TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Fecal Coliform

In

Choctawhatchee Bay

Prepared by:

US EPA Region 4
61 Forsyth Street SW
Atlanta, Georgia 30303

March 2006

EPA
United States
Environmental Protection
Agency

Region 4
serving the
southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S Environmental Protection Agency is hereby establishing the Total Maximum Daily Load (TMDL) for Fecal Coliform in the Choctawhatchee River Basin (WBID 778B). Subsequent actions must be consistent with this TMDL.

Gail Mitchell

James D. Giattina, Director
Water Management Division

03-31-06

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Date

Concurrences:

J. Greenfield _____

A. Godfrey _____

A. Bartlett _____

G. Mitchell _____

J. Giattina _____

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
CFU	Colony Forming Units
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
F.A.C.	Florida Administrative Code
FDACS	Florida Department Agriculture and Consumer Services
FDEP	Florida Department Environmental Protection
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMP	Water Management Plan

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1. **303(d) Listed Waterbody Information**
   State: Florida
   County: OKALOOSA AND WALTON
   Major River Basin: Choctawhatchee Bay (HUC 03130014)

   Impaired Waterbodies (1998 303(d) List):

WBID	Segment Name and Type	River Basin	County	Constituent(s)
778B	Choctawhatchee Bay (estuary)	Choctawhatchee Bay	OKALOOSA, WALTON	Fecal Coliform

2. **TMDL Endpoints (i.e., Targets)**
   Class II Waters (estuary)
   Fecal Coliforms: 43 MPN/100mL

3. **Fecal Coliform Allocation:**

WBID	$WLA_{Continuous}$	WLA_{MS4} (reduction)	LA Background (cfu/day)	LA Wet Weather (cfu/day)	TMDL (cfu/day)	Reduction (to nonpoint sources)
778B	None	N/A	1.2×10^{13}	1.2×10^{14}	1.3×10^{14}	15% (see note 2)

Note:
1. N/A = not applicable
2. Overall reduction required from Choctawhatchee River and the Choctawhatchee Bay tributaries during wet weather events should result in attainment of standards in Central Choctawhatchee Bay and WBID 778B

4. **Endangered Species (yes or blank):** Yes

5. **EPA Lead on TMDL (EPA or blank):** EPA

6. **TMDL Considers Point Source, Nonpoint Source, or both:** Both

7. **Major NPDES Discharges to surface waters:** No

TOTAL MAXIMUM DAILY LOAD (TMDL)
FECAL COLIFORM IN CHOCTAWHATCHEE BAY

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework DEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Group 3 basin includes waters in the Choctawhatchee Bay. Group 3 waters were first assessed in 2002 with plans to revisit water management issues in 2007. FDEP established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. The Choctawhatchee Bay is located in the Northwest Florida Water Management District (NWFWMD).

For the purpose of planning and management, the WMDs divided the district into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, cannel, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified WBID 778B in the Choctawhatchee Bay as not supporting water quality standards (WQS). After assessing all readily available water quality data, EPA is responsible for developing fecal coliform TMDLs in WBID 778B. The geographic locations of these TMDLs are shown in Figure 1. The TMDLs addressed in this document are being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

Choctawhatchee Bay, WBID 778B is designated as Class II water. The designated use of Class II waters is shellfish propagation or harvesting, whereas the designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The TMDL for Choctawhatchee Bay (WBID 778B) is based on Class II water quality criteria. Note

that WBID 778B in Choctawhatchee Bay is just a portion of the impaired waters in the Bay; the other impaired WBIDs (778C and 778D) are on FDEP's list for future TMDL development. However, it is impractical if not impossible to address only WBID 778B in the pollution source and reduction analyses; therefore the analytical portion of this TMDL addresses the whole Bay system and the fecal coliform reductions necessary for WBID 778B should also provide protection for the other impaired WBIDs.

To determine the status of surface water quality in the state, three categories of data – chemistry data, biological data, and fish consumption advisories -- were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (F.A.C.). The IWR defines the threshold for determining if waters should be included on the state's planning list and verified list. Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list.

The format of the remainder of this report is as follows: Chapter 3 is a general description of the impaired watersheds; Chapter 4 describes the water quality standard and target criteria for the TMDLs; and Chapter 5 describes the development of the coliform TMDLs. Water quality data collected are available in the IWR and the Sanitary Survey document Documentation of the numerical model developed for Choctawhatchee Bay is provided in Appendix A.

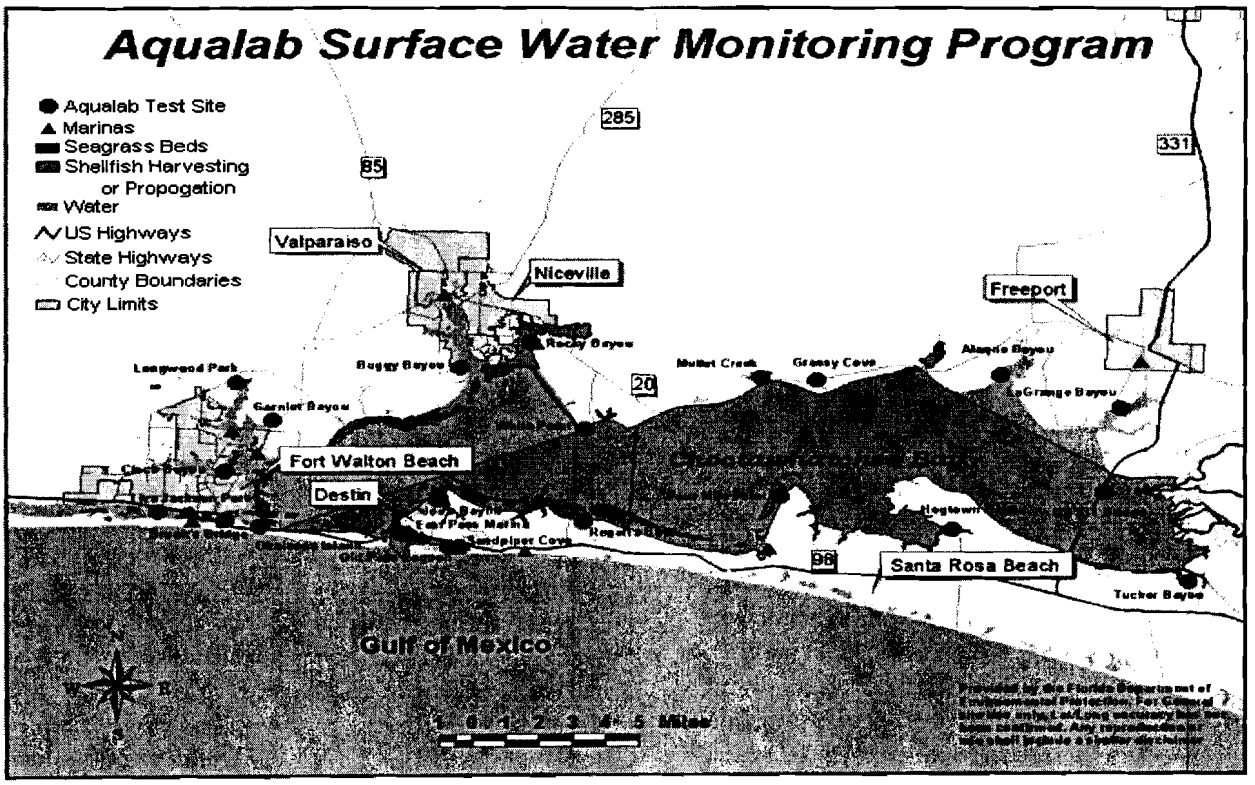

Figure 1 Location of Choctawhatchee Bay

3. WATERSHED DESCRIPTION

The Choctawhatchee Bay is defined by USGS Hydrologic Unit Code (HUC 03140102). Florida's Choctawhatchee Bay is located just east of Pensacola Bay on the western end of the Florida panhandle. Freshwater flow to the bay comes from the13,856 sq. km watershed which includes the Choctawhatchee River, Pea River, Wrights Creek, Sandy Creek, Pine Log, Seven Run, Holmes Creek and Bruce Creeks (CBA, 2002). The bay is separated from the Gulf of Mexico along most of its length, but connects through the Pensacola and East passes entering through the south at Destin Pass.

The bay system is fringed by forested wetlands and also characterized by marshes and patches of oyster beds. The system supports the endangered Okaloosa darter (*Etheostoma okaloosae*). Numerous fish, birds and wildlife make the Choctawhatchee Bay their home.

Coordinates: 30.45° N 86.45° W

Selected Characteristics: (USEPA, 1999)
Surface Area: 334 km^2
Drainage Area: 14,000 km^2
Average Daily FW Inflow: 241 m^3/s
Average Depth: 5.0 m
Average Salinity: 25 ppt
Coastal Wetlands: 1,133 km^2
Submerged Aquatic Vegetation: 12 km^2

Choctawhatchee Bay is characterized as a large, shallow, estuarine tidal embayment with a surface area of 86,295 acres or 129 square miles. It is approximately 27 miles long and ranges from one to six miles wide. Average depths range from 10 feet in the eastern portion of the Bay to 30 feet in the western portion. The maximum depth occurs north of Destin and is approximately 43 feet at mean low tide (McNulty, et al., 1972; Thorpe, P. and P. Ryan, 1996). The surface water hydrology of Choctawhatchee Bay is influenced primarily by freshwater inputs from the Choctawhatchee River, and tidal exchange from the Gulf of Mexico via East Pass at Destin. Choctawhatchee Bay has an indirect connection to the Gulf of Mexico via Santa Rosa Sound to the west and an indirect connection to the St. Andrew Bay System via the Intra-coastal Waterway (ICWW) to the east. The net movement of water is southwesterly towards East Pass and into the Gulf of Mexico. Tidal movement is northeast and northwest during flood tide and southeast and southwest during ebb tide. Current speeds at East Pass may reach one knot or more, but in other portions of the bay they are generally less than 0.5 knots (Goldsmith, 1966; Barnett, E. and W.H. Teehan, 1989). East Pass is a relatively shallow pass that is approximately 985 feet wide and 12 feet deep (Jones W.K. and W. Huang, 1994). The dimensions of the pass, combined with low tidal amplitudes, allow limited flushing of the bay. This causes a halocline or stratification of high salinity waters below lower salinity surface waters that is evident throughout the bay (Livingston, R.J., 1986). In addition to the Choctawhatchee River, at least twenty-one creeks and streams discharge into Choctawhatchee Bay. Fifteen major bayous are located along the perimeter of the bay.

The Choctawhatchee River discharges into the easternmost portion of the bay and is the primary influence on circulation (Jones W.K. and W. Huang, 1994). It is the fourth largest river in Florida and travels approximately 87 miles from the State line through six counties before it reaches Choctawhatchee Bay. It is the largest source of freshwater for the bay with an average annual

discharge of 7,198 cubic feet per second (Thorpe, P. and P. Ryan, 1996). Livingston (1987) reported that peak river flows usually occur between the months of December and April, with the lowest flows during the fall.

4. WATER QUALITY STANDARD AND TARGET IDENTIFICATION

The Choctawhatchee Bay designated use of Class II waters is shellfish propagation or harvesting. The water quality criteria for protection of Class II waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time.

Chapter 62R-7 of the F.A.C. details FDEP's authority to regulate harvesting, processing, and shipping of shellfish according to the National Shellfish Sanitation Program (NSSP) standards and guidelines. A basic concept of the NSSP is to control sanitary quality of shellfish by allowing shellfish harvesting only from waters of high bacteriological quality. The NSSP Manual of Operations, Part 1 (USDOH, 1985) requires a sanitary survey of shellfish areas to identify and evaluate all actual and potential sources of pollution which may affect the shellfish growing area; determine the distance such sources to the growing area; assess the effectiveness and reliability of sewage treatment systems; and ascertain the presence of poisonous or deleterious substances (e.g., industrial and agricultural wastes, pesticides, or radionuclides).

A sanitary survey includes the collection of growing area water samples and their analysis for bacterial quality. The collection of samples provides a profile for periods defining adverse pollution conditions which reflect adverse meteorological, hydrographic, seasonal, and point sources of pollution to assure that the requirements for classifying growing areas as approved, conditionally approved, restricted, or conditionally restricted are met. Sanitary surveys are formally reviewed on an annual basis and completely reevaluated every three years. The 2001 Sanitary Survey completed in Choctawhatchee Bay provided the shell fish classifications and the source assessment information, along with the majority of the fecal Coliform data and information. This survey should be consulted for additional information.

The specific criteria for the impaired WBID 778B addressed in this TMDL are as follows:

Fecal Coliform Bacteria (Class II Waters)

The MPN per 100 ml of fecal coliform bacteria shall not exceed a median value of 14 with not more than 10 percent of the samples exceeding 43, nor exceed 800 on any one day. FDEP calculates the geometric mean of all samples collected and compares this value to the 14 MPN/100ml criteria.

Choctawhatchee Bay WBID 778B Bay was included on the 303(d) list because WBID 778B is located in the Conditionally Approved Central classification area. Conditional areas are subject to intermittent pollution and for Choctawhatchee bay intermittent pollution is due to higher fecal Coliform loads in response to rainfall events. Conditionally approved is a shellfish harvesting area classification of the National Shellfish Sanitation Program for the harvest of shellfish for direct

consumption. A survey indicates that poisonous and deleterious substances are not present, microbiological pollution is intermittent and conditions associated with the release, persistence, and distribution of bacterial pollution are known. At least fifteen of the most recent samples collected at each station during adverse pollution conditions were used to determine compliance with the 14/43 fecal coliform standard. The survey must clearly demonstrate that the area will meet approved area classification criteria when the area is used as a source of shellfish for direct market.

The target for the fecal coliform TMDLs is the not to exceed 10 percent of the time the 43 counts/100mL criteria under all wet weather event conditions so that the Bay can be classified as "approved".

5. FECAL COLIFORM TMDLS

This section of the report details the development of the fecal coliform TMDLs. Fecal coliforms are a subset of the total coliform group and indicate the presence of fecal material from warm-blooded animals.

5.1 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

FDEP maintains ambient monitoring stations throughout the basin. All data collected at monitoring stations within the impaired WBID are used in the analysis. The 2001sanitary bacteriological survey provided a great deal of additional data and information and these data were included in the basis for the TMDL developrnent. The study period for the bacteriological survey was from January 1, 1994 through December 31, 2000. Additional data were collected for the years 2001 through 2004. The WBID 778B was listed due to the area being in a conditional approved shell fish area and fecal data had an exceedence of the 830 counts/100mL not to exceed standard and the 43 counts/100mL were exceeded during the wet weather events.

Table 1 provides a list of the monitoring stations in the Bay and Figure 2 shows the location of these Stations.

Table 1 Monitoring Stations used in the Development of Coliform TMDLs

Station	Latitude (N)	Longitude (W)	Verbal description	Current classification
Central				
204	302700.8	862339.5	Stake Point	Cond Approved Central
208	302738.7	862232.1	Mouth of Eagle Creek	Cond Approved Central
211	302825.0	861951.1	Mouth of Mullet Creek	Cond Approved Central
212	302825.0	861712.2	Houses East of Hammock Point	Cond Approved Central
350	302743.0	862154.1	Mouth of unnamed creek draining Lake Sharon	Cond Approved Central
351	302715.8	862436.4	Mouth of Pippen Lake	Cond Approved Central
400	302349.8	862012.0	Channel Marker #1 Sandestin Channel	Prohibited Central
420	302541.5	861846.9	Channel Marker #49	Cond Approved Central
430	302408.9	861705.9	Mouth of Hewitt Bayou	Cond Approved Central

Station	Latitude (N)	Longitude (W)	Verbal description	Current classification
431	302434.5	861806.2	Mouth of Buck Bayou	Cond Approved Central
432	302331.8	861443.1	Mouth of Churchill Bayou	Prohibited Central
502	302335.1	863132.1	U.S. Coast Guard Station	Cond Approved Central
504	302339.3	863053.2	Entrance Old Pass Lagoon	Prohibited Central
524	302438.9	863021.9	Mouth of Marler Bayou	Cond Approved Central
532	302507.3	862935.0	Channel Marker #2 at mouth of Joes Bayou	Cond Approved Central
536*	302504.2	862835.2	Mossy Cove Town homes	Cond Approved Central
538*	302446.4	862657.1	Mouth of Indian Bayou	Cond Approved Central
544*	302425.5	862513.6	Mouth of first unnamed bayou E. of Mid-bay Bridge	Cond Approved Central
545	302408.2	862355.7	Golf course waterfront between 544 and 546	Cond Approved Central
546	302357.7	862314.3	First apartment complex east of station 545	Cond Approved Central
548	302328.0	862130.4	Legion Park	Cond Approved Central
552	302325.3	861945.3	Channel Marker #21 in Sandestin Channel	Prohibited Central
570	302420.0	861755.3	Mouth of Mack Bayou	Cond Approved Central
574	302340.6	861520.3	Mouth of Musset Bayou	Prohibited Central
600	302355.7	861343.5	Cessna Park/Hogtown Landing	Prohibited Central
608	302416.4	861548.7	.5 mile southwest of station 610 at tip of marsh	Cond Approved Central
610	302430.2	861525.1	Mouth of creek .5 mile northwest of station 608	Cond Approved Central
612	302524.8	861703.4	Between Fourmile & Live Oak Points	Cond Approved Central
619	302810.8	861549.9	Plant site poles east of Hammock Point	Cond Approved Central
760	302642.0	862517.3	White Point	Cond Approved Central
850	302401.3	863337.7	Channel Marker #1, 2.3 miles east of Santa Rosa Sound	Cond Approved Central
860	302416.4	863110.1	Channel Marker #15, North Channel in East Pass	Cond Approved Central
870*	302539.3	862914.3	Channel Marker #59, North of Joes Bayou	Cond Approved Central
890	302519.1	862559.9	1.0 mile north of Jones Bayou	Cond Approved Central
Eastern				
221	302804.9	861327.6	Southwest mouth of Alaqua Bayou (old plant site)	Cond Approved Eastern
222	302714.8	861007.8	Mouth of creek W of Channel Marker #11, LaGrange Bayou	Prohibited Eastern
236	302721.1	860921.6	Mouth of Canal near entrance to Mallet Bayou	Prohibited Eastern
260	302559.8	860935.9	Old Bay Grove Marina site	Prohibited Eastern
270	302641.7	861103.1	Channel Marker #5 south of LaGrange Bayou	Cond Approved Eastern

Station	Latitude (N)	Longitude (W)	Verbal description	Current classification
300	302838.9	861243.1	West point at mouth of Alaqua Bayou (post N of Piney Point)	Prohibited Eastern
320	302858.8	861507.8	Mouth of Basin Bayou	Cond Approved Eastern
440	302615.3	861433.5	Channel Marker #47	Cond Approved Eastern
450	302455.4	861150.7	Channel Marker #40	Cond Approved Eastern
470	302413.5	861033.4	Channel Marker #28	Cond Approved Eastern
614	302555.3	861511.2	Mouth of creek west of Live Oak Point	Cond Approved Eastern
618	302457.9	861259.4	Southeast side of Alligator Point	Cond Approved Eastern
621	302443.3	861215.6	Plant site poles south of station 450	Cond Approved Eastern
622	302410.9	861201.0	White house on west side of marsh .5 miles NW of station 624	Cond Approved Eastern
624	302355.6	861117.9	Accreted canal .5 miles SE of station 622	Cond Approved Eastern
628	302332.6	861031.8	Bailey's Restaurant	Cond Approved Eastern

* - WBID 778B Stations

Choctawhatchee Bay Sampling Stations

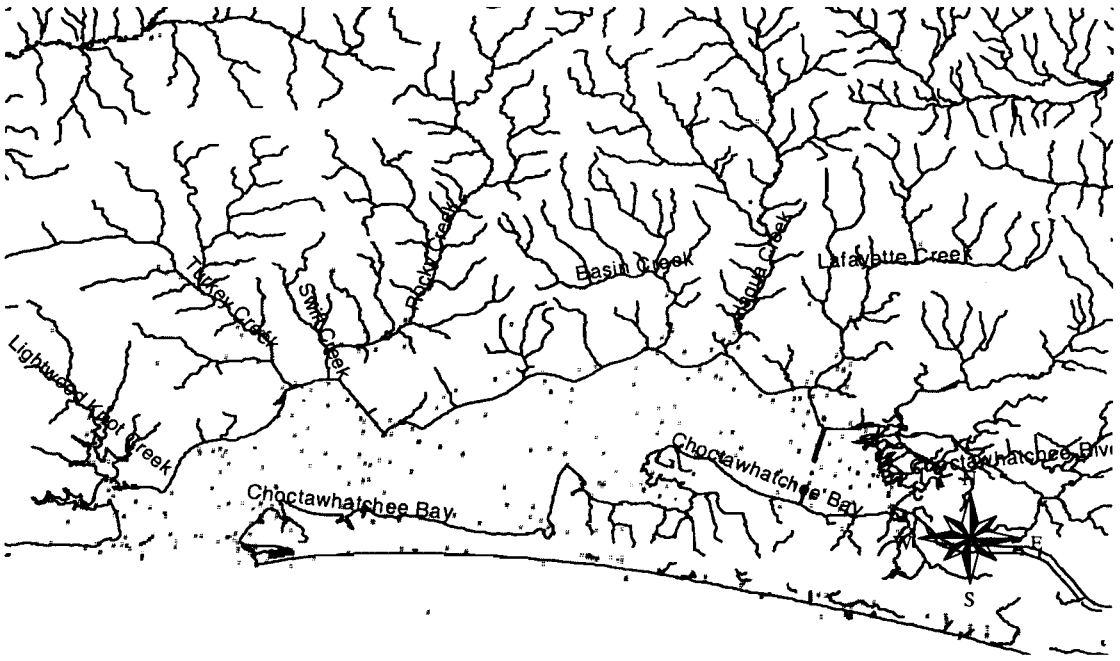

Figure 2 Choctawhatchee Bay Sampling Locations

The violations of fecal coliform criteria often occur in response to rainfall events. The National Oceanic and Atmospheric Administration (NOAA) collect meteorological data at numerous locations in Florida. Rainfall was determined to increase fecal coliform levels and was used as an adverse pollution condition in developing the current classification and a management closure criterion. This determination of the effects of rainfall was based on evaluations of rainfall levels and analyses of fecal coliform sample results. Rainfall was recorded at Eden State Gardens near Santa Rosa Beach (ARF, inches), the Point Washington Forestry Tower near Santa Rosa Beach (BRF, inches), and the Argyle Forestry Tower near DeFuniak Springs (CRF, inches).

5.2 SOURCE ASSESSMENT

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

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater or stormwater (i.e., Phase I or II MS4 discharges) are considered primary point sources of coliform.

Non-point sources of coliform are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of bacteria on land surfaces and wash off as a result of storm events. Typical non-point sources of coliform include:

5.2.1 Point Sources

It was determined that point sources have no impact to water quality of the shellfish harvesting area. There are no direct point source dischargers to the Bay and none of the fecal coliform loads from the upstream point source dischargers will impact the shell fish areas. The WLA for fecal Coliform discharges to the Bay is therefore set to zero.

The impact of domestic wastewater treatment plant (WWTP) systems on the shellfish harvesting area was evaluated in the 2001 Sanitary Survey. Results and review of monthly operating reports are summarized in the following table.

Table 2 Summary of wastewater treatment plants.

Wastewater Treatment Plant	Design flow (MGD)	Treatment type	Effluent disposal	Impact on shellfish area *
OKALOOSA COUNTY				
Destin Water Users	5.000	Tertiary	Spray irrigation, percolation ponds, drip fields	None

Wastewater Treatment Plant	Design flow (MGD)	Treatment type	Effluent disposal	Impact on shellfish area *
Eglin AFB Aux Field #3 STP	0.125	Secondary	Sprayfield irrigation	None
Eglin AFB Aux Field #6 STP	0.072	Secondary	Sprayfield irrigation	None
Eglin AFB Main Base STP	1.000	Secondary	Sprayfield irrigation	None
Eglin AFB Plew STP	1.500	Secondary	Sprayfield irrigation	None
Ft. Walton Beach WWTF	4.500	Secondary	Holding pond to spray irrigation sites	None
Niceville, Valparaiso, Okaloosa Co. Regional WWTF	3.350	Sec. & Tert.	Holding ponds to spray irrigation sites	None
Okaloosa Water and Sewer, Garnier Plant	6.500	Secondary	Sprayfield irrigation	None
WALTON COUNTY				
City of De Funiak Springs	0.750	Secondary	Sprayfield irrigation	None
City of Freeport	0.300	Secondary	Percolation ponds	None
Regional Utilities of Walton County-Pt Washington Plant	0.750	Tertiary	Percolation ponds, sprayfield irrigation	None
Regional Utilities of Walton County-Sandestin Plant	1.556	Secondary	Holding pond to spray irrigation site	None
South Walton Utility Company	2.500	Tertiary	Percolation ponds and spray irrigation	None
Walton Correctional Institution	0.175	Secondary	Percolation ditches	None
Eglin AFB Test Site C-6 STP	0.020	Secondary	Sprayfield irrigation	None
HOLMES COUNTY				
Bonifay WWTF	1.400	Secondary	Surface water discharge to Camp Branch Creek	None
Noma WWTF	0.025	Secondary	Surface water discharge to Wrights Creek	None
Vernon WWTF	0.126	Secondary	Percolation ponds overflow to Holmes Creek	None
JACKSON COUNTY				
Graceville WWTF	1.100	Secondary	Surface water discharge to	None

Wastewater Treatment Plant	Design flow (MGD)	Treatment type	Effluent disposal	Impact on shellfish area *
			Holmes Creek	
WASHINGTON COUNTY Chipley WWTF	1.200	Secondary	Surface water discharge to Alligator Creek	None

* Impact on portions of the shellfish harvesting area classified approved, conditionally approved, restricted, or conditionally restricted

Of these twenty WWTP systems, five discharge to tributaries of the Choctawhatchee River: City of Vernon, Town of Noma, City of Bonifay, City of Graceville, City of Chipley. The surface water outfall closest to the harvesting area that discharges to Holmes Creek at the City of Vernon, is located approximately thirty-five miles upstream of Choctawhatchee Bay. Buffer zones were not established because all WWTP's that discharge to surface waters are located a sufficient distance from the harvesting area for there to be no impact to water quality of the shellfish harvesting area.

The impacts of industry on the shellfish harvesting area were evaluated. Four major industrial facilities are located in the shoreline survey area near La Grange Bayou, Boggy Bayou, and the northwest portion of the bay. Industrial facilities were considered major if they had the potential to generate or use hazardous waste during operation. The locations of industrial facilities in the shoreline survey area are presented in Figure 3-1. Murphy Oil USA, Inc. is the only facility that has a permitted effluent discharge to surface waters. The discharge is intermittent and consists of hydrostatic test water and stormwater runoff. None of the facilities have the potential to directly impact the shellfish harvesting area because they are located adjacent to waters prohibited to shellfish harvesting. Results of file reviews and site evaluations are presented in the Sanitary Survey Appendix 3-1 and summarized below.

Table 3 Source of industrial waste

Source of industrial waste	Contaminant/Source of industrial waste	Discharge (MGD)	Impact *	Description of buffer zone
[a]Citgo Petroleum Corporation	Vehicular diesel fuel, unleaded gasoline, miscellaneous petroleum and additives	None	None	Boggy Bayou-prohibited area
[a]Eglin Air Force Main Base	Installation Restoration Project sites, chemical/fuel spills, aircraft and vehicle fuels, oils, lubricants, paints, solvents, aircraft/vehicle wash water and maintenance supplies, misc. chemicals and hazardous substances,	Upland	None	West of a line from Black Pt. to Buccaroo Pt.-prohibited area

Source of industrial waste	Contaminant/Source of industrial waste	Discharge (MGD)	Impact *	Description of buffer zone
	runoff from runways and industrial sites			
[a]Freeport Shipbuilding	Painting materials and solvents	None	None	La Grange Bayou-prohibited area
[a]Murphy Oil USA, Inc.	Petroleum products, vehicular diesel fuel, unleaded gasoline	0.046	None	La Grange Bayou-prohibited area

* Impact to portions of the shellfish harvesting area classified approved, conditionally approved, restricted, or conditionally restricted

[a]=listed on DEP Hazardous Waste Compliance and Enforcement Tracking System, 2/22/01

5.2.2 Non-point Sources

5.2.2.1 Wildlife

The impact of wildlife on the shellfish harvesting area was evaluated in the 2001 Sanitary Survey. There are several major wildlife areas within the survey area that are managed by various federal, regional, and state agencies. Wildlife rnanagement areas are listed below.

Table 4 Summary of wildlife management areas

Agency	Name of Area	Acres within watershed
U.S. Department of Interior, National Park Service	Gulf Islands National Seashore, Okaloosa Area	19
U.S. Department of Defense	Eglin Air Force Base Reservation	242,243
Northwest Florida Water Management District	Choctawhatchee River and Holmes Creek Water Management Area	51,189
FL DEP, Division of Recreation and Parks	Ponce de Leon Springs SRA	443
	Falling Waters SRA	155
	Fred Gannon Rocky Bayou SRA	357
	Eden State Gardens	12
FL DEP, Office of Coastal & Aquatic Managed Areas	Rocky Bayou Aquatic Preserve	480
FL DACS, Division of Forestry	Point Washington State Forest	15,180
	Pinelog State Forest	6,911
	Choctawhatchee River State Forest	355
Nature Conservancy	Choctawhatchee River Delta Preserve	2,700
TOTAL ACRES		320,044

Source: Thorpe, P. and P. Ryan, 1996; Kelson, N., 2001; www.dep.state.fl.us

Wildlife along the shoreline of Choctawhatchee Bay has the potential to increase fecal coliform in the nearshore waters of the shellfish harvesting area, especially following rainfall events. Feces of

wildlife likely make a significant contribution to the fecal coliform loading into the Choctawhatchee River, especially following rainfall and during periods of rising river levels. Migratory waterfowl populations are seasonal. A small nesting colony of Least Terns and Black Skimmers is located near the entrance to Destin Harbor on Norreigo Point. This colony does not impact the water quality of the growing area, because of its distance from conditionally approved waters. Water sample results indicate that waterfowl do not significantly contribute to fecal coliform loading.

In summary, the feces from wildlife has the potential to degrade bacteriological water quality of the shellfish harvesting area following rainfall and river events. Bacteriological sampling stations are located throughout the shellfish harvesting area to monitor the direct and indirect impacts of wildlife/waterfowl runoff in the shellfish harvesting area.

5.2.2.2 Agricultural Animals

The impact of wastes of domestic animals on the shellfish harvesting area was evaluated in the 2001 Sanitary Survey. Approximately twenty-four percent of land use within the Choctawhatchee Bay and River watershed is agricultural (Thorpe, P. and P. Ryan, 1996). Approximate livestock estimates within counties located in the watershed are listed in Sanitary Survey Appendix 3-2. Livestock (hogs, cattle, dairy), agriculture, and silviculture are reported as major pollution sources in the Choctawhatchee River drainage basin (Hand et al., 1996). Several tributaries of the Choctawhatchee River have degraded water quality due to agricultural operations. This is primarily a result of sedimentation from erosion, animal waste, pesticides, and herbicides (Hand et al., 1996; Thorpe, P. and P. Ryan, 1996). While degradations in water quality to tributaries of the Choctawhatchee River have been reported, there are no major agricultural operations located along the shoreline of the shellfish harvesting area.

The waste from domestic animals, fertilizers, and pesticides was found not to result in direct adverse affects on the shellfish harvesting area.

5.2.2.3 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

The impact of septic systems on the shellfish harvesting area was evaluated in the 2001 Sanitary Survey. There were no septic systems with direct impacts on the shellfish harvesting area. The areas with the highest septic tank densities were near the cities of Niceville (Rocky Bayou Basin), Freeport (La Grange Bayou Basin), and Santa Rosa Beach (Hogtown Bayou Basin). Some residences located along the shoreline of Choctawhatchee Bay are still using septic tanks even though sewer service is available. Rural areas located north and east of the bay are serviced by septic tanks. Most systems are installed near ground water in soils severely limited for disposal of domestic waste in drainfields.

In summary, septic systems in the shoreline survey area present a potential source of fecal coliform bacteria entering the growing area. Groundwater may contribute fecal coliform bacteria from waterfront property septic systems functioning properly. Sheet flow or stormwater may contribute fecal coliform bacteria from failing septic systems.

5.2.2.4 Boat Traffic and Marinas

The impact of marinas and moorings on the shellfish harvesting area was evaluated in the 2001

Sanitary Survey. The distance of classification boundaries from marinas was determined to provide for the reduction of fecal coliform to safe levels from a hypothetical discharge of human waste from boats in marinas and moorings in the shoreline survey area. A prohibited buffer zone was defined in the vicinity of each marina where fecal coliform from the hypothetical discharge exceeded 14 MPN/100 ml. A restricted buffer zone was defined for each marina where fecal coliform from the hypothetical discharge was greater than 14 MPN/100 ml and less than or equal to 88 MPN/100 ml.

Both commercial and recreational boating occurs within shellfish harvesting waters of Choctawhatchee Bay (WBID 1274). There are no mass harborage areas, which could adversely impact shellfish harvesting waters. Boat traffic occurring in Choctawhatchee Bay is not considered a significant contributor of fecal coliform to the bay.

5.2.2.5 Urban Development

The impact of stormwater on the shellfish harvesting area was evaluated in the 2001 Sanitary Survey. The land use types of the Choctawhatchee Bay drainage basin are primarily silviculture and urban development (Hand et al., 1996). Urban development is concentrated in several communities surrounding Choctawhatchee Bay including Destin, Fort Walton Beach, Cinco Bayou, Shalimar, Eglin Air Force Base (AFB), Valparaiso, Niceville, Freeport, and Santa Rosa Beach. Developed regions in the study area are illustrated as land use type sewer or septic on the Pollution Source Map. Both sewer and septic land use is present along the shoreline of the shellfish harvesting area.

The Choctawhatchee River is the major source of runoff in the shellfish harvesting area because it has a drainage basin of 4,646 square miles. The Choctawhatchee Bay drainage basin includes 699 square miles for a total river and bay watershed area of 5,345 square miles (Hand, et al., 1996). In addition to river runoff, stormwater enters Choctawhatchee Bay through numerous bayous, creeks, and ditches or is diffused across land entering as non-point discharge. Most of the direct stormwater outfalls are located adjacent to prohibited shellfish harvesting waters near the cities of Destin, Ft. Walton Beach, Valparaiso, and Niceville. During rainfall events, these discharges have the potential to elevate fecal coliform levels in shellfish harvesting area waters. The majority of stormwater pollution received in the shellfish harvesting area impacts the Eastern harvesting area and southern portions of the Central harvesting area. Bacteriological sampling stations are located to evaluate the impact of these pollution sources and any impact is considered during the development of a conditional management plan based on rainfall.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5)(c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the

generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

5.3 Analytical Approach

The approach for calculating coliform TMDLs depends on the number of water quality samples and the availability of flow data, for complex waterbodies such as the Choctawhatchee Bay, a numerical model was developed to estimate the loads, see Appendix A.

5.3.5 EFDC Modeling Approach to TMDL Analysis

The Environmental Fluid Dynamic Code (EFDC) model was used to develop the fecal coliform TMDLs for Choctawhatchee Bay. This model was selected as it has the capability of simulating the complex circulation in tidal waterbodies, including the density effects of salinity. The EFDC model takes pollutant loads from the various sources and through meteorological forcing functions simulates the advective transport and dispersion of the input loads. Attenuation of coliform loads was simulated by a first-order exponential decay. A general description of the model development and calibration follows; details on the model can be found in Appendix A.

A model grid was constructed covering all of the listed reaches along with those stream sections required to provide overall connectivity between the listed segments and tributary inputs. The model included 269 grid cells, each with four vertical layers. The grid covers the shellfish harvesting areas in the bay. When available, observed fecal coliform concentrations were used to set fresh water boundary conditions.

The calibration process was simplified to accommodate the available resources and data. The calibration was focused in two areas: 1) salinity and 2) water quality. Stream flow data collected at a USGS gage located on Choctawhatchee River (USGS 02366500) were used to calibrate hydrologic conditions in the riverine portion of the model. The tidal exchange rate calculated for Choctawhatchee Bay was used to calibrate hydrologic conditions in the estuary and bay portions of the model. The years 1994 to 2001 were chosen to determine TMDL and allocation scenarios because it was representative of the daily average flow values covering both higher and lower flow periods.

Calibration plots of simulated and observed salinity and fecal coliform concentrations are shown in Appendix A. These plots indicate that the model is reasonably representing the observed salinity and fecal coliform concentrations.

Once the model was calibrated, reductions were made to model inputs until simulated concentrations at the calibration stations no longer exceeded the target concentrations. Once reductions had been calculated it was necessary to assure simulated bacteria concentrations in the Bay achieve Class II water quality criteria at all stations used by FDACS to monitor shellfish classification and compliance.

5.4 Development of Total Maximum Daily Loads

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody,

identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

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

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. TMDLs for the impaired waterbodies are expressed in terms of a percent reduction, and where possible, as loads in units of counts per day. When expressed as a load, the TMDL value represents the maximum one-day load the stream can transport over a 30-day period and maintain water quality standards.

5.4.1 Critical Conditions

The critical condition for non-point source coliform loading is typically an extended dry period followed by a rainfall runoff event. During the dry weather period, coliforms build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Water quality data have been collected during both time periods. Most violations occur during median to high flow conditions.

5.4.2 Existing Conditions

In the EFDC model, existing loads for the listed segments are represented as the sum of the daily discharge load of the direct point sources, and the daily indirect load from all land uses (e.g., surface runoff) for calendar years 1997 - 2004. Table 2 gives the Choctawhatchee River and the Choctawhatchee Bay tributaries loading to Choctawhatchee bay.

Table 5 Exisitng Conditon Fecal Coliform Loading

WBID	$WLA_{Continuous}$	WLA_{MS4} (reduction)	LA Background (cfu/day)	LA Wet Weather (cfu/day)	TMDL (cfu/day)
778B	None	N/A	1.2×10^{13}	1.7×10^{14}	1.8×10^{14}

5.5 Margin of Safety

There are two methods for incorporating a MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In the EFDC model of Choctawhatchee Bay an explicit margin of safety was incorporated in the model by assuring that 90% of the time the 43 counts/100 ml was achieved during wet weather events excluding the dry weather background values.

5.5.1 Determination of TMDL, WLAs, & LAs

The TMDL represent the maximum daily load the stream can assimilate and maintain water quality standards. The TMDLs are based on the one-day maximum concentration of the parameter as specified in the standards. When it is possible to estimate flow at the time samples were collected, the TMDL is expressed in units of cfu per day, otherwise the TMDL is expressed as a percent reduction necessary to achieve the target criteria. The TMDL value is reduced by the WLA, if any, to obtain the LA component.

Table 6 Fecal Coliform TMDL Components

WBID	$WLA_{Continuous}$	WLA_{MS4} (reduction)	LA Background (cfu/day)	LA Wet Weather (cfu/day)	TMDL (cfu/day)	Reduction (to nonpoint sources)
778B	None	N/A	1.2×10^{13}	1.2×10^{14}	1.3×10^{14}	15%

N/A = not applicable
Overall reduction required from Choctawhatchee River and the Choctawhatchee Bay tributaries during wet weather events should result in attainment of standards in Central Choctawhatchee Bay and WBID 778B

This TMDL provides the fecal coliform percent reduction needed to meet the "approved" status in the Choctawhatchee Central BAY and in WBID 778B. To meet the "approved" status in the Choctawhatchee Northeastern Bay a 40 percent reduction is needed and to meet the "approved" status in the Choctawhatchee Bay near the Choctawhatchee River Mouth a 70 % reduction is needed.

5.5.2 Waste Load Allocations

The NPDES facilities located in the Choctawhatchee Bay with coliform permit limits discharge to spray fields. Only facilities discharging directly into streams and MS4 areas are assigned a WLA. The WLAs, if applicable, are expressed separately for continuous discharge facilities (e.g., WWTP) and MS4 areas as the former discharges during all weather conditions whereas the later discharges in response to storm events.

The TMDLs for Choctawhatchee Bay do not require reductions. Compliance with permit limits are expected to be maintained.

5.5.3 Load Allocations

There are two modes of transport for non-point source fecal coliform bacteria loading into the stream. First, loading from failing septic systems and animals in the stream are considered direct sources to the stream, as they are independent of precipitation. The second mode involves coliform loadings resulting from accumulation on land surfaces transported to streams during storm events.

The loading reductions necessary to meet the TMDL for WBID 778B in Choctawhatchee Bay were achieved by reducing wet weather fecal coliform runoff by 15 percent

5.5 Recommendations

Determining the specific source of bacteria in waterbodies is the initial step to implementing this coliform TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

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APPENDIX A EFDC MODELING REPORT OF CHOCTAWHATCHEE BAY

List of Tables

List of Figures

Introduction

The Choctawhatchee Bay is defined by USGS Hydrologic Unit Code (HUC 03140102). Florida's Choctawhatchee Bay is located just east of Pensacola Bay on the western end of the Florida panhandle. Freshwater flow to the bay comes from the13,856 sq. km watershed which includes the Choctawhatchee River, Pea River, Wrights Creek, Sandy Creek, Pine Log, Seven Run, Holmes Creek and Bruce Creeks (CBA, 2002). The bay is separated from the Gulf of Mexico along most of its length, but connects through the Pensacola and East passes entering through the south at Destin Pass.

The bay system is fringed by forested wetlands and also characterized by marshes and patches of oyster beds. The system supports the endangered Okaloosa darter (*Etheostoma okaloosae*). Numerous fish, birds and wildlife make the Choctawhatchee Bay their home.

Coordinates: 30.45° N 86.45° W

Selected Characteristics: (USEPA, 1999)
Surface Area: 334 km^2
Drainage Area: 14,000 km^2
Average Daily FW Inflow: 241 m^3/s
Average Depth: 5.0 m
Average Salinity: 25 ppt
Coastal Wetlands: 1,133 km^2
Submerged Aquatic Vegetation: 12 km^2

Choctawhatchee Bay is characterized as a large, shallow, estuarine tidal embayment with a surface area of 86,295 acres or 129 square miles. It is approximately 27 rniles long and ranges from one to six miles wide. Average depths range from 10 feet in the eastern portion of the Bay to 30 feet in the western portion. The maximum depth occurs north of Destin and is approximately 43 feet at rnean low tide (McNulty, et al., 1972; Thorpe, P. and P. Ryan, 1996). The surface water hydrology of Choctawhatchee Bay is influenced primarily by freshwater inputs from the Choctawhatchee River, and tidal exchange from the Gulf of Mexico via East Pass at Destin. Choctawhatchee Bay has an indirect connection to the Gulf of Mexico via Santa Rosa Sound to the west and an indirect connection to the St. Andrew Bay System via the Intracoastal Waterway (ICWW) to the east. The net movement of water is southwesterly towards East Pass and into the Gulf of Mexico. Tidal movement is northeast and northwest during flood tide and southeast and southwest during ebb tide. Current speeds at East Pass may reach one knot or more, but in other portions of the bay they are generally less than 0.5 knots (Goldsmith, 1966; Barnett, E. and W.H. Teehan, 1989). East Pass is a relatively shallow pass that is approximately 985 feet wide and 12 feet deep (Jones W.K. and W. Huang, 1994). The dimensions of the pass, combined with low tidal amplitudes, allows limited flushing of the bay. This causes a halocline or stratification of high salinity waters below lower salinity surface waters that is evident throughout the bay (Livingston, R.J., 1986). In addition to the Choctawhatchee River, at least twenty-one creeks and streams discharge into Choctawhatchee Bay. Fifteen major bayous are located along the perimeter of the bay.

The Choctawhatchee River discharges into the easternmost portion of the bay and is the primary influence on circulation (Jones W.K. and W. Huang, 1994). It is the fourth largest river in Florida and travels approximately 87 miles from the State line through six counties before it reaches

Choctawhatchee Bay. It is the largest source of freshwater for the bay with an average annual discharge of 7,198 cubic feet per second (Thorpe, P. and P. Ryan, 1996). Livingston (1987) reported that peak river flows usually occur between the months of December and April, with the lowest flows during the fall.

Data Availability and Analysis

A wide range of data and information were used to characterize the conditions of the Choctawhatchee River and Bay system. The categories of data used include physiographic data that describe the physical conditions of the watershed, environmental monitoring data that identify potential pollutant sources and their contribution, and in-stream water quality monitoring data.

Instream Flow Data

There is one continuous flow gage located on the lower Choctawhatchee River. Data collected at the gage were used to characterize hydrologic conditions necessary for the calibration of simulations. The year 1997 to 2004 were selected for the simulation period based on the reasonableness of the daily average flow values covering both high and low flows. Flow data from the USGS station were area-weighted to estimate the hydrology within the study area, downstream of the gage.

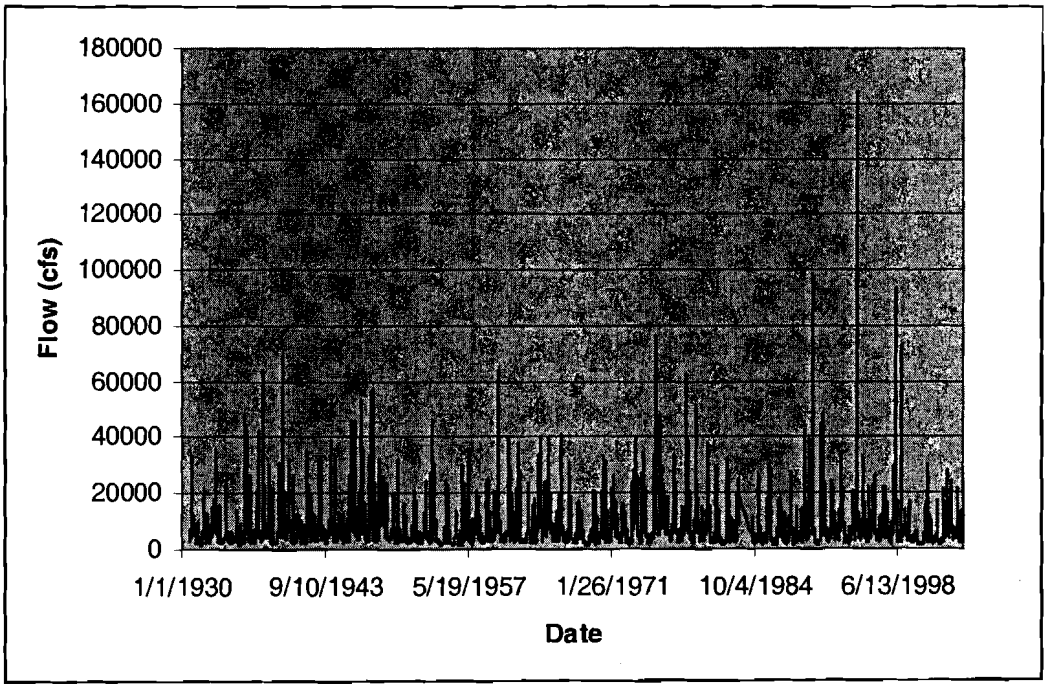


Figure A- 1. USGS Streamflow Period of Record at Gage 02366500

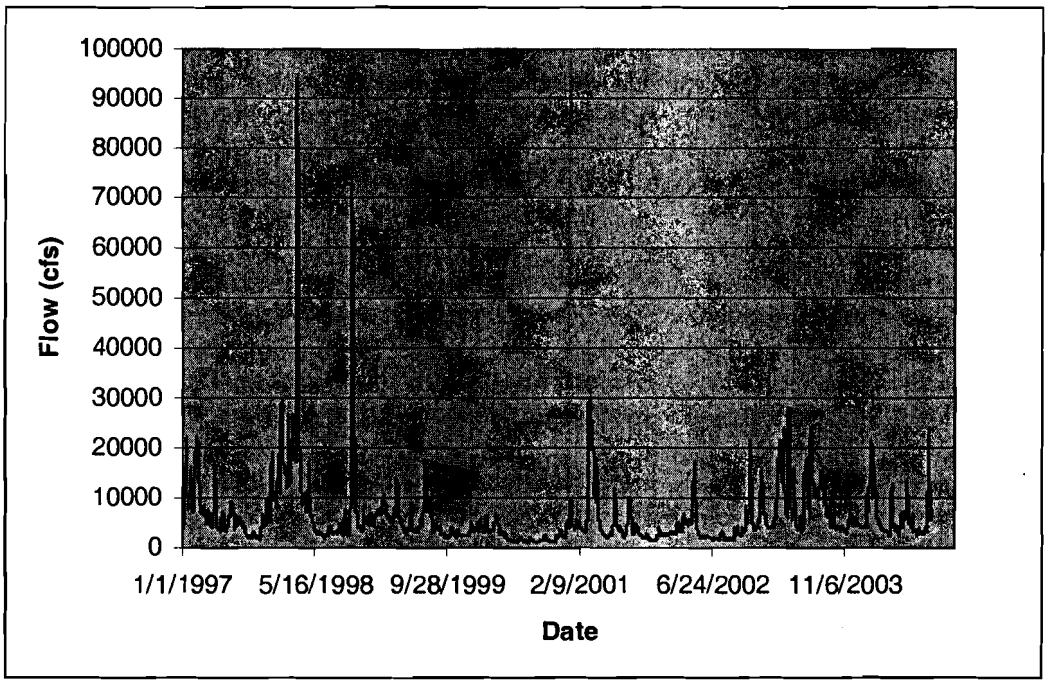


Figure A- 2. USGS Streamflow Period 1997 - 2004 at Gage 02366500

Table A- 1. USGS Station Employed in TMDL Development

Longitude (NAD27)	Latitude (NAD27)	USGS ID	Station Description	Period of Record
85°53'54"	30°27'03"	02366500	Choctawhatchee River near Bruce, FL	10/01/1930-09/30/2004

Meteorological Data

Meteorological data are a critical component of the instream model. The following meteorological parameters are necessary for the instream model:

- Rainfall,
- Solar radiation (computed),
- Cloud cover (estimated),
- Evaportation (computed),
- Relative humidity,
- Pressure,
- Air temperature, and
- Wind speed and direction.

Longterm hourly data of these parameters are available at a National Climatic Data Center (NCDC) weather station located at the Tallahassee Airport (WBAN 93805). Ideally, data closer to the study area is preferred, however, sufficient data were not available.

Tidal Data

Observed provisional tide data were retrieved from a NOAA NOS web site. The station was the nearest to Choctawhatchee Bay. The data were hourly values in meters referenced to Mean Lower Low Water (MLLW) and constructed into the PSER.INP file.

Instream Water Quality

Water quality data applied in this TMDL were obtained directly from FDEP's in-house impaired waters database and the 2005 Santitary Survey. These comprehensive databases includes intensive monitoring data from several federal, state and local governments and is used primarily to assess waterbodies in Florida for inclusion on the 303(d) list of impaired water segments. The dataset is highly dynamic and is continually updated to adjust for additional data and accurate locational associations. Data is included only if assurances of the use of appropriate QA/QC measures are provided.

Within the 303(d) listed WBID 778B, there are approximately 100 fecal coliform samples, taken between January, 1991 and June, 2003 and were taken mainly by FDEP's Shellfish Environmental Assessment Section (SEAS). Examination of the fecal coliform data from the stations confirms that water quality criteria were violated in the 303(d)-listed regions during rainfall events.

For the purposes of model configuration and calibration, 1997 to 2004 were selected as the years for which the model would be run. Fecal coliform samples were taken year-round and are representative of seasonal variances. In addition, coliform samples from other WBIDs within the general model area were incorporated into the analysis to allow for reasonable representation of additional inputs into the system. Figure A_3 illustrates the timeseries fecal coliform loading to the Bay.

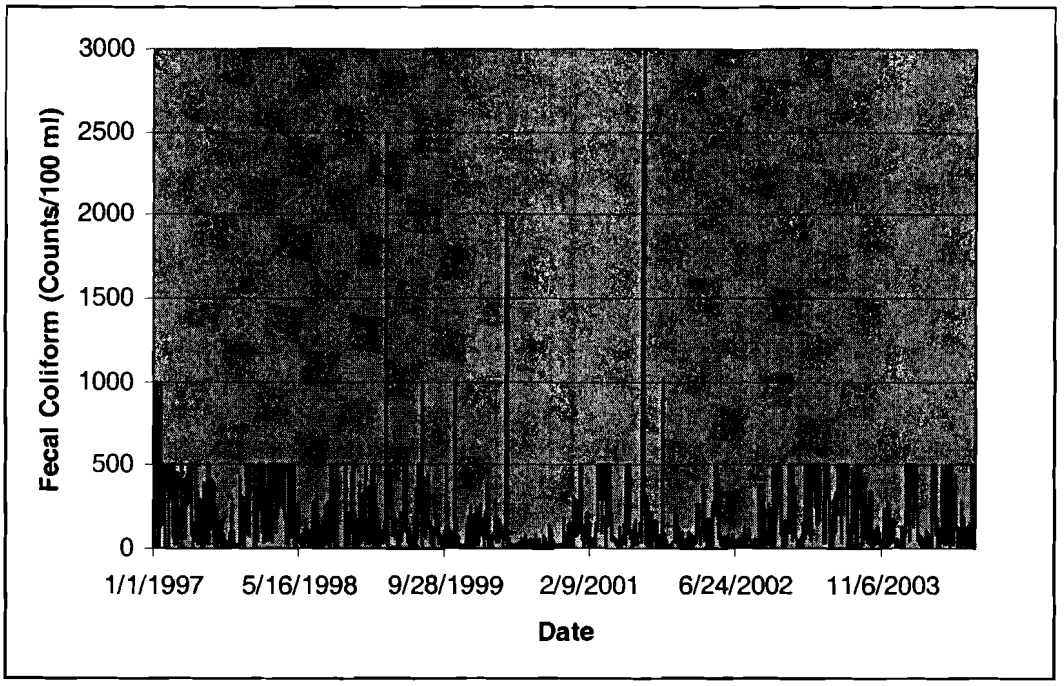


Figure A- 3. Fecal Coliform Timeseries Concentrations, 1997 - 2004

Model Development

Establishing the relationship between instream water quality and source loading is an important component of TMDL development. It allows the estimation of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling. For these TMDLs a model was developed to allow the determination of the watershed loads to the listed reaches, the instream flow and transport within the listed reaches, and the instream distribution of fecal coliform. The model was:

- Environmental Fluid Dynamics Code (EFDC) – to simulate the flow, transport and decay of fecal coliform within the tidal zone of the listed reaches.

The EFDC model is capable of simulating the complex circulation in tidal waterbodies, including the density effects of salinity. A general description of the model along with brief description of the model calibration and application follow.

Receiving Water Model – Environmental Fluid Dynamics Code (EFDC)

The receiving water model takes the pollutant loads from the forcing definitions and accounts for the transport and transformation of material as it moves through the system. In the case of fecal

Choctawhatchee Bay EFDC Grid

Figure A- 4. EFDC Grid Choctawhatchee Bay

Flow inputs to the system consist of 10 horizontal cell locations. 1 headwater flow, and 9 tributary flows. Where available, observed fecal coliform concentrations were used to force fresh water input. However, adequate instream fecal coliform observations were not present for the main fresh water input, the Choctawhatchee River as represented by the USGS station number 02366500. A fecal coliform concentration for this input was developed through an iterative process of experimental constant values relating measured fecal coliform concentrations to changes in daily flow at the USGS gage. Fecal coliform was modeled in EFDC as a conservative tracer with a decay rate of 0.5 1/d (Chapra 1997).

This simulation includes the effects of the 10 MPN/100 mL open boundary condition.

Model Calibration

Hydrodynamic Calibration

coliform, the model simulates for the advective transport and dispersion of the input loads. Attenuation of fecal coliform loads is simulated by a first-order exponential decay.

Hydrodynamic Model Selection and Set Up (EFDC)

A hydrodynamic model was developed to simulate the flow, velocity and transport in the listed reaches. The EFDC model was applied with 239 horizontal grid cells, each with four vertical layers. EFDC is a general purpose modeling package for simulating 1-D, 2-D, and 3-D flow and transport in surface water systems including: rivers, lakes, estuaries, reservoirs, wetlands and near shore to shelf scale coastal regions. The EFDC model was originally developed at the Virginia Institute of Marine Science for estuarine and coastal applications and is considered public domain software. The EFDC code has been extensively tested and documented.

Solutions for flow and transport can be made on multiple scales, i.e. 1-D or 2-D, within the EFDC modeling package. These models solve the 1-D/2-D continuity, momentum, and transport equations. The models use the efficient numerical solution routines within the more general 2-D/3-D EFDC hydrodynamic model, as well as transport, dispersion, and meteorological forcing functions. In addition, EFDC allows for specification of time variable water surface elevation at an open boundary, i.e. allowing a time-dependent Choctawhatchee Bay water surface elevation as a boundary condition. Specific details on the model equations, solution techniques and assumptions may be found in Hamrick (1996).

Inputs to the EFDC Choctawhatchee Bay hydrodynamic model include the following:

- Model grid and geometry,
- Choctawhatchee Bay tidal water surface elevation,
- Flows at headwaters and distributed flows from watershed, and
- Constituent concentrations at headwaters and distributed loads from watershed.

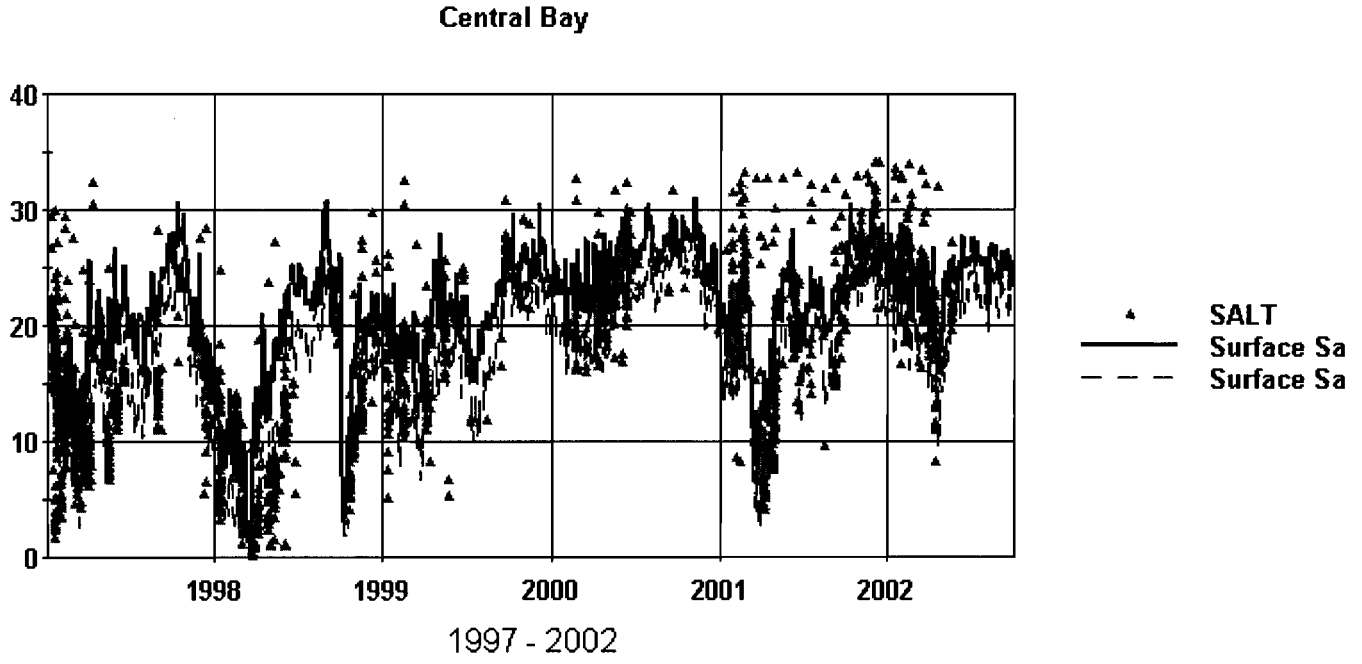
Figure C- 2. Extents of Instream Model Grid (Cell Centers)

The model grid was developed based upon the shorelines from USGS Topographic Maps, estimated cross-sectional information from GIS, bathymetry from NOAA, elevation data from the 30m resolution USGS National Elevation Dataset (NED), and stream connectivity from the National Hydrography Dataset (NHD) stream coverage. Figure C- 4 presents the extent of the EFDC model grid. The grid covers all of the listed reaches along with those stream sections required to provide overall connectivity between the listed segments and tributary inputs.

The hydrodynamics of the Bay is controlled by the fresh water inflow which the majority comes from the Choctawhatchee River. The Gulf tides have minimal impacts on the Bay's flow and velocity fields. River flows were determined from the USGS gage data where available and the ungaged flow inputs were developed using a simple drainage area ratio approach.

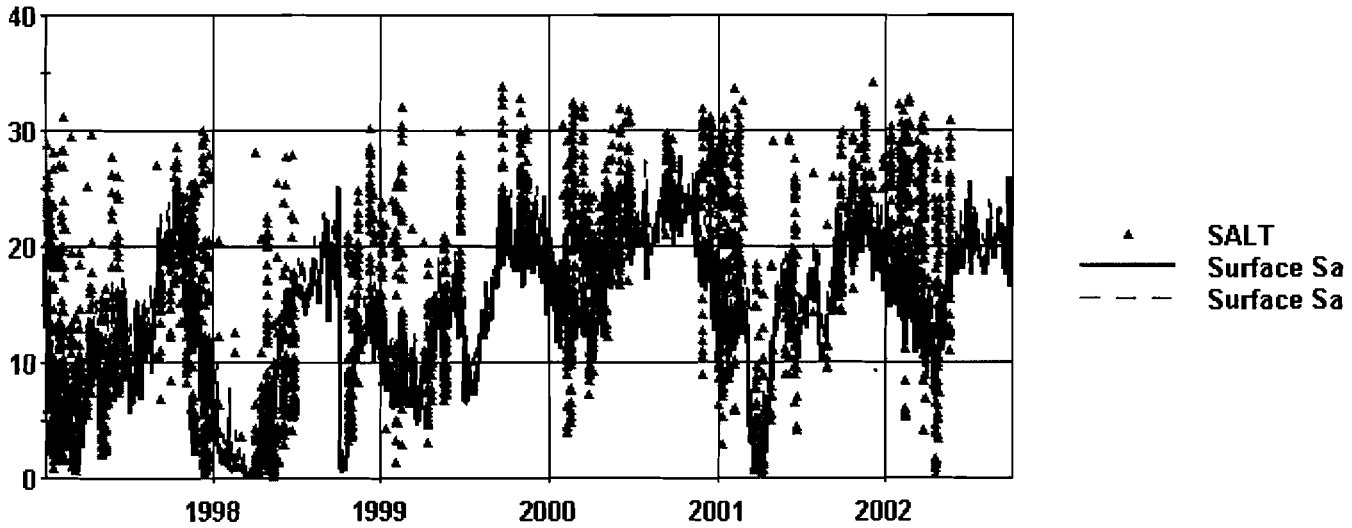
Salinity was used as the calibration parameter, with the offshore boundary cells set at a salinity of 32 ppt.

Salinity Calibration



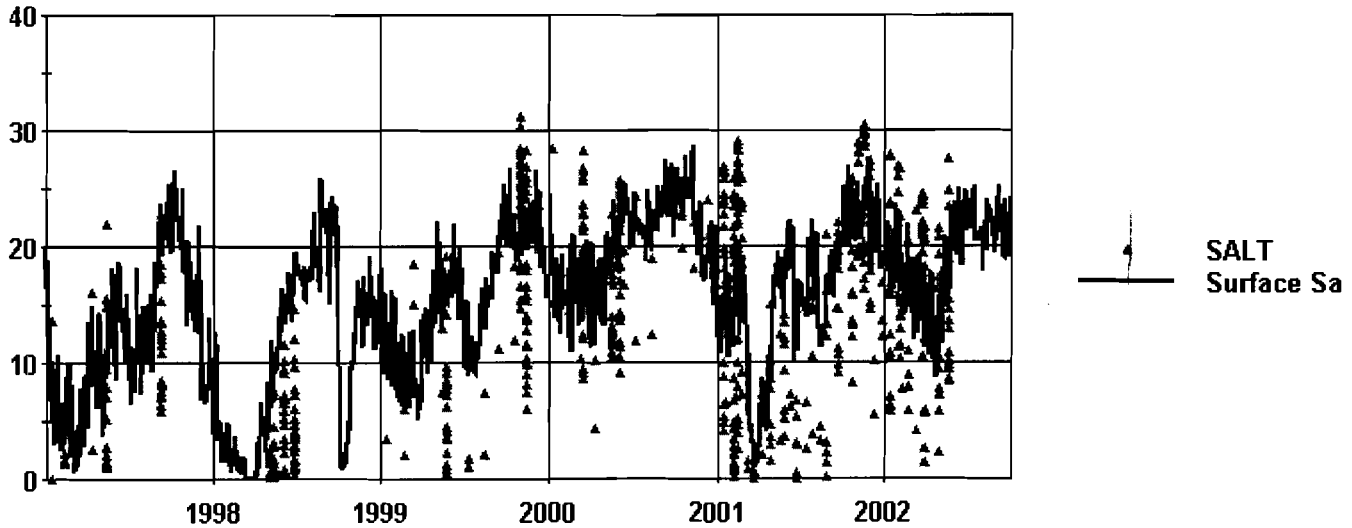
1997 - 2002

Northeastern Bay



1997 - 2002

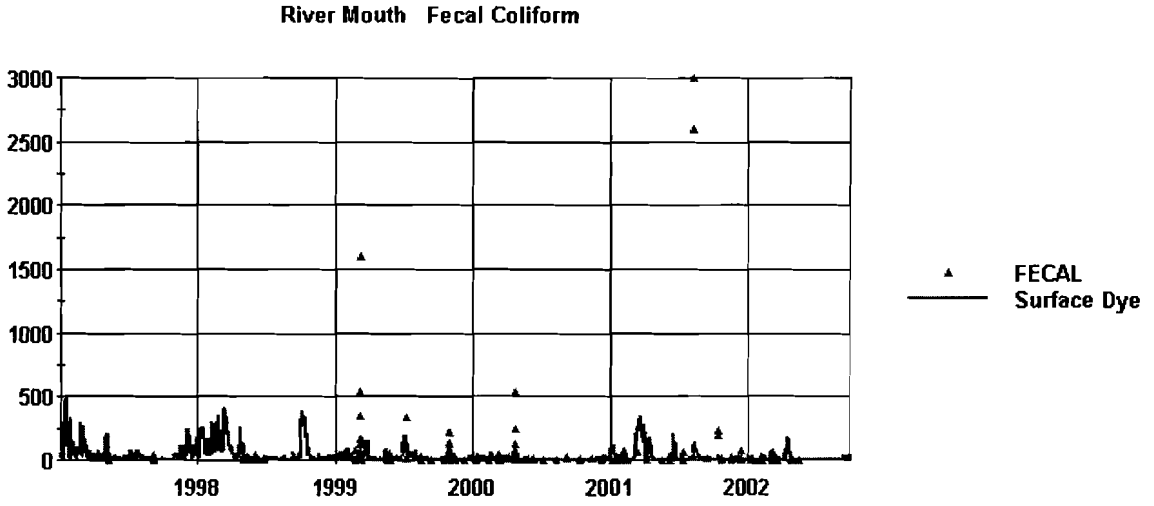
River Mouth



1997 - 2002

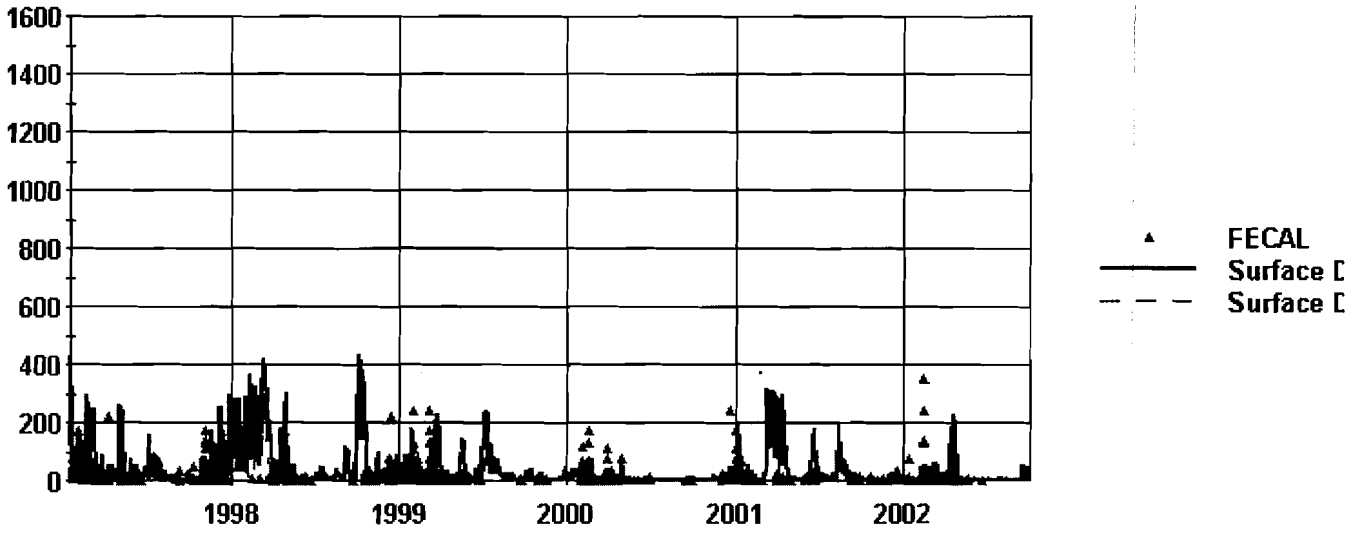
Fecal Coliform Calibration

The fecal coliform calibration was challenged by limited data from the upstream river flows. A daily fecal coliform timeseries was generated using the limited river data, the river flows and the USACE FLUX model (Figure xx). As such, it was more reasonable to simulate relative magnitudes than to match observed data on specific dates. Simulated and observed data for various regions in the Bay stations are presented in the following figures. All of these plots reveal that the model is reasonably representing the observed fecal coliform concentrations.



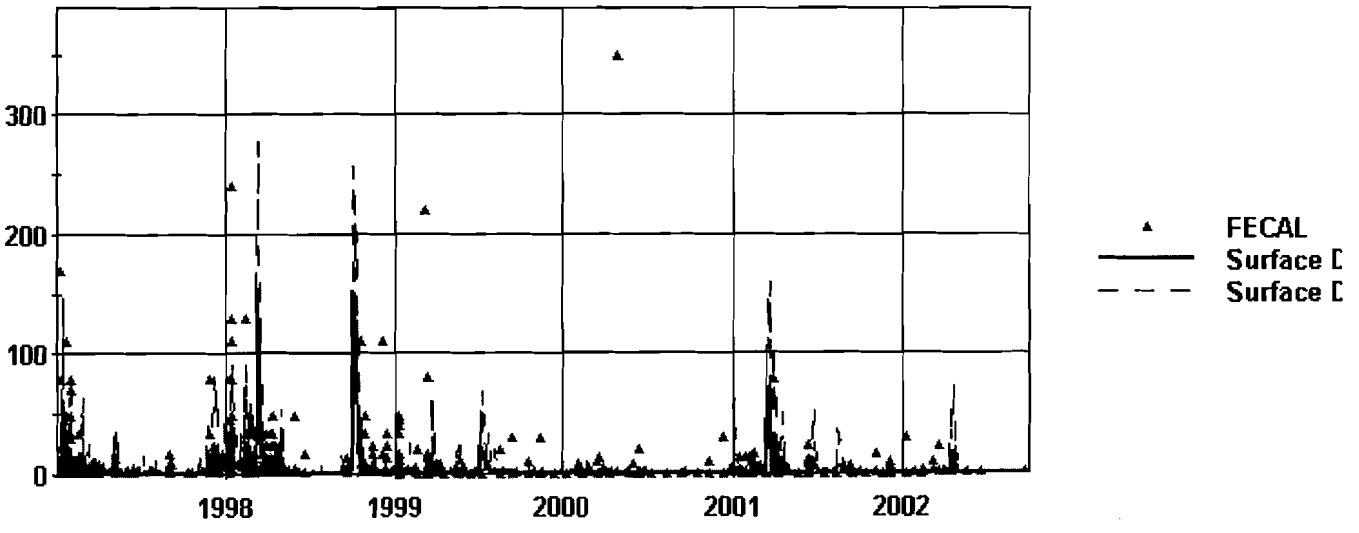
1997 - 2002

NorthEastern Bay Fecal Coliform



1997 - 2002

Central Bay Fecal Coliform



1997 - 2002

TMDL Development

Model output for 1997 – 2004 was used to determine TMDL and allocation scenarios because simulated water quality during this year represented critical conditions and provided a well-distributed sample set. The year 1997 was representative of typical weather conditions, but still contained storm events.

TMDL Endpoints

TMDL endpoints represent the instream water quality targets used in quantifying TMDLs and their individual components. For these TMDLs the endpoint is considered as not having more than 10 percent of the simulated daily values exceed 43 MPN/100 mL for fecal coliforms during the wet weather evants.

The basis for listing was Choctawhatchee Bay does not meet the Class II fecal Coliform standards and that the Bay has shellfish harvesting restrictions due to wet weather fecal Coliform concentrations not meeting the Class II standard of not more than 10% of the samples collected during wet weather events met the 43 colonies per 100 ml standard. To meet this target reductions in wet weather fecal coliform loadings were reduced until target achieved in each of the three main Bay shellfish areas and in WBID 778B.