BEACH AND NEARSHORE SEDIMENT BUDGET
OF HARRISON COUNTY, MISSISSIPPI:
A HISTORICAL ANALYSIS

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Department of Environmental Quality

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ABSTRACT

The shorefront and nearshore waters of Harrison County, Mississippi, have been extensively modified by human activity, especially since statehood in 1817. These modifications of the natural coastal environment have been in the form of shorefront and nearshore fill and subsequent reclamation and construction, and also ship channel dredging and associated dredge spoil deposition. This report summarizes the chronology of human-induced changes in sediment budget, both cartographically and volumetrically. The methodology entailed extensive archival research and comparative analysis of detailed historic maps which facilitated reconstruction of human shorefront modifications. As a result of various activities, including oyster canning (Biloxi and Pass Christian), harbor construction (Gulfport, Biloxi, Long Beach, and Pass Christian), urban expansion (Biloxi, Pass Christian), recreational development (between Biloxi and Gulfport), road/seawall/sand beach construction and maintenance (along the entire length of the county), and channel dredging and spoil disposal (primarily in the approaches to Gulfport and Biloxi), millions of cubic yards of shell, sand, and riprap have
been deposited. At least 600 acres of land have been reclaimed from Mississippi Sound between 1850 and 1992.

INTRODUCTION: THE PROBLEM

The beach and nearshore environment of Harrison County, Mississippi, has been subject to much human modification since the earliest relatively accurate maps of the coast were produced in the early 1850s. Sediment changes in the beach and nearshore environment of Harrison County may be analyzed in terms of gains and losses. Sediment gains are attributed to land fill, dredge-and-fill, shell deposition, and artificial beach nourishment, all of which have effectively extended the mainland shoreline seaward into the nearshore zone. Sediment losses are attributed to offshore, onshore, and longshore sand displacement by waves and winds, especially in conjunction with storm events. However, dredging for channel maintenance and for dredge-and-fill construction also accounts for sediment removal from the natural system for redistribution at other subaqueous and subaerial sites. As no comprehensive attempts at summarizing the history of sediment changes have been made, this study is offered as a preliminary baseline document with particular emphasis upon subaerial fill.

METHODOLOGY

To conduct the proposed research an investigation was made of records at various institutions, including: Biloxi Public Library, Gulfport Public Library, Pass Christian Public Library, the U.S. Army Corps of Engineers (Waterways Experiment Station library in Vicksburg and records division of the Mobile District Office), Brown & Mitchell, Inc. (Biloxi), the Mississippi State Port (Gulfport), Harrison County Planning Office, Gulf Regional Planning Commission (Gulfport), the Office of the Secretary of State (tidelands division, Gulfport), the Harrison County Sand Beach Department (Gulfport), the Mississippi State Highway Department (Jackson), the Mississippi Office of Geology (Jackson), the Mississippi State Archives (Jackson), the Historic New Orleans Collection (New Orleans), and archives at Mississippi State University and Louisiana State University. Data compiled by the author under previous investigations were incorporated into the present project as they were deemed applicable. In preparation of the results of the project, the following tasks were undertaken:

1. Shoreline change maps were evaluated to determine precise locations of significant alteration. This was facilitated by the shoreline change study recently completed for the Mississippi Office of Geology. Also, maps generated by the Secretary of State’s office for use in the “tidelands dispute” displayed shorefront reaches in which human encroachment into state water bottoms had taken place since the 1850s maps were produced.

2. From the results of Task 1, the various types of modifications (e.g., seafood, commercial, port, recreational) became apparent, and insights into nearshore sedimentary modifications were gained.

3. The U.S. Army Corps of Engineers (USACE) was consulted to document (and quantify) sedimentary displacements associated with various navigation, harbor improvement, and shoreline protection projects.

4. Archival and cartographic sources were consulted to compile additional data needed to complete the project. This
"literature review" process took the author to the various aforementioned institutions.

5. Because a lack of consistent quantitative data was found to document nearshore fill associated with the seafood industry, the historical record was reconstructed cartographically. Topographic maps, aerial photographs, and detailed land use maps prepared by the Sanborn Insurance Company were overlaid (after rectifying for scale differences) to document the chronology of nearshore land reclamation. Areal expansion was documented on draft maps for each map interval, and areas were measured by digitization. The newest large-scale aerial photographs available for Harrison County at the time of this study (Summer, 1993) dated to January 1992. Since that date, dockside casino gambling has been legalized in Harrison County, and numerous additional shoreline modifications have been made. Unfortunately, this study had no accurate basis for adding these recent modifications.

6. Hydrographic surveys were consulted to determine the water depths into which fill took place, and subaerial elevations were estimated from maps and also interpolations. Areal measurements were thus converted to volumetric measurements.

7. By summation of the compiled data and analysis thereof, the following historical reconstruction of beach and nearshore sediment changes was prepared.

RESULTS

In terms of sedimentary gain, the types of modifications to the beach and nearshore sediment budget along the mainland shoreline of Harrison County (from Henderson Point in the west to the U.S. Highway 90 bridge approach in the east) include the following:

1. reclamation (expansion of "functional uplands" into the nearshore zone)
   a. shell disposal and landfilling associated with the seafood industry
   b. pier and wharf construction and landfilling associated with harbors
      i. commercial harbors
      ii. marinas (for commercial fishing boats and recreational vessels)
   c. landfilling associated with commercial expansion (including in conjunction with the widening of U.S. Hwy 90)
   d. landfilling associated with U.S. Coast Guard base construction
   e. landfilling associated with recreational piers
   f. landfilling associated with recreational urbanization

2. shoreline "improvements" and protection
   a. Beach Boulevard construction
   b. seawall construction (to protect Beach Boulevard)
   c. artificial beach construction (to protect seawall)
      i. initial sand placement
      ii. sand renourishment

3. dredge spoil disposal (derived from dredging sediment from the nearshore and offshore zones)
   a. derived from harbor dredging
      i. initial construction
      ii. maintenance dredging & harbor improvements
   b. derived from channel dredging
      i. initial construction
      ii. maintenance dredging & channel improvements
   c. sand dredging to acquire nourishment material
      i. to create (and maintain) artificial beach
to nourish other critically eroding shoreline segments

The above processes identified as taking place in Harrison County also may be expressed geographically, i.e. shore and nearshore regions can be delineated into various "zones" of sediment gain or loss, where one or more of the processes prevail. Based upon broad divisions of shorefront and nearshore, the following "zones" represent the subsequent format in which this report is organized (Figure 1):

SHOREFRONT
1. Pass Christian Small Craft Harbor
2. Long Beach Small Craft Harbor
3. Gulfport Harbor
4. Courthouse Rd. Pier (Mississippi City)
5. Broadwater Beach Marina
6. Mladenich Recreational Complex (Sea'n'Sirloin/Rodeway Inn)
7. Biloxi Waterfront (CBD)
8. "Casino Row" (Front Beach of Point Cadet Seafood District)
9. Beach Blvd./Seawall/Artificial Beach Complex (entire county)

MISSISSIPPI SOUND
10. Ship Island/Gulfport Ship Channel
11. Deer Island/Biloxi Harbor Navigation Channel

Modifications to the shorefront or nearshore that did not entail the placement or removal of sediment are not included in this report. Such structures, which include piers, wharves, boathouses, seafood platforms/sheds, and occasionally more substantial building, are herein considered ephemeral and not
Figure 1. Index map of shoreline zones.
necessarily contributory to significant modifications to the sediment budget.

**SHOREFRONT**

1. Pass Christian Small Craft Harbor

The present-day Pass Christian Small Craft Harbor owes its origins to the same seafood industry boom that hit Biloxi in the late 1800s and early 1900s. Soon after 1893, the Biloxi-based Dunbar, Lopez, DukateIo company established Pass Packing Co. on piers jutting into the nearshore at the exact location of the present east side of the harbor (Figure 2). The packing complex, containing oyster-shucking, canning, and ice-making buildings, was located beginning 700 ft seaward of the natural shoreline and extending out to about 1300 ft from shore (or about the 6 ft isobath). The 1904 Sanborn map showed a distinct island (about 1.6 acres in size) underneath the packing company and a plank boardwalk (700 ft in length) connecting the oyster-shell island to the mainland. Between the 1909 and 1918 Sanborn maps, two types of sedimentary changes were noted: 1) the island became enlarged and also subaerially connected to the mainland, reflecting continued in situ disposal of oyster shells, and 2) apparent wave-sheltering by the artificial "shell tombolo" led to localized sand accretion to the natural shoreline, mostly to the east of the approach to the seafood cannery. Between 1924 and 1940, two more nearshore changes were evident: 1) the westside jetty, extending seaward 1000 ft, then angled eastward for 600 ft, was constructed to provide a small craft safe harbor, and about 5 acres of sand accreted against the jetty, and 2) about 5 acres of fill was added along the east side of the old packing house shell fill by a combination of natural sand accretion and fill placement. Although no records exist and this work precedes
federal involvement, the latter fills most likely represent local harbor-dredging and dredge-disposal activities.

<table>
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<tr>
<th>Dates</th>
<th>Area (ac)</th>
<th>Cum. (ac)</th>
<th>Depth (ft)</th>
<th>Elev. (ft)</th>
<th>Volume* (cu.yd.)</th>
<th>Cum. (cu.yd.)</th>
<th>Type of fill</th>
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<td>1.6</td>
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<td>6</td>
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<td>1909-1918</td>
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<td>5.2</td>
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<td>6</td>
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<td>86,500</td>
<td>shell</td>
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<tr>
<td>1909-1918</td>
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<td>8.1</td>
<td>0.5</td>
<td>0.5</td>
<td>4,700</td>
<td>91,200</td>
<td>accreted sand</td>
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<tr>
<td>1924-1940</td>
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<td>13.2</td>
<td>3</td>
<td>1</td>
<td>32,900</td>
<td>124,100</td>
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<tr>
<td>1924-1940</td>
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<td>18.1</td>
<td>2</td>
<td>2</td>
<td>31,600</td>
<td>155,700</td>
<td>accreted sand/fill</td>
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<tr>
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<td>18.6</td>
<td>2</td>
<td>3</td>
<td>4,000</td>
<td>230,900</td>
<td>dredge spoil</td>
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<td>3</td>
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<td>23.3</td>
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<td>7</td>
<td>5,300</td>
<td>290,500</td>
<td>dredge spoil</td>
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Table 1. Chronology of nearshore areal and volumetric expansion, Pass Christian Harbor and vicinity.
[length of shoreline impacted by nearshore reclamation and sand accretion: 2270 ft]

* In this and other tables, volume is calculated as follows: area (ac.) x 43560 ft²/ac. x (depth+elev.) ÷ 27 ft³/yd³ unless volumetric data were available.

In 1945, maintenance of the Pass Christian Harbor fell under the jurisdiction of the federal government (USACE, 1989), and a harbor depth of 7 ft and an entrance channel depth of 7 ft were authorized. By the time of the 1954 T-chart, much land along the "east pier" was above the 10-ft contour, thus apparently reflecting the location of deposited dredge spoil. Assuming an average elevation increase of 9 ft over the 4.9 acres east of
east pier, the calculated amount of net placed fill, 71,200 cubic yards (Table 1), roughly equals the removal of 3 ft of sediment from an area measuring 1000 ft by 700 ft, the exact dimensions of the Pass Christian Harbor. Also in the 1940-1954 interval, the artificial sand beach was placed on the flanks of the harbor, but these numbers will be incorporated into Section 9 of this report. Within the harbor, only a small amount of fill was noted at the north end parking area between 1940 and 1954. By 1966, many harbor improvements were made, particularly in the form of reinforcing the west pier with concrete and riprap. Also along the west pier riprap was placed at the pier terminus and sediment accretion (natural or dredge spoil?) was noted. Since the federal harbor-dredging project was officially completed in 1959, it is quite likely that some dredge spoil was placed along the west flank of the west pier. (Mr. Paul Warren of the USACE, Mobile District, stated that some material dredged from the entrance to the harbor was deposited on the beach east of the harbor [in the 1960s], but the high silt content was deemed undesirable by beachgoers.)

USACE records indicate that 37,000 cubic yards were dredged from the harbor and harbor entrance in June 1974 and apparently deposited to the west of the harbor. Aerial photos of 1987 show a retaining wall west of the west pier enclosing a dredge spoil deposition site, and about one acre of subaerial fill had been placed. An additional 0.3 acre appeared between 1987 and 1992, at which time the fill area had been paved over to create a parking area for the harbor and a new fishing pier.

2. Long Beach Small Craft Harbor

The east pier of the present Long Beach Small Craft Harbor has its origins in a rock rubble groin/pier that was constructed between 1924 and 1940 and was a seaward extension of Cleveland Ave. Extending out about 900 ft, the riprap groin measured about 0.7 ac in area (Figure 3, Table 2). In the 1940s, the "rock jetty" was extended seaward 350 ft, encompassing an areal expansion of 0.5 ac. By the early 1950s, the artificial sand beach had been placed along most of the Harrison County shorefront, and within the limits of what was to become the Long Beach Harbor a total of 4.5 ac of sand (or 40,000 cubic yards according to USACE fill design criteria) was placed. By 1966, the sand beach was still there within the future harbor limits, but a framework for the modern harbor had been laid.

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<td>0.7</td>
<td>4</td>
<td>6</td>
<td>11,300</td>
<td>11,300</td>
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<td>1940-1954</td>
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<tr>
<td>1940-1954</td>
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<td>1966-1987</td>
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<td>13.9</td>
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<td>6</td>
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<td>226,900</td>
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<td>1987-1992</td>
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<td>3</td>
<td>7</td>
<td>7,300</td>
<td>234,200</td>
<td>fill</td>
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</tbody>
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Table 2. Chronology of nearshore areal and volumetric expansion, Long Beach Harbor and vicinity.

A 500-ft riprap groin was built in 1966 as the beginnings of the west pier, and a right-angle breakwater (about 900 ft total) was built to semi-enclose the harbor. Spoil from harbor dredging was placed along the west side between the groin and the offshore breakwater, but the 1966 map does not indicate any subaerial expression of that spoil. The east pier was expanded by about
3.6 acres with riprap and other fill. (According to Long Beach Harbormaster Danny Kaletsch, no records of any of the harbor improvements exist.) Much of the riprap, especially from the breakwater, was lost to Hurricane Camille in 1969, and the present harbor dates to post-storm construction in the early 1970s. The west pier was substantially expanded and reinforced at this time, and the now enclosed sand beach became filled with spoil dredged from the harbor (thus leading to a seaward shift in position of the shoreline). The only significant change between 1987 and 1992 was that 1.5 ac of the east-flanking sand beaches were converted into an asphalt parking lot.

3. Gulfport Harbor

The history of the Port of Gulfport is a long and interesting one which has received much attention by historians (Black, 1986; Switzer, 1992). In 1887, a 5000-ac block of land was bought and platted as the town of Gulfport, which was located directly north of the preexisting natural ship anchorage in the lee of Ship Island (in the vicinity of Ft. Massachusetts). To make the new port a success, a direct rail link with the interior of Mississippi was necessary. Although a few problems were encountered, the Gulf and Ship Island Railroad connected Gulfport to Hattiesburg by 1896 (Switzer, 1992). Construction began on a pier at Gulfport (at the site of the present east pier), and exports, mostly lumber, were lightered out to ships in the Ship Island anchorage. Following completion of the 4500-ft-long trestle pier (to about 12 ft water depth), Capt. Joseph Jones (the man responsible for most of the successful early development of the port) foresaw possibilities of a mainland harbor (Switzer, 1992). Although an 1896 federal cost-benefit study of dredging a ship channel out to deep water found that costs greatly outweighed the benefits, a high demand for Mississippi timber the
following year led Capt. Jones to initiate channel-dredging himself.

In anticipation of a completed dredged channel to Ship Island Pass, expansion of the harbor began. A map made just prior to harbor expansion (no date, but estimated at 1897 or 1898) shows proposed widening and filling of the (east) pier using dredge spoil, construction of a second (west) pier, and several "to be filled" areas (Figure 4). One of these areas, completed in 1899 at the head of the harbor, contained a lake in which logs would be stored in fresh water, safe from the destroying teredo shipworm which thrives in salt water (Miller, 1993).

Widening of the east pier (in 1899) was accomplished by outlining a mile-long, 300-ft wide section (centered on the trestle pier) with sheetpile and then filling in with a combination of dredge spoil and oyster shells (Switzer, 1992). A rail line was subsequently laid on top of the now solid east pier, and in 1902 the Port of Gulfport was officially dedicated. Although records of the details of harbor construction are spotty, over the next few years a 5000-ft-long west pier was constructed (in a similar sheetpile/dredge spoil/oyster shell manner, as seen in a photo in Hancock Bank, 1982). Dredging within the harbor and the channel continued steadily, and while it appears that channel dredge spoil was deposited along both flanks of the channel, excess harbor dredge spoil was deposited onto the nearshore to the east of east pier.

The 1916 coast survey map (USCGS, 1916-17), although not very accurate, showed a total of 89 acres of subaerial land seaward of the old natural shoreline, including a 16-acre freshwater holding pond (Figure 5). A more accurate set of engineering plans dated 1927 (Figure 6) shows large acreages of
subaerial land which had accreted to both flanks of the harbor as a result of spoil deposition. In 1922 state and federal funding was authorized for channel- and harbor-dredging as well as construction of a creosote breakwater off of the west pier (USACE, 1959). The arrival of Mississippi Power Company led to expansion of the east pier (Switzer, 1992). Further funding in 1930, enhanced by creation of the Gulfport Port Commission and a favorable report by the U.S. Bureau of Engineers, led to renewed dredging and channel-deepening (Switzer, 1992). A 1932 fire on the west pier led to construction of a steel-reinforced concrete dock covering eight acres, upon which six acres of fire-proof warehouses were built (Switzer, 1992; Figure 7). Also, the state waterbottoms east of the port (where much dredge spoil had been deposited and perhaps some longshore-drifting natural beach sands had accumulated) were leased to the city of Gulfport, which constructed the Bert Jones Park and Yacht Basin (see Figure 7). The first accurate map to show the Bert Jones Park, however, was a 1949 U.S. Army Corps of Engineers map (USACE, 1950). The next report on the Port of Gulfport (USACE, 1959) contained a 1957 map which showed an addition of a commercial small craft basin west of the west pier and also a widening of the northern end of the west pier to 1000 ft. Also, the old 16-acre freshwater holding pond was filled in. As in past projects, no records of dredging or fill volumes were kept.

In 1961, the port authority was transferred from the City of Gulfport to the State of Mississippi, and soon several port expansion projects were authorized. The first to be completed was a 1966 extension of the west pier (which was built over a "trailing spit" of riprap). In 1973, there was a further 10-acre extension of the west pier which required 380,000 cubic yards of sand fill dredged from just off the beach at the foot of Hill Place (east of the port). At the same time, East Pier was widened by about 6.5 acres, again using nearshore sands from Hill Place.

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Figure 5. Nearshore changes, Port of Gulfport and vicinity.
Place (Mr. C. T. Green, pers. comm.). An 1987 air photo also showed 4 acres of new land in the port area (rip rap, accreted sand?) and about 5 acres of sand accretion along the east side of the Bert Jones Yacht Basin.

<table>
<thead>
<tr>
<th>Dates</th>
<th>Area (ac)</th>
<th>Cum. (ac)</th>
<th>Depth (ft)</th>
<th>Elev (ft)</th>
<th>Volume (cu.yd.)</th>
<th>Cum. (cu.yd.)</th>
<th>Type of fill</th>
</tr>
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<td>34.4</td>
<td>34.4</td>
<td>6</td>
<td>7</td>
<td>721,500</td>
<td>721,500</td>
<td>sand/shell</td>
</tr>
<tr>
<td>1899-1916</td>
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<td>73.1</td>
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<td>437,100</td>
<td>1,158,600</td>
<td>spoil*</td>
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<td>1916-1935</td>
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<td>108.7</td>
<td>4</td>
<td>5</td>
<td>516,900</td>
<td>1,675,500</td>
<td>spoil/conc.</td>
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<tr>
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<td>5</td>
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<td>spoil/conc.</td>
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<td>1949-1957</td>
<td>16.0</td>
<td>174.1</td>
<td>8</td>
<td>11</td>
<td>206,500</td>
<td>2,679,000</td>
<td>spoil/fill</td>
</tr>
<tr>
<td>1949-1957</td>
<td>27.4</td>
<td>201.5</td>
<td>4</td>
<td>5</td>
<td>397,900</td>
<td>3,076,900</td>
<td>spoil/sand accr.</td>
</tr>
<tr>
<td>1966</td>
<td>6.3</td>
<td>207.8</td>
<td>7</td>
<td>11</td>
<td>182,900</td>
<td>3,259,800</td>
<td>spoil/conc. (w. pier)</td>
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<tr>
<td>1973</td>
<td>10.0</td>
<td>217.8</td>
<td>12</td>
<td>11</td>
<td>380,000</td>
<td>3,639,800</td>
<td>spoil/conc. (w. pier)</td>
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<tr>
<td>1973</td>
<td>6.5</td>
<td>224.3</td>
<td>4</td>
<td>7.5</td>
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<td>3,763,800</td>
<td>spoil/conc. (e. pier)</td>
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<tr>
<td>1957-1987</td>
<td>9.0</td>
<td>233.3</td>
<td>2</td>
<td>2</td>
<td>58,100</td>
<td>3,821,900</td>
<td>sand accr.</td>
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<td>1993</td>
<td>18.0</td>
<td>251.3</td>
<td>5</td>
<td>11</td>
<td>455,000</td>
<td>4,276,900</td>
<td>spoil/conc. (w. pier)</td>
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</table>

Table 3. Chronology of nearshore areal and volumetric expansion, Port of Gulfport and vicinity. [length of shoreline impacted by nearshore reclamation and sand accretion: 5780 ft]

* these 38.7 acres include: 1) land at the head of the port (excluding the 16-acre timber holding pond), 2) the west pier, and 3) dredge spoil/sand accretion along the east side of east pier (no reliable data available)
In 1993, work commenced on both deepening and realigning the Gulfport Ship Channel to a location 1500 ft westward (because of continued shoaling problems in the vicinity of Ship Island). At the same time, expansion of the west pier by 18 acres (to a width of 1000 ft along its entire length) began. (Officially, the 1993 project encompasses 29 acres, but only 18 acres are estimated to replace water.) The estimated 455,000 cubic yards required are dredge spoil derived from the channel-deepening.

4. Courthouse Road Pier (Mississippi City)

<table>
<thead>
<tr>
<th></th>
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</thead>
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<tr>
<td>1940-1954</td>
<td>0.8</td>
<td>10,700</td>
<td>6</td>
<td>10,700</td>
<td>10,700</td>
<td>10,700</td>
<td>riprap (groin)</td>
</tr>
<tr>
<td>1940-1954</td>
<td>0.8</td>
<td>16,400</td>
<td>8</td>
<td>13,700</td>
<td>21,400</td>
<td>21,400</td>
<td>dirt fill w/in 5' contour</td>
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<tr>
<td>1954-1992</td>
<td>1.4</td>
<td>13,500</td>
<td>6</td>
<td>13,500</td>
<td>34,900</td>
<td>34,900</td>
<td>dirt fill parking area</td>
</tr>
</tbody>
</table>

Table 4. Chronology of nearshore areal and volumetric expansion, Courthouse Road pier.

[length of shoreline impacted by nearshore reclamation and sand accretion: 350 ft]

At the foot of Gulfport's Courthouse Road (formerly within Mississippi City) is a major public parking area, boat launch, restrooms, and fishing pier. This boat launch facility started as a riprap groin/pier built out 900 ft in the latter 1940s. Apparently fill was overlain upon the landward portion of the pier, but this is somewhat obscured by the recently placed sand
beach which appears on the 1954 T-chart (Figure 8). The evidence of fill is seen by the 5-ft contour which juts out about 550 ft from the edge of Beach Blvd. Little change was noted on the 1966 map (except for slight changes in the position of the shoreline), but by 1987 a wooden fishing pier had been extended to the west about 350 ft. By 1992, a second extension (south by 400 ft) had been added, and an area between the pier and a storm drain just west of the facility was filled and converted to a parking lot (1.4 ac) for a relocated boat launch site (Table 4).

5. Broadwater Beach Marina

The Broadwater Hotel was built in 1940 along a stretch of West Beach shorefront that contained only the 1920s seawall and beach highway (Prior, 1947). To enhance its attraction to tourists, the Broadwater built two timber groins, about 200 ft long and spaced about 500-600 ft apart, and pumped sand in between them (Figure 9). The source of the sand is unknown. A 400-ft pier on pilings extended to a pavilion.

<table>
<thead>
<tr>
<th>Dates</th>
<th>Area (ac)</th>
<th>Cum. (ac)</th>
<th>Depth (ft)</th>
<th>Elev. (ft)</th>
<th>Volume (cu.yd.)</th>
<th>Cum. (cu.yd.)</th>
<th>Type of fill</th>
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<tr>
<td>1940-1941</td>
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<td>2.3</td>
<td>2</td>
<td>3</td>
<td>18,500</td>
<td>18,500</td>
<td>sand beach</td>
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<tr>
<td>1963-1965</td>
<td>21.5</td>
<td>23.8</td>
<td>4</td>
<td>10</td>
<td>485,600</td>
<td>504,100</td>
<td>dirt/soil</td>
</tr>
</tbody>
</table>

Table 5. Chronology of nearshore areal and volumetric expansion, Broadwater Beach Marina.
[length of shoreline impacted by nearshore reclamation and sand accretion: 900 ft]

The Broadwater's private shorefront engineering efforts (i.e. Broadwater Beach) were soon obliterated by the federal sand
beach which was completed in the early 1950s and appears on the 1954 T-chart. During the 1960s, the Broadwater expanded and redesigned the hotel (incorporating the 1940 structure into it) and built a marina in the shorefront (Figure 10; Table 5). The marina, which extends 900 ft along the shorefront and juts out into the nearshore 1550 ft, contains about 21.5 acres of fill and concrete (the material at least partially derived by dredging of the harbor and harbor entrance). Little modification was made to the marina until 1992, when the President Casino was installed there. No areal expansion accompanied the introduction of casino gambling, but some dredging and pile driving was necessary to accommodate the boat, and a grass area was paved over to provide parking spaces.

Figure 9. The Broadwater Hotel’s sand beach, circa 1948. (photo courtesy of USACE, Mobile District)

6. Mladinich Recreational Complex

Less than 2000 ft east of the Broadwater Beach Marina is the western terminus of the 6000-ft-long "West Beach strip", Biloxi's post-World War II recreational business district (RBD) that developed just beyond the city’s western limits. Because of a low marshy shoreline in this area, it was not only settled later but also the beach highway had to curve inland away from the shoreline to remain on relatively dry land. This early obstacle to development became a later boon to development (following construction of the seawall in the 1920s and especially following completion of the sand beach in the early 1950s) as structures could be squeezed in between the beach and the highway. At the very western end of this recreational strip, near the point where the highway joins the beach (see Figure 10), lies the 6th zone of nearshore reclamation, herein referred to, for lack of a better name, the Mladinich Recreational Complex (MRC). Most of the 10.8-acre property (as measured seaward of the seawall, along which the MRC abuts for a length of 840 ft) was owned by Mr. Jake Mladinich, who built Capt. Jake's Sea'n'Sirloin Restaurant, the Fiesta Gift Shop, and an apartment complex (among other businesses). The eastern portion of the property was occupied by the former Sun'n'Sand Motel, now known as the Rodeway Inn.

The 1940 Tobin air photo displayed very little development in the area. The 1920s seawall formed the head of a narrow natural beach. The 1954 T-chart showed the new (early 1950s) 200-ft-wide sand beach (the new sand beach actually covered the seawall for about a mile beginning about 1000 ft east of the MRC). A large rectangular structure (the Sun'n'Sand Motel?) was squeezed in between the seawall and the highway, and a pier jutted out 900 ft into the Sound. To the west of this structure, Jake Mladinich began to build his "recreational complex". Beginning with a very narrow piece of property, Mladinich began to fill the beach and nearshore seaward of the seawall. This filling, which took place in the 1960s and 1970s, allegedly continued even after it became illegal to do so. Stories abound of night-time dumping of concrete riprap and fill from trucks.
Mladinich was able, both "legally" (before enforceable laws were in place) and possibly illegally, to expand his property considerably. The western "prong" of the MRC (Figure 10) consists of concrete rubble "illegally" dumped. Along the eastern flank of the MRC, a 900-ft-long riprap groin (covered with fill upon which a road was built) was constructed (early 1980s?) as part of a harbor constructed by the Rodeway Inn. For several years, the harbor was home to a paddlewheel cruise ship, which offered dancing and dining cruises around the Sound. This venture did not succeed, in part because of the high costs of maintaining an approach channel into the harbor. The city of Biloxi was asked to take over maintenance of the harbor, but because the riprap groin was private and the benefit-cost ratio not too great, the city declined the offer (pers. comm., Mr. Larry Manuel, Biloxi chief engineer, Nov. 10, 1993). To accurately document the evolution of the MRC is quite difficult (Table 6).

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1954-1987</td>
<td>9.1</td>
<td>9.1</td>
<td>3</td>
<td>7</td>
<td>146,800</td>
<td>146,800</td>
<td>riprap various</td>
</tr>
<tr>
<td>early 80s</td>
<td>1.7</td>
<td>10.8</td>
<td>4</td>
<td>7</td>
<td>30,000</td>
<td>176,800</td>
<td>riprap pier</td>
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</table>

Table 6. Chronology of nearshore areal and volumetric expansion, Mladinich Recreational Complex.
[length of shoreline impacted by nearshore reclamation and sand accretion: 840 ft]

The MRC, in spite of its semi-legal genesis, in 1992 became a much sought-after property on which to establish casinos. Jake Mladinich sold out his lease (supposedly for $20 million,
although there are still some legal complications), and the property is now (1994) the site of the Treasure Bay Casino.

7. Biloxi Waterfront

The historic City of Biloxi has experienced substantial modification of its shorefront and nearshore environment at two distinct locations: 1) the seashore adjacent to downtown (herein called the Biloxi waterfront), and 2) the distal "front beach" of Point Cadet, which faces Mississippi Sound, rather than Biloxi Bay, and is one of the major sites of the former flourishing seafood industry. (The latter is now the site of intensive casino development, and this has given rise to the now increasingly popular name "Casino Row"). With the exception of the Port of Gulfport, these two locations account for most of the nearshore reclamation in Harrison County.

The Biloxi waterfront represents the seashore edge of the Biloxi CBD (central business district), and its historical seaward expansion is linked to a combination of industrial (seafood), commercial, and recreational development. The oldest accurate map (1853) displayed considerable human modification in the form of wharf and pier construction and also smoothing of the natural dune scarp. The first Sanborn map (1893) showed a seaward shift of the shoreline (Figure 11), a shift mostly attributed to development of the oyster-canning industry. By 1893, there were several oyster-shucking houses along the Biloxi waterfront, and most of the 4.5-acre reclamation measured is attributed to in situ oyster shell disposal (Table 7). Although there was considerable commercial expansion onto newly reclaimed land into the 1940s, the foundation for this expansion still appears to have been oyster shells. One exception was a 400-ft-long sand beach built in the late 1930s near the present small craft harbor.
In the 1940s, state plans called for the four-laning of Beach Boulevard (US Hwy. 90). Because of the extensive commercial development in place, there was a problem in acquiring sufficient right-of-way to allow for adequate road widening. Furthermore, the 1947 hurricane caused extensive damage along the narrow western half of the Biloxi waterfront. To solve the right-of-way problem, the state authorized Harrison County to construct a seawall (7 ft above mean sea level), backfill behind the seawall, and grant property rights to the property owners displaced by the highway widening. Although state highway plans show a proposed seawall about 125 ft seaward of the pre-existing 1920s seawall (Miss. State Highway Dept., 1952), the county
eventually constructed the seawall 250 ft south of the old seawall...apparently to balance the 250-ft width previously enclosed by seawall along the eastern half of the Biloxi waterfront. Once backfilled (with dredge spoil?), 8+ acres of new land had been added to the western half. Completed in the early 1950s (just prior to completion of the 4-lane highway in 1955), the new artificial accretion allowed businesses, such as the Buena Vista Motel (now the Biloxi Belle Resort Hotel) and Baricev's Restaurant, to relocate.

Furthermore, in the 1950s and 1960s, several property owners reclaimed even more land south of the seawall and built structures (Baricev’s) upon it (Figures 12 and 13). Again, somewhat ironically, this semi-illegal (or semi-legal) expansion into the nearshore has now, in the early 1990s, provided a legitimate foundation for dockside casino gaming.
One casino, the Biloxi Belle, bought up many of the businesses that were established on the reclaimed land (including the Buena Vista Motel, Baricev's Restaurant, Pat Peck Honda, and David M's nightclub) and created a casino resort complex. A second casino, Gold Coast, opened immediately east of the Biloxi Belle in early 1994. Aside from some harbor construction and improvements, there has been relatively little new nearshore reclamation since the major seawall and backfill project of the early 1950s (and subsequent reclamation of land parcels south of the seawall).

8. "Casino Row" (Front Beach of Point Cadet Seafood District)

At the very eastern end of Biloxi is the region known as Point Cadet. There are several parts to this region, including the point itself, the Back Bay area, and "front beach" (which abuts Biloxi's East Beach). The Point Cadet region, especially Front Beach, became the core of the city's seafood district beginning in 1880.

Once the technology of canning was perfected in the 1870s, it was found that both shrimp and oysters lent themselves well to canning. The first seafood factory, Lopez, Elmer and Company, began operation in 1880. During the off-season for seafood, the cannery kept workers employed by canning figs and other fruits and vegetables (Fountain, 1966). In 1884, a large factory operated by Lopez, Dunbar, & Sons (later known as Lopez-Dukate, and even later as Dunbar-Dukate) was built adjacent to the beach road along Front Beach. Trams on piers extended out to deep water where the fishing boats could unload their catch. Except for the shallow nearshore, Front Beach was ideal because it was sheltered from waves by Deer Island yet it was close to the natural tidal channel which later was dredged to become the Biloxi Ship Channel.

Figure 14. Excess oyster shells along Point Cadet's Front Beach. (Hildebrand, 1937)
Within a few years, several more seafood factories located in this area, and by 1901, Biloxi ranked second only to Baltimore in terms of seafood production (Biloxi Daily Herald, 1902). That year, Lopez-Dukate Company alone shipped 525 carloads of shrimp and oysters, 26 trainloads of 20 cars each (Fountain, 1966). The bulky and important by-product of all this production was oyster shells, of which many thousands of cubic yards were produced annually. Many of these shells were used as paving material for roads and driveways, both whole and crushed, yet many if not most ended up being deposited in the vicinity of the seafood houses.

Later, once fisheries scientists determined that oyster reefs in Mississippi Sound were being depleted, a law was passed by which 50% of harvested oyster shells had to be returned to reefs to insure maintenance of the oyster population (Carter and Ragusin, 1951). In spite of increasing removal of oyster shells in various forms, including poultry grit (ground up shells sold to England as feed), the excess in situ shells formed the foundation of extensive reclamation along Point Cadet's Front Beach (Figures 14 and 15; Table 8).

In spite of economic swings in the seafood industry, factories continued production and the Point Cadet seafood district along Front Beach continued to grow as more and more “beach-heads” were created by oyster shell disposal (Figure 15). In 1933, the easternmost “beach-head” (former site of Barataria Canning Co. and later Biloxi Grit Co.) became selected as a site for a U.S. Coast Guard station. Although no records have been found, it is estimated that about 90,000 cubic yards of fill were added to provide a high foundation for construction of the facility. Much areal expansion took place in the 1925–1940 period, however, and it is difficult to separate the origins of the fill. Based on contours shown on the 1945 map (USCGS, 1949),
Figure 16. The seafood district, Front Beach of Point Cadet, circa 1930. (Hancock Bank, 1982)

Figure 17. Point Cadet's Front Beach Seafood District following Hurricane Camille, 1969. (USACE, 1970)
the 90,000 cubic yard figure was calculated. (The old U.S. Coast Guard property is now the site of the Marine Education Center of the Gulf Coast Research Laboratory, a division of the University of Southern Mississippi.)

<table>
<thead>
<tr>
<th>Dates</th>
<th>Area</th>
<th>Cum.</th>
<th>Depth</th>
<th>Elev.</th>
<th>Volume</th>
<th>Cum.</th>
<th>Type of fill</th>
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<td>12.8</td>
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<td>4</td>
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<td>123,900</td>
<td>shell</td>
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<td>1893-1909</td>
<td>8.2</td>
<td>21.0</td>
<td>2</td>
<td>4</td>
<td>79,400</td>
<td>203,300</td>
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<td>3.1</td>
<td>24.1</td>
<td>2</td>
<td>4</td>
<td>30,000</td>
<td>233,300</td>
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<td>7</td>
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<td>7</td>
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<td>4</td>
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<td>728,600</td>
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<td>5</td>
<td>5</td>
<td>58,100</td>
<td>786,700</td>
<td>shell, concrete</td>
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Table 8. Chronology of nearshore areal and volumetric expansion, Casino Row.
[length of shoreline impacted by nearshore reclamation and sand accretion: 3420 ft]

Since 1940, there has been relatively little new fill added, although a marina was built at the far east end. Hurricane Camille (1969) destroyed many of the businesses (Figure 17), but the heyday of seafood canning was already over anyway. Much of the seafood industry was inoperative in the 1980s, as facilities moved to Back Bay or (increasingly) overseas to places such as Korea. Beginning in the early 1990s, however, the old seafood district was transformed into prime casino real estate. Being away from public beaches and protected wetlands, the site became sold or optioned to casino operators. In 1992, the first casino opened in the region. By late 1993, two casinos were operating, two were under construction, and three more properties were planned for development (Figure 18)....hence the name "Casino Row". All of the casinos made modifications in the form of grading their property with trucked-in fill, but as this process has not been completed, no research into "casino fill" has been conducted.

Figure 18. "Casino Row", September 1993. (photo by author)

9. Beach Blvd./Seawall/Artificial Beach Complex (Harrison County)

Along the mainland shoreline of Harrison County, there has been substantial modification of the beach environment and reclamation of the nearshore environment aside from the eight zones just described. The "zone" in which these additional changes are found may be described as an interrupted "linear
"zone", which, in turn, may be described as Beach Boulevard, the Harrison County seawall, and the Harrison County sand beach. These three components of this "Beach Blvd./seawall/artificial beach complex" are discussed individually.

**Beach Boulevard**

As described in an earlier report (Meyer-Arendt, 1992b), the first true modifications to the Harrison County beachfront outside of the urban center can be traced to the creation of what has now become the four-lane Beach Boulevard (US Highway 90). Beginning in the late 1800s, the natural beach, which was up to 80 or 100 ft wide along many reaches, increasingly became used as a road. The main east-west artery was Pass Road, but the beach was popular for excursions, first by horses-and-buggies and later by automobiles, especially in the coastal reaches adjacent to the towns of Pass Christian, Gulfport, and Biloxi. As vehicles became mired in the often waterlogged sands, oyster shells, whole and later crushed, became employed for road fill material (hence the adopted name Shell Drive, or Shell Road) (Black, 1986; Sullivan et al., 1985). In places this shell road was built upon the backshore of the beach, yet in other places the road followed a course amidst the live oaks and above the Pleistocene dune scarp (bluff). In spite of a serious hurricane in 1893 which caused significant damage and shoreline erosion (Sullivan, 1988), the segments of the Shell Drive gradually became extended.

By the turn of the century, the beachfront contained telegraph poles and boardwalks and long reaches of the Shell Drive. Although another hurricane in 1901 caused extensive damage to the beachfront, plans for building a trolley line along the beach were not interrupted (Sullivan, 1988; Sullivan et al., 1985). When a 1909 hurricane caused serious damage to the shell road and new interurban trolley, petitioning for state involvement in erosion control began. A more severe hurricane in 1915 destroyed 50% of the beach roadway which was by then nearly continuous along Harrison County, and in the following year the Mississippi legislature passed a law committing the state to protect the beach "highway" (anon., 1930). Partly to ensure that the state commitment would be honored, the Harrison County communities linked and improved the old Shell Road and in 1918 incorporated it into the "Old Spanish Trail", a coast-to-coast highway development project sponsored by a coalition of local civic boosters. Rights-of-way were obtained, low areas were filled (source of fill unknown, but probably from local source areas, including the lowering of higher portions), and the road was graded and partially paved, a vast improvement over the oyster shells, according to Model T drivers (Bergeron, 1991) (Table 9).

**Seawall**

The 1915 storm directly stimulated seawall construction along the Mississippi coast. The greatest feat of all was the construction, at a cost of $3.4 million, of the 24-mile-long seawall fronting Harrison County, allegedly the second longest seawall in the world (Davis, 1988; MDWC, 1986). Funded by a state tax on gasoline, the 8-to-11-ft-high, stepped-concrete seawall (only 5 ft in some sections) was built between 1924 and 1930, although 1928 was the year it was officially dedicated (Charlier, 1984; Sullivan et al., 1985). Later, an additional 2 miles of seawall were added, making the total 26 miles (Burden, n.d.). The seawall was backed by a new state-maintained beach highway. Both the seawall and the highway required backfill sediment which was obtained from dredging 1000 ft offshore (USACE, 1948). Based on a seawall engineering profile, it is estimated that 50 cubic feet of backfill was needed per lineal foot, for a total of 250,000 cubic yards for the seawall alone.
Although the seawall proved to effectively protect the highway and coastal property in the absence of several storms, the narrow natural beach quickly disappeared, especially west of the Biloxi lighthouse. The lighthouse, sited on a small "headland", had been subject to erosion since the 19th century and was perhaps the first structure armored with riprap along the Mississippi coast.

<table>
<thead>
<tr>
<th>Dates</th>
<th>Area/Location</th>
<th>vol. (yd³)</th>
<th>cum. (yd³)</th>
<th>type of fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>1880-1915</td>
<td>beach-beach road</td>
<td>?</td>
<td>?</td>
<td>shell</td>
</tr>
<tr>
<td></td>
<td>shell road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1915-1918</td>
<td>linking of shell road-paving</td>
<td>?</td>
<td>?</td>
<td>fill/asphalt</td>
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<tr>
<td>1924-1928</td>
<td>construction of seawall/backfill</td>
<td>250,000</td>
<td>250,000</td>
<td>dredged sand</td>
</tr>
<tr>
<td>1924-1928</td>
<td>backfill of highway</td>
<td>?</td>
<td>250,000</td>
<td>dredged sand</td>
</tr>
<tr>
<td>1951</td>
<td>700 ac. of sand beach,</td>
<td>6,000,000</td>
<td>6,250,000</td>
<td>dredged sand</td>
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<td></td>
<td>Henderson Pt. to Biloxi</td>
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<td>1952-1953</td>
<td>25 ac. of sand beach,</td>
<td>506,700</td>
<td>6,756,700</td>
<td>dredged sand</td>
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<td>East Beach-Biloxi</td>
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<td></td>
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<td>beach renourishment</td>
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<td>beach renourishment</td>
<td>1,124,000</td>
<td>9,803,700</td>
<td>dredged sand</td>
</tr>
</tbody>
</table>

Table 9. Chronology of shorefront fill, Harrison County Beach Blvd./Seawall/Artificial Beach Complex.
[length of shoreline impacted: 26.0 miles]

Artificial Beach

The seawall performed its job of protecting the beach highway and beachfront infrastructure relatively well until the 1940s, although the natural fronting beach had disappeared. Several local efforts were made to retain a sand beach: in 1936, and artificial beaches were created at Biloxi's Community House (400 ft long, at present site of the small craft harbor), and the Broadwater Hotel (see earlier section), and planned for west of the lighthouse (900 ft long) and near the White House Hotel. The source of sand is unknown, but a precedent for beach nourishment in Harrison County was set in Gulfport in 1917, when sands were dredged from 800 ft offshore to create a sloping sand beach west of the harbor (Biloxi Daily Herald, Aug. 24, 1917). Following a request by county officials in 1942, a 1944 study by the federal Beach Erosion Board pointed out the potential of seawall failure in case of storms and recommended the construction of an artificial beach to protect the seawall (Burden, n.d.; USACE, 1948; Watts, 1958).

In 1947, a hurricane struck the Mississippi coast (Sullivan, 1988). This hurricane, the first significant storm since 1915, destroyed much of the Biloxi waterfront. Although the Harrison County seawall withstood the onslaught relatively well, several stretches of seawall were greatly damaged, and Harrison County requested that the U.S. Army Corps of Engineers assess the damage. In view of the assessment (USACE, 1948), it was recommended that an artificial beach be created to protect the seawall, with a high amount of federal funding (Wilson, 1951; Watts, 1958). Plans called for 5,700,000 cubic yards to be placed in front of the seawall, thereby creating a beach 265 ft wide and with a berm elevation of 5 ft.

In 1950, Harrison County made the requisite repairs to the seawall, and in 1951 the artificial beach was constructed. About 6 million cubic yards of fill material, derived from a shore-parallel borrow area 1500 ft offshore (up to 14 ft deep) was used to create over 700 acres of 265-ft-wide beach along 26.5 miles extending from Henderson Pt. to the Biloxi Lighthouse.
(Escoffier, 1956b; Escoffier and Dolive, 1954; MacArthur, 1956; Walton and Purpura, 1977; Watts, 1958). (169,000 cubic yards of that total were for backfilling behind newly made seawall repairs [Watts, 1958].) The placement of sand on Biloxi's East Beach, between the Biloxi Waterfront and Casino Row, was an authorized county project undertaken in 1952-53 (1954, according to Burdin, n.d.). Over 500,000 cubic yards of sand was pumped, with the aid of booster pumps, onto East Beach from a source 6000 ft away (anon., 1952). In 1955, the State of Mississippi completed four-laning Beach Boulevard, and a period of rapid tourism development ensued.

The relative effectiveness of the 1951 beach nourishment project in protecting the seawall became apparent in the 1950s and 1960s as the Mississippi coast was hit by a series of minor and major hurricanes (Sullivan, 1988). There was loss of sand, however, and the beach gradually narrowed. A 1958 study accounted for most of the sand as having moved offshore, and a shoaling of the borrow pit was noted (Watts, 1958). When Hurricane Camille, Force 5 on the Saffir-Simpson scale and among the worst hurricanes ever to strike the U.S. coast, made landfall at Pass Christian in 1969, the Harrison County sand beach and the seawall withstood the storm relatively well (USACE, 1970). Although the beach was due for sand renourishment even before Camille, the hurricane stimulated the call for completing the job. A two million dollar beach renourishment project was undertaken in 1972 and 1973 (Brown & Russell, Inc., 1972; Dixon and Pilkey, 1991). From a borrow area 2000-2500 ft offshore, almost 2 million cubic yards of sediment were pumped onshore, re-creating a 265-ft-wide beach (Field Associates, 1986).

During the 1970s and early 1980s, the sand beach continued to shrink again, and estimates were that 100,000 cubic yards of sand were lost each year, about half to the offshore and the other half onshore because of wind erosion. Since that time, there have been several projects to slow the loss of sand to the wind, projects which included vegetative stabilization and feeder dune construction. In the early 1980s there were calls for another round of beach sand replenishment, optimistically in time for the 1984 World's Fair in New Orleans. The project was delayed for various reasons, and a series of minor-to-medium hurricanes in 1985 (notably Elena) caused extensive wave erosion of beach sands. In 1987-1988, a $3.4 million project renourished the sand beach with 1,124,000 cubic yards of sand dredged from offshore (Brown Engineers, 1987). The source of the fill came from immediately seaward of the 21 borrow areas utilized for the 1972-1973 renourishment project, varying from 2000 to 3000 ft offshore. Also, not the entire sand beach, but only critically eroded segments, was renourished (including Biloxi's East Beach), and once again the Harrison County sand beach was restored to its 1951 condition.

MISSISSIPPI SOUND

10. Ship Island/Gulfport Ship Channel

Many millions of cubic yards of sediment have been dredged in the creation and maintenance of the Gulfport Ship Channel. Accurate records have been kept since the onset of federal involvement in 1960, and these are stored at the U.S. Army Corps of Engineers, Mobile District, field office in Irvington, AL. Although sediments dredged during initial harbor construction were utilized to build up the Port of Gulfport, most sediments dredged from the Gulfport Ship Channel have ended up in waters adjacent to the channel. As the depth of the maintained channel has increased over the decades (from an initial 20 ft to the present 32 ft, and soon to be increased to 36 ft), the volume of sediments has increased accordingly. With the increased minimum channel depth, dredging at the Ship Island bar has increased.
Some of these sediments, which were coarser silts and sands, have been used to provide beach nourishment at Ft. Massachusetts (on the west end of Ship Island) (Table 10). Due to the proximity of the Ship Channel to the west tip of the island and prevailing east-to-west longshore-drifting sediment, there have been high recent rates of channel infilling. This has increased the amount of dredging to maintain the channel. In 1993, a channel realignment began, and in the vicinity of the Ship Island bar, the ship channel will be displaced 1500 ft to the west. The impacts of this action upon maintenance of a beach to protect Ft. Massachusetts have yet to be evaluated.

<table>
<thead>
<tr>
<th>Date</th>
<th>Volume (cu. yd.)</th>
<th>Type of fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>385,000</td>
<td>dredge spoil</td>
</tr>
<tr>
<td>1980</td>
<td>50,000-100,000</td>
<td>dredge spoil</td>
</tr>
<tr>
<td>1983</td>
<td>109,600</td>
<td>dredge spoil</td>
</tr>
<tr>
<td>1991</td>
<td>58,500</td>
<td>dredge spoil</td>
</tr>
</tbody>
</table>

from dredge records, US Army Corps of Engineers, Mobile District

Table 10. Chronology of subaerial dredge spoil placement, Ship Island.

11. Deer Island/Biloxi Harbor Navigation Channel

Biloxi has maintained a commercially active harbor since the early 1800s. Federal jurisdiction over the navigation channel leading to Biloxi dates to the 1880s (U.S. Dept. of Army, 1953), and today a 12-ft-deep, 150-ft-wide channel is maintained into Biloxi Harbor from Biloxi Bay in the east (East Approach Channel) and a 10-ft-deep, 150-ft-wide channel is maintained into Biloxi Harbor from Mississippi Sound in the south (West Approach Channel) (Figure 19). The deeper and historically most used approach to Biloxi is from Biloxi Bay because of its sheltered
location in the lee of Deer Island. This wave sheltering extends also, as noted previously, to the Biloxi Waterfront and to Casino Row.

Although a natural tidal channel occupied (and occupies) the zone where the west tip of Deer Island comes close to the mainland, shoaling was characteristic of both approaches to Biloxi Harbor. Today dredging is important along the entire ship channel. Dredge spoil is normally disposed of adjacent to the channel being dredged, but by the 1950s some of the dredge spoil had become subaerial. Mississippi now has regulations which state that dredge spoil deposited in water bottoms should not come to within 4 ft of the surface, so alternative water bottom sites must periodically be found. Table 11 below lists some of the records of recent maintenance dredging in the Biloxi Ship Channel and approaches that have, directly or indirectly, subaerial expression.

A perusal of dredging records on file with the U.S. Army Corps of Engineers in Irvington, AL, indicated that in the late 1960s, the official dredge disposal site was against the northern edge of Deer Island. When Hurricane Camille breached and also removed part of the very western tip of Deer Island, it was decided to employ some restorative techniques. In 1976, a 1500-ft-long rubble dike was placed at the western tip of the island, and spoil was deposited "behind", or south of, the rubble dike. Also, along the north side of the island, the 1979 dredge disposal sites were relocated northward slightly, apparently because of shoaling. The western tip of the island was again renourished in 1981 (apparently because minor hurricanes in 1979 precluded a natural healing of the island), and as much as 100,000 cubic yards were dumped behind the rubble dike and in the breached area. The backfilled rubble dike seemed to have worked in protecting Biloxi Harbor from high wave energy, but the breach still was not healing as anticipated. In 1989, several years after the 1985 hurricane year (when Elena struck), another nourishment project added spoil behind the rubble dike and to the breach. Today, the breach is still open, but it is so shallow as to effectively dampen high wave energy.

<table>
<thead>
<tr>
<th>Date</th>
<th>Place of fill</th>
<th>Volume (cu yd)</th>
<th>Type of fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>in water adjacent to north side of Deer Is.</td>
<td>?</td>
<td>dredge spoil</td>
</tr>
<tr>
<td>1976</td>
<td>west tip of Deer Is.</td>
<td>?</td>
<td>riprap rubble</td>
</tr>
<tr>
<td>1976</td>
<td>west tip of Deer Is.</td>
<td>56,700</td>
<td>dredge spoil</td>
</tr>
<tr>
<td>1979</td>
<td>north of Deer Island, between 1969 site and 3 foot isobath</td>
<td>169,300</td>
<td>dredge spoil</td>
</tr>
<tr>
<td>1981</td>
<td>west tip of Deer Is. behind rubble dike</td>
<td>100,000</td>
<td>dredge spoil</td>
</tr>
<tr>
<td>1989</td>
<td>west tip of Deer Is. behind rubble dike</td>
<td>?</td>
<td>dredge spoil</td>
</tr>
<tr>
<td>1989</td>
<td>in Deer Is. breach on west spit of island</td>
<td>40,000</td>
<td>dredge spoil</td>
</tr>
</tbody>
</table>

Table 11. Chronology of subaerial dredge spoil placement, Deer Island.

LIMITATIONS OF STUDY

This project represents a first effort at documenting the sedimentary history of the beach and nearshore environment of Harrison County. Several different categories of sedimentary modifications have been presented. For many of these, such as the oyster shell disposal associated with the seafood industry,
detailed records for some types were spotty or absent, and volumetric calculations were made on the basis of areal measurements from historic cartographic sources. For other types of modifications such as dredge spoil removal and disposition, records are fairly good for the last 30 to 35 years. In fact, some of these records are so detailed (before and after bottom profiles, dredge volumes by range line, etc.) that much more work can be done, especially in the vicinity of the Gulfport and Biloxi harbors and their respective approach channels.

In 1990, the Mississippi Secretary of State’s office produced a series of maps and a report (Florida Engineering Services Corp., 1990) on the state’s historic tidelands. All of the mainland sites discussed in this report were identified in the 1990 study, and this report should clarify much of the historic basis behind those “zones of nearshore modification and reclamation” along the Harrison County shoreline. In spite of the many limitations to this study, particularly the lack of accurate data, it represents a “first effort” at better understanding historic human impacts along the Mississippi shores of Mississippi Sound.

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