Final

BAYOU CHAUVIN WATERSHED TMDL FOR BIOCHEMICAL OXYGEN-DEMANDING SUBSTANCES AND NUTRIENTS

SUBSEGMENTS 120507

SURVEYED SEPTEMBER 9 – 16, 2003

TMDL REPORT

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EXECUTIVE SUMMARY

This report presents the results of a watershed based, calibrated modeling analysis of Bayou Chauvin. The modeling was conducted to establish a TMDL for biochemical oxygen-demanding pollutants for the Bayou Chauvin watershed. The model extends from site BC01 at RKM 14.7 to its confluence with Lake Boudreaux. Bayou Chauvin is located in south Louisiana and this subsegment includes St. Louis Canal, and numerous unnamed pipeline canals as tributaries. Bayou Chauvin is in the Terrebonne Basin and this study includes Water Quality Subsegment 120507. The area is sparsely populated and land use is dominated by water, marsh, and wetlands. There are no permitted dischargers located in this subsegment except pump stations discharging stormwater runoff.

Input data for the calibration model was developed from data collected during the September 2003 intensive survey, data collected by LDEQ monitoring stations in the watershed, and USGS drainage area and low flow publications. The nonpoint source loads included nonpoint loading not associated with flow. A satisfactory calibration was achieved for the main stem. For the projection models, data was taken from ambient temperature records. The Louisiana Total Maximum Daily Load Technical Procedures, 09/22/2003, have been followed in this study.

The various spreadsheets that were used in conjunction with the modeling program may be found in the appendices. Projections were adjusted to meet the dissolved oxygen criteria by reducing total nonpoint source loads.

Modeling was limited to low flow scenarios for both the calibration and the projections since the constituent of concern was dissolved oxygen and the available data was limited to low flow conditions. The model used was LAQUAL, a modified version of QUAL-TX, which has been adapted to address specific needs of Louisiana waters.

Bayou Chauvin, Subsegment 120507, was on the 1999, 2002, and 2004 303(d) list. Subsegment 120507 is found to be "not supporting" any of its designated uses of Primary Contact Recreation, Secondary Contact Recreation, and Fish and Wildlife Propagation. Bayou Chauvin was subsequently scheduled for TMDL development with other listed waters in the Terrebonne Basin. In the draft 2006 303(d) list, the water is fully supporting Primary and Secondary Contact Recreation and is not supporting Fish and Wildlife Propagation. The suspected causes of impairment are low dissolved oxygen and nutrients. The suspected sources are municipal point source discharges, small flow discharges, sanitary sewer overflows, and total retention domestic sewage lagoons. Bayou Chauvin conveys intermittent flow from the Houma stormwater pumps located at a dam across the bayou about 13.6 kilometers from Lake Boudreaux. It is believed that stormwater conveyed by the bayou is primarily responsible for violations of dissolved oxygen criteria. The DO becomes lower towards the bottom at the confluence with Lake Boudreaux due to settling combined with tidal influence. The high chlorides and conductivity values are characteristic of tidal waterbodies. The high chlorophyll a is indicative of the algae blooms present in open waters. Houma is considering moving the stormwater pumps to Bayou Terrebonne which would likely enhance the water quality of Bayou Chauvin. As stated above, no permitted dischargers are located in this subsegment. There is significant oil and gas activity, but these facilities are no longer allowed to discharge into waters of the state. Additionally, the Houma South Wastewater Treatment Plant, though located in this subsegment, discharges to the

Houma Navigation Canal and does not impact Bayou Chauvin.

This TMDL establishes load limitations for oxygen-demanding substances and goals for reduction of those pollutants. LDEQ's position, as supported by the declaratory ruling issued by Secretary Givens in response to 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 this TMDL through wastewater discharge permits and implementation of best management practices to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources in the watershed will also control and reduce the nutrient loading from those sources.

A calibrated water quality model for the watershed was developed and projections were modeled to quantify the non-point source load reductions which would be necessary in order for Bayou Chauvin, subsegment 120507 to comply with its established water quality standards and criteria. This report presents the results of that analysis.

The results of the projection modeling for subsegment 120507 show that the water quality standard of 4.0 mg/l for dissolved oxygen can be maintained during the summer critical season with a 43% reduction of total nonpoint pollution. The minimum DO is 4.39 mg/l. Background loading could not be calculated because there were no reference stream studies available for this area.

Table 1. Total Maximum Daily Load (Sum of UCBOD[1], UNBOD, and SOD)

ALLOCATION	**SUMMER**		**WINTER**	
	% Reduction Required	**(MAR-NOV) (lbs/day)**	**% Reduction Required**	**(DEC-FEB) (lbs/day)**
Point Source WLA	0	0	0	0
Point Source Reserve MOS (20%)	0	0	0	0
Manmade Nonpoint Source LA	43	21,106	43	18,282
Manmade Nonpoint Source Reserve MOS(20%)	0	5,277	0	4,571
TMDL		26,383		22,853

***Note1: UCBOD as stated in this allocation is Ultimate CBOD.
UCBOD to $CBOD_5$ ratio = 2.3 for all treatment levels
Permit allocations are generally based on $CBOD_5$***

The results of the projection modeling for subsegment 120507 show that the water quality standard of 4.0 mg/l for dissolved oxygen can be maintained during the winter critical season with the same 43% reduction of total nonpoint pollution. The minimum DO is 6.17 mg/l in subsegment 120507. The TMDL is presented in Table 1. A summary of the point sources is presented in Table 2.

The dissolved oxygen level in Lake Boudreaux at it's confluence with Bayou Chauvin is extremely low. This is believed to be primarily due to the stormwater drainage from the Houma stormwater pumps.

LDEQ will work with other agencies such as local Soil Conservation Districts to implement agricultural best management practices in the watershed through the 319 programs. LDEQ will also continue to monitor the waters to determine whether standards are being attained.

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 is continuing to implement a watershed approach to the surface water quality monitoring. In 2004 a four year sampling cycle replaced the previous five year cycle. Approximately one quarter of the states watersheds will be sampled in each year so that all of the states watersheds will be sampled within the four 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.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

Bayou Chauvin, subsegment 120507, of the Terrebonne Basin is listed on the 1999, 2002, and 2004 303(d) list. The subsegment is listed as not supporting any of its designated uses which are Primary Contact Recreation, Secondary Contact Recreation, and Fish and Wildlife propagation. In the draft 2006 303(d) list, the water is fully supporting Primary and Secondary Contact Recreation and is not supporting Fish and Wildlife Propagation. The suspected causes of impairment are low dissolved oxygen and nutrients. The suspected sources are municipal point source discharges, small flow discharges, sanitary sewer overflows, and total retention domestic sewage lagoons. Bayou Chauvin conveys intermittent flow from the Houma stormwater pumps located at a dam across the bayou about 13.6 kilometers from Lake Boudreaux. It is believed that stormwater conveyed by the bayou is primarily responsible for violations of dissolved oxygen criteria. As stated above, no permitted dischargers are located in this subsegment. There is significant oil and gas activity, but these facilities are no longer allowed to discharge into waters of the state. Additionally, the Houma South Wastewater Treatment Plant, though located in this subsegment, discharges to the Houma Navigation Canal and does not impact Bayou Chauvin. Because of the impairment, this subsegment requires the development of a total maximum daily load (TMDL) for oxygen demand substances and nutrients. A calibrated water quality model for the Bayou Chauvin, subsegment 120507 watershed was developed and projections for current dissolved oxygen standards were run to quantify the wasteload required to meet established dissolved oxygen criteria. This report presents the model development and results.

2. Study Area Description

2.1 General Information

Terrebonne Basin

“The Terrebonne Basin covers an area extending approximately 120 miles from the Mississippi River on the north to the Gulf of Mexico on the south. It varies in width from 18 miles to 70 miles. This basin is bounded on the west by the Atchafalaya River Basin and on the east by the Mississippi River and Bayou LaFourche. The topography of the entire basin is lowland, and all the land is subject to flooding except the natural “and manmade” levees along major waterways. The coastal portion of the basin is prone to tidal flooding and consists of marshes ranging from fresh to saline.” (LA DEQ, 1996)

This TMDL addresses Bayou Chauvin from BC01 at RKM 14.7 to Lake Boudreaux. This subsegment is tidally influenced. Water flows in either direction depending upon tides and wind conditions. The bayou conveys intermittent flow from the Houma stormwater pumps located at a dam across the bayou about 13.6 kilometers from Lake Boudreaux. This area is typical of the basin and is primarily comprised of water, wetlands and marsh as documented in Table 3 (LADEQ, 1999). A detailed land cover map of Subsegment 120507 is also included in Appendix H2. Average annual precipitation in the segment, based on the nearest Louisiana Climatic Station, is 64 inches based on a 30-year period of record (LSU, 1999). There is a Louisiana average annual precipitation map located in Appendix H3.

Table 2. Land Uses in Segment 120507

Land Type	Acres 120507	Percent Land use 120507
Water	7483.57	26.79
Wetland Forest Deciduous	4900.46	17.54
Brackish Marsh	4520.84	16.18
Agriculture/Cropland/Grassland	3021.23	10.81
Fresh Marsh	2321.35	8.31
Vegetated Urban	1318.35	4.72
Wetland S/S Deciduous	933.39	3.34
Wetland S/S Evergreen	236.18	0.85
Upland S/S Mixed	177.92	0.64
Non-Vegetated Urban	140.11	0.50
Upland Forest Mixed	89.85	0.32
Upland Forest Deciduous	6.00	0.02
Upland Barren	0.67	0.00

Figure 1. Model Layout

Bayou Chauvin Model Layout
Subsegment 120507

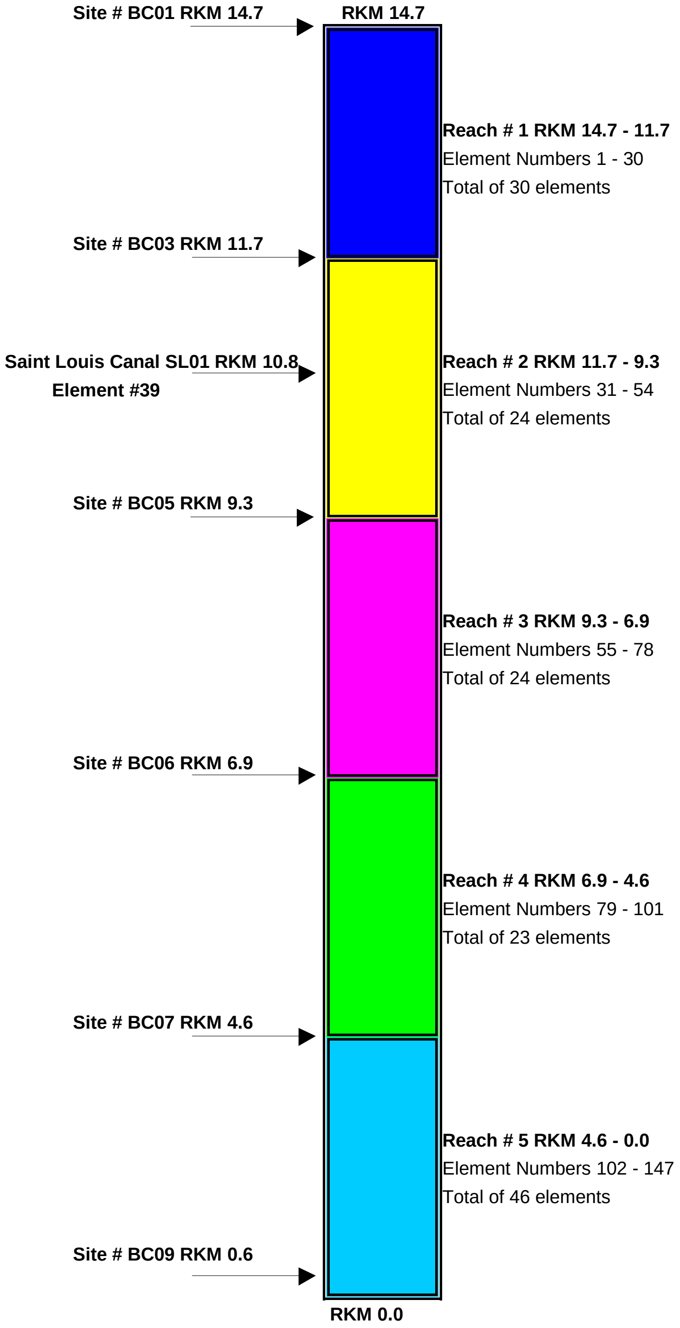
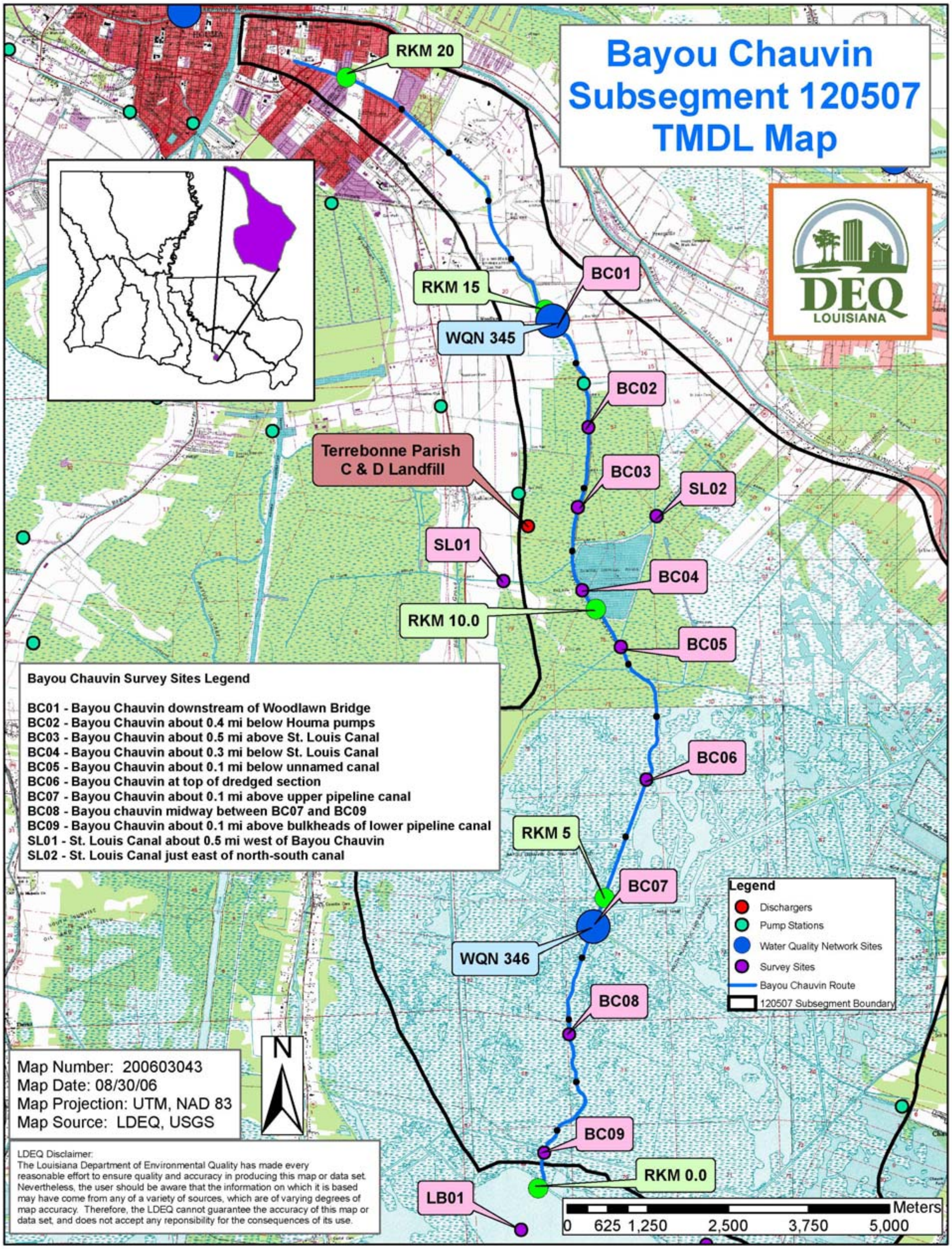


Figure 2. Map of Study Area



2.2 Water Quality Standards

The Water Quality criteria and designated uses for Bayou Chauvin Watershed are shown in Table 3. As noted in the table, Bayou Chauvin, Subsegment 120507 has a year round dissolved oxygen standard of 4.0 mg/L.

Table 3. Water Quality Numerical Criteria and Designated Uses

Parameter	Value
Designated Uses	A B C
DO, mg/L	4.0
Cl, mg/L	N/A
SO_4, mg/L	N/A
pH	6.5 – 9.0
BAC	1*
Temperature, deg Celsius	32
TDS, mg/L	N/A

USES: A – primary contact recreation; B - secondary contact recreation; C – propagation of fish and wildlife; D – drinking water supply; E – oyster propagation; F – agriculture; G – outstanding natural resource water; L – limited aquatic life and wildlife use.

*Note 1 – 200 colonies/100mL maximum log mean and no more than 25% of samples exceeding 400 colonies/100mL for the period May through October; 1,000 colonies/100mL maximum log mean and no more than 25% of samples exceeding 2,000 colonies/100mL for the period November through April.

2.3 Wastewater Discharges

No permitted facilities were found to be discharging directly into this subsegment. The primary source of oxygen demanding wastewater is believed to Terrebonne Parish Pump Station D-12, which pumps stormwater from Houma to Bayou Chauvin. There are three minor stormwater pump stations located within subsegment 120507 that may have a minor impact on the water quality of Bayou Chauvin. The location of these pumps is shown in the maps in Appendix H4.

Pump Station D-12 is the main Houma stormwater pumping station. The rest of the pumps shown are small units discharging stormwater from residential areas surrounding subsegment 120507. Pump Station D-06 discharges to a large canal leading to Bayou Chauvin. Pump Stations D-60 and D-36 discharge to marshes adjacent to Bayou Chauvin.

2.4 Water Quality Conditions/Assessment

Bayou Chauvin, subsegment 120507, of the Terrebonne Basin is listed on the 2004 303(d) list. This subsegment is listed as not supporting Primary Contact Recreation, Secondary Contact Recreation, and Fish and Wildlife Propagation. The suspected causes of impairment are low dissolved oxygen, and nutrients. The suspected sources are municipal point source discharges, small flow discharges, sanitary sewer overflows, and total retention domestic sewage lagoons. It is believed that stormwater conveyed by the bayou is primarily responsible for violations of dissolved oxygen criteria. Because of the impairment, this subsegment requires the development of a total maximum daily load (TMDL) for oxygen demanding substances and nutrients.

2.5 Prior Studies

LDEQ has two monthly water quality sampling stations on Bayou Chauvin. LDEQ Water Quality Site 345, Bayou Chauvin near Houma, LA has a period of record from February 1991 to April 1998. LDEQ Water Quality Site 346, Bayou Chauvin south of Houma, LA has a period of record from February 2000 to November 2000; January 2004 to November 2004; and January 1991 to May 1998. Data collected during the Eularian survey conducted in September 2003, included discharge data, cross-section data, field in-situ data, continuous monitor data, and lab water quality data. This data was used to establish the input for the model calibration and is presented in Appendix F.

3. Documentation Calibration Model

3.1 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 near shore 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)

The model used for this TMDL was LA-QUAL, a steady-state one-dimensional water quality model. LA-QUAL history dates back to the QUAL-I model developed by the Texas Water Development Board with Frank D. Masch & Associates in 1970 and 1971. William A. White wrote the original code.

In June, 1972, the United States Environmental Protection Agency awarded Water Resources Engineers, Inc. (now Camp Dresser & McKee) a contract to modify QUAL-I for application to the Chattahoochee-Flint River, the Upper Mississippi River, the Iowa-

Cedar River, and the Santee River. The modified version of QUAL-I was known as QUAL-II.

Over the next three years, several versions of the model evolved in response to specific client needs. In March, 1976, the Southeast Michigan Council of Governments (SEMCOG) contracted with Water Resources Engineers, Inc. to make further modifications and to combine the best features of the existing versions of QUAL-II into a single model. That became known as the QUAL-II/ SEMCOG version.

Between 1978 and 1984, Bruce L. Wiland with the Texas Department of Water Resources modified QUAL-II for application to the Houston Ship Channel estuarine system. Numerous modifications were made to enable modeling this very large and complex system including the addition of tidal dispersion, lower boundary conditions, nitrification inhibition, sensitivity analysis capability, branching tributaries, and various input/output changes. This model became known as QUAL-TX and was subsequently applied to streams throughout the State of Texas.

In 1999, the Louisiana Department of Environmental Quality and Wiland Consulting, Inc. developed LA-QUAL based on QUAL-TX Version 3.4. The program was converted from a DOS-based program to a Windows-based program with a graphical interface and enhanced graphic output. Other program modifications specific to the needs of Louisiana and the Louisiana DEQ were also made. LA-QUAL is a user-oriented model and is intended to provide the basis for evaluating total maximum daily loads in the State of Louisiana.

The development of a TMDL for dissolved oxygen generally occurs in 3 stages. 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 in to 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 water body, 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 judgment 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 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 of 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.

3.2 Input Data Documentation

Data collected during an intensive survey conducted from September 9 - 16, 2003, was used to establish the input for the model calibration. The data is presented in Appendix F. The flows in each reach and headwater were estimated based on the discharge measurement at BC09 and stream geometry.

Field and laboratory water quality data were entered in a spreadsheet for ease of analysis. The total CBOD curve presented in Appendix F5 is based on the measured daily CBOD values. The CBOD component was modeled in the LAQUAL model. NBOD simulated organic nitrogen, ammonia nitrogen, and nitrate/nitrite nitrogen. The Louisiana BOD program was applied to the BOD data in a separate spreadsheet and values were computed for each sample taken of ultimate CBOD, CBOD decay rate, CBOD lag time, as well as the NBOD, NBOD decay rate, and NBOD lag time. The survey data was the primary source of the model input data for initial conditions, decay rates, mainstem water temperature, dissolved oxygen loading, headwater temperature, and DO data.

3.2.1 Model Schematics and Maps

A vector diagram of the modeled area is presented in Figure 1 and Appendix C1. The vector diagram shows the locations of survey stations, the reach/element design, and the locations of the tributaries included in the model. An ARCVIEW map of the stream and subsegment showing river kilometers, survey stations, subsegment boundary and other points of interest are also included in Figure 2 and Appendix H1.

3.2.2 Model Options, Data Type 2

Five constituents were modeled during the calibration process. These were dissolved oxygen, carbonaceous biochemical oxygen demand, nitrogenous biochemical oxygen demand, chloride, and conductivity.

3.2.3 Program Constants, Data Type 3

A minimum K_L value of 0.7 m/day was used. This value is a conversion from 2.3 ft/day which is a Louisiana standard minimum. The K_2 maximum was set to 25 1/day at 20^o C which is the EPA Policy in the absence of a measured value.

The inihibition control value was set to option 3 which is all rates but sediment oxygen demand. The water column dissolved oxygen demand is assumed to come primarily from facultative bacteria under anoxic conditions and SOD is not influenced by modeled dissolved oxygen levels in the upper water column.

The hydraulic calculation method was set to option 2 or “widths and depths.” This was done because the low slopes in these waterbodies cause a substantial amount of water to be present in some reaches during critical flow. Using a modified Leopold relationship allows the model to predict a more accurate depth and width during low flow.

The settling rate units were set to option 2 which is 1/day. By making the settling rate a velocity, the rate becomes dependent upon the depth.

The tide height was set to 0.09 meters based upon the continuous monitor at BC09.

The maximum SOD rate was set to 20 gm/m^2-day as the maximum SOD allowable regardless of the amound of oxygen demanding materials settled.

Dispersion equation 3 was used to account for composite tidal and advective flows.

3.2.4 Temperature Correction of Kinetics, Data Type 4

The temperature values computed are used to correct the rate coefficients in the source/sink terms for the other water quality variables. These coefficients are input at 20 °C and are then corrected to temperature using the following equation:

$$X_T = X_{20} * \text{Theta}^{(T-20)}$$

Where:

X_T = the value of the coefficient at the local temperature T in degrees Celsius
X_{20} = the value of the coefficient at the standard temperature at 20 degrees Celsius
Theta = an empirical constant for each reaction coefficient

In the absence of specified values for data type 4, the model uses default values. A complete listing of these values can be found in the LA-QUAL for Windows User's Manual (LDEQ, 2004). For this model all values used were LAQUAL default values.

3.2.4 Reach Identification Data, Data Type 8

A diagram of the modeled area is presented in Appendix C1. The vector diagram shows the reach/element design and the location of St. Louis Canal. The modeled area is characterized by 6 sample sites. The model starts at site BC01 and extends approximately 14.6 km to Lake Boudreaux. This calibrated model includes 5 reaches, 147 elements, one headwater, and 1 tributary. A digitized map of the stream showing river kilometers, and the September 2003 survey sampling sites are included in Figure 2 and Appendix H1.

3.2.5 Advective Hydraulic Coefficients, Data Type 9

Louisiana streams typically do not empty out when the flow in the stream goes to zero. Therefore, hydraulic calculation method two was used for this stream to more accurately depict the geometry. The modified Leopold equations were utilized in this model for calibration. The measured widths and depths were based upon survey measurements. These measurements were used as the constants in data type 9. The coefficients and exponents were then acheived through calibration.

3.2.6 Dispersive Hydraulic Coefficients, Data Type 10

The tidal/wind dispersion was estimated based on the dye study. The dye study was conducted using the moving site method. There were three dye runs conducted during this study. Based on the data retrieved, the final dye run was determined to be most representative of the stream. This was because the final dye run had the longest run time, just over 24 hours. The longer time frame gave the dye a longer time to become more uniformly dispersed in the bayou. The Kd value was determined to be 0.266 and was conducted in Reach 2.

To take into consideration both advective and tidal transport, equation 3, ($D_L = aH^bQ^cV_M^d$) in Laqual was used. Using b=5/6, c=0, and d=1 will take into account both modes of transport in the manner of the Tracor and QUAL2E equations. The value for coefficient "a" was calibrated to in Reach 2 by setting all other parameters to the previously mentioned values. All documentation can be found in Appendix F6.

3.2.7 Initial Conditions, Data Type 11

The initial conditions are used to reduce the number of iterations required by the model. The values required for this model were temperature and DO by reach. The input values came from the survey station located closest to the reach. Chlorophyll a values were also used since the mild effects of algae on the dissolved oxygen concentrations were also simulated with this model. Since the initial conditions are only a starting point for the model, all values were set to averaged measured values. The input data and sources are shown in Appendix B2.

3.2.8 Reaeration Rates, Data Type 12

The applicability of the various reaeration equations was examined. The Texas Equation was the most applicable to Bayou Chauvin. The input data and sources are shown in Appendix B2.

3.2.9 Sediment Oxygen Demand, Data Type 12

The SOD values were achieved through calibration. The SOD value for each reach is shown in Appendix B2. The high SOD value in the first reach is indicative of the impact from the Houma stormwater pumps. The rest of the SOD values fall in a range that would be considered normal for this type of bayou. The conversion ratio of settled CBOD and settled NBOD to SOD was considered to be zero for all reaches due to the resuspension of bottom sediments.

3.2.10 Carbonaceous BOD Decay and Settling Rates, Data Type 12

The decay rates used were based on the bottle rates from the survey. The decay rates ranged from 0.054 to 0.094 per day. The CBOD curves presented in Appendix F5 were based on the measured daily CBOD values. The decay and settling rates used for each reach are shown in Appendix F5.

3.2.11 Nitrogenous BOD Decay and Settling Rates, Data Type 15

These rates are labeled NBOD Decay and Settling in the model. The decay rates used were based on the bottle rates from the survey. NBOD decay rates ranged from 0.059 to 0.191. The decay and settling rates used for each reach are shown in Appendix F5.

3.2.12 Nonpoint Sources, Data Type 19

Nonpoint source loads which are not associated with a flow are input into this part of the model. These can be most easily understood as resuspended load from the bottom sediments and are modeled as SOD, CBOD, and NBOD loads. These values are achieved through calibration.

3.2.13 Headwaters, Data Types 20, 21, and 22

The headwater flow was assumed to be an estimated flow based upon stream geometry and the measurement taken at BC09. The data and sources are presented in Appendix B2.

3.2.14 Wasteloads, Data Types 23, 24, and 25

No permitted facilities were found to be discharging directly into this subsegment. Additionally, St. Louis Canal was assumed to have a minimal flow during the survey.

3.2.15 Boundary Conditions, Data Type 27

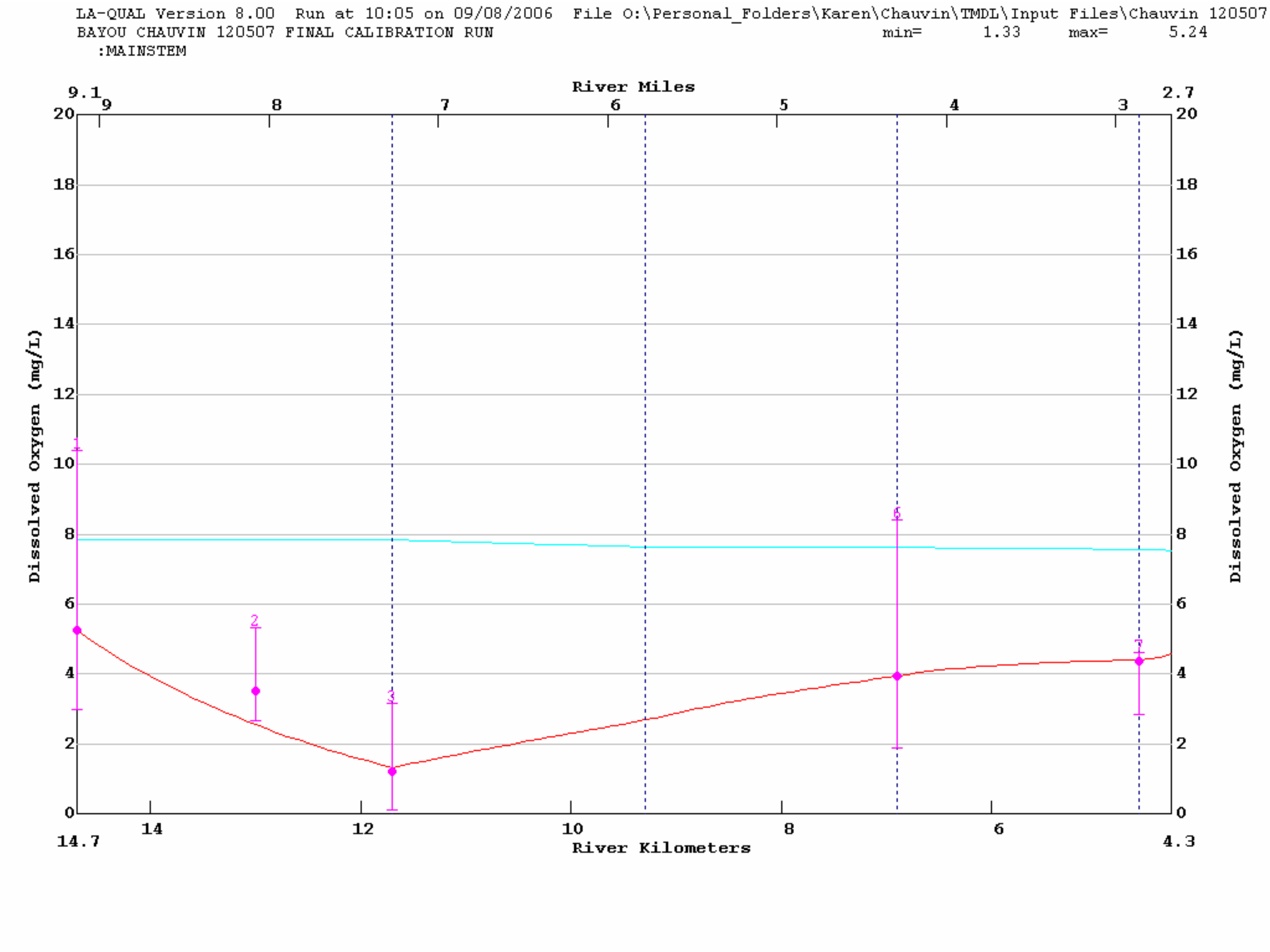
The lower boundary conditions were assumed to be equivalent to the measurements taken at survey station BC09.

3.3 Model Discussion and Results

The calibration model input and output is presented in Appendix B. The overlay plotting option was used to determine if calibration had been achieved. A plot of the dissolved oxygen concentration versus river kilometer is presented in Figure 3. The calibration points for dissolved oxygen and temperature were calculated based on the average continuous monitor readings wherever possible. The calibration points for CBOD and NBOD were the measured values from the water quality samples. The calibration points for conductivity were the insitu readings. The calibration points for the chlorides and chlorophyll A were the measured values from the water quality samples. There were no reference streams available, therefore, an overall reduction was calculated. The background conditions could not be determined.

An adequate calibration was achieved for DO, CBOD, and NBOD on the main stem. The calibration model shows that during September 2003 survey period, the DO standard of 4 mg/l was not being met in subsegment 120507 in reaches 1-3. The calibration model minimum DO on the main stem was 1.33 mg/l.

Figure 3. Calibration Model Dissolved Oxygen versus River Kilometer



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LA-QUAL Version 8.00  Run at 10:05 on 09/08/2006  File O:\Personal_Folders\Karen\Chauvin\TMDL\Input Files\Chauvin 120507
BAYOU CHAUVIN 120507 FINAL CALIBRATION RUN                                          min=      1.33     max=      5.24
  :MAINSTEM
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- numbered points indicate survey stations
- vertical lines indicate beginning of reach
- the horizontal line indicates the DO Criterion
- upper plotted line indicates DO saturation
- lower plotted line indicates calibration model output

4. Water Quality Projections

The traditional summer critical projection loading scenario was performed at the current annual DO standard. This scenario was based on reduced total nonpoint loads at summer season critical conditions (ie. 90th percentile seasonal temperatures and 7Q10 flows) in accordance with the LTP. A winter projection was run based on the percent reduction of total nonpoint loads used for summer critical projections.

4.1 Critical Conditions, 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 Chauvin, subsegment 120507 TMDL, an analysis of LDEQ ambient data has been employed to determine critical seasonal conditions and an appropriate margin of safety.

Critical conditions for dissolved oxygen were determined for Bayou Chauvin using water quality data from Bayou Chauvin water quality site number 345 for reaches 1 – 3 and water quality site 346 for reaches 4 - 5 on the LDEQ Ambient Monitoring Network. The 90th percentile temperature for each season and the corresponding 90% of saturation DO was determined. Ambient temperature data, critical temperature and DO saturation determinations are shown in Appendix G1.

Graphical and regression analysis techniques have been used by LDEQ historically to evaluate the temperature and dissolved oxygen data from the Ambient Monitoring Network and run-off determinations from the Louisiana Office of Climatology water budget. Since nonpoint loading is conveyed by run-off, this was 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 non-point 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 and DO saturation 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.

This phenomenon is interpreted in TMDL modeling by assuming that nonpoint loading associated with flows into the stream are responsible for the benthic blanket which accumulates on the stream bottom and that the accumulated benthic blanket of the stream, expressed as SOD and/or resuspended BOD in the calibration model, has reached steady state or normal conditions over the long term and that short term additions to the blanket are off set by short term losses. 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. The only mechanism for changing this normal benthic blanket condition is to implement best management practices and reduce the amount of nonpoint source loading entering the stream and feeding the benthic blanket.

Critical season conditions were simulated in the Bayou Chauvin, subsegment 120507 dissolved oxygen TMDL projection modeling by using the flow guidelines from the tidal algorithm procedure, and the 90th percentile temperature. The critical flow at BC09 was calculated using the tidal algorithm and then applied the same flow fractions used in the calibration shown in Appendix E3.

In reality, the highest temperatures occur in July-August, the lowest stream flows occur in October-November, and the maximum point and non point source discharge occurs following a significant rainfall, i.e., high-flow conditions. The summer projection model is established as if all these conditions happened at the same time. The winter projection model accounts for the seasonal differences in flows and BMP efficiencies. Other conservative assumptions regarding rates and loadings are also made during the modeling process. In addition to the conservative measures, an explicit MOS of 20% was used for all loads to account for future growth, safety, model uncertainty and data inadequacies.

4.2 Input Data Documentation

The LTP states that the flow for summer conditions should be 0.1 cfs or the 7Q10, whichever is greater. However, it also states that more appropriate critical conditions may be selected. A 7Q10 value cannot be determined for Bayou Chauvin because of tidal influences. The critical tidal flow was calculated at site BC09.

The total surface area of 8,145,920 square feet was multiplied by the tidal range of 0.6 feet. The tidal range was calculated from the continuous monitoring vented depth readings. This product was divided by the tidal period of 12 hours to determine the average tidal flow. The average tidal flow was calculated to be 113.14 cfs or 3.4604 cms. Therefore, the critical tidal flow was calculated to be one-third of the average tidal flow, which is 37.71 cfs or 1.0678 cms. The headwater flow and incremental inflows were then determined based on estimated flows from stream geometry. This is documented in Appendix F2.

Critical conditions include dissolved oxygen, temperature and flow. Pollutant loading is adjusted in the projection models to meet the dissolved oxygen criteria.

The calibration values were retained for the remaining parameters and used as input values in the summer and winter projections. The model adjusts the input values for SOD, CBODU decay, and NBODU decay based upon the input temperature. The model projects the width and depth values based upon the streamflow.

4.2.1 Model Options, Data Type 2

Three constituents were modeled during the projection process. These were dissolved oxygen, carbonaceous biochemical oxygen demand, and nitrogenous biochemical oxygen demand.

4.2.2 Temperature Correction of Kinetics, Data Type 4

The temperature correction factors specified in the LTP are entered in the model.

4.2.3 Reach Identification Data, Data Type 8

The reach-element design from the calibration was used in the projection modeling.

4.2.4 Advective Hydraulic Coefficients, Data Type 9

The hydraulic coefficients, exponents, and constants determined for the calibration were used in the projection model.

4.2.5 Initial Conditions, Data Type 11

The initial conditions were set to the 90th percentile critical season temperature in accordance with the LTP. The dissolved oxygen values for the initial conditions were set at the stream criteria.

4.2.6 Reaeration Rates, Carbonaceous BOD Decay and Settling Rates, Nitrogenous BOD Decay and Settling Rates, Data Type 12 and 15

The reaeration rate equations, CBOD decay and settling rates, NBOD decay and settling rates, and the fractions converting settled CBOD and settled NBOD to SOD were not changed from the calibration.

4.2.8 Sediment Oxygen Demand, Nonpoint Sources, Headwaters, Wasteloads, Data Type 12, 19, 20, 21, 22, 24, 25, and 26

The NPS values were calculated for each projection scenario using a load equivalent spreadsheet. An analysis was made of the calibration NPS and SOD loads in terms of total loading in units of gm-O_2/m^2/day. The same spreadsheet also calculated load reductions for the headwaters and wasteloads. The values and sources of the input data and the load analyses are presented in Appendix D for each of the projection runs.

LDEQ has collected and measured the CBOD and NBOD oxygen demand loading components for a number of years. These loads have been found in all streams including the non-impacted reference streams. It is LDEQ’s opinion that much of this loading is attributable to run-off loads which are flushed into the stream during run-off events, and subsequently settle to the bottom in our slow moving streams. These benthic loads decay and breakdown during the year, becoming easily resuspended into the water column during the low flow/high temperature season. This season has historically been identified as the critical dissolved oxygen season.

LDEQ simulates part of the non-point source oxygen demand loading as resuspended benthic load and SOD. The calibrated non-point loads, UCBOD, UNBOD and SOD, are summed to produce the total calibrated benthic load. The total calibrated benthic load is then reduced by the total background benthic load (determined from LDEQ's reference stream research) to determine the total manmade benthic loading. The manmade portion is then reduced incrementally on a percentage basis to determine the necessary percentage reduction of manmade loading required to meet the water body's dissolved oxygen criteria. These reductions are applied uniformly to all reaches sharing similar hydrology and land uses.

Following the same protocol as the point source discharges, the total reduced manmade benthic load is adjusted for the margin of safety by dividing the value by one minus the margin of safety. This adjusted load is added back to the total background benthic value to obtain the total projection model benthic load. This total projection benthic load is then broken out into its components of SOD, resuspended CBOD and resuspended NBOD by multiplying the total projection benthic load by the ratio of each calibrated component to the total calibrated benthic load.

LDEQ has found variations in the breakdown of the individual CBOD and NBOD components. While the total BOD is reliable, the carbonaceous and nitrogenous component allocation is subject to the type of test method. In the past, LDEQ used a method which suppressed the nitrogenous component to obtain the carbonaceous component value, which was then subtracted from the total measured BOD to determine the nitrogenous value. The suppressant in this method was only reliable for twenty days thus leading to the assumption that the majority of the carbonaceous loading was depleted within that period of time. The test results supported this assumption. Recently the suppressant started failing around day seven and the manufacturer of the suppressant will only guarantee it's potency for a five day period. LDEQ felt a five day test would not adequately depict the water quality of streams and began a search for a new test method. The research found a new proposed method for testing long term BODs in Standard Methods.

This proposed method is a sixty day test which measures the incremental total BOD of the sample while at the same time measuring the increase in nitrite/nitrate in the sample. This increase in nitrite/nitrate allows LDEQ to calculate the incremental nitrogenous portion by multiplying the increase by 4.57 to determine the NBOD daily readings. These NBOD daily readings are then subtracted from the daily reading for total BOD to determine the CBOD daily values. A curve fit algorithm is then applied to the daily component readings to obtain the estimated ultimate values of each component as well as the decay rate and lag times of the first order equations.

LDEQ implemented the new test method during the 2000 survey season. The results obtained using the new method showed that a portion of the CBOD first order equation does begin to level off prior to the twentieth day, however a secondary CBOD component begins to use dissolved oxygen sometime between day ten and day twenty-five. This secondary CBOD component was not being assessed as CBOD using the previous method but was being included in the NBOD load. Thus the CBOD and NBOD component loading used in the reference stream studies is not consistent with the results using the new proposed 60 day method and the individual values should not be used to determine background values for samples processed using the new test methods. However, the sum of CBOD and NBOD should be about the same for both new and old test methods. For this reason LDEQ decided to use the sum of reference stream benthic loads as background values. Again, background values can not be quantified for Bayou Chauvin.

The resuspended total nonpoint CBOD and NBOD loading was reduced by 43% for all reaches in the summer critical projection scenario to meet the summer water quality criterion for dissolved oxygen. Since LDEQ assumes these benthic loads are long-term loads brought to the stream by various sources throughout the year, the same percentage reductions were made in the winter projection model as were in the summer critical projection model. These reductions met the summer dissolved oxygen criteria and well surpassed requirements in the non-critical winter projection.

The reductions were determined using the calibrated values for nonpoint CBOD and NBOD. These values were summed by reach, as justified above and adjusted for the margin of safety. Each reach's total benthic nonpoint load was then reduced to meet the dissolved oxygen criteria in each reach. Using the ratios determined in calibration, this reduced total nonpoint load was then broken into its components of CBOD, NBOD, and SOD. The percentage reduction within the mainstem was calculated based on the comparison of the reduced total nonpoint benthic load to the calibration total nonpoint benthic load. These calculations are shown in Appendix E. The value and sources of CBOD and NBOD for each projection run are presented in Appendix F5.

4.2.12 Boundary Conditions, Data Type 27

The lower boundary conditions were set at the 90th percentile critical season temperature, the dissolved oxygen criteria, and the measured stream UCBOD and UNBOD loads for all projections and scenarios.

4.3 Model Discussion and Results

The projection model input and output data sets are presented in Appendix D.

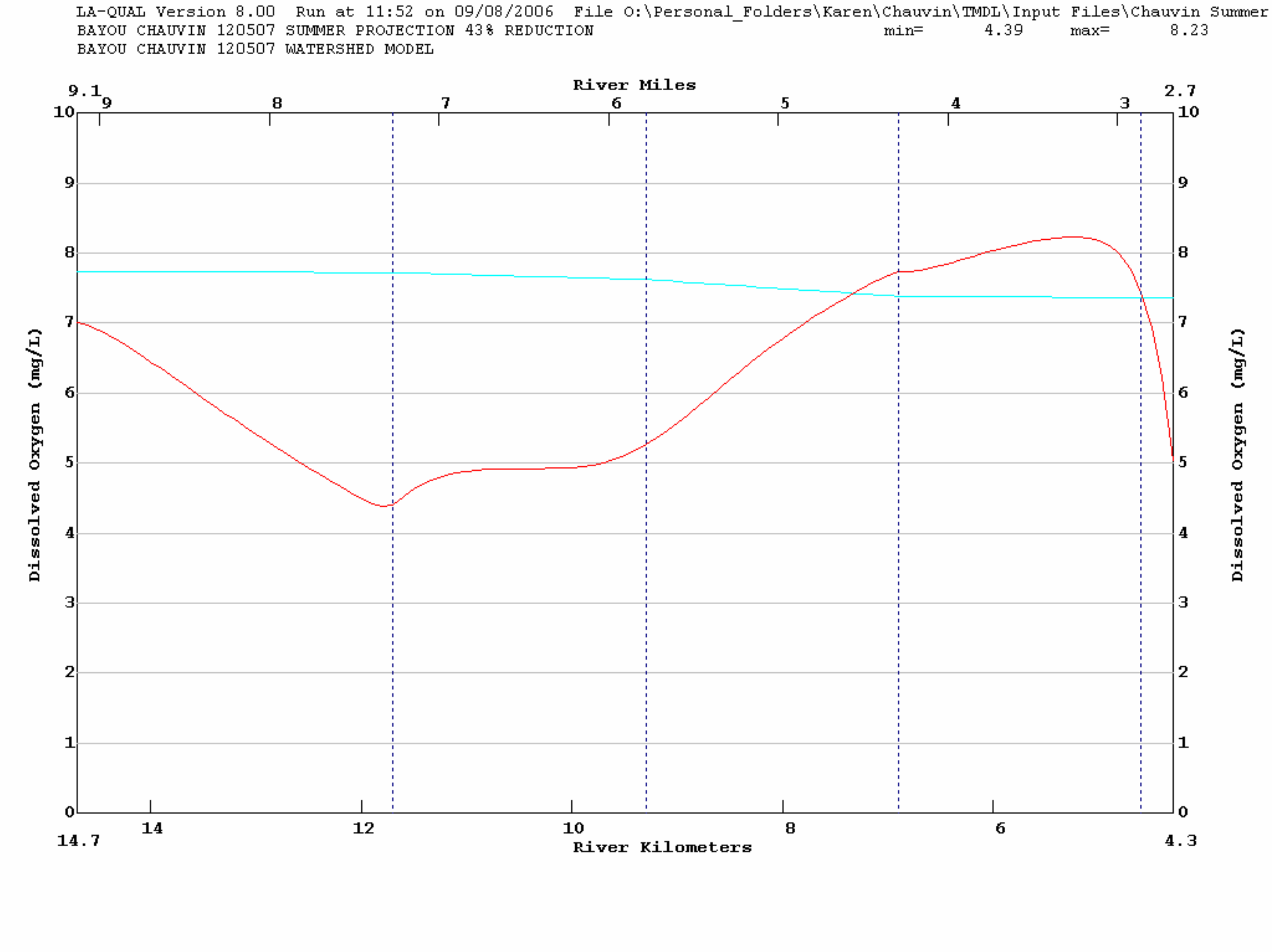
4.3.1 No-Load Projection

A no-load projection was not run because background loading could not be calculated. There were no reference stream studies available for this area.

4.3.2 Summer Projection

Summer critical season projections were run for the current standard of 4.0 mg/L May – November. In order to meet the standard, a 43% reduction of total nonpoint sources is necessary. With these percentage reductions in the benthic oxygen loads, Bayou Chauvin meets the dissolved oxygen criterion. The minimum DO on the main stem is 4.39 mg/L. A graph of the dissolved oxygen concentration versus river kilometer for the summer projection is presented in Figure 4.

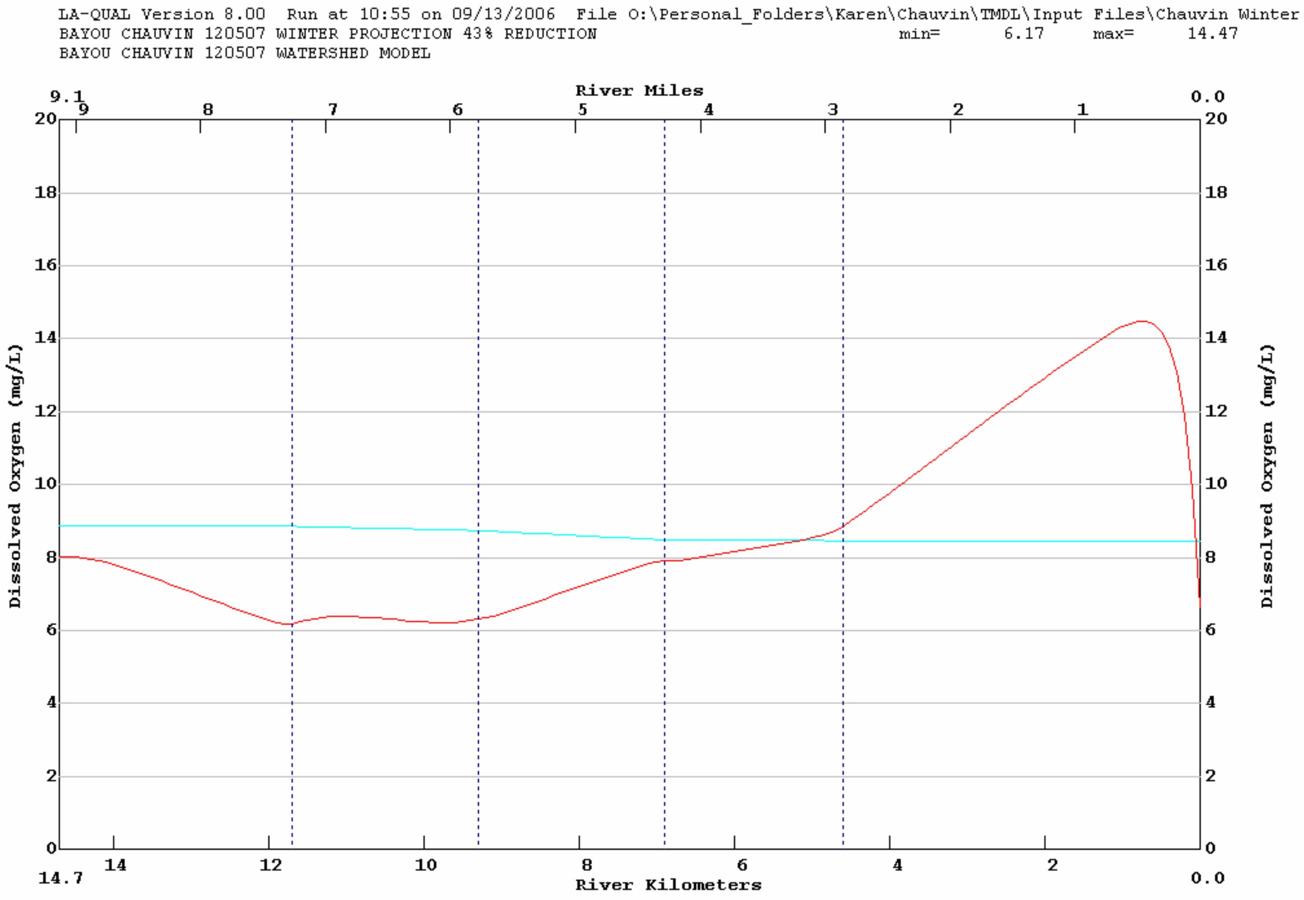
Figure 4. Summer Projection at 43% Removal of Man-Made NPS Loads



4.3.3 Winter Projection

The results of the model show that the water quality criterion for dissolved oxygen of Bayou Chauvin of 4.0 mg/l can be maintained during the winter critical season. The minimum dissolved oxygen is 6.17 mg/l. To achieve the criterion, the model assumed a 43% reduction from all manmade nonpoint sources. A graph of the dissolved oxygen concentration versus river kilometer for the winter projection is presented in Figure 5.

Figure 5. Winter Projection at 43% Removal of Man-Made NPS Loads



```
LA-QUAL Version 8.00  Run at 10:55 on 09/13/2006  File O:\Personal_Folders\Karen\Chauvin\TMDL\Input Files\Chauvin Winter
BAYOU CHAUVIN 120507 WINTER PROJECTION 43% REDUCTION                                  min=      6.17     max=     14.47
BAYOU CHAUVIN 120507 WATERSHED MODEL
```

4.4 Calculated TMDL, WLAs and Las

4.4.1 Outline of TMDL Calculations

An outline of the TMDL calculations is provided to assist in understanding the calculations in the Appendices. Slight variances may occur based on individual cases.

4.4.1.1 The natural backgrounds benthic loading was estimated from reference stream resuspension (nonpoint CBOD and NBOD), and SOD load data.

4.4.1.2 The calibration man-made benthic loading was determined as follows:

- Calibration resuspension and SOD loads were summed for each reach as gm O_2/m^2-day to get the calibration benthic loading.

- The natural background benthic loading was subtracted from the calibration benthic loading to obtain the man-made calibration benthic loading.

4.4.1.3 Projection benthic loads are determined by trail and error during the modeling process using a uniform percent reduction for resuspension and SOD. Point sources are reduced as necessary to subsequently more stringent levels of treatment consistent with the size of the treatment facility as much as possible. Point source design flows are increased to obtain an explicit MOS of 20%. Headwater and tributary concentrations of CBOD, NBOD, and DO range from reference stream levels to calibration levels based on the character of the headwater. Where headwaters and tributaries exhibit man-made pollutant loads in excess of reference stream values, the loadings are reduced by the same uniform percent reduction as the benthic loads.

- The projection benthic loading at 20 °C is calculated as the sum of the projection resuspension and SOD components expressed as gm O_2/m^2-day.

- The natural background benthic load is subtracted from the projection benthic load to obtain the man-made projection benthic load for each reach.

- The percent reduction of man-made loads for each reach is determined from the difference between the projected man-made non-point load and the man-made non-point load found during calibration.

- The projection loads are also computed in units of lb/d and kg/d for each kind.

4.4.1.4 The total stream loading capacity at critical water temperature is calculated as the sum of:

- Headwater and tributary CBOD and NBOD loading in lb/d and kg/d.

- The natural and man-made projection benthic loading for all reaches of the stream is converted to the loading at critical temperature and summed in lb/d and kg/d.

- Point source CBOD and NBOD loading in lb/d and kg/d.

- The margin of safety in lb/d and kg/d.

4.4.2 Bayou Chauvin, Subsegment 120507 TMDL

The TMDL for the biochemical oxygen demanding constituents (CBOD, NBOD, and SOD), have been calculated for the summer and winter critical seasons. The Summer TMDL for the Bayou Chauvin, Subsegment 120507 watershed was set equal to the total stream loading capacity. They are presented in Appendix A by reach. A summary of the loads is presented in Table 4.

Table 4. Total Maximum Daily Load (Sum of UCBOD[1], UNBOD, and SOD)

ALLOCATION	SUMMER		WINTER	
	% Reduction Required	(MAR-NOV) (lbs/day)	% Reduction Required	(DEC-FEB) (lbs/day)
Point Source WLA	0	0	0	0
Point Source Reserve MOS (20%)	0	0	0	0
Manmade Nonpoint Source LA	43	21,106	43	18,282
Manmade Nonpoint Source Reserve MOS(20%)	0	5,277	0	4,571
TMDL		26,383		22,853

***Note1: UCBOD as stated in this allocation is Ultimate CBOD.
UCBOD to $CBOD_5$ ratio = 2.3 for all treatment levels
Permit allocations are generally based on $CBOD_5$***

5. Sensitivity Analysis

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. The LAQUAL model allows multiple parameters to be varied with a single run. The model adjusts each parameter up or down by the percentage given in the input set. The rest of the parameters listed in the sensitivity section are held at their original projection value. 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 projections to these parameters is presented in Appendix I2. Parameters were varied by +/- 30%, except temperature, which was adjusted +/- 2 degrees Centigrade.

Values reported in Appendix I2 are percentage variation of minimum DO in the main stem Bayou Chauvin. As shown in Table 5, stream flow, stream velocity, initial temperature, benthal demand, headwater flow, and headwater DO are the parameters to which DO is most sensitive. The model is moderately sensitive to initial chlorophyll a and stream reaeration. The model is slightly sensitive to insensitive to the remaining parameters.

Table 5. Summary of Calibration Model Sensitivity Analysis

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SENSITIVITY ANALYSIS SUMMARY

Parameter                       %Param    Min   %D.O.  %Param    Min
%D.O.
                                   Chg    D.O.   Chg      Chg    D.O.
Chg

Stream Baseflow                    30.   2.07   52.4      -30.   0.16  -
88.1
Initial Chorophyll a               30.   1.52   12.2      -30.   1.19  -
12.2
Stream Velocity                    30.   2.06   51.9      -30.   0.17  -
87.4
Initial Temperature                 2.   0.84  -38.3       -2.   1.83
34.9
CBOD Aerobic Decay Rate            30.   1.31   -3.8      -30.   1.41
3.8
CBOD Settling Rate                 30.   1.36    0.2      -30.   1.35   -
0.2
NBOD Decay Rate                    30.   1.34   -1.2      -30.   1.37
1.2
NBOD Settling Rate                 30.   1.36    0.0      -30.   1.36
0.0
Benthal Demand                     30.   0.79  -42.0      -30.   2.59
90.9
Stream Dispersion                  30.   1.36    0.0      -30.   1.36
0.0
Stream Reaeration                  30.   1.64   20.8      -30.   1.06  -
22.2
Headwater Flow                     30.   1.95   44.1      -30.   0.53  -
60.9
Headwater DO                       30.   2.14   57.5      -30.   0.61  -
54.8
Headwater CBOD                     30.   1.32   -2.6      -30.   1.39
2.6
Headwater NBOD                     30.   1.34   -0.9      -30.   1.37
1.0
Stream Depth                       30.   1.42    5.1      -30.   1.31   -
3.7
Wasteload Flow                     30.   1.36    0.0      -30.   1.36
0.0
Wasteload Temperature               2.   1.36    0.0       -2.   1.36
0.0
Wasteload DO                       30.   1.36    0.0      -30.   1.36
0.0
Wasteload CBOD                     30.   1.36    0.0      -30.   1.36
0.0
Wasteload NBOD                     30.   1.36    0.0      -30.   1.36
0.0
Lower Boundary Temperature          2.   1.36    0.0       -2.   1.36
0.0
Lower Boundary DO                  30.   1.36    0.0      -30.   1.36
0.0
Lower Boundary CBOD                30.   1.36    0.0      -30.   1.36
0.0
```

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Lower Boundary NBOD              30.  1.36    0.0      -30.  1.36
0.0
```

6. Conclusions

This TMDL establishes load limitations for oxygen-demanding substances and goals for reduction of those pollutants. LDEQ's position, as supported by the declaratory ruling issued by Secretary Givens in response to 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 this TMDL through best management practices to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources in the watershed will also control and reduce the nutrient loading from those sources.

A calibrated water quality model for the watershed was developed and projections were modeled to quantify the non-point source load reductions which would be necessary in order for Bayou Chauvin, subsegment 120507 to comply with its established water quality standards and criteria. This report presents the results of that analysis.

The modeling, which has been conducted for this TMDL, is conservative and based on limited information. The TMDL requires a watershed-wide 43% decrease in total nonpoint source loads in order to meet the DO criterion of 4.0 mg/L in the summer critical season.

Bayou Chauvin conveys intermittent flow from the Houma stormwater pumps located at a dam across the bayou about 13.6 kilometers from Lake Boudreaux. It is believed that stormwater conveyed by the bayou is primarily responsible for violations of dissolved oxygen criteria. The DO becomes lower towards the bottom at the confluence with Lake Boudreaux due to settling combined with tidal influence. The high chlorides and conductivity values are characteristic of tidal waterbodies. The high chlorophyll a is indicative of the algae blooms present in open waters. Houma is considering moving the stormwater pumps to Bayou Terrebonne which would likely enhance the water quality of Bayou Chauvin. As stated above, no permitted dischargers are located in this subsegment. There is significant oil and gas activity, but these facilities are no longer allowed to discharge into waters of the state. Additionally, the Houma South Wastewater Treatment Plant, though located in this subsegment, discharges to the Houma Navigation Canal and does not impact Bayou Chauvin.

LDEQ has developed this TMDL to be consistent with the state antidegradation policy (LAC 33:IX.1109.A).

LDEQ will work with other agencies such as local Soil Conservation Districts to implement agricultural best management practices in the watershed through the 319 programs. LDEQ will also continue to monitor the waters to determine whether standards are being attained.

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 database 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 is continuing to implement a watershed approach to surface water quality monitoring. In 2004 a four year sampling cycle replaces the previous five year cycle. Approximately one quarter of the states watersheds will be sampled each year so that all of the state's watersheds will be sampled within the four year cycle. This will allow 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.

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