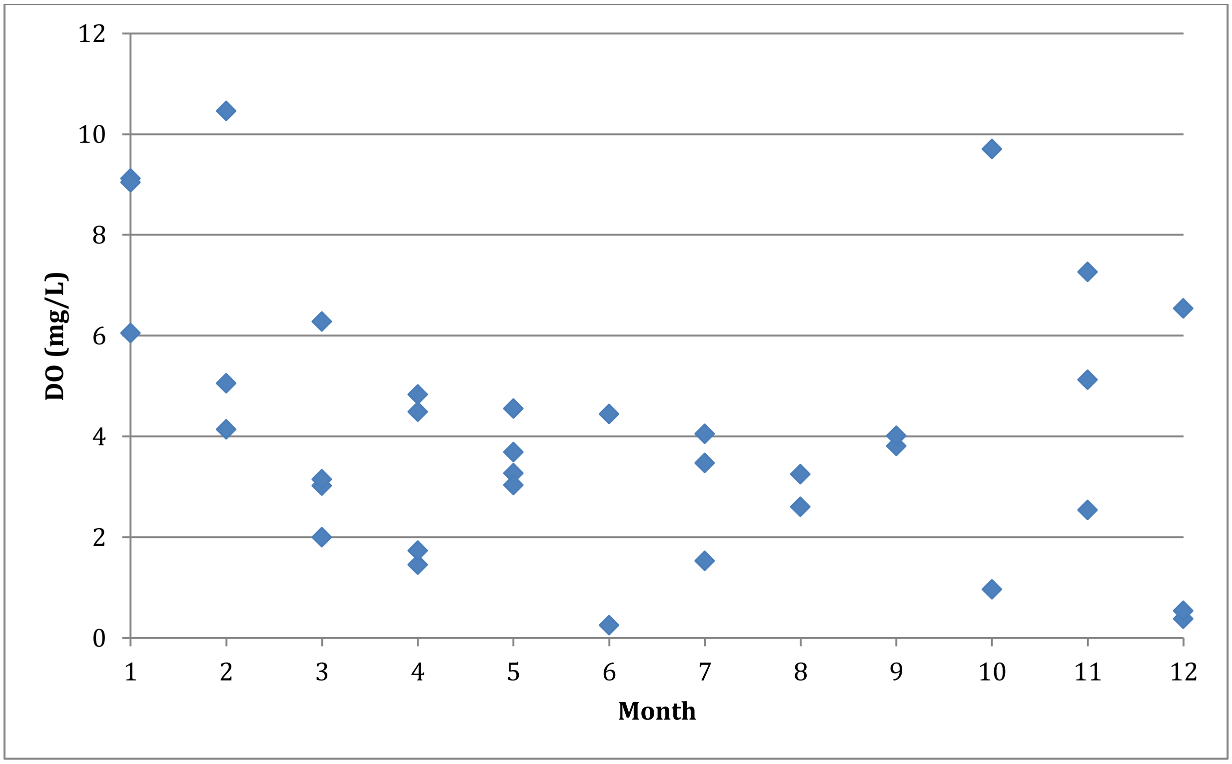

Figure 3-3. Seasonal DO concentrations at station 1112.

4. Model Setup and Calibration

4.1 Model Setup

LA-QUAL (Version 9.05) was chosen to simulate DO in the TMDL for subsegments 040505. LA-QUAL is a steady-state model that LDEQ developed based on the QUAL-TX (Version 3.4) model. Several modifications were made to the QUAL-TX model, including the addition of new aeration equations that better represent conditions in Louisiana. LA-QUAL evaluates the relationships between pollutant sources and water quality. Model configuration involved setting up the model segments and setting initial conditions, boundary conditions, and hydraulic and kinetic parameters. This section describes the configuration and key components of the model.

Only the main stems of the systems were explicitly simulated and thus segmented for modeling purposes. Segmentation refers to separating a waterbody into smaller computational units. Segmentation occurred around major hydrological features such as tributaries. Tributaries were represented through boundary condition designation. Appendix D includes a diagram of the model segmentations and stream kilometers.

Important during modeling is consideration of which factors contribute most to the DO depletion in Ponchatoula Creek and Ponchatoula River. In general, CBOD, ammonia, and sediment oxygen demand (SOD) reduce water column DO, and algae can cause a strong DO swing. During the August 2009 sampling period, no strong swing of DO was observed, indicating that DO depletion during that period was not caused directly by algae. It is reasonable to assume that SOD and CBOD were the major causes of DO depletion. In addition to SOD and CBOD, the ammonia level in Ponchatoula Creek is high, and nitrification also consumes DO. DO concentrations determined in previous years had been below the 5 mg/L water quality criterion, as shown in Figures 3-2 and 3-3. However, no flow data or other data had been obtained.

4.2 Model Options (Data Type 2)

Data type 2 is used to identify the parameters modeled to achieve calibration. For this TMDL, DO, CBOD, conductivity, and a nitrogen series (ammonia nitrogen and nitrate+nitrite) were the parameters being modeled.

4.3 Program Constants (Data Type 3)

LA-QUAL is programmed with certain default program parameters, including those for tidal variability. Data type 3 is used to override the default parameters and is optional; that is, values must be entered only if values other than the default values are desired. Default values were used for all program parameters except for those listed in Table 4-1. For descriptions of the parameters and their default values, see the LA-QUAL user manual (Wiland Consulting, Inc. 2010).

Table 4-1. Water quality kinetics rates

Program constant	Value
Hydraulic calculation method	2
Inhibition control value	0
Ocean exchange ratio	0.5
Tidal height (meters)	0.07
Tidal period (hours)	12
Period of tidal rise (hours)	6

4.4 Temperature Correction of Kinetics (Data Type 4)

Data type 4 includes factors used for temperature correction in rate equations. The temperature correction factors used in the model were consistent with the *Standard Operating Procedure for Louisiana TMDL Technical Procedures* (LTP) when these factors were available (LDEQ 2010b). Default values were used for all factors. For descriptions of the factors and their default values, see the LA-QUAL user manual (Wiland Consulting, Inc. 2010).

4.5 Hydraulics and Dispersion (Data Types 9 and 10)

Data types 9 and 10 describe the hydraulic and dispersion characteristics of the model reaches. The stream hydraulics were specified in the input file for the model using the following power functions:

$$width = a \times Qb + c$$
$$depth = d \times Qe + f$$

where

a =	width coefficient	=	0.0
b =	width exponent	=	0.0
c =	width constant	=	average width of segment
d =	depth coefficient	=	estimated – see text below
e =	depth exponent	=	estimated – see text below
f =	depth constant	=	0.0

Width and depth data for each segment were measured in August 2009 (Table 4-2).

Table 4-2. Average channel widths and depths for each model segment

Model reach	Width (m)	Depth (m)
1	2.74	0.500
2	0.91	0.152
3	3.35	0.183
4	3.08	0.450
5	3.87	0.396
6	3.20	0.150
7	5.18	0.610
8	18.29	0.500
9	51.82	1.600

While the measured width was used in LA-QUAL, the modeled depth was assumed to vary on the basis of flow. The following describes the methodology for estimating the depth-flow rating curve coefficients, variables *d* and *e*. Slight adjustments were made for some reaches to better simulate observed hydrology and water quality.

Because no active USGS flow-monitoring gages are in subsegment 040505, data from a nearby USGS gage (07376500) were used to estimate the depth-flow relationship (Figure 4-1). USGS gage 07376500 was chosen because of its proximity to subsegment 040505 and is in a similar watershed. The gage also has a long period of record available that includes measured flow and depth data. Figure 4-2 depicts the flow-depth relationship. Measured flow values were plotted against corresponding depth values (red points) and then fitted with a power function (blue line). Although depth-flow points appear to have a strong correlation, the power function is able to represent the data at only low-flow/depth values up to approximately 1,000 cubic feet per second (cfs) or 8 feet depth, which is the range of this system during low flow.

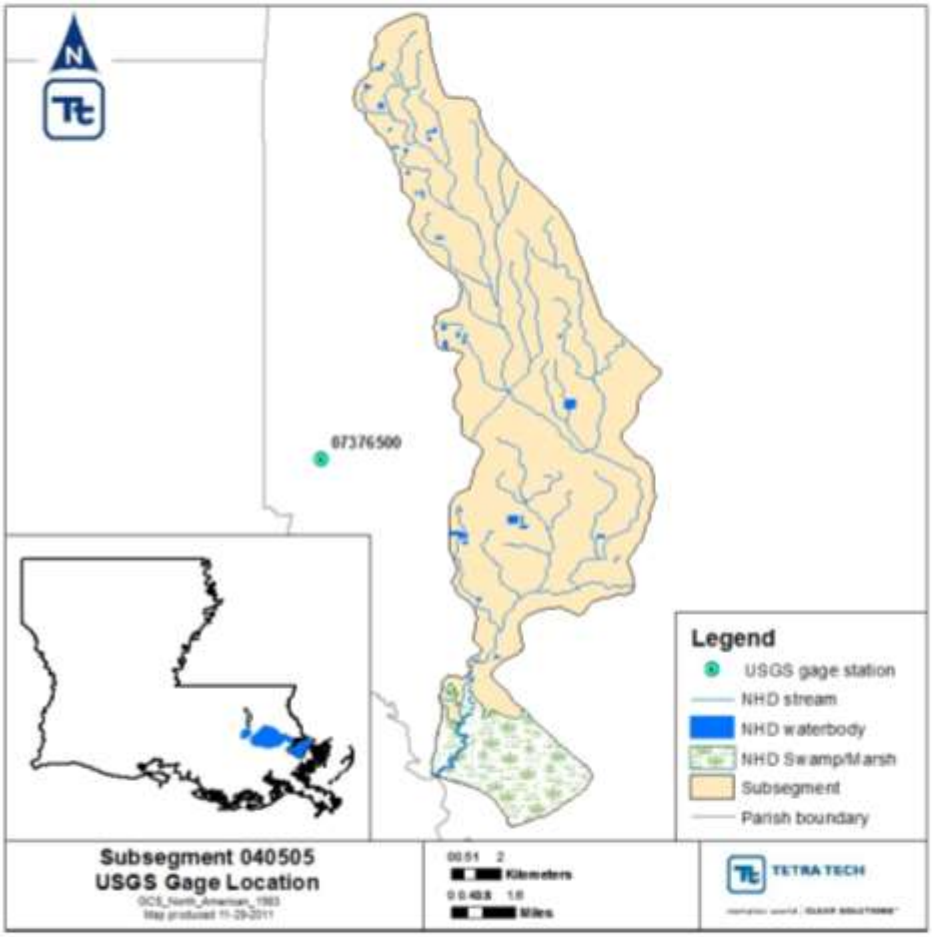

Figure 4-1. USGS gaging stations.

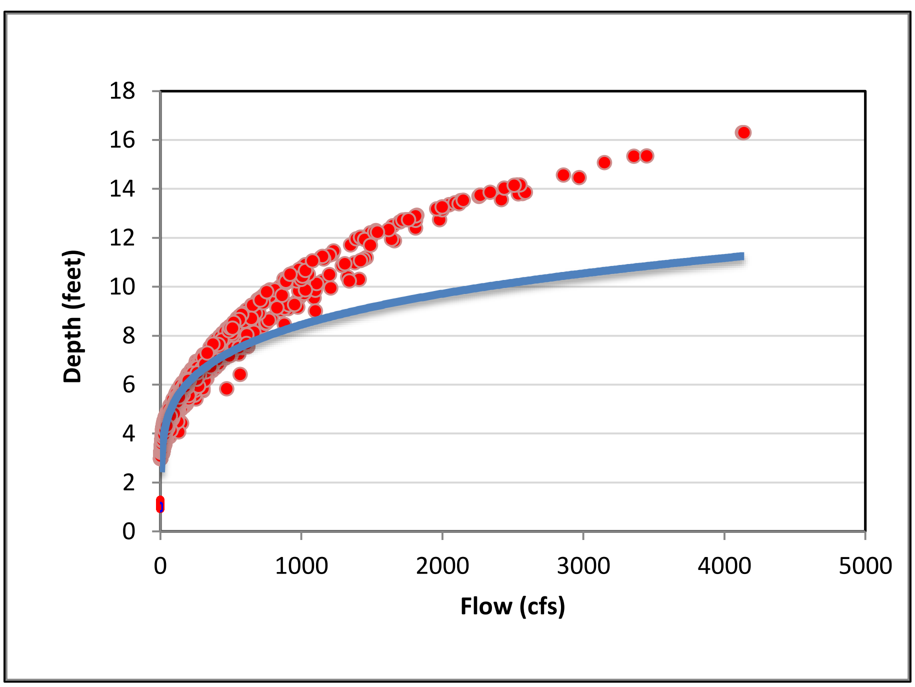

Figure 4-2. Flow versus depth at USGS gage 07376500.

The LA-QUAL model for subsegment 040505 was developed and calibrated for low-flow periods. For this TMDL, the critical condition was set for flows less than 35 cfs (1.0 cms) to account for baseline and TMDL conditions within subsegment 040505. The reduced data set of depth and flow measurements are plotted in Figure 4-3. The power function that best represents the relationship between depth and flow was determined to be $D = 1.2296Q^{0.1277}$ (blue line) with an R^2 value of 0.73. In this scenario, the R^2 value is the variation in depth accounted for by flow, with the remaining variation unexplained.

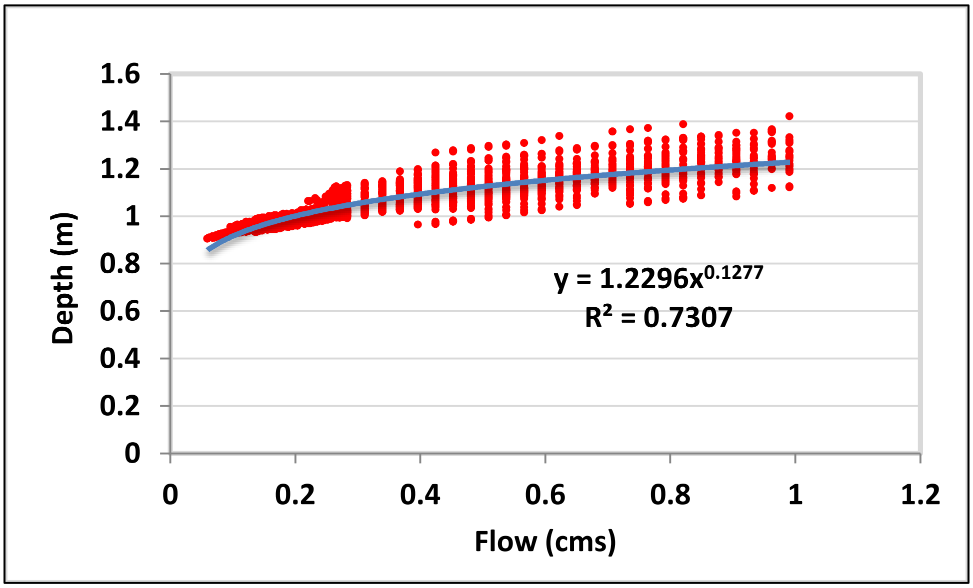

Figure 4-3. Flow versus depth at USGS gage 07376500 for flows below 1.0 cms (35 cfs).

For this gage, the rating curve formula for depth and flow is $D = 1.2296Q^{0.1277}$. Therefore, coefficient *d* is 1.2296, coefficient *e* is 0.1277, and the depth constant is 0. In the rating curve formula, coefficient *e* governs the shape of the rating curve as shown in Figure 4-4. Coefficient *d* determines the magnitude of the depth as shown in Figure 4-5. It is assumed that coefficient *e* does not change for different reaches in the tributaries, and the main Ponchatoula Creek and coefficient *d* varies for different reaches depending on the actual channel geometry. With that assumption and the existing flow and depths in the reaches, the individual coefficient *d* is determined iteratively. The coefficient *d* was adjusted using the difference of the depth calculated from the rating curve formula and the measured depth until they agree, as shown in Table 4-3. The values for coefficient *d* and coefficient *e* were used in the model.

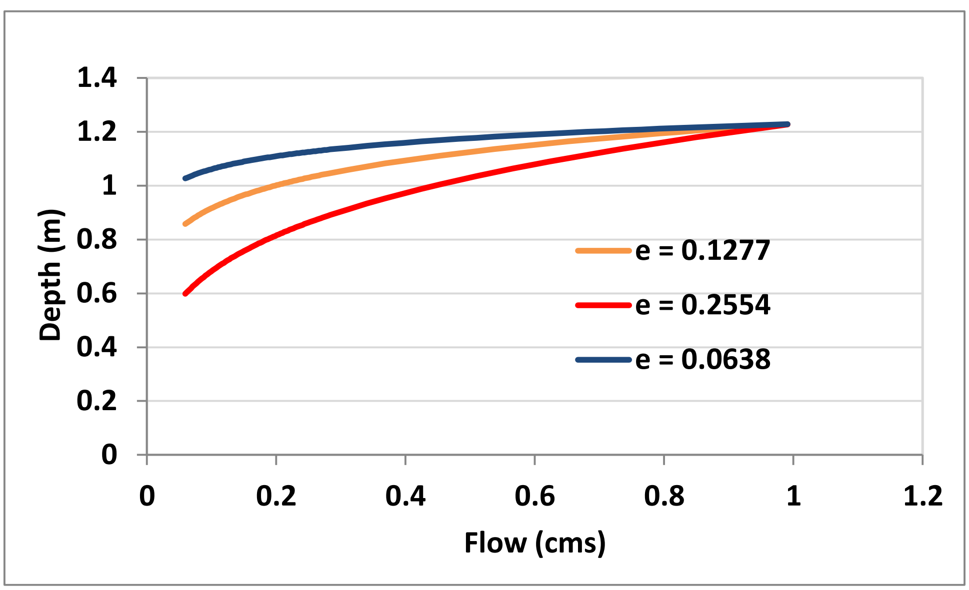

Figure 4-4. The effect of coefficient *e* in the depth-flow rating curve formula.

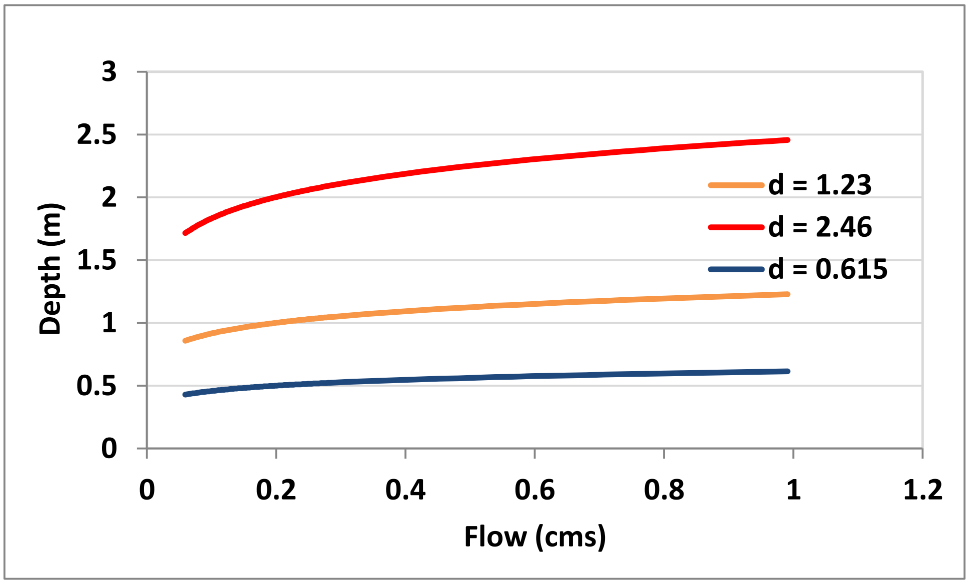

Figure 4-5. The effect of coefficient *d* in the depth-flow rating curve formula.

Table 4-3. Estimated coefficient *d* for each reach

Reach	Flow (cms)	Measured depth (m)	Coefficient *d*	Coefficient e	Estimated depth (m)
1	0.058	0.500	0.720	0.1277	0.501
2	0.0038	0.152	0.310	0.1277	0.152
3	0.076	0.183	0.253	0.1277	0.182
4	0.0395	0.450	0.680	0.1277	0.450
5	0.0389	0.396	0.600	0.1277	0.396
6	0.3473	0.150	0.170	0.1277	0.149
7	0.4443	0.610	0.675	0.1277	0.609
8	0.6586	0.500	0.527	0.1277	0.500
9	0.739	1.600	1.663	0.1277	1.600

4.6 Initial Conditions (Data Type 11)

Initial conditions were set for temperature, DO, nitrate+nitrite, and chlorophyll *a* using obtained water quality data, while ammonia data were set to a constant. Because LA-QUAL is a steady-state model, the initial conditions affect only the number of iterations needed to reach steady-state conditions. Setting initial conditions on the basis of observed data reduces the number of iterations the model must perform to reach a steady state.

Salinity, nitrate+nitrite, phosphorus, phytoplankton, and macrophytes were the parameters not simulated in the model. Their initial conditions were set to zero so that the model would not assume a fixed concentration and include their effects.

4.7 Water Quality Kinetics (Data Types 12 and 13)

Several kinetic rates, including reaeration, SOD, CBOD decay, nitrification, and mineralization (organic nitrogen decay) rates were used in the model. Data types 12 and 13 focus on different rates used by the model. Data type 12 is needed only if BOD or DO is being simulated; data type 13 is needed only if nitrogen or phosphorus is being simulated. For this TMDL, both data types were included.

The model calculates the reaeration rate by using one of a standard set of equations. For this TMDL, the Louisiana and Churchill-Elmore-Buckingham equations were used. The Louisiana equation is applicable to moderately deep to deep channels (0.3 to 3.0 feet, with flow between 0.02 and 0.8 feet per second). The Louisiana equation is

$$K_2 = \frac{0.664 \times (1 + 21.52V)}{D}$$

where

V = stream velocity (meters per second)
D = stream depth (meters)

The Churchill-Elmore-Buckingham is applicable to moderately deep to deep channels (2 to 11 feet with flow between 1.8 and 5 feet per second). The equation is

$$K_2 = \frac{5.026 \times V^{0.969}}{D^{1.673}}$$

where

V = stream velocity (meters per second)
D = stream depth (meters)

These values are provided in Appendix E as part of the output file results. Table 4-4 summarizes the water quality kinetics rates. The CBOD decay rates based on the measured $CBOD_3$, $CBOD_5$, $CBOD_{12}$, $CBOD_{20}$, and $CBOD_{25}$ data were used as reference decay rates. Those decay rates were based on measurements under laboratory conditions, and could differ from decay rates under actual stream conditions. Therefore, adjustments were made to better simulate observed water quality. The SOD was calibrated in the model and varied per subsegment reach. SOD was calibrated after the CBOD levels had been finalized. SOD rates changed iteratively until modeled DO concentrations agreed well with measured water column DO concentrations.

Table 4-4. Water quality kinetics rates

Program constant	Value range
Background SOD (g/m^2/d)	0.0–2.3
CBOD #1 decay rate (aerobic) (1/d)	0.03–0.05
CBOD settling rate (1/d)	0.01
Ammonia decay rate (1/d)	0.18
Denitrification rate (1/d)	0.10

4.8 Headwater Flow, Water Quality, and Junction Data (Data Types 20, 21, 22, and 23)

Data types 20, 21, 22, and 23 account for flow and water quality from upstream of the modeled subsegment. Headwater flow and water quality data were derived from monitoring data. In general, the flow measured at the most upstream station was regarded as the headwater flow. Water quality data (mainly $CBOD_u$ and DO) were estimated from the monitoring data obtained from the most upstream stations.

4.9 Wasteload Flow and Water Quality Data (Data Types 24, 25, and 26)

Data types 24, 25, and 26 account for flow and water quality from point sources discharging into the listed waterbodies. The model included 13 permitted outflows, plus 65 permitted sources that were combined because of location or lack of discharge pathway information. Also, one withdraw (Yellow River Water Canal) and one tributary (Yellow Water River) were included as input in these data types. The inputs and their associated flows and concentrations are listed in Table 4-5. Data from withdraw and tributary were developed from obtained data.

Design flows were used as the flows when DMR flows were not available. DO was set to either 2.0 of 5.0 for point sources, depending on the assumed level of treatment using the BOD_5 limits. For large dischargers (> 10,000 cfs), DMR BOD_5 concentrations from August 2009, if available, were converted to $CBOD_u$ by assuming that BOD_5 was approximately equal to $CBOD_5$ and then using a conversion factor of 2.3 to convert to $CBOD_u$. If no DMR data were available for smaller dischargers, permitted BOD_5 concentrations were used. Nitrogen concentrations were assumed at half the amount required by the oxygen demand, with two-thirds assumed to be ammonia loading and one-third to be organic nitrogen loading. Nitrate+nitrite concentrations were assumed. When point sources were combined, flow-weighted averages were used.

Table 4-5. Summary of calibration point sources and tributaries used in LA-QUAL

Point source/ tributary name	Flow (mgd)	DO (mg/L)	$CBOD_u$ (mg/L)	Org N (mg/L)	Ammonia (mg/L)	NO_3+NO_2 (mg/L)	Comment
LA0122424	0.00004	5	0	0	0	2	Point source
Grp1-Rch1	0.0012	2	71.5	5.2	10.36	2	Combined point sources
LAG541777	0.0012	2	71.5	5.2	10.36	2	Point source
LAG541118	0.00019	2	13.8	1	2	2	Point source
LAG570205	0.00369	5	22	4	0.15	0	Point source
LAG533605	0.00369	5	23	1.7	3.33	2	Point source
Grp2-Rch3	0.00032	2	74.8	5.4	10.83	2	Combined point sources
Grp3-Rch3	0.00028	2	89	6.4	12.89	2	Combined point sources
LAG532004	0.00003	2	103.5	7.5	15	2	Point source
Grp4-Rch3	0.00181	4.09	33.1	2.4	4.8	2	Combined point sources
YWRC	-0.0538	4.09	34.5	2.5	5	2	Yellow Water River Canal
Grp5-Rch4	0.00079	2.27	66.9	4.9	9.7	2	Combined point sources
LAG540869	0.00079	2.27	66.9	4.9	9.7	2	Point source
LAG532175	0.00006	2	29	2.1	4.2	2	Point source
Grp6-Rch5	0.00007	2	103.5	7.5	15	2	Combined point sources
Grp7-Rch5	0.00024	2	72	5.2	10.44	2	Combined point sources
Grp8-Rch5	0.00181	2.63	29	2.1	4.21	2	Combined point sources
LAG541365	0.00039	2	69	5	10	2	Point source
Grp9-Rch6	0.00183	3.28	48	3.5	6.95	2	Combined point sources
Grp10-Rch6	0.00183	3.28	48	3.5	6.95	2	Combined point sources
Grp11-Rch6	0.00017	5	0	0	0	2	Combined point sources
LAG750157	0.00017	5	0	0	0	2	Point source
LAG540662	0.00002	5	0	0	0	2	Point source
LAG531467	0.00042	2	69	5	10	2	Point source
Grp12-Rch8	0.00001	5	0	0	0	2	Combined point sources
Grp13-Rch8	0.00234	2.26	74.1	5.4	10.74	2	Combined point sources
Grp14-Rch8	0.00129	2	28.8	2.1	4.17	2	Combined point sources
YWR	0.08	2	11	1.4	0.32	4	Yellow Water River
LAG531729	0.00129	2	28.8	2.1	4.17	2	Point source

4.10 Calibration and Sensitivity Analysis

4.10.1 Calibration

Model calibration is a critical step for model development. Calibration data must be obtained for all the parameters of the model at the same time, or as close to concurrently as practicable. Only data taken in that manner can be used for the calibration because many of the parameters and rates depend on each other. Analysis of the data for calibration indicated some conditions that formed assumptions in the model. The process of calibration confirms assumptions or requires revised assumptions. In certain instances, calibrated models are not required to produce valid TMDLs.

Model calibration also depends on the available data and should not be considered data matching. For this model, the magnitude and spatial trends are all captured with reasonable assignment of kinetic rates. Rates were not changed in each reach to exactly match data. The calibration period was selected to coincide with the intensive field monitoring that occurred in August 2009. The data used for calibration are the averages of the sampling results during the measurement period of August 5 through 8, 2009. These dates were selected for calibration because they were the only dates for which data were available. This period is considered the summer critical condition period because high temperatures decrease DO saturation values and increase rates of oxygen-demanding processes such as CBOD decay, nitrification, and SOD. Moreover, lower flow rates do not cause strong re-aeration, and thus the exchange of oxygen between air and water is low.

Model calibration was a multi-step process using ammonia, $CBOD_u$, and SOD concentrations for each reach, starting with the most upstream reach and working down to the outflow reach. The ammonia and nitrate loads were adjusted so that the predicted nitrogen concentrations would agree well with the measured concentrations. After ammonia had been calibrated, the $CBOD_u$ loads were adjusted until the predicted $CBOD_u$ concentrations were similar to the observed concentrations. Finally, SOD was adjusted until the predicted DO concentrations were similar to the observed concentrations.

Table 4-6 lists the loadings for calibration conditions, which were based on existing conditions. Overall, the model did well in predicting the observed values for ammonia, $CBOD_u$, and DO, and was considered adequately calibrated on the basis of the data available. Plots of measured and calibration water quality are presented in Appendix F. Figure 4-6 is an example calibration plot.

Table 4-6. Calibration (existing) model loadings

	Loadings (lb/d)			
Subsegment	SOD	$CBOD_u$	Ammonia as N	Organic N as N
040505	2,184	3,806	67	176

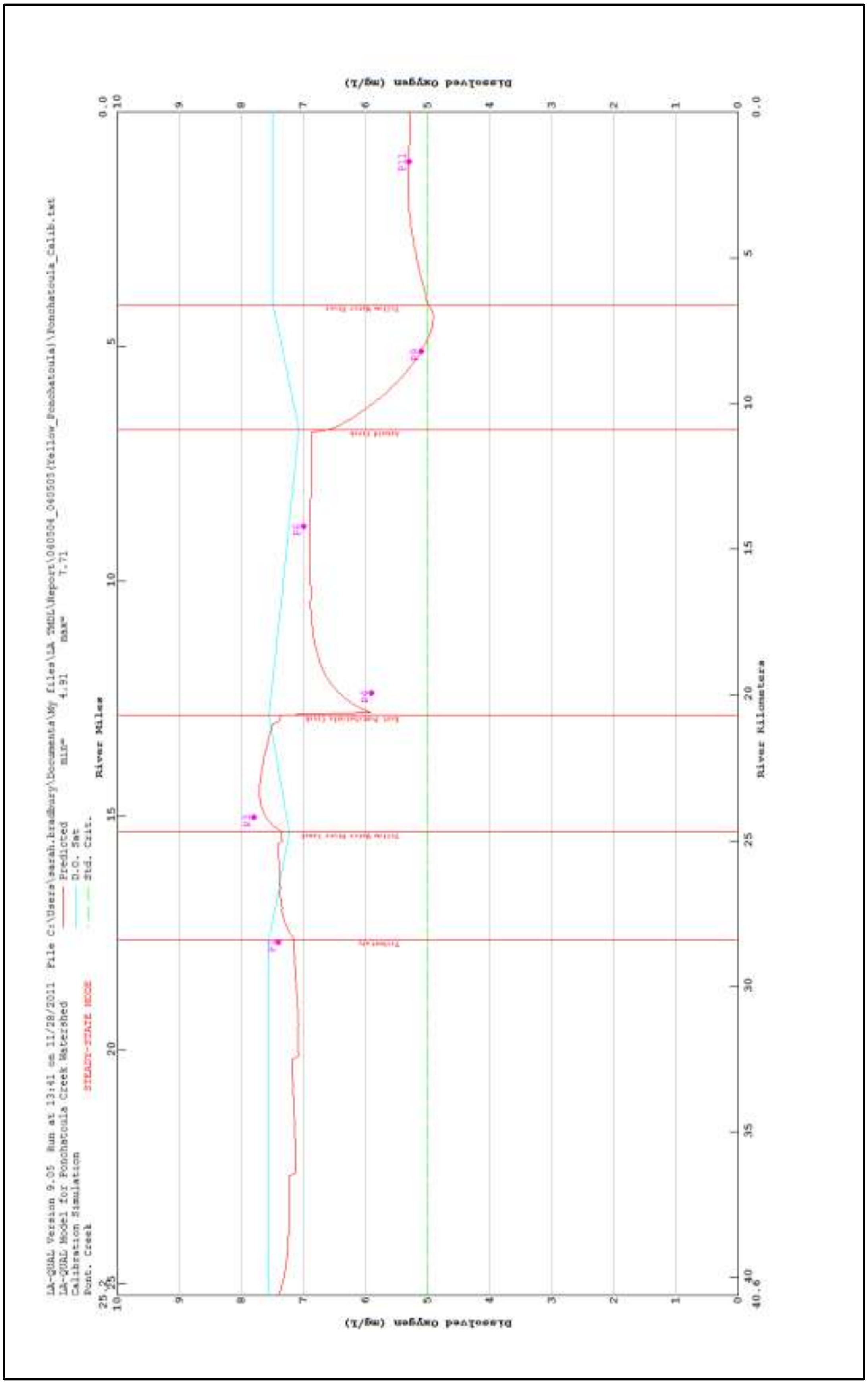

Figure 4-6. Calibration plot for DO for Ponchatoula Creek in subsegment 040505.

4.10.2 Processes Identified through Calibration

Adjustments of model rates and coefficients to help make modeled flow and loads agree with obtained data for significant pollutants led to an understanding of the processes controlling the conditions of Ponchatoula Creek and Ponchatoula River. On the basis of calibration of the model, the low DO problem is mainly caused by SOD and CBOD.

4.10.3 Sensitivity Analysis

Because a mathematical model is a simplified representation of the real world, its prediction is often subject to considerable uncertainty from a variety of sources. These sources include over-simplification of modeling assumptions and formulations, noise-distorted data, and model parameter values. To gain a better understanding of a model’s reliability, it is important to analyze the uncertainty associated with that model. Sensitivity analysis is a prime method of measuring a model’s uncertainty and reliability. Sensitivity is related to the actual waterbody or water system. For example, re-aeration in a narrow mountain stream depends strongly on velocity, while re-aeration in a wide river within a flat area depends on both wind and water velocities. Sensitivity runs provide useful information for understanding the physical, chemical, and biological processes within a specific waterbody. This model assessed the sensitivity of the DO concentration to various parameters. The analysis was performed by assessing the effects of the following:

- Velocity
- Dispersion
- Re-aeration
- CBOD aerobic decay rate
- Background SOD
- Nitrification rate

SOD results from deposition of dead phytoplankton and other organic matters from the watershed, and directly influences DO levels in the water column. CBOD loading from the watershed contributes to the oxygen demand and can be the source of SOD. Therefore, SOD is included in the sensitivity analysis.

A sensitivity analysis was performed on the model parameters using the sensitivity function built into LA-QUAL. LA-QUAL automatically changed the requested parameters by a set amount while keeping all other parameters constant. The calibration scenario was used as the baseline for the sensitivity analysis. For the analysis, all parameters were varied by ±30 percent. The results for DO and CBOD are listed in Table 4-7. Result plots are shown in Appendix G.

Table 4-7. Results of sensitivity analysis

	DO min/max (mg/L)						$CBOD_U$ min/max (mg/L)					
	CBOD aerobic decay rate	Dispersion	Reaeration	Background SOD	Velocity	Nitrification rate	CBOD aerobic decay rate	Dispersion	Reaeration	Background SOD	Velocity	Nitrification rate
base	4.91/7.71	4.91/7.71	4.91/7.71	4.91/7.71	4.91/7.71	4.91/7.71	10.79/26.85	10.79/26.86	10.79/26.86	10.79/26.86	10.79/26.86	10.79/26.86
30%	4.65/7.66	4.91/7.71	5.28/7.63	4.25/7.71	5.00/7.62	4.87/7.68	10.27/26.74	10.79/26.86	10.79/26.86	10.79/26.86	11.62/27.05	10.74/26.85
-30%	5.10/7.76	4.91/7.71	4.32/7.81	5.33/7.71	4.74/7.85	4.96/7.74	11.35/26.97	10.79/26.86	10.79/26.86	10.79/26.86	9.44/26.52	10.86/26.86

Discussion of each sensitivity variable is as follows:

- When the stream velocity increases or decreases, DO re-aeration rates change correspondingly. However, when velocity changes, the transport rates of CBOD and ammonia also change. As a result, in some parts of the stream, increasing velocity actually causes DO decrease. At the same time, in other parts of the stream, increasing velocity increases DO.
- Stream dispersion mixes and spreads material longitudinally. The sensitivity results show no change of DO with increased or decreased dispersion.

- Stream re-aeration rates govern how fast oxygen transfers through the air-water interface. High re-aeration rates bring water oxygen levels closer to the saturation level of DO. In Ponchatoula Creek and Ponchatoula River, DO typically increases with higher re-aeration rates and decreases with lower re-aeration rates. When algae level is high and DO is under supersaturation, increasing re-aeration rate lowers DO toward the saturation level.
- CBOD is one cause of DO depletion. When CBOD decays, oxygen is used. The sensitivity results show that changes in DO correspond to changes in CBOD decay rates.
- DO is sensitive to the background SOD rates. When SOD rates increase, DO decreases. When SOD rates decrease, DO increases.
- Ammonia nitrification also consumes DO. When ammonia nitrification rate increases, nitrifying bacteria use more DO, and DO decreases.

5. Dissolved Oxygen Model Projection

EPA's regulations at 40 CFR 130.7 require that parties determining TMDLs take into account critical conditions for stream flow, loading, and water quality parameters. The calibrated model was used to project water quality for summer and winter critical conditions. Two scenarios were run for each season's critical conditions: baseline and TMDL. The model was run for baseline conditions, which used the same water quality and model parameters as the calibration model; however, the flow and temperature were changed to critical conditions, and effluent water quality from permitted dischargers were changed to permit limits. The TMDL model run was the same as the baseline run; however, pollutant loadings were reduced so that DO met criteria at all locations. This section describes identification of critical conditions, temperature inputs, headwater and tributary (wasteload) inputs, point source inputs, baseline model results, and TMDL reduction model rates. Appendix H contains the baseline output files, and Appendix I contains the TMDL output files. The output files include the input parameters.

5.1 Identification of Critical Conditions

The LDEQ LTP defines critical conditions in terms of flow and temperature. Critical flow conditions for the summer scenario are simulated by using the annual 7Q10 flow or 0.1 cfs, whichever is greater. For winter, the critical flow condition is simulated using the annual 7Q10 flow or 1.0 cfs, whichever is greater. In addition, all point sources are assumed to be discharging at design capacity and at their permit limits. The LTP specifies that the critical temperature should be determined by calculating the 90th percentile seasonal temperature for the waterbody being modeled, if data are available. Otherwise, 30 ºC was used for summer and 20 ºC for winter critical conditions.

5.2 Temperature Inputs

The critical temperatures for the headwaters were based on the 90th percentile temperature of LDEQ ambient monitoring within the representative subsegment. For summer conditions, a critical temperature of 30 °C was used for incremental and wasteload inputs, unless the temperature was already greater than 30 °C, in which case the temperature was kept the same as calibration. For winter conditions, a critical temperature of 20 °C was used for incremental and wasteload inputs. The most critical time of year for meeting a constant DO standard is the period of high temperatures and low flows.

5.3 Headwater and Tributary (Wasteload) Inputs

Inputs for the headwater and tributaries for the projection simulation were based on guidance in the LTP. According to the LTP, the critical flow rates for summer should be set to either the 7Q10 flow or 0.1 cfs, whichever is greater and either the 7Q10 or 1 cfs in the winter. Because 7Q10 values for the waterbodies are not available, the headwater and tributary flows used in calibrating the model were replaced with 0.1 cfs for the summer scenario and 1 cfs for the winter scenario. It was assumed that during critical times, no headwater flow would occur for 7 days, making the 7Q10 equal to 0 cfs; therefore, 0.1 cfs and 1 cfs would be used.

DO values from headwaters and tributaries were set to the water quality criterion of 90 percent of the saturation level at 30^{o}C. CBOD and ammonia levels from headwaters and tributaries were reduced until modeled DO met the criteria.

5.4 Point Source Inputs

Inputs from point sources were changed from calibration inputs. Flow and CBOD concentrations were changed from DMR values to permit values. Ammonia and organic nitrogen levels were changed from measured or assumed concentrations to proposed concentrations. Nitrogen concentrations were assumed at half those required by the oxygen demand, with two-thirds assumed to be ammonia loading and one-third to be organic nitrogen loading. These assumptions are consistent with information presented in the LTP.

5.5 Baseline Model Results

The calibrated model was run for a baseline condition. Baseline conditions are run under critical temperature and water flow conditions for both summer and winter using calibrated parameters and water quality values. The baseline condition is essentially the starting point for TMDL analysis from which loading reductions are made, because the baseline condition represents critical conditions and the calibrated model. Plots of baseline water quality are presented in Appendix J. Table 5-1 presents the baseline loadings for subsegment 040505.

Table 5-1. Baseline model loadings

Season	Loadings (lb/d)			
	SOD	$CBOD_u$	Ammonia as N	Organic N as N
Summer	2,184	3,217	64.6	129.9
Winter	1,119	3,591	70.0	166.5

5.6 TMDL Reduction Model Results

The model demonstrates that with loading reductions, the subsegment will meet DO criteria (Figure 4-6). For projection runs, the flow (0.1 cfs) and weather conditions were kept identical to the baseline conditions. Only load inputs such as SOD and CBOD from the drainage basin were changed in order to determine the loadings for the TMDL.

Several steps were used to develop the reduction percentages for parameter loadings. The TMDL was calculated by first iteratively reducing SOD. After the DO criterion had been met by reducing SOD, the CBOD reduction rate was calculated by the SOD/CBOD relationship ($SOD = a \times \overline{CBOD}$) [Chapra 1997]). This equation assumes that the settled $CBOD_u$ is linearly related to the $CBOD_u$ load. The loading of CBOD is in mg/L of O_2 and the settled CBOD is in $m/m^2/d$ of O_2.Slight adjustments were made to the SOD reduction rate, and an updated CBOD reduction rate was calculated. This process was repeated until the optimal reduction rates were determined.

Plots of TMDL water quality are presented in Appendix K.

6. Dissolved Oxygen TMDL Development

A TMDL is the total amount of a pollutant that a receiving waterbody can assimilate while still achieving water quality standards. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established, thereby providing the basis for establishing water quality-based controls.

A TMDL for a given pollutant and waterbody is calculated using the sum of individual WLAs for point sources and LAs for nonpoint sources and natural background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account any lack of knowledge concerning the relationship between LAs and WLAs and water quality, and it may include a future growth (FG) component. The components of the TMDL calculations are illustrated using the following equation:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS + FG$$

This TMDL establishes LAs for oxygen-demanding substances and goals for reduction of those pollutants. LDEQ's position is that when oxygen-demanding loads are reduced in order to ensure that the DO criterion is supported, nutrients are also reduced. Implementation of this TMDL through discharge permits, along with application of best management practices (BMPs) to control and reduce runoff of oxygen-demanding pollutants from nonpoint sources in the watershed, will also reduce nutrient loading from those sources.

6.1 TMDLs, WLAs, and LAs

The DO TMDLs are presented as loadings from $CBOD_u$, ammonia nitrogen, and SOD, and they were derived using the LA-QUAL model. A summary of the TMDLs is presented in Table 6-1. The TMDLs were calculated from SOD, $CBOD_u$, ammonia, and organic nitrogen from nonpoint source model inputs, tributary flows, incremental flows, and background data.

Table 6-1. Summary of DO TMDLs, WLAs, LAs, MOSs, and FGs

Season	Loadings (lb/d)							
	SOD		$CBOD_u$		Ammonia as N		Organic N as N	
Summer	Baseline	TMDL	Baseline	TMDL	Baseline	TMDL	Baseline	TMDL
WLA	641.2	351.4	1,099.6	327.7	41.46	12.45	49.39	14.77
LA	1,106.2	606.2	1,474.3	439.3	10.26	3.22	54.57	16.35
MOS	218.4	119.7	321.7	95.9	6.46	1.96	12.99	3.89
FG	218.4	119.7	321.7	95.9	6.46	1.96	12.99	3.89
TMDL	2,184.3	1,196.9	3,217.4	958.8	64.65	19.60	129.94	38.90
Percent reduction	45%		70%		70%		70%	
Season	Loadings (lb/d)							
	SOD		$CBOD_u$		Ammonia as N		Organic N as N	
Winter	Baseline	TMDL	Baseline	TMDL	Baseline	TMDL	Baseline	TMDL
WLA	328.5	328.5	1,209.3	1,209.3	43.03	43.03	60.11	60.11
LA	566.8	566.8	1,663.5	1,663.5	12.96	12.96	73.07	73.07
MOS	111.9	111.9	359.1	359.1	7.00	7.00	16.65	16.65
FG	111.9	111.9	359.1	359.1	7.00	7.00	16.65	16.65
TMDL	1,119.1	1,119.1	3,591.0	3,591.0	69.99	69.99	166.47	166.47
Percent reduction	0%		0%		0%		0%	

6.1.1 Wasteload Allocation

The WLA portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. Permitted or average (expected or observed) flows were used to calculate the WLAs. If the permitted or average flow was unavailable, the permit maximum flow was used. The permit maximum flow was usually the maximum flow covered by the specific type of general permit. For example, the LPDES Class II Sanitary General Permit covers facilities with flow rates of up to 25,000 gallons per day. Sometimes the permit maximum flow was significantly greater than the expected flow, and therefore the permit maximum was used only when other flows were not available.

Loadings from point sources needed to be reduced in the summer to meet DO criterion. Loadings in the winter did not need to be reduced. WLAs are presented in Tables 6-2a (summer) and 6-2b (winter). LPDES-permitted discharges without DO or nutrient effluent allocations have been determined not to be sources of those parameters. If at some time, LDEQ determines that any of the discharges could contain the parameters, WLAs may be specified with the appropriate permit conditions.

Table 6-2a. Summer WLAs for subsegment 040505 within Lake Pontchartrain Basin

Agency interest (AI) #	NPDES permit #	Outfall	Facility name	Flow type	Flow (gpd)	BOD_5 (mg/L)	BOD_5 (lb/d)	BOD_u (mg/L)	BOD_u (lb/d)	Amm (mg/L)	Amm (lb/d)	Org N (mg/L)	Org N (lb/d)
43467	LA0106208	001	Tangi Meats LLC	Average	1,500	56.5	0.707	129.9	1.626	18.82	0.236	9.41	0.118
123236	LA0122424	001	Lamp Environmental Industries (LEI) Inc	Expected	500	13.4	0.056	30.8	0.129	4.47	0.019	2.24	0.009
87628	LAG470082	002	Kent Mitchell Bus Sales & Service LLC	Average	1,000	13.4	0.112	30.8	0.257	4.47	0.037	2.24	0.019
43813	LAG530002	001	H&D Investments Inc	Design	1,500	13.4	0.168	30.8	0.386	4.47	0.056	2.24	0.028
19037	LAG530215	001	Trafton Academy	DMR	1,705	8.9	0.127	20.6	0.292	2.98	0.042	1.49	0.021
24512	LAG530330	001	Lamp Environmental Industries Inc	Expected	175	13.4	0.020	30.8	0.045	4.47	0.007	2.24	0.003
43471	LAG530545	001	CM Fagan Special Service Center	Expected	1,500	13.4	0.168	30.8	0.386	4.47	0.056	2.24	0.028
43591	LAG530798	001	Cucchiara Trading Co - I-12 Commercial Park	Average	2,420	8.9	0.181	20.6	0.415	2.98	0.060	1.49	0.030
86947	LAG531227	001	Serenity Mobile Home Park	Average	3,000	8.9	0.224	20.6	0.515	2.98	0.075	1.49	0.037
75500	LAG531261	001	Minnie's Quickstop # 2	Expected	1,580	13.4	0.177	30.8	0.407	4.47	0.059	2.24	0.029
86965	LAG531467	001	Mary's Apartments	Expected	1,000	13.4	0.112	30.8	0.257	4.47	0.037	2.24	0.019
86945	LAG531552	001	T Brady Properties LLC	Average	3,600	8.9	0.269	20.6	0.618	2.98	0.090	1.49	0.045
86144	LAG531572	001	Green Meadows Apartments	Average	2,500	8.9	0.187	20.6	0.429	2.98	0.062	1.49	0.031
124820	LAG531729	001	Bobbys Mobile Home Park - WWTP - Construction	Expected	2,700	8.9	0.201	20.6	0.463	2.98	0.067	1.49	0.034
76298	LAG531846	001	Best Stop Quick Mart #7	Average	490	13.4	0.055	30.8	0.126	4.47	0.018	2.24	0.009
128347	LAG531856	001	Louis Kenneth Ridgel - Country Acre Apartments	Average	4,100	8.9	0.306	20.6	0.704	2.98	0.102	1.49	0.051
127326	LAG531897	001	Little Red Schoolhouse LLC	Average	590	13.4	0.066	30.8	0.152	4.47	0.022	2.24	0.011
130475	LAG531908	001	Pellco Properties LLC - Italian Gardens Apartments	Average	3,600	8.9	0.269	20.6	0.618	2.98	0.090	1.49	0.045
128352	LAG531915	001	Louis Carter Office Building	Expected	460	13.4	0.051	30.8	0.118	4.47	0.017	2.24	0.009
127868	LAG531926	001	Natalbany Bapist Church Inc	Average	1,100	13.4	0.123	30.8	0.283	4.47	0.041	2.24	0.021
127157	LAG531927	001	Taste of Bavaria Bakery & Restaurant	Average	500	8.9	0.037	20.6	0.086	2.98	0.012	1.49	0.006
133373	LAG531967	001	Regina Coeli Child Development Center - Regina Coeli Migrant Head Start	Expected	1,505	13.4	0.168	30.8	0.387	4.47	0.056	2.24	0.028
129656	LAG532004	001	ABC Academy LLC	Average	750	13.4	0.084	30.8	0.193	4.47	0.028	2.24	0.014
139859	LAG532098	001	Kinchen Rentals	Expected	2,700	8.9	0.201	20.6	0.463	2.98	0.067	1.49	0.034
141225	LAG532128	001	Tangipahoa Parish Council - Tangipahoa Parish Tourist Commission	Average	80	13.4	0.009	30.8	0.021	4.47	0.003	2.24	0.001
86949	LAG532130	001	Monteleone Mobile Home Park	Average	3,000	8.9	0.224	20.6	0.515	2.98	0.075	1.49	0.037
139858	LAG532140	001	May's Rental Apartments	Average	1,000	8.9	0.075	20.6	0.172	2.98	0.025	1.49	0.012
139833	LAG532147	001	Valenti Apartments	Expected	1,200	13.4	0.134	30.8	0.309	4.47	0.045	2.24	0.022

Agency interest (AI) #	NPDES permit #	Outfall	Facility name	Flow type	Flow (gpd)	BOD_5 (mg/L)	BOD_5 (lb/d)	BOD_u (mg/L)	BOD_u (lb/d)	Amm (mg/L)	Amm (lb/d)	Org N (mg/L)	Org N (lb/d)
141745	LAG532175	001	Wright's Rental Properties LLC	Average	1,700	13.4	0.190	30.8	0.438	4.47	0.063	2.24	0.032
150216	LAG532254	001	JayJa LLC - Range Road Mobile Home Park WWTP	Average	3,600	8.9	0.269	20.6	0.618	2.98	0.090	1.49	0.045
154899	LAG532542	001	US Postal Service - Natalbany Post Office	Average	60	8.9	0.004	20.6	0.010	2.98	0.001	1.49	0.001
163586	LAG533095	001	Global Press & Graphics LLC	Average	120	8.9	0.009	20.6	0.021	2.98	0.003	1.49	0.001
35536	LAG533109	001	Hammond Animal Hospital	Average	2,500	13.4	0.280	30.8	0.643	4.47	0.093	2.24	0.047
165514	LAG533179	001	Mission International Worship & Family Life Center - The Mission International Church	Design	2,500	8.9	0.187	20.6	0.429	2.98	0.062	1.49	0.031
170170	LAG533436	001	Sinsations of LA LLC - Sinsations of Hammond	Design	500	13.4	0.056	30.8	0.129	4.47	0.019	2.24	0.009
171855	LAG533544	001	Dollar General	Average	100	8.9	0.007	20.6	0.017	2.98	0.002	1.49	0.001
172560	LAG533605	001	Certified Roofing Specialist Inc	Average	2,500	13.4	0.280	30.8	0.643	4.47	0.093	2.24	0.047
40969	LAG540223	001	Catfish Charlie Restaurant	DMR	7,430	8.9	0.554	20.6	1.275	2.98	0.185	1.49	0.092
18245	LAG540278	001	Tangipahoa Parish Sewage District #1 - Cypress Creek Estates	Expected	14,000	8.9	1.045	20.6	2.402	2.98	0.348	1.49	0.174
41760	LAG540347	001	Mo-Dad Utilities LLC - High Hat Subdivision	Design	12,800	8.9	0.955	20.6	2.196	2.98	0.318	1.49	0.159
42690	LAG540531	001	O'Neill Mobile Home Park	DMR	1,434	8.9	0.107	20.6	0.246	2.98	0.036	1.49	0.018
43078	LAG540617	001	Tangipahoa Parish Sewerage District #1 - Roe Estates	DMR	30,168	8.9	2.251	20.6	5.177	2.98	0.750	1.49	0.375
43331	LAG540662	001	Southwood Ridge Utilities Inc - Southwood Ridge Estates	Average	9,600	8.9	0.716	20.6	1.647	2.98	0.239	1.49	0.119
43479	LAG540711	001	Natalbany Middle School	DMR	1,617	6.0	0.080	13.7	0.185	1.99	0.027	0.99	0.013
18069	LAG540715	001	Tangipahoa Parish Sewer District #1 - Sal-Mar-Deb Subdivision	Design	8,000	8.9	0.597	20.6	1.373	2.98	0.199	1.49	0.099
43485	LAG540869	001	Tangipahoa Parish Sewerage District #1 - Windsor Place Subdivision	Design	10,400	8.9	0.776	20.6	1.785	2.98	0.259	1.49	0.129
42760	LAG540936	001	Palm's Park	Average	7,500	8.9	0.560	20.6	1.287	2.98	0.187	1.49	0.093
86148	LAG541019	001	Phil's Mobile Home Park	Expected	7,200	8.9	0.537	20.6	1.236	2.98	0.179	1.49	0.090
98458	LAG541118	001	Woodland Estates Mobile Home Park	Expected	24,000	8.9	1.791	20.6	4.118	2.98	0.597	1.49	0.298
116147	LAG541179	001	Dorason Estates Mobile Home Park	Expected	7,500	8.9	0.560	20.6	1.287	2.98	0.187	1.49	0.093
123656	LAG541280	001	Mo-Dad Utilities LLC - The Village Subdivision	Design	20,000	8.9	1.492	20.6	3.432	2.98	0.497	1.49	0.249
114259	LAG541346	001	Intersection Connection Mobile Home Park	Expected	10,500	8.9	0.783	20.6	1.802	2.98	0.261	1.49	0.131
119923	LAG541365	001	Coleman Trailer Park	Average	9,000	8.9	0.671	20.6	1.544	2.98	0.224	1.49	0.112
130211	LAG541380	001	First True Love World Outreach Ministries - STP	Expected	5,000	8.9	0.373	20.6	0.858	2.98	0.124	1.49	0.062
135145	LAG541396	001	Emile J Silessi - Silessi Mobile Home Park	Average	24,000	8.9	1.791	20.6	4.118	2.98	0.597	1.49	0.298
130513	LAG541421	001	Strawberry Heights Mobile Home Park	Expected	8,700	8.9	0.649	20.6	1.493	2.98	0.216	1.49	0.108
141309	LAG541505	001	Blue Crystal Mobile Home Park Phase II	Average	9,300	8.9	0.694	20.6	1.596	2.98	0.231	1.49	0.116
86953	LAG541608	001	Pine Crest Apartments - WWTP	Design	2,500	8.9	0.187	20.6	0.429	2.98	0.062	1.49	0.031
86953	LAG541608	002	Pine Crest Apartments - WWTP	Design	2,500	8.9	0.187	20.6	0.429	2.98	0.062	1.49	0.031
152319	LAG541673	001	Mo-Dad Utilities LLC - Madeline Court Subdivision	Average	10,800	8.9	0.806	20.6	1.853	2.98	0.269	1.49	0.134
152604	LAG541736	001	FJS LLC - Deluxe Plaza	Expected	6,020	8.9	0.449	20.6	1.033	2.98	0.150	1.49	0.075
167337	LAG541777	001	Bobby Farrell - Country Side Mobile Home Park	Design	6,000	8.9	0.448	20.6	1.030	2.98	0.149	1.49	0.075
141651	LAG541814	001	Farmland Apartments	Average	6,050	8.9	0.451	20.6	1.038	2.98	0.150	1.49	0.075
42309	LAG560022	001	Lionsway LLC - Lions Way Apartments	Expected	27,200	6.0	1.353	13.7	3.112	1.99	0.451	0.99	0.225
42309	LAG560022	002	Lionsway LLC - Lions Way Apartments	Expected	16,000	6.0	0.796	13.7	1.830	1.99	0.265	0.99	0.133
18872	LAG570205	001	Tickfaw Village of - WWTP	Average	88,000	3.0	2.188	6.9	5.034	0.99	0.729	0.50	0.365

Agency interest (AI) #	NPDES permit #	Outfall	Facility name	Flow type	Flow (gpd)	BOD_5 (mg/L)	BOD_5 (lb/d)	BOD_u (mg/L)	BOD_u (lb/d)	Amm (mg/L)	Amm (lb/d)	Org N (mg/L)	Org N (lb/d)
91709	LAG570365	001	Curtis Environmental Utilities Inc - Hidden Pines STP	Expected	20,000	3.0	0.497	6.9	1.144	0.99	0.166	0.50	0.083
153143	LAG570435	001	S&P Land Co LLC - Milan Village Subdivision WWTP	Expected	18,400	3.0	0.458	6.9	1.052	0.99	0.153	0.50	0.076
154169	LAG570436	001	Advanced Construction Co - Blossom Creek Subdivision	Average	13,200	3.0	0.328	6.9	0.755	0.99	0.109	0.50	0.055
154102	LAG570446	001	Ophthalmology Clinic & Surgery Center	Design	7,500	3.0	0.187	6.9	0.429	0.99	0.062	0.50	0.031
158035	LAG570458	001	Elmwood Park Second Filing - Mo-Dad Utilities LLC	Design	26,000	3.0	0.647	6.9	1.487	0.99	0.216	0.50	0.108

Table 6-2b. Winter WLAs for subsegment 040505 within Lake Pontchartrain Basin

Agency interest (AI) #	NPDES permit #	Outfall	Facility name	Flow type	Flow (gpd)	BOD_5 (mg/L)	BOD_5 (lb/d)	BOD_u (mg/L)	BOD_u (lb/d)	Amm (mg/L)	Amm (lb/d)	Org N (mg/L)	Org N (lb/d)
43467	LA0106208	001	Tangi Meats LLC	Average	1,500	189.5	2.372	435.8	5.455	63.2	0.791	31.6	0.395
123236	LA0122424	001	Lamp Environmental Industries (LEI) Inc	Expected	500	45	0.188	103.5	0.432	15	0.063	7.5	0.031
87628	LAG470082	002	Kent Mitchell Bus Sales & Service LLC	Average	1,000	45	0.376	103.5	0.864	15	0.125	7.5	0.063
43813	LAG530002	001	H&D Investments Inc	Design	1,500	45	0.563	103.5	1.296	15	0.188	7.5	0.094
19037	LAG530215	001	Trafton Academy	DMR	1,705	30	0.427	69.0	0.982	10	0.142	5	0.071
24512	LAG530330	001	Lamp Environmental Industries Inc	Expected	175	45	0.066	103.5	0.151	15	0.022	7.5	0.011
43471	LAG530545	001	CM Fagan Special Service Center	Expected	1,500	45	0.563	103.5	1.296	15	0.188	7.5	0.094
43591	LAG530798	001	Cucchiara Trading Co - I-12 Commercial Park	Average	2,420	30	0.606	69.0	1.394	10	0.202	5	0.101
86947	LAG531227	001	Serenity Mobile Home Park	Average	3,000	30	0.751	69.0	1.727	10	0.250	5	0.125
75500	LAG531261	001	Minnie's Quickstop # 2	Expected	1,580	45	0.593	103.5	1.365	15	0.198	7.5	0.099
86965	LAG531467	001	Mary's Apartments	Expected	1,000	45	0.376	103.5	0.864	15	0.125	7.5	0.063
86945	LAG531552	001	T Brady Properties LLC	Average	3,600	30	0.901	69.0	2.073	10	0.300	5	0.150
86144	LAG531572	001	Green Meadows Apartments	Average	2,500	30	0.626	69.0	1.440	10	0.209	5	0.104
124820	LAG531729	001	Bobbys Mobile Home Park - WWTP - Construction	Expected	2,700	30	0.676	69.0	1.555	10	0.225	5	0.113
76298	LAG531846	001	Best Stop Quick Mart #7	Average	490	45	0.184	103.5	0.423	15	0.061	7.5	0.031
128347	LAG531856	001	Louis Kenneth Ridgel - Country Acre Apartments	Average	4,100	30	1.026	69.0	2.361	10	0.342	5	0.171
127326	LAG531897	001	Little Red Schoolhouse LLC	Average	590	45	0.222	103.5	0.510	15	0.074	7.5	0.037
130475	LAG531908	001	Pellco Properties LLC - Italian Gardens Apartments	Average	3,600	30	0.901	69.0	2.073	10	0.300	5	0.150
128352	LAG531915	001	Louis Carter Office Building	Expected	460	45	0.173	103.5	0.397	15	0.058	7.5	0.029
127868	LAG531926	001	Natalbany Bapist Church Inc	Average	1,100	45	0.413	103.5	0.950	15	0.138	7.5	0.069
127157	LAG531927	001	Taste of Bavaria Bakery & Restaurant	Average	500	30	0.125	69.0	0.288	10	0.042	5	0.021
133373	LAG531967	001	Regina Coeli Child Development Center - Regina Coeli Migrant Head Start	Expected	1,505	45	0.565	103.5	1.300	15	0.188	7.5	0.094
129656	LAG532004	001	ABC Academy LLC	Average	750	45	0.282	103.5	0.648	15	0.094	7.5	0.047
139859	LAG532098	001	Kinchen Rentals	Expected	2,700	30	0.676	69.0	1.555	10	0.225	5	0.113
141225	LAG532128	001	Tangipahoa Parish Council - Tangipahoa Parish Tourist Commission	Average	80	45	0.030	103.5	0.069	15	0.010	7.5	0.005
86949	LAG532130	001	Monteleone Mobile Home Park	Average	3,000	30	0.751	69.0	1.727	10	0.250	5	0.125
139858	LAG532140	001	May's Rental Apartments	Average	1,000	30	0.250	69.0	0.576	10	0.083	5	0.042
139833	LAG532147	001	Valenti Apartments	Expected	1,200	45	0.451	103.5	1.036	15	0.150	7.5	0.075
141745	LAG532175	001	Wright's Rental Properties LLC	Average	1,700	45	0.638	103.5	1.468	15	0.213	7.5	0.106
150216	LAG532254	001	JayJa LLC - Range Road Mobile Home Park WWTP	Average	3,600	30	0.901	69.0	2.073	10	0.300	5	0.150

Agency interest (AI) #	NPDES permit #	Outfall	Facility name	Flow type	Flow (gpd)	BOD_5 (mg/L)	BOD_5 (lb/d)	BOD_u (mg/L)	BOD_u (lb/d)	Amm (mg/L)	Amm (lb/d)	Org N (mg/L)	Org N (lb/d)
154899	LAG532542	001	US Postal Service - Natalbany Post Office	Average	60	30	0.015	69.0	0.035	10	0.005	5	0.003
163586	LAG533095	001	Global Press & Graphics LLC	Average	120	30	0.030	69.0	0.069	10	0.010	5	0.005
35536	LAG533109	001	Hammond Animal Hospital	Average	2,500	45	0.939	103.5	2.159	15	0.313	7.5	0.156
165514	LAG533179	001	Mission International Worship & Family Life Center - The Mission International Church	Design	2,500	30	0.626	69.0	1.440	10	0.209	5	0.104
170170	LAG533436	001	Sinsations of LA LLC - Sinsations of Hammond	Design	500	45	0.188	103.5	0.432	15	0.063	7.5	0.031
171855	LAG533544	001	Dollar General	Average	100	30	0.025	69.0	0.058	10	0.008	5	0.004
172560	LAG533605	001	Certified Roofing Specialist Inc	Average	2,500	45	0.939	103.5	2.159	15	0.313	7.5	0.156
40969	LAG540223	001	Catfish Charlie Restaurant	DMR	7,430	30	1.860	69.0	4.279	10	0.620	5	0.310
18245	LAG540278	001	Tangipahoa Parish Sewage District #1 - Cypress Creek Estates	Expected	14,000	30	3.505	69.0	8.062	10	1.168	5	0.584
41760	LAG540347	001	Mo-Dad Utilities LLC - High Hat Subdivision	Design	12,800	30	3.205	69.0	7.371	10	1.068	5	0.534
42690	LAG540531	001	O'Neill Mobile Home Park	DMR	1,434	30	0.359	69.0	0.826	10	0.120	5	0.060
43078	LAG540617	001	Tangipahoa Parish Sewerage District #1 - Roe Estates	DMR	30,168	30	7.553	69.0	17.372	10	2.518	5	1.259
43331	LAG540662	001	Southwood Ridge Utilities Inc - Southwood Ridge Estates	Average	9,600	30	2.403	69.0	5.528	10	0.801	5	0.401
43479	LAG540711	001	Natalbany Middle School	DMR	1,617	20	0.270	46.0	0.621	6.67	0.090	3.33	0.045
18069	LAG540715	001	Tangipahoa Parish Sewer District #1 - Sal-Mar-Deb Subdivision	Design	8,000	30	2.003	69.0	4.607	10	0.668	5	0.334
43485	LAG540869	001	Tangipahoa Parish Sewerage District #1 - Windsor Place Subdivision	Design	10,400	30	2.604	69.0	5.989	10	0.868	5	0.434
42760	LAG540936	001	Palm's Park	Average	7,500	30	1.878	69.0	4.319	10	0.626	5	0.313
86148	LAG541019	001	Phil's Mobile Home Park	Expected	7,200	30	1.803	69.0	4.146	10	0.601	5	0.300
98458	LAG541118	001	Woodland Estates Mobile Home Park	Expected	24,000	30	6.009	69.0	13.820	10	2.003	5	1.001
116147	LAG541179	001	Dorason Estates Mobile Home Park	Expected	7,500	30	1.878	69.0	4.319	10	0.626	5	0.313
123656	LAG541280	001	Mo-Dad Utilities LLC - The Village Subdivision	Design	20,000	30	5.007	69.0	11.517	10	1.669	5	0.835
114259	LAG541346	001	Intersection Connection Mobile Home Park	Expected	10,500	30	2.629	69.0	6.046	10	0.876	5	0.438
119923	LAG541365	001	Coleman Trailer Park	Average	9,000	30	2.253	69.0	5.182	10	0.751	5	0.376
130211	LAG541380	001	First True Love World Outreach Ministries - STP	Expected	5,000	30	1.252	69.0	2.879	10	0.417	5	0.209
135145	LAG541396	001	Emile J Silessi - Silessi Mobile Home Park	Average	24,000	30	6.009	69.0	13.820	10	2.003	5	1.001
130513	LAG541421	001	Strawberry Heights Mobile Home Park	Expected	8,700	30	2.178	69.0	5.010	10	0.726	5	0.363
141309	LAG541505	001	Blue Crystal Mobile Home Park Phase II	Average	9,300	30	2.328	69.0	5.355	10	0.776	5	0.388
86953	LAG541608	001	Pine Crest Apartments - WWTP	Design	2,500	30	0.626	69.0	1.440	10	0.209	5	0.104
86953	LAG541608	002	Pine Crest Apartments - WWTP	Design	2,500	30	0.626	69.0	1.440	10	0.209	5	0.104
152319	LAG541673	001	Mo-Dad Utilities LLC - Madeline Court Subdivison	Average	10,800	30	2.704	69.0	6.219	10	0.901	5	0.451
152604	LAG541736	001	FJS LLC - Deluxe Plaza	Expected	6,020	30	1.507	69.0	3.467	10	0.502	5	0.251
167337	LAG541777	001	Bobby Farrell - Country Side Mobile Home Park	Design	6,000	30	1.502	69.0	3.455	10	0.501	5	0.250
141651	LAG541814	001	Farmland Apartments	Average	6,050	30	1.515	69.0	3.484	10	0.505	5	0.252
42309	LAG560022	001	Lionsway LLC - Lions Way Apartments	Expected	27,200	20	4.540	46.0	10.442	6.67	1.513	3.33	0.757
42309	LAG560022	002	Lionsway LLC - Lions Way Apartments	Expected	16,000	20	2.671	46.0	6.142	6.67	0.890	3.33	0.445
18872	LAG570205	001	Tickfaw Village of - WWTP	Average	88,000	10	7.344	23.0	16.891	3.33	2.448	1.67	1.224
91709	LAG570365	001	Curtis Environmental Utilities Inc - Hidden Pines STP	Expected	20,000	10	1.669	23.0	3.839	3.33	0.556	1.67	0.278
153143	LAG570435	001	S&P Land Co LLC - Milan Village Subdivision WWTP	Expected	18,400	10	1.536	23.0	3.532	3.33	0.512	1.67	0.256

Agency interest (AI) #	NPDES permit #	Outfall	Facility name	Flow type	Flow (gpd)	BOD_5 (mg/L)	BOD_5 (lb/d)	BOD_u (mg/L)	BOD_u (lb/d)	Amm (mg/L)	Amm (lb/d)	Org N (mg/L)	Org N (lb/d)
154169	LAG570436	001	Advanced Construction Co - Blossom Creek Subdivision	Average	13,200	10	1.102	23.0	2.534	3.33	0.367	1.67	0.184
154102	LAG570446	001	Ophthalmology Clinic & Surgery Center	Design	7,500	10	0.626	23.0	1.440	3.33	0.209	1.67	0.104
158035	LAG570458	001	Elmwood Park Second Filing - Mo-Dad Utilities LLC	Design	26,000	10	2.170	23.0	4.991	3.33	0.723	1.67	0.362

EPA's stormwater permitting regulations require municipalities to obtain permit coverage for all stormwater discharges from MS4s. For each MS4 in the basin, a gross MS4 load was computed by multiplying the LA by the ratio of the MS4 area in the subsegment (20.8 square miles) to the subsegment area (56.6 square miles). Note that those values are estimates that can be refined in the future as more information about the MS4s and land-use-specific loadings becomes available. Note also that the MS4 loads presented reflect only that portion of the MS4 in the subsegment. The computed MS4 load was subtracted from the LA and included as a WLA component of the TMDL because MS4s are permitted dischargers but function similarly to nonpoint sources (through storm-driven processes). In addition, the TMDL was developed for critical, low-flow conditions, when stormwater is not expected to play a role in loadings.

Table 6-3 lists the individual WLA for the identified MS4 (Section 2.5). MS4 WLAs should not be considered as permit limits or targets. Permit limits will not be applied to MS4 permittees, and the requirements of this TMDL are expected to be met through stormwater management plans and BMPs. EPA expects that the MS4 WLAs will be achieved through BMPs and adaptive management.

Table 6-3. Summary of WLA for MS4 subsegment 040505 in the Lake Pontchartrain Basin

NPDES permit #	Agency interest (AI) #	Urban area (UA)	MS4 area (acres)	Season	Pollutant	MS4 (lb/d)
LAR041030	104053	Hammond, City of - Municipal Separate Storm Sewer System MS4	13,300	Summer	$CBOD_u$	254.6
					Organic nitrogen as N	9.48
					Ammonia as N	1.87
					SOD	351.4
				Winter	$CBOD_u$	964.2
					Organic nitrogen as N	42.35
					Ammonia as N	7.51
					SOD	328.5

The estimated annual runoff from the MS4 can be calculated with the following equation.

$$R = P \times Pj \times Rv$$

where

R = Annual runoff (inches)
P = Annual rainfall (inches)
Pj = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

Because watershed imperviousness is a reasonable predictor of the runoff coefficient, the runoff coefficient was substituted using the following equation.

$$Rv = 0.05 + 0.9Ia$$

where

Ia = Impervious fraction

The estimated annual runoff from the MS4 was calculated to be 14.4 inches per year. For that calculation, the average annual rainfall (58 inches) was calculated using the past 14 years of complete data collected by the National Climatic Data Center at New Orleans International Airport. The impervious fraction of the MS4 was estimated to be 25 percent using USGS impervious cover information. Once the runoff in inches was calculated, it was multiplied by the area to obtain the runoff is 5,184 million gallons per year (14.2 million gallons per day).

6.1.2 Load Allocation

The LA is the portion of the TMDL assigned to nonpoint sources such as natural background loadings or upstream loading; however, no upstream loading exists for this waterbody. For this TMDL, the LA was calculated by subtracting the WLA, MOS, and FG from the total TMDL allocation. LAs were not allocated to separate nonpoint sources because available source characterization data were unavailable. The LA covers the 35.8 square miles not covered in the MS4 WLA (Table 6-3).

6.2 Seasonality and Critical Condition

The federal regulations at 40 CFR 130.7 require that TMDLs include seasonal variations and take into account critical conditions for stream flow, loading, and water quality parameters. The sampling results for all pollutants were plotted over time and reviewed for any seasonal patterns (see Section 3). The water quality criteria for DO apply all year, accounting for seasonal variations. This TMDL was developed under critical conditions, providing a conservative year-round TMDL.

Critical conditions for DO have been determined as negligible nonpoint runoff and low-stream flow combined with high water temperatures. Oxygen-demanding substances can enter a water system during higher flows and settle to the bottom, where they exert a large oxygen demand during the high-temperature/low-flow seasons. Water temperature is one of the leading factors affecting DO in the segment. High water temperatures lower the DO saturation concentration, decreasing the amount of DO that the stream can contain. Moreover, high temperature increases CBOD decay and SOD. Therefore, it is most important to develop a TMDL to address the high-water-temperature conditions. Ambient water quality data from LDEQ show that low DO concentrations occur during the summer months.

6.3 Margin of Safety

Section 303(d) of the Clean Water Act and the regulations at 40 CFR 130.7 require that TMDLs include an MOS to account for any lack of knowledge concerning the relationship between load and WLAs and water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly using conservative assumptions in establishing the TMDL. In addition to the MOS, an FG component may be added to account specifically for FG in the TMDL area.

The MOS can be incorporated in two ways (USEPA 1991). One way is to implicitly incorporate it by using conservative model assumptions to develop allocations, including using the DO water quality criteria for model inflows. DO from headwaters and tributaries was set to the water quality criterion, which is lower than the 90 percent saturation level of DO at 30 ºC.

The other way to incorporate the MOS is to explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For this analysis, the MOS is explicit: 10 percent of each targeted TMDL was reserved as the MOS. Using 10 percent of the TMDL load provides an additional level of protection to the designated uses of the subsegments of concern.

6.4 Future Growth

The FG is an allocation for growth. Ten percent of the load was allocated for FG within the area covered by the TMDL. This growth includes future urban development, including point sources, MS4 areas, agriculture, and other nonpoint sources. The FG could also be used for unaccounted or unknown sources not included in the TMDL.

7. Future Activities

This section discusses TMDL implementation strategies, environmental monitoring activities, and stormwater permitting requirements and presumptive BMPs for the TMDL conducted for Ponchatoula Creek and Ponchatoula River.

7.1 TMDL Implementation Strategies

Current TMDL requirements do not require inclusion of implementation plans in TMDL reports. Louisiana is responsible for developing and implementing the TMDL implementation plans. Section 303(d) of the Clean Water Act and the implementing regulations at 40 CFR 130.7 states that EPA has no authority to approve or disapprove TMDL implementation plans.

WLAs will be implemented through LPDES permit procedures. LDEQ was delegated to manage the NPDES program in August 1996, and LDEQ is responsible for all permits covered by the delegation package. As part of that designation, a Memorandum of Agreement (MOA) was established between LDEQ and EPA. The designation and memorandum were revised in April 2004. In accordance with Section 1.C of the NPDES MOA between LDEQ and EPA (Revision 1, April 28, 2004), EPA has the responsibility of providing continued technical and other assistance, including interpreting and implementing federal regulations, policies, and guidelines on permitting and enforcement matters. The MOA further states that LDEQ has primary responsibilities for implementing the LPDES program in Louisiana, including applicable sections of the federal Clean Water Act, applicable state legal authority, the applicable requirements of 40 CFR Parts 122–125, and any other applicable federal regulations establishing LPDES program priorities with consideration of EPA Region 6 and national NPDES goals and objectives. For details on the designation and agreement, see the EPA Region 6 website at http://www.epa.gov/region6/water/lpdes/.[2] LDEQ's position is that, if any unresolved LDEQ comments regarding these TMDLs become the basis for an EPA Region 6 objection to an LDEQ-drafted permit or permittee objection/appeal of an LDEQ drafted permit, LDEQ may relinquish permitting authority to EPA Region 6.

7.2 LDEQ Phased TMDL Approach

LDEQ is using a phased approach to TMDL implementation, as shown in Table 7-1. This approach provides LDEQ with the opportunity to revise DO criteria for a subsegment by developing a meaningful and implementable DO TMDL on the basis of DO criteria appropriate for a specific waterbody and in accordance with the Consent Decree deadlines. In addition, it will lead to improved water quality while providing entities the opportunity to prepare for possible new permit requirements as a result of the TMDL developed in Phases I and II (LDEQ 2010d).

Table 7-1. Phased TMDL approach

Stage/Phase	DO criteria (mg/L)
Phase I: Phase I implementation required upon EPA approval of the TMDL and subsequent update of Louisiana's Water Quality Management Plan	5.0
Primary Activities: Ecoregion-based UAA developed and DO criteria revised and promulgated	
Phase II: Phase II implementation required upon EPA approval of Phase II of the TMDL and subsequent update of Louisiana's Water Quality Management Plan	Appropriate DO criteria based on UAA

UAA = Use attainability analysis

[2] Accessed January 11, 2011.

7.2.1 Phase I – Permit Implementation

All TMDL, permitting, and enforcement activities will be conducted in accordance with the Clean Water Act, the Louisiana Environmental Regulatory Code, and applicable state laws.

1. **New discharges of oxygen-demanding loads:** In general, LDEQ might not be able to permit additional discharges of oxygen-demanding loads because of the impaired status of Ponchatoula Creek and Ponchatoula River. However, LDEQ may permit new discharges on a case-by-case basis after evaluating relevant information (i.e., environmental impact statement). The typical permit limits will be 5 mg/L for BOD_5, 2 mg/L for NH_3, and 5 mg/L for DO. Such new facilities may be required to submit an environmental impact assessment to LDEQ's permitting staff, which will conduct a thorough evaluation of the proposed facility on the basis of environmental impacts, economic benefits, an analysis of alternatives, and other pertinent factors. Example scenarios where a new discharge may be permitted are as follows.

    a. The facility demonstrates that it will provide a significant load reduction of man-made, oxygen-demanding constituents to the impaired watershed(s) serviced by the facility. The facility must also contribute to a reduction in the number of facilities discharging to the watershed(s). Facilities that may be considered for permits under this provision include the following:

        i. A facility that will provide improved sewage treatment to multiple subdivisions previously serviced by WWTPs that are incapable of treating to tertiary limits.

        ii. A facility that will provide sewage collection and treatment to previously unsewered areas in which many of the sanitary discharges from permitted facilities and individual home treatment units were entering an impaired watershed. As a result, the facility would be expected to provide more efficient treatment to the wastewater and reduce the net loading of oxygen-demanding substances in the watershed.

    b. The facility demonstrates that its wastewater will not leave the facility or its property. Significant stormwater events do not apply to this provision. For this provision, a significant stormwater event is defined as a 25-year, 24-hour rainfall event or its numerical equivalent, as defined by the Southern Regional Climate Center.

        i. Facilities that may be considered under this provision include the following:

            a. Effluent reduction systems that have been approved by the Louisiana Department of Health and Hospitals.

            b. WWTPs equipped with overland flow systems in which the effluent will not leave the facility.

            c. WWTPs equipped with holding ponds that will retain the effluent such that the effluent will not leave the facility.

        ii. LDEQ recognizes that some local governments are in the process of building or expanding regional sewage collection and treatment systems. In such areas, LDEQ may, on a limited basis, grant permits of limited durations to facilities that agree to tie into a regional collection and treatment system when it becomes available. LDEQ must have assurance that the regional collection system will be available to the facility and the facility will connect to the regional collection system on or before the expiration date of the permit. Such assurance may include a formal agreement among the facility, the owner and operator of the regional wastewater treatment system, and LDEQ. The regional system must have the capacity to treat the additional wastewater. Such a permit may have a duration of less than 5 years or it may have a 5-year duration with interim permit limits. The permit will be written on the basis of projected completion dates for the construction of the collection and treatment system. The facility will be required to cease all wastewater discharges to the Ponchatoula Creek and Ponchatoula River watershed and transfer the discharge to the regional collection system once the permit or interim limits expire or the collection system is available to the facility, whichever comes first. If the permit or interim limits expire, but, because of unforeseen circumstances, the availability of the collection system has been temporarily delayed, the duration of the permit or interim limits may be extended. If the availability of the collection system has been indefinitely delayed, the facility may be required to cease all discharges to the Ponchatoula Creek and Ponchatoula River watershed. Such facilities may resort to options covered in item 1.b.i. above.

a. LDEQ reassesses subsegment 040505 (Ponchatoula Creek and Ponchatoula River). LDEQ determines that subsegment 040505 is meeting the appropriate DO criteria and designated uses.

2. **Existing discharges of oxygen-demanding loads**: Existing facilities discovered to be discharging oxygen-demanding loads without LPDES permits as of the TMDL approval date are to be permitted in accordance with the limits established for existing facilities with permits. Unpermitted facilities that are newly activated or reactivated and discharging after the TMDL approval date may be subjected to enforcement actions and will be required to tie into regional collection and treatment systems, once those systems are available. Once the TMDL is approved, existing facilities may have up to 3 years from their next permit renewal to meet the interim limits.
3. **Monitoring:** Nutrient monitoring (i.e., reporting for TN and TP) might be required for individual permits. Nutrient monitoring will be added to the general permit series (LAG530000, LAG540000, LAG560000, and LAG570000) in the next scheduled renewal of each series.

7.2.2 Phase II – Use Attainability Analysis Implementation

Phase II permit implementation will be developed on the basis of an ecoregion-based use attainability analysis (UAA), currently under development. Using existing data, this UAA is expected to propose new DO criteria for many of the Lake Pontchartrain Basin TMDLs that are being developed. These TMDLs have an EPA backstop date of March 31, 2012. This new DO criterion is expected to be developed and promulgated within the next two to three years.

If new criteria are not developed and promulgated within five years from the TMDL approval date, LDEQ intends to proceed in the following manner:

- **Case 1:** If the UAA study indicates that the current DO criterion is appropriate, the TMDL will be implemented using the existing criterion.
- **Case 2:** If the UAA is not likely to be completed or approved, the TMDL will be implemented using the existing DO criterion.
- **Case 3:** If the UAA is still being developed, but is expected to be approved, Phase II of this TMDL will be postponed for up to 2 years. If by then the UAA has not been completed, the UAA status will be reviewed again according to Cases 1–3.

7.3 Environmental Monitoring Activities

LDEQ uses funds provided under section 106 of the Clean Water Act and under the authority of the Louisiana Environmental Quality Act to run a program for monitoring the quality of Louisiana's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations using appropriate sampling methods and procedures to ensure the quality of the data obtained. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term database for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program are used to develop the state's biennial section 305(b) report (*Water Quality Inventory*) and section 303(d) list of impaired waters (*Draft 2010 Integrated Report*).

LDEQ has implemented a rotating approach to surface water quality monitoring. Through the rotating approach, the entire state is sampled on a 4-year cycle. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the 4-year cycle. Sampling is conducted monthly during a water year (October through September) to yield approximately 12 samples per site during each year the site is monitored. Sampling locations are selected to be representative of the waterbody. Under the current monitoring schedule, approximately one-half of the state's waters are newly assessed for section 305(b) and section 303(d) listing purposes for each biennial cycle. Monitoring allows LDEQ to determine whether any improvement in water quality occurs after implementation of the TMDLs. LDEQ evaluates the monitoring results to generate the Integrated Report submitted by April 1 in even-numbered years. More information can be found in *Louisiana's Water Quality Assessment Method and Integrated Report Rationale: 2010 Water Quality Integrated Report* (LDEQ 2010a). Monitoring will allow LDEQ to determine whether water quality improves following TMDL implementation. As the monitoring results are evaluated at the end of each year, waterbodies might be added to or removed from the section 303(d) list of impaired waterbodies.

Two watershed coordinators have been hired to work with the Lake Pontchartrain Basin Foundation (LPBF) on stakeholder involvement in watershed plans. LDEQ's nonpoint source staff is also cooperating with the LPBF to implement these plans, and will be assigned work on additional watersheds through the planning and implementation process. In order to address some of the known problems within this basin, LDEQ has been implementing programs that address fecal coliform, DO, and mercury—the primary water quality problems identified within these waterbodies. The LPBF has implemented many programs to restore water quality, and will be an important partner for LDEQ as TMDLs are implemented within the basin. Because much of the basin is included within the Coastal Zone Boundary, Louisiana Department of Natural Resources – Coastal Management Division will be working with LDEQ and LPBF on implementation of management measures required through the Coastal Nonpoint Source Pollution Control Program (LDEQ 2010c).

7.4 Stormwater Permitting Requirements and Presumptive Best Management Practices Approach

7.4.1 Background

The NPDES permitting program for stormwater discharges was established under the Clean Water Act as the result of a 1987 amendment. The Act specifies the level of control to be incorporated into the NPDES stormwater permitting program depending on the source (industrial versus municipal stormwater). These programs specify requirements for the regulated communities/facilities to establish a comprehensive stormwater management program (SWMP) or stormwater pollution prevention plan (SWPPP) to implement any requirements of the TMDL allocation (see 40 CFR Part130).

Stormwater discharges vary significantly in flow and pollutant concentration, and the relationships between discharges and water quality can be complex. For municipal stormwater discharges in particular, the use of system-wide permits and a variety of jurisdiction-wide BMPs, including educational and programmatic BMPs, does not easily accommodate to the existing methodologies for deriving numeric water quality-based effluent limitations. These methodologies were designed primarily for process wastewater discharges, which occur at predictable rates with predictable pollutant loadings under low-flow conditions in receiving waters. EPA has recognized such problems and developed permitting guidance for stormwater permits (USEPA 1996).

Because of the nature of stormwater discharges, and typical lack of information on which to base numeric water quality-based effluent limitations (expressed as concentration and mass), EPA recommends basing an interim permitting approach for NPDES stormwater permits on BMPs. EPA permitting guidance states that, "[t]he interim permitting approach uses BMPs in first-round storm water permits, and expanded or better-tailored BMPs in subsequent permits, where necessary, to provide for the attainment of water quality standards" (USEPA 1996).

A monitoring component is also included in the recommended BMP approach. According to EPA permitting guidance, "each storm water permit should include a coordinated and cost-effective monitoring program to gather necessary information to determine the extent to which the permit provides for attainment of applicable water quality standards and to determine the appropriate conditions or limitations for subsequent permits" (USEPA 1996). This approach was further elaborated in a guidance memo issued in 2002. "The policy outlined in this memorandum affirms the appropriateness of an iterative, adaptive management BMP approach, whereby permits include effluent limits (e.g., a combination of structural and nonstructural BMPs) that address stormwater discharges, implement mechanisms to evaluate the performance of such controls, and make adjustments (i.e., more stringent controls or specific BMPs) as necessary to protect water quality. … If it is determined that a BMP approach (including an iterative BMP approach) is appropriate to meet the stormwater component of the TMDL, EPA recommends that the TMDL reflect this" (Wayland and Hanlon 2002). This BMP-based approach to stormwater sources in TMDLs is also recognized and described in the most recent EPA guidance (USEPA 2008).

This TMDL adopts the EPA-recommended approach and relies on appropriate BMPs for implementation. No numeric effluent limitations are required or anticipated for municipal stormwater discharge permits.

7.4.2 Specific SWMP/SWPPP Requirements

As discussed in the Louisiana Small MS4 NPDES permit, if a TMDL assigns an individual WLA specifically to a MS4's stormwater discharge, LDEQ's permit specifies that the WLA must be included as a measurable goal for the SWMP.

Examples of activities that the MS4 may conduct to be consistent with the WLA include:

- Monitoring to evaluate program compliance, the appropriateness of identified BMPs, and progress toward achieving identified measurable goals
- Development of a schedule for implementation of additional controls and/or BMPs, if necessary, on the basis of monitoring results, to ensure compliance with applicable TMDLs.

8. Public Participation

Federal regulations require EPA to notify the public and seek comments concerning the TMDLs EPA prepares. These TMDLs were developed under contract to EPA, and EPA held a public review period seeking comments, information, and data from the public and any other interested parties. The notice for the public review period is anticipated to be published in the *Federal Register* around December X, 2011, and the review period closing around January X, 2012. Any comments will be reviewed, and these TMDLs may be revised if appropriate. All comments and EPA responses will be included in an appendix to the final TMDL document.

EPA will submit the final TMDL to LDEQ for implementation and incorporation into LDEQ's current WQMP.

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