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1. PURPOSE AND NEED FOR ACTION AND OBJECTIVES OF STUDY

1.1 Introduction

The Terrebonne Levee and Conservation District (formerly South Terrebonne Tidewater Management and Conservation District, STTMCD) has been vested with the authority and responsibility to establish flood control and conservation measures in Terrebonne Parish, Louisiana. Located just north of the Gulf of Mexico, the Terrebonne Levee and Conservation District (TLCD) has formulated a conceptual strategy (Terrebonne Parish Overall Hurricane Protection System) to reduce hurricane damages. The TLCD has also entered into a number of ongoing cooperative agreements with the Louisiana Department of Natural Resources (LDNR)- Coastal Restoration Division, the Natural Resources Conservation Service, and the United States Environmental Protection Agency to implement various wetlands restoration projects in the study area.

The study area extends north to the City of Thibodaux between Bayou Copasaw to the west and the hurricane protection levee west of Bayou Lafourche on the east (figure FPEIS-1). The overall study area encompasses some 1,700 sq. miles.

The National Environmental Policy Act (NEPA) process began in relation to a permit application to the Corps by TLCD for a comprehensive hurricane protection system in Terrebonne Parish-SW (Terrebonne Parish Wetlands) 1013. A Notice of Intent to prepare a drat Environmental Impact Statement (DEIS) for the TLCD plan appeared in the Federal Register on April 7, 1993. A decision was made by the Corps Mississippi Valley Division (MVD) office (formerly Lower Mississippi Valley Division, LMVD) in October 1994 to combine the NEPA efforts for regulatory and feasibility if the Corps entered into a feasibility study. In June 1995, the Corps began the feasibility study. Another Notice of Intent disclosing the new circumstances appeared in the Federal Register on September 8, 1995.

As the study progressed, the magnitude and complexity of the undertaking became evident. No "open" hurricane protection system of such size had been undertaken before. The hydraulic modeling of hurricane events took two years longer than first planned. Information to make decisions about the inclusion or exclusion of many components of a hurricane protection system came with painstaking analysis. It became obvious that the Corps would have great difficulty determining all the details of the system during the feasibility study. Therefore, it was determined to approach the DEIS from a programmatic perspective. Thus, impacts of an overall hurricane protection system for this area and a mitigation plan would be presented with as much detail as possible. However, additional NEPA and other environmental documentation would be needed to fully disclose the various components and impacts when designs become finalized. These additional NEPA documents would be tiered from the Programmatic EIS. This was announced in the Federal Register on October 22, 1999 with a Notice of Intent to prepare a Programmatic DEIS.

The expenditure of resources to develop detailed designs appeared unwise until a determination was made about whether to pursue the overall concept. A decision would need to be made about the Corps pursuing a hurricane protection project of this type. Enough detail is available and presented here to make that decision. If a decision is made to pursue one of the action alternatives, Section 404(b)(1) evaluations, coastal consistency determinations, and all other environmental compliance for each component of the selected alternative will be prepared as details are developed for that alternative.

This document discloses as much detail as possible concerning what a hurricane protection system would entail, but information and plans that are more detailed would be generated and evaluated if the concept meets approval. For example, if a system is authorized and a lock on the Houma Navigation Canal is part of that system, a complete analysis of the lock impacts would be conducted. In addition, a supplemental NEPA document would be prepared after all the details of lock design, construction, and operation are developed.

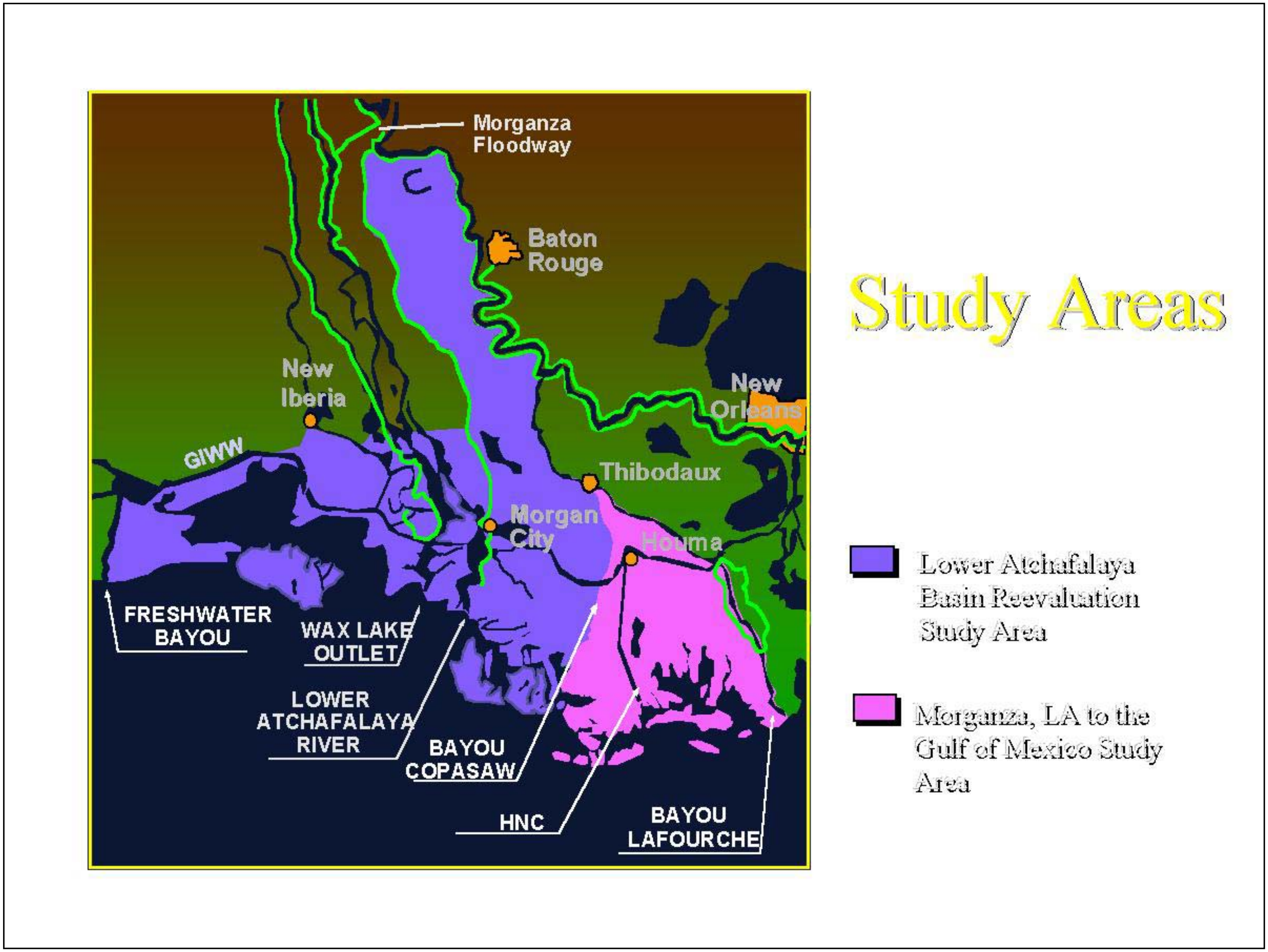

FIGURE FPEIS-1 Morganza to the Gulf of Mexico Study and Lower Atchafalaya Basin Reevaluation Study Area, Vicinity Map

1.2 Purpose

The primary purpose of the proposed action is to reduce flood damages from tropical storm and hurricane induced tidal flooding along Bayou du Large, Bayou Grand Caillou, Bayou Petit Caillou, Bayou Terrebonne, Bayou St. Jean Charles, and Bayou Pointe au Chien (plate 2).

The primary objective of this plan is to reduce flood damages in all the areas predicted to be impacted by storms up to the 100-year recurrent frequency storm event, as depicted on FEMA maps.

The secondary objective of the proposed action is the reduction of coastal wetlands loss and protection of the disintegrating and fragile ecosystem from damaging tidal surges resulting from tropical storms and hurricanes. The secondary objective would be achieved by eliminating the infrequent but detrimental high tides, wave action, and high salinities associated with tropical events. In this way, the hydrology would be disrupted as little as possible.

1.3 Need

Over the last 50 years, hurricanes have caused extensive damages to Terrebonne and Lafourche Parishes. An accounting of these damages has not been documented exclusively for the study area, but included Terrebonne Parish and several other parishes. Some of the figures from the more recent (last 30 years) hurricanes are summarized in this section.

During the aftermath of Hurricane Andrew (Category 3 Storm) in 1992, Terrebonne Parish residents qualified for more than $23 million in damages from FEMA claims. Hurricane Andrew destroyed over 360 homes and damaged approximately 2,900 homes in Terrebonne Parish. An estimated 184 million fish were killed and 25 percent of the state's public oyster breeding grounds were destroyed that year in the central coastal area, a majority of which falls in Terrebonne Parish (East 1995). Overall, Hurricane Andrew caused an estimated $55 million of losses in Terrebonne Parish. The American Red Cross provided over $400,000 of emergency vouchers.

Hurricane Andrew (figure FPEIS-2) also caused coastal wetlands and barrier island erosion. The wetlands act as a zone of defense against tidal surges. They have been subsiding and eroding in recent decades. The communities of coastal Louisiana are offered protection by the extensive coastal wetlands. The coastal wetlands serve as an energy dispersal system against hurricane induced tidal surges. As this protection decreases, damages to the unprotected coastal communities are expected to increase. It appears that damages to the coastal wetlands have a long-term impact on the socio-economic and natural resources in Terrebonne and Lafourche Parish, hence, emphasizing another reason for implementation of this plan. The impact of barrier islands on reduction of storm surge damage to coastal wetlands was being evaluated under a feasibility study funded by the Louisiana Department of Natural Resources.

Figure EIS-2 Hurricane Andrew Bears Down On The Terrebonne Basin

Unfortunately, Hurricane Andrew was not an isolated event. Damages to the socio-economic, cultural, ecological and biological resources of Terrebonne Parish have occurred each time a hurricane has hit this Parish. A brief overview of the damages that have historically occurred are evidenced by the following statistics:

In 1965, Hurricane Betsy (Category 3 Storm) caused over $1.2 billion (1965 dollars) in damages and 81 fatalities. Figure FPEIS-3 is a photo of Hurricane Betsy's aftermath. The majority of these damages were in southeast Louisiana.

Figure EIS-3 Hurricane Betsy Aftermath

In 1974, Hurricane Carmen (Category 3 Storm) inundated approximately 742,300 acres of land in Terrebonne Parish (Corps 1975). Carmen's path of destruction is shown in figure FPEIS-4. Hurricane Carmen caused close to $3,247 million (1974 dollars) in damages and resulted in three fatalities. This hurricane was primarily responsible for reducing the sugarcane yield by 30 percent. Table FPEIS-1 summarizes the damages in Terrebonne Parish by Hurricane Carmen.

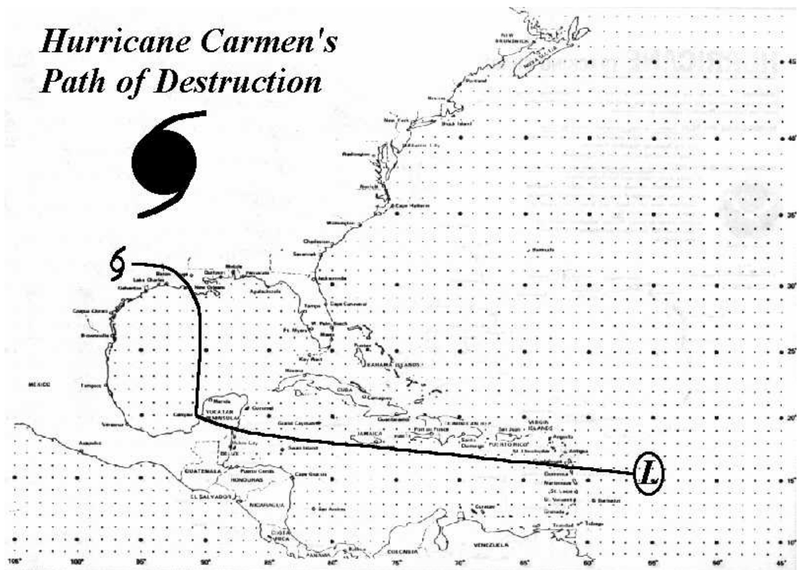

Figure FPEIS-4 Hurricane Carmen's Path of Destruction

TABLE FPEIS-1
Flood Damages in Terrebonne Parish
From Hurricane Carmen

Category	Damages (1974 Dollars)
Urban	$ 177,000
Rural	$ 1,997,000
Agricultural	$ 1,000,000
Government	$ 67,000
Transportation	$ 6,000
Total	$ 3,247,000

In 1985, Hurricane Juan (Category 1 Storm) resulted in flooding over 800 homes in Terrebonne Parish. Figure FPEIS-5 shows the track of Hurricane Juan. Although, no separate statistics were available for Terrebonne Parish, Hurricane Juan caused approximately $554 million in damages and 12 fatalities in the southeast parishes of Louisiana.

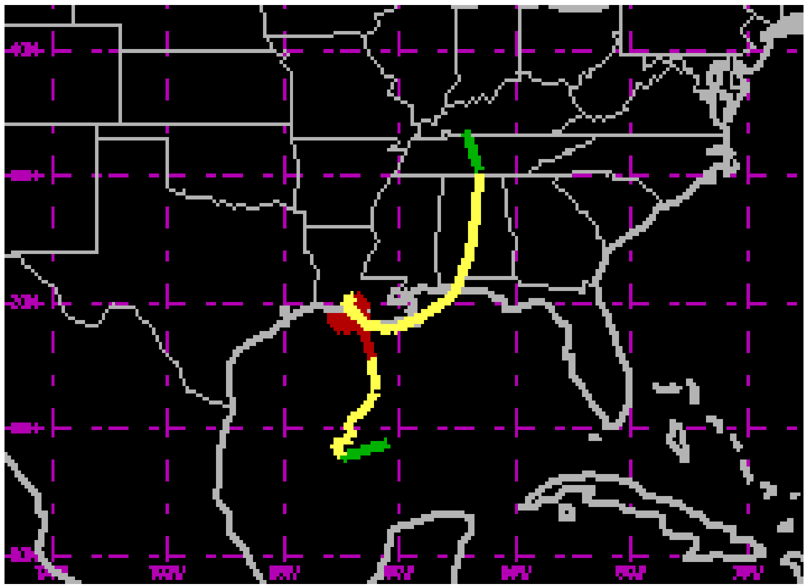

Figure FPEIS-5 Track of Hurricane Juan

From 1978 to 1991 over $20 million in FEMA flood claims were paid in Terrebonne Parish. A majority of these damages can be attributed to the hurricanes that impacted the Gulf Coast.

The United States Army Corps of Engineers (USACE) estimate of future damages to existing conditions in the study area, based upon a 100-year frequency storm event, is over $193 million. The annual damages for the 100-year period is estimated at $10.8 million. However, this estimate does not include fatalities, agricultural losses, personal losses, Red Cross costs and expenditures borne by local and state governments.

Tropical storms and hurricanes continue to threaten the area. Figure FPEIS-6 shows Hurricane Danny making landfall in 1997. During the past two decades, Terrebonne Parish and the TLCD have provided some degree of relief from recurrent hurricane induced tidal flooding and associated damages through their own programs. However, many area residents are still feeling the emotional and financial impacts of hurricanes. Their lives and property continue to be jeopardized by possible hurricane flood damage.

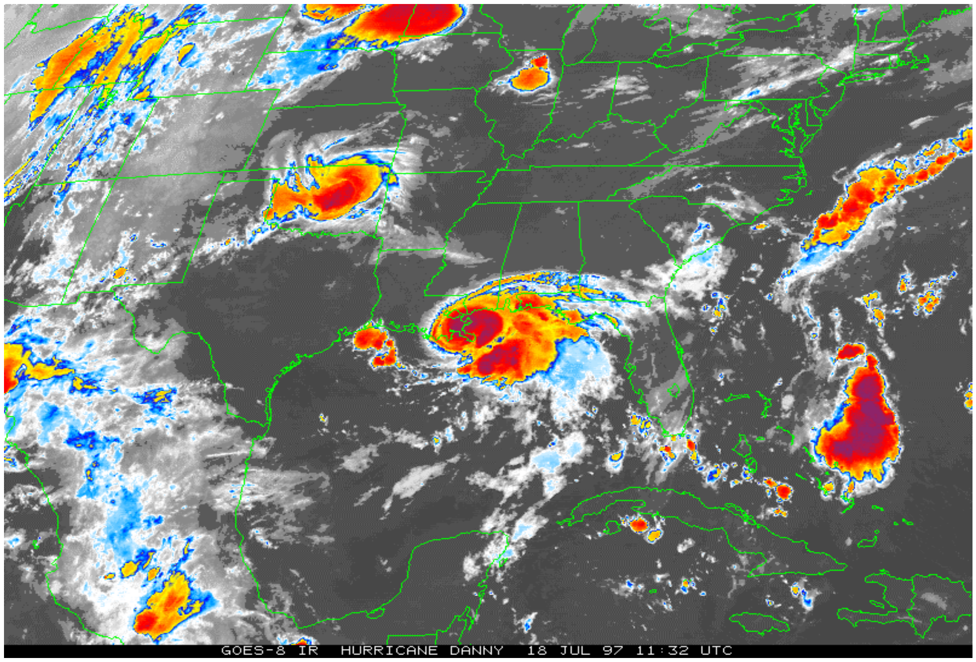

Figure FPEIS-6 Hurricane Danny 1997

Presently, some 30 square miles (19,200 acres) per year of coastal wetlands are lost in Louisiana. In the Terrebonne Basin, 6,656 acres (1.2 percent/year) are being lost (Fuller et al. 1995). Table FPEIS-2 summarizes the land loss rates in Terrebonne Parish by quadrangle (a quadrangle is 225 square miles). In addition, table FPEIS-2 shows the increasing trend of land loss in the Lake Boudreaux Basin between Bayou Grand Caillou and Bayou Petit Caillou, which is covered by the Houma and Dulac quadrangles (figure FPEIS-7).

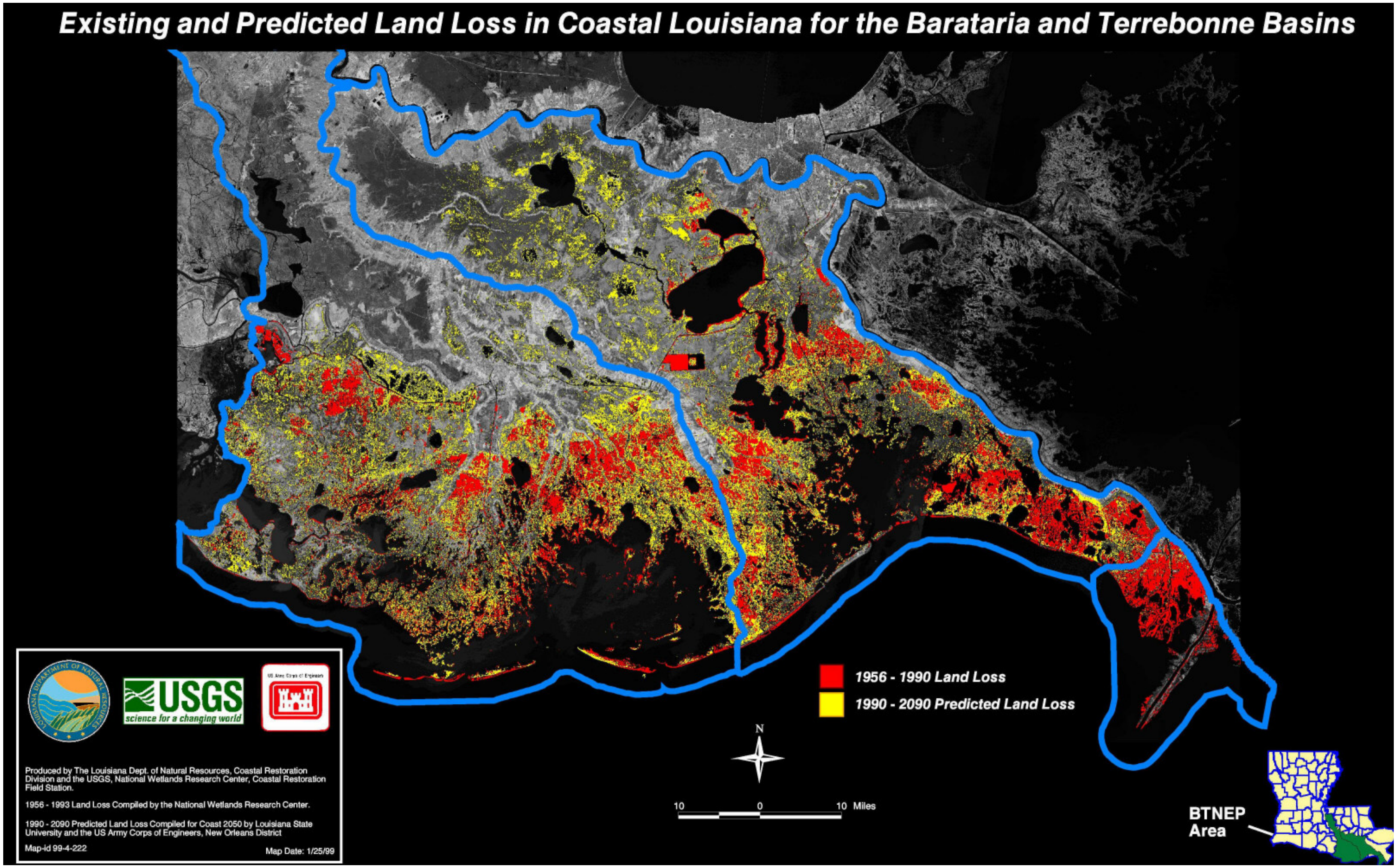

FIGURE FPEIS-7. Land Loss in the Terrebonne Basin as Documented by the Barataria-Terrebonne National Estuary Program

TABLE FPEIS-2
Land Loss Rates in Terrebonne Parish

Quadrangle	Time Period 1	Ave. Loss*	Time Period 2	Ave. Loss*	Time Period 3	Ave. Loss*	Time Period 4	Ave. Loss*
Bayou du Large	1932-58	0.18	1958-74	1.61	1974-83	0.65	1983-90	0.47
Caillou Bay	1932-58	0.22	1958-74	0.40	1974-83	0.43	1983-90	0.21
Dulac	1932-58	0.37	1958-74	0.98	1974-83	1.99	1983-90	1.49
Gibson	1939-58	0.11	1958-74	1.50	1974-83	0.45	1983-90	0.54
Houma	1939-58	0.13	1958-74	0.24	1974-83	0.17	1983-90	0.29
Lake Decade	1931-56	0.25	1956-74	1.31	1974-83	0.38	1983-90	0.26
Lake Felicity	1932-58	0.29	1958-74	1.32	1974-83	1.61	1983-90	1.35
Morgan City	1931-56	0.20	1956-74	1.37	1974-83	0.93	1983-90	0.31
Oyster Bayou	1931-56	0.07	1956-74	0.18	1974-83	0.15	1983-90	0.07
Terrebonne Bay	1932-58	0.1	1958-74	0.29	1974-83	0.49	1983-90	0.68
Thibodaux	1949-58	0.003	1958-74	0.02	1974-83	0.07	1983-90	0.26
Timbalier Bay	1932-58	0.21	1958-74	0.22	1974-83	0.41	1983-90	0.31

* Average Land Loss Rate is in Square Miles per Year
Source: Land Loss Rates, Report 3, USACE, March 1992

Damages caused to coastal wetlands by the winds and storm surges of hurricanes have been reported in a number of studies (Chabreck & Palmisano, 1973; Gardner et al., 1992; Meeder, 1987; and Pimm et al., 1994). Most of these studies have been localized and focused on single factors. They have generally concluded that long lasting changes to geomorphology are usually minor and that coastal wetland plant communities recover rapidly (Conner et al., 1989; and Penland et al., 1989), except where physical disruption of the substrate occurs (e.g., Guntenspergen et al., 1995).

Hurricane Andrew was probably studied in more detail than any previous hurricane that hit the Gulf Coast. Studies conducted by Guntenspergen et al. (1995) and Jackson et al. (1995) describe lateral compression and destruction of some marshes in the Terrebonne Basin. Cahoon et al. (1995) and Nyman et al. (1993a) indicate considerable deposits of sediment in the coastal marshes which are presumed to provide beneficial inputs of nutrients and inorganic sediments. Therefore, it appears that the effect of hurricanes on the marshes needs to be evaluated on a local scale for each basin.

1.4 Location

The study area extends south of the City of Thibodaux between just west of Bayou Lafourche in the east, Bayou Copasaw on the west, and south to the saline marshes bordering the Gulf of Mexico (figure FPEIS-1).

1.5 Study Authority

The reconnaissance study was authorized by a resolution adopted April 30, 1992, by the Committee of Public Works and Transportation of the U.S. House of Representatives. The Energy and Water Development Appropriation Act of 1995 (PL 103-316) authorized the Morganza, Louisiana to the Gulf of Mexico feasibility study. It directed the Corps to give particular attention to the interrelationships of the various ongoing studies in the area, and consider improvements for the Houma Navigation Canal (HNC). The Water Resources Development Act (WRDA) of 1996 authorized the Corps to conduct an independent study of a lock to be located in the HNC. That study was completed in 1997. In 1998, Congress authorized the Corps to initiate detailed design of the multipurpose lock in the HNC.

1.6 Planning Objectives

It was the intent of the Corps to formulate a plan or plans that would provide hurricane protection to the study area and at the same time factor environmental considerations into the process. The projected result was to produce alternatives to provide hurricane protection and at the same time allow valuable coastal wetlands to function as naturally as possible by providing connections to tidal influence. It was not TLCD's or the Corps's intention to increase development potential of wetlands enclosed within the protection system. All future development in wetlands inside and outside of the protection system would continue to be subject to the Corps regulatory process.

2. ALTERNATIVES

The alternatives studied in detail are described in the draft Feasibility Report (DFR); however, a brief description of the alternatives follows.

2.1 Alternatives Screening Process

The TLCD, the Corps, and the public generated possible alternatives and options through regulatory planning, and NEPA scoping processes. For an alternative to be considered, it had to address the purpose for action and at least partly satisfy the need for action. Alternatives were analyzed by the Corps for engineering effectiveness, economic efficiency, and environmental and social acceptability. Alternatives were formulated to accommodate existing, permitted, and authorized projects in the study area. Only those alternatives believed to satisfy these criteria continued into detailed analysis.

First, a qualitative screening of alternatives by the study manager took place to eliminate alternatives that were not designed to address the purpose for action or at least partly satisfy the need for action. After the qualitative screening, five main alternatives for hurricane protection remained, along with the possibility of non-structural alternatives for three remote areas at the end of Bayou du Large, Bayou Grand Caillou, and Bayou Isle de St. Jean Charles. A description of those five alternatives follows.

Alternative 1 (TLCD Plan) was the plan submitted by TLCD in their permit application in January 1993 (plate 3). Alternative 2 (Modified TLCD Plan) modified the TLCD Plan because of cost considerations. It did not include the Isle de St. Jean Charles area and the Montegut wetlands west of Bayou Pointe au Chien (plate 4). Alternative 3 (Highway 57) changed Alternative 2 by going south around the Lake Boudreaux Basin rather than cutting across the north end of Lake Boudreaux (plate 5). Alternative 4 (Northern) followed the same route as Alternative 2, but went to the north of the Lake Boudreaux Basin (plate 6). Alternative 5 (Reconnaissance) was the alternative that the Corps analyzed in the reconnaissance phase of study (plate 7). The reader should be aware that this document might contain occasional references to this original alternative numbering scheme where appropriate.

After initial investigations into the engineering, economic, and environmental considerations of the alternatives, an interdisciplinary planning team (IPT) met on March 30, 1998, to screen two of the three options (north, middle, and south) for crossing the Lake Boudreaux Basin. In doing so, the team could eliminate all but one of Alternatives 2, 3, or 4, which otherwise provided almost identical hurricane protection benefits. Alternative 3 (Highway 57) actually provided slightly greater benefits because it included some additional structures along Bayou Petit Caillou. However, the differences between alignments related primarily to construction costs and the costs of mitigation to offset environmental impacts. Only if the Highway 57 Alternative was not the cheapest alignment would an accounting of its slightly greater benefits be needed for the screening.

The northern option (Alternative 4) followed the existing forced drainage levees along the east and west sides of the Boudreaux Basin and enclosed the basin from the north by crossing Bayou Chauvin, south of Woodlawn Ranch Road near Houma. The modified TLCD (Alternative 2) option crossed the basin by traversing along the northern shore of Lake Boudreaux. The Highway 57 (Alternative 3) option followed Bayou Petit Caillou to Highway 57 around the southern basin boundary to Dulac.

Preliminary designs and construction costs for levees, navigation structures, and drainage/environmental structures were developed and compared for each of the alternatives around the Boudreaux Basin. The 100-year frequency event was used for the design of levees and navigation structures in the Boudreaux Basin. Due to the interconnectivity of the sub-basins outside the Boudreaux Basin, mitigation costs were developed for each alternative in its entirety. The differential impacts between each option and therefore the relative mitigation costs for the complete system were still valid because the remainder of the system outside of the Lake Boudreaux Basin was the same for each of the three alternatives.

The least cost option of the three, including environmental structures and environmental mitigation, was the southern option that followed Highway 57. The relative cost of the Highway 57 Alternative was $40.5 million, the Northern Alternative was $51.9 million, and the Modified TLCD Alternative was $131.6 million. Therefore, the IPT kept only the Highway 57 Alternative for detailed study along with the Reconnaissance Alternative (Alternative 5), which does not encompass the Boudreaux Basin. Alternative 1 was eliminated for other reasons discussed in section 2.3.1.

2.2 Alternatives Studied In Detail

2.2.1 NO ACTION (FUTURE WITHOUT CONDITION)

Description

The TLCD would continue to operate the forced drainage and partial hurricane protection system that currently exists. Plate 2 shows the portion of the forced drainage system that has already been built. The existing system contains segments and components that have been built to be individually self-sufficient. This partial system would consist of levees built to provide protection from up to the 10-year storm event. Developing protection from the 100-year event would be unlikely. Any forced drainage levees already permitted, but not constructed, such as the one along the west side of Bayou du Large, would be built by local entities. Additional permits could be issued for other self-contained forced drainage systems, but the overall protection system would not be constructed.

The Brady Canal Project from the Coastal Wetlands Protection and Restoration Act (CWPPRA) would be in place and would be maintained through its target year life span of 20 years to 2018. It would become ineffective after that time. The Falgout Canal marsh management project would be in place and operating until target year 20 for analysis in this study. The Boudreaux Canal weir, Lashbrook and Bayou LaCache Projects, and Louisiana Department of Wildlife and Fisheries (LDWF) structures on its 33,488-acre Pointe au Chien Wildlife Management Area, all within the study area, were assumed to be in place for the entire 50-year analysis period.

The CWPPRA Grand Bayou Project sponsored by the United States Fish and Wildlife Service (USFWS) would be in place. The planned floodgate at the upper end of Grand Bayou would have to accommodate at least 1,000 cubic feet per second (cfs) to be compatible with the CWPPRA project. The CWPPRA Lake Boudreaux freshwater diversion project would also be in place. It is designed to bring freshwater from the HNC when water is available to the northwest portion of the Lake Boudreaux Basin. The hurricane protection project could not impede the flow of water to either of the CWPPRA projects. The floodgates must be sized accordingly.

The Davis Pond freshwater diversion structure was authorized for construction in 1986 and it is scheduled for completion in 2001. It is located on the Mississippi River in St. Charles

Parish and it is expected to bring up to 10,650 cfs from the Mississippi River to marshes south of the river. The benefits will occur almost exclusively in the Barataria Basin. However, some of the flows will make it to the eastern portion of the Terrebonne Basin via the Gulf Intracoastal Waterway (GIWW). The resulting higher stages in the GIWW may influence the flows going east down the GIWW to Grand Bayou to a minor extent.

Construction

Levees and structures that are already permitted, but not built would be constructed. Additional levees would be only those for self-contained forced-drainage systems. The TLCD would likely attempt to connect the various forced-drainage systems to form a low level hurricane protection system. It is difficult to determine a schedule for this work or if it would ever be completed. Local entities have constructed forced-drainage systems for several decades. It would likely take at least 10 years for local entities to construct even a low level hurricane protection system.

Project Costs

The Corps would not fund any of the construction. All costs would be born by the state of Louisiana or a local entity like TLCD.

Operation and Maintenance

The existing floodgates, pumping stations, and levees would be maintained by local entities to provide drainage and some degree of hurricane storm surge protection.

Permits and Agreements Required

No additional permits would need to be obtained for existing facilities. A full range of compliance would need to be undertaken for any additional work, including a 404 permit, coastal consistency, water quality certification, etc.

2.2.2 HIGHWAY 57 ALTERNATIVE

Description

This alternative would consist of construction of a system of levees and floodgates to provide protection from the 100-year hurricane event (figure FPEIS-8 and plate 8). As originally formulated, it consisted of some 87 miles of levees, 11 floodgates, a lock, 12 fish and wildlife structures, and several drainage structures. The modified alternative has about 72 miles of levees and the same number of structures. One existing fish and wildlife structure at Bayou LaCache is not included in this count because it would not be affected. The multi-purpose structure at Bayou Grand Caillou is included in the count of floodgates but would have culverts in the tie-in walls for fish and wildlife benefits. The needed size of those auxiliary culverts has not yet been determined. Four of the floodgates already exist, built by the TLCD. However, it has not yet been determined if they all would be acceptable in a system designed and constructed by the Corps. At least three of the fish and wildlife structures would replace existing structures. Two of those are on the Pointe au Chien Wildlife Management Area and one is south of Lake Boudreaux. Levee widths would vary from 54-200 feet and adjacent borrow areas, where feasible, would range from 118-210 feet in width. For impact analyses, the Habitat Evaluation Team (HET) used preliminary figures generated in late 1996 that showed even greater widths.

The strategy for an overall hurricane protection system in Terrebonne Parish was to provide flood control and wetlands protection at the same time. The plan envisions as its primary feature, a levee/flood wall, from the western side of Terrebonne Parish, traversing the southern portion of the parish and connecting with the south Lafourche hurricane protection system at Larose. Of the nine individual projects that were part of the original plan conceived by the TLCD (Alternative 1), one has been completed, two are partially or fully permitted, three have been proposed, and three are undecided (table FPEIS-3). None of the levee systems built by TLCD are large enough to provide protection up to the 100-year hurricane event.

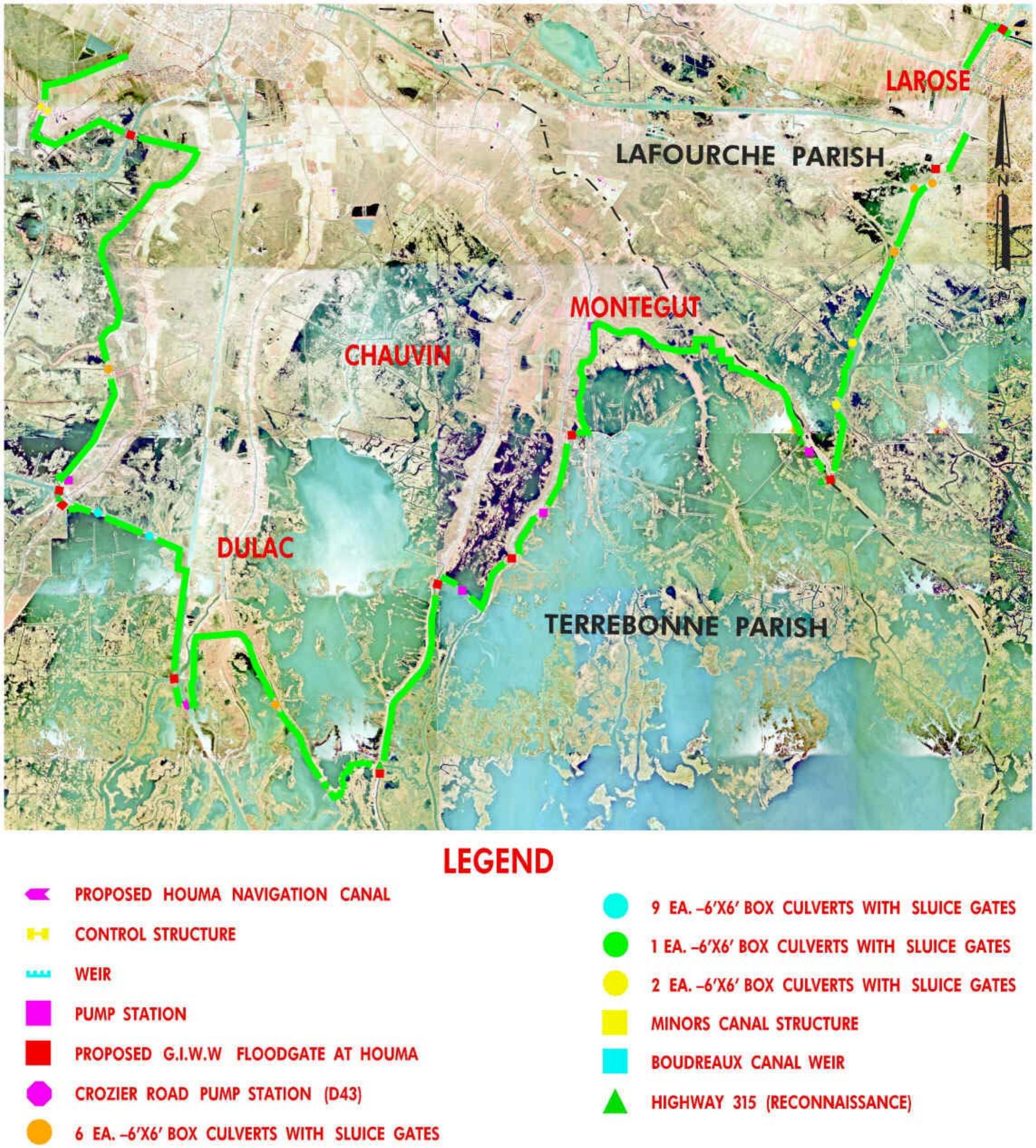

FIGURE FPEIS-8 Map of Modified Highway 57 Alternative.

TABLE FPEIS-3
Status of Existing and Planned Forced Drainage Protection System by TLCD

Project Name	Area	Status
Segment 1. du Large Flood Protection System	Bayou du Large Ridge and the community of Theriot	Permit issued 10/29/99. Under construction – 60% complete
Segment 2. Falgout Canal Flood Protection System	HNC and Falgout Canal Road	Project rejected to be evaluated under Morganza to Gulf
Segment 3. Bayou Grand Caillou Floodgate System	Bayou Grand Caillou and lower Dulac community	Grand Caillou Floodgate Permitted; Bayou Dulac Floodgate and Levee: Not built
Segment 4. Lake Boudreaux Flood Protection System	Lake Boudreaux Basin	Project rejected to be evaluated under Morganza to Gulf
Segment 5. Bayou Petit Caillou Floodgate	Bayou Petit Caillou near Boudreaux Canal	Project permitted and construction complete
Segment 6. Bush Canal, Bayou LaCache, and Bayou Terrebonne	Bush Canal and Southern end of Bayou Terrebonne	Project permitted and construction complete
Segment 7. Bayou Terrebonne to Montegut Flood Protection System	Southern end of Bayou Terrebonne to Humble Canal	Permitted and construction complete
Segment 8. Montegut to Pointe au Chien Flood Protection System	Communities of Isle de Jean Charles and Pointe au Chien	Permitted July 1999
Segment 9. Pointe au Chien to Larose Flood Protection System	Grand Bayou to near the Community of Larose	Project rejected to be evaluated under Morganza to Gulf

Construction

The HNC Lock would be built first, then floodgates, and connecting levees would follow in ssegments. Based on the current schedule, construction is predicted to begin in 2004 and last five years until 2009. Mitigation would be constructed while individual components are built so as to be finished by the time project construction is complete.

Because some areas of enclosed marsh would not receive adequate tidal exchange through the proposed navigation floodgates and the lock, additional openings would be integral and were planned as part of the alternatives development. Therefore, water control structures that allow tidal water exchange and ingress and egress of aquatic organisms during normal conditions became an integral part of the design of all hurricane protection alternatives. Most hurricane protection systems (e.g. those in the New Orleans area) completely enclose urban areas and make little or no attempt to emulate natural hydrology. However, the geography of the Terrebonne area demands that wetland areas be enclosed to avoid tremendous increases in construction costs.

The secondary purpose of this study was to protect sensitive and rapidly deteriorating marsh between bayou ridges. Disturbing or stabilizing hydrology can destroy or greatly devalue wetlands (Bourn and Cottom 1950; Fredrickson and Reid 1990). Therefore, one of the primary objectives was to leave the system as open as possible to allow tidal exchange to continue. An interagency HET comprised of resource agencies, the TLCD, and the Corps planned new and replacement fish and wildlife structures in selected locations to facilitate necessary water exchange. These structures would be needed for drainage with a levee system in place thus; they are not only for wetland, fish, and wildlife purposes.

The fish and wildlife/drainage structures are listed in table FPEIS-4, with their locations for the Highway 57 Alternative shown on figure FPEIS-9. Their locations and designs were decided after many discussions with members of the HET and hydraulic studies. There would be 12 fish and wildlife/drainage structures associated with this alternative. The fish and wildlife/drainage structures would remain open, as would floodgates except during high tidal events normally associated with tropical storms and hurricanes (elevations greater than 3.0 feet). The exception to this would be the replacement structures at the Pointe au Chien Wildlife Management Area, which normally would be operated as the existing ones are operated. They would be closed when exterior water elevations rise higher than 2.0 feet or salinities reach 10 part per thousand (ppt), which is the existing operational regime.

TABLE FPEIS-4
Fish and Wildlife Structures Associated With Prescreening Hurricane Protection Alternatives

Structure	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Description of structure
34	X	X	X	X	X	6-6' x 6' box culverts with sluice gates west of Grand Bayou at Dresser Canal
33	X	X	X	X	X	Same as 34 or double gap sizes in south spoilbank of pipeline canal south of structure 34
32	X	X	X	X	X	6-6' x 6' culverts with sluice gates and inside flap gates south pipeline canal west of Grand Bayou
31*	X	X	X	X	X	6-6' x 6' screwgate culverts with variable crest wier, sluice gates, vertical slots, and flap gates on Pointe au Chien Management Area north Grand Bayou Unit.
30*	X	X	X	X	X	same as 31 on Pointe au Chien Management Area south Grand Bayou Unit
29	X	X	X	X	X	same as 34 on borrow canal off Bayou Pointe au Chien
101	X					Same as 34 on Viguerie Canal
28		X	X	X	X	same as 34 at Point Farm Road
103	X					Same as 31 Montegut Unit, east Structure.
104	X					Same as 31 Montegut Unit west Structure
27			X			same as 34, but with flap gates Highway 57 east
26			X			same as 34, but with flap gates Highway 57 west
106*	X	X				same as 34 at Boudreaux Canal
107	X	X				same as 34 east Lake Boudreaux
111	X	X				3-6' screwgate culverts with variable crest wier, sluice gates, and vertical slots at Hog Bayou
12	X	X	X	X		Multipurpose structure to pass freshwater to the south and west at Bayou Grand Caillou
25	X	X	X	X		same as 34, but with 9 culverts and flap gates Falgout Canal east.
23	X	X	X	X		same as 25 Falgout Canal west

*Existing structures that would need to be replaced.

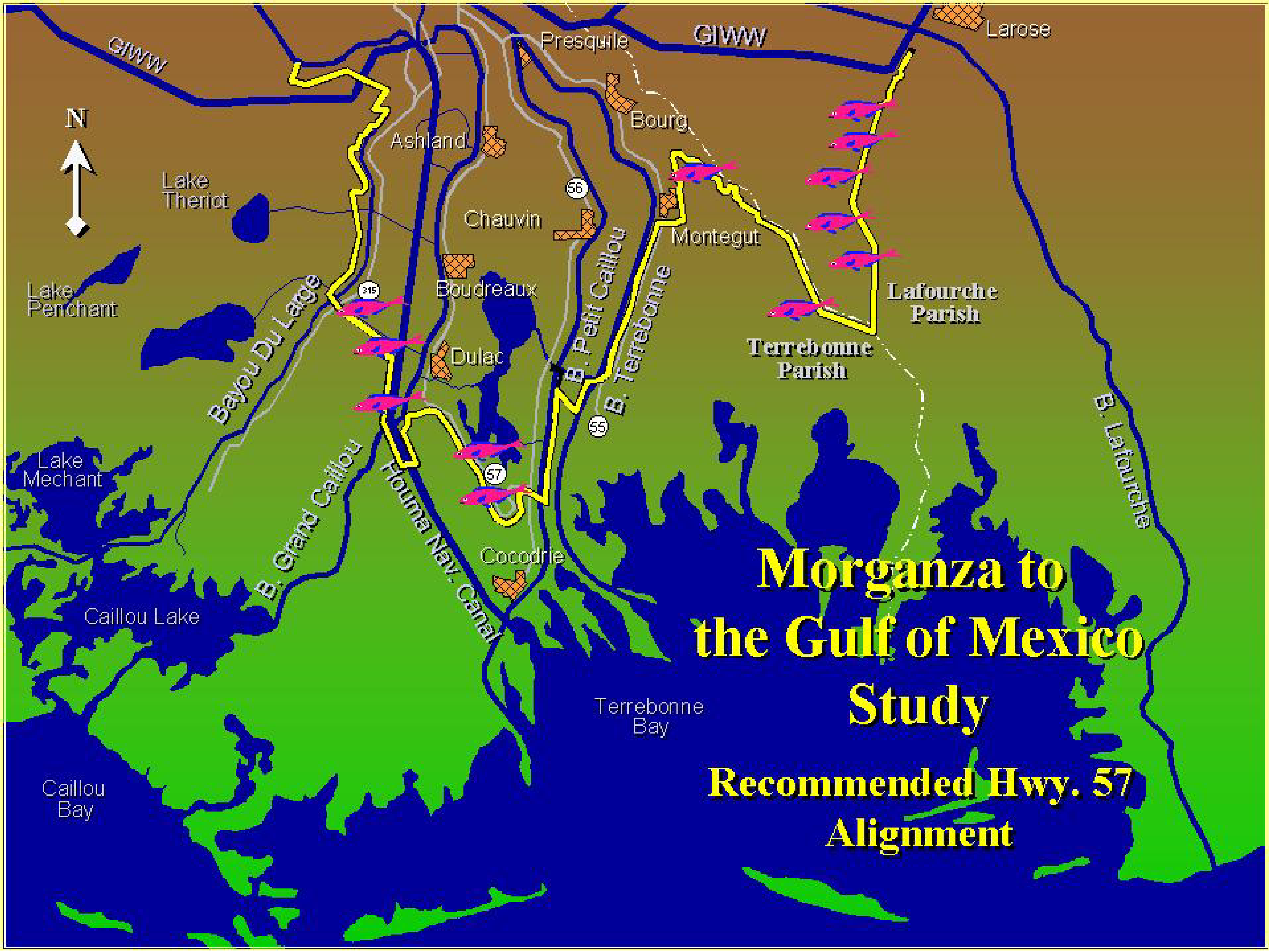

FIGURE FPEIS-9 Locations of Fish and Wildlife Drainage Structures With Modified Highway 57 Alternative

Project Costs

Total project costs for the Highway 57 Alignment are estimated to be $680,000,000. Non-Federal sponsors must provide the following:

a. Furnish all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas necessary for construction, operation, maintenance, repair and replacement of the project, and shall perform or ensure performance of all relocations necessary for the construction, operation, maintenance, repair and replacement of the project.

b. Contribute a minimum of 35 percent of total project costs in accordance with the Federal regulations.

c. At the non-Federal sponsor’s option, perform the following work-in-kind to satisfy a portion of the non-Federal share of the total project cost:

(1.) Design, construct and manage the construction of the Falgout Canal Floodgate, Bush Canal Floodgate, and Bayou Pointe au Chien Floodgate;

(2.) Design, construct and manage the construction of levee reaches K and L from the Bayou Pointe au Chien floodgate to the Larose to Golden Meadow hurricane protection levee;

(3.) Design, construct and manage the construction of the portion of levee reach J from the Bayou Pointe au Chien floodgate to the existing Terrebonne Parish levee system at Montegut; and,

(4.) Design, construct and manage the construction of the environmental WCS adjacent to Island Road, near the community of Isle de Jean Charles.

e. Should the Federal government determine that the value of contributions provided under paragraphs a, b, c and d above is less than 35 percent of the total project cost, then the non-Federal sponsor shall provide, during the period of construction, an additional cash contribution to bring the non-Federal share equal to 35 percent of the total project costs.

Operation and Maintenance

Operation and maintenance of the project will involve mowing approximately 72 miles of earthen levees and dewatering and refurbishing the floodgates and lock every 10 to 12 years. A portion of the levee crosses jurisdictional boundaries from Terrebonne Parish to Lafourche Parish. By letter June 7, 2000, the South Lafourche Levee District has agreed to enter into a cooperative agreement with TLCD for the Operation and Maintenance of the project in Lafourche Parish. Exact operation schedules for the proposed lock remain to be determined; however, evaluations in this document assumed the lock would be operated three months out of the year and open the remainder of the year.

Permits and Agreements Required

If the project goes forward as a Federal project, for each component, a NEPA document, Clean Water Act 404(b)(1) evaluation and 402 certification, and Coastal Consistency Determination would need to be completed. If the local TLCD desires to implement any specific part or parts of the project, permits would still be required from the Corps of Engineers and the LDNR and a water quality certification would need to be obtained from the Louisiana Department of Environmental Quality (LDEQ).

2.2.3 RECONNAISSANCE ALTERNATIVE

Description

East of Bayou Petit Caillou, the Reconnaissance Alternative (figure FPEIS-10; plate 7) is identical to the Highway 57 Alternative. At Bayou Petit Caillou this alternative turns north, crosses the bayou, and continues north along the west side of the bayou. This alternative has approximately 52 miles of earthen levee, 8 flood control structures, 7 fish and wildlife structures, and several drainage structures. A lock would not be constructed in the HNC with this alternative. Instead a floodgate would be constructed. Two of the floodgates already exist at Bayou Terrebonne and Humble Canal; however, it has not yet been determined if they would be acceptable in a system designed and constructed by the Corps. At least two of the fish and wildlife structures would be replacements of existing structures. Levee widths would vary from 40-300 feet and adjacent borrow areas, where feasible, would range from 41-354 feet in width. For impact analyses, the HET used preliminary figures that showed greater widths.

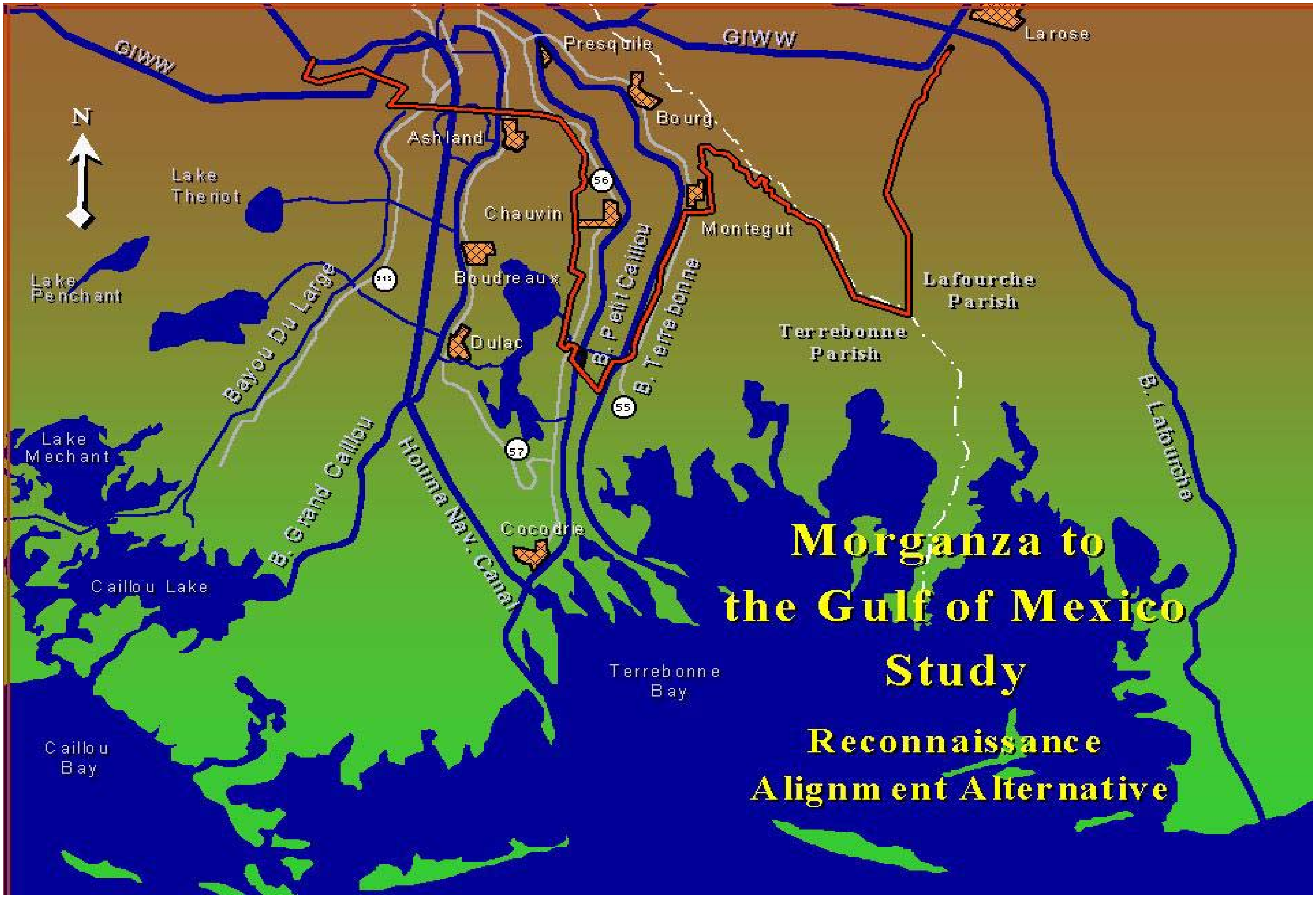

Figure FPEIS-10 Map of the Reconnaissance Alternative

Construction

Construction would follow a similar schedule to the Highway 57 Alternative. Fewer floodgates would be built and a shorter length of levee would be needed, so the first lift of levee could probably be completed in a shorter time. Only 7 fish and wildlife structures would be needed and would be constructed as surrounding levee is built. Mitigation would be constructed while other components are built. That way mitigation would be finished when project construction is complete.

Project Costs

Total project costs for the Reconnaissance Alignment are estimated to be $460,000,000. Non-Federal sponsors must provide the following:

a. Furnish all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas necessary for construction, operation, maintenance, repair and replacement of the project, and shall perform or ensure performance of all relocations necessary for the construction, operation, maintenance, repair and replacement of the project.

b. Contribute a minimum of 35 percent of total project costs in accordance with the Federal regulations.

c. At the non-Federal sponsor's option, perform the following work-in-kind to satisfy a portion of the non-Federal share of the total project cost:

(1.) Design, construct and manage the construction of the Falgout Canal Floodgate, Bush Canal Floodgate, and Bayou Pointe au Chien Floodgate;

(2.) Design, construct and manage the construction of levee reaches K and L from the Bayou Pointe au Chien floodgate to the Larose to Golden Meadow hurricane protection levee;

(3.) Design, construct and manage the construction of the portion of levee reach J from the Bayou Pointe au Chien floodgate to the existing Terrebonne Parish levee system at Montegut; and, (4.) Design, construct and manage the construction of the environmental WCS adjacent to Island Road, near the community of Isle de Jean Charles.

e. Should the Federal government determine that the value of contributions provided under paragraphs a, b, c and d above is less than 35 percent of the total project cost, then the non-Federal sponsor shall provide, during the period of construction, an additional cash contribution to bring the non-Federal share equal to 35 percent of the total project costs.

Operation and Maintenance

Operation and maintenance of the project will involve mowing approximately 52 miles of earthen levees and dewatering and refurbishing the floodgates every 10 to 12 years. A portion of the levee crosses jurisdictional boundaries from Terrebonne Parish to Lafourche Parish. By letter dated June 7, 2000, the South Lafourche Levee District has agreed to enter into a cooperative agreement with TLCD for the Operation and Maintenance of the project in Lafourche Parish.

Permits and Agreements Required

If the project goes forward as a Federal project, for each component, a NEPA document, Clean Water Act 404(b)(1) evaluation and 402 certification, and Coastal Consistency Determination would need to be completed. If the local TLCD desires to implement any specific part or parts of the project, permits would still be required from the Corps of Engineers and the LDNR and a water quality certification would need to be obtained from the LDEQ.

2.2.4 NON-STRUCTURAL ALTERNATIVES (RELOCATE OR FLOOD PROOF)

This alternative is always a consideration in a Corps flood protection study. The difficulty with it as an alternative for the entire study area is the nature of the geography and the arrangement of homes and businesses that have been built to fit the geography of finger ridges suspended south of Houma. The developments are all arranged in linear fashion along the bayous to follow the natural ridges, which do not generally flood except during extended and/or strong tropical events. Relocation is very problematic socially and economically because homes and businesses would have to be moved considerable distances north to the Houma or Thibodaux areas to remove them from the threat of coastal flooding from the 100-year storm event. To buyout or relocate about 5,600 structures at an average cost of $157,500 each, would cost $880 million. Some reaches along the bayous lend themselves to the possibility of elevation rather than relocation or protection. Elevation would be more socially acceptable than relocating. The average cost of elevating is $110,000 per structure, thus elevating approximately 6,000 structures would cost $654 million.

Three areas were considered practicable for non-structural improvements: Lower areas of Bayou du Large, Bayou Grand Caillou, and Isle de St. Jean Charles. The Bayou du Large and Bayou Grand Caillou areas were initially incorporated into the overall hurricane protection project due to the existence of earthen levee systems, residential and commercial development and the construction methods employed. They were later removed because of cost versus benefit considerations.

Isle de St. Jean Charles (the Island) contains approximately 100 residential structures. The Corps considered three options: providing 100-year flood protection, relocation of all residents in accordance with the Uniform Relocation Act (URA), and providing a low level flood protection with a ring levee.

The equivalent annual benefits associated with flood protection for the Island are estimated at $900,000 indicating that a project cost of approximately $13 million could be supported. The estimated construction cost for a 100-year flood protection levee is $190,000,000; therefore, it is not economically justified. A ring levee was also not justified. Relocation of all residents and facilities is estimated to cost approximately $8 million. Consultation with the community and local sponsor is necessary for the completion of this analysis, but relocation is not supported by the community. This leaves structure raising as a possible solution. The only road to the Island was recently raised to provide a better evacuation route. This, in combination with structure raising may be the best option for the Island.

2.3 Alternatives Considered But Eliminated

2.3.1 TLCD (ALTERNATIVE 1)

This plan was very similar to Alternative 2; however, on the eastern end, it included a levee section going from the southern end of the Pointe au Chien Road across the Viguerie Canal and then enclosing Isle Jean Charles. By November 15, 1996, the study manager recognized from preliminary soil borings that this variation was going to be very expensive in comparison with Alternative 2. It was eliminated from further environmental analyses at that time, but could have been brought back if the economic numbers showed justification. It was determined by later engineering investigations and economic benefit analyses that the added cost of the levee down to Isle de St. Jean Charles and across the Montegut Management Area would be too costly to justify. To protect the community, the levee would have to be built across open water and would require several additional lifts (raises of the levee to compensate for subsidence).

The New Orleans District is sensitive to the community's problems and intends to look further into providing flood protection. The Corps has authority under its Section 205 program to investigate small flood control projects, including non-structural measures such as raising homes. The plan must be economically justified and there must be a non-Federal sponsor to provide a share of the cost. The Isle de St. Jean Charles residents are not in favor of relocation.

2.3.2 MODIFIED TLCD (ALTERNATIVE 2)

This plan was eliminated in the screening on March 30, 1998, because it added additional costs in the Boudreaux Basin without additional benefits compared to the Highway 57 Alternative.

2.3.3 NORTHERN OR REGULATORY (ALTERNATIVE 4)

This plan was eliminated in the screening on March 30, 1998, because it added additional costs in the Boudreaux Basin without additional benefits compared to the Highway 57 Alternative. It did not reduce environmental impacts appreciably (appendix C).

2.3.4 LOCK AT HOUMA NAVIGATION CANAL RATHER THAN FLOODGATE

A separate study was initiated to look at the possibility of constructing the lock without connecting levees and the other alternatives. That study, completed in April 1997, recommended that the lock be analyzed as a component of a complete hurricane protection system rather than as a single element. As currently formulated, the Highway 57 Alternative contains a lock as one of its components, but it is possible that a floodgate could be selected during detailed design.

2.3.5 EXCLUDE PRIVATE RESIDENCES FROM PROTECTION IN SELECTED AREAS

This possibility was considered as part of the planning and screening process. The main decision factor affecting inclusion or exclusion in a hurricane protection system was the cost verses the benefits. Existing floodgates and levees that could form parts of a complete system were used as starting points. There were areas where the costs would obviously be so great compared to the benefits that they were not included in the array of possible alternatives. An example is the Cocodrie area.

2.3.6 BARRIER ISLAND CONSTRUCTION

This alternative is beyond the scope of the Morganza to the Gulf FPEIS. The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) authorized a barrier island plan and there was a Barrier Shoreline feasibility study (T. Baker Smith 1999) conducted by the LDNR and the Governor's Office for Coastal Activities. That study encompassed an area from Sandy Point in the Mississippi Delta on the east to Raccoon Point at the end of the barrier island chain on the west, which addresses this consideration. The CWPPRA Task Force is involved with barrier island restoration. The Louisiana Coast 2050 study, which started in March 2000, is also investigating barrier island restoration.

2.3.7 REROUTE GULF INTRACOASTAL WATERWAY SOUTH OF COCODRIE

This alternative was eliminated from further consideration because rerouting the GIWW would significantly increase project construction costs without an increase in benefits. This alternative would cause an increase in navigation costs and would not reduce the cost of levee construction or the overall direct impacts to wetlands. Furthermore, there would be no additional hurricane protection benefits to the study area with this scenario.

2.3.8 NO FLOODGATES ON THE GIWW

This option was analyzed by the One-Dimensional Unsteady Flow Through a Full Network of Open Channels (UNET) model and determined to be infeasible because storm surge could circumvent the levee system and enter from the GIWW. However, the west floodgate was doubled in size from one to two 125-foot floodgates to accommodate navigation concerns about water currents through the floodgate. Two cases were run through the UNET program for all 17 tropical and 6 extra-tropical events for base and future, without and with project conditions. These were the without project conditions and with project conditions with a single gate located in the western end of the GIWW. The results of the without project runs revealed flooding of developed areas adjacent to the GIWW. The results of the runs with the gate on the GIWW west of Houma indicated that the gate prevented significant flooding along western portions of the study area adjacent to the GIWW. However, the gate does not prevent flooding in the eastern portion of the study area adjacent to the GIWW. Because of these results, additional simulations were made for project in place conditions using Hurricane Juan with the gates on the GIWW east and west of Houma.

Questions remain about the effects of the western floodgate on distribution of water coming from the Atchafalaya River. The current model boundary stops at the floodgate so it can not analyze for possible ponding effects to the west and reductions of water to the east. Additional modelling would be required during detailed design to determine the exact water distribution impacts from the floodgate and if further redesign and mitigation would be needed. The environmental analysis in the current effort assumed that 4 inches of ponding would occur west of the floodgate. Hydraulic modelling would be needed to show if that assumption should be changed. The floodgate must be designed so as not to impede flow to the Grand Gayou and Lake Boudreaux CWPPRA projects.

2.3.9 PLUGS ON GRAND BAYOU AND BAYOU GRAND CAILLOU

Originally, the design of a protection system included a plug at the north end of Grand Bayou and another in Bayou Grand Caillou just west of its intersection with the HNC. These components were unacceptable for environmental and navigational reasons. They would block traffic and allow no freshwater exchange to large areas of marsh south of the structures. Therefore, they were changed to floodgates to allow the passage of boat traffic and water. Additional hydraulic analyses would be needed to ensure that the structures are capable of safely handling the amount of water expected to flow through them. It is possible that additional side gates would be needed on the structure at Grand Bayou and expected at Bayou Grand Caillou for environmental reasons.

Table FPEIS-5 is a summarized comparison of alternatives.

TABLE FPEIS-5
Summary Comparison of Alternatives

Significant Resource or Element	Alternative		
	No Action	Highway 57	Reconnaissance
Surface Water	Amounts of Atchafalaya River water would increase. Greater areas of open water would form in marsh areas leading to higher storm surges in developed areas.	Within the levee, normal water/land interface would remain as it was pre-project. High water would be eliminated and salinities within the protected area would be controlled.	Similar to Highway 57 Alternative. Bayou du Large and Bayou Grand Caillou would not be affected.
Soils, Prime and Unique Farmlands	Soils would change over the next 50 years as subsidence in the area continues to occur.	The levees and borrow pits would cover 3,743 acres, including 74 acres of prime and unique farmland. Other soils impacts would be similar to those expected under the No Action alternative.	The levees and borrow pits would cover 1,332 acres, including approximately 26 acres of prime and unique farmland. Other soils impacts would be similar to those expected under the No Action alternative.
Wetlands	About 93,792 acres of emergent marsh out of 271,551 would be lost in 50 years.	About 95,214 acres of emergent marsh would be lost in 50 years. -211 AAHU in fresh marsh; +1632 AAHU in intermediate marsh; -509 AAHU in brackish marsh; -295 AAHU in saline marsh, +220 AAHU in swamp. Losses of AAHU would be mitigated.	About 94,760 acres of emergent marsh would be lost in 50 years. -67 AAHU in fresh marsh; +485 AAHU in intermediate marsh; -94 AAHU in brackish marsh, -27 AAHU in swamp. Losses of AAHU would be mitigated.
Aquatic Resources and Essential Fish Habitat (EFH)	The loss of 35 percent of the emergent marsh in 50 years, all of which is considered EFH in the study area, would reduce populations of estuarine aquatic species and freshwater species.	Similar impacts to No Action would be expected.	Similar impacts to No Action would be expected.
Threatened and Endangered Species	The bald eagle would be expected to be delisted. The brown pelican may follow. The other species may recover, but it is too early to make any predictions.	Similar effects to No Action would be expected.	Similar effects to No Action would be expected.
Land Use	--Hurricanes, erosion, & subsidence would reduce the quality of land use.	++Reduced effects of hurricane surges would improve the quality of land use.	Similar impacts to Highway 57 would be expected.

Fish and Wildlife	--As fish & wildlife habitats decline, the productivity of related recreational & commercial resources would decline.	-+Habitat losses would continue; however, project design includes reductions in habitat loss plus mitigation.	Similar impacts to Highway 57 would be expected.
Business, Industry, Farming	-+Hurricanes, erosion, & subsidence would reduce economic potential; however, continued growth in some areas is anticipated.	++Additional hurricane protection would contribute to the quality of business & industrial development.	Similar impacts to Highway 57 would be expected.
Population, Housing, & Displacement of People	-+Periodic hurricanes would cause continued displacement & reductions in the quality of housing; however, continued growth is anticipated in some areas.	++Additional protection could contribute to the quality of housing & reduce potential displacements.	Similar impacts to Highway 57 would be expected.
Employment & Income	-+Periodic hurricanes would reduce employment & income; nevertheless, continued growth in some areas is anticipated.	++Improved protection would help maintain the quality of employment & amount of income generated in the area.	Similar impacts to Highway 57 would be expected.
Property Values	-+Periodic hurricanes & erosions would tend to reduce property values in some areas; however, values are expected to increase in some areas.	++Improved hurricane protection would help maintain property values.	Similar impacts to Highway 57 would be expected.
Community Cohesion	-+Periodic hurricanes can cause some residents to leave the community; emergencies like hurricane evacuations may lead to social bonding.	-+Social bonds between protected & unprotected communities may decline; however, increased protection may enhance social bonds within protected areas.	Similar impacts to Highway 57 would be expected.
Desirable Community & Regional Growth	--Hurricanes & erosion would reduce the potential for future growth.	+Hurricanes protection would improve the quality of future developments.	Similar impacts to Highway 57 would be expected.
Tax Revenues	-Hurricanes & erosion could limit the potential for future development influencing the local tax base.	+Improved hurricane protection would help maintain the local tax base.	Similar impacts to Highway 57 would be expected.
Public Facilities & Services	-Effects of hurricanes & erosion could reduce the quality of public facilities & services.	+ Improved hurricane protection would help maintain public facilities & services.	Similar impacts to Highway 57 would be expected.
Noise, Health, & Safety	-Periodic hurricanes would threaten public health &	+Improved hurricane protection would help reduce	Similar impacts to Highway 57 would be expected.

	safety, requiring harbors of refuge for navigation; erosion is causing increases in saltwater intrusion; no significant noise impact.	related safety hazards; gates and locks would help reduce the effects of saltwater intrusion on the HNC; temporary noise during construction.	
Energy	-Periodic hurricanes impact oil & gas production.	+Improved protection would help maintain supply vessels & reduce cost of production.	Similar impacts to Highway 57 would be expected.
Navigation	No significant impacts to navigation	--Installation of structures on the HNC would severely restrict navigation,	Similar impacts to Highway 57 would be expected.
Recreation and Aesthetics	Loss of marsh and reduction of the estuarine environment would decrease potential sport fishing and hunting success in the area.	Similar impacts to No Action would be expected.	Similar impacts to No Action would be expected.
Cultural	Land-use practices, oils & gas development, vandalism, marsh loss, & subsidence are all contributing to the destruction & loss of cultural resource sites.	Two National Register eligible and three potentially eligible cultural resource sites are located within the project right-of-way. Thirty six % of the project right-of-way has potential for the presence of additional National Register eligible sites. These locations need to be avoided by shifting the levee alignment. If resource cannot be avoided impacts would be mitigated through data recovery.	One National Register eligible cultural resource site is located within the project right-of-way. Twenty seven % of the project right-of-way has potential for the presence of additional National Register eligible sites. These locations need to be surveyed and tested. Impacts from project construction can be avoided by shifting the levee alignment. If resource cannot be avoided impacts would be mitigated through data recovery.
Hazardous, Toxic and Radioactive Waste (HTRW)	HTRW concerns/sites would not change much, and would mirror population and industry growth. However, by not providing hurricane protection, as erosion and subsidence continue, some increase of risk at known sites of concern would be expected in the future.	Generally, this alternative has less risk of encountering HTRW sites. Sites of concern identified along this alignment include oil and gas infrastructure (such as pipelines and well heads), Above Ground Storage Tanks (ASTs), Underground Storage Tanks (USTs), several marinas, L&L Oil Company, roadside dumps, and the Rebel Ice Plant. None	This alternative has a greater risk of encountering HTRW sites. Sites of concern identified along this alignment include sewage disposal ponds, Ashland Landfill, Gulf Island Fabrication Yard, ASTs and USTs roadside dumps, oil and gas infrastructure, and several marinas. The fabrication yard and landfill are

		of these sites are a significant concern.	significant concerns on the upper end of the HNC along the proposed alignment.

++ Positive impact
+ Minor positive impact
-- Negative impact
- Minor negative impact
-+ Both negative & positive impacts

2.4 Relationship To Other Activities

2.4.1 Various permits have been issued to the TLCD over the years to construct forced drainage projects, levees, and floodgates in the study area. In January of 1993, the TLCD filed a permit application with the Corps for a hurricane protection system. That system was based on the plan outlined in an October 1992 report prepared for TLCD, entitled "Basin Delineation of Terrebonne Parish Flood Protection System." That plan became Alternative 1 for the purposes of the Corps Morganza to the Gulf study.

2.4.2 The USFWS is sponsoring the Grand Bayou Diversion/Cutoff Canal Structure authorized February 28, 1996, and April 14, 1998, under CWPPRA to benefit some 27,000 acres west of Bayou Lafourche and east of Grand Bayou to slow marsh loss and reduce salinities. This project involves deepening Bayou L'eau Bleu by 4 feet and widening it 10 feet to allow more water from the GIWW to flow to Grand Bayou. This project is projected to increase flows through Bayou L'eau Bleu by 100 cfs to 600 cfs. The USFWS and the Corps have calculated that it is possible up to 1,000 cfs may flow down Grand Bayou in the future because of increased flows from the Atchafalaya River and the Davis Pond diversion. Therefore, the floodgate at Grand Bayou must be sized to handle up to 1,000 cfs flows. Also included are the installation of a water control structure in the Cutoff Canal and other water management structures.

2.4.3 The Lower Atchafalaya Reevaluation Study (LAR) and the Morganza to the Gulf hurricane protection study were originally part of the same reconnaissance study. However, since the purpose of the LAR is to provide a method to safely pass the project flood of 1.5 million cfs, as measured at Simmesport, in the lower Atchafalaya River it was separated from the hurricane protection study. The LAR study began in November 1994 after the Wax Lake weir was removed. The study is hydraulically connected to the hurricane protection study area via the GIWW, Bayou Black, and the western Terrebonne marshes. Rivers have a large influence on the landscape (Ward 1997) and the influence of the Atchafalaya River over a wide area should not be underestimated.

The habitat analysis for the present study assumed that flows would reach the Terrebonne marshes as if the authorized Atchafalaya Basin Priject was in place, since that is still the operating condition for that project. It is possible that the LAR study could change freshwater flows to the east into the hurricane protection study area. If a plan is implemented from the LAR that would lessen freshwater flows down the GIWW to the Terrebonne marshes compared to the no action condition for the LAR, the results of the habitat analyses conducted in this study would no longer be valid because they were based on increased flows (as shown in section 3.1.1) down the GIWW.

2.4.4 The Davis Pond freshwater diversion structure was authorized for construction in 1986 and is scheduled for completion in 2001. It is located on the Mississippi River in St. Charles Parish and it is expected to bring up to 10,650 cfs from the Mississippi River to marshes south of the river. The benefits will occur almost exclusively in the Barataria Basin. However, some of the flows will make it to the eastern portion of the Terrebonne Basin via the GIWW. The resulting higher stages in the GIWW may influence the flows going east from the Atchafalaya River down the GIWW to Grand Bayou to a minor extent.

2.4.5 In the eastern portion of the study area, the LDWF operates the 33,488 acre Pointe au Chien Wildlife Management Area about 15 miles southeast of Houma in Terrebonne and Lafourche Parishes. The area is comprised of a variety of vegetation types and wildlife species. Management and water control has been practiced on the area since its inception in 1968.

In addition, southwest of Houma, near Lake Hatch, the USFWS recently established the 4,618 acre Mandalay National Wildlife Refuge. That leaves about 96 percent of the 1,017,000 acres of wetlands in the Terrebonne Basin (Fuller et al. 1995) as privately owned. Therefore, a concerted effort to save and improve wetland habitat quality in the Terrebonne Basin has been difficult. Landowner cooperation would be needed to implement a comprehensive management plan.

2.4.6 To help address the problem of uniting efforts to protect the area, the Barataria-Terrebonne National Estuary Program was selected for the National Estuary Program in 1990. This program has identified the issues of changes in natural water flows, habitat loss, sediment loss, disease-causing bacteria, toxic substances, oxygen-depleting agents, and changes in living resources as problems to be addressed within a consensus building framework. This program is being cost shared by the U.S. Environmental Protection Agency and the State of Louisiana's Wetlands Conservation and Restoration Trust Fund.

2.4.7 Boudreaux Canal Weir Project- Permit SW (Boudreaux Canal)7, issued in January 1995 to the TLCD and Terrebonne Parish Consolidated Government. This project is located approximately 1 mile south of Chauvin, in Boudreaux Canal between Bayou Petit Caillou and Lake Boudreaux. It serves as mitigation for marsh impacts associated with three small parish forced drainage projects (Point au Chene, Isle de St. Jean Charles and Bayou Grand Caillou) and the TLCD's Bayou du Large flood protection project. It is projected to help protect and enhance marsh in the Lake Boudreaux Basin by restricting the movement of high salinity water into Lake Boudreaux from Bayou Petit Caillou.

2.4.8 Lashbrook Marsh Enhancement Project- Permit SW (Terrebonne Parish Wetlands)953, issued in November 1991 to the TLCD, also known as Lower Petit Caillou Project (TE-07b). Approximately .75 miles southwest of Chauvin, along the east shore of Lake Boudreaux, bordered by Boudreaux Canal on the south and Lashbrook Canal on the north. This project serves as mitigation for marsh impacts associated with two flood protection projects (Bayou Terrebonne and Bayou Grand Caillou). It is expected to enhance brackish marsh in about 3,500 acres east of Lake Boudreaux by reducing saltwater intrusion and uncontrolled tidal movement and by redirecting pumped freshwater through the marsh.

2.4.9 Upper Bayou LaCache Marsh Management Plan- Permit SW (Terrebonne Parish Wetlands)991 issued in May 1994 to the TLCD, also known as Upper Bayou LaCache Wetland Project (TE-03). The unit of just over 5,900 acres is located in the Bayou LaCache Basin between Montegut and Chauvin. It is bounded by Bush Canal on the south, Bayou Petit Caillou on the west, Bayou Terrebonne on the east and a forced drainage levee on the north. This is an active marsh management/flood protection project being maintained and operated jointly by the TLCD and the LDNR -Coastal Restoration Division. This project is expected to enhance approximately 4,400 acres of brackish marsh by allowing freshwater introduction from Bayou Terrebonne and reducing saltwater intrusion from Bush Canal. The project includes active water level management using variable crest weirs with flapgates in Bayou LaCache at Bush Canal and in the spoil bank along the west side of Bayou Terrebonne. The project also includes a pump on the southern end to induce freshwater flow and to facilitate drawdowns for environmental or flood control purposes.

The plan allows total shutdown of structures during abnormally high tide conditions to prevent tidal flooding. High levees along the east side of Bayou Petit Caillou (below the Petit Caillou Floodgate), north bank of Bush Canal, and the west side of Bayou Terrebonne (below the Bayou Terrebonne Floodgate) tie in with the floodgates and other levees to form a partial tidal flood protection system for Montegut and Chauvin. The marsh management plan is only partially implemented. The freshwater introduction structure and channel are not yet constructed. The water control structure on the east side is not yet modified and operational. Currently, the structure in Bayou LaCache is the only point of water exchange and control.

2.4.10 Falgout Canal Marsh Management Project – Permit SW (Falgout Canal)2 issued in March 1989 to the Terrebonne Parish Consolidated Government. This project is also known as the Falgout Canal Protection Project (TE-02). It encompasses about 7,400 acres located east of Theriot and bounded on the west by Bayou du Large, on the south by Falgout Canal, on the east by the HNC and on the north by Forty Acre Bayou. The project serves as mitigation for marsh and swamp impacts caused by five Parish forced drainage projects constructed in the early and mid-70's. It was designed to protect and enhance approximately 8,000 acres of brackish, intermediate, fresh marsh, and cypress-tupelo swamp. The project was designed to protect the area by reducing saltwater intrusion and uncontrolled tidal movement, facilitating freshwater input from Bayou du Large and allowing active water level manipulation to induce new vegetative growth.

The LDNR is assisting the Parish in the operation and maintenance of the system. The plan includes seven variable crest and/or flapgated water control structures, a freshwater introduction pump and bankline stabilization along the west bank of the HNC. The project is fully operational but the HNC bankline has not been adequately maintained. A monitoring report on the area (Bourgeois 1997) indicates that the structures have not been properly operated and maintained. Proper operation and maintenance are critical to a marsh management project as they would be for the much larger hurricane protection project.

2.4.11 Lower LaCache Hydrologic Restoration Project – CWPPRA project sponsored by National Marine Fisheries Service (NMFS) below Bush Canal. This project has not been constructed and has been deauthorized.

2.4.12 Lake Boudreaux Basin Freshwater Introduction and Hydrologic Management - is sponsored by the USFWS and is designed to bring fresh water and nutrients through Bayou Pelton into upper Lake Boudreaux just southwest of Chauvin. The project will feature dredging and seven sluice gates and water structures. The project area includes 3,755 acres of intermediate marsh, 1,640 acres of brackish marsh, and 1,827 acres of open water. This project was authorized on April 24, 1997. The proposed action can not reduce the amount of water expected to be provided by the Lake Boudreaux Project.

2.4.13 Montegut Wetland Project (TE-01) comprises 4,200 acres of marsh on the Pointe au Chien Wildlife Management Area, west of Bayou Terrebonne and northeast of Bayou St. Jean Charles. The southern boundary follows a series of oil and gas canals north of Wonder Lake. The project consists of dike system maintenance and water control structures to increase marsh vegetation and reduce salinities.

2.4.14 Brady Canal Hydrologic Restoration Project (TE-28) is located on about 7,650 acres in the Bayou Penchant area. It is bound by Bayou Penchant, Brady Canal, and Little Carencro Bayou to the north, Bayou de Cade and Turtle Bayou to the south, Superior Canal to the east, and Little Carencro Bayou and Voss Canal to the west. The Brady Canal Project is intended to slow marsh loss, decrease water level variations, and reduce salinities.

2.4.15 The EPA's Gulf of Mexico Program has identified the Barataria-Terrebonne Bays as 1 of 12 priority areas targeted for projects aimed at improving water quality, protecting fish and wildlife and their habitats, and ensuring a safe food supply and clean water for swimming.

2.4.16 Implementation of Coast 2050 projects in the Terrebonne Basin is likely in a few years. At present, efforts of this major restoration program are concentrated in the Barataria Basin to the east.

3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

3.1.1 BASELINE

The official starting date for measuring environmental impacts for this study is 2003 when construction of any action alternative would begin. Construction would be complete in 2008. However, it should be recognized that existing conditions for all resources were not documented with data coming from the same year. In 1996 and 1997, when most environmental analyses were completed, the most current literature, maps, databases, and photographs were used and supplemented with field data in many cases to generate existing conditions. Complete construction would take five years because components would be built in stages and the levees would be built in a series of lifts. However, virtually all direct impacts would occur during the initial levee lift; therefore, the environmental impact analyses accounted for all direct impacts in year one of construction. This is the worst case situation for environmental impacts.

3.1.2 LOCATION AND GENERAL PHYSICAL FEATURES

The overall study area is located mostly in Terrebonne Parish in southeast Louisiana at the northern edge of the Gulf of Mexico (figure FPEIS-1) and encompasses about 1,700 sq. miles. Of this total, 550,990 acres (mostly marshlands south of Houma) were analyzed for habitat characteristics. A portion of Lafourche Parish between Bayou Lafourche and Bayou Pointe au Chien is also included in the study area. The study area is approximately 40 miles wide from east to west and 32 miles across the north to south boundaries.

About 12 percent of the land area in Terrebonne Parish is developed. There are 23 public forced drainage projects protecting some 34,430 acres and 26 privately owned projects are protecting another 9,260 acres. The forced drainage projects protect about 10.6 percent of the parish. Another 27 projects protecting 76,023 acres are under proposal. The parish draws water levels down in its drainage canals within the project area to -3.0 ft. National Geodetic Vertical Datum (NGVD) (Sevier 1990) using 52 pumps (Richards et al. 1994).

The study area lies within the Barataria-Terrebonne estuary. This estuary extends from the west bank levees of the Mississippi River (north and east), to the East Guide Levee of the Atchafalaya River (west), to the Gulf of Mexico (south), and to the town of Morganza (north). The Barataria Basin covers about 1,551,800 acres while the Terrebonne Basin covers an area of about 2,063,500 acres. The study area lies within the southern end of the Terrebonne Basin and contains a complex of habitat types, including natural levees, lakes, swamps, marshes, and bayous formed from sediments of abandoned Mississippi River deltas. Elevations in the study area vary. Near Houma, the largest city in the area, the elevation is about 10 feet National Geodetic Vertical Datum (NGVD). The elevation along the bayou ridges is 4-5 feet NGVD and it is less than 1 foot NGVD along the southern portion near the Gulf of Mexico.

The study area lost about 210 square miles of land from the 1930's to 1983 (Britsch and Kemp 1990) due to a variety of factors. Land loss continues to occur in the study area. Coastal Louisiana in general has experienced a high rate of land loss during the last 50 years and the Terrebonne Basin has been no exception.

The major streams located in the study area or that influence the study area are the Atchafalaya River, Bayou du Large, Bayou Grand Caillou, Bayou Petit Caillou, Bayou Terrebonne, Bayou Pointe au Chien, Bayou Lafourche, Bayou L’eau Blue, and Bayou Black. There are no scenic streams in the study area designated under the Louisiana Natural and Scenic River System. The HNC runs north and south mainly between Bayou du Large and Bayou Grand Caillou. The GIWW follows an east-west path in the northern portion of the study area. These two structures, along with the natural channels in the area, have a strong influence on surface water in the area.

These rivers and bayous divide the study area into three main subbasins of the Terrebonne Basin. The Penchant subbasin is located between Atchafalaya Bay and the Atchafalaya River to the west and Bayou du Large to the east and is partly within the study area. The Gulf of Mexico forms its southern boundary and the natural ridge along Bayou Black demarcates its northern extreme. It is heavily influenced by flood flows from the Atchafalaya River. The Timbalier subbasin is located between Bayou du Large on the west, Bayou Lafourche on the east, the GIWW on the north, and the Gulf of Mexico to the south. The Timbalier subbasin has very limited fresh water inflow coming from rainfall and occasional high flows from the Atchafalaya River via the

GIWW to the HNC and Grand Bayou Canal. The Fields subbasin is found between Bayou Lafourche to the northeast, Bayou Terrebonne to the west and northwest, and Louisiana Highway 24 (Bayou L'eau Blue) to the south. This subbasin has the least variety of wetland habitat types of the three subbasins, mostly fresh marsh and swamp.

3.1.3 POPULATION

The 1990 and 1995 populations in Terrebonne Parish were 96,982 and 101,180 respectively. It is estimated that the population will be 129,000 by the year 2000 (Sevier 1990). The population of Houma was 30,495 in 1990. Lafourche Parish had a population of 87,577 in 1995 up from 85,860 in 1990.

3.1.4 CLIMATE

The climate along the Louisiana coast is subtropical, with long, hot summers and brief, mild winters. Winds during the summer are generally from the south, bringing warm, moist air from the Gulf of Mexico, which can produce periods of intense rainfall associated with thunderstorms. The growing season lasts 317 days and average rainfall at Houma is 62 to 62.5 inches per year (Muller and Fielding 1987; Sevier 1990). During the winter, the area experiences alternating cold and warm air as continental fronts pass through from the northwest. Snow is very infrequent.

Hurricanes and tropical storms can occur in Louisiana from June through November, but are most likely to occur in July and September (Muller and Fielding 1987). These storms can bring periods of intense rainfall and wind accompanied by storm surges from the Gulf of Mexico. Tropical storms have winds averaging between 35 knots (40 miles per hour) and 64 knots (73 miles per hour), while hurricanes have winds greater than 64 knots (73 miles per hour). Hurricanes are classified based on maximum sustained wind speed by using the Saffir/Simpson scale. The classification is as follows: Category 1, 74-95 miles per hour; Category 2, 96-110 miles per hour; Category 3, 111-130 miles per hour; Category 4, 131-155 miles per hour; and Category 5, winds greater than 155 miles per hour.

Although it is assumed that storms with higher wind speeds produce more damage, hurricane Juan, which was only a Category 1 Storm, produced significant damage from tidal flooding. These storms can also produce large amounts of rain in a given location, with 10-12 inches not unusual. From 1870 to 1989, 43 hurricanes and 56 tropical storms have struck Louisiana (Roth 1998). Tropical storms occur with a frequency of about one storm every 1.6 years (Simpson and Lawrence 1971) and hurricanes occur about once every 4.1 years within 75 miles of New Orleans (U.S. National Hurricane Center 1995). Louisiana has seen 25 hurricanes from 1899-1992 (Neumann et al. 1993). The last storm of note in the study area was hurricane Andrew (Category 3) on August 26, 1992 (East 1995), which hit Florida first and is listed as the most costly storm ever to hit the United States (Landsea 1998).

3.1.5 GEOLOGY

The geology of the area is heavily influenced by the Mississippi River and its delta plain, a complex of abandoned and active deltas of the Mississippi River. Three of four abandoned delta complexes shaped Terrebonne and Lafourche Parishes as sediments were deposited on the Pleistocene Prairie. The Mississippi River laid down sediments from 100-200 meters thick at each delta (Penland et al. 1988). The abandoned deltas were formed generally from the west to the east in chronological sequence starting about 9,000 years before present and ending less than 100 years ago (Sevier 1990). The most recent sediments of an abandoned delta were laid down as part of the Lafourche delta.

After delta abandonment occurs, sediments slowly deteriorate as they subside under their own weight. In addition, sea level has been rising throughout this time by about 5 to 8 m (Mossa et al. 1990). Historically, the cycle of delta growth and destruction took about 5,000 years (Gosselink and Sasser 1991). However, because of a variety of factors (most notably human), delta destruction is taking place in a few human generations rather than thousands of years.

The Lafourche delta complex in the study area, which includes Bayou Terrebonne, Bayou Black, Bayou Blue, Bayou Pointe au Chien, Bayous Grand and Petit Caillou, and Bayou du Large, began forming some 3,500 years ago. Delta development ended when the Mississippi River shifted to the east about 500 years ago to adopt its current configuration. From that time until about 100 years ago, overflows from the Mississippi River continued to maintain the Lafourche delta complex. The complex began to degrade when Bayou Lafourche was closed off early in the 20th century (Mossa et al. 1990).

The Atchafalaya River with its actively building delta is out of the study area, but its flows influence the study area. It was formed in the 16th century when a meander of the Mississippi River captured the Red River. It remained an insignificant river until late in the 19th century when an enormous logjam at its upper end was cleared (Mossa et al. 1990) and water could move unobstructed toward the Gulf of Mexico. The lower Atchafalaya delta began forming in 1952 and it continues to develop across Atchafalaya Bay.

According to Turner (1990) the driving factors in landscape changes include sea level rise, geological compaction, a 50 percent reduction in sediment supply from the Mississippi River since the 1950's, and hydrologic changes. Delaune et al. (1994), Kuecher (1994), and Gagliano (1999) conclude that geological factors, such as consolidation of deltaic sediments and active faulting, appear to be the underlying cause for a majority of the land loss in coastal Louisiana. Hydrocarbon withdrawals may also be a significant factor (White and Morton 1997) by activating faults that lead to subsidence.

Penland et al. (1987b) found that modern sea level rise is capable of transgressing and submerging the entire Terrebonne coastal region. The researchers state in this same paper that the magnitude of land loss occurring today can be expected to increase to catastrophic proportions.

Louisiana has the highest subsidence rates of any other land area around the Gulf of Mexico at 0.8 cm/year to 1.07 cm/year (Penland et al. 1987a). Louisiana is also experiencing the highest rate of relative sea level (RSL) rise in the Gulf of Mexico, with rates between 1.03 cm/year and 1.19 cm/year. Concerning coastal wetlands and flood damages to coastal communities, RSL (apparent subsidence) is a more critical unit of measure than subsidence or sea level rise by themselves. It is defined as the water surface level relative to the wetland surface and takes into account eustatic sea level rise, subsidence, and accretion.

Published literature shows that Terrebonne Parish is subsiding at an average de-compacted rate of 0.31 cm/year according to Kuecher (1994), a much higher rate than the 0.12 cm/year eustatic rise in sea level reported by Gornitz et al. (1982). Wiseman et al. (1991) determined a subsidence rate of 1.0 cm/year near the coast with a decreasing rate moving northward. Penland et al. (1989)

found that subsidence in the Terrebonne Basin was the highest in Louisiana. Turner and Cahoon (1987) discovered at least a 5.0-mm difference between annual subsidence and accretion in the Terrebonne Basin. Adding to that difference the 0.12 cm/year eustatic sea level rise gives a conservative estimate for RSL rise of 0.17 cm/year in southern Terrebonne Parish.

As part of this feasibility study, T. Baker Smith and Son, Inc. prepared a report entitled "Datum Epochs, Subsidence and Relative Sea Level Rise for Southeastern and South-Central Coastal Louisiana" (1996). This report summarized information on datum and subsidence for areas within the Morganza to the Gulf of Mexico study area. Historical data, public records, various publications, and other pertinent data were acquired through the assistance of the National Geodetic Survey (NGS); the New Orleans District Corps of Engineers, and through independent research of documents and files published or recorded as data bases by various sources.

From the T. Baker Smith report, subsidence rates within and adjacent to the Morganza to the Gulf of Mexico study area vary widely. Documented rates include 4 cm/year, 0.3 to 0.55 cm/year, 1.9 cm/year, 1 cm/year, 2 cm/year, 1.19 cm/year, 1.25 cm/year, 1.06 cm/year, and 0.92 cm/year. The report, however, did not recommend a subsidence rate to be used for the Morganza to the Gulf of Mexico study area.

For the Morganza to the Gulf of Mexico Reconnaissance Study, the Corps utilized information from the Atchafalaya River Delta Study, a study conducted by the Corps Waterways Experiment Station (WES) in the 1980s. The WES analysis showed a spatial and temporal variation in apparent subsidence for the period 1962-2030 from 0.7 cm/year in the Houma area to 1.4 cm/year at the mouth of the Lower Atchafalaya River.

The New Orleans District also analyzed water surface elevation data in the Lake Verret area for the reconnaissance study. Some of the stations experienced noticeable subsidence during the period of record, and, subsequently, periodic datum corrections were applied to the historical record. The datum corrections were incorporated back into the data so that the apparent subsidence estimates would not be erroneously biased low. The 50 percent exceedence water surface elevation for the months July through October was computed for each year of the gages' period of record. The months July through October were chosen because generally few flood events occur during this time of year.

In 1995, the Barataria-Terrebonne National Estuarine Program gathered elevation data within Barataria and Terrebonne Parishes to evaluate subsidence rates. Subsidence was also determined in a 1987 "Terrebonne Marsh Subsidence Study", performed by T. Baker Smith and Son, Inc. for the Corps. Subsidence rates were determined at three locations within or adjacent to the Morganza to the Gulf of Mexico study area: Houma 0.94 cm/year, Lake de Cade 3.0 cm/year, and Cocodrie, 2.4 cm/year.

The wide variation of documented subsidence rates warranted further analysis. An analysis of Corps gage data for three stations within or adjacent to the Morganza to the Gulf of Mexico study area was performed using the same methodology as employed in the Morganza to the Gulf of Mexico Reconnaissance Study. These stations are Intracoastal Waterway at Houma, Bayou Lafourche at Leeville, and Bayou Petit Caillou at Cocodrie. The following subsidence rates were determined: Houma 0.98 cm/year, Leeville 1.1 cm/year, and Cocodrie 1.46 cm/year.

Some of the subsidence data from the 1987 "Terrebonne Marsh Subsidence Study" was utilized to reset the datum of several Corps gages in the early 1990s. Subsequent Global Positioning System (GPS) work and evaluation of the water surface elevation data by the Corps have demonstrated that the subsidence rates from this report may be overestimated. Questions have also arisen concerning adjustments for curvature of the earth and gravity for the 1995 Barataria-Terrebonne work. Consequently, it is likely that the subsidence rates from these studies may be suspect.

Because of the significant variation in published subsidence rates, questions about the accuracy of subsidence rates from the 1987 Terrebonne Marsh Subsidence study and the 1995 Barataria-Terrebonne National Estuarine Program work, apparent subsidence rates from gaged data for the stations Bayou Lafourche at Leeville (1.1 cm/year or 0.036 ft/year) and Bayou Petit Caillou at Cocodrie (1.46 cm/year or 0.048 ft/year) were used for this feasibility study.

Information on land loss from the Barataria-Terrebonne National Estuarine Program was used to estimate subsidence. The maps identify what is "healthy" marsh, marsh that does not deteriorate significantly, and what is "unhealthy" marsh, marsh that becomes open water in 50 to 100 years (www.btnep.org/pages/maps.html).

One-Dimensional Unsteady Flow Through a Full Network of Open Channels (UNET) hydraulics model geometry files were developed that considered apparent subsidence for base conditions, in the year 2008 (15 years), and future conditions for the year 2058 (65 years). For base conditions, apparent subsidence was assumed to be a total of 0.54 ft (0.036 ft/year for 15 years) for all areas except "unhealthy" marsh areas, as identified in the land loss maps from the Barataria-Terrebonne National Estuarine Program. Unhealthy marsh was assumed to subside a total of 0.74-ft (0.048 ft/year for 15 years). Eighteen storage areas were considered to include predominantly unhealthy marsh. For future conditions, apparent subsidence was assumed to be 2.34 ft (0.036 ft/year for 65 years) for all areas except for unhealthy marsh areas where a value of 3.12-ft (0.048 ft/year for 65 years) was assumed. All Base and Future condition model geometry was lowered by these amounts; this including cross sections, culvert and bridge elevations, storage area elevation-volume curves, weir elevations, pump on/off elevations, and rating curves.

3.1.6 GROUNDWATER

Fresh water is obtained in the northern part of Terrebonne Parish from wells 150 to 200 feet deep, but the supply is limited and can be contaminated by salt water (Lytle et al. 1960). Potable ground water is rare in Lafourche Parish because of saltwater in most of the aquifers. Large quantities of saline water are available for some industrial cooling purposes (Matthews 1984).

3.1.7 AIR QUALITY

Terrebonne Parish is an attainment area for Louisiana air quality standards. Lafourche Parish's attainment approval was under review by the Environmental Protection Agency (LDEQ 1993), but was in attainment as of 1997 (EPA 1997) and continues to be in attainment. Lafourche Parish is a non-attainment area for Ozone (1-hour average) based on incomplete data. A minimal amount of construction would occur in Lafourche Parish. Implementation of any of the alternatives would not be expected to have significant impacts on air quality or change the designations for the area although emissions from construction equipment would occur with any of the action alternatives. Contractors would ensure that dust control would be implemented throughout the construction period and that all heavy equipment would receive factory recommended maintenance to assure that they are operating efficiently. No impacts to air quality would be expected after the construction period.

3.1.8 NOISE

Construction equipment would be expected to generate noise in the area of operation. Most of the construction would take place in fairly remote areas and would not be expected to have a significant impact on most humans other than construction employees working within 100 feet of heavy equipment. These workers would require hearing protection to avoid possible hearing loss. Impacts of noise on wildlife are less documented, but steady noise is generally less disruptive than sharp, loud noise such as generated by a pile driver (Bender 1977; Fletcher et al. 1971). It is very difficult to predict the sound level and duration that would disrupt a particular species and/or activity.

3.1.9 EXECUTIVE ORDER 12898

This executive order requires all Federal Agencies to seek to achieve environmental justice by " . . . identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low income populations." The study recognizes that a number of the residents living in the coastal region are of low income and in some cases are decendents of African slaves or Native Americans whose employment opportunities and incomes have traditionally been below average. Some of these individuals would not be included in the two levee alignments; however, the design of both basic project alignments would include hurricane protection for all residents, including minoritites and low income populations. See the discussion in section 3.8.8 Community Cohesion and Environmental Justice. The impacts for the proposed action and alternative are not anticipated to disproportionately affect the health or environment, or activities of minority and low-income populations. Construction would result in minimal relocation of residences and busineses.

3.2 Significant Resources

This section contains a description of significant resources (tables FPEIS-6 and FPEIS-7). Significant resources described in this section are those recognized by laws, executive orders, regulations, and other standards of national, state, or regional agencies and organizations.

TABLE FPEIS-6
Environmental Quality Attributes

SIGNIFICANT RESOURCE	ECOLOGICAL ATTRIBUTES	CULTURAL ATTRIBUTES	AESTHETIC ATTRIBUTES
Surface Water Resources	Necessary to support life.	Human settlements form near bodies of water for sustenance.	Creates environments and sounds that would not otherwise be possible
Prime and Unique Farmland and Soils	N/A	Farming (especially sugarcane) is a part of the local history.	Frequently wide open, unobstructed spaces.
Wetlands	Contains swamps, marsh, and riparian habitat, all of which is valuable to a variety of fish and wildlife species.	Traditional extractive economy supports fishing and hunting in the area.	Pleasing pattern and variety of colors and sounds brings change to the urban and suburban experience. Unobstructed, open spaces and panoramic views
Aquatic Resources and Essential Fish Habitat	Numerous species of fish and invertebrates use the area.	Consumptive use of these resources is one contributor to culture of area.	Presence of these resources is part of the basis for aesthetic value.
Endangered Species	Scarcity of species can be indicative of systemic problems in an area.	Species decline is generally related to man's activities.	Scarcity of a species is a contributor to public appreciation.
Cultural Resources	N/A	Indicators of previous residents.	Many cultural resources have high aesthetic value.
Recreational and Aesthetic Resources	Biological productivity affects some levels of participation.	Consumptive and nonconsumptive pursuits can and do occur in and on the bayous, marshes, and nearby agricultural lands.	Level of appreciation increases as the habitat value increases.

TABLE FPEIS-7
Environmental Quality Recognition

SIGNIFICANT RESOURCE	INSTITUTIONAL RECOGNITION	TECHNICAL RECOGNITION	PUBLIC RECOGNITION
Surface Water Resources	Clean Water Act	Corps, EPA, FWS, LDWF, NRCS, NMFS, etc. recognize that water is a critical biological factor for plants and animals including humans	Public values clean useable water for drinking, fishing, swimming, and other recreation.
Prime and Unique Farmlands and Soils	Farmland Protection Policy Act. CEQ Memorandum of August 11, 1990.	Natural Resource Conservation Service recognizes value of this land for crop production.	Value of productive agricultural land.
Wetlands	EO 11988, EO 11990, Fish and Wildlife Coordination Act, Water Resources Development Act of 1986. Clean Water Act of 1977, Coastal Zone Management Act of 1972,	Coastal wetlands being lost at a rapid pace in Louisiana.	Environmental organizations and public supports preservation of this habitat. Areas are in high demand by commercial and recreational fishermen and hunters.
Aquatic Resources and Essential Fish Habitat	Clean Water Act of 1977, Fish and Wildlife Coordination Act, Magnuson-Stevens Fishery Cons. And Man. Act, Louisiana Water Control Act.	USFWS, NMFS, LDWF, LDEQ, & Corps recognize value of water quality and aquatic habitat.	Environmental groups, fishermen, and general public desire preservation of good water quality and aquatic habitat.
Endangered Species	Endangered Species Act.	USFWS, LDWF, NMFS, and Corps recognize importance of endangered species.	Environmental groups and the public desire protection of these species.
Cultural Resources	National Historic Preservation Act of 1966; Archeological Resource Protection Act of 1979.	Corps, State Historic Preservation Officer, and Advisory Council for Historic Preservation recognize value of archeological and cultural resources.	Preservation groups support protection and enhancement of prehistoric and historical resources.
Recreational and Aesthetic Resources	Land and Water Conservation Fund Act of 1965.	Marsh, wooded, and open lands provide areas for pursuit of various game species.	Public desires expansion of recreational base.

3.3 Surface Water Resources

3.3.1 EXISTING CONDITIONS—HYDRAULICS

1956 Flood: Hurricane Flossy, during the period of September 21-30, was the cause of this flood. Tides reached 5 to 8 feet above normal along most of the southeastern coast. Rainfall during the storm was heavy. The heaviest rainfall occurred at Golden Meadow where 16.7 inches of rain was recorded.

1961 Flood: Hurricane Carla raised tides 3 to 4 feet above normal along the entire coastline of Louisiana during the period of September 4-14. Rainfall associated with the hurricane amounted to 6.2 inches at Morgan City and 3.4 inches at Houma.

1964 Flood: Hurricane Hilda, during the period of October 3-5, caused extensive tidal and headwater flooding in the study area. Heavy rainfall north of the study area associated with this hurricane ranged from 10.1 inches at New Roads to 8.9 inches at Baton Rouge.

1974 Flood: Hurricane Carmen was responsible for this flood from September 5-9. The highest known storm tide, 11.64 ft., NGVD occurred at Cocodrie in Terrebonne Parish. This stage was reportedly more than 10 feet above normal.

1985 Flood: Hurricane Juan, from October 27-31, caused massive flooding throughout the study area due to its 5-day stay along the Louisiana coast. Tides were generally 3 to 6 feet above normal and storm surges of 5 to 8 feet were reported in several coastal parishes. Rainfall amounts in the study area ranged from 5 to nearly 17 inches for this period.

1992 Flood: Hurricane Andrew, from August 24-27, set new maximum extreme of 7.65 ft., NGVD at Round Bayou at Deer Island and recorded 6.8 ft., NGVD for the Lower Atchafalaya River at Morgan City. The Intracoastal Waterway, at the Wax Lake East Control Structure, recorded a stage of 6.15 ft., NGVD.

Tides are diurnal and range from 1.5 to 2.0 feet. Inland, the extent of tidal range and area of influence are determined by the rainfall flow exiting the drainage areas into the Gulf of Mexico and by flows in the GIWW originating in the Atchafalaya River. Mean tide ranges are 1.3 ft. at Cocodrie and 0.9 ft. at Leeville; inland at Houma the mean tide range is only 0.2 ft. During a spring tidal cycle these ranges will be larger; during a neap tidal cycle these ranges will be less.

At present, about 26,000 cfs of flow enters the GIWW from the Atchafalaya River when the Atchafalaya River reaches a flow of 500,000 cfs at Simmsport. Of that amount, about 9,000 cfs is still flowing eastward near Bayou du Large (Demcheck 1998) toward the Timbalier subbasin. Because of channel constrictions, a maximum of 4,000 cfs flows east of the HNC. That leaves 5,000 cfs of the 9,000 cfs flowing down the HNC (Swarzenski 1999). Swarzenski has also found that up to 14,000 cfs flows down the GIWW east of Bayou du Large. The Corps assumed that 11,000 cfs flows down the GIWW east of Bayou du Large.

Within the study area, natural hydrology has been altered by canals, pipelines, hydrocarbon removal, roads, railroads, navigation channels, levees, and marsh management structures. The study area has 39 forced drainage areas, interior drainage areas where excess precipitation is removed by drainage canals and pumping water over levees. The HNC has been implicated in higher salinity water reaching the Houma area (Swenson and Swarzenski 1995). The north-south oriented bayous consisting of Bayou du Large, Bayou Grand Caillou, Bayou Petit Caillou, Bayou Terrebonne, Bayou Pointe au Chien, and Bayou Lafourche form finger ridges that characterize the area. Table FPEIS-8 includes approximate dimensions of several of the bayous in the area. Precipitation-produced runoff enters the system through a complex of coastal swamps and wetlands that provide for a slow release of freshwater to the south (Gosselink 1985).

Several models were used to simulate hydraulic conditions in the study area. A Hydrologic Engineering Center -1 (HEC-1) Version 4.1 model was used to model interior forced drainage areas. Water surface elevation and flow hydrographs were determined using UNET version 3.2. The model was used to perform 161 simulations that included the 2-, 5-, 10-, 25-, 50-, and 100-year extra-tropical storms and 17 tropical storms. The Advanced 3-Dimensional Circulation Model for Shelves, Coasts, and Estuaries (ADCIRC) was employed to simulate the effects of storm surge at all the boundaries of the study area using the latest numerical model. A total of 17 tropical storms were simulated in this model for the existing, base and future conditions. Verification of storm surge was limited to Hurricanes Carmen (1974), Juan (1985), and Andrew (1992).

These events represent the only storms for which sufficient reliable storm surge elevation data were available for the study area. The ADCIRC simulations were used to generate hurricane-specific storm surge hydrographs for input to the UNET model. A UNET model was also used to determine the impact and need for floodgates in the GIWW at each terminus of the levee system. Details of analysis methods including the various modelling efforts can be found in appendix A.

To evaluate the effect of the floodgates in the open-pass condition, a UNET model previously developed for a CWPPRA study was used. The CWPPRA UNET model extends from Bayou Lafourche to the Terrebonne Marsh area with limited detail regarding overbank storage along the GIWW west of Houma. Although the model does not accurately represent the prototype floodgate, it can still be used to evaluate the effects. The magnitude of flow in the GIWW east of Houma appears to be controlled by factors in addition to head. As stages on the Lower Atchafalaya River increase, flows in the HNC and in the GIWW east of Houma increase proportionally until the flow in the GIWW east of Houma reaches 4,000 cfs. The HNC conveys additional flows reaching the Houma area. As much as 8,000 cfs was measured in the HNC during the Atchafalaya high water season.

The area of two 125-ft wide floodgates west of Houma represents approximately 80 percent of the existing channel area. Therefore, head loss is minimal, and it is unlikely that flow patterns in the adjoining Terrebonne Marsh area, including Bayou Copasaw and Minors Canal, should be measurably affected. The CWPPRA UNET model indicated greater channel velocities in the GIWW with the floodgates in-place over their absence in lieu of any head loss and flows into the channels connected to the GIWW were not affected.

TABLE FPEIS-8
Approximate Dimensions of Several Important Bayous in the Study Area

Bayou/Channel	Length (km)	Average Width (m)	Average Depth (m)
GIWW*	61 in study area	138	3.7
HNC*	37 in study area	182	5.5
Grand Bayou	16	58	1.3
Bayou Pointe au Chien	17	27	2.0
Terrebonne**	72	38	2.3
Petit Caillou**	48	18	1.4
Grand Caillou**	40	30-450	1.8-6.1
Du Large**	40	24	1.2
Copasaw	10.5	50	2.1
Minors Canal	15	43	3

* From Corps 1995
** From Kilgen and Kilgen 1990

Discharges from storm-water pumping stations in the Barataria-Terrebonne system are likely to result in significant pollution loads because of fecal coliforms (Richards et al. 1994). There is a 56,800-cfs pumping capacity and 1,442 cfs average annual discharge rate for storm-water, far greater than the 28 cfs for treated sewage. There is a great potential to improve water quality by running storm-water through wetlands, which may also be enhanced by the storm-water (Richards et al. 1994, see pp. 30 and 33 for locations).

One of the primary causes for the increase in water levels in the Morganza to the Gulf of Mexico study area is apparent subsidence. Apparent subsidence is defined as the lowering of the land relative to the mean sea level. An alternative description is relative sea level rise.

As part of this feasibility study, T. Baker Smith and Son, Inc. prepared a report entitled "Datum Epochs, Subsidence and Relative Sea Level Rise for Southeastern and South-Central Coastal Louisiana" (1996).

According to the report, subsidence rates within and adjacent to the Morganza to the Gulf of Mexico study area vary widely; documented rates include 4 cm/year, 0.3 to 0.55 cm/year, 1.9 cm/year, 1 cm/year, 2 cm/year, 1.19 cm/year, 1.25 cm/year, 1.06 cm/year, and 0.92 cm/year. The report, however, did not recommend a subsidence rate to be used for the Morganza to the Gulf of Mexico study area.

For the Morganza to the Gulf of Mexico Reconnaissance Study, the New Orleans District utilized information from the Atchafalaya River Delta Study, a study conducted by WES in the 1980s. The WES analysis showed a spatial and temporal variation in apparent subsidence for the period 1962-2030 from 0.7 cm/year in the Houma area to 1.4 cm/year at the mouth of the Lower Atchafalaya River.

The Corps also analyzed water surface elevation data in the Lake Verret area for the reconnaissance study. Some of the stations experienced noticeable subsidence during the period of record.

In 1995, the Barataria-Terrebonne National Estuary Program gathered elevation data within Barataria and Terrebonne Parishes to evaluate subsidence rates. Subsidence was also determined in the 1987 "Terrebonne Marsh Subsidence Study", performed by T. Baker Smith and Son, Inc for the New Orleans District. Subsidence rates were determined at the following three locations, all within or adjacent to the Morganza to the Gulf of Mexico study area: Houma 0.94 cm/year, Lake de Cade 3.0 cm/year, and Cocodrie, 2.4 cm/year.

Because of the wide variation of documented subsidence rates, further analysis was warranted. An analysis of Corps gage data for three stations within or adjacent to the Morganza to the Gulf of Mexico study area was performed using the same methodology as employed in the Morganza to the Gulf of Mexico Reconnaissance Study. These stations are Intracoastal Waterway at Houma, Bayou Lafourche at Leeville, and Bayou Petit Caillou at Cocodrie. (See plate 2-1). The 50 percent exceedence water surface elevation was plotted against time, and a linear regression line developed. Using this methodology, the following subsidence rates were determined: Houma 0.98 cm/year, Leeville 1.1 cm/year, and Cocodrie 1.46 cm/year.

For the past 100 years, humans have drastically modified water and sediment flows into the study area. Some of the modifications have been local (e.g. levees along the lower Mississippi River) and some have resulted from activities 100's of miles away (e.g. dams on the Missouri River). The sediment load of the Mississippi River has declined almost 80 percent since 1850. The sediment that remains is funneled to the mouth of the river by an elaborate levee system where much of it is lost off the continental shelf (Reed 1995). Therefore, the water and sediment inputs to the study area do not resemble those experienced a short time ago. Poff et al. (1997) state that in order to manage river ecosystems better, people must first recognize that alteration of river flow results in widespread geomorphic and ecological changes. Sediment addition to the Terrebonne system has certainly been changed by human alteration of the Mississippi River system.

The Mississippi River still exerts a strong influence on coastal salinities (Wiseman et al. 1990). However, the only sediment sources for abandoned delta lobes are bay sediments reworked during winter storms and hurricanes (Baumann et al. 1984) and organic sediments from dead plant material (Evers 1990). In Lake Barre, sediments flux in and out of the marsh with winter storms, but with negligible winds and strong currents, suspended sediment concentrations were minimal.

The Atchafalaya River lies to the west of the study area, but influences freshwater inflows to the study area, particularly west of Bayou du Large in what is termed the Penchant subbasin. To the north, the Atchafalaya River connects to the Mississippi River at Old River and channels 30 percent of the combined flow of the Mississippi and Red Rivers at the latitude of Old River. The influence of the Atchafalaya River on the study area is dynamic from year to year depending on Mississippi River flows. As the Atchafalaya delta continues to form, it is expected that increasing flow from it will reach the Penchant subbasin and areas as far east as Grand Bayou. There are adverse impacts from too much water in the Penchant subbasin already.

During high Atchafalaya River stages, water flows east down the GIWW to the northern portion of the study area and through channels such as Bayou Copasaw and Minor Canal at the western end of the study area. To the east of Bayou du Large, in what is termed the Timbalier subbasin, water from a high Atchafalaya River moves south in large volumes down the HNC, which lowers salinities south of the junction with Bayou Grand Caillou. Fresh water from the Atchafalaya also flows via the HNC and Bayou Dulac into the western portion of Lake Boudreaux. South of Highway 57, between Bayou Grand Caillou and Bayou Petit Caillou the marshes are saline. The HNC supplies fresh water to this area when the Atchafalaya River flow is high. Bush Canal forms the same type of boundary separating saline and brackish areas between Bayou Petit Caillou and Bayou Terrebonne. Marshes and swamps east of Bayou Terrebonne to Bayou Lafourche can be influenced by fresh water supplied by the GIWW that makes it all the way to Bayou Lafourche via Company Canal and Grand Bayou via Bayou L'eau Blue.

Additional details on hydraulic analyses can be found in appendix A.

3.3.2 EXISTING CONDITIONS—WATER QUALITY

The in-situ water quality was evaluated using available data from various stations, which are sampled at periodic intervals. Stations have been established by the US Geological Survey (USGS) and the Louisiana Department of Environmental Quality (LDEQ). Currently, Louisiana Department of Health and Hospitals (LDHH) analyzes for coliforms at LDEQ stations. In addition, water samples collected at several locations within the basin were analyzed as a part of this study.

Measured parameters vary with the station and sampling agency. In general, the USGS and the LDEQ analyze for a variety of chemical and physical parameters, including pesticides and heavy metals. The LDHH is more biologically oriented with emphasis on coliforms.

Common parameters such as temperature, pH, dissolved oxygen (DO), and solids are recorded for most stations. Parameters analyzed for samples collected during this study included volatile organics, extractable organics, pesticides, PCB’s, dissolved metals, and common parameters.

The three stations (plate 2-14) listed in table FPEIS-9 were reviewed. Their locations are within the Terrebonne Basin and give a general picture of the existing water quality within the project area.

Of the 39-waterbody segments evaluated within the project area, approximately 51.3 percent fully support their designated uses; 25.6 percent partially support their designated uses; and 23.1 percent did not support their designated uses. From this, it can be seen that roughly, half of the waterbodies are fully supported; and half are either partially or not supported.

TABLE EIS-9.
Selected Water Quality Stations in Study Area

Station	Agency/ID	Description	Period of Record
1	LDEQ/58010113	Bayou Grand Caillou at Dulac, LA	3/6/78 –1/08/96
2	LDEQ/58010110	Bayou Terrebonne at Houma, LA	6/1/58 - 1/8/96
3	LDEQ/58010114	Bayou Black at Gibson, LA	6/1/58 – 3/9/93

3.3.2.1 WATER USE DESIGNATIONS IN STUDY AREA

The LDEQ has established seven water use designations for surface waters in the State. The seven designated water uses are: Primary Contact Recreation(A), Secondary Contact Recreation(B), Fish and Wildlife Propagation(C), Drinking Water Supply(D), Oyster Propagation(E), Agriculture(F), and Outstanding Natural Resource Waters(G). All of these LDEQ designations, except for Outstanding Natural Resource Waters, are used to describe various waterbodies of the Morganza to the Gulf of Mexico Study Area. The designated uses of the individual water bodies within the study area are indicated in Table EIS-10.

TABLE EIS-10.
1997 LDEQ Numerical Standards Applicable to Surface Waters in the Study Area

Stream Description	Designated Uses	CL mg/L	SO_4 mg/L	BAC	TDS mg/L
Bayou Black	A B C D	85	40	1	500
Tibodaux Swamp	C	*	*	2	*
Bayou Terrebonne - Thibodaux to segments 1203 and 1206	A B C	540	90	1	1350
Company Canal - Bayou Lafourcht to Intracoastal Waterway	A B C D F	500	150	1	1000
Lake Fields	A B C	500	150	1	1000
Itracoastal Waterway - Houma to Larose	A B C D F	250	75	1	500
Itracoastal Waterway - Bayou Boeuf Locks to Houma	A B C D F	250	75	1	500
Lake Hache, Lake Theriot	A B C	500	150	1	1000
Lake de Cade (Estuarine)	A B C E	N/A	N/A	4	N/A
Bayou Grand Caillou - Houma to Bayou Pelton	A B C	500	150	1	1000
Bayou Grand Caillou - Bayou Pelton to segments 1205 and 1207	A B C E	N/A	N/A	4	N/A
Bayou Petit Caillou - Bayou Terrebone to Klondyke Road	A B C E	500	150	4	1000
Bayou Petit Caillou - Klondyke Road to section 1205 and 1207	A B C E	N/A	N/A	4	N/A
Bayou Du Large - Houma to Marmande Canal	A B C	500	150	1	1000
Bayou Du Large - Marmande Canal to segments 1205 and 1207	A B C E	N/A	N/A	4	N/A
Bayou Chauvin	A B C	N/A	N/A	1	N/A
Houma Navigation Canal - Bayou Pelton to segemts 1205 and 1207	A B C E	N/A	N/A	4	N/A
Houma Navigation Canal - Houma to Bayou Pelton	A B C D	500	150	1	1000
Bayou Terrebonne - Houma to Company Canal	A B C	445	105	1	1230
Bayou Terrebonne - Company Canal to Humble Canal	A B C E	5055	755	4	10000
Company Canal - Intracoastal Waterway to Bayou Terrebonne	A B C	500	150	1	1000
Bayou Blue - Intracoastal Waterway to segments 1206 and 1207	A B C	445	105	1	1000
Bayou Pointe au Chien	A B C	445	105	1	1000
Bayou Blue - Grand Bayou to segments 1206 and 1207	A B C	5055	775	1	10000

Bayou Grand Caillou - segments 1205 and 1207 to Caillou Bay	A B C E	N/A	N/A	4	N/A
Bayou Petit Caillou - segments 1205 and 1207 to Houma Navigation Canal	A B C E	N/A	N/A	4	N/A
Bayou Du Large - segments 1205 and 1207 to Caillou Bay	A B C E	N/A	N/A	4	N/A
Bayou Terrebone - Humble Canal to Lake Barre	A B C E	N/A	N/A	4	N/A
Houma Navigation Canal	A B C E	N/A	N/A	4	N/A
Bayou Blue - segments 1206 and 1207 to Lake Raccourci	A B C E	N/A	N/A	4	N/A
Lake Boudreaux	A B C E	N/A	N/A	4	N/A
Bayou Petit Caillou -Houma Navigation Canal to Terrebonne Bay	A B C E	N/A	N/A	4	N/A
Caillou Bay	A B C E	N/A	N/A	4	N/A
Terrebonne Bay	A B C E	N/A	N/A	4	N/A
Timbalier Bay	A B C E	N/A	N/A	4	N/A
Lake Barre	A B C E	N/A	N/A	4	N/A
Lake Pelto	A B C E	N/A	N/A	4	N/A
Terrebonne Basin Coastal Bays and Gulf Waters to the State 3-mile line	A B C E	N/A	N/A	4	N/A

*=Designated Naturally Distrophic Water Segment

The following defines the criteria abbreviated in the table: CL - Chlorides in mg/L, SO_4 - Sulfates in mg/L, TDS - Total Dissolved Solids in mg/L, N/A - Not Available at Present, and BAC - Bacterial Criteria: 1 - Primary Contact Recreation, 2 - Secondary Contact Recreation, 3 - Drinking Water Supply, and 4 - Oyster Propagation

3.3.2.2. General Water Quality in the Project Area

Data and information on waterbodies are assessed at two levels by LDEQ. The two levels, "evaluated" and "monitored", use ambient monitoring data and other information, such as complaint investigations and spill records, to determine the water quality and designated use of the waterbody.

The evaluated water bodies are those for which the assessment is based on land use, location of point and nonpoint sources, citizen complaints, short-term fisheries surveys, intensive surveys, and general observations of the waterbody.

Monitored waters are those for which the assessment is based on site-specific data, i.e. where there are existing water quality stations. Monitored waterbodies were assessed by using a Use Impairment Index. For the 1996 monitored assessment, the computer-run Use Impairment Index used 5 years of monthly water quality data (1991-1995). Metals and toxics data were not taken into consideration in the index. The Use Impairment Index was calculated based upon the frequency of exceedence of water quality criteria for the specified parameters.

3.3.2.3 Lake Water Quality

The LDEQ's 1996 Water Quality Inventory identifies two inland freshwater lakes (Lake Fields, and Lake Long) and three coastal freshwater lakes (Lake Theriot, Lake Penchant, and Lake Hatch) in the study area. These lakes generally exhibit fresh water characteristics in water quality and vegetation; however, they are tidally influenced and do provide habitat to estuarine and marine fish and shellfish species.

For Louisiana's lakes, pathogen indicators were the most frequently cited suspected cause of use impairment. Metals were also frequently reported on the list of suspect causes, with organic enrichment/low dissolved oxygen, and siltation reported less frequently. The primary suspected sources included sanitary treatment plants, minor municipal point sources, septic tanks, and inflow and infiltration.

According to LDEQ, all Louisiana lakes are generally considered eutrophic due to their shallow depths and high nutrient levels. In eutrophic waterbodies, an increase in mineral and organic nutrients reduces the amount of dissolved oxygen. Thus, the environment of an eutrophic waterbody favors plant life over animal life. In many lakes, the shallow depths are a result of the geologic and hydrologic processes, which formed and maintain them. The continued degradation of coastal wetlands may also contribute to the shallowing of Louisiana's lakes through detrital contribution. Due to the mild climate and length of growing season, Louisiana lakes have a high level of primary productivity. Although eutrophication is a problem, study area lakes sustain diverse, productive fisheries and provide recreational opportunities for residents and visitors of the state.

3.3.2.4 Estuary/Coastal Water Quality

Areas of specific concern in estuarine and coastal waters include eutrophication, habitat modification, shellfish waters, and produced water discharges. A serious result of eutrophication is the incidence of hypoxia, or low dissolved oxygen, due to the stimulation of oxygen consumption during the decay of phytoplankton. Hypoxia is designated as less than 2 mg/L dissolved oxygen. One such factor is nutrient enrichment from point sources and nonpoint sources of phosphorus and nitrogen. Nutrients, organic inputs, and the physical processes, which influence water movement, are some of the major features, which influence the amount of dissolved oxygen. Terrebonne Basin is one of the five areas in Louisiana where hypoxia is a major environmental concern. The source of nutrients that contribute to eutrophication in the upper Terrebonne basin is primarily runoff from agriculture, especially sugarcane fields. Another source of high nutrient input and the cause of shellfish bed closures is municipal sewage from the Houma area.

Over the last few years, the state of Louisiana has become increasingly concerned about a large area of oxygen-depleted water that develops seasonally each year near shore of the Gulf of Mexico close to the mouth of the Mississippi River. The size of the oxygen-depleted area varies from year to year and has extended from the mouth of the Mississippi River west to near the Texas border. The area can form as early as February and last as late as October with the most widespread and persistent conditions occurring from mid-May to mid-September.

Research has shown a relationship between Mississippi River flow, riverborne nutrients, plankton productivity and bottom water hypoxia. The hypoxia is believed to be due to both the effects of stratification of the fresh and marine waters that restricts vertical reoxygenation of bottom waters and the oxygen-consuming breakdown of organic material mostly derived from the river stimulated plankton. The hypoxic conditions vary spatially and seasonally depending on the phasing and amplitude of the Mississippi River discharge but are also affected by physical features such as water circulation patterns, density stratification, wind mixing, tropical storms and thermal fronts.

3.3.2.5. River Water Quality

The water quality of Louisiana's rivers, including bayous, creeks, and canals, have been evaluated within the LDEQ 1996 Water Quality Inventory. In general, pathogen indicators (fecal coliform bacteria) are the most frequently cited causes of use impairment in Louisiana's rivers. Secondarily, organic enrichment/low-dissolved oxygen and nutrients are also cited as suspected causes of impairment. Minor industrial point sources were the most frequently cited contributor to river quality impairment. Minor municipal point sources were the second most cited contributor; and septic tanks were the third. These suspected sources presently affect all of the rivers identified within the project area.

3.3.3 ENVIRONMENTAL CONSEQUENCES

3.3.3.1 Future With No Action Alternative—Hydraulics

A local, non-Federal levee system was constructed over time by local interests as expanding development demanded protection. Existing non-Federal levee heights vary greatly, from 3 ft., NGVD to 15 ft., NGVD. The natural ground elevation within the study area varies from -3 ft., NGVD in some of the Forced Drainage Areas (FDAs) to almost 15 ft., NGVD along the natural alluvial ridges north of Houma.

Stability of the local levee systems is questionable given levee failures that occurred in levee systems in southern Louisiana during Hurricane Juan. However, geotechnical analysis of the existing levee system revealed that the levees were not high enough to have stability problems from a geotechnical standpoint. The failure point was located above the top of the levee. Since waves cannot be calculated in the UNET program, to account for the unreliability of the levees from scour due to wave overtopping, 1 foot was removed from all levee heights. An additional foot was removed from the levee heights south of Houma, because of datum discrepancies between the Houma and Cocodrie gages. This assumption and the already low heights of the existing protective structures produced extensive flooding in the study area during modelling. Because the damages from this flooding were almost as extensive for the extreme events as for a 'without levees' scenario, a levee failure scenario was not pursued.

3.3.3.2 Future With No Action Alternative—Water Quality

For without-project conditions, projected water quality for the study area is expected to remain similar to current conditions. The determining factor is if pollution levels continue at present levels or increase. If pollution levels remain constant or increase, then the water quality will likely decline. Industrial point sources, surface runoff from urban areas or storm sewers, and petroleum activities are currently problem areas for rivers in the basin. With recent increased government regulation and legislation (such as the National Pollution Discharge Elimination System (NPDES)), these sources should decrease and water quality should improve. The impact of eutrophication of the project area lakes should also decrease due to decreased agricultural, industrial and municipal runoff, and because of the government regulation and legislation. Estuary water quality, which is affected primarily by petroleum activities and nonpoint sources, should also improve for the same reasons.

Due to the complex nature of the system, it is difficult to predict the without project condition. The without project condition is affected by the outcome of the Lower Atchafalaya River Re-evaluation, the Bayous Chene, Boeuf, and Black Dredged Material Management Plan, and by the Davis Pond Freshwater Diversion. It is most likely that the average number of days annually exceeding the EPA chloride standard will remain relatively constant, and perhaps continue the decreasing trend that has occurred since the construction of the Bayous Chene, Boeuf, and Black; but this is not certain.

3.3.4 FUTURE WITH-PROJECT CONDITIONS

3.3.4.1 Highway 57 Alternative—Hydraulics

For project conditions, levee heights were determined for the 100-year hurricane for both base and future conditions. In addition, for comparative purposes levee heights for a project providing 85- and 500-year degrees of protection were developed. Heights of the protective structures were designed to an elevation sufficient to prevent all overflow from free flow over the structure and from waves. The vertical height to which water from a breaking wave will run up on a given protective structure determines the top elevation to which the structure must be built to prevent wave overtopping.

Where levees or floodwalls are fronted by a limited fetch (sheltered from the fully developed hurricane-generated waves) wave runup will be less than in more exposed reaches. Wave runup and overtopping of the levee can result from small locally generated waves that cannot be predicted with standard methodology. For this feasibility study, estimates of the lengths of these sheltered fetches were used to develop small, locally generated wave heights and periods. These small wave heights and periods were in turn used to compute runup for the reaches of limited fetch. The fetch length also varies with storm frequency and between base and future conditions. For the 100-yr frequency storms under base conditions the reaches of minimum runup for the Highway 57 alignment are on the east side south of Larose to about 4 miles south of Bayou Blue, the levee sheltered by the ridge along Small Bayou La Point, and on the western side north of Marmande Ridge.

Floodwalls constitute a minute portion of the overall protective structures and slight overtopping of the walls would occur in the event of a design hurricane. However, such overtopping would be minimal, occurring into interior channels, and no serious flooding would result. Design elevations for the protective structures in each reach for base and future conditions for each alignment for 100-year protection are shown in tables FPEIS-11 to FPEIS-14. Elevations for the 85-year and 500-year levels of protection are shown in appendix A.

TABLE FPEIS-11

. 100 Year Frequency Hurricane, Wave Characteristics, Design Wave Runup and Design Elevations of Protective Structures, Highway 57 Alternative-Base Conditions

		Length	Depth	Height(H_s)	Period(T)		Elevation	Slope
	feet NGVD	feet	feet	feet	seconds	feet	feet NGVD	1:00
A	8	0.5	7	2.2	2.1	2	10	3.0
B	8	10	8	4.2	4.6	3	11	7.0
C	9	0.5	8	2.2	2.1	2	11	3.0
	9	10	9	4.6	4.7	3	12	7.5
	10	10	10	5.0	4.8	3	13	8.0
D	10	10	10	5.0	4.8	3	13	8.0
E	10	10	10	5.0	4.8	3	13	8.0
BRG	10	10	10	5.0	4.8	3	13	8.0
F	10	10	10	5.0	4.8	3	13	8.0
G	11	10	11	5.3	4.9	3	14	8.3
H	11	10	11	5.3	4.9	3	14	8.3
	12	10	12	5.6	4.9	3	15	8.5
I	11	10	11	5.3	4.9	3	14	8.3
	10	10	10	5.0	4.8	3	13	8.0
J	10	10	10	5.0	4.8	3	13	8.0
JSC(1)	10	10	10	5.0	4.8	3	13	8.0
JSC(2)	11	10	11	5.3	4.9	3	14	8.3
K	10	10	10	5.0	4.8	3	13	8.0
	9	10	9	4.6	4.7	3	12	7.5
	8	10	8	4.2	4.6	3	11	7.0
L	8	0.5	7	2.2	2.1	2	10	3.0
	7	0.5	6	2.1	2.1	2	9	3.0

TABLE FPEIS-12
100 Year Frequency Hurricane, Wave Characteristics, Design Wave Runup and Design Elevations of Protective Structures, Highway 57 Alternative – Future Conditions

Reach	Stillwater Elevation (SWL)	Fetch		Significant Wave		Runup	Design Levee	
		Length	Depth	Height(H_s)	Period(T)		Elevation	Slope
	feet NGVD	feet	feet	feet	seconds	feet	feet NGVD	1:00
A	8	1	10	3.0	2.6	3	11	3.0
B	8	10	11	5.3	4.9	4	12	6.4
C	8	10	11	5.3	4.9	4	12	6.4
	9	10	12	5.6	4.9	4	13	6.6
	10	10	13	5.9	5.0	4	14	6.9
D	10	10	13	5.9	5.0	4	14	6.9
E	10	10	13	5.9	5.0	4	14	6.9
BRG	10	10	13	5.9	5.0	4	14	6.9
F	10	10	13	5.9	5.0	4	14	6.9
G	11	10	14	6.2	5.0	4	15	7.1
H	11	10	14	6.2	5.0	4	15	7.1
	12	10	15	6.5	5.1	4	16	7.4
I	11	10	14	6.2	5.0	4	15	7.1
	10	10	13	5.9	5.0	4	14	6.9
J	10	10	13	5.9	5.0	4	14	6.9
JSC(1)	10	10	13	5.9	5.0	4	14	6.9
JSC(2)	11	10	14	6.2	5.0	4	15	7.1
K	10	10	13	5.9	5.0	4	14	6.9
	9	10	12	5.6	4.9	4	13	6.6
	8	10	11	5.3	4.9	4	12	6.4
L	8	1	10	3.0	2.6	3	11	3.0
	7	1	9	2.9	2.6	3	10	3.0

TABLE FPEIS-13
100 Year Frequency Hurricane, Wave Characteristics, Design Wave Runup and Design Elevations of Protective Structures, Reconnaissance Alternative - Base Conditions

Reach	Stillwater Elevation (SWL)	Fetch		Significant Wave		Runup	Design Levee	
		Length	Depth	Height(H_s)	Period(T)		Elevation	Slope
	feet NGVD	feet	feet	feet	seconds	feet	feet NGVD	1:00
A	8	0.5	7	2.2	2.1	2	10	3.0
B	7	0.5	6	2.1	2.1	2	9	3.0
C	7	10	7	3.8	4.5	3	10	6.5
	8	10	8	4.2	4.6	3	11	7.0
D	9	10	9	4.6	4.7	3	12	7.5
E	10	10	10	5.0	4.8	3	13	8.0
	11	10	11	5.3	4.9	3	14	8.3
F	11	10	11	5.3	4.9	3	14	8.3
	10	10	10	5.0	4.8	3	13	8.0
G	10	10	10	5.0	4.8	3	13	8.0
H	10	10	10	5.0	4.8	3	13	8.0
	9	10	9	4.6	4.7	3	12	7.5
	8	10	8	4.2	4.6	3	11	7.0
I	8	0.5	7	2.2	2.1	2	10	3.0
	7	0.5	6	2.1	2.1	2	9	3.0

TABLE FPEIS-14
100 Year Frequency Hurricane, Wave Characteristics, Design Wave Runup and Design Elevations of Protective Structures, Reconnaissance Alignment - Future Conditions

Reach	Stillwater Elevation (SWL)	Fetch		Significant Wave		Runup	Design Levee	
		Length	Depth	H_s	Period(T)		Elevation	Slope
	feet NGVD	feet	feet	feet	seconds	feet	feet NGVD	1:00
A	8	1	10	3.0	2.6	3	11	3.0
B	7	1	9	2.9	2.6	3	10	3.0
C	7	10	10	5.0	4.8	4	11	6.1
	8	10	11	5.3	4.9	4	12	6.4
D	9	10	12	5.6	4.9	4	13	6.6
E	10	10	13	5.9	5.0	4	14	6.9
	11	10	14	6.2	5.0	4	15	7.1
F	11	10	14	6.2	5.0	4	15	7.1
	10	10	13	5.9	5.0	4	14	6.9
G	10	10	13	5.9	5.0	4	14	6.9
H	10	10	13	5.9	5.0	4	14	6.9
	9	10	12	5.6	4.9	4	13	6.6
	8	10	11	5.3	4.9	4	12	6.4
I	8	1	10	3.0	2.6	3	11	3.0
	7	1	9	2.9	2.6	3	10	3.0

Typical cross-sections by reach for the 100-year project are shown on figures FPEIS-11 and FPEIS-12. All cross sections are depicted in appendix A. Reaches are shown on the design plates in appendix A.

The Corps contracted to FTN and Associates, Ltd. (FTN) to perform several UNET simulations. The simulations were used to:

1. Determine the size of the environmental structures (number of 6 ft by 6-ft box culverts) needed to drain sensitive wetland areas within two weeks after the onset of storms of varying size and tidal conditions.

2. Assess the effects of the GIWW floodgates on flooding; and

3. Assess the effects of a Houma Navigation Canal Lock closure during the high water season on the Lower Atchafalaya River.

UNET simulations were performed using modifications of the Morganza to the Gulf of Mexico Feasibility models. The modifications included adding wetland structures and pump stations not included in the "Without Project" models and arrays of 6 ft. x 6 ft. box culverts and floodgates at locations specified by the New Orleans District for the "Highway 57/Bourg Levee Alignment" for Base (year 2008) and Future (year 2048) conditions.

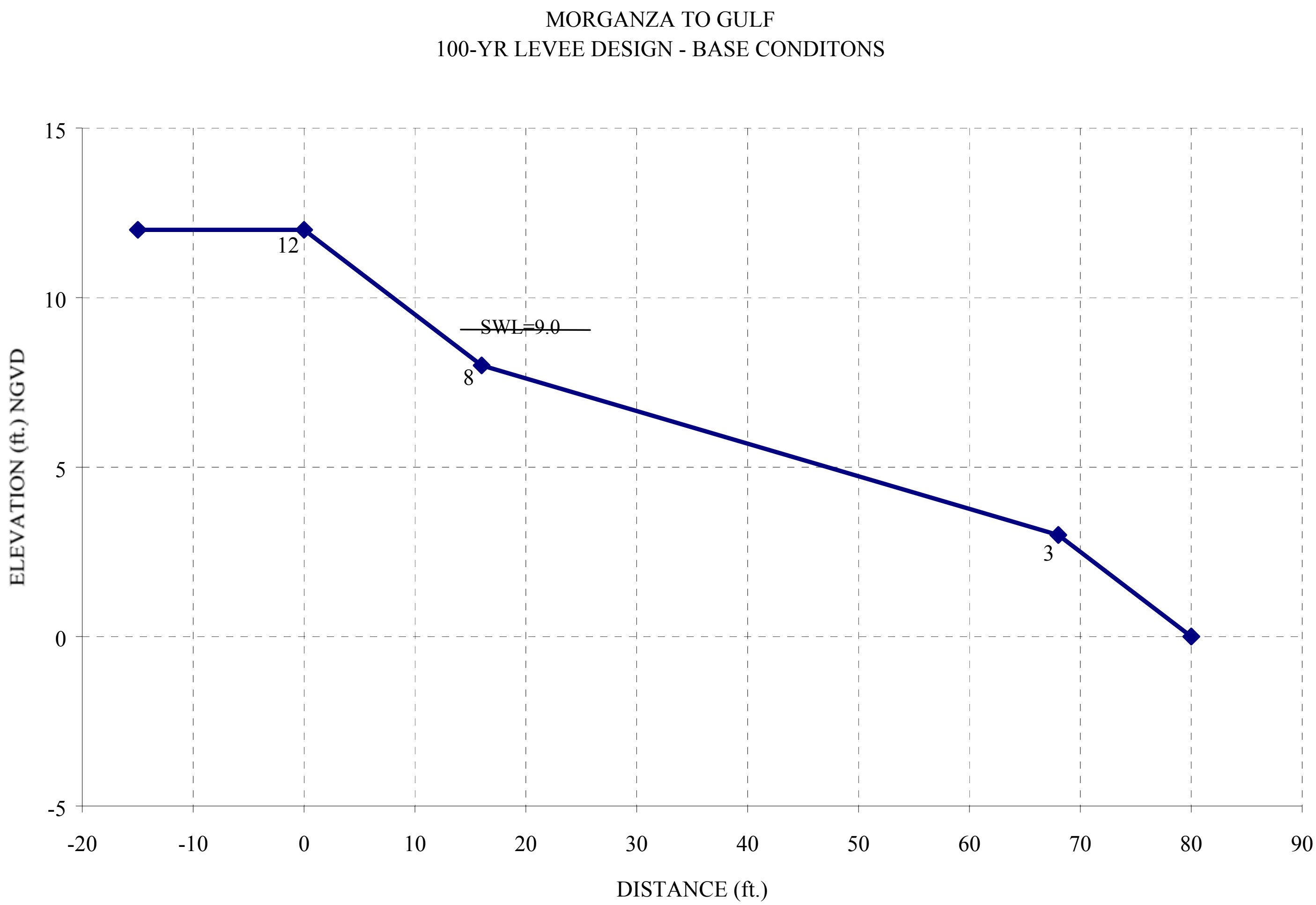

FIGURE FPEIS-11. Highway 57 Alternative – Reach C & K and Reconnaissance Alternative – Reach D & H

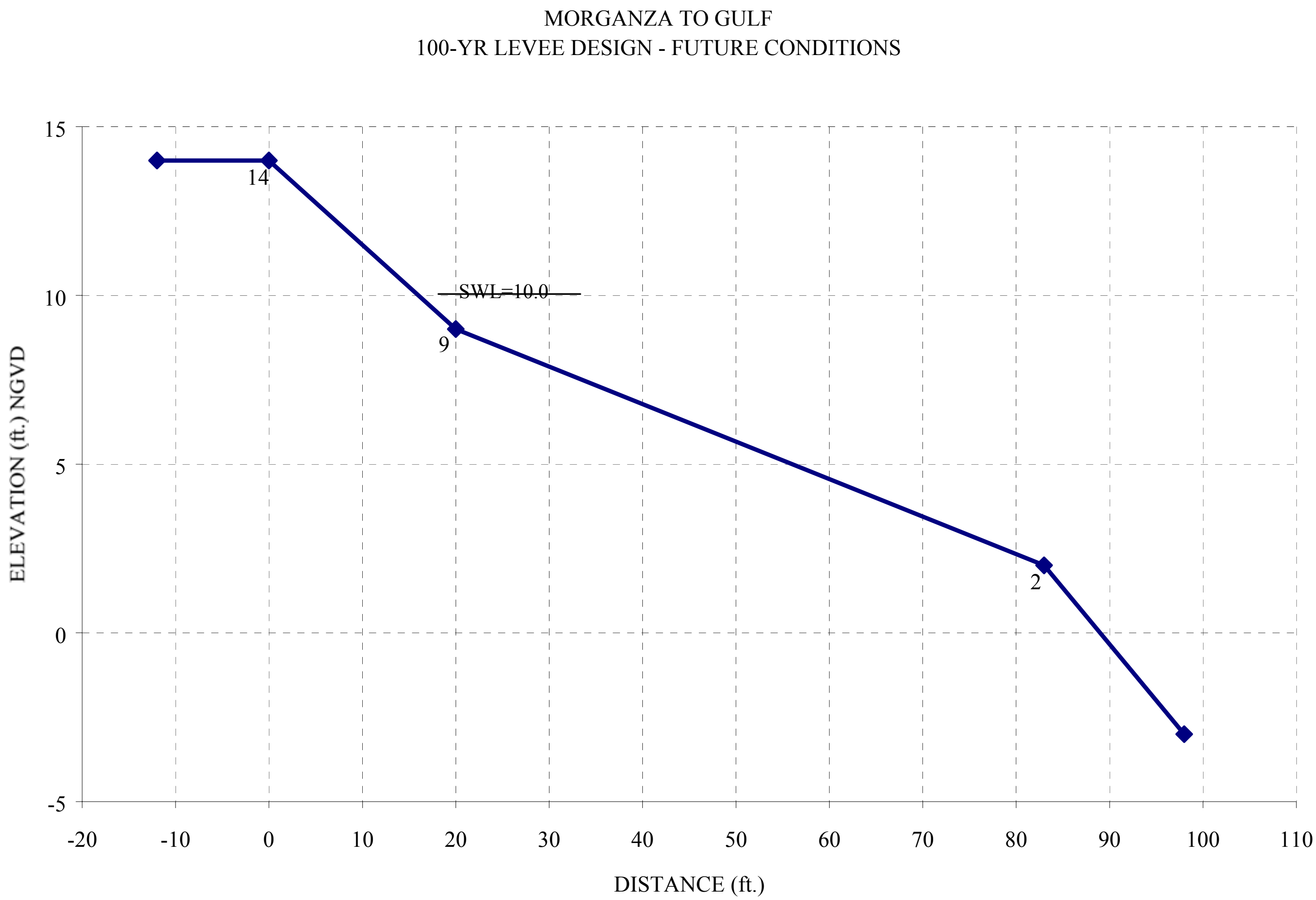

FIGURE FPEIS-12. Highway 57 Alternative - Reach BRG, C, D, E, F, I, J, JSC&K and Reconnaissance Alternative - Reach E, F, G&H

3.3.4.1.1 Gate Operations

For simulations where floodgates are operating, gates were closed at elevation +3.0 ft., NGVD at each gate location and opened again when elevations fell below +3.0 ft., NGVD or within 5 days of the storm completion, whichever occurred first.

3.3.4.1.2 Environmental Structures Hydraulic Analysis

A test was performed to determine if the number of 6 ft by 6-ft box culverts required at each location was adequate. Four additional culverts were modeled at each location in another set of simulations; however, these simulations showed no significant differences in peak stages from the simulations done with the original number of structures (table FPEIS-15).

TABLE FPEIS-15
Wetland Drainage Structures Added for the "Highway 57/Bourg Levee Alignment" Models

No. (Figure 1)	Area	Box Culverts	Closure	for Structure
26	LB-5	6	Sluice	105-110
28	4-MGT	6	Sluice	111-116
29	PAC-1	6	Sluice	117-122
32	PAC-1	6	Sluice	123-128
34	PAC-1	6	Sluice	129-134
24	HNC-9	9	Flap	135-139
22	HNC-9	9	Flap	140-144

The results of the analysis are presented in table FPEIS-16. This table shows the time required to return the wetlands to pre-storm conditions with culverts added. The table also lists the number of culverts required at each location to return the specified wetland storage area elevations to pre-storm elevations within 14 days. The 14-day criteria were developed by the HET.

TABLE FPEIS-16
Time Required to Return Wetlands to Pre-Storm Conditions With Culverts Added

Time (days) taken by the system to return to normal conditions

Area	Structure ID	Without Project				With Project											
		Base		Future		Base						Future					
		SEP	MAY	SEP	MAY	SEP		MAY		JUAN		SEP		MAY		JUAN	
		Run 1	Run 11	Run 2	Run 12	Run 3	Run 5	Run 13	Run 15	Run 7	Run 9	Run 4	Run 6	Run 14	Run 16	Run 8	Run 10
3_2		NA	NA	NA	NA	4	4	4	4	10	10	10	12	4	4	13	13
4_2AB		4	4	7	7	4	4	4	4	9	9	7	6	7	7	14	14
4_2C		10	10	7	7	11	11	8	9	16	16	7	6	6	6	8	7
4_7		3	3	6	5	3	3	3	3	6	6	6	6	4	4	9	9
4MGT	9	2	2	6	10	3	4	4	3	7	7	4	3	3	4	11	12
5_1A		5	5	7	7	5	5	5	6	11	11	7	6	7	6	14	14
5_1B		2	3	7	4	2	2	3	3	6	6	3	2	3	3	9	9
HNC0		2	2	6	6	3	2	3	3	9	9	7	6	6	6	9	10
HNC1		6	3	7	7	7	7	7	4	11	12	7	7	4	3	11	10
HNC2		8	4	7	7	8	8	7	4	12	12	8	8	4	4	12	12
HNC3		8	12	7	7	8	8	8	6	12	12	8	8	4	4	11	11
HNC4		7	12	7	7	7	7	7	6	11	12	7	7	4	4	11	11
HNC5		7	11	7	7	7	7	7	5	11	12	8	7	4	4	10	10
HNC6		7	11	7	7	8	8	7	4	11	12	8	7	3	3	8	8
HNC7		7	11	7	7	7	7	6	5	12	12	8	7	4	5	10	10
HNC8		7	5	7	6	7	7	6	6	11	12	7	7	4	4	10	10
HNC9	28A; 29A	NA	NA	NA	NA	7	7	4	6	11	12	7	7	4	4	12	10
LB1		2	4	7	7	5	5	5	2	10	10	8	7	6	5	9	9
LB2		10	8	7	7	5	14	8	8	11	12	7	8	6	5	9	9
LB3		1	9	7	7	2	1	8	3	5	8	7	7	6	6	10	9
LB4		1	11	6	7	5	2	8	6	12	13	7	7	5	5	10	9
LB5	17; 17A	7	10	7	7	8	7	5	4	9	13	7	7	4	4	14	14
PAC1	1; 3; 4; 5; 6	13	6	7	7	7	7	7	6	12	12	7	7	6	6	11	11
SL1		2	3	3	4	3	3	3	2	7	8	7	5	3	3	10	10
SL2		10	6	7	7	8	6	6	3	14	14	8	8	7	7	10	12

Recommended sizes and number for proposed culverts:

Structure ID	Culvert size and number
17A	6-6x6
9	6-6x6
6A	6-6x6
3	6-6x6
1	6-6x6
28A	9-6x6
29A	9-6x6
29	9-6x6
28	9-6x6

Sizes and number of the existing culverts:

Structure ID	Culvert size and number
4	4-48"
5	5-48"
17	3-48"

3.3.4.1.3 GIWW Floodgate Capacity

Because the floodgates will be open the majority of the time, it is necessary for the floodgate to be navigable. The safe navigable velocity is 3 feet per second. To evaluate the effect of the floodgate on navigation, the floodgate was modeled in a UNET model previously developed for a CWPPRA study to evaluate the effects of diversions at Bayou Lafourche. The CWPPRA UNET model extended westward into the Terrebonne marsh area and included the GIWW in the vicinity of the proposed floodgates.

Because of the Atchafalaya River influence on flow in the GIWW, it was necessary to compute flow conditions in the GIWW west of Houma that represent the Atchafalaya high water season. The stage-discharge relationship in figure FPEIS-13 was used to select a representative annual maximum flow in the GIWW west of Houma. For existing conditions, the annual maximum stage for the Lower Atchafalaya River at Morgan City is 6.5 ft NGVD, corresponding to a flow in the GIWW west of Houma of approximately 11,000 cfs.

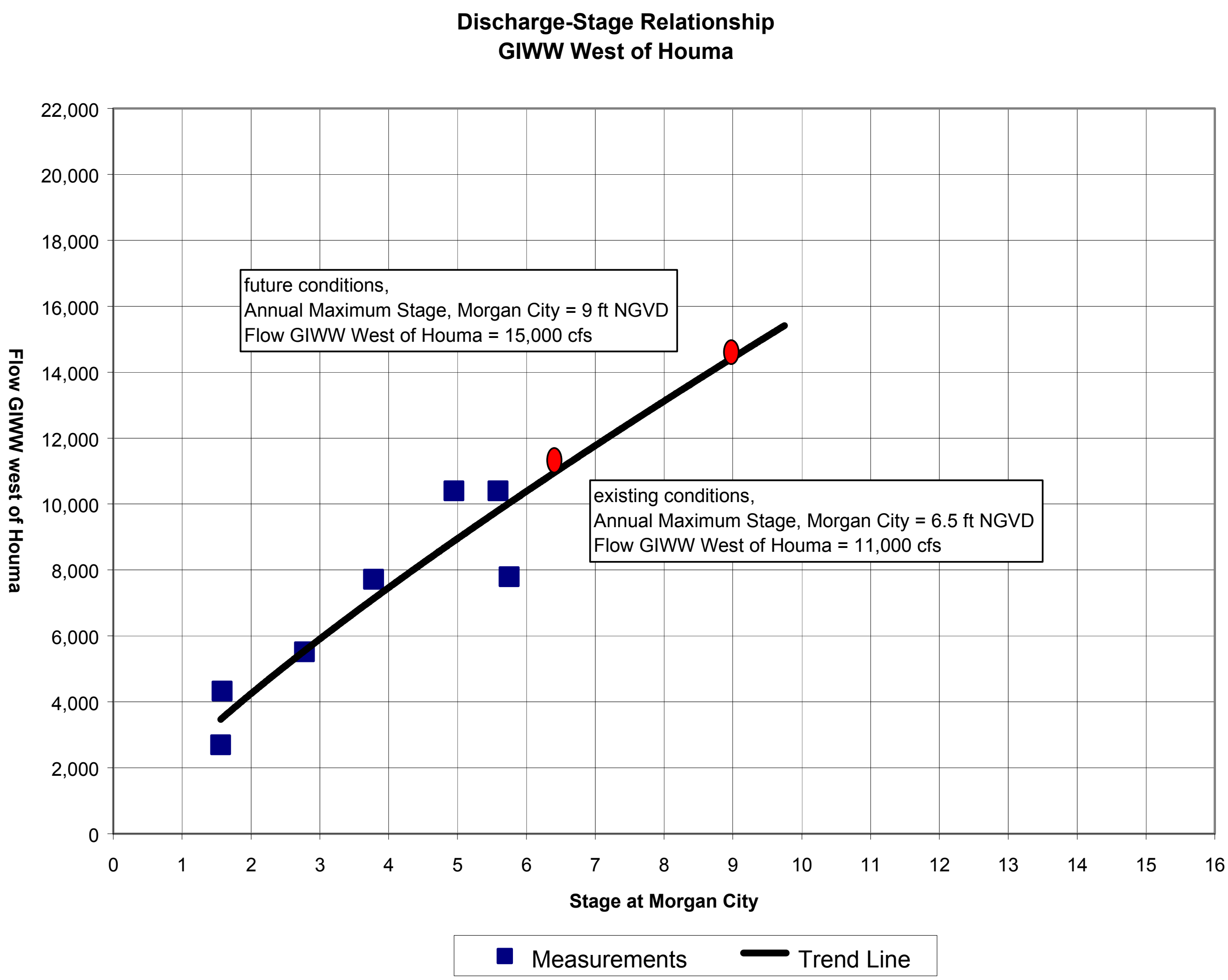

FIGURE FPEIS-13. Discharge-Stage Relationship

As the Atchafalaya River system develops, stages will continue to rise in the Lower Atchafalaya River. Annual maximum stages for the Lower Atchafalaya River at Morgan City have risen at a rate of 0.05 feet per year. It is estimated, for future conditions (year 50), that the annual maximum stage for the Lower Atchafalaya River at Morgan City will be 9 feet NGVD. Using figure FPEIS-13, this stage corresponds to an annual maximum flow in the GIWW of 15,000 cfs.

Using the CWPPRA UNET model results, the velocity through the floodgate opening was determined to be 4.2 feet per second (fps). The first modification evaluated was the addition of several culverts adjacent to the floodgate. Computations were made to determine the flow capacity of the floodgate with a maximum velocity of 3 fps. Based on a width of 125 feet, a bottom elevation of -20 feet NGVD, and a water surface elevation of 2 feet NGVD, the flow capacity of the floodgate is 9,000 cfs. Therefore, for future conditions, it will be necessary to pass 6,000 cfs through the culverts. During the annual high water season, it is likely that head loss through the structure will be small. Water surface elevations in the UNET model confirm this assumption. Therefore, the size and number of culverts required to pass 6,000 cfs will be large. In lieu of culverts, a second floodgate, 125 feet wide, is proposed.

The CWPPRA UNET model was also used to assess the effects the two floodgates west of Houma on the GIWW have on flows and stages in the Terrebonne Marsh area to the west of the study area. The CWPPRA UNET model has limited detail in the Terrebonne Marsh area; overbank storage along the GIWW is not modeled. Although the model does not accurately represent the prototype, it can still be used to evaluate the effects.

Because the area of two new floodgates is approximately 80 percent of the existing channel area, head loss from the two structures will be minimal. Since head loss is minimal, it is unlikely that flow patterns in the Terrebonne Marsh area will be measurably affected. Flows in channels connected to the GIWW, such as Bayou Copasaw and Minors Canal, should not be measurably affected. The CWPPRA UNET model showed greater channel velocities with the floodgates in place over their absence in lieu of any head loss; flows into the channels connected to the GIWW were not affected.

3.3.4.1.4 Houma Navigation Canal Lock Hydraulic Analysis

Simulations were made using the UNET model to represent conditions that would exist during the high water season on the Lower Atchafalaya River with the HNC Lock closed. Because the

HNC conveys a significant portion of the flow in the study area from the Lower Atchafalaya River, it is important to identify where the water goes should the canal be closed for any reason.

Runs were made with the HNC closed and the Grand Caillou structure open. Consequently, flow is still present in the HNC upstream of the lock. During the event modeled, water from the Gulf of Mexico entered and exited the study area via Bayou Grand Caillou.

Average daily flows and stages during a rainfall event were evaluated for base and future conditions. For base conditions, the HNC experienced a 20 to 25 percent decrease in flow moving south above Falgout Canal. Falgout Canal experienced a similar percent increase in flow. There was also an increase in flow into Lake Boudreaux and into Bayou Grand Caillou east of the HNC.

Flows in the GIWW to the east of the HNC increased by 5 to 15 percent. Flow in Bayou Terrebonne, south of the GIWW, experienced an increase in flow that varied from 5 to 20 percent. Company Canal, north of the GIWW, also experienced an increase in flow moving north.

Stages changed along the HNC and along the channels closest to the HNC. Water levels rose 0.5 to 1.0 ft. along the HNC north of the proposed lock. Similar changes were experienced in Bayou Grand Caillou and Boudreaux Canal. Stages in the GIWW and Bayou Petit Caillou rose 0.1 to 0.5 ft. There were minimal changes in water levels for the other channels in the study area.

For future conditions, the HNC experienced a 10 to 20 percent decrease in flow moving south above Falgout Canal. Falgout Canal experienced a 50 percent increase in flow. There was also an increase in flow into Lake Boudreaux and into Bayou Grand Caillou east of the HNC.

3.3.4.1.5 Hydraulic Design Criteria

The proposed lock and floodgates will be impacted on the flood side by water levels originating in the Gulf of Mexico. On the protected side of the proposed structures, water levels will be impacted by the accumulation of rainfall in the basin when the system is closed. Under existing conditions, stages in the area are increased significantly during the occurrences of tropical storms. In the future, these effects can be expected to become more severe. Construction of the proposed levee system and floodgates will significantly reduce these effects on stages within the protected area.

The design 100-yr stage at the location of the proposed lock is 11.0 ft., NGVD. The allowance for wave runup is 3 feet for base conditions and 4 feet for future conditions. The lock must therefore provide protection up to a net grade of 15.0 ft., NGVD.

Overland runoff drainage at the location of the road floodgates and ramps was not analyzed in this study, but will be evaluated during the preparation of plans and specifications. After evaluation, any necessary structural components will be added to the design. No reverse flow protection (sluice gates, check valves, etc) was considered for the interior drainage analysis, but the need for this protection will be evaluated during the preparation of plans and specifications. Once evaluation is complete, necessary structural components will be added to the design of the front-end protection systems.

3.3.4.2 Reconnaissance Alternative Hydraulics

Along the Reconnaissance alignment, the shelter reaches for the 100-yr storm under base conditions are on the east side south of Larose to about 4 miles south of Bayou Blue, a small section along Boudreaux Canal, and on the west side from the start to about 3 miles east of Bayou Chauvin. Wave runup of 2 feet was determined for the sheltered reaches of levee under base conditions. For future conditions, wave runup was limited to 3 feet for the sheltered reaches of levee. The length of the sheltered reaches diminishes for future conditions for the 100-yr storm because of the increase in fetch length caused by the loss of the higher ridges. For the 100-yr frequency storms under future conditions, the reaches of minimum runup for the Highway 57 alignment are on the east side south of Larose to near Bayou L'eau Blue and on the western side near the Duplantis Canal. Along the Reconnaissance alignment, the sheltered reaches for the 100-yr storm for future conditions are on the east side south of Larose to near Bayou Blue and on the west side from the start just east of Bayou Grand Caillou. For the 85-year frequency events, the reaches of minimum runup were nearly the same and wave runup was limited using the same methodologies as for the 100-year. For the 500-year event there are fewer reaches of minimal runup.

In exposed reaches, a large fetch exists for the waves accompanying the design hurricane. Waves larger than the significant wave may overtop the protective structures. However, given the limited number of waves that are larger than the significant wave, such overtopping will not endanger the security of the structure or cause damaging interior flooding. During the time of maximum surge height, the berms on the flood side of the levee become submerged and waves of lesser height than the significant wave, but of the same period, break further up the levee slope. Sometimes runup from these smaller waves reaches an elevation higher than that from the significant wave. Therefore, runup was computed for the significant wave and for smaller waves breaking on each berm. The required levee height was determined by adding the highest computed runup value to the maximum stillwater elevation.

3.3.4.3 Reconnaissance Alternative—Water Quality

Impacts would be similar to those experienced with the Highway 57 alternative in the areas where construction would occur. However, construction would be undertaken in a less extensive area so impacts would be reduced somewhat.

3.4 Soils and Prime and Unique Farmland

3.4.1 AFFECTED ENVIRONMENT

The following information is taken from the Terrebonne Parish soil survey (Lytle et al. 1960) and the Lafourche Parish soil survey (Matthews 1984). Sugarcane is the principal agricultural crop in Terrebonne Parish. Corn is also a major crop. Soybeans, rice, vegetables, and pasture grasses are also grown. About 9 percent of the parish is used for crops and pasture.

The highest parts of the natural levees along the bayous, including along Highway 57 to the south of Lake Boudreaux contain soils of the Mhoon-Commerce association (5.8 percent of Terrebonne Parish and 7.0 percent of Lafourche Parish). They rarely to never flood. These soils are brown to grayish brown soils are a silt loam, silty clay loam, or silty clay.

The lower portions of the natural levees are formed by the Sharkey-Swamp soil association (6.7 percent of Terrebonne Parish and 9.0 percent of Lafourche Parish). These soils are black to dark gray on the surface and have much more clay material and organic matter than those of the Mhoon-Commerce association. They are subject to rare or occasional flooding. These soils support bottomland vegetation.

The Swamp soil association occurs off the ridge areas and forms 11.5 percent of Terrebonne Parish and 16 percent of Lafourche Parish. They are usually wet and frequently flooded.

These soils range from clays to peats and are not conducive to cultivated crops.

The largest area of the parishes (75.1 percent in Terrebonne and 62 percent in Lafourche Parish) is comprised by soils of the Marsh soil association. This association occurs over a broad plain about level with the Gulf of Mexico between the ridge areas and is frequently flooded. These soils generally have a peat or muck surface layer, 2 to 5 feet thick, over alluvial clays and silty clays. These soils are generally too wet and soft for any agricultural uses. The marsh soil organic content decreases moving from fresh to saline. Fresh marsh soils contain a mean of 52 percent organic matter whereas saline soils contain only 18 percent organic matter (Chabreck 1982).

There are 116,630 acres of farmable land in the environmental study area, confined to ridge areas along the bayous. Of this acreage, 83,347 acres are considered farmland as defined by the Farmland Protection Policy Act. The average farm size is 494 acres, mostly growing sugarcane and soybeans.

3.4.2 ENVIRONMENTAL CONSEQUENCES

3.4.2.1 No Action Alternative

Soils would change over the next 50 years as subsidence in the area continues to occur. Marsh soils in particular would continue to subside and erode as marsh vegetation succumbs to increasing water levels (see Wetlands Section 3.5.2.1). No large-scale loss of farmland would be expected from subsidence. The greatest loss of farmland would come from conversion to development.

3.4.2.2 Highway 57 Alternative

The levees and borrow pits would cover or remove 4,112 acres, including 74 acres of prime and unique farmland. Other soils impacts would be similar to those expected under the No Action alternative. Some erosion would likely occur in construction areas.

3.4.2.3 Reconnaissance Alternative

The levees and borrow pits would cover or remove 1,332 acres, including approximately 26 acres of prime and unique farmland based upon the factor of 0.0198 acres prime and unique for each acre impacted. This ratio of prime and unique farmland to total impacts was generated from the ratio results of Alternatives 2, 3, and 4, which varied from 0.0197-0.0199.

3.4.3 MITIGATION AND MONITORING

Erosion at construction areas would be controlled with berms during construction so that lands outside the construction right of way would not be impacted. All levees and berms would be seeded with grass immediately after construction so that erosion threats would not continue.

3.5 Wetlands

3.5.1 AFFECTED ENVIRONMENT

Louisiana contains 40 percent of the continental United States coastal wetlands (Gosselink 1984) and wetlands are certainly a prevalent characteristic in the study area. They range from swamps and freshwater marshes in the northern portion of the area that grade into brackish marsh and finally to salt marshes and estuarine bays moving to the south. Coastal marshes are flooded 50-80 percent of the time (Swenson and Swarzenski 1995). Elevation is critical to the type of wetland occurring in an area, and small elevation changes (inches) can result in major shifts in community type (Brown 1972). Freshwater habitats generally have salinities less than 0.5 ppt, salinities in intermediate marsh range between 0.5-5.0 ppt, brackish marsh has salinities of 5-18 ppt, and saline marsh salinities vary between 18-30 ppt (Cowardin et al. 1979).

There has been no appreciable deltaic development in the Terrebonne Basin for the past 500 years. Data for the entire Terrebonne Basin (over 1 million acres), which includes the study area, shows that land was lost from 1956-1978 at a rate of 0.79 percent per year. From 1978 to 1990, the land loss rate was 1.2 percent per year (Reed et al. 1995). There were extensive areas of land loss fringing Terrebonne Bay, south of Lake DeCade and the Turtle Bayou area. The Terrebonne Parish coastline stretches 70 km from Point au Fer to Timbalier Island (Penland et al. 1988).

Coastal wetland loss in Louisiana has averaged 65 km^2/yr (25 mi^2/yr)(Boesch et al. 1994). Land loss in Terrebonne Parish has averaged 27.7 km^2/yr (10.7 mi^2/yr) (Wicker et al. 1980; Penland

and Boyd 1981). In 1983, Ledet (1986) determined that the more easily erodible areas of central and eastern Terrebonne Parish had been lost and that the loss rate was declining. Penland et al. (1988) calculated the land loss rate at 20.5 km^2/yr. Penland (1991) added that it is forecasted the Isle Dernieres would be gone by 2007 and the demise of barrier islands will accelerate wetland loss. Penland's later conclusion has become a topic of heated debate among coastal ecologists and engineering professionals.

Causes of marsh breakup in Louisiana and Terrebonne Parish were not known a short time ago when Wicker et al (1980) documented an alarming amount of land loss (116,709 acres from 1955-1978). There are still unanswered questions, but researchers have made great strides into understanding the causes of the land loss. Water level and salinity data show no coast-wide trends that can explain all of the land loss. Although there seems to be a trend toward an increase in pulses of high salinity during dry periods since 1960 (Swenson and Swarzenski 1995), there is no consistent evidence for saltwater intrusion (Wiseman et al. 1991). Restoration of marsh has been found to be affected more by degree of plant inundation and reduced soil conditions (oxygen depleted) rather than salinity (Mendelssohn and McKee 1991). In addition, canals have been implicated as a major contributor to land loss in the area (Turner and Rao 1990; Bass 1993; St. Pe~ and Demay 1993; Turner 1997). Turner and Rao conclude that canals and their spoil banks are directly related to wetland-to-water conversion. According to Turner and Rao (1990), wetland loss is evident as far as 2 km away from canals. The effects of RSL rise on marsh deterioration have also been demonstrated.

Turner and Rao (1990) and Nyman et al. (1993a) found that marsh appears to be breaking up internally, rather than eroding at the edges. Boesch et al. (1994) conclude that wetland loss is a consequence of sinking land and inadequate soil replenishment rather than erosion of its edges, filling, or draining. Interior marsh loss accounts for about two-thirds of coastal land loss (Wayne et al. 1994) and appears to be caused by rising RSL.

Long-term water level records show RSL rises as much as 2.0 cm/yr (0.78 in/yr)(Swenson and Swarzenski 1995) and averages 1.0 cm/yr (0.39 in/yr) (Ritchie and Penland 1990; Ramsey 1991) in the area. When RSL rise exceeds accretion, plants slowly become inundated, stressed, and eventually die. Most of the RSL rise in this area (50 to >90 percent) is related to subsidence of marsh surface (0.8-1.07 cm/yr)(Penland et al. 1987a) rather than eustatic sea level rise (Gosselink and Sasser 1995), which ranges from 0.12 to 0.24 cm/yr (0.047 to 0.094 in/yr)(Gornitz et al. 1982; Penland et al. 1989; Ramsey and Penland 1989). Nyman et al. (1993) found an even higher rate of subsidence (1.3 cm/year) in the area. In fresh and intermediate marsh, experiments showed that increasing depths by 15 cm produced higher leaf heights than control plants; aboveground biomass was not affected; but root biomass was reduced and leaf tissue concentrations of calcium, copper, iron, magnesium, and zinc were lower over a 15 month period (Howard and Mendelssohn 1995).

As stated previously in this document, the RSL rise rate must be counteracted by accretion of sediment at a similar rate for marsh to remain viable. This does not occur in most Terrebonne coastal marshes, which have accretion rates of only 0.6-0.9 cm/yr (Penland et al. 1988). Delaune et al. (1994) detected that submergence in the study area averaged 1.38 cm/year and accretion averaged 0.98 cm/yr, leaving a net submergence rate of 0.4 cm/yr. When the marsh plants become inundated, they become stressed (Mendelssohn and McKee 1987) and eventually die, removing a major source for organic matter accumulation. Day et al. (1973) estimated that as much as 70 percent of the total organic production available in the water was detritus from marsh grasses. The remainder was plankton and benthic vegetation. Even more problematic is that the marsh surface falls rapidly (about 10 cm) after the plants die, creating shallow ponds that are too deep to revegetate (Day et al. 1994). Interior marshes that undergo this rapid progression are termed hotspots (Leibowitz and Hill 1987). These researchers found that hotspots accounted for 43 percent of marsh loss.

The major factors that influence the type of wetland community are elevation, hydrology, salinity, and soil type. Few plant species are well adapted to high salinities and frequent flooding. Spartina alterniflora is one of the few plant species well adapted to these conditions and it dominates saline marsh. Therefore diversity of plants is lowest in the marsh zone nearest the Gulf of Mexico (saline marsh).

The Terrebonne hydrologic unit (a subunit of the Terrebonne Basin) includes the study area and south to the Gulf of Mexico and west to the Atchafalaya River protection levee. Bottomland hardwoods (BLH) (e.g. red maple, green ash, oaks, and American elm) covered less than 1.0 percent of the Terrebonne hydrologic unit as of 1978 (Bahr et al. 1983). This is not surprising given the low elevations, flat relief, and coastal influences of the area. BLH areas are not flooded for extended periods. This community type is usually found in the Sharkey-Swamp soil association discussed in the soils section. Due to the relatively small amount of BLH, it was combined with swamp for analysis in this study.

Swamp occupied about 4.0 percent of the Terrebonne hydrologic unit as of 1978 (Bahr et al. 1983) or four times the BLH area. The two dominant species normally associated with this type of habitat in the area are bald cypress and water-tupelo. Most of the cypress was clear-cut prior to 1920 (Emmer et al. 1993), which destroyed old-growth cypress forest. This wetland community is found normally in the Swamp soil association discussed in the soils section.

Between the forested wetlands and marsh lies a thin band of scrub shrub habitat. Typical vegetation includes elderberry, wax myrtle, buttonbush, Drummond red maple, and eastern baccharis. Scrub shrub was lumped with the swamp habitat for analysis in this study. There is no Wetland Value Assessment (WVA) model for scrub-shrub habitat.

This study used a four-zone classification system to document conditions and impacts in marsh. The four zones of marsh, demarked by salinity zones are fresh, intermediate, brackish, and saline.

Fresh marsh habitat comprised some 12 percent of the Terrebonne hydrologic unit in 1978 and was undergoing a precipitous decline in areal extent having occupied 24 percent of this area in 1955 (Bahr et al. 1983). Water salinity in fresh marsh is normally less than 1.0 ppt, but can range from 0.1 to 3 ppt (Chabreck 1982).

There are two basic types of fresh marsh in the area, flotant emergent and attached emergent. The flotant marsh is actually not attached to the underlying soil although the marsh plants form a dense mat that appears to be solid. The flotant marshes contain primarily maiden-cane, coastal arrowhead, and Baldwin's spikerush (Sasser et al. 1994). Sasser et al. (1994) estimate that about 70 percent of the marshes in the Barataria-Terrebonne estuary are flotant. Figure FPEIS-14 shows the flotant marsh areas in the Barataria-Terrebonne estuary. The attached emergent fresh marsh is attached to the underlying soil and also contains predominantly maidencane and coastal arrowhead, along with spikerush, alligatorweed, common reed, coastal water-hyssop, penny-wort, and saltmeadow cordgrass (Bahr et al. 1983; Gosselink 1984; Conner and Day 1987). Ledet (1986) found that from 1956-1978, fresh marsh in the eastern half of Terrebonne Parish had been displaced about 1-4 km inland.

Intermediate marsh habitat lies between fresh marsh and brackish marsh and the species of vegetation are not much different from fresh marsh. Water salinitys average 3 ppt and range from 0.5 to 8 ppt (Chabreck 1982). The boundary between fresh marsh and intermediate marsh can be thought of as approximating the influence of salt water. The dominance of the species is different. Many investigators have not even distinguished intermediate marsh, particularly in older literature. Bahr et al. (1983) did not present data for this marsh type for comparison. Saltmeadow cordgrass is the dominant species, with coastal arrowhead, common reed, coastal water-hyssop, seashore paspalum, spikerush, and Olney's bulrush also common (Gosselink 1984).

Brackish marsh as described by Bahr et al. (1983) covered 16 percent of the Terrebonne hydrologic unit in 1978. However, they lumped intermediate marsh into this category. No figures were given for 1955. Water salinity in brackish marsh average 8 ppt with a range of 1-18 ppt (Chabreck 1982). The dominant brackish marsh plant is saltmeadow cordgrass, comprising about one-half of the plants (Gosselink 1984: Conner and Day 1987). By comparison, this species comprises about one-third of the plants in intermediate marsh (Gosselink 1984). Other important species include seashore saltgrass, camphorweed, and coastal water-hyssop (Conner and Day 1987).

The last broad category of marsh used in this document is salt marsh, which has the least diverse plant community. Water salinities average 18 ppt and range from 8-29 ppt (Chabreck 1982). The salt marsh represented some 10 percent of the Terrebonne hydrologic unit in 1978, down considerably from 24 percent in 1955 (Bahr et al. 1983). Saltmarsh cordgrass dominates this community, comprising some 62 percent of the plants. Other important species are needlegrass rush, seashore saltgrass, and saltmeadow cordgrass (Conner and Day 1987). Saltmeadow cordgrass is prevalent only at slightly higher elevations along distributary ridges.

Open water areas frequently contain submerged and floating-leafed vegetation, most commonly within water bodies in forested wetlands and low salinity marshes. Submerged aquatic vegetation (SAV) in the study area includes coontail, hydrilla, elodea, pondweeds, water stargrass, wild celery, fanwort, and Eurasian milfoil. Floating leafed species such as American lotus, water lettuce, water hyacinth, water sprangles, and duckweed are frequently encountered.

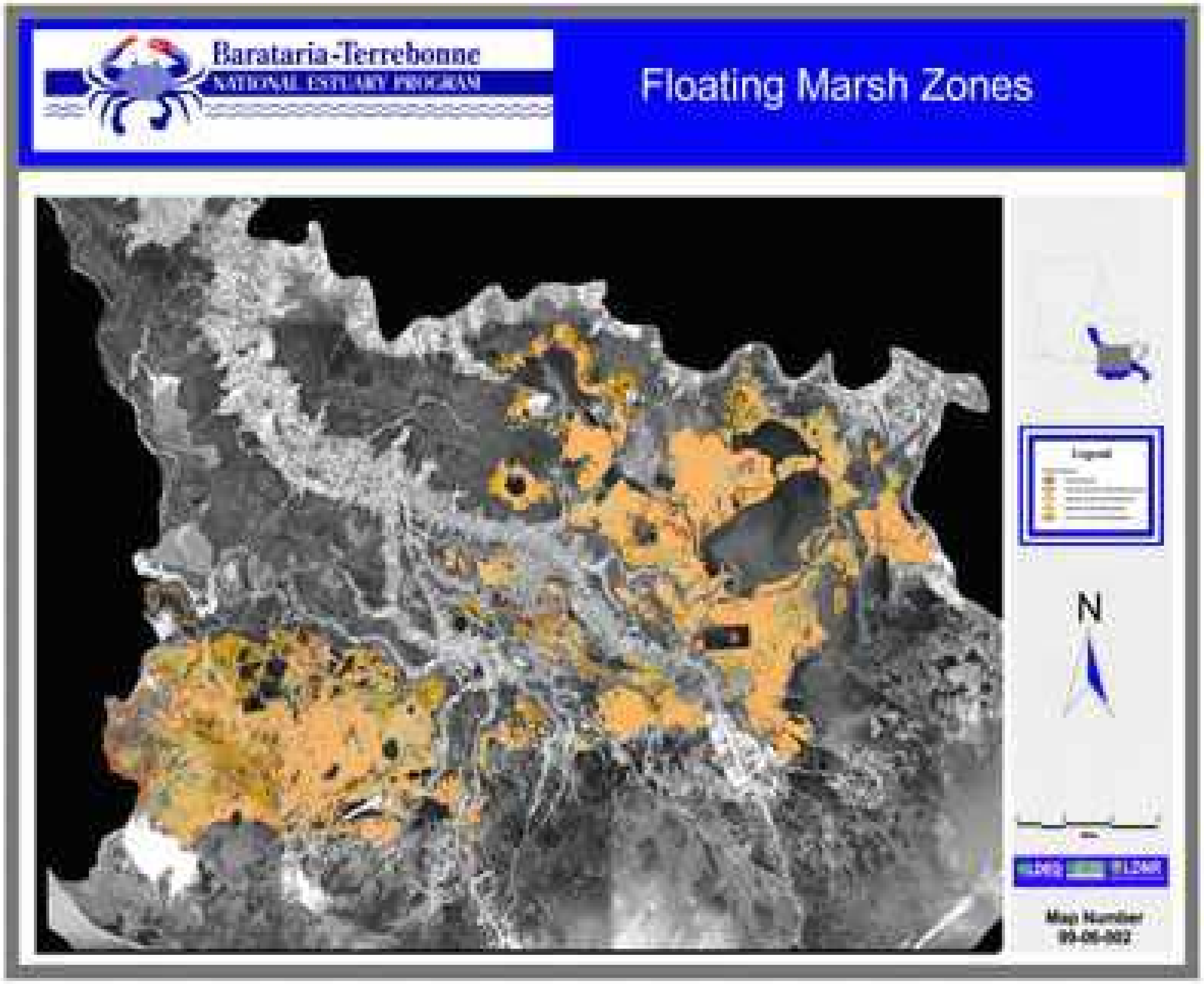

FIGURE FPEIS-14 Flotant Marsh Areas in the Barataria-Terrebonne Estuary

Submerged and floating-leafed vegetation are most common in waterbodies associated with forested wetlands and fresh and intermediate marshes. Submerged aquatic vegetation (SAV) consists mainly of coontail, hydrilla, elodea, pondweeds, water stargrass, wild celery, fanwort, and Eurasian milfoil. The floating leafed species include American lotus, water lettuce, water hyacinth, water sprangles, and duckweeds. In brackish marshes, SAV is most often found in protected areas away from excessive wave action. Wigeon grass, southern naiad, and Eurasian milfoil are the most common species in brackish water.

Sedimentation in salt marshes in the Terrebonne Basin appears to come mainly from open bay areas, mainly during winter prior to cold front passage when strong southerly winds precede the frontal passage (Reed 1989). After frontal passage, previously set-up water flows back to the Gulf, bringing suspended matter out to the bays and Gulf of Mexico (Roberts et al. 1987). Contribution of sediment deposition from hurricanes was not clear from that study, but has since been documented (Jackson et al. 1995; Cahoon et al. 1995). Damage to marshes from hurricanes has been found to be short-term except where substrate is physically disturbed (Conner et al. 1989; Guntenspergen et al. 1995). In other words, simple inundation from a hurricane surge is not particularly damaging to the marshes. The limiting factors and management recommendations for the various marsh types are shown in table FPEIS-17. As one would expect, the factors and recommendations can be quite different, depending on the marsh type.

Table FPEIS-17
Limiting Factors and Management Recommendations of Marshes

Marsh Type	Major Limiting Factors	Best Management Strategies
Fresh	Sensitive to salt and sulfate intrusion. Thin flotant mats of spikerush easily disrupted in storms, but maiden-cane mats can withstand storms. Flotant marshes can not be replaced by more salt tolerant species association.	Avoid oceanic influence, introduce freshwater, control nutria, and conduct regular burning.
Intermediate & Brackish	More sensitive to subsidence than salt marsh; sensitive to tidal and wave energy; restrictive range of salinity and hydrogen sulfide.	Maximize sediment introduction, control muskrats, and conduct carefully controlled burning.
Salt	Mineral sediment deficit leads to degradation.	Maximize sediment input and maintain an open system.

Source: Gosselink and Sasser 1995

Several centimeters of clayey/silt were deposited on salt marsh by hurricane Andrew (Jackson et al. 1995). Cahoon et al. (1995) also found an increase in short-term sediment deposition from hurricane Andrew up to 75 km distant from the storm's track. The accretion was 2.5 cm in a salt marsh. Sediments were coarser and lower in organic matter than in prestorm marsh soils. The storm year resulted in greater accretion at Falgout Canal compared to the following year or the previous year. Furthermore, no sites studied suffered deterioration of the substrate except for the quaking marsh at Jug Lake in the western portion of the study area. Here, the upper 10-cm of poorly consolidated muck layer of intermediate marsh were removed (Jackson et al. 1995). The vegetation appeared to be sheared off at the roots. USFWS post-Hurrican Andrew observation indicated widespread effects of Hurrican Andrew on the project-area marsh substrate. Cahoon et al. (1995) conclude that the magnitude of storm deposits and their longevity in vegetated coastal marshes indicate the potential importance of hurricanes to provide a pulse of sediment to balance the effects of subsidence and sea level rise.

The marshes also influence hurricane effects. In the Terrebonne Basin, the surge height from hurricane Andrew was reduced from 2.0 meters at the coast to 0.15 meters in the marshes east of the Atchafalaya River (Swenson 1994).

In addition to the many human (see Surface Water) and abiotic factors that influence the coastal wetlands in the study area, they can be affected by animals, particularly furbearers (see muskrats and nutria below). Waterfowl and wading birds occur in abundance and can exert an influence on vegetative species composition and biomass (Chabreck et al. 1983; Fuller et al. 1985). Over 200 species of birds including 35 species of waterfowl have been reported from the Barataria-Terrebonne estuarine system (Condrey et al. 1995; Mitchell 1991). In general, wildlife species are greatest in the swamp and decrease moving into salt marsh. In swamps, 25 mammalian, 32 reptilian, and 18 amphibian species occur, but only 8 species of mammals, 4 species of reptiles (not including sea turtles), and no amphibians are found in salt marsh (Gosselink 1984). This trend is reversed for colonial nesting water birds (i.e. wading birds and seabirds),that are found in greater variety in salt marshes.

Songbirds such as the northern parula, prothonotary warbler, mockingbird, and Carolina chickadee nest and feed in forested wetlands and scrub-shrub areas. Numerous other bird species, including common flicker, white-eyed vireo, loggerhead shrike, redheaded woodpecker, and American woodcock also use forested areas.

Alligators are abundant in fresh to brackish bayous and lakes (Joanen and McNease 1972 and Platt et al. 1989). Alligators consume a wide variety of food items including insects, crawfish, crab, birds, fish, muskrat, nutria, turtles, shrimp, snails, and turtles (Chabreck 1971; Platt et al. 1990). They build nests in marshes and along levees, particularly wax myrtle thickets in fresh marshes (Gosselink 1984) where salinities are less than 10 ppt. The alligator is listed as a threatened species due to similarity of appearance, but are harvested in Louisiana because populations are in no danger of declining.

Waterfowl are mostly winter residents that migrate north each spring and summer and populations are highly variable. Wood duck and mottled duck are really the only species which breed in the area. In salt and brackish marsh, gadwall, American coot, and blue-winged teal are the most abundant species. In fresh marsh, American coot, blue-winged teal, and mallard are the most abundant species (Sasser et al. 1982). Puddle ducks (e.g. gadwall and blue-winged teal) prefer marshes with small shallow ponds less than 0.5 meters deep. Widgeon-grass is the preferred food of puddle ducks in brackish marshes, while pondweed, naiad, and duckweed are the preferred items in fresh marsh. Diving ducks (e.g. Scaup spp.) prefer deeper water and dive to depths of over 10 meters to feed on invertebrates (Gosselink 1984).

Wading birds (e.g. herons and egrets) are common year-round residents to the marshes and swamps. These birds are mostly carnivorous. They catch frogs, small fish, snakes, crawfish, worms, and insects in shallow ponds and along bayous for food. They appear to prefer brackish marshes for feeding (Gosselink 1984), but colonies tend to be located in wooded and shrub swamps that are isolated and flooded during the nesting season (Mitchell 1991) (March-August). Seabirds (e.g. gulls and terns) nest on shell, sand, or bare soil primarily on barrier islands and bay islands that have these soil characteristics (Mitchell 1991). There are 14 nesting colonies of wading or seabirds within or in close proximity to the study area (Martin and Lester 1990), but many are not active. Three large colonies are located north of the GIWW in subarea A1 and consist mostly of great egret, lettle blue heron, and glossy and white faced ibis. A medium colony of mostly great egret occurs east of Lake Theriot in subarea A4. A small colony predominantly composed of snowy egret is located in subarea C2. Small colonies of Forster's tern occur south of Lake Felicity near subarea E3.

Muskrat (probably a native species) is a furbearer found mostly in brackish marshes with Olney bulrush. Nutria (introduced from South America in 1938 and about 6 times larger than muskrat) has become the predominant furbearer in fresh marsh (especially flotant) and swamp (Gosselink and Sasser 1995). Reports of muskrat damage in brackish marsh are common with high populations of this rodent. There seems to be a 10 to 14-year cycle of marsh growth and collapse associated with muskrat populations (O'Neil 1949). Recovery of the vegetation following an eat-out is poor (Gosselink and Sasser 1995). Muskrat eat one-third of their weight per day (about 0.3 kg/day)(O'Neil 1949) or less than 1 percent of plant production. It is actually their nest building and digging that causes most of the marsh deterioration. Linscombe and Kinler (1994) found that vegetation damage by nutria can also be serious, particularly in fresh marsh. Recovery appears to take >1 year.

White-tailed deer are most prevalent in BLH and swamp habitat with density declining with increasing marsh salinity. Deer prefer areas above standing water, such as natural levees and dredged material disposal areas and prefer newly grown succulent vegetation (Self 1975) including alligator weed, eastern false-willow, black willow, and common reed. They are common however in fresh and intermediate marshes provided there are suitable cover and browse plants.

To document habitat quality conditions, the WVA technique was used (CWPPRA Interagency Team 1994; LDNR 1994) by the HET. See appendix C-1 for details concerning this methodology. Details of the model results are also in appendix C-1. A summary of the results of that evaluation is shown in table FPEIS-18A & FPEIS-18B. The study area was first divided into sub-basins and then subareas within the sub-basins (figure FPEIS-15). Some of the subareas were eventually lumped back together because they were determined to be similar. Our subbasin A lies within the Penchant subbasin. Our subbasins B-G lie within the Timbalier subbasin and our subbasin H lies in the Fields subbasin.

The lowest existing conditions habitat suitability index (SI) of 0.44 went to subarea C9-10, analyzed as brackish marsh in the Lake Boudreax area. The highest existing conditions SI of 0.71 was attributed to subarea A2-4-5, a fresh marsh area located northeast of Lake de Cade and extending north to the Bayou Black ridge. SI's can range from 0.0 to 1.0 with a 1.0 indicating perfect habitat conditions and a 0.0 denoting no habitat. The SI's indicate that the habitat is of moderate quality (SI's between .5 and .75) in most of the subareas. Approximately 3,000 acres of wetland have been impacted for construction of existing levees and borrow pits. The alternatives begin with these existing levees and expand upon them.

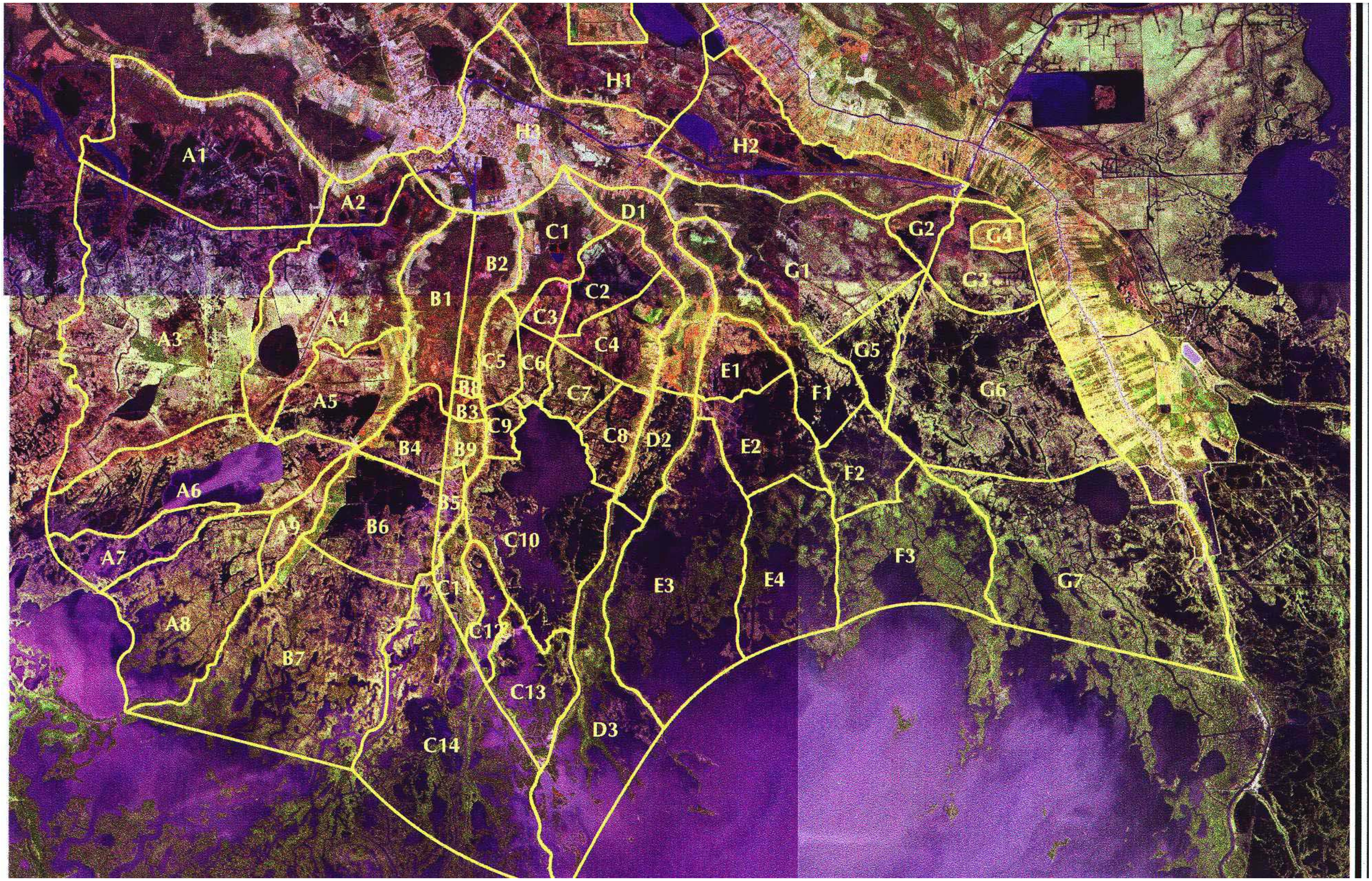

FIGURE FPEIS-15 Aerial Photograph From 1993 With Habitat Subbasins and Subareas Demarcated.

TABLE FPEIS-18A
Existing Conditions Subarea
Acreage and Wetland Loss rates

Subarea	Total acreage	Percent of total wetland type (1990)	Vegetated wetland acreage (1990)	Calculated Percent Annual Loss Ratio (1983-1990)
A1 FM	13,892	12.6	8,184	1.459
A2-4-5 FM	22,243	20.2	15,919	0.325
A3 FM	39,161	35.5	31,726	0.260
A6-7 IM	24,093	39.0	11,664	0.536
A8-9 BM	19,340	16.0	12,590	0.227
B1-2-3 S	11,263	73.3	10,218	0.001
B4 IM	3,938	6.4	1,899	0.796
B5-6 BM	11,944	9.9	4,916	0.842
B7 BM	30,190	25.0	19,446	0.287
C1 S	4,087	26.6	3,747	0.001
C2-3-4 IM	9,204	14.9	4,676	2.422
C5-6-7-8 BM	10,849	9.0	7,373	0.973
C9-10 BM	20,944	17.4	5,891	2.160
C11-12-13 BM	12,459	10.3	6,279	0.095
C14 SM	29,641	16.5	13,150	0.632
D2 BM	5,085	4.2	2,451	2.465
D3 SM	17,929	10.0	4,790	1.187
E1 BM	4,086	3.4	1,597	3.943
E2-3-4 SM	47,596	26.5	12,953	3.115
F1 BM	5,702	4.7	2,341	3.108
F2-3 SM	22,456	12.5	10,957	0.817
G1-5 IM	16,329	26.4	12,874	0.943
G2-3 IM	8,185	13.3	6,100	0.920
G6-7 SM	62,192	34.6	30,129	1.234
H1-2 FM	34,919	31.7	29,681	0.191
TOTAL	487,727	499.9	271,551	N/A

S=Swamp(15,350 acres); FM=Fresh Marsh(110,215 acres); IM=Intermediate Marsh(61,749 acres); BM=Brackish Marsh(120,599 acres); SM=Saline Marsh(179,814 acres).

Source: Interagency HET WVA analyses

TABLE FPEIS-18B
Suitability Index (SI) Results of
WVA Evaluations for Existing Conditions
and the Various Alternatives in 50 Years

Subarea	Existing Conditions	No Action (%change)	Highway 57	Reconnaissance
A1 FM	.61	.38 (-37.7)	.36	.36
A2-4-5 FM	.71	.66 (-7.0)	.66	.66
A3 FM	.67	.66 (-1.5)	.66	.66
A6-7 IM	.57	.46 (-8.1)	.5	.54
A8-9 BM	.65	.65 (0.0)	.65	.65
B1-2-3 S	.51	.58 (+13.7)	.55	.55
B4 IM	.48	.45 (-6.3)	.59	.45
B5-6 BM	.59	.47 (-20.3)	.46	.47
B7 BM	.62	.51 (-17.7)	.5	.51
C1 S	.52	.61 (+17.3)	.64	.61
C2-3-4 IM	.6	.19 (-68.3)	.26	.19
C5-6-7-8 BM	.67	.5 (-25.4)	.53	.5
C9-10 BM	.44	.24 (-45.5)	.24	.24
C11-12-13 BM	.55	.51 (-7.3)	.47	.51
C14 SM	.55	.55 (0.0)	.47	.55
D2 BM	.55	.46 (-16.4)	.46	.46
D3 SM	.48	.35 (-27.1)	.34	.35
E1 BM	.52	.28 (-46.2)	.28	.28
E2-3-4 SM	.48	.25 (-47.9)	.22	.22
F1 BM	.54	.22 (-59.3)	.22	.22
F2-3 SM	.62	.48 (-22.6)	.48	.48
G1-5 IM	.68	.54 (-20.6)	.55	.55
G2-3 IM	.64	.47 (-26.6)	.5	.5
G6-7 SM	.61	.41 (-32.8)	.41	.41
H1-2 FM	.69	.66 (-4.3)	.66	.66

S=Swamp; FM=Fresh Marsh; IM=Intermediate Marsh; BM=Brackish Marsh; SM=Saline Marsh.

3.5.2 ENVIRONMENTAL CONSEQUENCES

3.5.2.1 No Action Alternative

Penland and Boyd (1982) estimated Terrebonne Parish barrier islands will be converted to submerged shoals in less than 60 years at a loss rate of 0.326 km^2/yr. Penland et al. (1987b) state that sea level rise is capable of submerging the entire Terrebonne coastal region and that the magnitude of land loss can be expected to increase to catastrophic proportions in the future. Penland et al. (1988) predicted that the entire Terrebonne Parish deltaic plain will be open water in 100 years. East Terrebonne marshes are likely to continue experiencing rapid rates of deterioration, especially if any man-made control structures are placed so as to restrict Atchafalaya floodwater into these areas (Delaune et al. 1987).

The fresh marshes in the western portion of the study area (in the Penchant subbasin) would likely continue to receive increasing amounts of fresh water from the Atchafalaya River. As the river's delta enlarges, high water would be more likely to escape laterally to the east and west. The acreage likely to receive the fresh water, nutrients, and sediment from the Atchafalaya River would increase. The increase in fresh water would likely encourage more submerged aquatic vegetation in open water areas. Land loss rates in this area would likely remain low as subsidence would be counteracted largely by increased freshwater flows and sediment arriving from the Atchafalaya River and stimulated marsh growth. Land loss has been highest around Jug Lake. It is anticipated that land loss near this location would continue to remain the highest in this subbasin in the future.

In the Timbalier subbasin, wetlands would continue to be lost at an annual ratio of about what has been measured from 1983-1990 because of subsidence, inundation of marsh plants, and subsequent erosion in brackish and saline marshes. As these marshes disappear, salt water would begin to move northward more rapidly, stressing fresh and intermediate marshes. These marshes would likely not tolerate the increasing salinity well and would probably not convert to brackish marsh because the soils would be comprised of too much organic matter. Research by Lessman et al. (1997), and McKee and Mendelssohn (1989) indicate these marshes would be very susceptible to the deleterious effects from the sudden influx of salt water from a tidal surge associated with a hurricane.

In the Fields subbasin, fresh water inflow via the GIWW would increase when the Atchafalaya River is high, but the wetlands would also continue to experience the low annual losses similar to those documented from 1983-1990. This particular area (subbasin H) showed little decline in suitability or wetlands area.

The HET projected that suitability indices would generally decline throughout the study area except for B1-2-3 and C1, which were evaluated as swamp. Subarea C2-3-4 was predicted to lose 68.3 percent of its suitability over 50 years. The main reason for the general decline in suitability was the continued loss of vegetated wetlands.

For this study, the HET used the 1983-1990, land loss ratio developed by the Corps of Engineers for each of the subareas to project future conditions of marsh. This was the most recent complete land loss data available at the time of analysis in 1996-1997. In a few instances, however, those rates were adjusted to account for anticipated land-loss rate chages due to recently completed or authorized projects. The actual rates can be found in Table 6 of the FWS August 2001 revised Draft FWCA Report (Volume II, Appendix C-6). The HET applied these land loss ratios to produce annual acreages lost from each subarea. Using the annual acreage figure resulted in a linear trend of marsh loss through the 50-year projection period. Projections started with the acreage from 1990, the latest complete year of data available during analyses. Land losses and gains from 1956-1990 overlaid with the habitat study subareas are shown in figure FPEIS-16. That representation, perhaps more than any data shows the crisis that the coastal marshes have faced and would continue to endure in the study area. Vast acreages of wetlands have been lost and would continue to be lost. It would be only a matter of time before the Gulf of Mexico would be at the subareas designated here as G3, G1, D1, C1, B1, and A4.

The overall habitat value and acreage of remaining wetlands would decline with the No Action alternative. Swamp areas show an increase in the suitability index due to maturation of trees. However, under the No Action scenario, the HET predicted that 93,792 acres or 34.5 percent of remaining vegetated wetlands in the study area would be lost in 50 years. Emergent vegetated wetland acreage and AAHU's in each subarea for the 50-year study period are contained in tables FPEIS-19A and FPEIS-19B respectively. This may actually be a conservative estimate because of the linear trend assumed by the HET (See appendix C for a discussion on this assumption). Others have appeared to predict greater land loss (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1998). Several of the subareas (C2-3-4; C9-10; E1; E2-3-4; and F1) are predicted to lose all emergent wetlands before the end of the 50-year evaluation period. The swamp areas near Houma are the only subareas predicted to have an increase in habitat value. Even this finding is subject to debate. Figure FPEIS-17 shows infrared photography of portions of subareas C10, D3, and E3 taken in 1978 and 1995. Except for the ridge areas, almost none of these wetlands would remain in 50 years.

Approximately 3,070 acres of wetland area is impacted from existing and permitted levee and borrow pits. For this analysis, no additional acreage was assumed to be permitted for levee construction or enlargement.

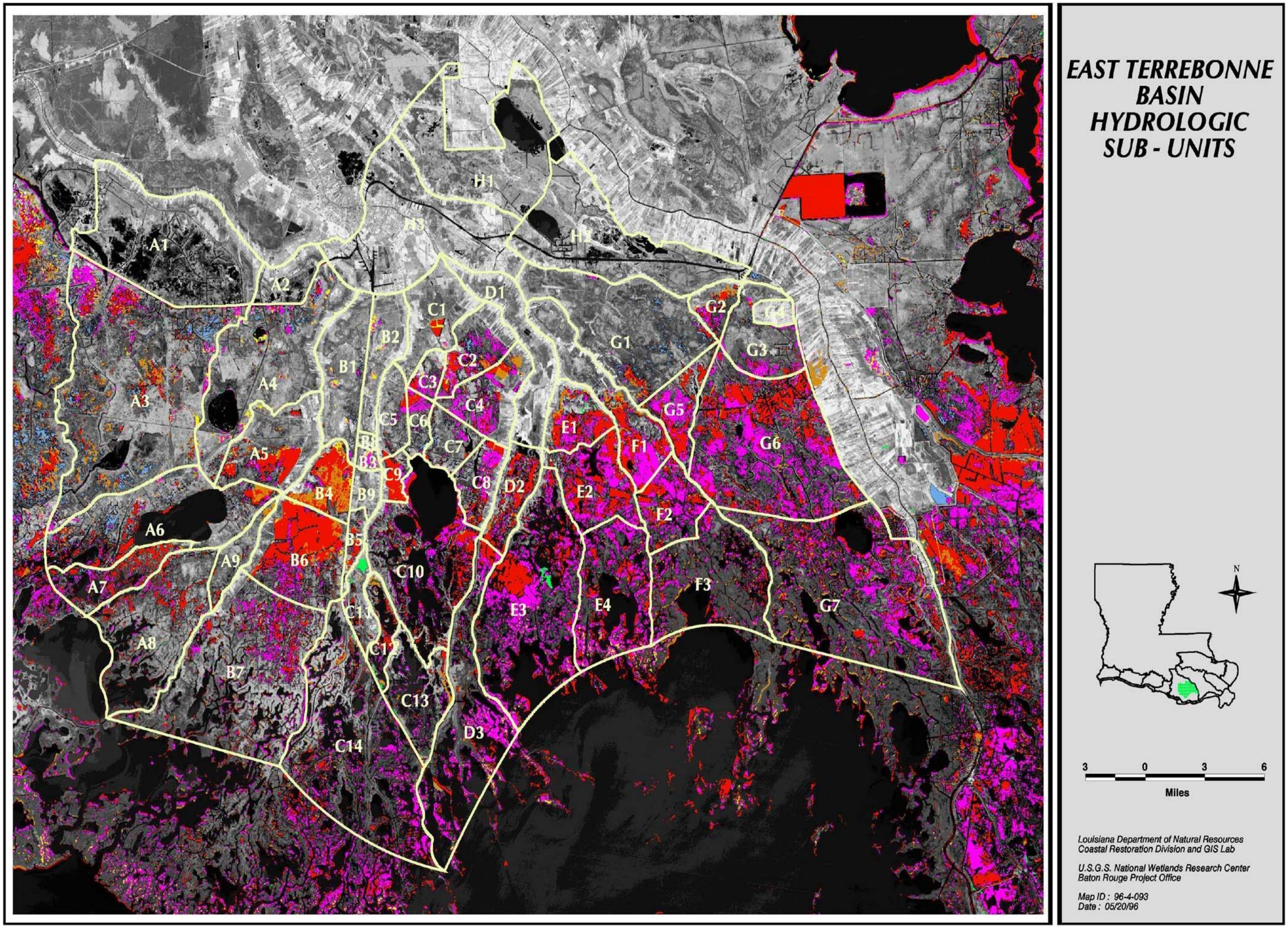

FIGURE FPEIS-16 Land Losses and Gains From 1956-1990 Overlaid With the Habitat Study Subareas

TABLE FPEIS-19A
Emergent, Vegetated Wetland Acreage
Remaining After Year 50 in Each Subarea

Subarea	Alternative			
	Existing (1990)	No Action	Highway 57	Reconn
A1 FM	8184	2234	1615	1615
A2-4-5 FM	31726	27526	27396	27396
A3 FM	15919	13269	12906	13158
A6-7 IM	11664	8819	9085	8964
A8-9 BM	12590	11140	10966	11210
B1-2-3 S	10218	11263	11263	11242
B4 IM	1899	1322	1659	1322
B5-6 BM	4916	2826	2945	2846
B7 BM	19446	14990	14971	14990
C1 S	3747	4087	4087	4059
C2-3-4 IM	4676	0	156	0
C5-6-7-8 BM	7373	3786	4324	3781
C9-10 BM	5891	0	0	0
C11-12-13 BM	6279	5981	5040	5981
C14 SM	13150	9008	8785	9008
D2 BM	2451	1545	1506	1494
D3 SM	4790	1948	1856	1948
E1 BM	1597	0	0	0
E2-3-4 SM	12953	0	0	0
F1 BM	2341	0	0	0
F2-3 SM	10957	6479	6458	6458
G1-5 IM	12874	9839	9668	9668
G2-3 IM	6100	3293	3267	3267
G6-7 SM	30129	11537	11537	11537
H1-2 FM	29681	26847	26847	26847
Total Acres	271551	177759	176337	176791

S=Swamp; FM=Fresh Marsh; IM=Intermediate Marsh; BM=Brackish Marsh; SM=Saline Marsh.

TABLE FPEIS-19B
AAHU's In Each Subarea (50 Year Study Period)

Subarea	Alternative		
	No Action	Highway 57	Reconnaissance
A1 FM	6852	6662	6662
A2-4-5 FM	15167	15039	15183
A3 FM	26018	26125	26125
A6-7 IM	12546	12925	12751
A8-9 BM	12553	12476	12571
B1-2-3 S	6048	6213	6037
B4 IM	1883	2237	1883
B5-6 BM	6334	6167	6321
B7 BM	17168	16678	17156
C1 S	2347	2402	2331
C2-3-4 IM	3468	4071	3452
C5-6-7-8 BM	6321	6517	6321
C9-10 BM	6990	7117	6990
C11-12-13 BM	6592	6131	6592
C14 SM	15070	15057	15070
D2 BM	2577	2557	2546
D3 SM	7352	7070	7352
E1 BM	1525	1488	1472
E2-3-4 SM	15588	15588	15588
F1 BM	1971	1940	1940
F2-3 SM	12297	12297	12297
G1-5 IM	9930	10025	10025
G2-3 IM	4537	4738	4738
G6-7 SM	32009	32009	32009
H1-2 FM	23573	23573	23573
Total AAHU	256716	257102	256985

S=Swamp; FM=Fresh Marsh; IM=Intermediate Marsh; BM=Brackish Marsh; SM=Saline Marsh.

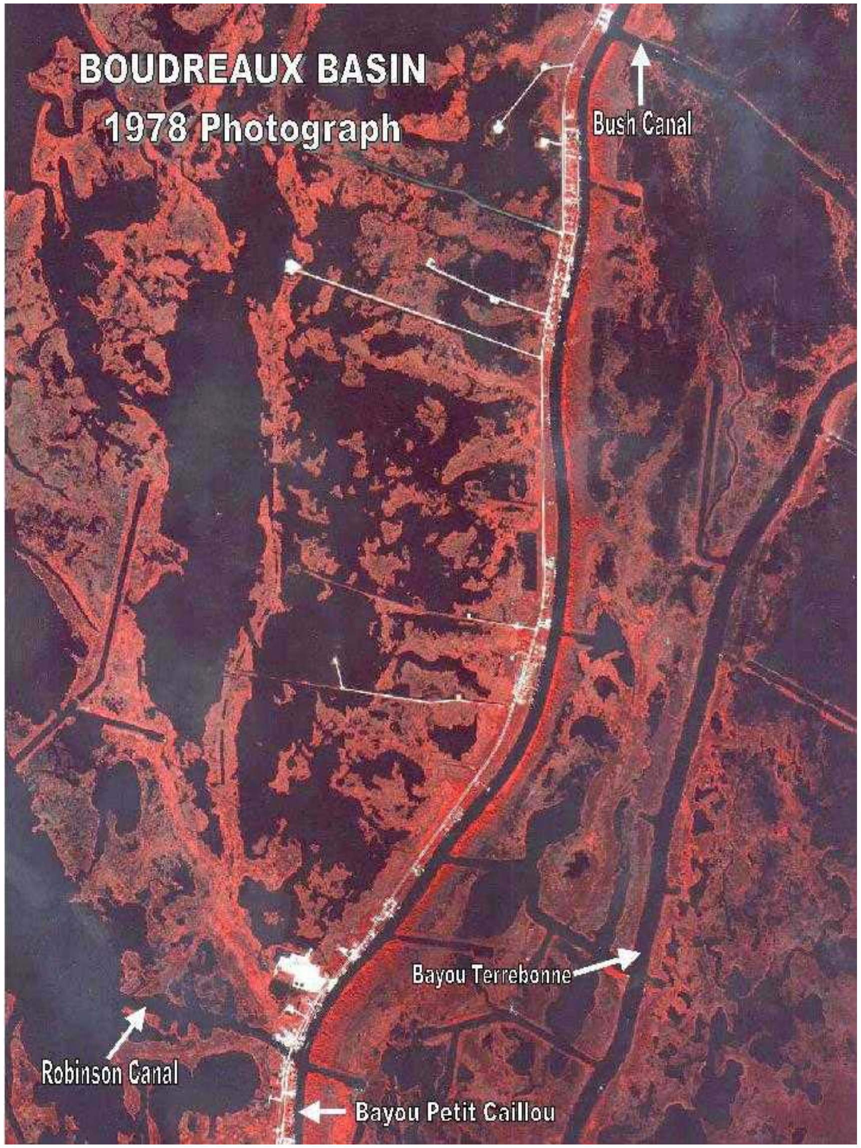

FIGURE FPEIS-17 Comparison of Marsh Areas in 1978 and 1995 Using High Altitude Infrared Photographs of Portions of Subareas C10, D3, and E3

3.5.2.2 Highway 57 Alternative

The initial impression might be that the proposed project would function as an immense marsh management project, indirect effects of which have been found to be positive or negative (Corps 1996; Cahoon 1990) depending on their focus and circumstances. However, unlike a marsh management plan that attempts to manipulate water on a seasonal basis, usually against natural tendencies, the goal of the hurricane protection project is quite different. The goal here is to leave the system open most of the time, but shut off the potentially damaging influx of tidal water, with its associated wave action and high salinity, which accompanies a hurricane.

The alignment for the most part builds on natural ridges, roadbeds, or existing levees that have been built for other purposes such as forced drainage or marsh management. Of the estimated 72 miles of levee proposed in the current alignment, approximately 15 miles would cross part of the estuaries that are currently open to estuarine exchange. Thus, the construction of the levee itself would cause very little new indirect impacts on estuarine hydrology and for the most part would follow existing hydrologic barriers. The proposed project includes numerous environmental water control structures in the levees to allow hydrologic exchange through the protection levees. Existing wetlands on the 'inside' would still be tidal wetlands.

With this in mind, the Corps and its advisory agencies tried to develop alternatives that resulted in the least disruption of normal hydraulic movement, while still providing hurricane protection and conservation of the enclosed wetlands. A saltwater intrusion abatement plan will be developed for the HNC Lock and possibly, the auxiliary gates at the Bayou Grand Caillou Floodgate. The only areas where structures would be placed and operated under marsh management plan conditions are where they would occur without the project (e.g. Pointe au Chien Wildlife Management Area). All other structures would remain open until an impending tropical event necessitated closing them. They would be reopened immediately after the storm or threat abates.

A modified Highway 57 alternative was adopted late in the process to save on construction costs. The modified alternative removed levees in the lower Bayou du Large and lower Bayou Grand Caillou areas. The changes can be seen by comparing figure FPEIS-8 and plate 8 of the modified alternative to figure FPEIS-18 and plate 5 of the original alternative. The removal of these levee sections reduces environmental impacts to a very minor extent, not enough to warrant a reevaluation of impacts given the programmatic nature of this document. Therefore, the impacts and mitigation discussed are from the original Highway 57 alternative.

The direct impacts to wetlands, which include borrow areas and levee footprint, total an estimated 4112 acres. This alternative would impact about 3,743 acres or 1.4 percent of the approximately 271,551 acres of baseline emergent marsh in the study area (table FPEIS-20). This figure was based on engineering information provided to the HET in late 1996. It appears that these figures would decline during detailed design because of reduced levee widths and relocation of some borrow pits to open water or upland areas.

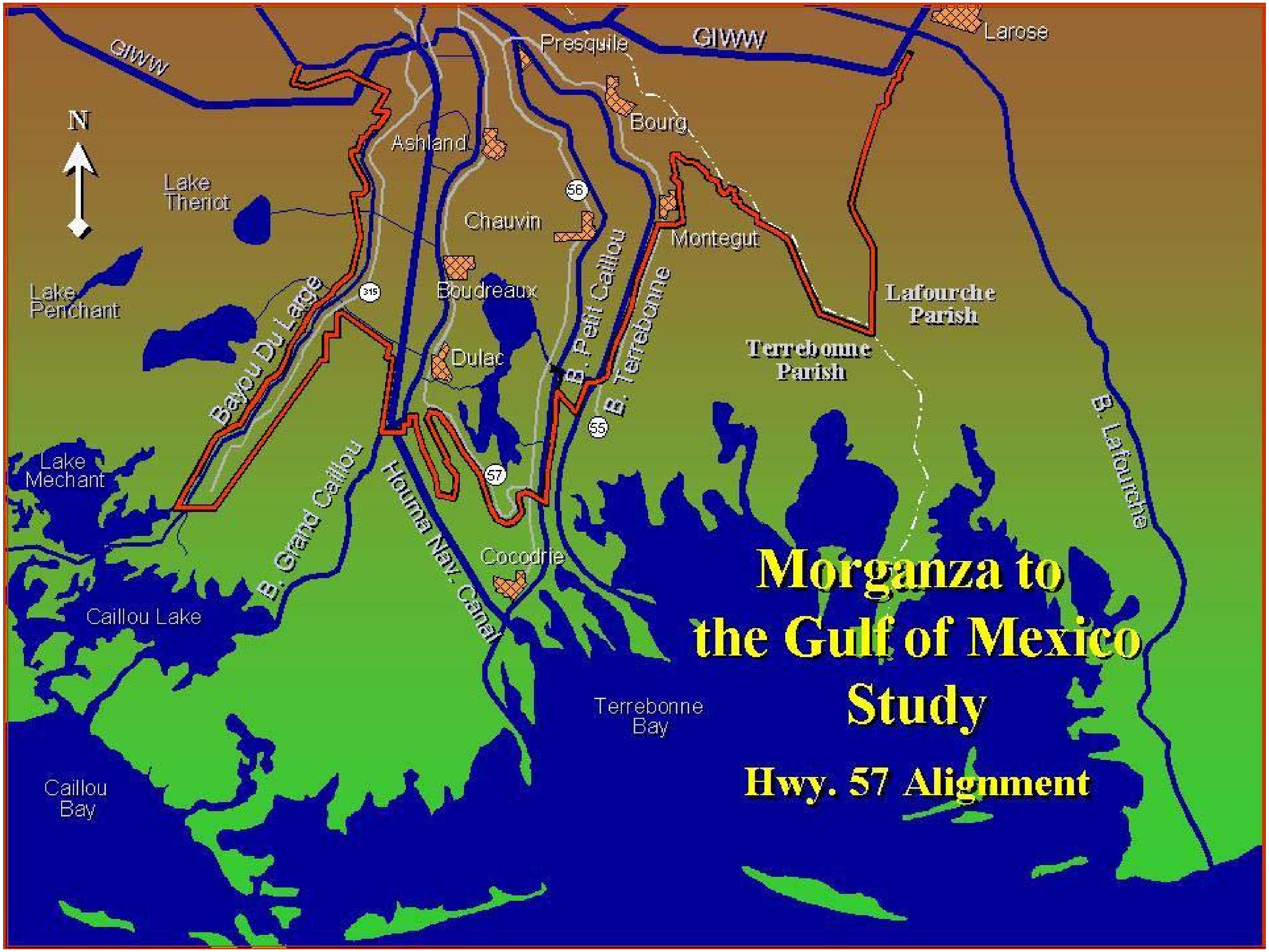

FIGURE FPEIS-18 Map of Original Highway 57 Alternative

TABLE FPEIS-20
Vegetated Wetland Impacts Summary[1]

Alternative	Total Direct Impact	Percent reduction	Net acreage at TY50	Percent reduction at TY50	Net AAHU Difference per WVA results
No Action	0	0	0	0	0
Highway 57	-3743	1.4	-1422	0.8	837
Reconnaissance	-1332	0.5	-968	0.55	297

[1s] Combines all habitat types.

Over the project life, the annual loss ratio of marsh would be decreased slightly because of a reduction in storm and salinity damages to wetlands enclosed by the levee system. At target year 50, the vegetated marsh acreage lost with this alternative would be approximately 1422 acres more than with No Action or an increase of 0.8 percent. The overall Average Annual Habitat Unit (AAHU) would increase during the 50-year analysis period by 837. The discrepancy between acreage of vegetated marsh and AAHU is explained by improvements in habitat quality in remaining wetlands. Remaining intermediate marsh and swamp would have improved AAHU, but fresh, brackish, and saline marsh would never completely overcome the initial impacts in the 50-year analysis period (table FPEIS-21).

TABLE FPEIS-21
Wetland Impacts in AAHU's
by Wetland Type and Subbasin

Wetland Type or Subbasin	Alternative		
	No Action	Highway 57	Reconn
Fresh	0	-211	-67
Intermediate	0	1632	485
Brackish	0	-509	-94
Saline	0	-295	0
Swamp	0	220	-27
Subbasin A	0	81	157
Subbasin B	0	324	-24
Subbasin C	0	507	-32
Subbasin D	0	-302	-31
Subbasin E	0	-38	-38
Subbasin F	0	-31	-31
Subbasin G	0	296	296
Subbasin H	0	0	0

It should be noted that the amount of impacts could decrease if the plans are refined. The levee and borrow footprints might be expected to decline rather than increase during detailed planning. The HET used a preliminary estimate of the levee and borrow pit widths to determine direct impacts. It is likely that many of the marsh borrow pit areas would not be usable; thus, material will have to be hauled from upland sites. Finally, some of the borrow pit material from the top layer would not be suitable for levee construction and could be used for marsh restoration. Quantification of these impact decreases was not possible so the worst case scenario is presented here.

3.5.2.3 Reconnaissance Alternative

Direct impacts would be far less with the Reconnaissance Alternative compared to the Highway 57 Alternative since it leaves out protection for two of the bayou ridges (du Large and Grand Caillou). The direct impacts to marsh, (including borrow areas and levee footprint), total an estimated 1,332 acres or a 0.5 percent reduction of the approximately 271,551 acres of emergent marsh in the study area at the start of the analysis period. Table FPEIS-20 summarizes the vegetated wetlands impacts. Both the Reconnaissance and Highway 57 alternatives would provide storm surge and salinity damage reduction benefits to enclosed wetlands. According to the HET"s assumptions, however, the indirect benefits to enclosed wetlands would be greater with the Highway 57 alternative, because it would increase the influence of freshwater inflows, while the Reconnaissance alternative would only maintain (or possibly reduce) the effects of such inflows. At target year 50, the marsh acreage lost with this alternative would be approximately 968 acres less than with No Action or an increase of 0.55 percent. The overall AAHU would increase during the 50-year analysis period by 297. The discrepancy between acreage of vegetated marsh and AAHU is explained again by improvements in habitat quality of the enclosed wetlands. Remaining intermediate marsh and swamp would have improved AAHU, but fresh, brackish, and saline marsh acreage would never completely overcome the initial impacts in the 50-year analysis period (table FPEIS-20).

3.5.3 MITIGATION AND MONITORING

3.5.3.1 Background

The WVA analysis showed that overall impacts from either of the action alternatives would have a positive effect on the coastal wetlands in the study area. This was due to gains in intermediate marsh habitat units. However, fresh, brackish, and saline marsh would be adversely impacted. The NMFS and USFWS opposed substituting gains in intermediate marsh for losses in saline, brackish, or fresh marsh because of functional differences between the marsh types. The Corps agreed with their assessment. In addition, the Corps noted the extent of direct impacts involved and the remaining marsh acreage impacts at TY 50. The direct impacts are more definite than the indirect or qualitative gains predicted in future years. Therefore, each habitat type was viewed independently except that mitigation in brackish marsh could be substituted for saline marsh. It is possible that the sponsor and the Corps could set up a mitigation bank for intermediate AAHU gains; however, that option will not be pursued in this document. Therefore, mitigation plans were developed for the Highway 57 Alternative, which had the largest losses for fresh, brackish, and saline marsh. Similar, but smaller mitigation plans would be needed to balance losses of the Reconnaissance Alternative because it had only about 20 percent of the negative impacts associated with the Highway 57 Alternative. The NMFS and USFWS agreed that mitigation in brackish marsh could serve as a substitute for saline marsh during mitigation planning and evaluation.

Several plans were generated as possible mitigation alternatives by the HET (See appendix C for details). Alternatives were generated for fresh marsh and brackish marsh. The focus of the plans was to restore marsh to offset direct impacts rather than rely on possible future marsh improvement by manipulating hydrology. This was not possible for most areas of fresh marsh, because creating marsh in the fresh marsh areas would likely cause damage to existing marsh rather than improve marsh. The exception to this was a plan to restore marsh in an area of converted pastureland. The plans were first evaluated qualitatively by the HET to reduce the number of plans. The final array of plans was evaluated using the WVA methodology to determine their relative benefits. The plans were then submitted to cost engineers to determine construction costs of each plan.

3.5.3.2 WVA Mitigation Results

The WVA results for the final mitigation plans on the Highway 57 Alternative are shown in table FPEIS-22. The same type of mitigation plans would apply to the Reconnaissance Alternative, but smaller amounts would be needed to offset impacts (table FPEIS-20). The second column shows the actual HET results based on the acreage assumed in the WVA analysis. It was not possible to predict how many AAHU could be gained by a given acreage. Therefore, the final AAHU needed to be prorated to match the 211 AAHU needed for fresh marsh and 804 AAHU needed for brackish and saline marsh. It should be noted that detailed design would likely reduce the AAHU impacts and therefore the needed mitigation. The prorated acreages are contained in the final column. Any of the possible plans could provide the AAHU needed. However, the Corps selected a plan after conducting cost effectiveness and incremental cost analysis.

Any net impact the project has on wetlands would be mitigated as part of the project by building new wetlands or improving the condition of existing ones. The Corps, in consultation with an interagency Habitat Evaluation Team (HET) consisting of representatives from various resource agencies will refine the compensatory mitigation estimates during the detailed engineering and design phase as the plan components are more fully developed.

TABLE FPEIS-22
Mitigation Acreage Needed for the
Highway 57 Alternative Based on WVA Results

	MITIGATION OPTION	WVA ASSUMED ACREAGE AND CALCULATED AAHU	ACREAGE NEEDED FOR AAHU*
Fresh Marsh, AAHU Needed = 211	Minors Canal Enlargement	NA/259	NA
	Benefits to G3 from restoration in G6	NA/229	NA
	Restore Marsh in G4	400/341	248
	Restore Marsh in A7	511/295	366
Brac & Sal Marsh, AAHU Needed = 804	Restore Marsh in G6	468/248	1515
	Restore Marsh in C10	1358/709	1538
	Restore Marsh in C12	1319/696	1521
	Restore Marsh in C13	633/376	1352
Combinations	G6 and C10		468 in G6 & 1063 in C10
	G6 and C12		468 in G6 & 1052 in C12
	G6 and C13		468 in G6 & 934 in C13

*The ratio will not match exactly because of indirect benefits and the complexities of the WVA formulas.

3.5.3.3 Incremental Analysis

Cost effectiveness and incremental analysis (CE/IA) of the possible mitigation plans were conducted using the methods outlined in Orth 1994 and Robinson et al. 1995. See appendix C- for a complete presentation of the results. This analysis is a tool to help with the decision of selecting a given plan or plans. It does not dictate a final answer or require selection of a certain plan. Using this analysis as a tool to help with selection, the selected mitigation plan would entail the Minor Canal enlargement for fresh marsh along with 1352 acres of marsh restoration in subarea C13 for brackish and saline marsh. This mitigation option would cost about $48 million to construct not including real estate costs. The Minors Canal plan could have some implementation difficulties and some additional construction costs such as driving piles to block off the widened area, which were not included in the estimate.

Therefore, a backup plan may be needed if the costs of the first choice rise too high. The next selected plan would be the combination plan of 468 acres of marsh restoration in subarea G6 and 934 acres of restoration in subarea C13. That plan would cost approximately $53 million to construct. That estimate does not include real estate costs.

3.5.3.4 Monitoring

The proposed project would have a pre-construction and post-construction monitoring plan developed by the interagency team to evaluate impacts to the mitigation areas and other affected wetlands. Small modifications to the environmental water control structures (EWCS's) may be possible using this funding source, but it is highly unlikely that the funding would be sufficient to support adding additional structures. Future construction for adaptive management would be pursued using the Post Authorization Change (PAC) process. Monitoring would be a critical aspect to any selected action plan. Salinity, vegetation types, land loss, and fish would all be needed components of the monitoring. Because of the size and complexity of the study area, no amount of prior study and analyses can guarantee exact results. Therefore, operation of the system must be flexible to respond to unexpected changes in the system. The only way to know if unexpected changes occur is to monitor the situation and use the information to make informed decisions. Decisions to change operations based on monitoring information would be made by a team consisting of members from the agencies that participated in the habitat evaluation Corps and TLCD, along with voluntary cooperation from FWS, NMFS, NRCS, Louisiana Department of Natural

Resources Coastal Management Division (LDNRCMD), Louisiana Department of Natural Resources Coastal Restoration Division (LDNRCRD), and LDWF. These same agencies will perform annual inspections of all water control structures and gates to determine if they are being maintained and operated properly. They also would review the salinity, vegetation, land loss, and fisheries data. A report would be prepared and submitted to the Commander, New Orleans District and other interested parties. The Commander would determine the need to implement any corrective actions in conjunction with the local cost share partner and resource agencies.

Therefore, the following monitoring plan is proposed to accompany the Highway 57 Alternative. The Reconnaissance Alternative would have to monitor an area about half the size of the Highway 57 Alternative and therefore would be about half the cost.

Salinity

Monitoring of salinities in the HNC and Bayou Grand Caillou below and above the proposed lock location would be critical. These stations would also need the ability to monitor temperature and flow. Monitoring stations in Bayou Decade, lower Minors Canal, the marsh north and south of Falgout Canal to the west of the HNC, Bayou Dulac, Robinson Canal, northern, and Grand Bayou and marsh to the east would also be needed. The monitoring would be done continuously before, during, and the first five years after construction. After the five years, continuous monitoring would continue in the HNC for the project life. In the other locations, monitoring could be reduced to monthly sampling.

Vegetation

Vegetation would be monitored throughout the study area to determine the extent of vegetation zone shifts over time. Surveys of vegetation to monitor zones have been conducted using techniques designed to achieve similar results (Visser et al. 1998; Evers et al. 1998). Vegetation zones would be monitored biennially before, during, and for the first five years after construction. After that, surveys would continue on a triennial basis for the project life.

Marsh Loss or Gain

Wetland loss or gain, including SAV in the study area would be monitored on a biennial basis before, during and five years after construction. The study area would be monitored using aerial photography, the vegetation survey information, and Geographic Information Systems to map changes and quantify wetland areas. After that, the analyses would continue on a triennial basis for the project life. These investigations should be designed to correspond with year 3 after mitigation restoration areas have been constructed to determine if the restoration worked as expected.

Fisheries

Juvenile fish would be sampled quarterly in the Lake Boudreaux area to determine numbers and species composition before, during, and after construction. Salinity, temperature, and other pertinent environmental data would be collected at the same time. After that, the sampling would be reduced to a biannual schedule.

Flow and Water Elevation

Continuous measurement of flows and water levels west and east of the GIWW floodgate would be needed to ensure that flow moves through the floodgate with little resistance so that water levels to the west of the floodgate do not rise above the assumed 3-4 inches. Flow and water levels would also need to be measured at the HNC lock, Bayou Grand Caillou floodgate, Minors Canal, and the Grand Bayou Floodgate. Water elevations should be measured inside and outside of all environmental structures to ensure that ponding does not occur in the system (unless that is the expected condition under an existing management plan). Flow and water level measurements should continue throughout the project life.

Costs

The costs for monitoring for the Highway 57 Alternative are estimated in year 2000 dollars at $400,000/year during the first nine years and then dropping to $200,000/year for the remainder of the project life. These estimates were based in part on monitoring costs for the Davis Pond freshwater diversion project. The monitoring costs for the Reconnaissance Alternative would be about half of the Highway 57 estimates.

3.6 Aquatic Resources and Essential Fish Habitat (EFH)

3.6.1 AFFECTED ENVIRONMENT

Most of the economically important saltwater fishes and crustaceans harvested in Louisiana spawn offshore and then use estuarine areas for a nursery habitat (Herke 1995). Over two decades ago, Lindall and Saloman (1977) recognized the importance of Gulf of Mexico estuaries to fishery resources. In compliance with the Sustainable Fisheries Act (SFA) the following section also addresses essential fish habitat (EFH) for important estuarine species in the area. The study area contains a variety of aquatic habitats including ponds, lakes, bayous, shallow open water, and embayments. Salinity conditions range from fresh to saline. The fresh and intermediate water bodies often contain submerged or floating leafed vegetation (SAV). Brackish and saline areas usually do not contain SAV. Much of the open water area has been generated at the expense of emergent marsh. Open water is now the dominant habitat type in the study area, but it was not always that way.

The most abundant species found in freshwater marsh in the study area are grass shrimp, sheepshead minnow, rainwater killifish, inland silverside, and sailfin molly (Rogers et al. 1992). These species are found along marsh edges and among SAV. The intermediate and fresh marshes also provide habitat for commercial and recreation fisheries. Species include largemouth bass, black crappie, bluegill, channel catfish, buffalo, freshwater drum, bowfin, and gar.

Estuaries, a dynamic aquatic zone where fresh water dilutes seawater, serve as nursery areas for a variety of fish and shellfish from the Gulf of Mexico. Estuaries represent some of the most productive habitats in the world. They support high primary and fisheries production (Whittaker and Likens 1973; Walme 1972). The annual volume of river discharge to the estuaries has been correlated with fish harvest and abundance (Chapman 1966 and Moore et al. 1970). As stated by Kutkuhn (1966), "Estuaries are not closed, self-contained ecological systems. Their production of organic matter is as dependent on material contributed from land and sea as is their brackishness".

Commercial landings (by weight) of fish and shellfish, including freshwater fish, in the Barataria-Terrebonne estuarine basins peaked in 1984 and by 1990 declined by 49 percent (Perret and Melancon 1991). This paralleled a statewide trend. Fluctuations in year to year landings can be caused by a variety of factors including winter freezes, drought, tropical storms, and transportation costs, and usually do not indicate long-term environmental problems. Individual organisms produce large numbers of eggs, so populations can recover quickly from short-term detrimental conditions. However, long-term (defined here as

3 years or more) declines in landings can signify that there are ongoing environmental problems and/or over-fishing of the resource, or a weakening market. In this case, the main environmental problem would be the disappearance of estuarine marsh nursery areas. Remaining areas can not support as many young.

By far, the top position in landings of finfish for the Barataria-Terrebonne estuaries has been held by Gulf menhaden, which contributes more than 90 percent of the annual finfish landings, but landings have been declining. The next five species in finfish landings (tunas, black drum, catfish and bullheads, red drum, and sharks) have also declined in recent years (Perrent and Melancon 1991). For shellfish, landings have been dominated by brown shrimp and white shrimp, with blue crab, crawfish, and oysters rounding out the top five species. These five species comprised about 96 percent of all shellfish landings from 1986-1990 (Perret and Melancon 1991). All are estuarine or freshwater dependent species for at least a portion of their life. The landings of shellfish have continued to rise generally, but are subject to year to year variations dictated by environmental conditions in the estuaries.

The Corps obtained 1985-1998 fishery landings data from the National Marine Fisheries Service for an area (Terrebonne, Lafourche, and Jefferson Parishes) that focuses on the study area more than the data reported by Perret and Melancon (1991). The 1985-1995 data indicate that finfish and shellfish landings, exclusive of menhaden, from 1990-1995 may have dropped somewhat from the 1985-1989 landings. However, no gross trends are easily discernable and the plant in Terrebonne Parish stopped operating after 1995 so no further analysis is possible. Tables FPEIS-23A and FPEIS-23B contain the fishery landings data from the National Marine Fisheries Service divided into individual species of shellfish and finfish. Landings for shellfish and finfish as a whole are shown in table FPEIS-24.

TABLE FPEIS-23A
Major Commercial Fishery Landings
Within the Study Area 1985-1998 x 1,000 pounds

RELEVANT SPECIES	1985	1986	1987	1988	1989	1990	1991
Finfish:							
Catfish & Bullheads*	135.5	104.8	133.6	280.0	164.3	*	*
Catfish, Blue*	*	*	*	*	*	10.0	90.8
Catfish,Channel*	*	*	*	*	*	712.2	57.3
Drum, Black	542.5	2,185.7	3,218.7	4,993.6	1,540.1	1,307.1	1,008.6
Drum, Red**	725.1	2,095.9	1,709.0	80.1	15.5	**	**
Garfish	123.5	153.7	198.0	141.9	171.3	66.6	97.6
Menhaden***	***	***	***	***	***	***	***
Mullet, Striped or Black	4.0	5.8	2.8	73.9	291.0	238.7	513.7
Sea Trout,Spotted	209.6	520.4	745.6	401.1	300.8	63.5	256.5
Tuna, all	163.4	205.3	680.1	1,781.7	1,904.4	2,065.4	1,954.4
Sub-total:***	1,903.6	5,271.6	6,687.8	7,752.3	4,387.44	4,463.5	3,986.8
Shellfish:							
Crab, Blue, hard	8,145.2	9,881.3	23,350.4	24,909.2	16,373.4	19,692.1	20,426.8
Oyster, all American	4,069.8	3,406.4	3,240.8	4,041.7	3,905.9	3,141.8	2,395.6
Shrimp, Brown	35,995.0	41,780.3	36,685.4	29,490.9	37,515.6	43,622.4	28,680.8
Shrimp, White	31,999.1	42,192.2	27,443.1	22,044.1	19,767.9	23,210.2	25,695.9
Sub-total	80,209.1	97,260.2	90,719.7	80,485.9	77,562.89	89,666.7	77,199.1
TOTAL AREA***	82,112.8	102,531.8	97,407.4	88,238.4	81,950.2	94,130.2	81,185.9

* Blue and channel catfish data prior to 1990 were reported in the catfish and bullheads group.
** The commercial harvest of Red Drum (redfish) was restricted in 1988.
*** Menhaden landings represent by far the vast majority of all commercial fishery landings; data have been withheld to avoid disclosure of confidential market data.
SOURCE: National Marine Fisheries Services (NMFS), preliminary, unpublished data. Data presented are for the combined landings in Jefferson, Lafourche, and Terrebonne Parishes. (Minor differences between the sums of Sub-totals and Totals for some years are due to rounding.)

(continued on the following page)

TABLE FPEIS-23B (cont.)
Commercial Fishery Landings Within the Study Area 1985-1998 x 1,000 pounds

RELEVANT SPECIES	1992	1993	1994	1995	1996	1997	1998
Finfish:							
Catfish & Bullheads*	*	*	*	*			
Catfish, Blue*	129.4	52.7	152.1	84.0	133.8	127.3	131.8
Catfish, Channel*	96.2	152.7	124.7	186.8	137.8	192.2	82.8
Drum, Black	1,370.7	817.5	1,079.2	1,116.3	907.0	634.7	477.6
Drum, Red**	**	**	**	**	1.1	2.2	2.5
Garfish	110.4	80.0	111.8	103.8	94.7	106.1	27.2
Menhaden***	***	***	***	***	***	***	***
Mullet, Striped or Black	112.3	192.4	185.0	294.6	2.6	no data	0.4
Sea Trout, Spotted	153.6	133.8	97.9	85.3	165.0	93.7	5.6
Tuna, all	2,846.3	2,412.8	1,410.8	1,604.2	2,599.4	2,814.1	1,913.2
Sub-total:	4,821.2	3,841.9	3,161.5	3,475.0	4041.4	3,970.3	2,641.1
Shellfish:							
Crab, Blue, hard	25,725.9	27,548.9	15,487.6	16,126.6	16,922.8	15,404.1	13,139.5
Oyster, all American	2,768.7	2,421.5	3,154.3	5,828.6	4,837.1	3,972.0	3,612.8
Shrimp, Brown	22,872.6	24,045.4	21,041.2	27,110.7	29,916.5	24,543.8	28,686.9
Shrimp, White	23,681.4	19,453.9	23,244.4	22,970.0	13,670.1	17,040.9	26,743.2
Sub-total	75,048.6	73,470.1	62,928.5	72,076.8	65,346.5	60,960.8	72,182.4
TOTAL AREA***	79,869.8	77,312.0	66,090.0	75,551.8	69,387.4	64,931.1	74,823.5

* Blue and channel catfish data prior to 1990 were reported in the catfish and bullheads group. A comparatively small amount of other catfish is included in the finffish total for the period from 1990 to 1995.

** The commercial harvest of Red Drum (redfish) is currently restricted.

*** Menhaden landings represent by far the vast majority of all commercial landings; data have been withheld to avoid disclosure of confidential market data.

SOURCE: National Marine Fisheries Services (NMFS), preliminary, unpublished data. Data presented are for the combined landings in Jefferson, Lafourche, and Terrebonne Parishes. (Minor differences between the sums of Sub-totals and Totals for some years are due to rounding.).

(continued on the following page)

TABLE FPEIS-24
Major Commercial Fishery Landings (pounds x 1,000) from 1985-1995 for an Area Encompassing the Study Area*

Year	Finfish	Shellfish	Total
1985	1,904	80,209	82,113
1986	5,272	97,260	102,531
1987	6,688	90,720	97,407
1988	7,752	80,486	88,238
1989	4,387	77,563	81,950
1990	4,464	89,667	94,130
1991	3,987	77,199	81,186
1992	4,821	75,049	79,870
1993	3,842	73,470	77,312
1994	3,162	62,929	66,090
1995	3,475	72,077	75,552
1996	4,041	65,347	69,388
1997	3,970	60,960	64,931
1998	2,641	72,182	74,824

Exclusive of menhaden data, which represent the majority of all commercial landings. Specifics on Menhaden data have not been included to avoid disclosure of confidential market data.

Menhaden landings have declined since the 1985-1989 period. Data are not presented here to avoid disclosure of confidential market data. The average annual landings from 1990-1995 were only about 40 percent of what they were in 1985-1989 indicating a sustained decrease might be occurring. The reasons for the decline are unclear. Landings of most fish species (especially short-lived ones) are expected to vary somewhat from year to year depending on naturally varying environmental conditions.

Other than menhaden, tunas and black drum are consistently the biggest contributors of finfish since 1988 when red drum harvest was restricted. Within the shellfish group, brown and white shrimp have provided in equitable fashion, the greatest percentage of the landings in most years. However, blue crab has taken the top position on occasion. Shrimp landings appear to have declined from 1991-1995 compared to the landings from 1985-1990. Oyster landings have remained fairly steady.

Oysters are an important resource in the Terrebonne estuary. Oysters have been harvested for commercial sale for at least 150 years. Oyster leases are located in southern portions of the study area and the nearest oyster seed grounds to the study area are located at Caillou (Sister) Lake and Bay Junop at the southern end of Bayou du Large. The seed grounds are managed by the LDWF to produce a ready supply of seed oysters that can be planted on private leases for later harvest. Louisiana supplies about 50 percent of the oysters landed on the U.S. Gulf coast (Dugas et al. 1992). The central region of Louisiana, which includes the Terrebonne estuary, supplies 26 percent of the oyster landings in Louisiana ((Keithly and Roberts 1988). The amount of oyster lease acreage in Terrebonne and Lafourche Parishes is presented in table FPEIS-25. The locations of oyster leases in the study area are shown in figure FPEIS-19.

TABLE FPEIS-25
Oyster Lease Acreage in the Project Area

Year	Terrebonne Parish	Lafourche Parish	Louisiana Total
1959-60	19,127	5,827	73,591
1969-70	22,539	11,535	138,837
1979-80	41,265	15,689	228,960
1990-91	53,530	18,870	345,394
1999	88,886	22,356	403,141

Source: http://oysterweb.dnr.state.la.us/oyster/oystertable.htm

Oysters spawn when water temperature reaches above 20C (Schlesselman 1955), which usually corresponds to their spawning period of April to October. Spawning may occur more than once per year. Each female releases 15 to 115 million eggs (Yonge 1960) that if fertilized quickly hatch into planktonic larvae. Within a few weeks, the larvae develop tiny shells (spat) and settle on a suitable hard, clean substrate if available. Once settled they can no longer move. Adult oysters, which are filter-feeders, usually live in groups called reefs or beds (Stanley and Sellers 1986) at water depths of 0.3 to 12 meters below mean low tide (Butler 1954). Oyster abundance is greatest with salinities at 10 to 20 ppt (Bulter 1954).

According to LDWF maps, the nearest public oyster seed grounds are located in Caillou Lake about 10 miles south of Lake DeCade, southwest of the study area. Private oyster leases occur from just north of Lake DeCade, angling northeast to lower Lake Boudreaux and then east toward Catfish Lake.

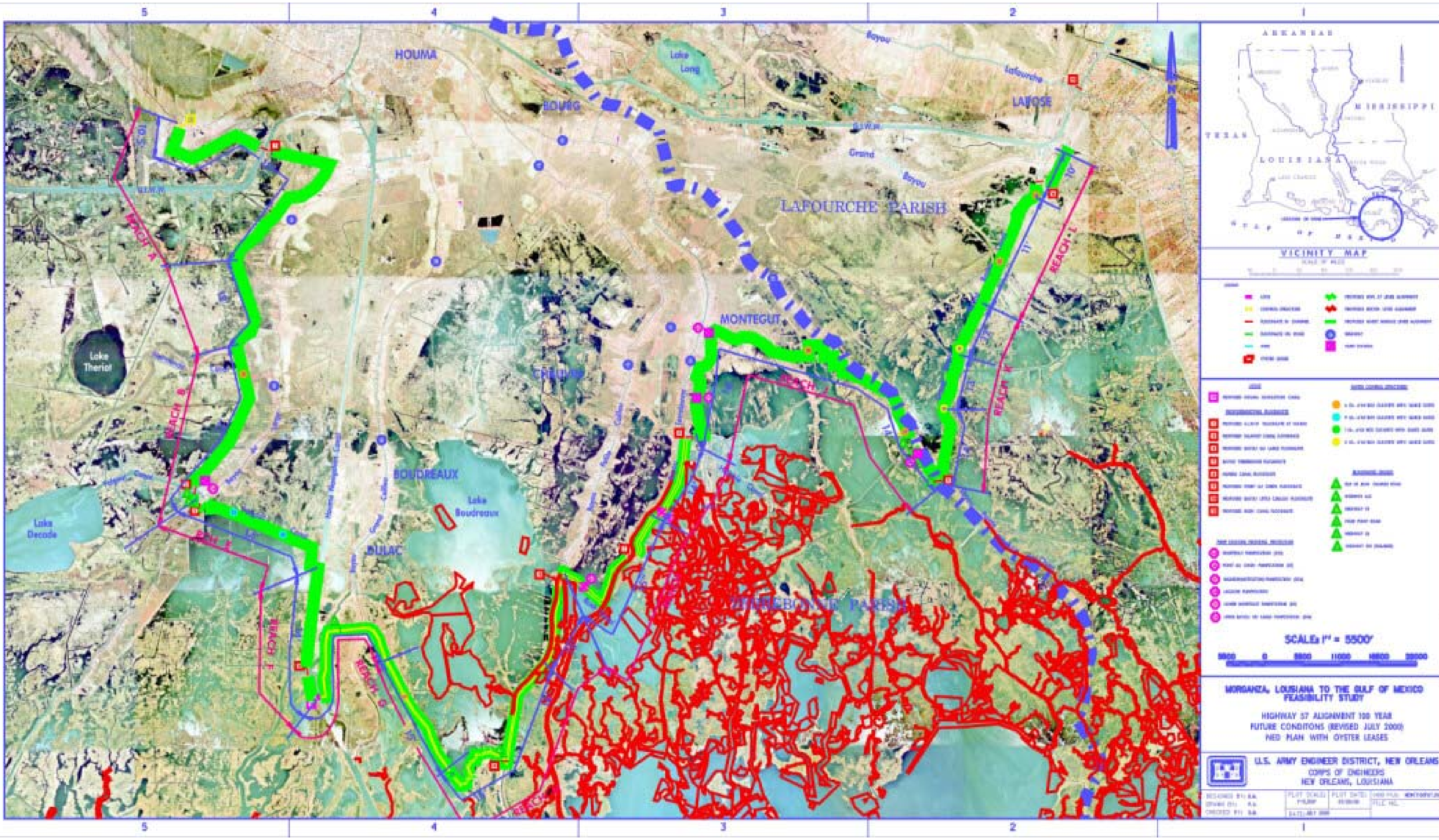

FIGURE FPEIS-19 Location of Oyster Leases in the Study Area (Shown With Original Highway 57 Alternative)

Blue crabs occupy all estuarine aquatic habitat at some time during their life cycle, tolerating a wide array of salinities and temperatures, but prefer lower to moderate salinity (Perry and McIlwain 1986). Temperatures above 30C are stressful for prolonged periods. Blue crabs are benthic omnivores, feeding on various crustaceans, mollusks, fish, and detritus. Eggs are produced in two batches averaging 1,500,000 eggs in each. Larval blue crabs reach their peak during February and March (Adkins 1972). Juveniles are most abundant from November to May and occur in the northern portions of the estuaries. The juveniles prefer areas with soft, mud substrate. After 1-1.5 years, the crabs then move from shallow areas into larger bays and bayous as adults where they will live for at least one more year. Mating occurs in the spring after which time the females migrate southward to higher salinity waters (Adkins 1972 and Perry 1975).

Brown and white shrimp spawn in the Gulf of Mexico. Larvae drift into estuarine waters as postlarvae and inhabit coastal wetlands. After becoming juveniles, the shrimp move offshore where they become adults. There may be up to three spawns per year in Louisiana (Gaidry and White 1973) with females each producing from a half million to a million eggs. Brown shrimp wash into estuaries mainly from February to April (White and Boudreaux 1977) while white shrimp come in from late spring to autumn when temperatures are above 25 C (Baxter and Renfro 1967). White shrimp spawn in shallower Gulf water and move further into estuarine nursery areas [up to 160km (99 miles)] as postlarvae and juveniles than brown shrimp (Turner and Brody 1983). Brown shrimp leave the estuaries to the Gulf of Mexico from May through August (Lassuy 1983a) whereas white shrimp leave from September to December (Muncy 1984).

Recruitment of shrimp to the fishery is not dependent on parent stocks the year before because environmental conditions are the overriding factor (Muncy 1984). Recruitment of brown shrimp increased in the Gulf from 1960-1986 despite a two-fold increase in catch effort and catch. White shrimp showed similar trends, but the catch per unit effort declined slightly, indicating that recruitment can not maintain a stable catch per unit effort as effort increases (Nance and Nichols 1988). The optimum salinity for brown shrimp survival and growth in the estuary appears to be around 19 ppt, but salinities from 15 to 20 ppt are very favorable (Barrett and Gillespie 1973). While shrimp can apparently do well in water with lower salinities than this. Both species prefer shallow, soft-bottomed estuaries (Muncy 1984; Lassuy 1983a). Water temperatures over 20 C after the first week in April are also important. Production of brown shrimp in Barataria Bay and Caminada Bay is inversely related to average spring (March-May) Mississippi River discharge. The same type of relationship holds for white shrimp, but it is related to average summer Mississippi River discharge. The Atchafalaya River discharges emulate the same trends as the Mississippi River, so similar relationships would be expected between production of shrimp and discharge (Barrett and Gillespie 1973).

Shrimp yields have been related to wetland habitat quantity (Turner 1992) and land-water interface. The land-water interface relationship suggests that shrimp yields will decrease when the land-water interface declines. This was predicted to occur in the mid-1990's (Browder et al. 1989). This prediction seems to follow the catch trends observed in recent years. However, it appears that the peak in fisheries catch in Louisiana may have occurred earlier than the prediction. Catch will likely continue a trend of decline in future years as nursery areas continue to subside and disintegrate.

Gulf menhaden spawn up to five times in the Gulf of Mexico from October to April. The eggs hatch and larvae drift into estuaries from January to April. Juveniles then develop in shallow, lower-salinity estuarine and wetland habitats, moving in dense schools. Eventually, the menhaden migrate to deeper waters and then they move offshore and become harvestable in their second year of life (Guillory et al. 1983). Immatures and adults migrate into estuarine waters from April to October (Christmas et al. 1982). Gulf Menhaden support a large commercial fishery in Louisiana (Dunham 1972) and by weight, the largest in the United States (Lassuy 1983b).

Spotted seatrout generally spawn at the end of their second year of life with a peak in late April to July (Tabb 1966) although in Louisiana, spawning may start and end later. They live for about five years. Females lay over 1 million eggs (Lassuy 1983c). Juveniles prefer shallow vegetated estuarine areas (Perret et al. 1980). Adults tend to move to the slightly deeper water of bays and passes where they feed on fish and shrimp (Lassuy 1983c). Seasonally fluctuating salinity is important to spotted seatrout productivity and rapid and/or sustained decreases in water temperature below 4 C, produce mortality.

Red drum spawn in mid-August to December in deeper water near the mouths of bays and inlets and on the Gulf side of barrier islands in the Mississippi Sound (Perret el al. 1980). The females produce an average of 1.2 million eggs per spawn (Lasswell 1977). Juvenile reddrum move into shallower bays and estuaries where they feed primarily on shrimp and other small fish (Bass and Avualt 1975) in quiet water. They prefer seagrass areas (Miles 1950). Reddrum reach maturity by age 4 or 5 and feed mainly on fish, shrimp, and crabs depending on the season (Reagan 1985). Reddrum occur primarily in schools in near-shore marine waters (Buckley 1984).

Catch of fish emigrating from weired and unweired ponds showed that the weir caused substantial reductions in number and total weight of most of the important estuarine-dependant fishes and crustaceans (Herke et al. 1992). Rogers et al. (1994) found that structures that allow the greatest amount of water exchange work best for marine-transient species.

To document trends of juvenile fisheries use in the study area, results from seine and trammel net surveys conducted by the LDWF from 1986 to 1999 in Lake Boudreaux were analyzed (Baltz 2000). As part of this analysis, indices of habitat suitability were derived for spotted seatrout, red drum, white shrimp, brown shrimp, and blue crab based on salinity and temperature information. The analysis showed that 19 species of fish were caught in trammel nets and 70 taxa were identified in seines. Black drum and red drum were the most common species in trammel nets. Ten species comprised 99.5 percent of the total number of individuals. Bay anchovy and Inland silversides were the most abundant species in seine samples. Ten species accounted for 92.5 percent of the total numbers.

Trammel net samples showed that spotted seatrout preferred a salinity of about 4 ppt and a temperature of 16 C. Suitabilities below 3.0 ppt dropped quickly and above 6 ppt suitabilities were low. For red drum, the peak suitability occurred at 10 ppt and 16 C. Suitabilities were moderate across a broad range of salinities (8-16 ppt) and temperatures (14-22 C). Shrimp and Blue crab were not caught in trammel nets.

Seine samples showed that spotted seatrout salinity suitabilities change with size class and season. Highest suitabilities ranged from 4-12 ppt. Temperature suitabilities showed a more definitive pattern with a peak in winter at 18 C, 30 C in summer, and 32 C in the fall. Red drum also showed variation with size class and season, but generally had highest suitabilities between 8-14 ppt. Temperature suitabilities for red drum varied from a peak at 12 C in winter and 20 C in fall, spring, and summer. Brown shrimp were most abundant in the spring with peak suitabilities at 8 ppt 22 C. White shrimp were most abundant in the fall, having peak suitabilities of 6-10 ppt and 22-32 C. Blue crab appeared to have peak suitabilities of 2-8 ppt and 12-26 C.

Essential Fish Habitat

This resource is institutionally significant because of the Magnuson-Stevens Act of 1996 (Public Law 104-297). Essential Fish Habitat (EFH) is technically significant because, as the Act states, EFH is "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." EFH is publicly significant because of the high value that the public places on the seafood and the recreational and commercial opportunities EFH provides.

Specific categories of EFH (http://www.gsmfc.org/efh.html) include all estuarine waters and substrates (mud, sand, shell, rock, and associated biological communities), including the sub-tidal vegetation (seagrasses and algae) and adjacent inter-tidal vegetation (marshes and mangroves). The Gulf of Mexico Fishery Management Council lists the following Federally managed species or species groups as being potentially found in coastal Louisiana: brown shrimp, pink shrimp, white shrimp, Gulf stone crab, red drum, Spanish mackerel, and gray snapper. Table FPEIS-26 shows the salinity regimes where they can be found.

Table FPEIS-26
Managed species in the Terrebonne system

Salinity Zone	Life stage	Brown Shrimp	Pink Shrimp	White Shrimp	Gulf Stone Crabs	Red Drum	Spanish Mackerel	Gray Snapper
0 - 0.5 ppt.	Adults			R		R		
	Eggs							
	Juveniles	C to HA	R	R		R		
	Larvae							
	Spawners							
0.5 -5 ppt.	Adults	R	R	R	C	R to C		
	Eggs							
	Juveniles	C to HA	C	C to A	R	C	R	
	Larvae							
	Spawners							
5 - 15 ppt.	Adults	R	R to C	C	C	R to C		
	Eggs							
	Juveniles	C to HA	C	C to A	R	C	R	R to C
	Larvae							
	Spawners							
15 - 25 ppt.	Adults	C to A	R to C	C to A	C	R to C	R	R
	Eggs							
	Juveniles	C to HA	C	C to A	C	C	R to C	R to C
	Larvae							
	Spawners							
>25 ppt.	Adults	C to A	R to C	C to A	C	C	R to C	R
	Eggs							
	Juveniles	C to HA	C	C to A	C	C	R to C	R to C
	Larvae							
	Spawners							

Relative Abundance: Blank - Not Present R - Rare C - Common A – Abundant HA - Highly Abundant
Modified from: NOAA SEA Division website http://christensenmac.nos.noaa.gov/gom-efh/

In addition, coastal wetlands provide nursery and foraging habitat that supports economically important marine fishery species such as spotted seatrout, southern flounder, Atlantic croaker, gulf menhaden, striped mullet, and blue crab. These species serve as prey for other Federally managed fish species such as mackerels, snappers, groupers, billfishes, and sharks. EFH encompasses all the wetlands (approximately 271,551 acres as of 1990) and the bays in the study area and is obviously an important consideration in the development of any hurricane protection plan. Table 27 shows the habitat, the managed species occupy.

Table EIS-27
Essential Fish Habitat for Life Stages

Species	Life Stage	Essential Fish Habitat
Brown shrimp	Adults	Gulf of Mexico <110 m, Silt sand, muddy sand
	Juvenile	Marsh edge, SAV, tidal creeks, inner marsh
Pink shrimp	Adults	Gulf of Mexico <65 m, sand/shell substrate
	Juvenile	SAV, sand/shell substrate
White shrimp	Adults	Gulf of Mexico <33 m, Silt, soft mud
	Juvenile	Marsh edge, SAV, marsh ponds, inner marsh, oyster reefs
Gulf stone crab	Adults	Shell, SAV
	Juvenile	Shell, SAV
Red Drum	Adults	Gulf of Mexico & estuarine mud bottoms, oyster reef
	Juvenile	SAV, estuarine mud bottoms, marsh/water interface
Spanish Mackerel	Adults	Marine pelagic
	Juvenile	Offshore, beach, estuarine
Gray Snapper	Adults	Marine/estuarine, SAV, mangrove, riverine
	Juvenile	Estuarine, SAV, mangrove, mud

3.6.2 ENVIRONMENTAL CONSEQUENCES

3.6.2.1 No Action Alternative

The opening of the HNC in 1962 altered salinities dramatically at the Houma water intake on the GIWW (Corps 1999). Salinity changes can certainly impact fisheries (Reid 1957); however, salinities are not expected to change drastically in the future, but will slowly increase over the next 50 years so that more marine conditions will prevail.

Faller (1979) found that harvest of shrimp is highly correlated with shoreline length and complexity. Shoreline is a major controlling factor in the production of shrimp through its regulation of the transport of detritus. Browder et al. (1985) established that land-water interface increases with marsh disintegration when the marsh area is less than 50 percent water, but decreases with disintegration when the marsh area is more than 50 percent water. Assuming a relationship between length of interface and fishery production, fishery production may be stimulated by the early stages of marsh disintegration, but negatively impacted by later stages. Browder et al. (1989) found a statistically significant relationship ($P < 0.0001$) between brown shrimp catch and land-water interface length. Browder et al. (1989) predicted that brown shrimp catches dependent upon Barataria, Timbalier, and Terrebonne Bays would peak around the year 2000 and may fall to zero within 52 to 105 years.

Despite the best intentions and efforts thus far, one third of the marsh in the study area will be gone (converted to open water) within the next 50 years. Production and catch of shrimp and finfish will likely decline dramatically over that same time period given the dependence of these species on the estuarine marshes as estuaries. Finfish catch may have already peaked in the Barataria-Terrebonne estuary basins in the mid-1980's at around 800,000,000 pounds (Perret and Melancon 1991) and will likely decline over the 50-year analysis period. A similar pattern would be expected for shellfish.

Essential Fish Habitat

The No-Action alternative would allow continued loss of some types of EFH, predominately emergent wetlands. Some of this wetland EFH will be converted over to other types of EFH. The HET projected that suitability indices would generally decline throughout the study area except for B1-2-3 and C1, which were evaluated as swamp. Subarea C2-3-4 was predicted to lose 68.3 percent of its suitability over 50 years. The main reason for the general decline in suitability was the continued loss of vegetated wetlands. The total wetland acreage remaining after year 50 with the No-Action alternative would be approximately 177,759. This would be a 34.5 percent loss of wetlands. The total AAHU's would be 256,716.

Faller (1979) found that harvest of shrimp is highly correlated with shoreline length and complexity. Assuming a relationship between length of interface and fishery production, fishery production may be stimulated by the early stages of marsh disintegration, but negatively impacted by later stages. Browder et al. (1989) predicted that brown shrimp catches dependent upon Barataria, Timbalier, and Terrebonne Bays would peak around the year 2000 and may fall to zero within 52 to 105 years.

3.6.2.2 <u>Highway 57 Alternative</u>

Aquatic resources and fisheries would experience declines related to marsh loss discussed under the No Action alternative. This alternative would result in immediate losses of 3,743 acres of vegetated wetlands. Vegetated wetlands, particularly brackish and saline marsh, provide food and shelter for aquatic estuarine species. In addition to lost acres of vegetated habitat, access would be made more difficult for many of the estuarine organisms because of the levees and floodgates. Even with the system of open control structures and floodgates, estuarine organism access would be reduced. Over the project life, marsh loss ratios and salinities inside the hurricane protection system would be reduced slightly by the protection system and submerged aquatic vegetation would be increased. These would be positive impacts. All these factors are taken into account in the WVA analysis, which showed a net positive impact on wetlands in the study area. However, the WVA results demonstrated a negative effect in brackish and saline marsh (-804 AAHU).

While WVA results are not conclusive with regard to particular species, it would be expected that the losses in brackish and saline marsh AAHU, even though apparently slight over the 50-year analysis period, could be significant for aquatic estuarine species in an ecosystem like the Terrebonne marsh which is rapidly degrading. Without compensatory mitigation for the AAHU losses, it is likely that this alternative would have a negative impact on aquatic resources, including redfish, spotted sea trout, and white and brown shrimp.

The lock and floodgates are expected to be fabricated elsewhere and floated to their final positions. It is likely that this would require some dredging to gain enough water depth to float the structures into position. The dredging would result in increases in suspended solids, reduced dissolved oxygen concentrations, and possible release of contaminants from the substrate. These impacts could occur up to 1,300 feet away from the dredge operations and take up to two weeks for ambient conditions to return (Carstea et al. 1976). The impacts from the dredging are expected to be localized and short term. The dredged material would be used for marsh restoration if appropriate or placed on existing banks. The extent of dredging, quantities of material, and area of placement would be determined during detailed design of each structure and would be documented and coordinated in NEPA supplements to this programmatic FPEIS.

Essential Fish Habitat

The Highway 57 Alternative would allow for continued loss of some types of EFH, predominately emergent wetlands. The strategy for an overall hurricane protection system in Terrebonne Parish was to provide flood control and wetlands protection at the same time. Unlike most hurricane protection systems (e.g. those in the New Orleans area) one of the primary objectives was to leave the system as open as possible and to allow tidal exchange to continue. However, at the same time shutting off the potentially damaging influx of tidal water, with its wave action and high salinity, which accompanies a hurricane. There would be 12 fish and wildlife/drainage structures associated with this alternative. These structures would provide fisheries access to the EFH inside the hurricane protection system. These structures were coordinated with the National Marine Fisheries Service.

The direct impacts to marsh, which include borrow areas and levee footprint, total an estimated 3,412 acres or a 1.3 percent reduction of the approximately 271,551 acres of emergent marsh in the study area. The total wetland acreage remaining after year 50 with the No-Action alternative would be approximately 176,337. This would be a 35.1 percent loss of wetlands. The marsh acreage lost with this alternative would be approximately 1,422 acres more than with No-Action, which is a loss of just under 1.0-percent. The total AAHU's would be 257,102 for this alternative. This is 386 units greater then the No-Action alternative. This is primarily due to a positive increase in swamp and intermediate marsh. AAHU's would be less for fresh, brackish, and saline marsh

The HET has developed a mitigation plan to compensate for the loss of AAHU in fresh, brackish, and saline marsh due to this alternative. With the mitigation plan in effect, there would be a net gain in habitat because of the increased AAHU in intermediate marsh.

3.6.2.3 Reconnaissance Alternative

The marsh losses and probable losses of fisheries associated with the No Action Alternative would be expected with this alternative as well. . This alternative would have about one third to one half of the overall additional impacts compared to the Highway 57 Alternative. The Reconnaissance Alternative would have an impact of -94 AAHU in brackish and saline marsh, or about 12 percent of the negative impact associated with the Highway 57 Alternative. It would result in about 20 percent of the overall adverse impacts associated with the Highway 57 Alternative. Therefore, a similar, but smaller compensatory mitigation plan would be needed compared to the Highway 57 Alternative to equalize adverse impacts. Impacts resulting from the probable need for dredging to float floodgates into position would be similar to the Highway 57 Alternative except that they would occur in fewer locations.

Essential Fish Habitat

The Reconnaissance Alternative would allow for continued loss of some types of EFH, predominately emergent wetlands. The strategy for an overall hurricane protection system in Terrebonne Parish was to provide flood control and wetlands protection at the same time. Unlike most hurricane protection systems (e.g.

those in the New Orleans area) one of the primary objectives was to leave the system as open as possible to allow tidal exchange to continue. There would be 10 fish and wildlife/drainage structures associated with this alternative. These structures would provide fisheries access to the EFH inside the hurricane protection system. These structures where coordinated with the NMFS.

The direct impacts to marsh, which include borrow areas and levee footprint, total an estimated 1,332 acres or a 0.5 percent reduction of the approximately 271,551 acres of emergent marsh in the study area. The total wetland acreage remaining after year 50 with the No-Action Alternative would be approximately 176,791. This would be a 34.9 percent loss of wetlands. The marsh acreage lost with this alternative would be approximately 968 acres more than with No-Action which is a loss of just under 0.5 percent The total AAHU's would be 256,985 for this alternative. This is 269 units greater then the No-Action Alternative. This is primarily due to a positive increase in swamp and intermediate marsh.

The HET has developed a mitigation plan to compensate for the loss of wetlands due to this alternative. There would be no direct or indirect significant impacts to EFH by this alternative.

3.6.3 MITIGATION AND MONITORING

Mitigation and monitoring discussed in Section 3.5.3 would apply to aquatic resources as well.

Mitigation measures are used to avoid, minimize, or compensate for adverse impacts to environmental resources. The HET used this approach to reduce impacts of the action alternatives on aquatic resources, including EFH. Moving borrow areas to upland areas would be an example of avoidance. Designing the project with borrow areas in less valuable aquatic habitat and with fish and wildlife/drainage structures would be examples of mitigation by minimization. Because all details of borrow pits and levee dimensions were not available when the HET analyzed impacts, a worst case scenario was analyzed. It is expected that impact could be reduced when complete information becomes available. The compensatory mitigation plan developed by the HET was for the worst case scenario, see section 3.5.3 for complete details of that plan.

3.7 Threatened and Endangered Species

3.7.1 AFFECTED ENVIRONMENT

In a letter to the Corps dated March 29, 1996, NMFS listed the threatened Gulf sturgeon and five species of endangered or threatened sea turtles. The sea turtles mentioned in the letter were: green (threatened), Kemp's ridley (endangered), hawksbill (endangered), leatherback (endangered), and loggerhead (threatened)] as occurring in the northern Gulf near the study area. Four species of baleen whales (northern right, sei, finback, and humpback) and one species of toothed whale (sperm whale) are also listed by NMFS as possibly in the Gulf of Mexico near the study area. All are currently listed as endangered. There is no proposed or designated critical habitat for these species in Louisiana. The FWS, in an April 16, 1996, letter to the Corps, noted that the bald eagle (threatened), brown pelican (endangered), piping plover (threatened), and Kemp's ridley sea turtle (endangered) may occur in or near the study area and under their responsibility. No critical habitat has been designated in the project area by FWS or NMFS, but critical habitat was proposed by the FWS in July 2000 for the piping plover. The proposed habitat is located on barrier islands and beaches. Although the bald eagle has been proposed for delisting, no final action has taken place to change its status. The Biological Assessment and letters from resource agencies concerning threatened and endangered species in the study area can be found in appendix C-4.

3.7.1.1 Aquatic Species

The Gulf sturgeon is listed as a threatened species by the NMFS. According to Barkaloo (1988) this fish is found in most major river systems from the Mississippi River to the Suwannee River that connect to the Gulf of Mexico and in the central and eastern Gulf of Mexico. They are found mostly in the eastern areas of the Gulf of Mexico near Florida. Particularly important are the Apalachicola and Suwannee Rivers in Florida. The Gulf sturgeon is anadramous, spending much of its life in rivers and bays, but venturing into the marine environment to feed as they reach 3-4 years of age. They still return to rivers for spawning from March through October, but they no longer feed there (Wooley and Crqateau 1985). Sexual maturity is reached in about 7-8 years. Some specimens reach over 20 years in age (Huff 1975) and over 7 feet in length. Spawning occurs after upstream migration in rivers to areas with sand, gravel, and rock substrate (Odenkirk et al. 1988), but only a small percentage of migrating sturgeon are ripe (Carr 1988).

Five species of endangered or threatened sea turtles: green (threatened), Kemp's ridley (endangered), hawksbill (endangered), leatherback (endangered), and loggerhead (threatened) occur in the northern Gulf.

The green turtle has worldwide distribution in tropical and subtropical oceans. In the United States, Atlantic waters, green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in larger numbers along the east coast of Florida. It is a large sea turtle with carapace length in adults commonly reaching 1 meter or more (NMFS and USFWS 1991). Estimates of age at sexual maturity range from 20 to 50 years (Balazs 1982; Frazer and Ehrhart 1985) and they may live over 100 years Zug et al. (1986). During their first year of life, green sea turtles are thought to feed mainly on invertebrates, with adults preferring an herbivorous diet and frequenting shallow water flats for feeding (Fritts et al. 1983a). The adult turtle feeds primarily on seagrasses (i.e., Thalassia testudinum and turtle grass) and algae (Bjorndal 1985). Defunct green turtle fisheries in Louisiana and Texas indicate it was more common in areas where it is now rare (Rebel 1974, in Fritts et al. 1983).

Juvenile/subadult and adult Kemp's ridleys are found throughout the Gulf of Mexico, but reproduction only occurs on the northeastern coast of Mexico (USFWS and NMFS 1992). Sexual maturity is reached no sooner than 6-7 years (Marquez 1970 and 1972) and maximum carapace length is about 70 cm (27 inches). Juveniles can be found in bays, coastal lagoons, and river mouths in the northern Gulf whereas adults normally stay in the Gulf of Mexico. All post-pelagic stages feed largely on crabs in sandy or muddy bottomed areas. Recent information from ongoing studies suggests that use of the near-shore upper Texas and Louisiana coasts by Kemp's ridleys (and other turtles) is seasonal (primarily April-October) and is likely to occur in coastal areas south of the study area. There is no proposed or designated critical habitat for these species in Louisiana.

The hawksbill turtle is the second smallest sea turtle averaging 87 cm carapace length (Eckert 1992), somewhat larger than the Kemp's ridley. These turtles generally live most of their life in tropical waters such as the warmer parts of the Atlantic Ocean, Gulf of Mexico and the Caribbean Sea (Carr 1952 and Witzell 1983). Florida and Texas are the only states where hawksbills are sighted with any regularity (NMFS and USFWS 1993). They nest throughout the range, on restricted beaches, to which they return each time they nest. Sponges form the principal diet of hawksbills after they enter shallow coastal waters and begin feeding on the bottom (Meylan 1988).

The leatherback turtle is the largest sea turtle (often over 1.5-m carapace length) and is highly migratory. It is the most oceanic of all sea turtles (NMFS and USFWS 1992), and is most often found in continental shelf waters (Pritchard 1971; Hirth 1980; Fritts et al. 1983). The Pacific coast of Mexico supports the worlds largest known concentration of nesting leatherbacks. There is very little nesting in the United States and no nesting has been reported from Louisiana (Gunter 1981). Sexual maturity is apparently reached quickly in 2-3 years (NMFS and USFWS 1992). Leatherback turtles feed primarily on jellyfish and other coelenterates.

Reproduction of loggerhead turtles occurs in several general locations, but in the United States, most nesting occurs on high energy barrier island beaches from the Carolinas to and including Florida with most nesting in Florida (NMFS and USFWS 1991). Sexual maturity may not be reached for 12-30 years (Frazer and Ehrhart 1985). Maximum carapace length of loggerhead turtles is about 122 cm (48 inches). Post-hatchlings become part of the Sargassum (seaweed) raft community for several years. Post-pelagic individuals occupy a variety of habitat and feed on a diverse collection of benthic invertebrates (Dodd 1988). Although they could be in the project area, loggerhead turtles are mostly found east of the Mississippi River Delta (Thompson et al. 1990).

Four species of baleen whales (northern right, sei, finback, and humpback) and one species of toothed whale (sperm whale) were identified by NMFS as possibly in the Gulf of Mexico near the study area. All are currently listed as endangered. All have all been uncommon to rare in the Gulf of Mexico except for the sperm whale (DOI 1994), which is found in deeper waters. Sperm whales were observed 229 miles off the coast of Louisiana by Fritts et al. (1983b). There is no proposed or designated critical habitat for these species in Louisiana.

3.7.1.2 Terrestrial Species

The threatened piping plover breeds in northern latitudes and winters along the south Atlantic and Gulf coasts, including coastal Louisiana. Overwintering populations in Louisiana occur on beaches, sandflats, mude flats, algal flats, washover passes, and dunes in Cameron, Jefferson (Grand Terre Island and Grand Isle), Vermilion, Terrebonne, Lafourche, Plaquemines, and St. Bernard Parishes (USFWS 1988). They do occur on the Isle Dernieres barrier island chain in Terrebonne Parish. Numbers are highly variable, based on recent census data provided by Steve Shively of LDWF. Historically they also have been reported from several other coastal parishes. The piping plover begins arriving on the wintering grounds as early as late July and remains until late March or April. A detailed description of piping plover winter habitat was published in the *Critical Habitat for Wintering Piping Plovers Final Rule* (Federal Register Vol. 66, No. 132, July 10, 2001)

Piping plover adults leave nesting grounds in the northern United States and southern Canada in July-early August, with the juveniles following a few weeks later (Wiens 1986). There were just over 2,000 breeding pairs in 1986-1987. This number is not comparable to historical numbers because data is lacking. Piping plovers can apparently live five years or somewhat longer (Wilcox 1957). Birds normally return to the same breeding area by mid-April (Prindiville 1986; Haig 1987), but occasionally they go to other areas (Haig and Oring 1988). Primary prey for wintering plover includes polychaete marine worm, various crustaceans, insects, and occasionally bivalve mollusks.

The eastern brown pelican is found along the Gulf coast, including Louisiana. The Louisiana population was destroyed in the late 1950's and early 1960's (McNease et al. 1984), primarily because of organochlorine pesticides in the food chain. They were reintroduced into Louisiana from Florida from 1968 to 1980. Nesting populations were established east of New Orleans on North Island in the Chandeleur Islands and Queen Bess Island in Barataria Bay, southeast of the study area (Hingtgen et al. 1985). Additional nesting colonies were later established on Isles Dernieres, south of the study area and natural expansion has established a colony on Grand Gosier Island in the Chandeleur Islands (McNease et al. 1992). In 1993-1994, about 20,000 fledglings were produced in Louisiana and in 1995 the number rose to 16,000 (1996 LDWF data), indicating the state bird has made a dramatic return in the last few years.

Eastern brown pelicans begin nesting in Louisiana during February, with eggs normally laid for three months and up to six months. About 1.6 young are fledged from each nest (LDWF data). Production of young fledglings requires about 18 weeks (Schreiber 1979). The principal source of eastern brown pelican nesting failure is now direct and indirect human interference with nesting colonies (Clapp et al. 1982). Pelicans disperse southward and probably winter south of the United States (Schreiber and Schreiber 1983) after nesting.

The pelicans forage primarily in shallow estuarine waters (Schreiber 1978) and in ocean waters within 32 km of shore. Food consists mainly of gulf menhaden, mullet, and other species of forage fish (Krantz 1968) normally less than 25 cm. They plunge-dive from heights of up to 20 m to capture prey with their bill and pouch (Schreiber et al. 1975) in the top 1 meter of water (Schnell et al. 1983).

The bald eagle is a raptor that is found in various areas throughout the United States and Canada. Populations experienced drastic declines from the 1940's to the 1970's (Grier 1982), but populations are on the rebound. The ban on the use of DDT in the United States in 1972 resulted in higher productivity nationwide (Peterson 1986). In 1995, the bald eagle was downlisted from an endangered status to a threatened status in most of the lower 48 states, including Louisiana and in 1999, it was proposed for delisting.

Bald eagles begin nesting in September with peak egg laying in December. Fledging takes 10-12 weeks (Murphy et al. 1989) and then the birds tend to move up to 1,000 miles northward. The main basis of the bald eagle diet is fish (DeGraff et al. 1980), but they will feed on other items such as birds and carrion depending upon availability of the various foods. Eagles require roosting and nesting habitat, which in Louisiana consists of large trees in fairly open stands (Anthony et al. 1982).

This species prefers habitat near large rivers, lakes, and estuaries and occurs throughout Louisiana. From 1989 to 1995, the number of nests and number of young produced have been steadily increasing (LDWF data) consequently, 157 eagles were produced in 1995. There are at least 30 documented (i.e., present and historical) bald eagle nest locations within the study area, all are in the northern portion (where larger trees are found) as would be expected and most are in subbasin A, west of Bayou du Large.

3.7.2 ENVIORNMENTAL CONSEQUENCES

3.7.2.1 No Action Alternative

The bald eagle would be expected to continue its recovery in the United States and in Louisiana barring any unforeseen circumstances. It would likely be delisted in the near future, but would still be protected under the Bald Eagle Protection Act. Brown pelican numbers should continue to increase such that they may be eligible for downlisting if they continue their dramatic comeback over the next few years. The remaining threatened and endangered species should at least retain existing population levels and they may improve given enough time and the protection afforded them by the Endangered Species Act.

3.7.2.2 Highway 57 Alternative

Recent research has shown that sea turtles are virtually absent from the near-shore waters of the northern Gulf from December through March (Renaud et al. 1995). Furthermore, they would never be present far enough inland to be directly impacted by any of the action alternatives. This leaves only the possibility of indirect and/or cumulative impacts to sea turtles. Hawksbill and leatherback sea turtles are very unlikely to occur near the study area. Green and loggerhead sea turtles are unlikely to occur, but Kemp's ridley sea turtles may be found in coastal waters near the study area during the summer. Because construction would occur several miles from Gulf edge marshes and passes, this alternative should not impact Kemp's ridley sea turtles. Over the life of the project, habitat in the study area would improve (see section 3.5) and should benefit sea turtles

Whales are extremely unlikely to be found anywhere near the study area and should not be impacted.

Piping plover do not overwinter in or near the areas of proposed work and would not be adversely affected. The proposed cultural habitat would not be adversely affected.

Eastern brown pelicans occur in the study area, particularly immature pelicans. Nesting does not occur in the area. It is unlikely that pelicans would be greatly disturbed by construction activities or completed work.

Bald eagles nest in northern Terrebonne Parish, primarily west of Bayou du Large, in the westernmost portion of the study area. Trees used by bald eagles for nesting and roosting should not be removed. If a nesting tree does occur in the alignment and the alignment cannot be changed, there would be an adverse impact to the bald eagle. Construction activities should be held to a minimum within 3000 feet of eagle nesting and roosting areas from from October through mid-May.

3.7.2.3 Reconnaissance Alternative

Similar impacts to the Highway 57 Alternative would be expected.

3.7.3 MITIGATION AND MONITORING

Construction activities within 3,000 feet of bald eagles could be disruptive to feeding and nesting and should be avoided from October through mid-May. Cutting of bald eagle nest trees, or damaging its root system, is strictly prohibited at any time. As each segment of the levee alignment undergoes detail design, a supplemental NEPA document will revisit this determination. As part of this, an aerial survey may be conducted to determine the presence of undocumented eagle nests.

3.8 Economics

3.8.1 INTRODUCTION

Section 3.8 summarizes the existing social and economic conditions in the project area, the effects of flood damages caused by hurricanes without further protection, and the effects of the two project alternatives. The summarized information was obtained using the parameters recommended by federal guidelines and indicated in the environmental impact review process. As discussed in previous sections, the reconnaissance phase of this study included areas extending southward from Morganza, Louisiana (in Point Coupee Parish) to the Gulf of Mexico. The current study focuses on areas referred to as the Highway 57 and Reconnaissance Alternatives, both within portions of Terrebonne and Lafourche Parishes. As studies for flood improvements have developed, alignments have been modified to identify project alternatives that may meet economic justification. The Highway 57 project would be more costly but would provide protection to a larger area, and to more people. In many instances, reliable social and economic data are available only for areas within political boundaries, rather than hydrologic reaches; therefore, much of the statistical data reported below are for complete Parishes. As part of this review, however, the District has also estimated flood damages prevented within significant hydrologic reaches. In some instances improving hurricane protection within project alignments may indirectly improve the larger Lafourche and Terrebonne Parish community that currently form the Houma Metropolitan Statistical Area (MSA). Historically environmental conditions in the area have enhanced the productivity of fish and wildlife, important for both commercial and recreational purposes. Uplands more suitable for agricultural purposes are used primarily for sugarcane production. The discovery of oil and gas, and the technology to extract these resources from wetlands and adjacent waterbottoms, generated additional waterborne commerce, sources of employment and income, the demands for more housing, retail and wholesale markets, commercial services, and the need for additional public facilities and services. As in the case of most other coastal parishes, however, a large portion of the Houma MSA is wetland and subject to the effects of frequent rainstorms, the threat of periodic hurricanes, spring floods, subsidence, erosion, and land loss. The dynamics of these developments have also influenced the need for additional hurricane protection. The primary purpose of both the Highway 57 and Reconnaissance alternatives are to reduce its adverse effects. While the proposed projects could not prevent the severe rainstorms or wind damage caused by hurricanes, they can reduce the potential damage from tidal surges. The monitoring procedures of project alternatives would include an annual comparison of costs and benefits of reducing these damages.

3.8.2 LAND USE

3.8.2.1 Affected Environment

A major factor influencing the need for hurricane protection in the area is the limited availability of land usable for various social and economic purposes. During the 20th century, coastal erosion increased significantly, converting marshes to waterbottoms and increasing the threat of flood damage in developed areas further inland. Table 28 summarizes the total land and water within the Houma MSA as of 1993. This area is part of the larger Mississippi River Deltaic Plain; and much of it falls within the Louisiana Coastal Zone. The information presented in the table indicates that about 50 percent of the MSA is open water. Of the total land, about 921,000 acres or 80 percent are wetlands. While the coastline includes scattered sections of sand, most of it is formed by tidal marshes, intersected by winding bayous and numerous canals leading southward to shallow lakes and bays, sounds, barrier islands, and the open Gulf. As previously mentioned, the "barrier islands" and marshes have been considered beneficial in reducing the initial impact of hurricanes. The wetlands contribute to the value of commercial and recreational fish and wildlife resources. In 1993 the agricultural land was estimated at about 165,000 acres, and represent about 14 percent of all land in the MSA.

Urban land was estimated at about 48,000 acres and represented about 6 percent.

The average rate of land loss in the Louisiana Coastal Plain appears to have declined since the early 1980's. However, the rate of land loss remains a significant concern to the local community and others who have social and economic interests in the region. A composite of land loss rates occurring from the early 1930's to 1983 indicates that the average annual loss in the Louisiana Coastal Plain was 30.71 square miles (Dunbar, 1990). A composite averaging annual loss between the 1930's and 1990 estimated a much lower rate of 25.34 square miles (Dunbar, 1992). These studies indicate that about 17.8 percent of the available land in the Louisiana Coastal Area was lost during this period. By far the most severe loss has occurred in the Mississippi River Deltaic Plain, including areas of Lafourche and Terrebonne Parishes. While much of the land loss appears to be occurring in the undeveloped lower elevations, concern has increased over its effects on existing industrial, commercial and residential areas further inland as well as its impacts on commercially and recreationally harvested fish and wildlife. A variety of local, state, and federal programs have been developed to reduce continued land loss in the area. The CWPPRA is a major federal effort that includes reductions in land loss.

TABLE FPEIS-28
Lafourche and Terrebonne
Parishes Land & Water Resources (acres)

Land & Water Resources	Code	Lafourche Parish	Terrebonne Parish	Houma MSA
Fresh Marsh	1	122,362.4	160,107.0	282,469.4
Wetland Forest - Deciduous	2	146,388.4	104,895.2	251,283.6
Wetland Forest- Evergreen	3	231.2	10.0	241.2
Wetland Forest - Mixed	4	0	2,062.8	2,062.8
Upland Forest- Deciduous	5	2,388.4	1,410.6	3,799
Upland Forest - Evergreen	6	0	0	0
Upland Forest - Mixed	7	1,943.4	2,342.5	4,285.9
Dense Pine Thicket	8	0	0	0
Wetland Shrub/Scrub - Deciduous	9	13,242.6	18,278.9	31,521.5
Wetland Shrub/Scrub - Evergreen	10	3,871.3	5,515.2	9,386.5
Wetland Shrub/Scrub - Mixed	11	279.1	6,566.2	6,845.3
Upland Shrub/Scrub - Deciduous	12	0	0	0
Upland Shrub/Scrub - Evergreen	13	0	0	0
Upland Shrub/Scrub - Mixed	14	2,555.0	2,282.3	4,837.3
Agriculture-Cropland-Grassland	15	116,610.0	48,442.5	165,052.5
Vegetated Urban	16	24,190.9	21,993.1	46,184
Non-Vegetated Urban	17	429.8	1,762.4	2,192.2
Wetland Barren	18	634.8	903.1	1537.9
Upland Barren	19	242.2	227.9	470.1
Water	20	380,134.7	745,746.0	1,125,880.7
Intermediate Marsh	21	33,326.8	41,124.3	74,451.1
Brackish Marsh	22	22,862.7	80,949.9	103,812.6
Saline Marsh	23	70,481.8	86,562.8	157,044.6
Total		942,175.5	1,331,183.0	2,273,358.5
Land Area Only		562,040.8	585,437.0	1,147,477.8

Source: Based on unpublished information provided by Dames & Moore, Inc. on January 20, 2000.

A variety of factors appear to have contributed to these increases, including economic expansion and related transportation, population growth, efforts to reduce flood damage, and geological changes not directly related to human behavior such as sea level rise. One of the technical advancements influencing erosion has been reduced flood damage along the Mississippi River through a system of levees and other structures extending from Cairo, Illinois to the Gulf of Mexico. Stabilization of river, however, appears to have contributed to erosion and loss of wetlands along other areas of the Coast. Other economic developments influencing land loss have included oil and gas production in the coastal region, and construction of canals needed to access these resources.

The drainage area under study covers 137 hydrologic reaches in portions of Terrebonne and Lafourche Parishes. It includes a total of about 307,600 acres of land and water extending southward from a point near the town of Thibodaux, Louisiana to the coastal marshes. Data collected for this study determined that an estimated 28,500 acres are currently used for various urban purposes. About 76,200 acres are considered highly developable, including 70,700 acres of agricultural land. Another 112,600 acres are lands considered marginally developable; and about 90,300 acres are not available for development, including about 55,500 acres of open water, and 34,800 acres of intermediate, brackish, or saline marsh. The study identified 116 reaches with population and employment in an area covering 274,000 acres, including 26,400 acres of urban developments; another 71,200 acres of highly developable land (66,300 acres cropland); 92,900 acres of marginally developable land (most of it wetland); and an area considered undevelopable, most of it open water and the remainder marsh. All of the land considered marginally developable and portions of the highly developable land are wetlands and subject to federal regulations to minimize adverse impacts to flood control conditions and adverse environmental impacts. The study also identified land values of the 116 populated reaches. Current planning indicates that the costs would be greater than the benefits of extending hurricane protection to several reaches. Most of the land in these reaches is near the coastline and highly susceptible to the effects of erosion and subsidence. They include reaches BSJC1, BSJC2, BSJC3, BDL4A, BDL4B, 8-14, 8-15, and portions of BDL0, GW11, and 3-2. Of the 20,000 acres of land and water within these reaches but no longer part of the project alignments, almost 18,000 acres are either wetlands or open water. Reach 2-1B and Reach LBB5, located along the western boundary of the initial study area have also been eliminated from the project alignments. Most of the land in reaches 2-1B and LBB5 has been developed for residential and agricultural purposes. Other possible methods of improving protection in these areas will be considered in additional planning efforts. Some of the residents who are concerned that their property would be left out of the project alignment are descendents of Native Americans living along Bayou St. Jean Charles (see also section 3.8.8 Community Cohesion).

3.8.2.1.1 Highway 57 Alternative

The estimated total land and water area within the immediate Highway 57 Alternative is about 253,100 acres. Of this total, approximately 25,400 acres have been identified as urban land. Another 68,500 acres are considered highly developable, including about 64,200 acres used for agricultural purposes. An estimated 88,700 additional acres are considered marginally developable although wetlands. About 70,500 acres also include water bottoms and saltwater marsh and are not considered suitable for development.

3.8.2.1.2 Reconnaissance Alternative

The estimated total land and water within the immediate Reconnaissance Alternative is about 177,600 acres. It includes about 23,400 acres of urban land; 61,600 acres of highly developable land, including 58,600 acres of agricultural land; 67,900 additional acres considered marginally developable; and another 24,800 acres of water and saltwater marsh.

3.8.2.2 Environmental Consequences

3.8.2.2.1 No Action Alternative

Under the No Action Alternative, continued land loss and the threat of hurricanes could reduce the potential for future land uses. The rate of land loss in the project area appears to have declined in recent years; however, subsidence and land loss in some areas are expected to continue, threatening developments susceptible to hurricane damage and flooding. The economic analysis conducted for this study assumes that future land developments will occur only within the 116 hydrologic reaches that are already used for residential, commercial, and industrial purposes. In order to account for future subsidence in the study area, the elevation of each structure in the inventory for the reaches surrounding "healthy marsh" was lowered 2.34 feet during the 50-year life of the project. For the study area reaches located along "unhealthy marsh," the elevation of each structure in the inventory was lowered 3.12 feet during the 50-year life of the project. Economic projections indicate that the most likely scenario for future land use would result in the conversion of about 350 acres of highly developable land by 2008 (including 50 acres of agricultural land), and the conversion of a total of 2,330 acres (including 904 acres of agricultural land) by 2057.

3.8.2.2.2 Highway 57 Alternative and Reconnaissance Alternative

While the amount of land converted from undeveloped or agricultural uses is anticipated to be the same with or without the project in place, the property on that land would be less vulnerable to hurricane surges. A detailed comparison of the amount of land within the 137 reaches indicates that more than 90 percent of the additional land needed for residential, commercial, and industrial purposes by the year 2057 will be developed within the Reconnaissance Alternative. No additional residential or commercial development is anticipated in reaches currently unpopulated. The most likely projection for the 116 reaches currently populated suggests a development increase of 2,330 acres by 2057. 1998 to 2057 projections for the Highway 57 alignment indicate that agricultural land will decline from 64,200 to 63,300 acres while urban developments will increase from 25,400 to 27,600 acres. The Highway 57 Alternative would protect a large area, and help maintain the quality of land and its uses. Agricultural land in the Reconnaissance alignment is expected to remain at approximately 58,500 acres; while urban developments between 1998 and 2057 is projected to increase from 23,400 acres to 25,400 acres. An estimated 10 additional acres of land is anticipated for residential purposes along Bayou St. Jean Charles (Reaches BSJC1, BSJC2, and BSJC3) by the end of the 50-year project life.

3.8.3 FISH AND WILDLIFE

3.8.3.1 Affected Environment

While the unique topography, weather conditions, and other environmental factors have contributed to flooding, land loss, and hurricane damage in the area, they have also led to an unusual abundance of fish and wildlife resources important both for commercial and recreational purposes. The quantity and variety of fish and shellfish harvested are important not only to local seafood markets but regional markets, restaurants, and tourist trade. Recreational fin fishermen in Louisiana may contribute as much as $500 million annually to the state's economy (1984, Bertrand).

Table FPEIS-29 provides preliminary estimates of historical data on commercial fisheries heavily dependent upon estuaries near Terrebonne, Lafourche, and Jefferson Parishes. Data for Jefferson Parish (immediately adjacent to Lafourche Parish) have been included to avoid disclosure of confidential market data. Information on menhaden landings has been withheld to avoid disclosure of confidential market data. In 1998, two of the nation's 50 most active commercial fishing ports were located in the immediate vicinity of the project area, including the ports of Dulac-Chauvin and Golden Meadow-Leeville, Louisiana. The exvessel value of landings at Dulac-Chauvin totaled $38.7 million and ranked ninth in the nation. The value of landings at Golden Meadow-Leeville was $27.1 million. The exvessel value of landings at Morgan City-Berwick, Louisiana, located immediately west of the project area in St. Mary Parish, was $17.8 million. The value of landings at Grand Isle, Louisiana, immediately east of the project area in Jefferson Parish, was $17.1 million. The economic analysis showed that an estimated 900 commercial fishing vessels frequent the project area. Most are moved to a harbor of refuge when severe storms approach. Another 400 large recreational boats operate in the area and tend to seek shelter during storms, along with approximately 200 houseboats and oil and gas crew boats.

In recent years, the total amount of commercial fishery landings in Louisiana has been exceeded only by the total of landings in Alaska, in terms of both pounds and value. Preliminary estimates of the NMFS indicate that in 1998 commercial landing in Louisiana totaled 1,119.5 million pounds, valued at $291.9 million (exvessel value to the fishermen). Total pounds represented more than 12 percent of all domestic landings in the United States. Its value represented more than 9.3 percent of the U.S. total. A variety of fish and shellfish are harvested. Shrimp, menhaden, oyster, crab, tuna, crayfish, black and red drum, catfish, red snapper, and sea trout, are among those generating the most revenue. Menhaden, a finfish harvested largely for export and industrial purposes, has represented 80-90 percent of the total pounds of all fish and shellfish landed in the state. Its value, however, has accounted for 20-25 percent of the gross value to the fishermen.

TABLE FPEIS-29
Commercial Fishery Landings Within the Study Area 1985-1998
(in 1,000's of dollars)

RELEVANT SPECIES	1985 $(1,000's)	1986 $(1,000's)	1987 $(1,000's)	1988 $(1,000's)
Finfish:				
Catfish & Bullheads*	63.5	48.4	62.4	128.8
Catfish, Blue*	*	*	*	*
Catfish, Channel*	*	*	*	*
Drum, Black	155.2	695.7	1,086.5	1,006.6
Drum, Red**	737.4	1,808.3	2,197.6	88.4
Garfish	63.1	38.0	68.9	68.8
Menhaden***	***	***	***	***
Mullet, Striped or Black	0.4	0.6	0.6	39.2
Sea Trout, Spotted	227.8	443.1	686.4	432.8
Tuna, all	208.8	335.0	1,441.8	3,321.6
Sub-total:***	1,456.2	3,369.0	5,544.2	5,086.2
Shellfish:				
Crab, Blue(hard)	2,250.5	2,794.7	8,449.7	9,784.2
Oysters, American	6,446.4	6,165.5	7,098.8	8,679.5
Shrimp, Brown	30,515.3	46,159.7	49,643.4	39,715.6
Shrimp, White	52,577.2	78,691.3	54,114.6	37,477.4
Sub-total	91,789.4	133,811.2	119,306.5	95,656.7
TOTAL AREA***	93,245.5	137,180.2	124,850.6	100,743.0

* Blue and channel catfish data prior to 1990 were reported in the catfish and bullheads group.
** The commercial harvest of Red Drum (redfish) was restricted in 1988.
*** Menhaden data are withheld to avoid disclosure of confidential market data important when only one or two processors are involved.

(continued on the following page)

TABLE FPEIS-29 (continuation)
Commercial Fishery Landings Within the Study Area 1985-1998
(in 1,000's of dollars)

RELEVANT SPECIES	1989 $(1,000)	1990 $(1,000's)	1991 $(1,000's)	1992 $(1,000's)
Finfish:				
Catfish & Bullheads*	82.9	*	*	*
Catfish, Blue*	*	6.6	50.9	60.2
Catfish, Channel*	*	710.5	30.4	51.2
Drum, Black	496.7	251.6	298.1	444.6
Drum, Red**	17.0	**	**	**
Garfish	86.3	46.5	56.5	65.5
Menhaden***	***	***	***	***
Mullet, Striped or Black	238.0	91.1	262.3	52.5
Sea Trout, Spotted	322.9	97.0	330.6	179.4
Tuna, all	3,478.6	4,809.1	4,855.6	6,684.5
Sub-total:	4,722.4	6,012.4	5,887.3	7,538.9
Shellfish:				
Crab, Blue, hard	6,699.8	7,032.7	6,534.4	12,775.9
Oyster, all American	10,670.5	11,603.0	6,678.7	6,756.3
Shrimp, Brown	43,183.9	43,032.3	32,855.8	33,801.0
Shrimp, White	29,782.0	40,076.5	45,604.6	40,211.7
Sub-total	90,336.4	101,744.8	91,673.5	93,544.9
TOTAL AREA***	95,058.6	107,757.2	97,560.8	101,083.8

* Blue and channel catfish data prior to 1990 were reported in the catfish and bullheads group.
** The commercial harvest of Red Drum (redfish) was restricted in 1988.
*** Menhaden data are withheld to avoid disclosure of confidential market data important when only one or two processors are involved.

(continued on the following page)

TABLE FPEIS-29 (continuation)
Commercial Fishery Landings Within the Study Area 1985-1998
(in 1,000's of dollars)

RELEVANT SPECIES	1993 $(1,000's)	1994 $(1,000's)	1995 $(1,000's)	1996 $(1,000's)
Finfish:				
Catfish & Bullheads*	*	*	*	8.6
Catfish, Blue*	24.5	71.5	48.5	75.5
Catfish, Channel*	75.7	69.1	109.2	82.3
Drum, Black	457.9	612.6	857.5	526.6
Drum, Red**	**	**	**	1.8
Garfish	45.2	89.2	78.5	82.5
Menhaden***	***	***	***	***
Mullet, Striped or Black	122.6	140.6	210.8	1.0
Sea Trout, Spotted	164.9	111.7	86.5	163.1
Tuna, all	6,645.1	3,509.7	4,206.4	7,041.1
Sub-total:	7,535.9	4,604.4	5,594.4	7,982.6
Shellfish:				
Crab, Blue, hard	13,925.1	9,112.1	14,255.4	9,805.6
Oyster, all American	4,375.7	5,900.5	11,030.9	9,842.1
Shrimp, Brown	26,383.1	33,295.1	37,292.7	35,661.2
Shrimp, White	34,044.9	46,142.9	48,456.9	27,250.9
Sub-total	78,729.0	94,450.8	111,038.9	82,559.8
TOTAL AREA***	86,264.9	99,055.2	116,633.3	90,542.4

* Blue and channel catfish data prior to 1990 were reported in the catfish and bullheads group.
** The commercial harvest of Red Drum (redfish) was restricted in 1988.
*** Menhaden data are withheld to avoid disclosure of confidential market data important when only one or two processors are involved.

(continued on the following page)

TABLE FPEIS-29 (continuation)
Commercial Fishery Landings Within the Study Area 1985-1998
(in 1,000's of dollars)

RELEVANT SPECIES	1997 $(1,000's)	1998 $(1,000's)
Finfish:		3.0
Catfish & Bullheads*	6.2	281.3
Catfish, Blue*	64.8	53.9
Catfish, Channel*	133.3	305.9
Drum, Black	431.4	2.8
Drum, Red**	2.7	26.9
Garfish	94.9	***
Menhaden***	***	
Mullet, Striped or		0.2
Black	-	9.1
Sea Trout, Spotted	103.8	4,939.2
Tuna, all	7,158.3	
Sub-total:	7,995.4	5,622.3
Shellfish:		
Crab, Blue, hard	9,578.8	8,828.9
Oyster, all		
American	9,118.5	8,469.3
Shrimp, Brown	37,407.9	30,817.3
Shrimp, White	33,373.2	46,477.7
Sub-total	89,478.4	94,593.2
TOTAL AREA***	97,473.8	100,215.5

*   Blue and channel catfish data prior to 1990 were reported in the catfish and bullheads group.
**   The commercial harvest of Red Drum (redfish) was restricted in 1988.
*** Menhaden data are withheld to avoid disclosure of confidential market data important when only one or two processors are involved.

SOURCE: National Marine Fisheries Services (NMFS), preliminary, unpublished data. NMFS combined landings for Jefferson Parish with Lafourche and Terrebonne Parishes to avoid disclosure of confidential market data. (Minor differences between the sums of Sub-totals and Total for some years are due to rounding.

Some of the public concerns expressed regarding fishing and hunting in recent years have included the general decline of fish and wildlife habitat; the overfishing of important commercial species; the effects of international aquaculture and traditional markets; the possible need for "limited entry" into the domestic and local commercial markets; and perceived adverse effects of over regulation of fish and wildlife production.

Currently, the wildlife harvested for commercial purposes in Louisiana and the project area are mostly alligators, some taken from their natural environment and more farmed in controlled environments. Most alligators are harvested for their hides; however, some of the meat is also used for food. Recently the gross value of alligator harvesting has ranged from $10-15 million annually. Previously, alligators have been on a list of endangered species, once threatened by extinction. Alligator harvests have increased significantly since 1972. In the past, millions of beaver, raccoon, otter, mink, nutria, and other wildlife were harvested each year for their pelts. The commercial harvest of these resources has declined, in part due to a growing interest in wildlife conservation. Another reason is due to the growth of alternative materials available at much lower prices.

3.8.3.2 Environmental Consequences

3.8.3.2.1 No Action Alternative

Public support for fish and wildlife conservation may help reduce the loss of fish and wildlife habitat; however, the current rate of land loss, erosion, and subsidence indicate a continued decline in fish and wildlife resources in the project area. The expansion of aquaculture could limit severe declines in the commercial production of some of the most important species, including shrimp and oysters. As the loss of land in the coastal area increases, the cost of maintaining adequate harbors of refuge currently used by commercial and recreational fishing vessels could increase.

3.8.3.2.2 Highway 57 Alternative and Reconnaissance Alternative

Land loss, erosion, and subsidence are expected to continue with or without the project alternatives; however, both project alternatives include the creation of additional habitat units beyond those for the No Action alternative.

3.8.4 BUSINESSES, INDUSTRIES, AND FARMS

3.8.4.1 Affected Environment

In addition to commercial fishing and markets supporting recreational fishing and hunting, economic activities in the project area include the harvest of sugarcane, oil and gas production, the transport of these resources, the construction and maintenance of oil rigs, and commercial activities supporting the local communities. Table FPEIS-30A summarizes selected business, industrial, and agricultural data for Lafourche and Terrebonne Parishes as reported by the Bureau of the Census.

Note that some of the data are for 1997 (reported in 1999) and some for 1992, which are to date the latest information available. Comparisons between business, industrial, and agricultural activities in the MSA and its relationship to activities statewide indicate that Houma tends to be more residential than commercial or industrial. The 1990 census estimated that the combined population of Lafourche and Terrebonne Parishes was about 4.3 percent of the state, or about the same as the percentage of the statistics reported for retail trade (4.5 percent and 4.6 percent). While Houma is identified as one of the state's metropolitan statistical areas, its political boundaries are immediately adjacent to the political boundaries of the MSA's of Baton Rouge and New Orleans.

Houma originally developed as a market center for fish, wildlife, and agricultural production; however, with the discovery of oil and gas and the technology to extract them from surrounding wetlands and waterbottoms, employment and income opportunities increased. By far the most important crop harvested has been sugarcane.

During the 1980s, however, the maturing of oil and gas industries, and its availability at more competitive prices in other countries, caused severe unemployment and out-migration in the area. During the 1990s the continued availability of oil, water resources, fish and wildlife for both commercial and recreational purposes, and national economic trends, appear to have contributed to the area's gradual economic recovery.

Table FPEIS-30B summarizes a recent estimate of the types and amounts of employment occurring in the Houma MSA and compares it to employment categories statewide. The relatively high "Mining" category includes oil and gas production and processing. The relatively high "Transportation" category may be an indication of the importance of waterborne commerce for both mineral production and commercial and recreational fishing.

TABLE FPEIS-30A
Business, Industries, and Farms

Selected Business and Industrial Activity	Lafourche	Terrebonne	Total	% of State
Manufacturing, 1992:				
No. of Companies	66	116	182	4.5
Total employment	2,600	3,000	5,600	3.1
Value Added by Manufacture($millions)	125.7	143.6	269.3	1.3
Value of Shipments($millions)	350.5	273.2	623.7	1.0
Retail Trade, 1997:				
No. of Companies	323	482	805	4.5
Retail Sales($1,000)	569,976	1,064,086	1,634,062	4.6
Wholesale Trade, 1992:				
No. of Companies	119	228	347	4.7
Wholesale Sales ($1,000)	316,751	466,296	783,047	2.1
Services Receipts, 1992:				
No. of Companies	427	636	1,053	3.9
Receipts ($1,000)	185,946	374,304	560,250	3.5
Agricultural, 1997*:				
Total Land Area, acres	694,272	803,264	1,497,536	5.4
Land in Farms, acres	112,112	41,388	146,914	2.3
No. of Farms	175	57	232	2.4
Market Value of All Products Sold($1,000)	31,442	13,978	45,420	2.3
Value of Crops Sold($1,000)	26,661	12,101	38,762	2.8
Value of Livestock & Livestock Products Sold($1,000)	4,781	1,877	6,658	1.1

*The 1997 Census of Agricultural publications limited data for farms with total sales of $10,000 or more.

SOURCES: U.S. Department of Commerce, Bureau of the Census, Geographic Area Series: 1997 Census of Agriculture, Louisiana (AC97-A-18); 1992 Census of Manufactures, Louisiana (MC92-A-19); 1992 Census of Wholesale Trade, Louisiana (WC92-A-19); 1997 Census of Retail Trade, Louisiana (RC92-A-19); and 1992 Census of Service Industries, Louisiana (SC92-A-19).

TABLE FPEIS-30B
1999 First Quarter of Employment Characteristics

Number of Jobs	Lafourche Parish	Terrebonne Parish	Houma MSA	% in MSA*	% in State*
Agriculture	358	265	623	0.8	0.8
Mining	589	5,276	5,865	7.8	2.7
Construction	1,510	2,916	4,426	5.9	7.6
Manufacture	3,756	4,724	8,480	11.3	10.3
Transportation	4,786	4,050	8,836	11.8	7.0
Wholesale	861	2,657	3,518	4.7	5.3
Retail	5,210	9,268	14,478	19.3	18.8
Financial	739	1,248	1,987	2.7	4.5
Services	10,293	13,851	24,144	32.2	37.7
Public	1,026	1,499	2,525	3.4	5.3
Totals	29,128	45,754	74,882	99.9**	100.0

* The last two columns of the table compare the percentage of employment by category within the Houma MSA and within the State of Louisiana.
** Total is not 100% due to effects of rounding.
Source: State of Louisiana, Department of Labor, "Employment and Total Wages Paid by Employers Subject to the Employment Security Law, First Quarter 1999." November, 1999.

3.8.4.1.1 Highway 57 Alternative

The structure inventory prepared for the economic analysis identified 880 commercial and industrial structures within the 116 reaches in the immediate impact area, and 870 structures falling within the Highway 57 Alternative area. An estimated 110 farms are located within the Highway 57 Alternative area. This estimate is based on the total amount of agricultural land within this alternative and the average size of farms with gross sales of $10,000 or more in Lafourche and Terrebonne Parishes (1997 Census of Agriculture). Out of the 880 commercial and industrial structures identified in the study area, less than 40 are beyond the Highway 57 Alternative.

3.8.4.1.2 Reconnaissance Alternative.

Data collected for the economic analysis indicates that 750 of the structures within the Reconnaissance Alternative are used for business and industrial purposes. An estimated 100 farms or less, are within the Reconnaissance Alternative.

3.8.4.2 Environmental Consequences.

3.8.4.2.1 No Action Alternative.

The increase in the number of businesses, industries, and farms is projected to be the same with or without the proposed project. However, the stability of economic activity and its potential may decline as the level of erosion, subsidence, and threat of storm damage increases and overall environmental quality declines. The economic analysis estimates that the number of business and industrial structures are projected to rise from 880 in 1997 to 1,220 in 2057, for an increase of 340 non-residential structures within the 116 hydrologic reaches.

3.8.4.2.2 Highway 57 Alternative.

This study estimates that about 315 additional non-residential structures will be built on land within the Highway 57 Alternative by 2057, resulting in a total of approximately 1,155 structures. Most of these structures would be used for commercial and industrial purposes. Projected trends toward a slight decline in agricultural land, and historical trends toward continued automation in agricultural production, suggest that farming in the area is unlikely to increase and will probably slightly decline by 2057.

3.8.4.2.3 Reconnaissance Alternative.

The economic analysis of the project indicates that 300 additional commercial and industrial structures will be built within the Reconnaissance Alternative by 2057. This could lead to a total of approximately 1,045 business and industrial structures within the Reconnaissance Alternative. As in the case of the Highway 57 Alternative, no additional farms are anticipated. Again, if the project helps retard the deterioration of fish and wildlife resources, it could also help maintain businesses and industries dependent upon these resources, including the commercial production of fish and wildlife, and related sales (for example, boats and equipment) and services (for example, the related maintenance, refrigeration, canning, and charter services).

3.8.4.3 Mitigation and Monitoring.

As in the case of other projects constructed by the Corps of Engineers, the monitoring of the project would include an annual analysis of project benefits and costs.

3.8.5 POPULATION, HOUSING, AND DISPLACMENT OF PEOPLE.

3.8.5.1 Affected Environment.

Declining natural resources and the threat of hurricane damage to businesses and industries can influence population and housing trends. Table FPEIS-31 compares recent historical population estimates of communities in the Houma MSA and total housing trends in Lafourche and Terrebonne Parishes. Hurricanes and high water stages have significantly influenced population and housing trends and the potential for displacement of people, particularly in communities within the Louisiana Coastal Zone. While the city limits of Houma are entirely within Terrebonne Parish, the Houma Urbanized Area (as defined by the Bureau of the Census in 1990) extends eastward into suburban developments in Lafourche Parish.

TABLE FPEIS-31
Houma MSA Population and Housing Trends

HOUMA MSA	1950	1960	1970	1980	1990	1999**
Total Population	85,537	116,152	144,990	176,876	182,842	193,029
Total Housing Units	22,579	31,039	39,898	57,864	66,748	N/A
Vacancy Rate(%)	7.0%	7.1%	5.8%	5.5%	9.1%	-
Lafourche Parish	42,209	55,381	68,941	82,483	85,860	88,712
Chackbay	-	13,403	-	-	2,276	-
Cut Off	-	-	-	5,049	5,325	-
Des Allemands	-	-	225***	337***	409***	-
Galliano	-	-	-	5,159	4,294	-
Golden Meadow	2,820	3,097	2,681	2,282	2,049	2,177
Larose	1,286	2,796	4,267	5,234	5,772	-
Lockport	1,388	2,221	2,398	2,424	2,503	2,838
Mathews	-	-	-	-	3,009	-
Raceland	2,025	3,666	4,880	6,302	5,564	-
Thibodaux	7,730	13,403	15,028	15,810	14,125	15,662
Total Housing Units	11,340	15,177	19,054	27,033	31,332	N/A
Vacancy Rates(%)	8.6%	7.4%	5.5%	6.1%	8.0%	-
Terrebonne Parish	43,328	60,771	76,049	94,393	96,982	104,317
Bayou Cane	2,212	3,173	9,077	15,723	15,876	-
Chauvin	-	-	-	3,338	3,375	-
Dulac	-	-	-	-	3,273	-
Gray	-	-	-	-	4,260	-
Houma	11,505	22,561	30,922	32,602	30,495	34,139
Montegut	-	-	-	-	1,784	-
Schriever	-	-	-	-	4,958	-
Total Housing Units	11,239	15,862	20,844	30,831	35,416	N/A
Vacancy Rates(%)	5.4%	6.9%	6.0%	5.0%	10.1%	-

* Houma MSA- Houma Metropolitan Statistical Area (MSA), combined areas of Lafourche and Terrebonne Parishes.

** Based on 1 July 1998 estimates provided by Louisiana Tech University provisional population estimate, unpublished.

*** A portion of Des Allemands is within St. Charles Parish, which is part of the New Orleans MSA. The 1990 census reported that the total population of Des Allemands was 2,504.

SOURCES: U.S. Department of Commerce, Bureau of the Census, 1960, 1970, and 1980 Census of Population "Number of Inhabitants, Louisiana;" 1990 Census of Population and Housing" Population and Housing, Unit Counts, Louisiana;" and unpublished 1998 estimates, Louisiana Tech University, College of Administration and Business, Research Division.

The Urbanized Area includes the city of Houma, as well as the nearby census designated places (CDP's) of Bayou Blue, Bayou Cane, Bourg, and Crozier. A portion of Bayou Blue is within Lafourche Parish. Declines in population and housing growth have resulted from the decline of oil and gas activities since the early 1980's. Some of the severe affects of hurricanes, particularly within areas nearest the coast, have been reduced by improved weather forecasting, improving evacuation routes, planning more temporary housing at protected locations, and other civil defense measures. Increasing land loss and other changes in environmental conditions, however, have also increased public awareness of the possible need to move into more protected areas on a permanent basis. Federal planning has been developed to encourage residential development only in areas where flood insurance is affordable and to limit the displacement of people and reduce unrecoverable damages.

3.8.5.1.1 Highway 57 Alternative.

The economic analysis for this project indicates that the total population within the Highway 57 Alternative in 1998 was 62,900. Another 5,500 residents of the study area live within the boundaries of the study area but live beyond the project alignment, including about 400 descendents of Native Americans residing in a small community along Bayou St. Jean Charles.

An estimated 22,700 housing units were located in the project alignment. As discussed in other areas of this report, providing hurricane protection for the residents living along Bayou St. Jean Charles would be cost prohibitive. The potential for population displacements due to hurricane damage occurs frequently, particularly within the Coastal Zone and other low elevations.

3.8.5.1.2 Reconnaissance Alternative.

In 1998 an estimated 57,500 people lived within the Reconnaissance project alignment. An estimated 20,700 residential units were located within the immediate project alignment.

3.8.5.2 Environmental Consequences.

3.8.5.2.1 No Action Alternative.

Total population in Lafourche Parish is projected to increase from 88,700 in 1998 to 115,900 in 2057, and the population of Terrebonne Parish will increase from 100,200 in 1998 to 130,900 in 2057. Population of the 116-reach study area is projected to increase from 68,000 to 89,900 over the same time period, with or without the project. The number of residential structures is projected to increase from approximately 24,800 in 1998 to 32,500 in 2057. If subsidence and land loss continue without improvements to flood protection, the prospects for displacement of people in areas highly susceptible to flooding and hurricane damage will tend to increase.

3.8.5.2.2 Highway 57 Alternative.

The population within the Highway 57 Alternative is projected to increase to 82,200 by 2057. The total number of housing units projected for this area by 2057 is 29,700.

3.8.5.2.3 Reconnaissance Alternative.

The most likely population projection for the Reconnaissance Alternative by 2057 is 75,100. An estimated 27,200 housing units will be located within the project area by 2057.

3.8.6 EMPLOYMENT AND INCOME.

3.8.6.1 Affected Environment.

Similar to the effects on business and industry, the threat of hurricane damage reduces the stability of employment and income near the project area. Table FPEIS-32 summarizes employment and income trends in the Houma MSA. Employment increased steadily until the expansion of oil and gas production and the decline of international prices during the 1980's, which caused significant unemployment in the area. For several decades, the median family incomes in Lafourche and Terrebonne Parishes were above estimates for median family incomes for the state. These conditions begun to decline as oil production and related industries declined. As shown in the latest data reported, employment and income conditions in the area have improved along with the national economic trend. The 1990 census estimated that the median family income for Houma was $23,708, slightly below the $26,313 median family income of the state of Louisiana. The median family income of other communities within the Houma MSA ranged from $30,536 in Bayou Cane, $29,091 in Mathews, $19,682 in Chauvin, $18,636 in Galliano to as low as $13,378 in Dulac.

TABLE FPEIS-32
Historical Employment and Income Trends

AREA	1960	1970	1980	1986	1990	1999 (Oct.)
Houma MSA:						
Labor Force	36,052	45,637	72,305	77,500	73,527	96,100
Employed	33,963	43,922	69,857	64,100	66,184	92,300
Unemployment Rate(%)	5.8%	3.8%	3.4%	17.3%	10.0%	4.0%
Per Capita Personal Income (PPI)*	$1,550	$2,580	$8,858	$10,516	$12,753	$19,146
% of Louisiana PPI	94%	91%	105%	93%	89%	94%
Lafourche Parish:						
Labor Force	17,481	21,900	33,376	35,100	35,020	44,800
Employed	16,598	20,964	32,154	29,300	31,571	43,100
Unemployment Rate(%)	5.1%	4.3%	3.7%	16.5%	9.8%	3.8%
Per Capital Personal Income (PPI)*	$1,541	$2,512	$8,301	$10,640	$12,678	$19,266
% of Louisiana PPI	94%	88%	98%	94%	89%	94%
Median Family Income**	$4,330	$7,852	$19,947	N/A	$24,219	N/A
% of Louisiana	123%	104%	110%	-	92%	-
Terrebonne Parish:						
Labor Force	18,571	23,737	38,929	42,400	38,507	51,300
Employed	17,365	22,958	37,703	34,800	34,613	49,200
Unemployment Rate(%)	6.5%	3.3%	3.1%	17.9%	10.1%	4.1%
Per Capital Personal Income (PPI)*	$1,557	$2,621	$9,344	$10,406	$12,488	$19,043
% of Louisiana PPI	95%	92%	111%	92%	87%	93%
Median Family Income**	$4,831	$8,338	$20,918	N/A	$24,710	N/A
% of Louisiana	138%	111%	116%	-	93%	-

* Per capita personal income figures in the 1960 and 1970 columns are for 1959 and 1969. Per capital personal income figures shown in the 1999 column are the latest available (1997).

** Median family income figures were income estimates for 1959, 1969, 1979, and 1989, in the 1960, 1970, 1980, and 1990 census reports.

SOURCES: U.S. Department of Commerce, Bureau of the Census, 1962, 1977, and 1983 County and City Data Book;" 1960, 1970, 1980, and 1990 Census of Population reports, "General Social and Economic Characteristics, Louisiana." Bureau of Economic Analysis, Survey of Current Business, selected months. State of Louisiana, Department Labor, unpublished reports (1986 and 1999 estimates).

3.8.6.2 Environmental Consequences

3.8.6.2.1 No Action Alternative

As in the case of projected population, total employment is expected to continue increasing with or without additional hurricane protection. However, under the "no action" alternatives, continued erosion, subsidence, land loss, and the threat of hurricane impacts could create economic instability in some areas, reducing income potential.

3.8.6.2.2 Highway 57 Alternative and Reconnaissance Alternative

Although these project alternatives are not expected to directly affect employment and income trends significantly in the area, indirect impacts may help maintain the stability of employment and income in protected areas.

3.8.7 PROPERTY VALUES

3.8.7.1 Affected Environment

Reduction in flood damages is the primary objective of projects similar to those proposed, and can have a commensurate positive impact on property values. Conversely, the lack of hurricane protection in areas most sensitive to storm damage could limit the growth of property values. The estimated replacement value of the 880 commercial structures within the 116 reaches of the project area in 1998 was $188.5 million; the replacement value of the 24,769 residential units was an estimated $1,400.1 million (2000 prices).

In 1998, the replacement value of residential structures within the Highway 57 alignment totaled about $1,303.5 million, 93 percent of the property value in the project area. The replacement value of commercial and industrial structures has been estimated to be $181.3 million (2000 prices) and 96 percent of the commercial and industrial property value in the study area.

In 1998, the replacement value of residential structures within the Reconnaissance Alternative has been estimated to be $1,196.8 million, about 85 percent of the value of the replacement value within the Highway 57 Alternative. The replacement value of commercial property in the Reconnaissance alignment has been estimated to be $162.0 million, about 86 percent of the replacement value of commercial structures within the Highway 57 alignment.

3.8.7.2 Environmental Consequences

3.8.7.2.1 No Action Alternative

Assumptions used in the economic analysis indicate that future values of residential, commercial, and industrial property within the immediate project area to the year 2057 be the same with or without the project; however, the effects of land loss, subsidence, and erosion may contribute to instability in future property values. The total number of residences in the study area has been projected to increase by 7,693 units by 2057, and that residential value in the area will increase to $1,763.5 million.

3.8.7.2.2 Highway 57 Alternative

The projected number of residential, commercial, and industrial property is expected to increase between 1998 and 2057, with or without the project. The number of residential properties within the Highway 57 Alternative by 2057 is expected to have a replacement value of $1,636.5 million, and almost 93 percent of the replacement value of residential property in the study area. The value of all commercial and industrial properties within the project alignment is projected to be $246.5 million.

In evaluating projected damages to residential and commercial structures and its value, the economic analysis of this study assumes that future development will continue at a modest rate; that new developments will be built above the current 100-year base flood elevation as required by FEMA; and that this most likely future anticipates continued subsidence and sea level rise (see subsection 3.8.2 LAND USE). Because the population in the study area is expected to grow during the next 50 years, a projection was made of the future residential and non-residential development to take place in the area, as discussed in the "Description of the Study Area" section of this report. Based on historical and economic trends, a total of 965 residential and 108 non-residential structures were placed on the undeveloped land within the reaches of the study area as part of the existing condition structure inventory (2008). These structures were placed one-half foot above the current 100-year base flood elevation as required by FEMA. An additional 6,673 residential and 232 non-residential structures were added for the future condition structure inventory (2057). These structures were placed one-half foot above the stage associated with the future 100-year frequency event. The value of the residential and non-residential structures added to the existing and future condition inventory was based on the average depreciated replacement cost of the existing structures in the study area. As subsidence continues, its effects will cause increasing damages to both existing and future developments, including developments currently or potentially within the 100-year floodplain.

Planning Guidance Letter (PGL) 25 and Executive Order (EO) 11988 state that the primary objective of a flood control project is to protect existing development, rather than to make undeveloped land available for more valuable uses. During the past decade, per capita income increased approximately 50 percent, the unemployment rate decreased from 5.5 percent to 3.95 percent, and total population increased 7.2 percent in Terrebonne Parish and 2.8 percent in Lafourche Parish. Also during this period, improvements were made in the transportation network, such as the opening of Interstate 310 between Houma and New Orleans, technological advancements were made in the oil exploration industry, such as 3D seismic drilling, and a regional cancer treatment facility was opened in Houma. Given these recent growth trends, it is reasonable to assume that development will continue to occur in the study area with or without the hurricane protection project. With the project in place, future development may shift from the northern portions of the study area to the southern portion of the study area south of Houma. However, the overall projected growth rate will be the same with or without the project in place. Thus, the project will serve to stabilize the projected growth trends rather than to induce growth.

3.8.7.2.3 Reconnaissance Alternative

The estimated value of residential property within the Reconnaissance Alternative would total about $1,502.6 million, including the estimated total in 1998 and the net increase anticipated through 2057. The value of commercial and industrial property is expected to have a replacement value of about $220.8 million, still 87 percent of the value of commercial and industrial structures in the overall study area. As in the case of the Highway 57 Alternative, reductions in hurricane damage would tend to enhance the value of property within developments in the Reconnaissance Alternative.

The effects would be similar to those described for the Highway 57 Alternative, Highway 57 Alternative, except in a smaller area that does not include the Bayou du Large and Bayou Grand Calliou ridges.

3.8.8 COMMUNITY COHESION

3.8.8.1 Affected Environment

Community cohesion is the unifying force of a group due to one or more characteristics that provide commonality. These characteristics may include such commonality as race, education, income, ethnicity, religion, language, and mutual economic and social benefits. Community cohesion is the force that keeps group members together long enough to establish meaningful interactions, common institutions, and agreed upon ways of behavior. It is a dynamic process, changing as the physical and human environment changes. The changes brought about by water resource developments can impact community cohesion in different ways. For example, changing a right-of-way may divide a community; it may cause the dislocations of a significant number of residents; or it may require the relocation of an important local institution, such as a church or community center. On the other hand, a water resource development such as construction of a hurricane levee can represent an important public works project heavily supported by the local community. Guidance on the evaluation on environmental justice directed by Executive Order 12898 indicates that federal programs are to consider how their activities might adversely affect minority and low income populations. Table FPEIS-33 below compares the population, household incomes, number of residents living below poverty, and number of residents by racial groups, in Terrebonne and Lafource Parishes as reported by the 1990 census. The figures shown for "Coastal Districts" are essentially the voting districts in Lafourche and Terrebonne Parishes that include areas south of the GIWW. As shown in the table, a comparitively large number of residents living in the area are decendents of Native Americans, as well as Europeans and Africans. The 1990 census reported that the vast majority of the residents in the "Coastal Districts" were "White;" however, the second largest group appears to have been "Native American." Note that a large percentage of the Native Americans in the Coastal Districts have been reported as living below poverty.

Table FPEIS-33
1990 COMPARISONS OF RACIAL MINORITIES AND LOW INCOME GROUPS

Areas	Population	Median HouseHold Income	Persons Reporting Poverty Status	Persons Below Poverty	% Below Poverty	White	Black	Native American, Eskimo, or Aleut	Asian, or Pacific Island	Other
Louisiana	4,219,973	21,969	4,101,071	967,002	23.6	2,839,138	1,299,283	18,541	41,099	21,914
Terrebonne	96,982	21,765	95,875	23,203	24.4	75,082	16,032	4,905	692	271
% of Groups	-	-	-	-	-	77.4%	16.5%	5.1%	0.7%	0.3%
Dist. F	7,441	24,149	7,302	1,428	19.6	5,953	1,073	349	25	41
Dist. G	5,825	20,426	5,789	1,471	25.4	5,028	111	669	9	8
Dist. H	7,584	19,269	7,547	1,802	23.9	6,881	560	117	12	14
Dist. I	6,800	15,415	6,755	2,755	40.8	4,177	294	2,284	16	29
Coastal Districts	27,650	-	27,393	7,456	27.2%	22,039	2,038	3,419	62	92
% by Groups		-	-	-	-	79.7%	7.4%	12.4%	0.2%	0.3%
Lafourche	85,860	21,416	84,189	19,254	22.9	72,371	10,703	1,909	678	199
% by Groups	-	-	-	-	-	84.3%	12.5%	2.2%	0.8%	0.2%
Dist. 10	6,133	25,000	5,873	925	14.8	5,971	54	90	7	11
Dist. 11	6,732	21,871	6,728	1,609	23.9	6,104	62	533	13	20
Dist. 12	5,784	22,116	5,752	1,328	23.1	4,705	539	253	249	38
Dist. 13	5,388	21,886	5,362	954	17.8	5,038	43	233	57	17
Dist. 14	5,321	20,686	5,230	1,152	22.0	5,036	13	196	66	10
Dist. 15	5,329	15,157	5,392	1,534	28.4	4,850	12	417	26	24
Coastal Districts	34,687	-	34,337	7,502	21.8%	31,704	723	1,722	418	120
% by Groups	-	-	-	-	-	91.4%	2.1%	5.0%	1.2%	0.3%

SOURCES: U.S. Department of Commerce, Bureau of the Census, 1990 Census of Population and Housing, "Summary Social Economic and Housing Characteristics, Louisiana" CPH-5-20; and "Social and Economic Characteristics, Louisiana" CP-2-20.

3.8.8.2 Environmental Consequences

3.8.8.2.1 No Action Alternative

Under the No Action Alternative, the current patterns of behavior and social identity that characterize existing community cohesion and environmental justice would continue changing as the dynamics of the physical and human environment changed, but without the proposed flood control project. The threat of flood damage from storms and hurricanes as well as subsidence, erosion, and land loss will increase, impacting minorities and low income groups as well as other groups. Impacts to all structures at low elevations and along the coastline will tend to increase, including the structures of minorities and low income residents as well as camps and second homes of people with higher incomes.

3.8.8.2.2 Highway 57 Alternative and Reconnaissance Alternative

The local sponsor is Terrebonne Parish, supported by the State of Louisiana. The environmental impact review process has included opportunities for public comment. Issues raised are summarized in Section 4, Consultation and Coordination. Any project authorized would require congressional approval and include appropriate mitigation.

As mentioned in 3.8.2 Land Use, the District received a letter from the Chief of the Isle de Jean Charles Band of Biloxi-Chittmacha Choctaw, indicating that he represents the interests of local descendents of Native Americans living along Bayou St. Jean Charles, and that they are protesting the project. The letter expresses several social concerns, among them the community's exclusion from both project alternatives. The economic analysis prepared for this study indicates that approximately 100 families and 7 businesses are located in this area. This area was not included within the primary project alignments due to its prohibitively high cost. Preliminary estimates indicate that the cost of providing 100-year flood protection to this small area might be as high as $190 million, or more than $600 thousand per resident. Measures for improving flood protection within this small community are being considered by the Terrebonne Parish Conservation District, including a 7-foot ring levee, but will not be part of this project. Final determinations of a project alignment will be determined based primarily on economic justification, rather than racial or ethnic considerations, income levels, and poverty status. Employment opportunities and income levels influence property values which, in turn, influence national economic benefits evaluations. However, the primary purpose of this project is to provide hurricane protection for as many people as economically feasible including racial minorities and people with poverty status.

3.8.9 DESIRABLE COMMUNITY AND REGIONAL GROWTH

3.8.8.1 Affected Environment

Desirable community and regional growth with respect to the proposed hurricane protection project is considered growth that responds to the needs of the local communities and region, and is consistent with National Economic Development (NED) guidelines. The construction of the Mississippi River bridge at Luling and the Interstate Highway 310 (I-310) have expanded the potential for community and regional development between the New Orleans MSA and the Houma MSA.

3.8.9.2 Environmental Consequences

3.8.9.2.1 No Action Alternative

The No Action Alternative would leave the problems of hurricane protection to the local and state residents, and others with economic interests in the area.

3.8.9.2.2 Highway 57 Alternative and Reconnaissance Alternative

While most of the construction of both project alignments would take place in relatively undeveloped areas, initial planning has included the possible need to mitigate adverse effects to community and regional concerns.

3.8.10 TAX REVENUES

3.8.10.1 Affected Environment

If hurricanes significantly impact businesses, industries, farms, and property values, and impact local employment and income, the tax base created by these activities could be impacted as well.

3.8.10.2 Environmental Consequences

3.8.10.2.1 No Action Alternative

Continued flood damages caused by hurricanes that pass through the project area would continue, contributing to related impacts on the local tax base and the cost national emergency programs.

3.8.10.2.2 Highway 57 Alternative and Reconnaissance Alternative

Both projects would indirectly reduce adverse impacts to the local tax base, since they would help maintain economic stability on which the tax base depends.

3.8.11 PUBLIC FACILITIES AND SERVICES

3.8.11.1 Affected Environment

Public and quasi-public facilities and services in the project area include schools, hospitals, police and fire protection, an extensive network of pumps and levees for flood protection, and a series of navigation canals, including the HNC and the Gulf Interharbor Navigation Canal (see section 3.8.14 Navigation). Of the total 880 non-residential structures identified within the 116 project reaches in 1998, approximately 79 structures were public or semi-public structures. During the threat of hurricanes and severe flooding, public buildings are occasionally used as temporary shelter for residents who are impacted.

3.8.11.2 Environmental Consequences

3.8.11.2.1 No Action Alternative

The total number of public and semi-public structures in the project area is estimated to increase from 79 in 1998 to 127 in 2057.

3.8.11.2.2 Highway 57 Alternative and Reconnaissance Alternative

Both alternatives would help reduce storm damage in the project area, including damage to public structures subject to flooding. Projections for the Highway 57 Alternative estimate that the number of public and semi-public structures would increase from 70 in 1998 to 117 in 2057. During the same period of time, the number of public and semi-public structures within the Reconnaissance Alternative increased from 62 to 109. Note that only 1 of the 48 public structures anticipated for construction between 1998 and 2057 is expected to be built on land that extends beyond the Reconnaissance Alternative. Both alternatives include a lock on the HNC that would curtail saltwater intrusion while maintaining navigation (see section 3.8.14 Navigation).

3.8.12 NOISE, HEALTH, AND SAFETY

3.8.12.1 Affected Environment

To prevent adverse affects of construction and maintenance, Corps projects follow appropriate guidelines set by other federal agencies, including the Occupational Safety and Health Administration.

3.8.12.2 Environmental Consequences

3.8.12.2.1 No Action Alternative

The No Action Alternative would cause no adverse impacts.

3.8.12.2.2 Highway 57 Alternative and Reconnaissance Alternative

Projects would be required to follow appropriate federal regulations and mitigate concerns accordingly.

3.8.13 ENERGY

3.8.13.1 Affected Environment

Federal regulations require that the engineering design of Corps projects meet appropriate energy conservation measures. Coastal Louisiana has been one of the nation's important sources of crude oil and natural gas. Salt caves along the Gulf Coast are used to maintain the nation's Strategic Petroleum Reserve.

3.8.13.2 Environmental Consequences

3.8.13.2.1 No Action Alternative

This study has identified no significant adverse impacts from the No Action Alternative. Oil and gas crew boats will continue to travel west to Texas, or areas north of Morgan City to avoid hurricane surges.

3.8.13.2.2 Highway 57 Alternative and Reconnaissance Alternative

The project would reduce travel costs to oil and gas crew boats and reduce potential damage to vessels that need harbors of refuge during the storms.

3.8.14 NAVIGATION

3.8.14.1 Affected Environment

Navigation in the vicinity includes the movement of oil and gas supply vessels, commercial fishing vessels, pleasure crafts, and other barge traffic along the GIWW, the HNC, Bayou Terrebonne and other lesser waterways. The GIWW extends from the Mexican border to Appalachee Bay in Florida. The HNC is maintained for about 40.5 miles, from Houma to Terrebonne Bay, leading to the open Gulf of Mexico (See also appendix B, XV NAVIGATION IMPACTS).

3.8.14.2 Environmental Consequences

3.8.14.2.1 No Action Alternative

Under the No Action Alternative traffic on the waterways will follow past trends, changing as technology or the availability of resources change.

3.8.14.2.2 Highway 57 Alternative and Reconnaissance Alternative

Both alternatives would include a 200-foot wide flood control structure on the HNC as part of the overall plan for improving hurricane protection, maintaining navigation, and minimizing the effects of saltwater intrusion. The Reconnaissance Alternative would provide for a floodgate at the upper end of the canal, where navigation activity is minimal. The Highway 57 Alternative requires a lock because of its impact on the level of marine traffic along the canal beyond the Reconnaissance Alternative alignment. The cost of a lock would be significantly greater than the cost of a floodgate; however, Gulf Island Marine, a major operator on the canal, has indicated that the Highway 57 alignment would require a 200-foot lock to maintain its current level of use of the waterway. The design of both alignments includes harbor of refuge benefits for commercial fishing vessels and recreational vessels. The economic analysis for the study includes benefits of reduced travel costs for the commercial and recreational fleets seeking shelter from storms and avoiding related damage. The Highway 57 Alternative would provide approximately twice the benefits achieved by the Reconnaissance Alternative.

3.9 Recreation

3.9.1 AFFECTED ENVIRONMENT

The recreation study area includes southern portions of Lafourche and Terrebonne parishes. It is included in region 3 of the Louisiana State Comprehensive Outdoor Recreation Plan (SCORP). Major bodies of water located in the study area include Lake Boudreaux, Lake Felicity, Bayou Terrebonne, Bayou Pointe au Chien, Bayou du Large and many others including numerous oil field canals. The Pointe au Chien Wildlife Management area is located within the study area. The Lower Atchafalaya Basin, and the Wisner Wildlife Management areas are located in the vicinity. Most of the study area is brackish and saline marshes with some forested wetlands and uplands. Recreational facilities include camps, marinas, boat launch ramps and small neighborhood parks.

Recreational fishing in the study area occurs almost entirely from boats. The physical characteristics of the shoreline in the study area, especially the presence of wetlands, limit access to shore fishing. Factors contributing to the high proportion of boating activity for fishing include the high quality of the recreational fishery, especially an abundance of red fish and trout. Pleasure boating occurs to a lesser degree than boat fishing. One indicator of the amount of recreational fishing that occurs in the study area is the number of recreational boats registered in the two parishes. In 1999 within the parishes of Lafourche and Terrebonne, there were 25,790 registered boats, 55,624 resident fishing, and 14,085 resident hunting licenses issued by the State of Louisiana.

The Pointe au Chien Wildlife Management area lies in the center of the study area. Topography of the area is mostly marsh, varying from nearly fresh to brackish interspersed with numerous ponds, bayous, and canals. Game species hunted are waterfowl, deer, rabbit, squirrels, rail, gallinule, and snipe. Inland saltwater fish species, crabs, and shrimp are available in the more brackish water. Fishing success is excellent due to the proximity of the Timbalier and Terrebonne Bay watersheds. Freshwater fisheries may be caught in the more northern portions of the management area. Non-consumptive forms of recreation are boating, nature study, undeveloped camping and picnicking.

3.9.2 ENVIRONMENTAL CONSEQUENCES

3.9.2.1 No Action

With the No Action Alternative the forced drainage and partial hurricane protection system will continue to operate as it does in the current condition. Salt water intrusion and subsidence will continue to occur. Marshes will continue to erode and open water areas will increase in size. Increased saltwater intrusion will impact upland and aquatic plant life causing it to slowly deteriorate in size and quality. The fish and wildlife community dependent on this cover for food and shelter will decrease in population as the resource lessens in availability. A degrading plant habitat lessens the estuarine quality of the marsh, and in turn, produces fewer adult sport fish and huntable wildlife species.

3.9.2.2 Highway 57 Alternative

Recreational hunting and fishing activity in the project area will experience minimal impacts associated with the building of 7 new floodgates adding to 4 already existing, a new lock, 12 new fish and wildlife structures (replacing 3), several drainage structures and 72 miles of levees. The water control structures are not navigable. However, positive freshwater flow benefits to the vegetation community occur by closing the water control structures in times of high tides, restricting saltwater intrusion. Improved vegetative growth provided by way of the water control structures will benefit the marsh, which in turn will provide suitable food and cover for huntable game species. Fisheries also benefit by improved estuarine conditions and increased food sources. The proposed floodgates, water control structures, and lock will provide similar benefits by restricting saltwater flow when necessary. The floodgates and lock will remain open most of the time, closing only in times of storms and high tides. Construction of these facilities will impact boat passage through the canals and bayous where they are placed. Localized turbidity within the construction vicinity will impact fisheries in the area of work. However, these impacts will be short term. Upon completion of the structures, sport fisheries will return to their pre-project condition with improved water flow conditions and more probable fishing success. A potential restriction impact will occur in the vicinity of T Irv's marina. This marina is located on the northern side of a proposed floodgate on Bayou Grand Caillou. When the gate is closed, boaters will be required to use a proposed by-pass channel, which will provide access around the floodgate. This channel will increase the travel time required to reach the southern marshes. The impacts related to construction of these floodgates and lock facilities will be relatively short lived. When the floodgates and lock are open there will be no impact to users, however when these facilities are closed users will be contained within the levee system. Eighty-seven miles of levees will be developed with this plan, in areas of new levee construction, the levee's footprint will permanently destroy a corridor of potential hunting habitat through the area of development. Hunting which currently takes place on the land where the new levees will be constructed will transfer to adjacent areas with minimal apparent losses to the overall hunting experience. The levees will provide a linear walking path for hunters and sightseers within the perimeter of the Pointe au Chien Wildlife Management Area.

3.9.2.3 Reconnaissance Alternative

This plan is similar to the Highway 57 Alternative with the exception of the development of 52 miles of earthen levees, 8 floodgates (2 are replacements), 7 fish and wildlife structures, and several drainage structures to be built with implementation of this plan. East of Bayou Petit Caillou, the Highway 57 alternative and this alignment are identical. Recreational impacts of the Reconnaissance Alternative are similar to those of the Highway 57 Alternative.

3.10 Cultural Resources

3.10.1 AFFECTED ENVIRONMENT

This resource is institutionally significant because of: the National Historic Preservation Act of 1966, as amended; the Native American Graves Protection and Repatriation Act of 1990; and the Archeological Resources Protection Act of 1979; as well as other statutes.

Cultural resources are technically significant because of: their association or linkage to past events, to historically important persons, and to design and/or construction values; and for their ability to yield important information about prehistory and history.

Cultural resources are publicly significant because preservation groups and private individuals support their protection, restoration, enhancement, or recovery.

Prehistoric and historic settlement within the study area was primarily based upon the geomorphology of the region. Elevated natural levees along past and present distributary channels provided elevated dry ground for settlement and temporary subsistence use. Past cultural resource investigations in both Terrebonne and Lafourche parishes have resulted in the identification of prehistoric cultural resources dating between 1,500 B.C. and A.D.1,500. Earlier prehistoric cultural remains assigned to both the Paleo-Indian and Archaic time periods (10,000 B.C. to 1,500 B.C.) have not been identified in these parishes. The majority of the prehistoric cultural resource sites located within the project area are associated with either the Coles Creek (A.D.700 - A.D.1200) and/or Plaquemine (A.D.1200 - A.D.1500) cultural periods. Typically, Coles Creek peoples were widely dispersed in small hamlets. Subsistence patterns centered on the exploitation of marsh resources. Within the project area, small shell middens represent the typical Coles Creek site. The later Plaquemine culture continues to exploit marsh resources in the same manner; however, agricultural dependence increased. Larger villages that are more permanent and ceremonial centers developed.

Several earthen mound sites are located within the project area and may represent village and/or ceremonial centers.

Later historic Indian and Anglo cultural resources are also present in the project area. Many of the later prehistoric cultural resource sites in the region have ancestral ties to the present day Chitimacha. Another historic group, the Houma, began a migration down Bayou Lafourche in the early nineteenth century. Settlements were eventually established along Bayou Terrebonne and Bayou Lafourche in Terrebonne and Lafourche parishes. The Houma have remained in this region since that time and are now dispersed among six communities along Bayou du Large, Grand Caillou-Dulac, Lower Montegut, Lower Pointe au Chien, Champs Charles, and Bayou Lafourche.

Historic Anglo settlements associated with the French Colonial (1698-1765), the Spanish Colonial (1765-1803), and Anglo-American (1803-present) periods are located throughout the region. Under Spanish rule, Acadian settlements were established throughout the project area and the descendents of these early settlers remain. Both Terrebonne and Lafourche parishes were established in 1822 from what was formerly known as the Lafourche Settlement. By 1850, several hundred farms and plantations were producing cane in Terrebonne and Lafourche parishes. As the sugar plantations and farms developed, the region became increasingly dependent upon slave labor; thus, by 1860, African-American slaves made up the majority of the region's population. Large sugar plantations such as Ashland (located six miles south of Houma on Bayou Grand Caillou) and Terrebonne (located 18 miles south of Houma on Bayou Terrebonne) flourished well into the early quarter of the twentieth century.

In addition to the terrestrial cultural resources sites noted above, the project area also contains numerous historic shipwrecks. Bayou Terrebonne, du Large, and Grand Caillou were primary routes for waterborne commerce. Thus, watercraft from all time periods could be present within the project area. In 1997, cultural resource investigations along Bayou du Large recorded and documented six historic vernacular watercrafts. Thus dredging activities associated with lock and floodgate construction could result in the disturbance of the significant historic watercraft.

Past cultural resource investigations within Terrebonne and Lafourche parishes have resulted in the recording of 559 cultural resource sites. In 1999, NOD contracted for a 1000-acre cultural resource sample survey of the proposed project right-of-way. The sample survey tested a model of cultural resource site occurrence that was based upon the regions unique geomorphology. The project right-of-way was divided into low and high potential areas. Both high and low potential areas were included in the survey coverage.

Five potentially significant cultural resource sites were identified within the combined project right-of-way of both project alternatives. Additional significant prehistoric and historic cultural resource sites may be found within the unsurveyed portions of the project area. The Louisiana State Historic Preservation Officer concurred with the model of cultural resource site occurrence and future recommendation in a letter dated July 19,2000.

3.10.2 ENVIRONMENTAL CONSEQUENCES

3.10.2.1 No Action Alternative

The modern inhabitants of Terrebonne and Lafourche parishes occupy the same elevated natural levees as their forebears. Thus, modern land-use practices associated with agriculture, the timber industry, oil and gas exploration, urban/commercial development, flood control construction activities and vandalism have all contributed to the disturbance and loss of cultural resource sites. Impacts from oil and gas exploration, flood control projects, and ship channel construction have brought about increased saltwater intrusion. The resulting loss of marsh vegetation increased erosion and cultural resource site destruction. Erosion and natural subsidence are the primary causes for cultural resource site destruction within the study area.

3.10.2.2 Highway 57 Alternative

Fifteen previously recorded cultural resource sites are located within the proposed project right-of-way. Ten of the these cultural resource sites are not significant due to past disturbance, lack of cultural evidence and/or they have no research potential. Three sites, 16TR160, 16TR71, and 16TR304 need additional testing to determine their significance. Sites 16TR19 and 16TR33 are significant National Register eligible prehistoric Indian mounds. Both of these sites have cultural materials ranging in time from A.D.700 to A.D.1500. Both sites are close to the centerline of the proposed levee. Each could be easily avoided by a slight change in the levee alignment. Placement of these sites inside of the levee would help preserve them by reducing saltwater intrusion and erosion. If they can not be avoided expensive data recovery efforts would be needed to mitigate the construction impacts. Additionally, prehistoric human remains would likely be encountered during the excavation process. Under the provisions of the Native American Graves Protection and Repatriation Act of 1990, the Chitimacha tribe would be directly involved in the development and approval of the final mitigation plan.

Approximately 19 percent of the project right-of-way has been previously surveyed by a professional archeologist. Approximately 35 percent of the project right-of-way traverses areas that have a low potential for the presence of cultural resources. Cultural resource surveys are not needed in these areas. Sixty five percent of the project right-of-way is located in areas that have a high potential for the presence of cultural remains. Twenty nine percent of these areas have been previously surveyed. The remaining 36 percent (2,717 acres) need to be surveyed prior to construction. Five to six additional potentially significant cultural resource sites can be expected in these areas.

The proposed modified Highway 57 alignment would reduce cultural resource impacts. The number of high potential acres that would need to be surveyed would be reduced by approximately 751 acres.

The cultural resource survey of these high potential areas would be accomplished through shovel, auger tests, backhoe trenches and/or by metal probes. The goal of this testing will be to locate buried cultural resource sites, and once located, determine their horizontal and vertical dimensions, and if possible, their cultural affiliation, integrity, and eligibility for nomination to the National Register of Historic Places. Avoidance as opposed to data recovery/excavation would be the recommended alternative for newly recorded significant cultural resource sites.

Watercraft from all periods could be present within the project area. Dredging activities associated with lock and floodgate construction could result in the disturbance of significant historic watercraft. Natural bayous and canals that have not been previously dredged would have to be surveyed for underwater cultural resources. As with the terrestrial resources noted above, avoidance as opposed to data recovery would be recommended.

3.10.2.3 Reconnaissance Alternative

Four previously recorded cultural resource sites are located within the proposed project right-of-way. Three of the these cultural resource sites are not significant due to past disturbance, lack of cultural evidence and/or they have no research potential. One site, 16TR33 is a significant National Register eligible prehistoric Indian mound. Cultural materials ranging in time from A.D.700 to A.D.1500 have been recovered from this site. The site is located close to the centerline of the proposed levee. It could easily be avoided by a slight change in the levee alignment. Placement of this site inside of the levee would help preserve it by reducing saltwater intrusion and erosion. If the site can not be avoided expensive data recovery efforts would be needed to mitigate the construction impacts. Additionally, prehistoric human remains would likely be encountered during the excavation process. Under the provisions of the Native American Graves Protection and Repatriation Act of 1990, the Chitimacha tribe would be directly involved in the development and approval of the final mitigation plan.

Approximately 27 percent of the project right-of-way has been previously surveyed by a professional archeologist. Approximately 36 percent of the project right-of-way traverses areas that have a low potential for the presence of cultural resources. Cultural resource surveys are not needed in these areas. Sixty four percent of the project right-of-way is located in areas that have a high potential for the presence of cultural remains. Forty two percent of these areas have been previously surveyed. The remaining 58 percent (1,293 acres) need to be surveyed prior to construction. Three to four additional potentially significant cultural resource sites can be expected in these areas. The cultural resource survey of these high potential area would be accomplished through shovel, auger tests, backhoe trenches and/or by metal probes. The goal of this testing will be to locate buried cultural resource sites, and once located, determine their horizontal and vertical dimensions, and if possible, their cultural affiliation, integrity, and eligibility for nomination to the National Register of Historic Places. Avoidance as opposed to data recovery/excavation would be the recommended alternative for newly recorded significant cultural resource sites.

Watercraft from all periods could be present within the project area. Dredging activities associated with lock and floodgate construction could result in the disturbance of significant historic watercraft. Natural bayous and canals that have not been previously dredged would have to be surveyed for underwater cultural resources. As with the terrestrial resources noted above, avoidance as opposed to data recovery would be recommended.

As part of the Morganza to the Gulf study, R. Chistopher Goodwin & Associates prepared a report entitled "Cultural Resource Literature and Records Review for the Morganza to the Gulf Feasibility Study, Terrebonne and Gulf Feasibility Study, Terrebonne and Lafourche Parishes, Louisiana." The report was submited to the Corps-New Orleans District in June 1997.

3.11 Hazardous Toxic and Radioactive Wastes

3.11.1 AFFECTED ENVIRONMENT

The site and vicinity are dominated by wetlands; including marsh, cypress/tupelo gum swamp, bottomland hardwood, and scrub shrub wetlands. Developed lands, which are the minority land use, are utilized for residential and for light commercial to heavy industrial purposes. Most of the land is between 0-5 feet above mean sea level and is subject to tidal flooding during hurricanes.

The developed areas are on either bank of Bayou du Large, Bayou Grand Caillou/HNC/Grassy Bayou, Bayou Petit Caillou/Boudreaux Canal, Bayou Terrebonne, Bayou Blue/Grand Bayou Canal, and Bayou St. Jean Charles/Bayou Pointe au Chien. Along these bayous, the following communities exist: Crozier, Ashland, Theriot, Grand Caillou, Dulac, Chauvin, and Montegut. These areas contain residential properties and light commercial to heavy industrial businesses supporting the offshore petroleum industry, and the seafood industry.

The study area also contains some older oil and gas production fields including: North Montegut Gas Field, South Bourg Gas Field, Southwest Bourg Gas Fields, Houma Gas Field, Sunrise Gas Field, South Sunshine Gas Field, Bayou du Large Gas Fields, Sauveur Bayou Gas Field, Lake Gero Gas Field, Lapeyrouse Oil and Gas Fields, Lake Boudreaux Gas Field, South Chauvin Gas Field, South Houma Gas Field, Montegut Oil and Gas Field, Lirette Oil and Gas Field, and Baptist Bay Gas Field.

Main access roads through the study area begin near Houma and generally traverse south with each road ending at land’s end. Highways include LA Hwy 315, LA Hwy 55, LA Hwy 56, LA Hwy 57, LA Hwy 58, and LA Hwy 665.

Most of the shallow subsurface is composed of natural levee and marsh deposits which are composed of clays with minor amounts of silt and are not favorable for contaminant migration. There are some Lacustrine deposits in the study area, which may favor conditions for contaminant migration. The most likely mechanism for contaminant migration is surface water flow.

As part of the Morganza to the Gulf study, Gulf Engineers & Consultants prepared a report entitled “Environmental Data for Hazardous, Toxic, and Radioactive Waste (HRTW) Investigations-Morganza, Louisiana, to the Gulf of Mexico. The report was submitted to the Corps in September of 1997.

3.11.2 ENVIRONMENTAL CONSEQUENCES

3.11.2.1 No Action Alternative

The following represents a listing of research for the project area. Generally speaking, these would not be impacted or of a significant concern under the No Action alternative. The initial project area that was searched extends 1.6 km (1 mi) beyond the current project limits. It considers all Superfund sites (those cataloged on the National Priorities List, NPL), as well as any Resource Conservation and Recovery Act (RCRA) Temporary Disposal Site (TDS) locations. There are no NPL or RCRA TSD sites that lie within the project corridor boundaries or a 1.6 km (1 mi) search distance beyond project limits.

Numerous governmental agencies and environmental databases were consulted in evaluating the HTRW risks of the Morganza to the Gulf Feasibility project area in Terrebonne and Lafourche parishes, Louisiana. The process involved several levels of scrutiny and evaluation. For example, an after initial scrutiny of 347 facilities with records on file with the Air Quality Division, DEQ, only 25 facilities were determined to be relevant (i.e., facilities that fell in the general vicinity of the project corridor). As part of the subsequent research on these 25 facilities, 36 files were inspected. Of the 25 facilities examined only 5 actually fell inside the project corridor, and these 5 proved either to be non-applicable or they had no violations.

In the Radiation Protection Division 60 facilities were considered; however, only 5 files representing 2 facilities were examined. Neither facility fell inside the current project area.

The Resource Conservation and Recovery Information System (RCRIS) listings contained 806 records that were representative of 777 facilities. An extensive examination of 76 facilities resulted in the identification of 15 facilities within the project corridor. The investigation revealed three large quantity generators, one small quantity generator, and a transporter of hazardous waste in the project corridor.

In the Solid Waste Division, DEQ, six files were checked. Only one facility actually fell within the limits of the proposed project corridor. In the records of inactive and abandoned sites, the records of 62 facilities were examined; 22 of the facilities were determined relevant. Nevertheless, from the 22 files examined, only 1 of the facilities was located in the project corridor: a Texas Eastern compressor station listed as a potential site but with no problems noted.

A total of 610 Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) entries were examined and 10 of these facilities warranted additional study. Of the 10 facilities studied in detail, none fell within the limits of the current project corridor. An examination of the Toxic Release Inventory (TRI) identified 13 entries that were studied and checked. While five of these entries deserved additional research, none of the associated facilities fell within the project corridor.

The Water Pollution Control Division contained no less than 4,194 violation entries that had to be checked in order to winnow out 144 potentially relevant facilities. Files on these 144 facilities were narrowed down to include 5 operations that were located inside the project corridor. The most serious problem was an oilfield violation for L & L Oil, which has now complied with regulations.

In the Ground Water Protection Division, 11 facilities were checked. Only one facility in the project corridor had a violation.

From an initial listing of 1,280 Coastal Use Permits issued in the vicinity of the project corridor, 561 permits were determined to lie within the area under examination. From the 84 coastal violations noted, 49 pertained to areas encompassed by the study site. All violations were minor, and none involved hazardous, toxic, and/or radioactive waste.

On the Emergency Response Notification System (ERNS) report, 418 entries were scrutinized. Of these, 87 were checked, 52 were entered, and 39 were determined finally to be relevant.

Because of the processes described above, a number of twentieth century commercial and industrial activities were identified within that portion of eastern Terrebonne and western Lafourche parishes, Louisiana, i.e., inside the current project corridor. The land use history, environmental data report, and Initial Site Assessment (ISA) revealed few facilities associated with the production and disposal of hazardous, toxic, and radioactive waste. While oil wells proliferate throughout the project area, and they always represent potential hazardous waste disposal sites, overall the project area seems to be relatively "clean," especially when compared to the industrial corridor found along the Mississippi River between Baton Rouge and New Orleans. No significant or outstanding problems/concerns are known from the study area. In the future, as erosion and subsidence continue, many of the facilities noted above may become more of a risk from flooding. Since surface water seems to be the primary pathway for contaminant migration in this area, a potential does exist for future increased HTRW risk.

3.11.2.2 Highway 57 Alternative

The majority of the project corridor traverses undeveloped or lightly developed land. In a review of this alternative, the areas on either side of Bayou du Large (LA Hwy 315), Falgout Canal (Falgout Road), lower portion of Bayou Grand Caillou/Houma Navigation Canal/Grassy Bayou (LA Hwy 57), Bayou Petit Caillou/Boudreaux Canal (LA Hwy 56), Bayou Terrebonne (LA Hwy 55), Bayou Blue/Grand Bayou Canal (LA Hwy 24), and Bayou St. Jean Charles/Bayou Pointe au Chien (LA Hwy 665/Isle of Jean Charles Road) are developed with some residential, commercial and industrial enterprises. In general, no obvious signs of significant contamination were observed within or adjacent to the investigated areas and nothing in the records research indicated strong potential for such contamination to be present within the investigated study area.

From data reviewed and the site reconnaissance performed during this ISA, numerous users of hazardous materials and generators of hazardous wastes in the corridor area were observed. However, no further investigations into the environmental condition of the project corridor are warranted at this time. The sites of highest concern for potential sources of significant contamination within the corridor of this alternative include: the abandoned Underground Storage Tanks (USTs) at the supermarket in Crozier; the Above Ground Storage Tanks (ASTs) at Bayou du Large Marina/Phillips 66 Service Station south of Theriot; abandoned ASTs located adjacent to Rebel Ice Company; the numerous ASTs located west of LA Hwy 315 between Falgout Road and du Large; the USTs at du Large Sporting Goods; a random dump west of LA Hwy 315, 0.4 miles north of du Large, and the facility of L&L Oil Company, Dulac Terminal. When this project is constructed, right-of-way acquired from these properties that will require the removal of above ground storage tanks; excavation and removal of any underground storage tanks; excavation and removal of debris; or excavation and relocation of a landfill, it may be necessary to test the soils and/or groundwater to determine if any contamination has occurred. Other sites located within the proposed corridor include, Somanie Packing Co., Haliburton, M-I Drilling Fluids Co., Baker Hughes, B.J. Services, and Pointe au Chien Marina. A portion of the aforementioned facilities is located within the construction corridor. However, these are not sites of high concern for contamination.

3.11.2.3 Reconnaissance Alternative

This project corridor, while similar to the Highway 57 alternative, essentially eliminates the Bayou du Large segment and lower Grand Caillou segment of the proposed flood protection. Furthermore, it follows an alignment through a more developed area along Bayou Petit Caillou and the northern portion of the HNC. The two alternatives then follow a common alignment at the lower part of Bayou Petit Caillou. In a review of the this levee alternative, upper portion of Bayou Grand Caillou/HNC (LA Hwy 57), Bayou Petit Caillou/Boudreaux Canal (LA Hwy 56), Bayou Terrebonne (LA Hwy 55), Bayou Blue/Grand Bayou Canal (LA Hwy 24), and Bayou St. Jean Charles/Bayou Pointe au Chien (LA Hwy 665/Isle of Jean Charles Road) are developed with some residential, commercial and industrial enterprises. In general, no obvious signs of significant contamination were observed within or adjacent to the investigated areas and nothing in the records research indicated strong potential for such contamination to be present within the investigated study area. The alignment through the more developed area along Bayou Petit Caillou and the northern portion of the HNC does have some sites of concern though.

From data reviewed and the site reconnaissance performed during this ISA, numerous users of hazardous materials and generators of hazardous wastes in the corridor area were observed. However, no further investigations into the environmental condition of the project corridor are warranted at this time. The sites of highest concern for potential sources of significant contamination within the corridor include: sewerage disposal ponds, USTs at an unoccupied supermarket, Ashland Landfill, Gulf Island Fabrication Yard, some potential USTs in the right of way, the Island Road and Pointe au Chien marinas. When this project is constructed, right-of-way acquired from these properties that will require the removal of above ground storage tanks; excavation and removal of any underground storage tanks; excavation and removal of debris; or excavation and relocation of a landfill, it may be necessary to test the soils and/or groundwater to determine if any contamination has occurred. This reconnaissance alternative represents the highest risk for encountering HTRW, though with proper alignment coordination, risk can be maintained at acceptable levels that do not warrant further actions.

3.12 Cumulative Impacts

The use of the programmatic EIS represents a means at getting at the spatial component of cumulative impacts.

Surface Water Resources

The hydrology in the study area and the Terrebonne Basin has been altered extensively over the past 150 years by human activities. Levees on the Mississippi River, dams on the Missouri River, roads, canals, pipelines, marsh management, forced-drainage systems, and other factors all have contribute hydrologic changes. There are now restoration efforts that will change the hydrology in selected areas by bringing in more fresh water than would otherwise enter those areas. The proposed project would have an additional hydrologic effect by preventing high storm surges and salinities from entering fragile marshes that are in a deteriorating condition. The possible systems of levees, floodgates, and water control structures would change sheet (over marsh) flow in and out of the enclosed areas. All water entering the system from rainfall or the GIWW to the north would have to exit to the south through floodgates and water control structures.

There have been many alterations to the Terrebonne Basin (see section 3.3 hydrology) and the alternative actions would have an additional significant effects on that hydrology by preventing major tidal surges from entering the areas enclosed. The proposed action is designed to work with the hydraulic conditions that presently exist and future conditions so that homes and people can be protected while at the same time allowing water to flow into and out of the system the vast majority of the time.

The system is very complex with tides, storm surges, Atchafalaya flows, rainfall, and water movement into and out of marshes and small channels. Additional modelling may be needed to ensure that the floodgates are sized so that they do not change flows to any great extent outside of infrequent tropical events. The Corps believes the sizes of floodgates as planned are in the appropriate range, but fine-tuning would be necessary during detailed design. There are many other activities being implemented in the study area (see section 2.4). The proposed action has been planned to work in concert with these activities, many of which involve coastal restoration.

Farmlands and Soils

The ridges in the study area where farmlands occur have been and will continue to be under pressure for housing and commercial developments. The proposed project would remove 74 acres of prime and unique farmlands because of construction. However, it would be difficut to determine if project implementation would speed development on the already rapidly developing ridge areas. Soils would be disturbed permanently along the entire levee alignment, but with proper erosion control techniques, additional erosion and soil disturbance should be eliminated. Houses and businesses have been built in the past on areas with prime and unique farmlands in the area and this trend would likely continue.

Wetlands

Louisiana contains 40 percent of the continental United States coastal wetlands (Gosselink 1984) and wetlands are a prevalent characteristic in the study area. Coastal wetland loss in Louisiana has averaged 65 km^2/yr (25 mi^2/yr)(Boesch et al. 1994).

There has been no appreciable deltaic development in the Terrebonne Basin for the past 500 years. Data for the entire Basin (over 1 million acres), which includes the study area, shows that land was lost from 1956-1978 at a rate of 0.79 percent per year. From 1978 to 1990, the land loss rate was 1.2 percent per year (Reed et al. 1995). These losses occurred from a variety of activities, including Mississippi River levees, oil and gas development, navigation channels, etc. Such land losses are predicted to continue with or without the proposed action. The proposed action would increase direct losses initially, but would increase the quality of recurring habitat over the project life.

Thousands of acres of wetlands in the study area, Terrebonne Basin, and south Louisiana have been lost to subsidence, erosion, dredging, and development over the past 100 years. The Terrebonne Basin has a very high rate of wetland loss, estimated at about 10.4 square miles per year from 1978-1990 (Fuller et al. 1995). This trend will likely continue, mainly with respect to subsidence and erosion. Of 1.4 million acres of coastal area in the Terrebonne Basin analyzed by Fuller et al. 1995, there was 44 percent open water in 1956. That percentage increased to 54 percent in 1978 and 59 percent in 1990. The HET found similar results in the study area, a smaller zone than investigated by Fuller et al, 1995. Large programs are now in effect (e.g. CWPPRA, Coast 2050, BTNEP, etc.) to develop information, raise consciousness, and implement solutions to stabilize coastal wetlands in Louisiana. Specific projects are discussed in Section 2.4. However, it is questionable that the wetland losses can be stopped and doubtful that these programs will reverse the major losses that have already occurred. The proposed action is expected to curtail losses of wetlands over the long term, but not in the short term. With the proper mitigation for initial direct impacts, over the 50-year life of the project, a net beneficial impact to wetlands would occur. The wetlands section above discusses the wetlands loss problem in the Terrebonne Basin in detail. Without the project, much of the coastal wetlands in Terrebonne Parish would be lost. With the project, the wetlands should fare better over the life of the project.

The years of 1998-2000 have seen unprecedented historical drought for southern Louisiana. In 2000, some 20,000 acres (31 square miles) of saline marsh turned brown and died, much of it in the Terrebonne Basin. Greater losses are likely to be documented in the coming year. This marsh will likely never recover. While much of the loss occurs south of the study area, it is another event in a continuing sequence of loss that places interior wetlands and communities in greater jeopardy.

In a report published in the Baton Rouge Advocate on 2/5/00, the author of Rising Tide: The Great Mississippi River Flood of 1927 and How it Changed America, John M. Barry spoke with the Nature Conservancy. Mr. Barry, who lives in New Orleans, noted "if nothing is done, we'll have ocean-front property. If Coast 2050 works and other things are done, it may look a lot like it looks now". Mr. Barry may be correct that the best we can do is try to hang on to what is left. The proposed action would not reverse past land losses, but would set a line of defense in place for remaining wetland areas.

The proposed action alternatives may reduce development pressure on areas outside the protection systems. However, people have built many farms, businesses, and houses in areas with little or no hurricane protection in the past. The proposed action alternatives should not change overall development rates for the region.

Aquatic Resources

While marine fisheries habitat is not being lost like the wetlands in the study area, it has certainly changed dramatically over the past 50 years. Large areas of marsh have turned into open water. While those open water areas still provide fisheries habitat, they do not provide cover for larval and juvenile stages and do not provide detrital input to the system like marsh areas.

It has been shown that deteriorating marshes increase productivity of fisheries, but as the marshes decline past a critical point, fisheries productivity would likely decrease. Eventually, it is possible that so little wetlands would remain that fisheries production would collapse. The proposed action alternatives are designed to slow marsh loss over the long term and should be beneficial to aquatic resources. However, the alternatives would not prevent wide ranging subsidence that would continue to impact the area.

Threatened and Endangered Species

Threatened and endangered species that may occur in the area have been and would continue to be adversely affected by the large scale wetlands loss occurring in the Terrebonne Basin. The proposed action would not make the situation worse. The initial direct impact losses of marsh would be mitigated and beneficial impacts would be expected in future years. Therefore either of the action alternatives should improve conditions for endangered species over the life of the project.

Socioeconomics

The cumulative impacts of social and economic conditions from both project alternatives would include net benefits to hurricane protection, improve inland areas as harbors of refuge for vessels 26-feet in length or longer, reduce damage to agricultural developments, and reduce damage to recreational and commercial fishing resources. Beneficial impacts would also reduce damage to fresh water supplies in the Houma area and reduce costs of emergency operations during severe storms and hurricanes. These improvements could help maintain the stability of industries that may otherwise require relocation, which could lead to unemployment, loss of income, displacement of people, the decline of the local tax base, and other conditions influencing the local community and region.

The adverse cumulative social and economic impacts of the project alternatives would largely be those associated with the financial costs of constructing and maintaining a project, including the cost of mitigating damages to wetlands that are part of the human environment. As discussed in other sections of this report, initial plans considered the construction of a gate on the HNC, to reduce saltwater intrusion during periods of low water. While this design would be less costly, installation of a lock on the canal has been determined more appropriate because it would reduce saltwater intrusion more effectively and would accommodate waterborne commerce at all times.

Recreation and Tourism and Aesthetic Resources

Recreational hunting and fishing in the project area will experience minimal impacts associated with the building of new floodgates, a new lock, new fish and wildlife water control structures and many miles of levees. The floral and faunal community will receive benefits from the water control structures. Closing the water control structures in times of high tides will restrict saltwater intrusion and protect existing vegetation. Improved water conditions provided by the control structures will benefit the marsh and increase plant cover for game species. Fisheries will also benefit by improved estuarine conditions and increased food sources.

The floodgates and lock will remain open most of the time, closing only in times of storms and high tides. When the floodgates and lock are open there will be no impact to boater's mobility, however when these facilities are closed boats will be contained within the confined levee system. Levees constructed with this project will permanently destroy a corridor of potential hunting habitat. Hunting which currently took place on the land covered by the levee will transfer to adjacent lands with minimal apparent losses to the overall hunting experience. The new levee will provide a linear walking path for hunters and sightseers on the perimeter of the Pointe au Chien Wildlife Management Area.

Cultural Resources

Modern land-use practices associated with agriculture, the timber industry, oil and gas exploration, urban/commercial development, flood control construction and vandalism have all contributed to the disturbance and loss of cultural resource sites. Impacts from oil and gas exploration, flood control projects, and ship channel construction have brought about increased saltwater intrusion. The resulting loss of marsh vegetation has increased erosion and cultural resource site destruction. Erosion and natural subsidence are the primary causes for cultural resource site destruction within the study area.

Cultural resource sites could be disturbed and/or destroyed by levee construction, related borrow activities, and secondary impacts resulting from commercial and recreational development. Nonetheless, cultural resource sites could be easily avoided by a change in the levee alignment and/or shifting the borrow locations away from the resource. Cultural resource sites located on the protected side of the levee could benefit from the levee protection. The levees would help preserve them by reducing saltwater intrusion, erosion, and subsidence. Dredging activities associated with lock and floodgate construction could result in the disturbance of significant historic watercraft. However, areas that have potential for the presence of historic vessels would be surveyed prior to construction and potentially significant sites could then be avoided.

4. CONSULTATION AND COORDINATION

PUBLIC AND AGENCY INVOLVEMENT

Independent of the present study, The University of New Orleans (1993) conducted a survey in the area and respondents agreed on three basic goals for estuary management: 1) preserve habitat, 2) abate pollution, and 3) allow people to continue to make a living there.

A Notice of Intent to prepare an DEIS for the TLCD plan appeared in the Federal Register on April 7, 1993, and invited public comment. A decision was made in October 1994 to combine the NEPA efforts if the Corps entered into a Feasibility study of hurricane protection for the area. In June 1995, the Corps began a Feasibility study on the same problem. Another Notice of Intent disclosing this situation appeared in the Federal Register on September 8, 1995. A Notice of Intent was issued in the Federal Register on October 22, 1999, announcing that a programmatic DEIS would be prepared because of the difficulty planning all details of such a massive project.

The Corps of Engineers held a scoping meeting for a proposed hurricane protection system on May 12, 1993, in Houma, Louisiana and written comments were accepted to scope the DEIS from April 7 to May 24, 1993. Eleven letters were provided to the Corps and 52 individuals registered at the scoping meeting. A scoping document that summarized comments and concerns was sent to all interested participants on April 12, 1994. That document included copies of all letters. Some of the issues raised such as answering legal questions and restoration of barrier islands were determined by the Corps to be beyond the scope of the DEIS. However, most of the concerns were considered relevant and were considered during the planning and analysis of alternatives. Most of the concerns are summarized below as they pertain to the DEIS sections.

Purpose and Need

1. Why follow wetland interface in some areas and not others?
2. Relate protection to category of hurricane.

Alternatives

1. Lock at Houma Navigation. Canal rather than floodgate.
2. Consider excluding private residences from protection in some cases.
3. Barrier island construction.
4. Build levees along wetland interface.
5. Consider alternatives to levee construction (i.e. non-structural).
6. Reroute GIWW south of Cocodrie.
7. Provide a response plan for levee overtopping.
8. Design gates for diverse benefits.
9. Describe coordination of management plans.
10. Will Bayou Grand Caillou project be moved southward?
11. Maintain public access to areas structurally closed off by levee.
12. Who is liable if the levee fails?
13. Life expectancy?
14. O&M, who will do it and who will pay for it? Describe O&M.
15. Who will regulate water flow and timing through the structures?
16. Who will pay for construction?

Impact Analysis

1. Complete hydraulic analysis with levees in place will be needed, including sheet flow and other flows from upstream.
2. Levee design must be analyzed to ensure safety for the level of flood protection.
3. Conduct a cumulative impacts analysis.
4. How will the existing system be impacted?
5. Need analysis of water quality impacts to shellfish and oysters from water pumped out of the system.
6. Conduct a wetland impact analysis of lands inside of levee, including habitat changes and how they will be protected from development and pollution.
7. Will marsh access by available? State water bottoms (e.g. Bayou LaCache?
8. Need historical and cultural resources analysis.
9. Impacts to drinking water and sewage facilities.
10. Impacts on people outside of the system (WQ impacts, will it increase flood elevations, will marsh erode more quickly).

11. Impacts to commercial fisheries including ingress and egress of marine organisms. The design should accommodate this resource.
12. Will FEMA flood insurance be available?
13. Will there be any particular restrictions inside the system?
14. Will material for the levees come from inside or outside the levees?
15. Any loss of jobs? Document socioeconomic analysis, including compensation to landowners.
16. Document Threatened and endangered species consultation.
17. Document mitigation analysis.
18. Analyze hazardous wastes.
19. Delineate wetlands impacted by fill for 404 evaluation.
20. Document prime and unique farmlands.
21. Will marsh support a levee of the size proposed?

An interagency habitat evaluation team (Corps, TLCD, FWS, NMFS, NRCS, LDNRCMD, LDNRCRD, and LDWF) was formed on November 15, 1995. The purpose of the team was to evaluate impacts from proposed plans, suggest methods for reducing impacts, and develop compensatory mitigation if needed, and suggest monitoring efforts. EPA and DEQ were invited to participate, but declined. That team was involved throughout the planning process and would continue to be involved if a project is implemented to evaluate individual components and participate in monitoring.

A public involvement program was implemented for the Morganza, La. to the Gulf of Mexico and Lower Atchafalaya Basin Re-Evaluation studies to achieve early inclusion of stakeholders and address issues in the plan formulation process. The program purpose was to obtain consensus on the options that should be carried forward in the planning process. The program centered on the operations of a Leadership Group and various work groups, which comprised representatives from various interests.

The four initial meetings of the Leadership Group were held in Morgan City on November 15, 1995, February 14, 1996, April 26, 1996, and May 29, 1996. Work groups were formed to address specific issues and screen options. Initially, there was one work group, which was unwieldy. Therefore, groups were differentiated according to the stakeholders in a particular area. Work group meetings occurred about the same timeframe in 1995 and 1996. The groups were directed to discuss the issues at hand and bring conclusions and recommendations back to the Leadership Group for action. The Leadership Group continues to meet annually in Morgan City.

The DPEIS was sent out for public review on November 13, 2001. The Comment period ended February 21, 2002. Thirty-three comment letters where received. Corps responses to these letters were used to modify the DPEIS. The letters and responses can be found in Volume IV of this report. A public meeting was held in Houma on December 12, 2001. Transcript of this meeting is included in Volume IV of this report.

An interagency (Corps, TLCD, LDOTP, FWS, NMFS, NRCS, LDNR, EPA) meeting was held on March 6, 2002 to discuss agency comments to the DPEIS.

Agency Coordination

Federal Agencies

Fish and Wildlife Service
National Marine Fisheries Service
Environmental Protection Agency
Natural Resources Conservation Service
Coast Guard

State Agencies

Department of Wildlife and Fisheries
Department of Transportation and Development
Department of Environmental Quality
Department of Natural Resources

Local Agencies

Terrebonne Parish
Terrebonne Levee and Conservation District

Compliance

The feasibility study and FPEIS have been prepared in compliance with the following applicable laws and executive orders.

Abandoned Shipwreck Act
Archeological and Historic Preservation Act
Bald Eagle Protection Act
Clean Air Act
Clean Water Act
Coastal Barrier Resources Act
Coastal Zone Management Act consistency
Comprehensive Environmental Response, Compensation, and Liability Act
Endangered Species Act, Section 7 consultation

Estuary Protection Act
Farmland Protection Policy Act
Federal Environmental Pesticide Control Act
Federal Water Project Recreation Act
Fish and Wildlife Coordination Act
Floodplain Management (E.O. 11988)
Food Security Act
Intergovernmental Cooperation Act
Land and Water Conservation Fund Act
Marine Protection, Research and Sanctuaries Act
Magnuson-Stevens Act
National Environmental Policy Act
National Historic Preservation Act
Noise Control Act
Noise Pollution and Abatement Act
Paperwork Reduction Act
Preservation of Historic and Archeological Data Act
Protection and Enhancement of Environmental Quality (E.O. 11991)
Protection and Enhancement of the Cultural Environment (E.O. 11593)
Protection of Wetlands (E.O. 11990)
Quiet Communities Act
Resource Conservation and Recovery Act
Rivers and Harbors Appropriation Act
Safe Drinking Water Act
Toxic Substances Control Act
Uniform Relocation Assistance and Real Property Acquisition Policies Act
Water Resource Development Acts
Wild and Scenic Rivers Act

Unresolved Issues

Design and operation details would be generated for each component of a hurricane protection project. Additional calculations regarding GIWW flows and distribution would be needed. An agreement with LDWF would probably be needed to monitor placement of nets around the F&W structures.

Distribution List

Federal

EPA Field Office – Baton Rouge

Federal Aviation Administration/DOTD
Federal Emergency Management Administration - Division Administrator
Federal Emergency Management Administration - Mr Matthew Miller
Federal Highway Administration
Honorable Richard Baker
Honorable John B Breaux
Honorable Thomas A Greene
Honorable William Jefferson
Honorable Chris John
Honorable Mary Landrieu
Honorable Jim McCrery
Honorable Billy Tauzin
Honorable David Vitter
Martin Cancienne – Honorable Billy Tauzin
National Marine Fisheries Service – Terri Jordan
National Marine Fisheries Service
National Marine Fisheries Service – Reg Administrator Reg IV
U.S. Advisory Council on Historic Preservation - Executive Director
U.S. Advisory Council on Historic Preservation
U.S. Army Corps of Engineers-CEMVD-PM-R
U.S. Army Corps of Engineers-HQ
U.S. Coast Guard-Commander (M) 8th District
U.S. Department of Agriculture-Louisiana Cooperative Extension Service
U.S. Department of Agriculture - Mr. Martin Bonura
U.S. Department of Agriculture-Natural Resource Conservation Service-State Conservationist
U.S. Department of Agriculture-Natural Resources Conservation Service
USDA Natural Resources Conservation Service
U.S. Department of Energy-Office of Environmental Compliance
U.S. Department of Health & Human Services-Center for Disease Control
U.S. Department of Housing & Urban Development-Environmental Officer
U.S. Department of the Interior-National Park Service-Jean Lafitte Historical Park
U.S. Department of the Interior-Office of Environmental Policy & Compliance
U.S. Department of the Interior-Samuel W. Holder
U.S. Environmental Protection Agency-Office of Federal Activities/EIS Section
U.S. Environmental Protection Agency - Region VI
U.S. Fish & Wildlife Service Field Supervisor – Lafayette

State

Barataria-Terrebonne National Estuary Program – Kerry St. Pe
Cultural & Historic Preservation-Tunica-Biloxi Indians of LA
Cultural & Historical Research & Development
Honorable Kathleen Blanco
Honorable Hunt Downer
Honorable Reggie Dupre, Jr.
Honorable Mike Foster
Honorable D.A. Gautreaux
Honorable Richard Ieyoub
Honorable W Fox McKeithen
Honorable Bob Odom
Honorable Michael Robichaux
Honorable John Siracusa
Honorable Mitch Theriot
Honorable Warren Triche, Jr.
LA Department of Agriculture & Forestry-Mr. Matthew Keppinger
LA Department of Agriculture & Forestry-Office of Forestry
LA Department of Culture Recreation & Tourism
LA Department of Culture Recreation & Tourism/Office of State Parks-Division of Outdoor Recreation
LA Department of Environmental Quality-Office of Water Resources
LA Department of Environmental Quality-Inactive & Abandoned Sites
LA Department of Environmental Quality-Office of the Secretary
LA Department of Environmental Quality - Solid & Hazardous Waste
LA Department of Environmental Quality-Air Quality and Radiation Protection
LA Department of Environmental Quality-Bayou Lafourche Regional Office
LA Department of Health & Hospitals
LA Department of Natural Resources
LA Department of Natural Resources Office of Coastal Restoration & Management
LA Department of Transportation & Development
LA Department of Transportation & Development-Federal Projects Section
LA Department of Transportation & Development – Mr. Curtis Patterson
LA Department of Transportation & Development – Ms. Sharon Balfour
LA Department of Wildlife & Fisheries
LA Department of Wildlife & Fisheries-National Heritage Program
LA Department of Wildlife & Fisheries-Secretary
LA Division of Administration-State Land Office
LA Division of Administration-State Planning Office
LA Mosquito Control Board
LA State Attorney General’s Office
LA State Board of Commerce & Industry-Research Division

Mr. Arthur L. Long – DNR/CRD
Mr. Rick Serpas – DNR/CMD
Mr. Garrett Broussard – DNR/CRD
Office of the Governor – Dr. Len Bahr

Local

Acadian Region Clearinghouse – Federal Program Review Coordinator
Atchafalaya Basin Levee Dist
Department of Planning, Zoning, and Coded
Honorable Warren Triche, Jr
Lafourche Parish Council:
Mr. Jerry Jones – Lafourche Parish Council, District 1
Mr. Charles R. Banta, III – Lafourche Parish Council, District 2
Mr. Roland Soignet – Lafourche Parish Council, District 3
Mr. Joseph "Joe" Fertitta – Lafourche Parish Council, District 4
Mr. Rhebb Rybiski – Lafourche Parish Council, District 5
Mr. Lindell Toups – Lafourche Parish Council, Disrtict 6
Mr. Phillip Gouaux, II – Lafourche Parish Council, District 7
Mr. Darryl Marlbrough – Lafourche Parish Council, District 8
Mr. Daniel Lorraine – Lafourche Parish Council, Disrtict 9
Lafourche Parish President - Mr. Gerald J. "Buzz" Breaux
Lafourche Parish Public Works Director – Mr. Rufus Savoie
Mayor- City of Berwick
Mayor of Morgan City - Honorable Timothy Matte
North Delta Region Planning & Development District – Federal Program Review Coordinator
NW Regional Clearinghouse – Federal Program Review Coordinator
Port of Greater Baton Rouge
Port of Morgan City – Mr. Jerry L Hoffpauir
Port of West St. Mary – Mr. Merlin Dupre
Regional Planning Commission Mayor of Thibodaux
South Central Planning & Development District
Terrebonne Levee & Conservation District Board of Commissioners:
Mr. Donald Chaisson - Terrebonne Levee & Conservation District
Mr. David Crochet - Terrebonne Levee & Conservation District
Mr. Walton Daisy - Terrebonne Levee & Conservation District
Mr. Willis Henry - Terrebonne Levee & Conservation District
Mr. Allan Luke - Terrebonne Levee & Conservation District
Mr. Thomas Naquin - Terrebonne Levee & Conservation District
Mr. E. Pellegrin - Terrebonne Levee & Conservation District
Mr. Gilbert Talbot, Sr - Terrebonne Levee & Conservation District
Mr. Marvin Thibodeaux - Terrebonne Levee & Conservation District
Mr. Michael Scurto - Terrebonne Levee & Conservation District
Mr. Jerome Zeringue - Terrebonne Levee & Conservation District
Terrebonne Parish Council:

Mr. Alvin Tillman – Terrebonne Parish Council, Councilman District 1
Mr. Wayne Thibodeaux – Terrebonne Parish Council, Councilman District 2
Mr. Ray Boudreaux, Jr – Terrebonne Parish Council, Vice Chairman Disrtict 3
Ms. Christa Duplantis – Terrebonne Parish Council, Councilwoman District 4
Mr. J.B. Breaux – Terrebonne Parish Council, Councilman District 5
Mr. Harold Lapeyre – Terrebonne Parish Council, Councilman Disrtict 6
Mr. Clayton Voisin – Terrebonne Parish Council, Councilman Disrtict 7
Mr. Peter Rhodes – Terrebonne Parish Council, Councilman District 8
Mr. Daniel Henry – Terrebonne Parish Council, Chairman District 9
Terrebonne Parish President - Mr. Bobby Bergeron
Terrebonne Parish Council-Waterways & Permit Committee
Terrebonne Parish Cultural Resources & Economic Development Director – Mr. Mart Black
Terrebonne Parish Engineer – Mr. Bob Jones
Terrebonne Parish Port Commission:
Mr. Bobby Barthel - Terrebonne Parish Port Commission
Mr. Barry Belanger - Terrebonne Parish Port Commission
Mr. Kerry Chauvin – Terrebonne Parish Port Commission
Mr. Gary Landry - Terrebonne Parish Port Commission
Mr. Joel Lapeyrouse - Terrebonne Parish Port Commission
Mr. John Woodard – Terrebonne Parish Port Commission, Chairman
Terrebonne Parish Public Works Director – Mr. Al Levron

Groups

Alliance of Concerned Citizens
Association of Louisiana Bass Clubs
Audubon Society-Orleans
Audubon Society-National
Audobon Society-National Chairman
Audubon Society-National Regional Representatives
CLIO Sportsman League
Coalition of Coastal Parishes
Coalition to Restore Coastal Louisiana
Concerned Citizens for Informed Choices
Ducks Unlimited Inc - Dr. Tom Morromon
Environmental Committee – Bonnet Carre Rod & Gun Club
Environmental Defense Fund
Gulf Coast Conservation Association

Gulf of Mexico Fisheries Management Council
Gulf Restoration Network
Gulf States Marine Fisheries Commission
League of Women Voters of Louisiana
Louisiana Inshore Shimpers Association
Louisiana Nature Conservancy
Louisiana Wildlife Federation
National Wildlife Federation
Natural Resources Defense Council
Terrebonne Fisherman's Organization – Charles Ledet
Terrebonne Fisherman's Organization – Donald Lirette
Terrebonne Fisherman's Organization – Donald Norman
Sierra Club – Delta Chapter
Sierra Club – Honey Island Group
Sierra Club – Legal Defense
South Louisiana Environmental Council

Individuals

Gerald Adkins
W.J. Athlement
W.J. Athlement
Oubre Bradley
Donald Chanberlain
Henry Chauvin
Mr. R Collins
Kenneth Domanque
Elise Duplantis
Robert Gorman
Jimmy Guinry
Leward Henry
Michael Jefferson
Gregory Layton
Roy Leboeuf, Jr.
Melvin Lerette
Dr. Clyde Lindsey
Mr. C C Lockwood
O'Neil Malbrough
Baird McElroy
Captain O T Melvin Jr.
W.A. Monteleone
Albert P. Naquin
Jerry Nettleton
Kary Nettleton
Larry Nettleton
Mr. & Mrs. Jimmie Price
Jerry Nettleton

Michael Robinson
Mr. Victor L. Roy, III
Harold Schoeffler
Mildred Pellegrin & Roy Simoneaux
Wayne Simoneaux
Gibert Talbot
Mr. H J Thibodaux
Gretchen Thompson
Floyd Trosclair
Jamesel Vedros
Mr. Jay Vincent
Mr. & Mrs. Evest Voison, Jr.
Billy Ward
Montgomery Watson
Mr. John Zimmer

Libraries & Museums

Coastal Studies Institute-Louisiana State University
Lafayette Natural History Museum & Planetarium
Lafourche Library
Louisiana Collection/Howard-Tilton-Tulane Univeristy
Louisiana Collection-University of New Orleans
Louisiana State University-Mrs. Roberta A. Scull
News Orleans Public Library-Louisiana Division
Nicholls State University Library
Terrebonne Parish-Main Branch
State Library of Louisiana-Louisiana Section

Media

East Bank Times-Picayune
The Advocate-Lafayette
The Daily Comet-Thibodaux
The Houma Courier
The Times-Picayune-Mr. Mark Schleifstein
State-Times/Morning Advocate- Outdoor Editor- Mr. Mike Cook

University Affiliated

Curator of Anthropology – Louisiana State University

Dr. Anatoly Hochstein - Louisiana State University
Dr. Jack R Van Lopik - Louisiana State University
Louisiana State University SEA Grant Legal Program
Earl Melancon - Nicholls State University
H. Paul Friesema - Northwestern University
Dr. Oliver Houck - Tulane University Law School
Melanie Reed - Tulane Environmental Law Clinic
Denise Reed - Univeristy of New Orleans

Businesses

American Waterways Operation - Mr. Ken Wells
AVOCA Inc - Mr. Paul Hogan/ President
Burlington Resources/ LL&E - Jeff Deblieux
Chamberlain Construction - Donald Chamberlain
Conrad Industries - Mr. J Parker Conrad/President
Continental Land & Fur Co - Mr. George A Strain
Digital Engineering
Fina-Laterre Oil Co - Mr. John Woodward
Fina Oil and Chemical Company - John Woodard
Gibbons & Blackwell Attorneys at Law - Mr. Dennis Stevens
Giroir Enterprises - Mr. Everett Giroir, Jr
Harry Bourg Corp. - Cyrus Theriot
J H Menge & Co - Buren Jones
Louisiana Land & Exp Co
Mid-Continent Oil & Gas Assoc
Middle South Services Inc - Mr. Joe D Patterson
Shintaux Environmental Services Inc
St. Mary Land & Exploration Co - Ms. Linda Ditsworth
Swiftships Inc
T Baker Smith & Son Inc
T. Baker Smith & Son, Inc - H.J. Thibodaux and Son
T. Baker Smith & Son, Inc - William Clifford Smith
T. Baker Smith - Jens Nielsen
Thompson Marine Transport - Mr. Bob Thompson
Walk Haydel - Mr. Frank H Walk
Westerfelt Real Estate - Mr. Carl Heck, Jr
Williams Inc - Mr. Rudy Sparks

5. U.S. Fish and Wildlife Services Recommendations

The Service submits the following recommendations to mitigate project impacts on fish and wildlife resources, and to obtain optimal project benefits for those resources:

1. The feasibility report should clearly state that a goal of the recommended plan is to maintain existing and future without-project freshwater flows transported by the GIWW from the Atchafalya River to the central project area and to distribute those flows to optimize project benefits to coastal wetlands and associated fish and wildlife resources.

The Corps' analyses verified that the floodgates west of Houma in the GIWW have little or no impact on water flowing to the east. Two adjacent floodgates in the GIWW are anticipated to perform better than attempting to place flap-gate structures in the tie-in walls. The Corps can not commit to distributing and optimizing flows into coastal wetlands. That function may be conducted by other agencies or under separate project authorities, such as CWPPRA and Coast 2050. The Corps has committed to maintaining existing and projected future flows from the Atchafalaya River through the GIWW. The Corps recognizes that the project, though very large, has been formulated to cause as little disruption to existing flow patterns as possible.

2. Estimates of all direct and indirect project-related wetlands impacts, including those associated with changes in freshwater inflow and distribution, should be refined during the engineering and design phase.

The Corps agrees that as project components are refined, environmental impact analysis would need to be conducted for each of those features using the latest available information and models. Environmental compliance would be obtained for individual components, as details of each component are refined in the next phase.

3. Because of its substantial wetland benefits, construction of the HNC Lock should be given top priority for implementation.

The Corps agrees.

4. The Corps should coordinate closely with the Service and other fish and wildlife conservation agencies throughout the engineering and design of the proposed HNC Lock, floodgates, and other water control structures (including fish and wildlife structures in the levees) to ensure that those structures are designed, constructed and operated consistently with wetland and associated fish and wildlife resource needs. In that regard, the Service recommends the following items.

   a. The Bayou Grand Caillou Floodgate shall include installation and operation of one or more large auxiliary gates sufficient to maintain existing downstream freshwater flows and to preclude saltwater intrusion.

The Corps agrees.

   b. The Service and other fish and wildlife conservation agencies shall be involved in developing operation plans for all fish and wildlife structures and the final coordinated operation plans for the HNC Lock, the Bayou Grand Caillou Floodgate, and the structures along Falgout Canal Road. Those plans should include floodgate, lock, auxiliary gate, and fish and wildlife structure closures to prevent saltwater intrusion, and operations to improve freshwater distribution during high Atchafalaya River stages or high southward freshwater flows.

The Corps intends to continue to involve the interagency HET for evaluation and planning purposes on individual components of the project and systematic operation of all components.

   c. Where the operation plans referenced in item number 4.b. above include salinity, water level, or flow criteria, monitoring of those parameters shall be as recommended by the Service and other fish and wildlife conservation agencies.

Monitoring would be an integral part of the selected plan and the interagency HET would be involved in the development of detailed monitoring plans.

   d. Should the design studies for the Grand Bayou Floodgate show that additional cross-section is needed to pass 1,000 cfs (see additional information request number 8d below), it should be provided via additional non-navigable gates.

The Corps recognizes that there is an authorized CWPPRA project for this area and intends to meet its obligations fully to allow that project to function as designed.

5. To the greatest degree practical, the hurricane protection levees and borrow pits should be located to minimize direct and indirect impacts to emergent wetlands. Further efforts should be made to reduce those direct impacts by hauling in fill material and/or using sheetpile for the levee crest to reduce the size of the levee base. If possible, the levee and/or borrow canal reach along the southern end of the Lake Boudreaux Basin should be constructed on the north side of Louisiana Highway 57 where impacts would be lessened by siting that feature in an area of high wetland loss rates.

The current analyses of direct impacts are most likely a liberal estimate. The Corps would attempt to reduce those impacts by locating borrow from open water areas, hauling fill, etc. in the next phase.

6. Material dredged during construction should be used to create or restore emergent wetlands to the greatest extent practicable.

The Corps recognizes that there may be opportunity to create wetlands from material obtained from the surface of borrow areas. The Louisiana Department of Natural Resources would require that material be used for beneficial purposes. Use of this material to create marsh would likely reduce compensatory mitigation. However, because the exact location of borrow areas would likely change this beneficial use was not accounted for in the present evaluation.

7. Full, in-kind compensation (quantified in AAHUs) should be provided for unavoidable net adverse project impacts on forested wetlands, marsh, and associated submerged vegetation, including any additional losses that are determined during post-authorization engineering and design studies. To ensure that the proposed marsh-creation mitigation features meet their goals, the Service provides the following recommendations:

a. The proposed enlargement of Minors Canal should include the installation of piling barricades on both ends of the canal to preclude use by heavy vessels that cause excessive bank erosion, a water control structure on the southern end of the canal to regulate freshwater flows and preclude saltwater intrusion, and the maintenance of spoil banks along both sides of the canal.

The Corps agrees.

b. Brackish marsh impacts should be mitigated in subarea G6 through the creation of a brackish marsh land bridge separating the fresh and low-salinity habitats to the north from brackish marshes to the south.

The Corps agrees to this concept.

c. Marsh creation mitigation projects shall be determined to have met their goals (in AAHUs) when the acreage of created marsh/land equals or exceeds that projected by the HET at target year 3.

The Corps agrees to offset AAHU's lost for specific wetland types. The Corps also agrees that by target year 3, a created wetland should be functional. This may be just a different way of stating recommendation 7.c.

d. The Service should be consulted in the development of plans and specifications for mitigation features.

The Corps agrees.

8. Extensive additional information is needed by the Service to complete our required evaluation of project effects and fulfill our reporting responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act. Much of that information will not be available until engineering and design of the selected plan is completed. To help ensure that sufficient information is provided, the Service recommends that the Corps perform the following tasks during the engineering and design phase. The Service also recommends that the Corps provide the Service with the opportunity to review and comment on model assumptions and input data prior to initiating modeling analyses necessary to complete those tasks.

a. Conduct a hydrologic model analysis of the entire project to determine system-wide effects on the flow and distribution of fresh water entering the project area via the GIWW. That analysis should simulate a range of Atchafalya River stages and provide outputs including discharge, water levels and (where appropriate) salinities. The results of those analyses are needed to aid in siting, design, and developing coordinated operating plans for the various water control structures.

The Corps agrees.

b. Determine the effects of the West GIWW Floodgate, including water level changes west of the floodgate and on the passage of existing and projected future eastward flows of Atchafalya River water.

While an analysis has been conducted for the West GIWW Floodgate, the Corps recognizes that additional modelling would be needed to detail the impacts of the structure.

c. Determine the effects of the Bayou Grand Caillou Floodgate, including water level changes north of the floodgate and the passage of existing and projected future southward flows of Atchafalya River water.

The Corps agrees that additional work needs to be done in this area.

d. Determine the effects of the Grand Bayou Floodgate on the Grand Bayou/GIWW Freshwater Diversion Project, including water level changes across the floodgate, velocities at the structure, and the ability of that floodgate to pass 1,000 cfs. This analysis should validate the previous modeling assumption (i.e., that velocities of 3 feet per second would occur at the floodgate, and that the floodgate would thus be able to pass at least 1,000 cfs of fresh water during periods of maximum freshwater availability).

The Corps believes that it has conducted analyses to show that the structure will pass 1,000 cfs and will operate in concert with the Grand Bayou/GIWW Freshwater Diversion Project.

e. Determine, through an analysis of hourly water levels in the HNC at Bayou Pelton, how the operation of the HNC

Lock and Bayou Grand Caillou Floodgate would affect the intended function of the CWPPRA-funded Lake Boudreaux Basin Freshwater Introduction Project.

A more complete analysis of the influences would be conducted.

f. Determine the effect of HNC Lock and Bayou Grand Caillou Floodgate operations on salinities north of the HNC Lock and in the Lake Boudreaux Basin.

Additional information would be provided on salinity changes caused by the various components of a hurricane protection project. The Corps has been criticized at this point for not giving these structures more beneficial impact, but the Corps would rather err on the conservative side at this point if there is an error.

g. Provide additional information on anticipated construction techniques and their associated wetland impacts, such as additional dredging to install floodgates and water control structures, dredging temporary by-pass channels, and the method for disposing organic surface soils that are unsuitable for levee construction.

Each component would be evaluated thoroughly when details are generated.

h. Provide final locations and designs for borrow sites used in levee construction.

When details on final borrow locations are known for the various reaches, environmental compliance would be conducted and the Service would be included in those evaluations.

9. Sufficient funding should be provided to the Service for participation in the post-authorization engineering and design studies, and to allow the Service to fulfill its responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act.

Funding would be provided.

10. The Corps should obtain a right-of-way from the Service prior to conducting any work on Mandalay National Wildlife Refuge, in conformance with Section 29.21-1, Title 50, Right-of-Way Regulations. Issuance of a right-

of-way will be contingent on a determination by the Service's Regional Director that proposed work will be compatible with the purposes for which the refuge was established.

The Corps would comply with this recommendation.

Section 303(d) of CWPPRA requires the Secretary of the Army, in consultation with the Director of the Fish and Wildlife Service and the Administrator of the Environmental Protection Agency, to ensure that Corps projects are consistent with the purposes of the restoration plan prepared in compliance with Section 303(b) of CWPPRA. That plan includes the Grand Bayou/GIWW Freshwater Diversion Project being implemented by the Service. Other small-scale freshwater introduction projects, like the CWPPRA-funded Lake Boudreaux Basin Freshwater Introduction Project, while not specifically mentioned in the plan, are part of the plan's strategy for the Timbalier Subbasin. In 1998, the Louisiana Coastal Wetlands Conservation and Restoration Task Force updated and revised that plan; the revised plan is called the Coast 2050 Plan (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). As noted above, additional modeling analyses will be required to sufficiently determine the hydrologic effects of the floodgates and structures included in the Tentatively Selected Plan. Therefore, the Service cannot yet definitely determine if the Tentatively Selected Plan is consistent with the current Louisiana Coastal Wetlands Restoration Plan.

So that the Service may fulfill its responsibilities under the Fish and Wildlife Coordination Act, the Service will require additional funding during the engineering and design phase of this project. Estimates of Service funding needed would be coordinated in advance with the Service, and based on the nature and complexity of issues associated with the project components being implemented.

Provided that the above recommendations and associated funding needs are included in the feasibility report and related authorizing documents, the Service will support the Tentatively Selected Plan.

6. LIST OF PREPARERS

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CWPPRA- see Coastal Wetland Planning, Protection, and Restoration Act

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