



Report

# Field Investigation of Continuous Seawall

South Side of U.S. Highway 90 in Mississippi

*July 10, 2007*



**FEMA**

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Task Order 18

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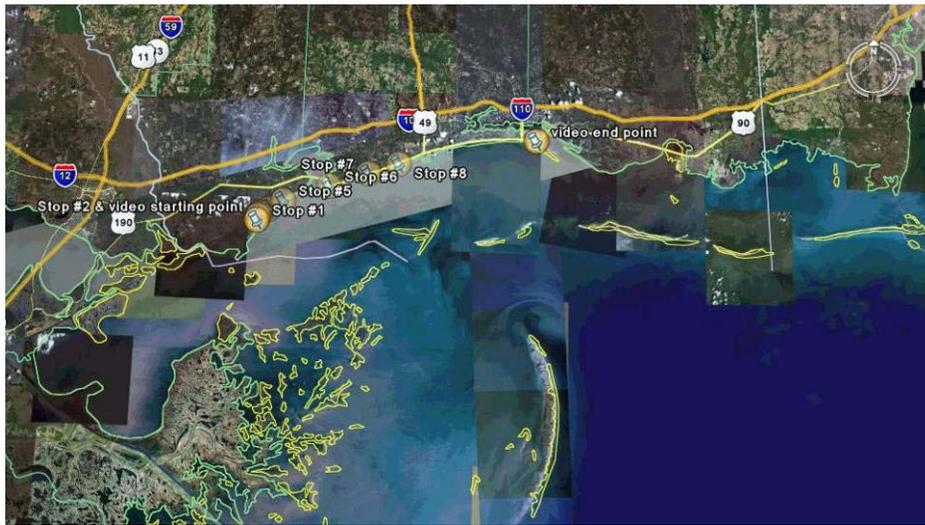
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## Appendices

Appendix A	Biloxi Chamber of Commerce Report
Appendix B	U.S. Army Corps of Engineers Overview of Seawalls

On May 23-24, 2006, URS performed a field investigation to evaluate the extent and character of the Mississippi Seawall. The purpose of this investigation was to assess the seawall's importance and potential mechanisms for including it into the advance circulation (ADCIRC) grid for the Federal Emergency Management Agency (FEMA)-URS Mississippi flood map study. This investigation involved visual assessments from the ground, and this report includes 25 digital photographs from 7 of the stopping points during the reconnaissance effort. Also, while driving eastbound along the coastal roadway (U.S. Highway 90) at approximately 30 miles per hour, digital video was collected of the seawall and beach along approximately 30 miles of the Mississippi coastline. Figure 1 is a plan view map showing the locations of this documentation.



**Figure 1. Plan view map of entire Mississippi coast, with place marks identifying the locations of the photographs and video collected during the May 2006 field reconnaissance visit.**

The photographs are included in Section 2, organized by the stopping points where they were taken, numbered west to east. The location of each stopping point is given in latitude/longitude (Lat/Lon) coordinates obtained from a handheld digital Global Positioning System (GPS). The video segments are saved on CD as .mpg files, labeled with their location in respect to the stopping points and the video end point. Figure 2 is a close-up view of the entire Hancock and Harrison County area of investigation, and Figure 3 is a close-up view of the stop locations (near St. Louis Bay) where the photographs were collected.

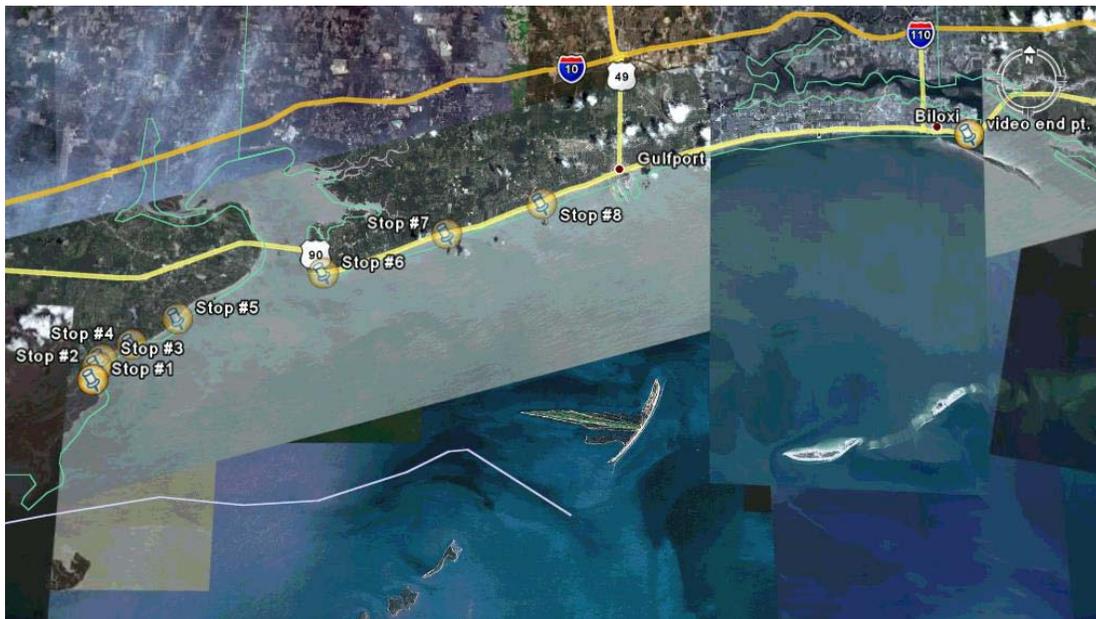


Figure 2. Plan view of the entire area of investigation.



Figure 3. Close-up view of the stop locations where the photographs were collected.

Table 1 includes the Lat/Lon coordinates for each of the 8 stops from which the 25 photographs were taken.

**Table 1. Photograph Locations**

Stop Number	Location in Lat/Lon	Number of Pictures
1	N 30° 14.514', W 89° 25.512'	5
2	N 30° 14.945', W 89° 25.399'	3
3	N 30° 15.196', W 89° 25.219'	4
4	N 30° 15.714', W 89° 24.114'	4
5	N 30° 16.612', W 89° 22.435'	2
6	N 30° 18.257', W 89° 16.915'	4
7	N 30° 19.684', W 89° 12.215'	3
8	N 30° 20.783', W 89° 08.560'	0

Table 2 includes the filename of each video clip, with a brief explanation of the nature of each. (Note: Videos are archived with the principal investigator, Dr. Don Slinn of the University of Florida.)

**Table 2. Video Clips**

Video Clip Number and <i>Filename</i>	Quick Video Notes
01_at Stop 2.mpg	Panning 360° at Stop 2 and zooming in distance.
02_at Stop 3.mpg	Panning 270° at Stop 3 and zooming in distance.
03_driving between Stop 3 & Stop 4.mpg	Video while driving between Stops 3 and 4.
04_driving towards & at Stop 4.mpg	Resuming from video 4, driving toward Stop 4, and panning 180° at Stop 4.
05_at Stop 6 & driving between Stop 6 & Stop 7.mpg	Panning 360° at Stop 6 and zooming in distance from mid-berm and from seaward edge of berm. Then looking at road failure caused by undermining from failed stormwater drainage pipes under the road. Lastly, driving east away from Stop 6.
06_driving to & away from Stop 7 & at Stop 7.mpg	Resuming from video 5 and driving toward Stop 7, panning 360° at Stop 7 from mid berm and zooming in distance. Then driving east away from Stop 7.
07_driving after Stop 8 part 1 including parking lot.mpg	Resuming from video 6. Driving away from Stop 7, U-turn around seawall at McDonald's sign to get seaward face of seawall, then resuming driving east away from Stop 7.
08_driving after Stop 8 part 2.mpg	Resuming from video 7.
09_driving after Stop 8 part 3.mpg	Resuming from video 8.
10_driving after Stop 8 part 4.mpg	Resuming from video 9. Stopping at video endpoint shown in Figures 1 and 2.

Descriptions and photographs of each stop location follow.

May 23, 2006

STOP #1, 4:55 p.m.

Location: N 30° 14.514', W 89° 25.512'

No video collected at this location.



Figure 4. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.



Figure 5. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.



**Figure 6. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 7. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 8. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**

STOP #2, 5:10 p.m.

Location: N 30° 14.945', W 89° 25.399'

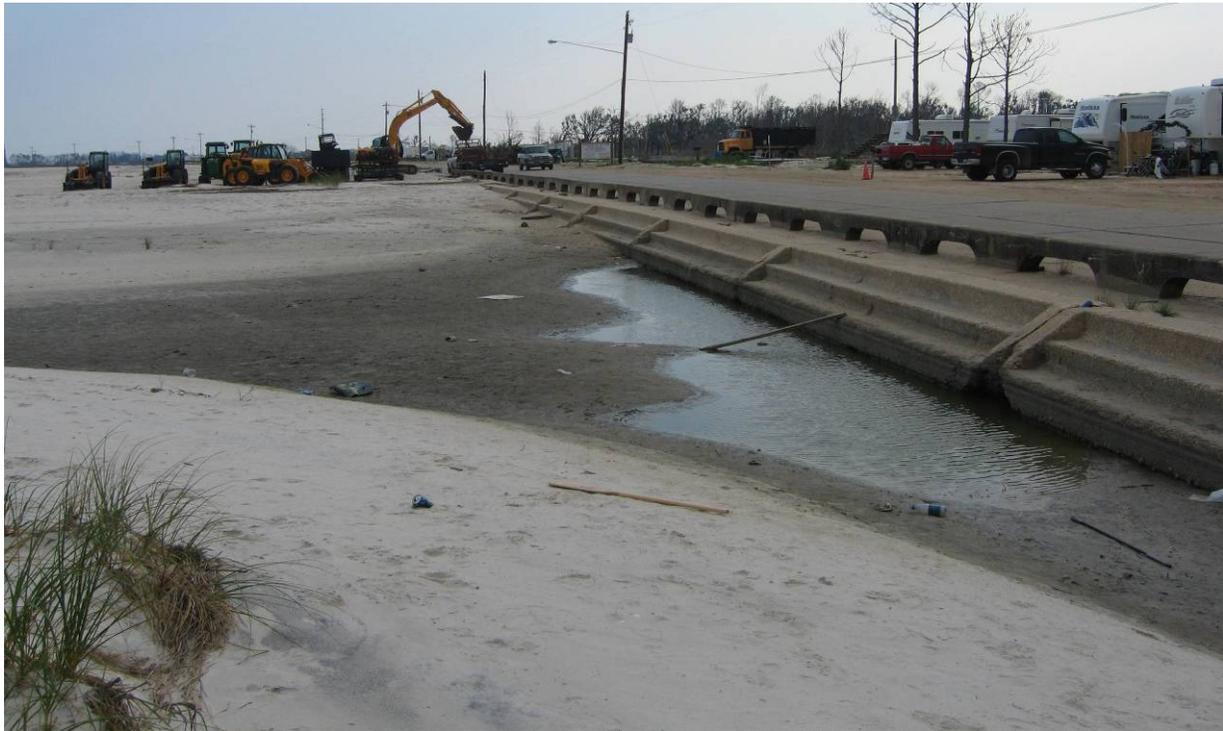
See also video clip 01, collected at this location.



**Figure 9. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 10. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 11. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**

STOP #3, 5:30 p.m.

Location: N 30° 15.196', W 89° 25.219'

See also video clip 02, collected at this location.



**Figure 12. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 13. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 14. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 15. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**

STOP #4, 5:40 p.m.

Location: N 30° 15.714', W 89° 24.114'

See also video clip 03, driving between Stops 3 and 4; and video clip 04, up to and at Stop 4.

Notice recent wrack lines and spots where the sidewalk adjoining the landward side of the top of the seawall has failed due to failure of underground stormwater drainage structures during the storm. Note where the road or sidewalk failed on the landward of the seawall. The seawall never failed.



**Figure 16. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 17. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 18. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**



**Figure 19. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.**

STOP #5, 5:50 p.m.

Location: N 30° 16.612', W 89° 22.435'

No video collected at this location.



Figure 20. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.



Figure 21. Hancock County seawall located along Gulf shorelines of Waveland and Bay St. Louis.

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May 24, 2006

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STOP #6, 1:30 p.m.

Location: N 30° 18.257', W 89° 16.915'

See also video clip 05, at Stop 6 and driving away from Stop 6.



**Figure 22. Harrison County seawall along Gulf shorelines of Pass Christian, Long Beach, and Gulfport.**



**Figure 23. Harrison County seawall along Gulf shorelines of Pass Christian, Long Beach, and Gulfport.**



**Figure 24. Harrison County seawall along Gulf shorelines of Pass Christian, Long Beach, and Gulfport.**



**Figure 25. Harrison County seawall along Gulf shorelines of Pass Christian, Long Beach, and Gulfport.**

STOP #7, 2:05 p.m.

Location: N 30° 19.684', W 89° 12.215'

See also video clip 06, driving up to and away from Stop 7.



**Figure 26. Harrison County seawall along Gulf shorelines of Pass Christian, Long Beach, and Gulfport.**



**Figure 27. Harrison County seawall along Gulf shorelines of Pass Christian, Long Beach, and Gulfport.**



**Figure 28. Harrison County seawall along Gulf shorelines of Pass Christian, Long Beach, and Gulfport.**

STOP #8, 3:10 p.m.

Location: N 30° 20.783', W 89° 08.560'

No still pictures taken, however, see video clips 07, 08, 09, and 10; driving up to and away from Stop 8 and up to the video end point, shown on Figures 1 and 2.

There is a concrete seawall, extending approximately 5 feet above sea level, running along approximately half of the coastline of Mississippi. Where no seawall is present, it is typically because that stretch of coast is covered with marshland, and the area closest to the ocean is unimproved. In the regions that are improved or that have a sandy beach on the ocean, the nearly continuous seawall is located along the seaward right-of-way of the coastal highway (U.S. Highway 90) or at the back of the beach. Typically the beach is about 50-100 meters wide, and in remarkably good shape, free from significant regions of beach erosion. We saw several large tractors working on the beach, smoothing and spreading the sand. Local residents told us that some sections of beach had been re-nourished a few months before Hurricane Katrina. For approximately 30 miles, between Pass Christian and East Biloxi, the seawall runs right next to U.S. Highway 90. On the west side of St. Louis Bay the seawall runs for about 10 miles, almost to the Louisiana-Mississippi border, as far as there is a beach front road. In some locations there is little or no beach, depending on the tide level. Here the ocean comes right up to the seawall and the road, with rocks placed to help prevent toe scour under the seawall. The seawall survived Hurricane Katrina with little damage. The structural purpose of the seawall is to protect the coastal roads from erosion. The walls were very successful in accomplishing this purpose.

It is URS' clear assessment that the seawall can simply be considered a part of the armoring of the roadway for the purposes of storm surge modeling. If the roads are modeled in ADCIRC as weirs, there should not be any need to include the seawall in a fashion separate from the roadway. The seawall almost always sits immediately next to the exposed coastal flank of the road. It typically extends to a height of between 6 inches and 1 foot above the grade of the southern (seaward) side of the road. In many instances along the coast that included the seawall, the road was a divided four-lane roadway, with two lanes going both east and west. For approximately half of this distance, the roadway was divided, with a (grass or landscaped) median between the eastbound and westbound lanes. In many cases, the westbound lanes were on an elevation approximately 2 to 5 feet higher than the grade of the eastbound lanes of traffic. In these cases, the grade of the westbound roadway was much higher than the seawall, and the coastal roadway (usually Highway 90) was a much more significant barrier to storm surge than the seawall would be alone.

The relative height of the seawall above the beach typically varied from approximately 6 inches to 4 feet. The seawall was made of steps or tiers, as shown in the photographs. The steps were typically about 18 inches wide and one foot tall, and very comfortable and safe to walk up and down. Often the top of the seawall was integrated into the sidewalk and curb along the seaward side of the road. Because of the horizontal grid resolution included in ADCIRC for these studies, it is permissible to ignore the separate effect of the seawall, as long as the roadway is included in the model grid.

Appendix A includes a report on the construction of the Mississippi Sea Wall by the Biloxi Chamber of Commerce.

Appendix B includes a brief overview report from the U.S. Army Corps of Engineers on the Coastal Counties of Mississippi that were affected by Hurricane Katrina.

## **Appendix A**

**Biloxi Chamber of Commerce Report (from Web site)**

In 1927 the seawall was constructed to protect the Mississippi Gulf Coast from the eroding effects of hurricanes.

In 1950, sand was dredged from the Mississippi Sound to create a manmade beach as additional protection from hurricanes. Hurricanes have devastated the Mississippi Coast for years. Some of the most notable occurred in 1722, 1893, 1915, and 1947. On August 17, 1969, Hurricane Camille dealt the Mississippi Gulf Coast and Biloxi a catastrophic blow. In the aftermath, Biloxi and other coastal cities began the difficult task of digging out of the rubble. Like after previous catastrophic storms, Biloxians immediately started rebuilding, while at the same time building a new future that would take them into the next century.

After Hurricane Camille, the economy of Biloxi slowly recovered. All that changed in 1992, however, when the State of Mississippi chose to allow legalized dockside gaming. Since the law required casinos to be on the water, and since Biloxi was already a popular vacation spot, the addition of gaming was a boon to the city.

(Source: Biloxi Chamber of Commerce Web site: [www.biloxi.org](http://www.biloxi.org))

## **Appendix B**

**U.S. Army Corps of Engineers Overview of Seawalls (excerpts from undated Post-Katrina report)**

## INUNDATED AREAS

### DESCRIPTION OF COASTAL COUNTIES AFFECTED

Those coastal counties in the Mobile District affected by the hurricane surge from Katrina were (from west to east): Hancock, Harrison, and Jackson Counties in Mississippi, and Mobile and Baldwin Counties in Alabama.

In Mississippi, the length of the coastline, which runs generally east and west, is 75 miles. The coastal area is bounded on the west by the Pearl River, on the east by the Alabama State line, and on the south by the Mississippi Sound. The latter is a partially protected body of water averaging 8 to 10 miles wide, and separated from the Gulf of Mexico by a series of five barrier sand islands, with rather large gaps or passes between them. Four of the five islands lie off the Mississippi coast. Proceeding from west to east, the five are: Cat Island, Ship Island, Horn Island, Petit Bois Island, and Dauphin Island. The Gulf Intra-coastal Waterway (project dimensions 12 by 150 feet) traverses deep water in the Mississippi Sound a few miles from the mainland shore. The mainland shore is broken by the entrances to St. Louis Bay, between Bay St. Louis and Pass Christian, and Biloxi Bay, between Biloxi and Ocean Springs. U. S. Highway 90 traverses the area a few miles inland except in Harrison County, where it closely borders the coastline. Two major rivers empty into the Mississippi Sound: the Pearl River, which forms the boundary between Mississippi and Louisiana; and the Pascagoula River, which traverses Jackson County and enters the sound at Pascagoula. Coastal elevations vary generally from low-lying marsh reaches at the eastern and western extremities, to relatively high ground near shore in the central portion. Major towns along the coast are, from west to east: Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Mississippi City, Biloxi, Ocean Springs, and Pascagoula.

Hancock County, with a 1960 population of 14,000, is the least populous of the three Mississippi counties. The western half of its 20-mile-long coast is composed of low-lying salt marshes traversed by a number of small creeks and streams. The eastern half, which includes the towns of Bay St. Louis and Waveland, is afforded some protection by seawalls, constructed along the Mississippi Sound shore by local interests at various times between 1915 and 1928. A paved highway adjoins the wall throughout. Most of the county lies below elevation 25 feet, although some of the inland pine hills rise to almost 250 feet. The Louisiana marshes, which enclose the western end of the Mississippi Sound about 5 miles offshore, consist of innumerable tidal marsh islands of varying sizes separated by interconnecting bays and passages. The coastal area of Hancock County is separated from Harrison County by St. Louis Bay, an arm of the Mississippi Sound.

The coast of Harrison County extends for 27 miles, between St. Louis and Biloxi Bays, and is urbanized throughout. Principal coastal towns are Pass Christian, Long Beach, Gulfport, Mississippi City, and Biloxi. The relatively straight shore is protected by a concrete, step-type seawall constructed in 1926-28. The seawall was rehabilitated and an artificial beach constructed along its seaward face in 1951, with Federal aid provided under authority of the 1948 River and Harbor Act (Harrison County Shore Protection Project). Except for about 13 miles (at 5 feet), the top elevation of the seawall is between 8 and 11 feet above mean sea level (msl), depending on the general elevation of the backshore area. The seawall and beach protect adjacent U. S. Highway 90. Cat Island and Ship Island lie about 10 miles off the coast; Deer Island, a long, narrow sand island in the Mississippi Sound just offshore from Biloxi, partially shelters the eastern part of that town, as well as the mouth of Biloxi Bay. Back Bay of Biloxi, a landlocked,

mile-wide westward continuation of Biloxi Bay, parallels the coast for about 10 miles. Separating it from Mississippi Sound is a peninsula about 2 miles wide occupied on the eastern end by the City of Biloxi.

The 28-mile coastline of Jackson County is bisected by the Pascagoula River, which empties into Mississippi Sound through an estuary just west of the City of Pascagoula. The only coastal towns of any size are Ocean Springs on the east shore of Biloxi Bay; Pascagoula, on the east bank of the lower 3 miles of the Pascagoula River; and Moss Point, adjoining Pascagoula on the north. The south section of Pascagoula faces Mississippi Sound and is protected to some extent by a low concrete seawall. A considerable portion of the coastal area of the county consists of low-lying salt marshes, which extend in places as much as 4 miles inland. U. S. Highway 90 generally follows high ground a few miles inland, and crosses the Pascagoula River delta by a 3-mile-long causeway and bridge. Horn Island and Petit Bois Island, both National Wildlife Refuges, lie about 10 miles offshore.

In Alabama, Mobile and Baldwin Counties border the Gulf Coast. The two counties are separated by the Mobile River and by Mobile Bay, which is 30 miles long and varies in width from 8 miles, at the upper end, to 20 miles, at the lower end. The entrance to the bay is constricted by a narrow peninsula that extends westward from the southern tip of Baldwin County to within 3 miles of the east end of Dauphin Island, practically inclosing Mobile Bay and its arms. Dauphin Island, about 14 miles long and 1 mile wide at its widest point, lies about 4 miles offshore. The island is being developed as a beach resort area. Estimated summer population is about 2,600. The western 10-mile portion of the island is a low-lying sand spit, ranging up to one-fourth of a mile wide with elevations up to about 5 feet msl. The eastern 4-mile portion, where most of the development is concentrated, is wooded, with elevations generally 5 to 10 feet above msl. Sand dunes along the Gulf side of this portion of the island range up to 40 feet in height. The island is the easternmost of the chain of barrier beaches bordering Mississippi Sound.

The shoreline of Alabama is about 135 miles long, including bays and sounds. East of Mobile Bay, the coastline is characterized by white sandy beaches. A few hundred feet from the shore lay a dune line with an average elevation of 10 to 15 feet. West of the bay, which is the eastern limit of the Mississippi Sound, the mainland shore is low and marshy with numerous bayous and tidal flats. Bayou La Batre, Coden, and other fishing villages are located on some of these bayous. The shoreline of the west and north side of Mobile Bay is generally low and marshy, while on the east side it is considerably higher.

The principal communities affected by the hurricane tide and waves are Mobile and its environs, Bayou La Batre, Coden, Dauphin Island, Gulf Shores, and several other small beach communities and fishing villages.

#### 15. ACREAGES FLOODED

Widespread tidal flooding of the coastal lowlands occurred as Katrina moved inland. The three coastal Mississippi counties comprise a land area of 1,161,000 acres, of which 211,900 acres were flooded. Along the two coastal Alabama counties, 209,100 acres, a large part consisting of low-lying marshland, were flooded, out of a total land area of 1,827,200 acres. Maximum overland penetration of 8 miles occurred in Hancock County, Mississippi, in the Waveland-Bay St. Louis area. Along the lower Pascagoula and Jourdan River estuaries, the flood extended

about 20 miles upstream. In the Mobile River delta, the flood tide extended about 30 miles above the U. S. Highway 90 causeway at the head of Mobile Bay.

The populations (1960 census) of the Mississippi and Alabama coastal counties are 189,000 and 364,000, respectively. Residents in the flooded area number 53,300 in Mississippi and 7,500 in Alabama. Total land area flooded along the mainland and the offshore barrier islands was 433,700 acres, a large portion of which consisted of low-level uninhabited swampland or marshland.

All the islands along the Mississippi and Alabama coasts were completely covered by the flood waters except Dauphin Island, which experienced about 70 percent inundation. The investigation disclosed that 542 acres were lost to erosion. The U. S. Coast and Geodetic Survey reported that Pelican Island, a low sand bar in the Gulf opposite Dauphin Island, completely disappeared. Some of the islands have regained a portion of the loss as a result of natural accretion.