BAYOU TECHE WATERSHED TMDL
FOR DISSOLVED OXYGEN
INCLUDING WLAS FOR TWENTY-TWO FACILITIES
AND ADDRESSING NUTRIENTS

SUBSEGMENTS 060205, 060301, 060401, AND 060501

SURVEYED APRIL AND NOVEMBER, 1978

By:

Jay Carney
Louisiana Department of Environmental Quality
Office of Environmental Assessment
Environmental Technology Division
Engineering Services Group 2

December 1, 1999
Revised: January 5, 2000

EXECUTIVE SUMMARY

This report presents the results of a watershed based, calibrated modeling analysis of Bayou Teche. The modeling was conducted to establish a dissolved oxygen TMDL for the Bayou Teche watershed. The model extends from the headwaters at Bayou Courtableau near Port Barre to just above the northern section of the Charenton Drainage and Navigation Canal. Bayou Teche is in the Vermilion-Teche River Basin and includes water quality subsegments 060205, 060301, 060401, and 060501. A total of twenty-two facilities were included in the modeling effort.

The 1996 303(d) list cites Bayou Teche, subsegments 060205, 060301, 060401, and 060501 as being impaired due to organic enrichment/low DO. Subsegment 060205 is listed as priority nine, and subsegments 060301, 060401, and 060501 are listed as priority seven. The 1998 303(d) list cites two areas of Bayou Teche, subsegments 060401 and 060501, as being impaired due to organic enrichment/low DO. Both of these subsegments are priority one and require the development of a Total Maximum Daily Load (TMDL) for dissolved oxygen (DO).

Bayou Teche was also listed as impaired due to nutrients. The 1996 303(d) list cites subsegment 060401 as being impaired due to nutrients and the 1998 303(d) list cites subsegments 060401 and 060501 as being impaired due to nutrients. Bayou Teche has natural levees which convey nonpoint sources away from the Bayou. The sources for nutrients in Bayou Teche are the upstream watersheds, Bayou Cocodrie and the Atchafalaya Basin. LDEQ's position, as supported by the ruling in the lawsuit regarding water quality criteria for nutrients (Sierra Club v. Givens, 710 So.2d 249 (La. App. 1st Cir. 1997), writ denied, 705 So.2d 1106 (La. 1998), is that when oxygen-demanding substances are controlled and limited in order to ensure that the dissolved oxygen criterion is supported, nutrients are also controlled and limited. The implementation of best management practices in the Bayou Cocodrie watershed and the Atchafalaya Basin to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources will also control and reduce the nutrient loading entering the Bayou Teche watershed. The primary nutrient source is the Atchafalaya Basin which has the Mississippi River as its primary source. The key to reducing nutrient loading in Bayou Teche is the reduction of nutrient loading to the Mississippi River.

Subsegment 060501 was not included in this modeling effort. This subsegment of Bayou Teche is a conveyance channel that stretches from Wax Lake Outlet to the southern section of the Charenton Drainage and Navigation Canal. The source of water for this subsegment is either Wax Lake Outlet or the Lower Atchafalaya River depending on the operation of the East Calumet Floodgate. This stretch of Bayou Teche exhibits negative and positive flow as indicated at the USGS Station 07385800 near Franklin, Louisiana. A review of the flow data at the station for the period of 1986-1992 revealed that only 125 values out of 1,911 were positive. The remainder were negative indicating that the flow in subsegment 060501 is predominately coming through the West Calumet Floodgate and into the southern section of the Charenton Drainage and Navigation Canal where it exits. There are no point sources discharging to this reach of Bayou Teche;

therefore, the Waste Load Allocation (WLA) is zero. Also, the Load Allocation (LA) for man-made nonpoint source contributions is assumed to be zero due to the natural levee along Bayou Teche. Therefore, the loading for this subsegment is the background loading which comes from the Atchafalaya Basin. This loading from the Atchafalaya Basin has not been quantified at this time.

Input data for the calibration model for DO was developed from the previous model completed in 1984. The 1984 model used data from surveys conducted in April and November 1978. A satisfactory calibration was achieved. For the projection models, data was taken from the current discharge permits and applications.

LIMNOSS, a well documented and frequently utilized water quality model, was used in this study. Its popularity is derived from the simplicity of its input dataset construction and comprehensible output. LIMNOSS is a one-dimensional, steady-state dissolved oxygen (DO) model developed by LimnoTech, Inc. (LimnoTech, 1984). The program is written in FORTRAN IV, and uses a finite-difference solution technique that is a recognized method for water quality simulations under flowing conditions.

The current state standard requires a DO of 5 mg/L throughout the year. A UAA is proposed reducing the DO standard for Bayou Teche to 3 mg/L March-November and 5 mg/L December-February. Therefore, model projections were performed at those particular seasons. In addition, projections were performed at the current year-round DO criterion of 5 mg/L using the same seasons as mentioned above. Projection results are summarized below.

Summer, March-November, 3 DO criterion and Winter, December-February, 5 DO criterion:

These two scenarios met the DO criterion without assigning stricter limits for the facilities. Furthermore, the SOD was kept at the calibration values. The minimum summer DO was 4.3 mg/L and the minimum winter DO was 5.2 mg/L. The resulting permit limits and TMDLs are shown in the tables below.

Permit Limits for March-November with DO criterion of 3 mg/L and December-February with DO criterion of 5 mg/L:

FACILITY	CURRENT PERMIT LIMITS ($CBOD_5/NH_3$-N/DO), mg/L	PROPOSED PERMIT LIMITS ($CBOD_5/NH_3$-N/DO), mg/L
Port Barre, Town of; Port Barre Wastewater Treatment Plant	10/*/*	10/10/2
St. Landry Parish Sewer District #1, Linwood Subdivision	10/*/*	10/10/2
CBS Enterprises, CBS Mobile Home Park (east pond)	30/*/*	30/15/2
St. Landry Parish School Board, Leonville High School	30/*/*	30/15/2
St. Martin Parish School Board, Teche Elementary School	30/*/*	30/15/2
Acadiana Treatment Sys Inc, Magenta Plantation Townhomes Subdivision	45/*/*	45/15/2
Dallas Trailer Park	45/*/*	45/15/2
LA Sugar Cane Coop Inc, Breaux Bridge Branch	*/*/*	0/0/2 (once-through non-contact cooling water)
Bent Oak Trailer Park	30/*/*	30/15/2
St. Martin Parish Police Jury, St.Martinville Industrial Park Wastewater Treatment Plant	10/*/*	10/10/2
Loreauville, Village of	10/*/*	10/10/2
Breaux's Bay Craft Inc	45/*/*	45/15/2
Iberia Parish Sewerage Dist #1, Breaux Estates Subdivision	30/*/*	30/15/2
Cajun Sugar Coop., Inc.; Cajun Sugar Factory	15/*/* (calculated from mass limit)	15/0/2 (Sugar mills are not a source of ammonia)
Louisiana Water Co.-New Iberia Water Treatment Plant	*/*/*	2/1/2
Iberia Sugar Coop., Inc.	Outfall 004: 18/*/* (calculated from mass limit) Outfall 006: */*/*	18/0/2 (Sugar mills are not a source of ammonia) 0/0/2 (once-through non-contact cooling water)
Bayou Side Trailer Park	45/*/*	45/15/2
Mosquito Control Contractors Inc. (MCCI)	45/*/*	45/15/2
Iberia Parish Government, Rosedale Subdivision	30/*/*	30/15/2
Iberia Parish School Board, Jeanerette Sr. High School	30/*/*	30/15/2
Yellow Bowl Restaurant	45/*/*	45/15/2
Cypress Bayou Casino	10/*/*	10/10/2

*Currently not permitted for this parameter

Calculation of the TMDL, Summer, 3 mg/L DO			
Load description	WLA (lbs/day)	LA (lbs/day)	Reserve/ MOS Load (lbs/day)
Point Source loads	3,157		789
Headwater / Tributary loads		25,100	
Benthic loads		12,589	
SUB-TOTAL	**3,157**	**37,689**	**789**
TMDL = WLA + LA + MOS		***41,636***	

Calculation of the TMDL, Winter, 5 mg/L DO			
Load description	WLA (lbs/day)	LA (lbs/day)	Reserve/ MOS Load (lbs/day)
Point Source loads	3,157		789
Headwater / Tributary loads		23,922	
Benthic loads		5,314	
SUB-TOTAL	**3,157**	**29,236**	**789**
TMDL = WLA + LA + MOS		***33,183***	

Summer, March-November, 5 DO criterion:

In this scenario, the limits for two facilities were changed as well as the SOD in order meet the DO criterion of 5 mg/L. The limits for the St. Martin Parish Police Jury and Cajun Sugar were made more stringent. The tables below present the permit limits for all of the facilities and the TMDL. The SOD was reduced 25% in order to meet the DO criterion. An SOD reduction of 25% could possibly be attained since there is TMDL modeling taking place for the Bayou Cocodrie/Bayou Boeuf system, which would lead to implementation of nonpoint controls in that system, which in turn, would reduce the nonpoint loading reaching Bayou Teche. The Cocodrie/Boeuf system is headwaters to Bayou Teche.

Permit Limits for March-November with DO criterion of 5 mg/L:

FACILITY	CURRENT PERMIT LIMITS ($CBOD_5/NH_3$-N/DO), mg/L	PROPOSED PERMIT LIMITS ($CBOD_5/NH_3$-N/DO), mg/L
Port Barre, Town of; Port Barre Wastewater Treatment Plant	10/*/*	10/10/2
St. Landry Parish Sewer District #1, Linwood Subdivision	10/*/*	10/10/2
CBS Enterprises, CBS Mobile Home Park (east pond)	30/*/*	30/15/2
St. Landry Parish School Board, Leonville High School	30/*/*	30/15/2
St. Martin Parish School Board, Teche Elementary School	30/*/*	30/15/2
Acadiana Treatment Sys Inc, Magenta Plantation Townhomes Subdivision	45/*/*	45/15/2
Dallas Trailer Park	45/*/*	45/15/2
LA Sugar Cane Coop Inc, Breaux Bridge Branch	*/*/*	0/0/2 (once-through non-contact cooling water)
Bent Oak Trailer Park	30/*/*	30/15/2
St. Martin Parish Police Jury, St.Martinville Industrial Park Wastewater Treatment Plant	10/*/*	5/2/2
Loreauville, Village of	10/*/*	10/10/2
Breaux's Bay Craft Inc	45/*/*	45/15/2
Iberia Parish Sewerage Dist #1, Breaux Estates Subdivision	30/*/*	30/15/2
Cajun Sugar Coop., Inc.; Cajun Sugar Factory	15/*/* (calculated from mass limit)	5/0/5 (Sugar mills are not a source of ammonia)
Louisiana Water Co.-New Iberia Water Treatment Plant	*/*/*	2/1/2
Iberia Sugar Coop., Inc.	Outfall 004: 18/*/* (calculated from mass limit) Outfall 006: */*/*	18/0/2 (Sugar mills are not a source of ammonia) 0/0/2 (once-through non-contact cooling water)
Bayou Side Trailer Park	45/*/*	45/15/2
Mosquito Control Contractors Inc. (MCCI)	45/*/*	45/15/2
Iberia Parish Government, Rosedale Subdivision	30/*/*	30/15/2
Iberia Parish School Board, Jeanerette Sr. High School	30/*/*	30/15/2
Yellow Bowl Restaurant	45/*/*	45/15/2
Cypress Bayou Casino	10/*/*	10/10/2

*Currently not permitted for this parameter

Calculation of the TMDL, Summer, 5 mg/L DO			
Load description	WLA (lbs/day)	LA (lbs/day)	Reserve/ MOS Load (lbs/day)
Point Source loads	1,624		406
Headwater / Tributary loads		25,100	
Benthic loads		9,441	
SUB-TOTAL	**1,624**	**34,541**	**406**
TMDL = WLA + LA + MOS		***36,572***	

In accordance with Section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act, the LDEQ has established a comprehensive program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters. This information is also utilized in establishing priorities for the LDEQ nonpoint source program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list. The sampling schedule for the first five-year cycle is shown below.

1998 - Mermentau and Vermilion-Teche River Basins
1999 - Calcasieu and Ouachita River Basins
2000 - Barataria and Terrebonne Basins
2001 - Lake Pontchartrain Basin and Pearl River Basin
2002 - Red and Sabine River Basins

(Atchafalaya and Mississippi Rivers will be sampled continuously.) Mermentau and Vermilion-Teche Basins will be sampled again in 2003.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

1.0 Introduction

The 1996 303(d) list cites Bayou Teche, subsegments 060205, 060301, 060401, and 060501 as being impaired due to organic enrichment/low DO. Subsegment 060205 is listed as priority nine, and subsegments 060301, 060401, and 060501 are listed as priority seven. The 1998 303(d) list cites two areas of Bayou Teche, subsegments 060401 and 060501, as being impaired due to organic enrichment/low DO. Both of these subsegments are priority one and require the development of a Total Maximum Daily Load (TMDL) for dissolved oxygen (DO).

Bayou Teche was also listed as impaired due to nutrients. The 1996 303(d) list cites subsegment 060401 as being impaired due to nutrients and the 1998 303(d) list cites subsegments 060401 and 060501 as being impaired due to nutrients. Bayou Teche has natural levees which convey nonpoint sources away from the Bayou. The sources for nutrients in Bayou Teche are the upstream watersheds, Bayou Cocodrie and the Atchafalaya Basin. LDEQ's position, as supported by the ruling in the lawsuit regarding water quality criteria for nutrients (Sierra Club v. Givens, 710 So.2d 249 (La. App. 1st Cir. 1997), writ denied, 705 So.2d 1106 (La. 1998), is that when oxygen-demanding substances are controlled and limited in order to ensure that the dissolved oxygen criterion is supported, nutrients are also controlled and limited. The implementation of best management practices in the Bayou Cocodrie watershed and the Atchafalaya Basin to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources will also control and reduce the nutrient loading entering the Bayou Teche watershed. The primary nutrient source is the Atchafalaya Basin which has the Mississippi River as its primary source. The key to reducing nutrient loading in Bayou Teche is the reduction of nutrient loading to the Mississippi River.

Surveys were conducted on Bayou Teche in April and November 1978. A calibrated water quality model, verification, and projections were developed in November 1984 using the 1978 survey data. A recalibration of the previous model was developed and projections were modeled to quantify the point source and nonpoint source waste load reductions which would be necessary in order for Bayou Teche to comply with its established water quality standards and criteria. Updated stream flows and discharger data were used. This report presents the results of water quality modeling which was based on the previous model.

2.0 Study Area Description

2.1 General Information

Water quality subsegments 060205, 060301, 060401, and 060501 are part of the Vermilion-Teche River Basin. Most of Bayou Teche is located in the Vermilion-Teche River Basin which lies in south-central Louisiana. The upper end of the basin lies in the central part of the state near Alexandria, and the basin extends southward to the Gulf of Mexico. The basin is bordered on the north and northeast by a low escarpment and the lower end of the Red River Basin. The Atchafalaya River Basin is to the east, and the

Mermentau River Basin is to the west. The Vermilion-Teche River Basin has an area of approximately 4,000 square miles (LDEQ, 1987).

Bayou Teche occupies the highest part of a very large alluvial ridge similar in size to the nearby ridge of the Mississippi River. Elevations on the ridge near the bayou range from 30 feet above sea level at Port Barre to 20 feet at New Iberia and 10 feet at Franklin. The ridge slopes gently to the swamps which lie from one to three miles back on either side where elevations are generally from 5 to 10 feet lower than near the bayou. Since all local drainage is away from the stream, it functions principally as a flume, conveying drainage from Bayou Courtableau to the Vermilion and lower Teche systems (LDEQ, 1987).

The subsegments of interest in this TMDL effort are 060205, 060301, 060401, and 060501. The land use for these subsegments is summarized in Tables 1-4.

Table 1. Land Uses in Segment 0602

LAND USE TYPE	NUMBER OF ACRES	% OF TOTAL AREA
Urban	46,942	4.5
Extractive	3,450	0.3
Agricultural	676,490	64.1
Forest Land	245,115	23.2
Water	5,180	0.5
Wetland	73,230	6.9
Barren Land	4,258	0.4
TOTAL AREA	1,054,665	100

Table 2. Land Uses in Segment 0603

LAND USE TYPE	NUMBER OF ACRES	% OF TOTAL AREA
Urban	186	35.3
Extractive	47	8.9
Agricultural	294	55.8
Forest Land	0	0.0
Water	0	0.0
Wetland	0	0.0
Barren Land	0	0.0
TOTAL AREA	527	100

Table 3. Land Uses in Segment 0604

LAND USE TYPE	NUMBER OF ACRES	% OF TOTAL AREA
Urban	1,805	21.5
Extractive	0	0.0
Agricultural	6,497	77.5
Forest Land	0	0.0
Water	9	0.1
Wetland	74	0.9
Barren Land	0	0.0
TOTAL AREA	8,385	100

Table 4. Land Uses in Segment 0605

LAND USE TYPE	NUMBER OF ACRES	% OF TOTAL AREA
Urban	4,303	10.4
Extractive	127	0.3
Agricultural	27,710	67.3
Forest Land	0	0.0
Water	357	0.9
Wetland	8,675	21.1
Barren Land	24	0.1
TOTAL AREA	41,196	100

Subsegment 060501 was not included in this modeling effort. This subsegment of Bayou Teche is a conveyance channel that stretches from Wax Lake Outlet to the southern section of the Charenton Drainage and Navigation Canal. The source of water for this subsegment is either Wax Lake Outlet or the Lower Atchafalaya River depending on the operation of the East Calumet Floodgate. This stretch of Bayou Teche exhibits negative and positive flow as indicated at the USGS Station 07385800 near Franklin, Louisiana. A review of the flow data at the station for the period of 1986-1992 revealed that only 125 values out of 1,911 were positive. The remainder were negative indicating that the flow in subsegment 060501 is predominately coming through the West Calumet Floodgate and into the southern section of the Charenton Drainage and Navigation Canal where it exits. Appendix A contains a flow analysis of Bayou Teche at Franklin and information about Wax Lake Outlet and the East & West Calumet Floodgates. There are no point sources discharging to this reach of Bayou Teche; therefore, the Waste Load Allocation (WLA) is zero. Also, the Load Allocation (LA) for man-made nonpoint source contributions is assumed to be zero due to the natural levee along Bayou Teche. Therefore, the loading for this subsegment is the background loading which comes from the Atchafalaya Basin. This loading from the Atchafalaya Basin has not been quantified at this time.

Bayou Fusilier, a small alluvial stream about 6 miles in length, functions as a distributary by connecting the Vermilion River at its head with Bayou Teche at Arnaudville. Another distributary, Ruth Canal, is about 4 miles long and connects Bayou Teche with the Vermilion River. It was built by private interests for diverting a portion of the Bayou Teche flow to the Vermilion River for rice irrigation (LDEQ, 1987).

The U.S. Army Corps of Engineers implemented a flow augmentation project that is designed to supplement the low flows in the Vermilion River and Bayou Teche by pumping water from the Atchafalaya River just north of Krotz Springs through a series of diversion structures. Atchafalaya River water is pumped into Bayou Teche and from there into the Vermilion River by way of Ruth Canal and Bayou Fusilier. This project was designed both to improve water quality in the Vermilion and Teche during summer low flow conditions and to provide additional water for irrigation of the area's crops. The first pumping began in November 1982, and the project plan was implemented in June 1983 (LDEQ, 1987).

The model extends from the headwaters at Bayou Courtableau near Port Barre to just above the northern section of the Charenton Drainage and Navigation Canal. Bayou Tortue, a tributary, was included as a point source in the model. A total of 22 facilities were included in the modeling effort. Maps of the study area are presented in Appendix A.

2.2 Water Quality Standards

The Water Quality criteria and designated uses for subsegments in the Bayou Teche watershed are shown in Table 5.

Table 5. Water Quality Numerical Criteria and Designated Uses

Subsegment	060205	060301	060401	060501
Stream Description	Headwaters at Bayou Courtableau to Interstate Hwy. 10	Interstate Hwy. 10 to Keystone Lock and Dam	Keystone Lock and Dam to the northern section of the Charenton Canal	Southern section of the Charenton Canal to Wax Lake Outlet
Designated Uses	A B C	A B C	A B C	A B C D
Criteria:				
Cl	40	40	80	80
SO_4	30	30	50	50
DO	5.0	5.0	5.0	5.0
pH	6.0 - 8.5	6.0 – 8.5	6.0 – 8.5	6.0 – 8.5
BAC	1	1	1	1
°C	32	32	32	32
TDS	220	220	350	350

USES: A – primary contact recreation; B – secondary contact recreation; C – propagation of fish and wildlife; D – drinking water supply

A Use Attainability Analysis is in progress for Bayou Teche which would change the current DO standard of 5 mg/L to seasonal criteria of 3 mg/L March – November and 5 mg/L December – February.

2.3 Wastewater Discharges

The discharger inventory for Bayou Teche and its tributaries was reviewed. A search on the LDEQ Permit Tracking System yielded 110 facilities discharging to Bayou Teche and its tributaries. Of these 110, twenty-two were included in the model projections. The remaining facilities were not included in the model and were eliminated based on the following:

- they were no longer discharging to the watershed
- they did not discharge oxygen demanding pollutants
- the volume of their discharge was insignificant
- their location was not in the Vermilion-Teche basin
- best professional judgement

The list of facilities and the modeling decision for each is shown in Appendix B.

2.4 Water Quality Conditions/Assessment

Subsegment 060205, Bayou Teche from the headwaters at Bayou Courtableau to I-10, is not supporting its designated uses according to the 1996 305(b) Water Quality assessment for Louisiana. Suspected causes of impairment are oil and grease, organic enrichment/low DO, pathogens, suspended solids, and turbidity from irrigated crop production, land development, minor industrial and municipal point sources, package plants (small flows), and septic tanks.

Subsegment 060301, Bayou Teche from I-10 to Keystone Lock and Dam, is not supporting its designated uses according to the 1996 305(b) Water Quality assessment for Louisiana. Suspected causes of impairment are organic enrichment/low DO, pathogens, suspended solids, and turbidity from land development, minor industrial point sources, nonirrigated crop production, package plants (small flows), petroleum activities, and septic tanks. The 1998 305(b) list has subsegment 060301 as partially supporting its designated uses.

Subsegment 060401, Bayou Teche from Keystone Lock and Dam to the northern section of the Charenton Canal, is not supporting its designated uses according to the 1996 305 (b) Water Quality assessment for Louisiana. Suspected causes of impairment are habitat alterations, nutrients, organic enrichment/low DO, pathogens, suspended solids, and turbidity from land development, minor industrial and municipal point sources, nonirrigated crop production, package plants (small flows), removal of riparian vegetation, and septic tanks. The 1998 305(b) list has subsegment 060401 as partially supporting its designated uses.

Subsegment 060501, Bayou Teche from the southern section of the Charenton Canal to Wax Lake Outlet, is partially supporting its designated uses according to the 1996 305 (b) Water Quality assessment for Louisiana. Suspected causes of impairment are habitat alterations, organic enrichment/low DO, pathogens, suspended solids, and turbidity from minor industrial and municipal point sources, nonirrigated crop production, removal of riparian vegetation, and septic tanks. The 1998 305(b) list has subsegment 060501 as fully supporting its designated uses.

2.5 Prior Studies

Surveys were conducted on Bayou Teche in April and November 1978. Water quality modeling was performed in November, 1984 using the survey data collected in 1978. It should be noted that the 1978 surveys did not produce the necessary data for modeling the tributaries to Bayou Teche.

3.0 Documentation of Calibration Model

3.1 Model Description and Input Data Documentation

3.1.1 Program Description

"Simulation models are used extensively in water quality planning and pollution control. Models are applied to answer a variety of questions, support watershed planning and analysis and develop total maximum daily loads (TMDLs). . . . Receiving water models simulate the movement and transformation of pollutants through lakes, streams, rivers, estuaries, or nearshore ocean areas. . . . Receiving water models are used to examine the interactions between loadings and response, evaluate loading capacities (LCs), and test various loading scenarios. . . . A fundamental concept for the analysis of receiving waterbody response to point and nonpoint source inputs is the principle of mass balance (or continuity). Receiving water models typically develop a mass balance for one or more constituents, taking into account three factors: transport through the system, reactions within the system, and inputs into the system." (EPA841-B-97-006, pp. 1-30)

LIMNOSS, a well documented and frequently utilized water quality model, was used in this study. Its popularity is derived from the simplicity of its input dataset construction and comprehensible output. LIMNOSS is a one-dimensional, steady-state dissolved oxygen (DO) model developed by LimnoTech, Inc. (LimnoTech, 1984). The program is written in FORTRAN IV, and uses a finite-difference solution technique that is a recognized method for water quality simulations under flowing conditions.

The development of a TMDL for dissolved oxygen generally occurs in 3 stages. 1) Data Collection Activities, 2) Calibration Model Development, 3) Projection Modeling and TMDL.

Stage 1 encompasses the data collection activities. These activities may include gathering such information as stream cross-sections, stream flow, stream water chemistry, stream temperature and dissolved oxygen at various locations on the stream, location of the stream centerline and the boundaries of the watershed which drains into the stream, and other physical and chemical factors which are associated with the stream. Additional data gathering activities include gathering all available information on each facility which discharges pollutants into the stream, gathering all available stream water quality chemistry and flow data from other agencies and groups, gathering population statistics for the watershed to assist in developing projections of future loadings to the waterbody, land use and crop rotation data where available, and any other information which may have some bearing on the quality of the waters within the watershed. During Stage 1, any data available from reference or least impacted streams which can be used to gauge the relative health of the watershed is also collected.

Stage 2 involves organizing all of this data into one or more useable forms from which the input data required by the model can be obtained or derived. Water quality samples, field measurements, and historical data must be analyzed and statistically evaluated in order to determine a set of conditions which have actually been measured in the watershed. The findings are then input to the model . Best professional judgement is used to determine initial estimates for parameters which were not or could not be measured in the field. These estimated variables are adjusted in sequential runs of the model until the model reproduces the field conditions which were measured. In other words, the model produces a value of the dissolved oxygen, temperature, or other parameter which matches the measured value within an acceptable margin of error at the locations along the stream where the measurements were actually made. When this happens, the model is said to be calibrated to the actual stream conditions. At this point, the model should confirm that there is an impairment and give some indications of the causes of the impairment. If a second set of measurements is available for slightly different conditions, the calibrated model is run with these conditions to see if the calibration holds for both sets of data. When this happens, the model is said to be verified.

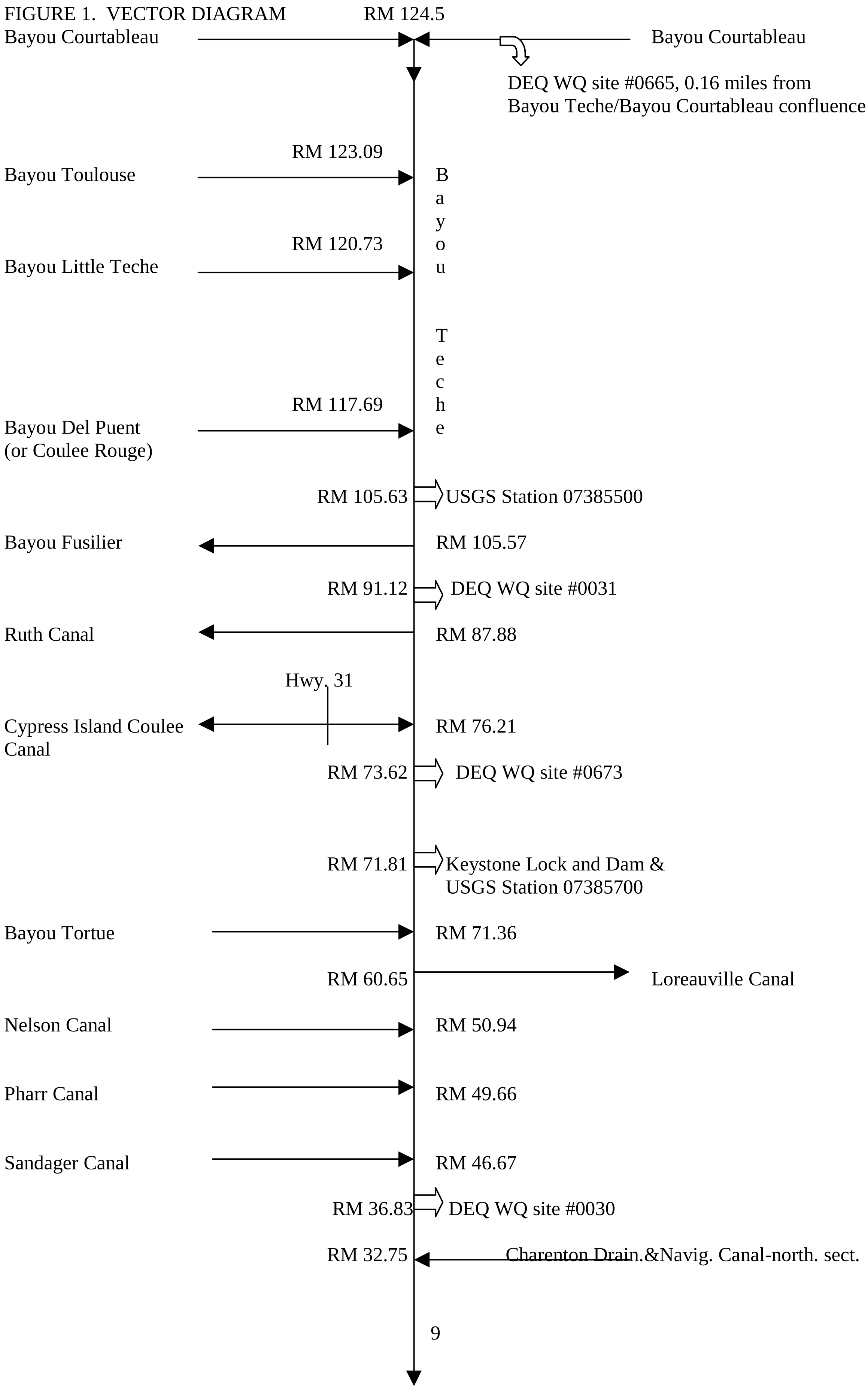
Stage 3 covers the projection modeling which results in the TMDL. The critical conditions of flow and temperature are determined for the waterbody and the maximum pollutant discharge conditions from the point sources are determined. These conditions are then substituted into the model along with any related condition changes which are required to perform worst case scenario predictions. At this point, the loadings from the point and nonpoint sources (increased by an acceptable margin of safety) are run at various levels and distributions until the model output shows that dissolved oxygen criteria are achieved. It is critical that a balanced distribution of the point and nonpoint source loads be made in order to predict any success in future achievement of water quality standards. At the end of Stage 3, a TMDL is produced which shows the point source permit limits and the amount of reduction in man-made nonpoint source pollution which must be achieved to attain water quality standards. The man-made portion of the NPS pollution is estimated from the difference between the calibration loads and the loads observed on reference or least impacted streams.

The previous modeling work completed in 1984 included a calibration using the April 1978 survey data. It was necessary to recalibrate the previous model since the model was calibrated to 5-day BOD, not the ultimate values. Furthermore, the model was calibrated to TKN, not ultimate NBOD values. The data for recalibration was taken directly from the April 1978 calibration input dataset, where appropriate.

3.1.2 Model Schematic or Vector Diagram

A vector diagram of the modeled area is shown in Figure 1.

FIGURE 1. VECTOR DIAGRAM



3.2 Model Input Discussion

3.2.1 Rivermiles

The model started at rivermile 124.5, the headwaters at Bayou Courtableau, and extended downstream to rivermile 33.5, just north of the Charenton Drainage and Navigation Canal.

3.2.2 Width

Widths were taken directly from the 1984 calibration model input. Widths ranged from 101-129 feet.

3.2.3 Depth

Depths were taken directly from the 1984 calibration model input. Depths ranged from 8-37 feet.

3.2.4 Temperature (TEMP)

Individual temperatures at each rivermile were not used as in the previous model. By looking at the range of temperatures used in the previous model, two temperature values were used to describe the temperatures in Bayou Teche during the survey. Temperatures of 23 and 24 ºC were used.

3.2.5 Photosynthesis (PHOTO) & Respiration (RESP)

The previous model included photosynthesis and respiration; however, photosynthesis and respiration were not necessary in the recalibration. A review of the data indicated algal activity was improbable. pH values were about 7.2-7.4; a pH of 8.0 or greater indicates algal activity. Furthermore, there was no substantial diurnal DO swing, secchi readings were low resulting in little light penetration, and nitrate values did not change significantly indicating no uptake of the nitrate by algae. Therefore, photosynthesis and respiration were set to zero.

3.2.6 Dissolved Oxygen Saturation (SATDO)

DO saturation values at the stream temperatures were obtained from the Standard Methods for the Examination of Water and Wastewater. At 23ºC, SATDO=8.6 mg/L and at 24 ºC, SATDO=8.4 mg/L.

3.2.7 Sediment Oxygen Demand (SEDI)

The SOD values were changed when the new calibration was performed. SOD ranged from 0.0-1.0 g/m^2-day.

3.2.8 Dispersion (DISP)

Dispersion values were taken directly from the previous model input. Dispersion values ranged from 32.3-64.5 ft^2/s. These values were in agreement with dispersion estimates on similar slow-moving, tidally influenced waterbodies in Louisiana, such as Bayou Queue de Tortue.

3.2.9 Carbonaceous Deoxygenation Rate (COXY)

COXY was taken directly from the previous model input. A value of 0.120/day was used.

3.2.10 Nitrogenous Deoxygenation Rate (NOXY)

NOXY was taken directly from the previous model input. A value of 0.030/day was used.

3.2.11 Reaeration (C-REAER)

The reaeration equation from Owens, Edwards, and Gibbs was used in the new calibration. This equation is applicable for most of the velocities and depths found in Bayou Teche.

3.2.12 Headwater Flow

The previous model used 695 cfs which was taken from the USGS Station 07385500 at Arnaudville on April 25, 1978, the date of the survey. The new calibration used the same flow, except that the flows from the tributaries and facilities upstream of the USGS station were subtracted out so that the model output would have 695 cfs at the rivermile of the USGS station.

3.2.13 Facility, Tributary, and Distributary Flows

All of these flows used in the previous calibration were used in the new calibration.

3.2.14 NBOD, CBOD, and DO Concentrations for Headwater, Facilities, and Tributaries

These concentrations were taken directly from the 1984 calibration. These values had to be converted to concentration units as required in LIMNOSS. The previous model required mass units. NBOD and CBOD ultimate values were used. The previous model was in error because it used 5-day BOD and TKN values. The spreadsheet in Appendix C shows the conversions from lbs/day to mg/L.

3.3 Model Discussion and Results

The calibration model input and output along with plots are presented in Appendix D. A hydrologic calibration was not done due to the lack of chloride and time of travel data. However, the flow balanced at the downstream USGS Station 07385700 as shown in the flow plot. No nonpoint flow was needed to balance the flow. Very good calibration was achieved for DO, CBOD, and NBOD. No nonpoint loads were needed in the water quality calibration.

4.0 Water Quality Projections

If the UAA is realized, the DO standard for Bayou Teche will be 3 mg/L March-November and 5 mg/L December-February. Therefore, model projections were performed at those particular seasons. In addition, projections were performed at the current year-round DO criterion of 5 mg/L using the same seasons as mentioned above.

4.1 Critical Conditions

4.1.1 Seasonality and Margin of Safety

The Clean Water Act requires the consideration of seasonal variation of conditions affecting the constituent of concern, and the inclusion of a margin of safety (MOS) in the development of a TMDL. For the Bayou Teche TMDL, LDEQ has employed an analysis of its long-term ambient data to determine critical seasonal conditions and used a combination of implied and explicit margins of safety.

In order to explain the relationship among parameters such as nonpoint loading, temperature, dissolved oxygen and SOD, LDEQ analyzed the Mermentau River Basin. Critical conditions for dissolved oxygen were determined for the Mermentau River Basin using long term water quality data from six stations on the LDEQ Ambient Monitoring Network and the Louisiana Office of State Climatology water budget. Graphical and regression techniques were used to evaluate the temperature and dissolved oxygen data from the Ambient Monitoring Network and the run-off determined from the water budget. Since nonpoint loading is conveyed by run-off, this seemed a reasonable correlation to use. Temperature is strongly inversely proportional to dissolved oxygen and moderately inversely proportional to run-off. Dissolved oxygen and run-off are also moderately directly proportional. The analysis concluded that the critical conditions for stream dissolved oxygen concentrations were those of negligible nonpoint run-off and low stream flow combined with high stream temperature.

When the rainfall run-off (and nonpoint loading) and stream flow are high, turbulence is higher due to the higher flow and the temperature is lowered by the run-off. In addition, run-off coefficients are higher in cooler weather due to reduced evaporation and evapotranspiration, so that the high flow periods of the year tend to be the cooler periods. Reaeration rates are, of course, much higher when water temperatures are cooler, but BOD decay rates are much lower. For these reasons, periods of high loading are periods of higher reaeration and dissolved oxygen but not necessarily periods of high BOD decay.

LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for the accumulated benthic blanket of the stream, which is, in turn, expressed as SOD and/or resuspended BOD in the model. This accumulated loading has its greatest impact on the stream during periods of higher temperature and lower flow. The manmade portion of the NPS loading is the difference between the calibration load and the reference stream load where the calibration load is higher.

LDEQ simulated critical summer and winter conditions in the Bayou Teche dissolved oxygen TMDL projection modeling by using the seasonal 7Q10 flow for all headwaters, and the 90th percentile temperature for the season. Nonpoint flows and loads were zero. As mentioned earlier in the report, Bayou Teche occupies the highest part of a very large alluvial ridge similar in size to the nearby ridge of the Mississippi River. Elevations on the ridge near the bayou range from 30 feet above sea level at Port Barre to 20 feet at New Iberia and 10 feet at Franklin. The ridge slopes gently to the swamps which lie from one to three miles back on either side where elevations are generally from 5 to 10 feet lower than near the bayou. Since all local drainage is away from the stream, it functions principally as a flume, conveying drainage from Bayou Courtableau to the Vermilion and lower Teche systems (LDEQ, 1987). Model loading was from point sources, one tributary, sediment oxygen demand, and resuspension of sediments. In addition, LDEQ assumes that all point sources are discharging at maximum capacity.

In reality, the highest temperatures occur in July-August, the lowest stream flows occur in October-November, and the maximum point source discharge occurs following a significant rainfall, i.e., high-flow conditions. The combination of these conditions plus the impact of other conservative assumptions regarding rates and loadings yields an implied margin of safety which is estimated to be in excess of 10%. Over and above this implied margin of safety, LDEQ used an explicit MOS of 20% for point source loads. The total MOS is estimated to exceed 30% for the Bayou Teche TMDL.

4.2 Model Input Discussion

4.2.1 Rivermiles

The model started at rivermile 124.5, the headwaters at Bayou Courtableau, and extended downstream to rivermile 33.5, just north of the Charenton Drainage and Navigation Canal. Updated rivermiles were obtained from ArcView.

4.2.2 Width

Widths from the previous model were used. For the summer season, widths from the “Nov 78 Verification” were used and ranged from 100-129 feet. Widths from the “Apr 78 Calibration” were used for the winter season and ranged from 101-129 feet.

4.2.3 Depth

Depths from the previous model were used. For the summer season, depths from the "Nov 78 Verification" were used and ranged from 5-12 feet. Depths from the "Apr 78 Calibration" were used for the winter season and ranged from 8-37 feet.

4.2.4 Temperature (TEMP)

LDEQ has two water quality sites on Bayou Teche for which data is available. Site 0030 is at Adeline, Louisiana and site 0031 is at Breaux Bridge, Louisiana. Data from both of these sites was retrieved for 1989-1998. The summer and winter 90^{th} percentile temperatures were calculated for each station, and then the average of the two 90^{th} percentile temperatures was taken and used as the seasonal critical temperature. Appendix E contains the temperature data and the percentile calculations. A summer critical temperature of 29.9°C was used, and the winter critical temperature was 15.9°C.

4.2.5 Photosynthesis (PHOTO) & Respiration (RESP)

Photosynthesis and respiration were set to zero.

4.2.6 Dissolved Oxygen Saturation (SATDO)

DO saturation values at the critical stream temperatures were obtained from the Standard Methods for the Examination of Water and Wastewater. At 29.9°C, SATDO=7.6 mg/L. At 15.9°C, SATDO=9.9 mg/L.

4.2.7 Sediment Oxygen Demand (SEDI)

Sediment Oxygen Demand (SOD) values remained at calibration values, 0.0-1.0 g/m^2-day, in two of the three projection runs. In the summer projection with a 5 mg/L DO criterion, the SOD ranged from 0.0-0.75 g/m^2-day. Thus, the SOD was lowered 25% in conjunction with more stringent limits for two facilities in order to meet the DO criterion of 5 mg/L.

4.2.8 Dispersion (DISP)

Dispersion values were not changed from calibration. They range from 32.3-64.5 ft^2/s.

4.2.9 Carbonaceous Deoxygenation Rate (COXY)

COXY was not changed from calibration. A value of 0.120/day was used.

4.2.10 Nitrogenous Deoxygenation Rate (NOXY)

NOXY was not changed from calibration. A value of 0.030/day was used.

4.2.11 Nonpoint: Flow, NBOD, CBOD, & DO (NONPFLOW, NONPNBOD, NONPCBOD, NONPDO)

Nonpoint values were not changed from calibration. They were set to zero.

4.2.12 Reaeration (C-REAER)

Reaeration was not changed from calibration. The reaeration equation from Owens, Edwards, and Gibbs was used.

4.2.13 Headwater Flow

A summer 7Q10 value of 634 cfs and a winter 7Q10 of 604 cfs were used. The 7Q10s were calculated using data from the USGS Station 07385500 at Arnaudville.

4.2.14 Headwater NBOD, CBOD, and DO

These headwater concentrations were from a sample at site 10 taken during the Bayou Courtableau survey on July 27-28, 1999. The site is located on Bayou Teche at Robin Street in Port Barre. The GSBOD program was used to analyze the BOD data. An ultimate CBOD value of 4.36 mg/L was used. Ultimate NBOD was expressed as TKN X 4.3 which gave a value of 2.92 mg/L. A value of 5.17 mg/L was used for DO. The GSBOD spreadsheet and field data can be found in Appendix F.

4.2.15 Facility Flows

Flows were determined based on available data from current permits and applications and then increased by 25% in order to explicitly incorporate a 20% margin of safety in the effluent loads. A 20% margin of safety would imply that the facility would be scaled up by 1/0.8 = 1.25, or by a 25% increase. Appendix B presents a spreadsheet with facility flow information.

4.2.16 Facility NBOD, CBOD, and DO

The model requires ultimate NBOD and CBOD values. Ultimate NBOD was calculated as NH_3-N X 4.3. Ultimate CBOD was calculated as $CBOD_5$ X 2.3. Some facilities were only permitted for BOD; therefore, appropriate permits limits for NH_3-N and DO were assumed based upon industry standards. Appendix B presents a spreadsheet with this information.

4.2.17 Tributary Flows

Bayou Toulouse: The winter and summer 7Q10 for this tributary is zero; therefore, it was not included in the model. Charles G. Lawson Trucking, Inc. is the only discharger on Bayou Toulouse. This facility was not included in the model since the flow is insignificant.

Bayou Little Teche: The winter and summer 7Q10 for this tributary is zero; therefore, it was not included in the model. There are three dischargers to Bayou Little Teche. Savoie's Sausage and Food Products, Inc. was not included because the facility flow is insignificant. Mark's Scrap and Salvage was not included since the file was created due to a complaint, and there is no permit. Opelousas Compressor Station was not included since the discharge is stormwater.

Bayou Del Puent: The winter and summer 7Q10 for this tributary is zero; therefore, it was not included in the model. No facilities were found discharging to Bayou Del Puent.

Coulee Rouge: The summer and winter 7Q10 for this tributary is zero; therefore, it was not included in the model. CBS Enterprises-CBS Mobile Home Park (east pond) and St. Landry Parish Sewer District #1-Linwood Subdivision discharge to Coulee Rouge. It is not known how close together the facilities are since Linwood Subdivision has no map in its file and the physical address did not help. If these two facilities are close enough to each other, their combined discharges could be significant. Therefore, CBS Enterprises-CBS Mobile Home Park (east pond) and St. Landry Parish Sewer District #1-Linwood Subdivision were included as point sources going directly to Bayou Teche.

Cypress Island Coulee Canal: When looking at a map, this waterbody appears to be a tributary of Bayou Teche; however, from LDEQ observations, only the first 0.3 miles (east of Highway 31) of Cypress Island Coulee Canal flow to Bayou Teche. The remainder flows away from Bayou Teche. Cypress Island Coulee Canal was not included in the model.

Bayou Tortue: This tributary was included in the model. It has a summer and winter 7Q10 of zero. However, it was included as a point source with a flow equal to the design capacity of the City of St. Martinville. The City of St. Martinville discharges to Bayou Tortue. Water quality data for this point source was taken from the previous model calibration at the Bayou Teche/Bayou Tortue confluence. The City of St. Martinville is 10 miles from Bayou Teche so its effluent has recovered by the time it enters Bayou Teche.

Nelson Canal: There are no dischargers to this tributary. It was not included in the model since there is no data to describe its water quality.

Pharr Canal: This tributary was not included in the model since there is no data to describe its water quality. Cleve Frederrick & Son Tank Co. is the only discharger on this tributary and was not included in the model. This facility's file exists only because of a complaint, and there is no permit.

Sandager Canal: This tributary was not included in the model since there is no data to describe its water quality. There are no dischargers on Sandager Canal.

Loreauville Canal: This canal is closed. There is no flow entering or leaving Bayou Teche.

Charenton Drainage and Navigation Canal (northern section): This tributary was not included in the model since the model stopped just north of the Charenton Drainage and Navigation Canal.

4.2.18 Distributary flows

Bayou Fusilier and Ruth Canal are distributaries of Bayou Teche, and each has a USGS station. 10^{th} percentile flows were used in the model. A summer 10^{th} percentile flow of 189 cfs for Bayou Fusilier was calculated using data from the USGS Station 07386200. A winter 10^{th} percentile flow of 169 cfs was used. From USGS Station 07386700, Ruth Canal had a summer 10^{th} percentile flow of 143 cfs and a winter 10^{th} percentile flow of 93 cfs. The 10^{th} percentile calculations can be found in Appendix G. However, the actual data was not printed out because the spreadsheet contains over 3000 lines.

4.3 Model Discussion and Results

The projection model input and output along with DO plots are presented in Appendix H. Three projection scenarios were modeled:

4.3.1 Summer, March-November, 3 DO criterion and Winter, December-February, 5 DO criterion

These two scenarios met the DO criterion without assigning stricter limits for the facilities. Furthermore, the SOD was kept at the calibration values. The minimum summer DO was 4.3 mg/L and the minimum winter DO was 5.2 mg/L. The resulting permit limits are shown in Table 6.

Table 6. Permit Limits for March-November with DO criterion of 3 mg/L and December-February with DO criterion of 5 mg/L

FACILITY	**CURRENT PERMIT LIMITS ($CBOD_5$/NH_3-N/DO), mg/L**	**PROPOSED PERMIT LIMITS ($CBOD_5$/NH_3-N/DO), mg/L**
Port Barre, Town of; Port Barre Wastewater Treatment Plant	10/*/*	10/10/2
St. Landry Parish Sewer District #1, Linwood Subdivision	10/*/*	10/10/2
CBS Enterprises, CBS Mobile Home Park (east pond)	30/*/*	30/15/2
St. Landry Parish School Board, Leonville High School	30/*/*	30/15/2
St. Martin Parish School Board, Teche Elementary School	30/*/*	30/15/2
Acadiana Treatment Sys Inc, Magenta Plantation Townhomes Subdivision	45/*/*	45/15/2
Dallas Trailer Park	45/*/*	45/15/2
LA Sugar Cane Coop Inc, Breaux Bridge Branch	*/*/*	0/0/2 (once-through non-contact cooling water)
Bent Oak Trailer Park	30/*/*	30/15/2
St. Martin Parish Police Jury, St.Martinville Industrial Park Wastewater Treatment Plant	10/*/*	10/10/2
Loreauville, Village of	10/*/*	10/10/2
Breaux's Bay Craft Inc	45/*/*	45/15/2
Iberia Parish Sewerage Dist #1, Breaux Estates Subdivision	30/*/*	30/15/2
Cajun Sugar Coop., Inc.; Cajun Sugar Factory	15/*/* (calculated from mass limit)	15/0/2 (Sugar mills are not a source of ammonia)
Louisiana Water Co.-New Iberia Water Treatment Plant	*/*/*	2/1/2
Iberia Sugar Coop., Inc.	Outfall 004: 18/*/* (calculated from mass limit) Outfall 006: */*/*	18/0/2 (Sugar mills are not a source of ammonia) 0/0/2 (once-through non-contact cooling water)
Bayou Side Trailer Park	45/*/*	45/15/2
Mosquito Control Contractors Inc. (MCCI)	45/*/*	45/15/2
Iberia Parish Government, Rosedale Subdivision	30/*/*	30/15/2
Iberia Parish School Board, Jeanerette Sr. High School	30/*/*	30/15/2
Yellow Bowl Restaurant	45/*/*	45/15/2
Cypress Bayou Casino	10/*/*	10/10/2

*Currently not permitted for this parameter

4.3.2 Summer, March-November, 5 DO criterion

In this scenario, the limits for two facilities were changed as well as the SOD in order meet the DO criterion of 5 mg/L. The limits for the St. Martin Parish Police Jury and Cajun Sugar were made more stringent. Table 7 below presents the permit limits for all of the facilities. The SOD was reduced 25% in order to meet the DO criterion. An SOD reduction of 25% could possibly be attained since there is TMDL modeling taking place for the Bayou Cocodrie/Bayou Boeuf system, which would lead to implementation of nonpoint controls in that system, which in turn, would reduce the nonpoint loading reaching Bayou Teche. The Cocodrie/Boeuf system is headwaters to Bayou Teche.

Table 7. Permit Limits for March-November with DO criterion of 5 mg/L

FACILITY	CURRENT PERMIT LIMITS ($CBOD_5$/NH_3-N/DO), mg/L	PROPOSED PERMIT LIMITS ($CBOD_5$/NH_3-N/DO), mg/L
Port Barre, Town of; Port Barre Wastewater Treatment Plant	10/*/*	10/10/2
St. Landry Parish Sewer District #1, Linwood Subdivision	10/*/*	10/10/2
CBS Enterprises, CBS Mobile Home Park (east pond)	30/*/*	30/15/2
St. Landry Parish School Board, Leonville High School	30/*/*	30/15/2
St. Martin Parish School Board, Teche Elementary School	30/*/*	30/15/2
Acadiana Treatment Sys Inc, Magenta Plantation Townhomes Subdivision	45/*/*	45/15/2
Dallas Trailer Park	45/*/*	45/15/2
LA Sugar Cane Coop Inc, Breaux Bridge Branch	*/*/*	0/0/2 (once-through non-contact cooling water)
Bent Oak Trailer Park	30/*/*	30/15/2
St. Martin Parish Police Jury, St.Martinville Industrial Park Wastewater Treatment Plant	10/*/*	5/2/2
Loreauville, Village of	10/*/*	10/10/2
Breaux's Bay Craft Inc	45/*/*	45/15/2
Iberia Parish Sewerage Dist #1, Breaux Estates Subdivision	30/*/*	30/15/2
Cajun Sugar Coop., Inc.; Cajun Sugar Factory	15/*/* (calculated from mass limit)	5/0/5 (Sugar mills are not a source of ammonia)
Louisiana Water Co.-New Iberia Water Treatment Plant	*/*/*	2/1/2
Iberia Sugar Coop., Inc.	Outfall 004: 18/*/* (calculated from mass limit) Outfall 006: */*/*	18/0/2 (Sugar mills are not a source of ammonia) 0/0/2 (once-through non-contact cooling water)
Bayou Side Trailer Park	45/*/*	45/15/2
Mosquito Control Contractors Inc. (MCCI)	45/*/*	45/15/2
Iberia Parish Government, Rosedale Subdivision	30/*/*	30/15/2
Iberia Parish School Board, Jeanerette Sr. High School	30/*/*	30/15/2
Yellow Bowl Restaurant	45/*/*	45/15/2
Cypress Bayou Casino	10/*/*	10/10/2

*Currently not permitted for this parameter

5.0 Calculated TMDLs, WLAs and LAs

TMDLs for the oxygen demanding constituents (CBOD, NH_3-N, and SOD) have been calculated for the summer and winter projection runs. They are presented in Appendix I. A summary of the loads is presented in Tables 8-10.

Table 8. Calculation of the TMDL, Summer, 3 mg/L DO

Load description	WLA (lbs/day)	LA (lbs/day)	Reserve/ MOS Load (lbs/day)
Point Source loads	3,157		789
Headwater / Tributary loads		25,100	
Benthic loads		12,589	
SUB-TOTAL	**3,157**	**37,689**	**789**
TMDL = WLA + LA + MOS		***41,636***	

Table 9. Calculation of the TMDL, Winter, 5 mg/L DO

Load description	WLA (lbs/day)	LA (lbs/day)	Reserve/ MOS Load (lbs/day)
Point Source loads	3,157		789
Headwater / Tributary loads		23,922	
Benthic loads		5,314	
SUB-TOTAL	**3,157**	**29,236**	**789**
TMDL = WLA + LA + MOS		***33,183***	

Table 10. Calculation of the TMDL, Summer, 5 mg/L DO			
Load description	WLA (lbs/day)	LA (lbs/day)	Reserve/ MOS Load (lbs/day)
Point Source loads	1,624		406
Headwater / Tributary loads		25,100	
Benthic loads		9,441	
SUB-TOTAL	**1,624**	**34,541**	**406**
TMDL = WLA + LA + MOS		***36,572***	

6.0 Sensitivity Analyses

All modeling studies necessarily involve uncertainty and some degree of approximation. It is therefore of value to consider the sensitivity of the model output to changes in model coefficients, and in the hypothesized relationships among the parameters of the model. In LIMNOSS, one parameter is varied while all others remain unchanged. Thus the sensitivity of each parameter is reviewed separately. A sensitivity analysis was performed on the calibration. The sensitivity of the model's minimum DO to these parameters is presented in Appendix J. Parameters were varied by +/- 30%, except temperature, which was adjusted +/- 2 degrees Celsius.

As shown in the summary table in Appendix J, reaeration is the parameter to which DO is most sensitive. The other parameters creating major variations in the minimum DO values are depth, temperature, width and SOD. Nitrogenous and carbonaceous deoxygenation rates are slightly sensitive. The model is not sensitive to dispersion.

7.0 Conclusions

This modeling effort included three projection scenarios:

(1) Summer, March-November, 3 mg/L DO criterion (if UAA is realized)
(2) Winter, December-February, 5 mg/L DO criterion (if UAA is realized)
(3) Summer, March-November, 5 mg/L DO criterion

In order to meet the 5 mg/L DO criterion for the summer season, two facilities required more stringent limits along with a 25% decrease in SOD. The 25% decrease in SOD could possibly be achieved by current modeling efforts in the Boeuf/Cocodrie systems which are north of Bayou Teche. The control strategies that will be implemented for the Boeuf/Cocodrie system will help reduce SOD in Bayou Teche.

The two remaining scenarios required no changes in SOD or point sources.

In accordance with Section 106 of the federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act, the LDEQ has established a comprehensive program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters. This information is also utilized in establishing priorities for the LDEQ nonpoint source program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list. The sampling schedule for the first five-year cycle is shown below.

1998 - Mermentau and Vermilion-Teche River Basins
1999 - Calcasieu and Ouachita River Basins
2000 - Barataria and Terrebonne Basins
2001 - Lake Pontchartrain Basin and Pearl River Basin
2002 - Red and Sabine River Basins

(Atchafalaya and Mississippi Rivers will be sampled continuously.)
Mermentau and Vermilion-Teche Basins will be sampled again in 2003.

8.0 References

LimnoTech, Inc. 1984. LIMNOSS Users' Manual: A One-Dimensional Steady-State Water Quality Model based on the USEPA ADAXIAL Framework, LimnoTech, Inc. Ann Arbor, MI. 71p.

Louisiana Department of Environmental Quality. 1987. State of Louisiana Water Quality Management Plan: Volume 4, *Basin/Segment Boundaries and Inventories*. LDEQ, Office of Water Resources, Water Pollution Control Division, Baton Rouge, Louisiana.

Louisiana Department of Environmental Quality. 1990. State of Louisiana Water Quality Management Plan: Volume 6, Part A *Nonpoint Source Pollution Assessment Report*. LDEQ, Office of Water Resources.

Louisiana Department of Environmental Quality. 1999. Environmental Regulatory Code: Part IX, *Water Quality Regulations*. Baton Rouge, Louisiana.

Rogers-Ramsey, Madeline. 1993. *Intensive Survey for Bayou Teche, April 1978*, for Louisiana Department of Environmental Quality, Office of Water Resources, Division of Water Pollution Control, Engineering Section, November 30, 1993; Revised January 31, 1995.

Rogers-Ramsey, Madeline. 1994. *Intensive Survey for Bayou Teche, November 1978*, for Louisiana Department of Environmental Quality, Office of Water Resources, Division of Water Pollution Control, Engineering Section, June 21, 1994; Revised February 14, 1995.

Standard Methods for the Examination of Water and Wastewater, 18th edition, 1992, page 4-101.