DEER ISLAND - SANDBAR OR GOLDMINE?

by

David A. Hunter, Jr.
Vice President, de Laureal Engineers, Inc.
Consulting Engineers
New Orleans, Louisiana

GENERAL BACKGROUND

The term "Mississippi Gulf Coast" refers to a strip of land from Waveland on the West to Pascagoula on the East, but represents primarily a sand beach and a narrow strip of hotels, restaurants and motels on Mississippi Sound in Harrison County extending from Pass Christian on the West to the Bay of Biloxi on the East.

The Gulf Coast, originally French, was lost to the British in 1763 and they in turn lost it to the Spanish in 1780. In the meantime, the French continued to hold New Orleans. In 1810 the Gulf Coast area revolted against the Spanish rule and formed the Republic of West Florida. The United States recognized the revolt and took possession of the territory. In 1811, the area was annexed to the Mississippi Territory, which became the twentieth state in the Union.

In the early years of development, the state economy thrived on large cotton plantations, and the Mississippi River as an avenue of trade. No seaports were developed along the Gulf Coast, and by 1830 New Orleans had grown into an influential marketing and financial center. Large fortunes were made, and it was only natural that residents who were financially able sought relief from the heat and humidity of New Orleans by building along the Gulf Coast. This was the beginning of the establishment of the Gulf Coast as a summer playground. Since then the area has grown steadily as a tourist mecca.

Biloxi was established as a French outpost in 1699, and is now the largest city in the Gulf Coast area. The city occupies a peninsula bounded on the south by Mississippi Sound, the east by the Bay of Biloxi and on the north by Back Bay.

The economy of the area has for many years been based primarily on agriculture, the seafood industry and the tourist trade. Since World War II, an important section of the area's payrolls has come from Keesler Air Force Base and the Biloxi Veterans Administration Center. As

the Gulf Coast has become urbanized the importance of agriculture to the economy has diminished.

The city is at the eastern end of the Harrison County Industrial Seaway, and through the efforts of the Biloxi Port Commission, has an impressive industrial park now under construction keyed to this economically important development.

As the result of the physical limitations inhibiting the growth of Biloxi on all four sides (Gulfport to the west and water to the north, east and south), the vast areas of land utilized by the various government installations, and the general dense pattern of development in the City, there is no substantial area open for residential growth. Annexation of a portion of the land lying between Biloxi and Gulfport has provided immediate relief, but this will only be a temporary solution.

The dense pattern of development in Biloxi has presented the City with a corollary problem -- the lack of space for recreational facilities. The beach along Mississippi Sound provides the only recreation area of consequence. There is a tremendous need to supplement these facilities with major parks and play areas.

The Deer Island Project was conceived in response to these two basic major needs of the community.

Deer Island is a spit of land approximately 1500 feet from the mainland five miles in length, varying in width up to 2500 feet, containing a total of approximately 550 acres above mean sea level. For many years the island has captured the imagination of dreams and speculators alike. Everyone has wanted to live on an island at sometime in his life and the dreamers see this ambition coming alive in Deer Island. Speculators, with possibly less sensitive souls but more common sense, see a virtual gold mine in this sand bar.

The idea of developing this piece of land for resort and residential usage is quite old. Mr. Mayer Eiseman subdivided a small section of the island, about 45 acres, around the turn of the century; however, this subdivision was apparently unsuccessful and was abandoned.

During the boom days of the 1920's, another attempt was made to develop the island. An engineer was retained and a topographic survey of the island was made. A suggested subdivision plan was prepared and a permit was acquired from the Corps of Engineers for the construction of a seawall around the proposed development. In connection with this plan, some of the comments of the Engineer, Mr. D.G.W. Ricketts, of Laureal, Mississippi, are of interest.

"In the autumn of 1925, Mr. John Liuzza, a realtor of New Orleans, commissioned me to carry out a topographic survey of the Island and a hydrographic survey of the immediate shore area. He had acquired or optioned all of Deer Island except about 12 acres of the sand spit adjoining a small strip of wooded area at its northeast extremity...a study...(showed) that in order to protect Deer Island itself would require about 10 miles of seawall to be constructed along the three or four foot contour m.s.l. and this wall would enclose about 600 acres, whereas by following contour minus 2 m.s.l. it would entail another two miles of seawall, more or less, that would confine almost five times more area...The estimates in 1926 were in round figures $5 million and $11 millions dollars for units one and two respectively. I cannot refrain from according Mr. Liuzza some of the credit for the useful suggestions he supplied from time to time during the creative stages of the design. Of Creten ancestry, he possessed a keen and versatile intellect, but the fates were unkind to him. Had it not been for the depression of 1929, he would undoubtedly have succeeded in developing Deer Island".

The plan to which this refers contained approximately 2,775 acres. It included many of the facilities being planned in the current development shown herein, as well as some features (such as a polo field and airport) which now seem grandiose. Basically, the plan called for the development of numerous interior waterways, with the golf course, parks and greenbelts being developed for interior residential lots. The plan was updated by Mr. Ricketts in 1947.

In the late 1950's the engineering firm of Radar and Associates was retained by the Biloxi Bridge and Park Commission (an agency created by the state to effect the development of the island) to develop an engineering and economic report for Deer Island. The report was submitted in draft form in May, 1958 and in final form in July, 1960. This project envisioned the development, in three stages, of an island totaling 3,265 acres, with an estimated construction cost of $19,305,800.00. A serious effort was made to finance the project and get it under way in the early 1960's, but legal problems intervened and the project languished.

In February, 1965, the Biloxi Bridge and Park Commission, having determined that most of its legal problems were solved, retained the engineering firm of de Laureal Engineers, Inc., and the investment banking firm of Scharff and Jones, to put the project on the right track to get it moving. It was evident to banking interests that the 1960 report did not present the development plan in sufficient detail to develop accurate estimated construction costs,

nor did it develop sufficiently valid estimates of revenue to permit the issuance of municipal bonds. The Biloxi Bridge and Park Commission then applied to the Housing and Home Finance Agency (now Department of Housing and Urban Development) for a Planning Advance to permit the development of a comprehensive plan based on sound economic projections and modern planning concepts. In November of 1965, the HUD planning advance was approved, and in January 1966 the Engineers were directed to proceed.

Although none of the concepts involved in the development of the Deer Island project are particularly unique or difficult, it became obvious from the first that the sheer magnitude of the project and the number of disciplines involved would result in problems of scheduling and coordination. In an effort to reduce these problems, a critical path diagram was prepared to establish, in general, the responsibilities of the different individuals and firms associated with the project. This procedure was of significant value in keeping the study on schedule and completing it on time.

In addition to the engineering studies and overall project coordination provided by de Laureal Engineers, Inc. advice was sought in the areas of planning, real estate market analysis and real estate consultation, surveying, subsurface and soils investigations, analysis of hurricane effects and protective structures, fiscal planning, and legal advice from municipal bond counsel. During the preparation of the report the advice, concurrance and approval of the Biloxi Bridge and Park Commission and Biloxi authorities was solicited on an almost continuous basis.

The net result of the study is a plan for the development of Deer Island as a recreational-resort community providing substantially increased recreational areas for the Biloxi community, space for the expansion of the Biloxi resort area, and much needed area for the residential expansion of the City of Biloxi.

Development of the island will be accomplished in four phases. The initial 900 acre development will be followed by three phases of 1000, 1000, and 700 acres respectively, ultimately providing for a population of 35,000.

There are many aspects of the Deer Island Project which are of interest. However, this report will concentrate on the elements of the design which are concerned with the utilization of the area's water resources. The planning process will be considered and the steps reviewed which led to the development of the final land use plan. In this process, engineers, planners, market analysts, and consultants worked closely to develop a facility which would be marketable, feasible, safe, and based on sound planning and engineering

criteria. Since these are not necessarily mutually compatable the task at times became difficult.

PROJECT PLANNING

The basic configuration and planning of the Deer Island project was limited to a large extent by the physical limitations imposed by the site. These included the actual land mass of the existing island, the location of existing ship channels to the north, east and west of the island, the depth of water in areas surrounding the island, foundation conditions in the area, the location of borrow pit material, and considerations of island elevation required to resist the effect of the frequent hurricanes and tropical storms which attack the area.

Planning and real estate consultants were brought together with the design team at an early date so that all professions could gain a full appreciation and understanding of the total program requirements. The planning consultant's contribution at the time consisted of tentative recommendations for the overall character of development, a list of suitable land uses and percentage distribution for such uses, standards for each land use and circulation systems standards. At the same time the design team prepared rough approximations of cost.

The real estate consultant then proceeded with a preliminary study of market conditions to determine, in general, the types of land that might be sold, the size of potential market in relation to time (absorbtion schedule), income levels of potential purchasers, sizes of parcels, and all of the other variables that relate to the evaluation of the real estate market. Based on these preliminary studies the following conclusions were reached:

1. Although a substantial primary market (demand resulting from the natural growth in the area) exists, it will not be sufficient to support the project.

2. A significant demand exists for retirement homes on the Gulf Coast.

3. There exists a real demand for "second homes", primarily generated by New Orleans residents.

4. A substantial recreational-resort complex can be supported in the area, particularly if facilities are provided to cater to small recreationally oriented conventions.

5. Maximum real estate value for all types of residential, commercial and resort property will result from a water oriented development supplemented by other recreational possibilities.

A series of meetings with Biloxi and Harrison County officials served to establish the interests and recommendations of these local agencies.

This market and planning data were assimilated and evaluated, together with the engineering concepts and physical limitations previously established. A preliminary plan defining island access, island configuration and major land uses was developed by the planning consultant on the basis for further studies.

There are seven basic classifications of land use as follows:

1. Residential
2. Commercial
3. Resort (Hotels/Motels/Boatels)
4. Institutional
5. Public
6. Recreational
7. Circulation

Concurrent with the preparation of the preliminary plan the real estate consultant proceeded with detailed market studies. These studies served to confirm earlier observations and recommendations insofar as the total market potential was concerned, although there were adjustments within the various land use classifications. Upon completion of these detailed findings and their acceptance by the Biloxi Bridge and Park Commission the planning consultant was able to begin preparation of the generalized development plan.

At this time the planning consultant also submitted recommendations concerning the phasing of the total development and a list of tentative protective covenants designed to safeguard and preserve property values, and to insure adherance to the objectives of the program. Figure I delineates the recommended land use allocations for each stage, establishing the size and relationship of the parts as well as the major circulation philosphy. The plan does not attempt to translate land use allocation configurations literally into final lotting and development maps, but is solely a division of land mass by functional uses.

The final Detailed Development Plan prepared by the engineers carries to a logical conclusion the work of the Planning Consultants, establishing in detail the location of streets, waterways, parks, greenbelts, and the detailed sub-

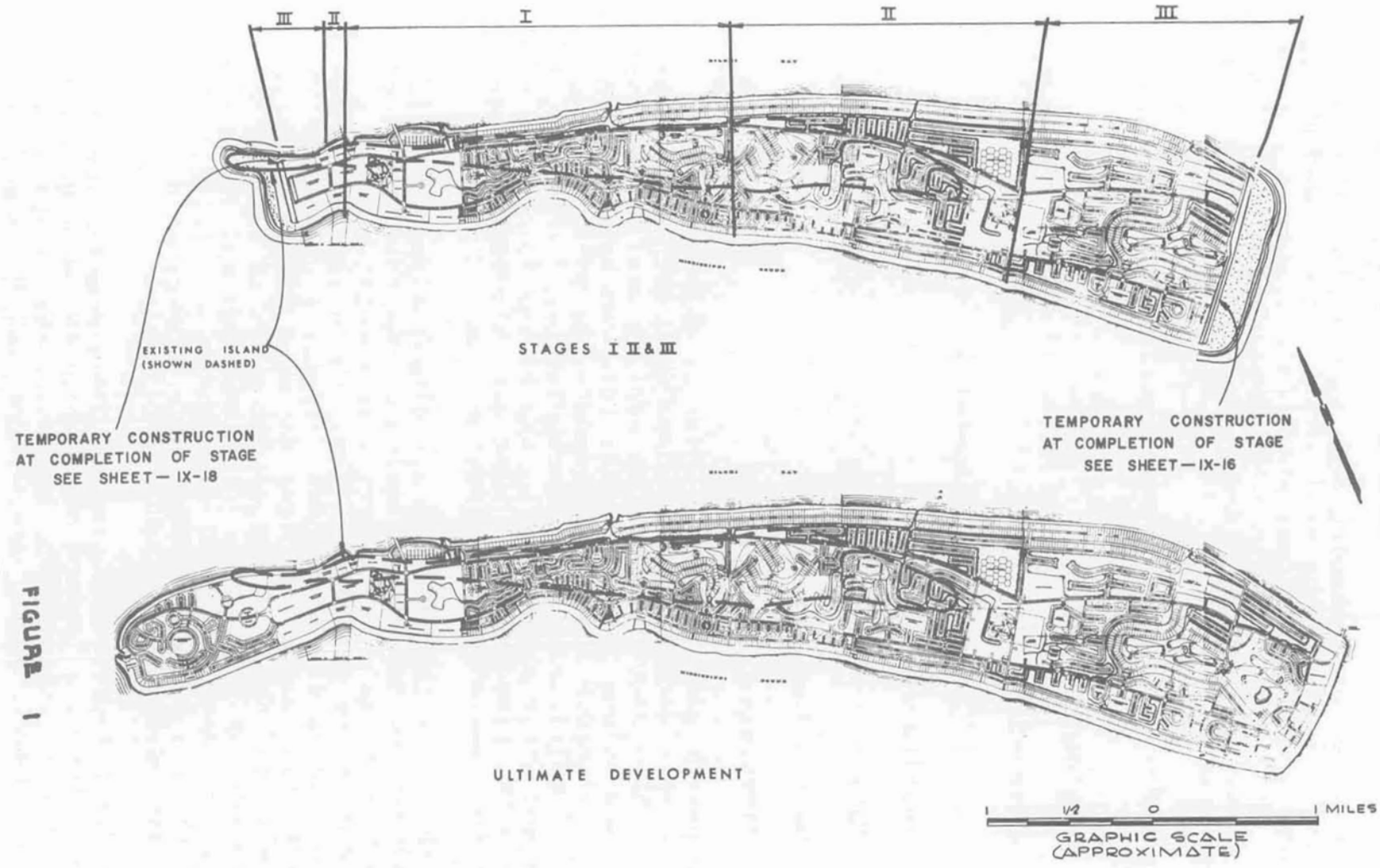

FIGURE 1

STAGE DEVELOPMENT STAGES III & IV

VIII-2

division of land parcels into neighborhood units. The final plan is based on the principles and standards previously established, as well as on the following broad guidelines:

Each lot was placed contiguous to one of the major amenities (beachfront, waterfront, greenbelt, golf course, park or club).

Interior waterways (which also serve as drainage channels) provide amenities to lots which would otherwise have none and are used as a means to provide aesthetic relief in the high density areas.

Greenbelts provide for a "secondary" circulation system connecting schools, churches, parks, playground and adjacent neighborhoods.

The hotel-motel-boatel assignment in each stage has been divided between the major shorelines of the island.

Residential and resort-oriented land uses are separated, with high density uses providing a buffer between the two. Traffic associated with the resort area is likewise separated from residential area traffic.

Figures 2 and 3 show the detailed land use and lotting plans for a portion of the First Stage development which is more or less typical. Table I shows the number of residential lots associated with each type of ammenity. Table 2 shows the percentage of area devoted to each land use.

EARTHWORK AND HURRICANE STUDIES

The earthfill for the Deer Island project represents the single most costly item in each development phase. Not only is earthwork important from a cost standpoint, but it also has a strong influence on the cost of drainage, sewerage, shore protection and other basic elements of the island design.

In connection with this portion of the design, conferences were held with representatives of the U.S. Corps of Engineers, Contractors experienced and regularly engaged in hydraulic fill operations, and the Commission's Soils Consultants, Eustis Engineering Company. During these meetings, consideration was given to construction methods, scheduling, cost factors, available borrow pit material, borrow pit location, length of pumping and other items affecting or influencing the design of the project. The most important design consideration was, however, the anticipated effect of hurricanes on the island.

The Mississippi Gulf Coast has experienced numerous

TABLE I

SUMMARY OF SINGLE FAMILY RESIDENTIAL
LOT TABULATIONS BY FRONTAGE TYPE

STAGE	FRONTAGE TYPE (UNITS)									
	Ocean Front	Bay Front	Inland Waterfront Navigable	Park Front	Golf Course Front	Schools, Clubs and Church Front	Green Belt	None	Sub-Total Stage	TOTAL UNITS
1	88L ---	82L ---	44L 412M	--- 20M	87L 68M	--- 7M	--- 609M	2L 59M	303L 1175M	1478
2	93L ---	103L ---	108L 941M	--- ---	79L 95M	--- 28M	--- 810M	1L 85M	384L 1959M	2343
3	68L ---	56L 31M	172L 775M	--- 17M	84L ---	--- 9M	32L 524M	-- 52M	412L 1408M	1820
4	70L 37M	33L 39M	--- 171M	--- ---	67L ---	3L 30M	--- 713M	1L 53M	174L 1043M	1217
SUB-TOTAL	319L 37M	274L 70M	324L 2299M	--- 37M	317L 163M	3L 74M	32L 2656M	4L 249M	1273L 5585M	
TOTAL	356	344	2623	37	480	77	2688	253		6858

M = Medium Density sites 60 ft. x 100 ft.
L = Low Density Sites 90 ft. x 200 ft.

TABLE 2
LAND USE DISTRIBUTION BY STAGE

	STAGE I	STAGE II	STAGE III	STAGE IV	TOTAL Development Acres	TOTAL % Distribution By Line Item
I. RESIDENTIAL						
a. Single Family						
1. Low Density	125	159	170	.72	526	14.70
2. Medium Density	162	270	194	144	770	21.52
b. Apartments						
1. High Density	54	48	54	91	247	6.90
2. Multiplex	10	19	23	21	73	2.04
SUB-TOTAL	351 Ac. (42.13%)	496 Ac. (47.60%)	441 Ac. (43.88%)	328 Ac. (46.99%)	1616 Ac.	45.16%
II. COMMERCIAL						
a. Motel/Hotel/Boatel	27	18	21	22	88	
b. Shopper Commercial	6	8	22	22	58	
SUB-TOTAL	33 Ac. (3.96%	26 Ac. (2.50%)	43 Ac. (4.28%	44 Ac. (6.30%)	146 Ac.	4.08%
III. PUBLIC						
a. Parks						
1. General	6	-	4	4	14	.39
2. Beach	2	3	2	7	14	.39
b. Greenbelt	87	79	130	108	404	11.30
c. Waterways	80	154	156	22	412	11.51
d. Tournament Golf Course	-	-	59	71	130	3.63
e. Marina & Launching Ramps	9	1	-	1	11	.31
f. Civic Center	5	-	-	-	5	.14
SUB-TOTAL	189 Ac. (22.69%)	237 Ac. (22.74%)	351 Ac. (34.93%)	213 Ac. (30.52%)	990 Ac.	26.67%

TABLE 2
LAND USE DISTRIBUTION BY STAGE

		STAGE I	STAGE II	STAGE III	STAGE IV	TOTAL Development Acres	TOTAL % Distribution By Line Item
IV.	SEMI-PUBLIC						
	a. Par 3 Golf	20	20	-	-	40	1.12
	b. Commercial-Entertainment	26	-	-	-	26	.73
	c. Regulation Golf Course	66	79	-	-	145	4.05
	d. Clubs	5	10	13	11	39	1.09
	e. Convention Center	6	9	-	-	15	.42
	f. Schools	9	17	34	9	69	1.93
	g. Churches	2	2	3	3	10	.28
	h. Utility	5	-	-	-	5	.14
	SUB-TOTAL	139 Ac. (16.69%)	137 Ac. (13.15%)	50 Ac. (4.98%)	23 Ac. (3.30%)	349 Ac.	9.76%
V.	CIRCULATION						
	a. Streets r/w	121 Ac. (14.53%)	146 Ac. (14.01%)	120 Ac. (11.98%)	90 Ac. (12.89%)	477	13.33%
VI.	TOTAL	833 Ac. (100%)	1042 Ac. (100%)	1005 Ac. (100%)	698 Ac. (100%)	3578 Ac.	100.00%

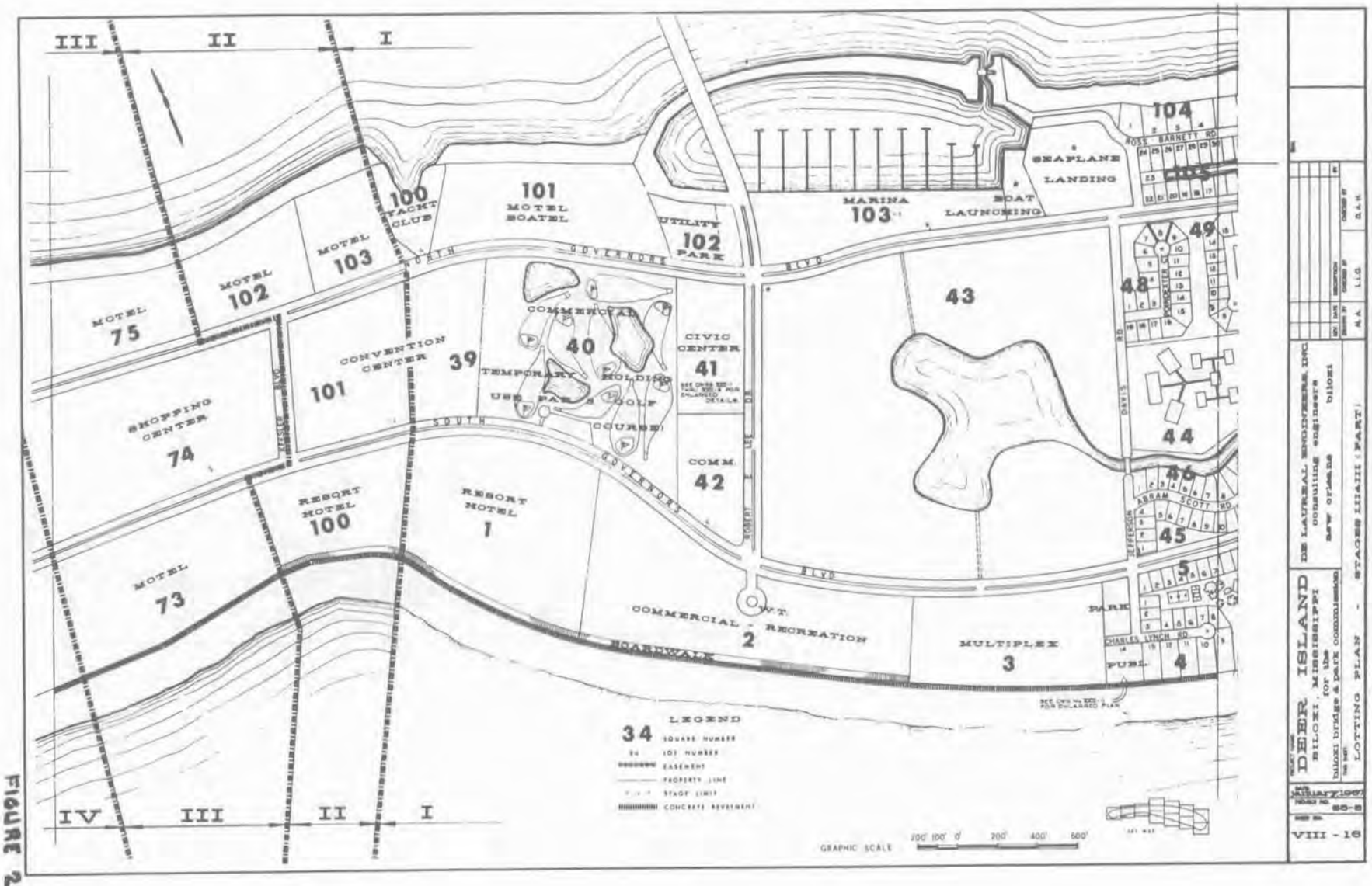

FIGURE 2

DEER ISLAND
BILOXI, MISSISSIPPI
for the
biloxi bridge & park commission

DE LAUREAL ENGINEERS, INC.
consulting engineers
new orleans
biloxi

LOTTING PLAN - STAGES IIIAIII (PART)

JANUARY 1967
80-8
VIII - 16


LEGEND
34 SQUARE NUMBER
34 LOT NUMBER
EASEMENT
PROPERTY LINE
STAGE LIMIT
CONCRETE REVETMENT
GRAPHIC SCALE
200 100 0 200 400 600
SOUTH SHORE BEACH
BARNETT RD
ROSS
NORTH GOVERNORS BLVD
GRENADA ST
DRAINAGE PUMP STATION N°
WEST J. P. COLEMAN RD
PARK ROAD
TILGHAM
TUCKER
JOHN GUION RD
MELROSE ST
PAUL JOHNSON
PUBLIC
ELEM SCHOOL
DEER ISLAND
BILOXI MISSISSIPPI
for the harbor commission
DE LAUREAL ENGINEERS INC.
consulting engineers
new orleans louisiana
LOTTING PLAN - STAGE I (PART)
DATE JANUARY 1967
PROJECT NO 65-15
SHEET NO VIII - 17

FIGURE 8

damaging hurricanes. Damage has been caused not only by the high velocity winds associated with such storms but also by the rapid increase in water levels preceding a storm and accompanying wave action. The hurricane of 1947, the most severe in recent history, caused $17,478,000 damage in Harrison County, including $3,371,000 in Biloxi alone.

The question of providing adequate protection against hurricane forces is one which was of primary concern from the inception of the Deer Island study. In 1965 Hurricane "Betsy", which hit far to the west of Harrison County, caused sufficient damage to bring this matter to the attention of everyone involved. It is evident that financial interests will require assurance of adequate protection for their investment.

The term "Standard Project Hurricane" (SPH) is defined as "...the most severe storm that is considered reasonably characteristic of the region in which the basin is located." The recurrent interval for the SPH is generally taken to be 100 years. A study of the isovel patterns for the Biloxi area shows maximum wind velocities that vary from 100 to 111 miles per hour, the latter value being for a fast-moving hurricane. However, the maximum velocity is in each case confined to a very small area in the isovel pattern.

A review of three hurricane protection studies, one for the Mississippi Coast, one for Grand Isle, La., and one for Texas City, Texas, all by the Corps of Engineers, indicates in all three cases that the 100-year hurricane was selected as the design hurricane. No design wind velocity is given in the Mississippi Coast study. In the Grand Isle study the design wind velocity is given as 100 miles per hour, and in the Texas City study as 99 miles per hour.

The 100-year hurricane was selected for the Deer Island study as being conservative when compared to the life of bonds proposed for financing the project, the projected period of project development, the amortization period of projects to be developed on the island, etc. The design wind velocity associated with the 100-year hurricane is 100 miles per hour.

Data on surge and storm tides at various points along the Gulf Coast is shown for a seventy-year period in Table 3. It is interesting to note from this tabulation the significantly higher storm tides experienced in Bay St. Louis area when compared to Biloxi. A study of Figure 4 explains this phenomenon. The Louisiana and Mississippi coasts create a "funnel". Hurricanes moving into the Gulf of Mexico cause a general increase in tides along the coast, and storms moving in the characteristic northwesterly direction force water into the "throat" of the

TABLE 3

STORM TIDES AT VARIOUS LOCATIONS IN MISSISSIPPI
(1893-1965)

(Elevations in Feet Above Mean Sea Level)

Storm	Wave-land	Bay St. Louis	Pass Christian	Long Beach	Gulf-port	Biloxi	Pascagoula
2 Oct. 1803	10.8		10.8				
27 Sept. 1906						6.2	
20 Sept. 1909	8-12 feet above normal tide along Mississippi coast						
29 Sept. 1915		11.8	12.8		9.0	9.0	
5 July 1916						4.3	
28 Sept. 1917						2.5	
21 Sept. 1920	Mississippi Sound 5 to 6 ft. above normal					5.4	
15 Oct. 1923						7.0	
26 Aug. 1926						3.0	
21 Sept. 1932		2.3	6.0		6.0	5.4	
31 Sept. 1932					2.0		
6 Aug. 1940	Mississippi Coast 5 to 6 feet above normal						
19 Sept. 1947		15.2	13.4[1]	14.0	14.0	11.1[2]	9.0[3]
4 Sept. 1948		6.0			6.0	5.6	4.0
4 Sept. 1949		5.0				4.3	
26 Aug. 1955		3.8			6.0	3.5	
24 Sept. 1956		2.7	3.0	2.4	4.0	3.3	3.2
18 Sept. 1957					6.5		
15 Sept. 1960					5.0	5.1	4.5
3 Oct. 1964		6.0			3.1	4.6	3.5
Sept. 1965						8.8	

[1] A tide of 11.8 feet m.s.l was recorded on east St. Louis Bay at Pass Christian

[2] Maximum elevation of 10.8 feet m.s.l. recorded by automatic gage in open bay approximately one mile northeast. A tide of 12.0 m.s.l. was recorded at north Biloxi on Back Bay.

[3] From U.S. Weather Bureau records. Corps of Engineers automatic recording gage registered 7.68 feet mean sea level.

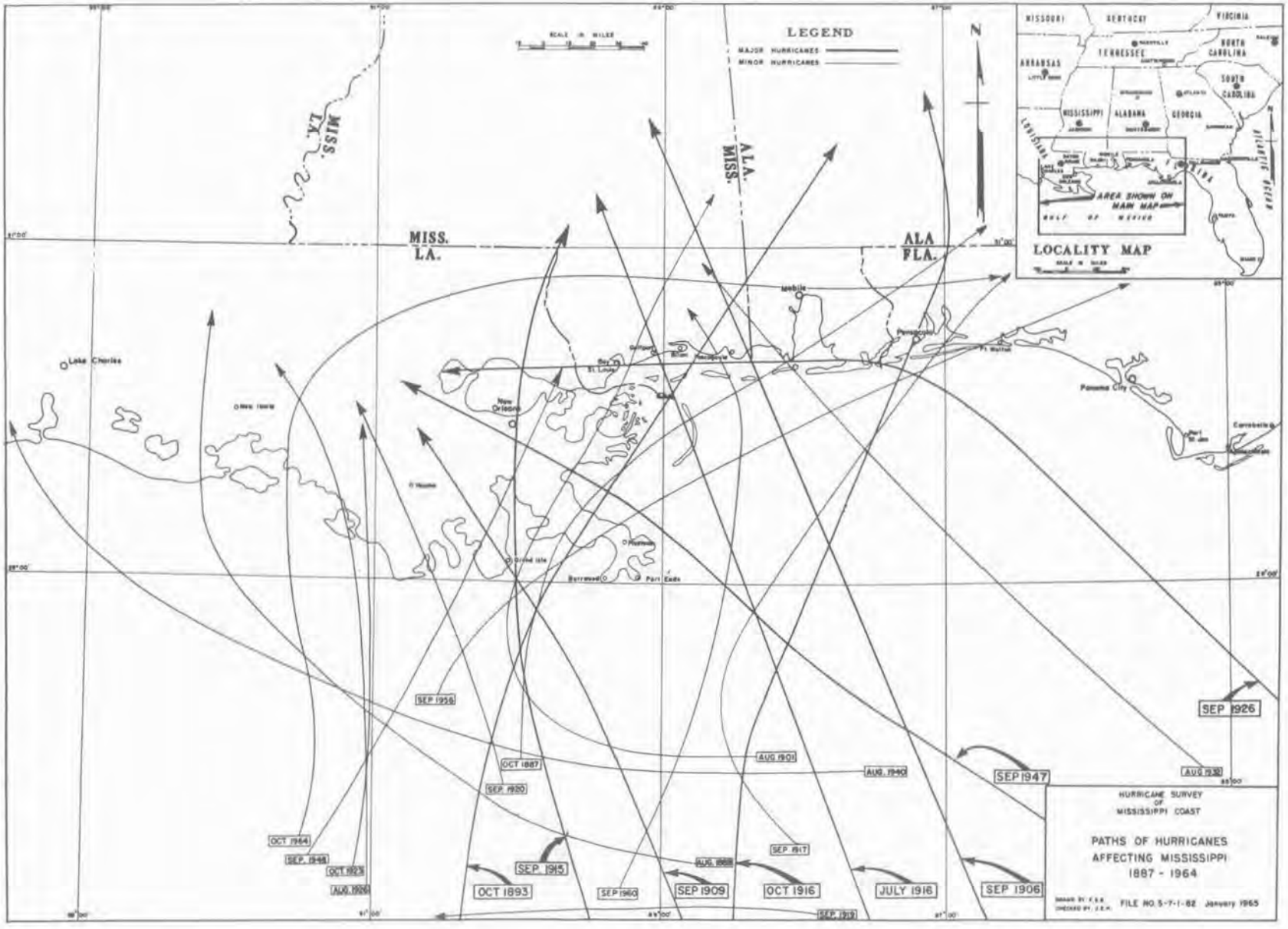
LEGEND
MAJOR HURRICANES
MINOR HURRICANES
SCALE IN MILES
N
MISS. LA.
ALA. MISS.
ALA FLA.
LOCALITY MAP
AREA SHOWN ON MAIN MAP
GULF OF MEXICO
Lake Charles
New Orleans
Mobile
Pensacola
Panama City
Apalachicola
Grand Isle
Burrwood
Port Eads
OCT 1964
SEP. 1948
OCT 1923
AUG. 1926
SEP 1956
OCT 1887
SEP 1920
SEP 1915
OCT 1893
SEP 1960
AUG. 1888
SEP 1909
SEP 1917
OCT 1916
SEP 1919
AUG 1901
AUG. 1940
JULY 1916
SEP 1906
SEP 1947
SEP 1926
AUG 1932
HURRICANE SURVEY
OF
MISSISSIPPI COAST
PATHS OF HURRICANES
AFFECTING MISSISSIPPI
1887 - 1964
DRAWN BY: F.S.S.
CHECKED BY: J.E.M.
FILE NO. 5-7-1-82 January 1965

FIGURE 4

funnel, producing significantly higher water level in the west.

This factor explains to a large extent why Dauphin Island near Mobile, Alabama, and Santa Rosa Island near Pensacola, Florida, have been satisfactorily developed at relatively low elevations of 6 to 8 feet above mean sea level, while waterfront developments in Harrison County, at similar elevations, have been flooded.

When data for maximum hurricane tides as recorded on the Biloxi gage is plotted on log-probability paper the storm surge associated with the 100-year storm is found to be approximately thirteen feet above mean sea level.

The prediction of wave characteristics consistent with the 100-year storm presents serious problems. Hurricane winds acting over the deep waters of the Gulf of Mexico for prolonged periods will generate waves of large magnitude. Such waves will have long lengths and long periods. When these waves hit the shelf and outer rim of islands (Dauphine Island, Horn Island, Ship Island, Cat Island, etc.) they will break up, dissipating a large part of their energy. It can be expected that an occasional wave will infiltrate through the gaps in the barrier, but these will be quickly eroded by the shallow water in Mississippi Sound.

Even though the deep water waves will be broken up on the outer islands, the period of these waves can be expected to cause long period oscillations in Mississippi Sound. There is no way to evaluate quantitatively the height of these oscillations, but their presence will amplify the normal problems associated with the shallow water waves generated in the Sound.

Waves generated in Mississippi Sound are subject to a more classic analysis. Calculations have been based primarily on the information included in "Shore Protection Planning and Design", Tech. Report No. 4, U.S. Army Coastal Research Center. Assuming a wind speed of 100 miles per hour and an average water depth of 12 feet, a significant wave height (a height which will be exceeded by one-sixth of all waves) of 8.1 feet can be anticipated.

It is normally considered that something less than 75 percent of a wave projects above the still water elevation. Because of the long period oscillations mentioned above it has been assumed that the crest of a significant wave may exceed the still water level by 100 percent of the significant wave height. This would yield a wave crest height of 21.1 feet.

Because of the irregularities of the shallow bottom, the refraction patterns set up by the outer islands and the

long period oscillations previously mentioned, it is not expected that a regular wave pattern will develop. However, for the purpose of these calculations a regular pattern has been assumed. This assumption is considered conservative.

As waves move across the shallow waters of Mississippi Sound to the shore of Deer Island their height will be governed by the water depth over the protective beach, the slope of this beach, and the depth to which the beach is eroded. As the wave crosses the beach and breaks, its energy is continuously dissipated, ending finally in a sheet of water running up the protective slope.

For the purpose of designing protective structures, the wave height is taken at a point approximately seven times the wave height from the toe of the protective structure or berm. For the "basic" design described hereinafter for the south shore, the significant wave height is 8.4 feet. For the alternate" design the significant wave height is 6.2 feet. Wave runup is discussed in the following paragraphs.

The ways or directions in which hurricane winds and tides can attach the proposed Deer Island Development are limited to a large extent by the physical characteristics of the site. Winds and waves acting perpendicularly to the south beach (moving in a northeast direction) would not be compatible with a storm causing maximum surge in Mississippi Sound. Although conditions of wind and fetch would be such as to produce maximum waves, the surge would not be present to produce maximum water depth at the same time.

Conditions which have been assumed to produce worse conditions are generally as follows:

a. Hurricanes approach within the southeast quadrant.

b. Maximum danger to south shore occurs with due north approach.

c. Maximum danger to north shore occurs when storm moving generally west-north-west parallel to the axis of the island.

d. Maximum danger to east end (including temporary completions at the ends of construction stages) occurs with generally north-west approach.

It is expected that whatever protective works are placed along the south shore, there will be intermittent overtopping by occasional waves of abnormally great magnitude. Such overtopping is to be expected and is consistent with economical design procedures. (Large quantities of water in the form of spray will also be blown by the high velocity winds

onto the island).

Runup, the action of a breaking wave forming a sheet of water which is propelled up a slope or structure to the point where the wave energy is dissipated, is a problem which has been carefully considered. Runup is obviously less on long, shallow, permeable slopes than on short, steep, impermeable slopes. This subject is discussed further in the paragraphs following on shore protection.

The tabulation of storm surges shown in Table 3 indicates that any community of a resort-residential type featuring interior waterways would have to:

1. Be constructed to an elevation of sufficient height to avoid inundation;

2. Be constructed to a low level with zoning and title restrictions enacted requiring structures to be constructed on stilts at a safe height above storm tides;

3. Provide a means for closing off the interior waterways at times of abnormally high tides with adequate means for pumping out rain and storm water.

Serious consideration was given to Alternate One. Two problems defied reasonable solution. First, the vast quantities of fill involved made the concept uneconomical. Second, the development of waterfront (interior waterway) lots became impractical. With a 100-foot lot depth it was obviously impossible to maintain a building site elevation at plus 12 m.s.l. and still maintain an elevation of +5 m.s.l. at the edge of the waterway. The slope would make such a lot virtually unusable.

Because of the general standard of development considered necessary to attract residents and resort and commercial activities to the island, the real estate consultants considered Alternate Two to be an unrealistic approach. They felt the trend should be away from a camp or summer home atmosphere and more emphasis given to permanent construction.

It was recognized that Alternate Three would present difficulties, but it appeared to offer the most economical and practical solution to the problem. Planning proceeded on this basis with the interior of the island proposed at an average elevation of +5 m.s.l. and the perimeter to an elevation of sufficient height to prevent the intrusion of storm water. Gates are provided at waterway entrances for enclosures during times of high tides. Pumping stations are provided to remove storm water from the island during the times that the gates are closed. Figure 5 shows one of the

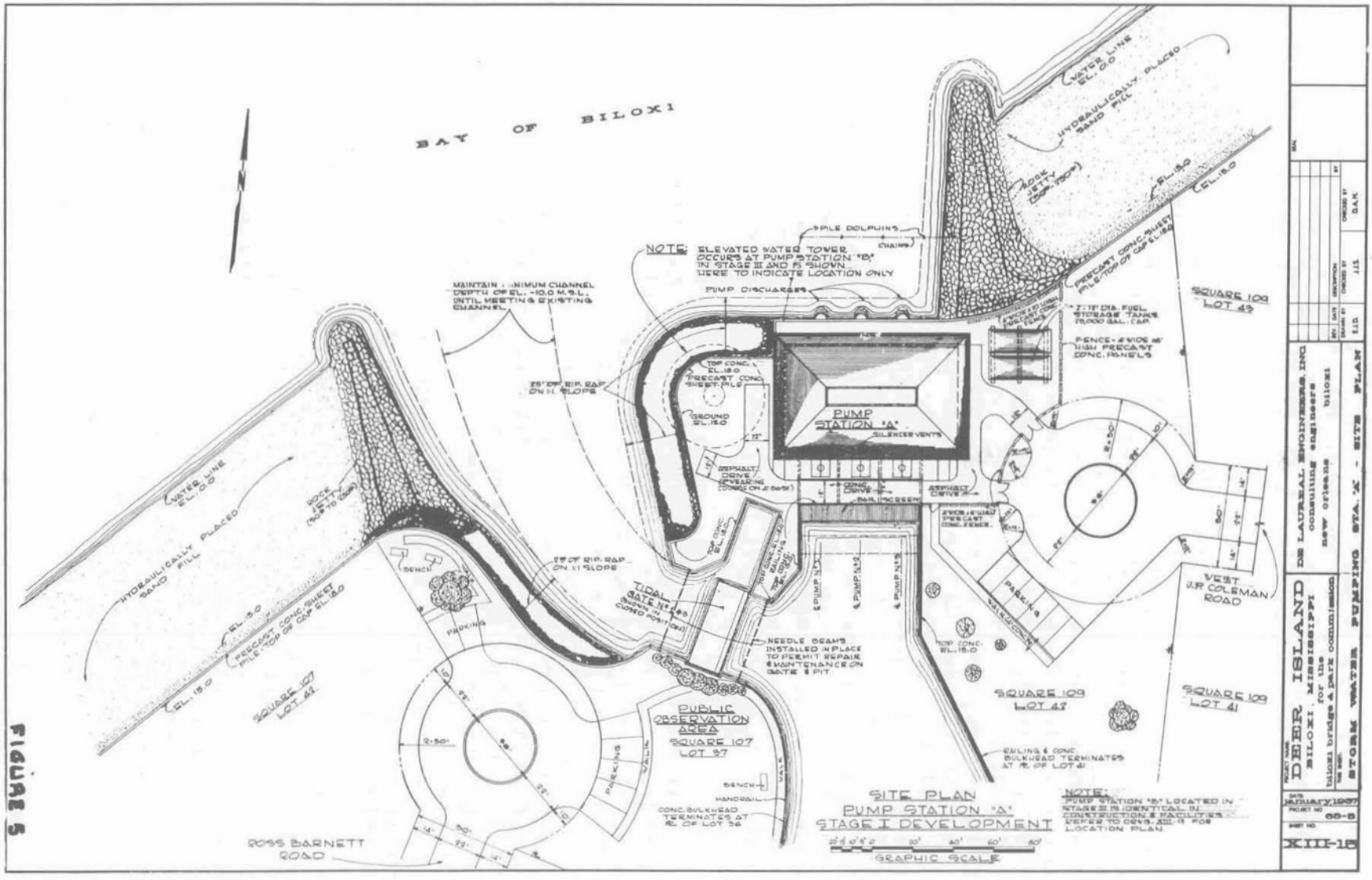
BAY OF BILOXI
N
WATER LINE EL. 0.0
HYDRAULICALLY PLACED SAND FILL
ROCK JETTY (TOP TO CONC.)
EL. 15.0
PRECAST CONC. SHEET PILE-TOP OF CAP EL. 15.0
SQUARE 107 LOT 41
BENCH
PARKING
TOP OF RIP-RAP ON 1:1 SLOPES
TIDAL GATE No. 1
(SHOWN IN CLOSED POSITION)
PUBLIC OBSERVATION AREA
SQUARE 107 LOT 37
BENCH
HANDRAIL
CONC. BULKHEAD TERMINATES AT NE OF LOT 36
ROSS BARNETT ROAD
MAINTAIN MINIMUM CHANNEL DEPTH OF EL. -10.0 M.S.L. UNTIL MEETING EXISTING CHANNEL
NOTE: ELEVATED WATER TOWER OCCURS AT PUMP STATION "B" IN STAGE II AND IS SHOWN HERE TO INDICATE LOCATION ONLY
PUMP DISCHARGES
STEEL DOLPHINS
CHAINS
TOP CONC. EL. 15.0 PRECAST CONC. SHEET PILE
GROUND EL. 15.0
PUMP STATION "A"
SILENCER VENTS
ASPHALT DRIVE (REVERSING CURVES ON 2 DAYS)
CONC. DRIVE
BAR SCREEN
TOP CONC. EL. 15.0
RIP-RAP AT 1:1 SLOPES
4 PUMP No. 1
4 PUMP No. 2
4 PUMP No. 3
NEEDLE BEAMS INSTALLED IN PLACE TO PERMIT REPAIR & MAINTENANCE ON GATE & PIT
TOP CONC. EL. 15.0
RAILING & CONC. BULKHEAD TERMINATES AT NE OF LOT 41
SQUARE 109 LOT 43
SQUARE 109 LOT 41
SQUARE 109 LOT 42
7-15' DIA. FUEL STORAGE TANKS 75,000 GAL. CAP.
FENCE - 8' SIDE 16' HIGH PRECAST CONC. PANELS
PRECAST CONC. SHEET PILE-TOP OF CAP EL. 15.0
TOP CONC. EL. 15.0
ASPHALT DRIVE
PRECAST CONC. FENCE
PARKING
WATER FOUNTAIN
WEST J.R. COLEMAN ROAD
SITE PLAN
PUMP STATION "A"
STAGE I DEVELOPMENT
GRAPHIC SCALE
NOTE: PUMP STATION "B" LOCATED IN STAGE II IS IDENTICAL IN CONSTRUCTION & FACILITIES REFER TO DRWG. XIII-9 FOR LOCATION PLAN
DE LAUREAL ENGINEERS, INC. consulting engineers new orleans
DEER ISLAND BILOXI, MISSISSIPPI
for the biloxi bridge & park commission
STORM WATER PUMPING STA. "A" - SITE PLAN
January 1967
65-8
XIII-18

FIGURE 5

three drainage station complexes including the storm gates.

Based on the information developed in the preceding paragraphs, protective construction has been designed for the various exposures of Deer Island. These are discussed in detail as follows:

The south shore will bear the brunt of the attack of any hurricane which has the potential of doing maximum damage to the island. Winds operating across the fetch of 45,000 feet will produce waves 8.4 feet in height in the open waters of the Mississippi Sound. Two designs have been developed, both of which are considered to offer equal protection. The "basic" design provides for a beach some 200 feet in width, topped by pre-cast concrete block revetment, extending to a height of plus 18 m.s.l. At the top of the pre-cast concrete block revetment is a wave screen which extends up to plus 21 m.s.l. Land behind the wave screen is filled to plus 18 m.s.l. The pre-cast concrete block revetment is underlaid by a gravel drain approximately 12 inches thick, which is placed on top of a plastic filter, which in turn rests directly on the hydraulically placed sand fill. The toe of the pre-cast concrete block revetment is closed off with a pre-cast concrete sheet pile toe wall extending to elevation minus 4.0 m.s.l. A similar but much shorter sheet pile is placed at the top of the revetment.

The sand fill at the water's edge has been placed at a slope of 1 in 10. This is the natural slope which is currently being maintained on the artificial beach along the balance of Harrison County. Samples of sand taken from the artificial beaches along Harrison County and from the potential borrow pit areas for the Deer Island fill indicate that the grain size distribution of these samples will be essentially equal. Samples taken from the natural beaches along the north and south shore of Deer Island indicate a similarity to the borrow pit material, except that the fines have been leached out of the natural beach sand. From an elevation of plus 5, the beach slopes back to the pre-cast revetment on a general slope of 1 in 20.

The pre-cast concrete blocks proposed for use in the Deer Island revetment are similar to those which have been utilized along the east coast of Florida. There has been no record of these Florida revetments failing in the past six years that they have been in use, and there are indications that they have been acted on by waves of substantial size and storms of long duration. The block design has been modified to provide for improved air circulation between the joints. The pre-cast sections, designed to roughen the surface and inhibit runup, will be glued to the blocks with poxy. This represents an innovation which

should result in more economical construction.

The revetment would be placed under the same construction contract with the hydraulic sand fill. It is expected that contractors would leave a trench to the south of the revetment toe wall and construct the revetment from barge-mounted equipment. Sand fill to the south of the revetment would then be placed by hydraulic dredge.

The alternate south shore section provides protection against hurricane waves primarily from a wide expansive beach. The beach for this alternate section is 460 feet wide, with the only structure required being a bulkhead at the top extending to elevation plus 21 m.s.l. Wide beaches that have been properly constructed and well maintained have demonstrated a great resistance to the hurricane forces. On a wide beach such as that proposed, wave energy is dissipated in rolling up the long, shallow, permeable slope, and little wave energy is left to attack the levee of sand at the top of the berm. The alternate section has the primary advantage of being less costly.

In the event that some erosion takes place near the face of the bulkhead, rubble has been provided to limit the amount of scour. The disadvantage of the alternate section is the added cost of maintaining such a wide beach.

Problems on the north shore are considered to be substantially less than those to the south. No waves of significant magnitude will be developed in Biloxi Bay, and the main danger will develop from the overtopping of waves moving parallel to the axis of the island. In order to guard against overtopping by the occasional swell associated with the long period oscillations mentioned in previous paragraphs, a low sheet-pile bulkhead has been placed along the north shore rim, extending to elevation plus 18.

It has been strongly recommended that the construction of piers, inlets, boat launching ramps and other such structures not be permitted along the north shore. Such structures would provide points at which scour could begin, and then spread to cause considerable damage.

The proposed south shore construction will be extended around the nose forming the east end of the island and a sand beach of generous width placed at this point. In addition to providing protection from storms moving in a northwesterly direction, the beach at this location will provide a sand stock pile for beach maintenance in other areas.

Similar protection is recommended for the west end, however at this point the problems of direct attack are almost nil.

As previously mentioned, random overtopping of the south shore structure must be anticipated. This overtopping will not occur at the same place and will occur infrequently. It is expected that water that does overtop will enter the storm drainage system and will be handled in the storm drainage system provided on the island.

Experience along the existing Harrison County beach indicates that there is a general literal drift from east to west along the Mississippi Gulf Coast. This drift can also be anticipated on Deer Island. Because of the limited wave action in Mississippi Sound, this drift does not cause the movement of substantial amounts of beach material. A report on the Harrison County beach made in 1957 indicated the loss amounted to approximately 5,000 cubic yards per mile for a three-year period. Should this drift develop into more of a problem than is currently anticipated, a series of inexpensive groins could be constructed across the face of the island to help in trapping this sand. (An examination of the drain pipe groins and spur groins along the Harrison County coast leads to doubt about the effectiveness of such construction).

It is of interest to note that none of the construction proposed will infringe in any way on the ship channels existing to the north, east and west of the proposed island.

Finally, it should be noted that consideration has been given to the effect of Deer Island on the remaining land mass in the Biloxi area. In particular, the channel between the existing Deer Island and Biloxi shore was investigated to determine if narrowing the channel would result in a substantial increase in water velocities through that channel which could cause scour or other erosive problems on both the island and the mainland. Because of the width of the channel at this point no such problem is anticipated.

Preliminary plans for streets, bridges, water supply and distribution, sewage collection and treatment (primary and secondary), pumping stations and flood gates, storm drainage, civic center development and park development are all included in the Preliminary Engineering Report.

The total estimated project cost (1966) is approximately $43,000,000. Gross real estate sales are estimated to generate (1966) $99,000,000. The key to the project however, is the First Stage of development which is saddled with first costs for bridge access, land acquisition, sewage treatment facility, etc. The estimated project cost of first stage construction is in excess of $12 million while real estate sales over a period over seven years are estimated to generate approximately $21 million. As population and economic activity on the Gulf Coast increase and as

access from major population centers is improved market demand for Deer Island property will intensify. With this increased demand and project costs of subsequent phases proportionally reduced the financial outlook for future stages of the project is much improved.

The Preliminary Engineering Report concludes:

1. The development of Deer Island will represent a significant contribution to the Gulf Coast as a whole and to the City of Biloxi in particular. Deer Island will provide the land areas required for expansion by the City of Biloxi and recreational facilities that will fulfill the needs of the community.

2. The development of Deer Island will encourage and enhance the development of resort facilities in Biloxi, thereby broadening and strengthening the economic base of the community.

3. Over the thirty-year life of the project substantial revenues will accrue to the Biloxi Bridge and Park Commission and can be used for the development of community facilities, with surpluses being turned over to the City in recognition of their early support of the project.

4. The project, as outlined, is feasible. Subject to proper conditions in the municipal bond market and the availability of home construction mortgage money, the project can be implemented.

With today's high interest rates and unsettled bond market, funding of a project such as Deer Island becomes extremely difficult. Until these problems can be solved Deer Island must remain a sand bar. The gold mine is ever elusive.