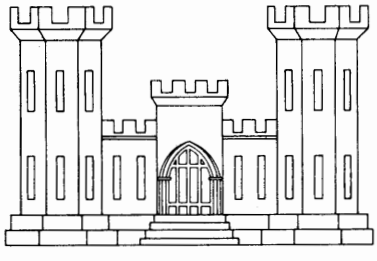
REVIEW OF REPORTS

ST. BERNARD PARISH, LOUISIANA



DEPARTMENT OF THE ARMY

NEW ORLEANS DISTRICT, CORPS OF ENGINEERS

NEW ORLEANS, LOUISIANA

18 NOVEMBER 1969

SERIAL NO. 196

REVIEW OF REPORTS
ON
ST. BERNARD PARISH, LOUISIANA

SYLLABUS

This study area is located in and adjacent to the coastal marsh area of St. Bernard Parish, Louisiana, just downriver of New Orleans. Hurricane protection projects have been authorized for areas along the Mississippi River including parts of St. Bernard Parish. The projects in St. Bernard Parish are the Chalmette area of the Lake Pontchartrain and Vicinity, Louisiana project and "Reach E" of the Mississippi River Delta at and below New Orleans, Louisiana. The studies for these projects were made prior to the occurrence of Hurricane "Betsy" on 9 - 10 September 1965. As a result of the heavy damage in St. Bernard Parish from Hurricane "Betsy", public officials and commercial, public, and private interests requested that additional hurricane protection beyond that authorized be provided in St. Bernard Parish including hurricane protection for the communities of Yscloskey, Hopedale, Delacroix, and Caernarvon. These communities are located along the alluvial banks of the Mississippi River and Bayous La Loutre and Terre aux Boeufs.

Investigations made for this study indicated that extension of the plan of protection for the Chalmette area of the Lake Pontchartrain and Vicinity project to encompass Caernarvon and Verret was justified and could be accomplished under an existing authorization. This extension was approved by the Chief of Engineers and construction work by local interests is under way. Further extension of the levee protection system to encompass additional areas is not economically justified. Consequently no further authorization by Congress is appropriate at this time.

It is concluded that the Corps of Engineers should accelerate its work with state and local people through the Flood Plain Management Services Program by providing information and technical services regarding flood hazard and non-structural measures, including flood proofing of public buildings, that would be helpful in alleviating flood problems; that funds for these specific services be budgeted annually through the Flood Plain Management Services Program; and that local interests should develop and keep current plans for evacuation of people and movable property from the unprotected areas of St. Bernard Parish.

REVIEW OF REPORTS
ON
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DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P. O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

LMNED-PR 18 November 1969

SUBJECT: Review of Reports on St. Bernard Parish, Louisiana

TO: Division Engineer, Lower Mississippi Valley

SECTION I - AUTHORIZATION AND PURPOSE

1. AUTHORITY

This report is submitted in response to a resolution adopted 8 May 1964 by the Committee on Public Works of the House of Representatives, United States which reads as follows:

> Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Mississippi River Delta at and Below New Orleans, Louisiana, published as House Document No. 550, 87th Congress, and other pertinent reports, with a view to determining the advisability of modifying the authorized project at this time with respect to additional hurricane protection in St. Bernard Parish, including Yscloskey, Hopedale, Delacroix, and Caernarvon, Louisiana.

2. EXTENT OF INVESTIGATION

a. Purpose. The purpose of this study is to examine existing authorizations for projects in St. Bernard Parish and to make additional studies and examinations to determine if the existing hurricane protection projects in St. Bernard Parish should be expanded to include protection for a larger area and in particular to include the settlements of Caernarvon, Yscloskey, Hopedale, and Delacroix.

b. Extent of investigation.

(1) Available data used in this study include surveys, soil borings, design, construction, and maintenance data from existing projects in and near the study area (see paragraph 12); quadrangle maps and aerial photographs; water levels and rainfall records for many years at stations in and near the study area; geological studies of the Mississippi River and its deltas; historical records of hurricanes and previous studies, particularly those presented in House Document 550,87th Congress, entitled "Mississippi River Delta at and below New Orleans, Louisiana" and design memoranda studies for the Chalmette Area of the Lake Pontchartrain and Vicinity, Louisiana project.

(2) Additional investigations made for this study include additional hydraulic studies to reflect a larger design hurricane resulting from reevaluation by the U. S. Weather Bureau subsequent to studies presented in House Document 550, 87th Congress; field reconnaissance and surveys; hydrologic, hydraulic, design,cost, and benefit studies; consideration of non-structural alternatives; and consultation with other Federal and state agencies.

c. Scope of presentation. This report presents the results of studies for additional hurricane protection for areas in St. Bernard Parish conducted under the above mentioned resolution. The authorization for the Lake Pontchartrain and Vicinity, Louisiana project provided for the reexamination of the levee alignment in the preconstruction stage with a view to protecting additional lands. The Chalmette area of this project is in Orleans and St. Bernard Parishes just upstream of the study area. Investigations for this study showed that the extension of the plan of improvement for the Chalmette area to encompass the Poydras, Caernarvon, and Verret areas (see plate 1) could be justified. Therefore, the extension of the plan of improvement for the Chalmette area southward to include Caernarvon and Verret was recommended in letter dated 29 November 1966 and approved by the Chief of Engineers on 31 January 1967. The letter of 29 November 1966 and subsequent indorsements are attached hereto as appendix D. Since the Poydras, Caernarvon, and Verret areas have been reported under another authority, this report generally will be limited to coverage of studies for the remainder of St. Bernard Parish with minor references to the area incorporated in the plan of improvement for the Chalmette area.

3. PRIOR REPORTS

a. The report under review is House Document No. 550, 87th Congress, entitled "Mississippi River Delta at and below New Orleans, Louisiana." This report, submitted to Congress on 31 August 1962, considered hurricane protection for five areas along the Mississippi River downstream of Violet, Louisiana by the enlargement of existing

back levees and/or the construction of new levees. Construction of four of the reaches was recommended in the report. One reach was found not justified. The recommended levees were authorized by the Flood Control Act of 1962. The only reach of importance to this study is "Reach E" which provides partial protection for the Violet, Caernarvon, and Verret areas. (See subparagraph 12c and plate 1.)

b. The report, "Lake Pontchartrain and Vicinity, Louisiana," published as House Document No. 231, 89th Congress, was submitted to Congress on 28 June 1965. The Chief of Engineers recommended hurricane protection improvements for the areas adjacent to Lake Pontchartrain including New Orleans and that part of St. Bernard Parish upriver from Bayou Dupre. The recommended improvements were authorized by the Flood Control Act of 1965.

c. Several reports containing information and recommendations on flood control improvements along the Mississippi River have been submitted to Congress. The most recent report, House Document No. 308, 88th Congress, contains a review of the comprehensive "Flood Control, Mississippi River and Tributaries" project. The Chief of Engineers recommended an increase in levee grades, foreshore protection, and bank stabilization works in that area along the river below Baton Rouge and many other improvements on the river and its tributaries in the alluvial valley below Cape Girardeau, Missouri. Prior reports for flood control on the river are shown in paragraph 3 and in annex B of House Document No. 308, 88th Congress.

d. The report "Mississippi River-Gulf Outlet," published as House Document No. 245, 82nd Congress, was submitted to Congress on 25 September 1951. The Chief of Engineers recommended the construction of a 36- by 500-foot ship channel from the Inner Harbor Navigation Canal in New Orleans to the Gulf of Mexico. The recommended tidewater ship channel was authorized by the River and Harbor Act approved 29 March 1956.

SECTION II - DESCRIPTION

4. DESCRIPTION

a. Location. The study area is located in St. Bernard Parish, Louisiana. It is adjacent to and on the left bank of the Mississippi River downstream of New Orleans (see plate 1).

b. Topography. The principal topographic features in the problem area are the Mississippi River and its former distributaries, Bayou Terre aux Boeufs and Bayou La Loutre. The problem area, except for elevated areas along the Mississippi River and the banks of the former distributaries, is generally low coastal marsh having an elevation of about 2 feet m.s.l.[1] or less. It is subject to frequent overflow by high tides and from hurricane surges.

c. Geology.

(1) The area included in this study is located in a part of the Mississippi River deltaic plain now occupied by the present course of the river. Principal physiographic features of the area are the river channel, natural levee ridges along its banks and along the banks of abandoned distributary channels, and low marshlands situated between and bordering the channels. The crests of the natural levees are the highest grounds in the region. The marshlands are only a foot or two above mean sea level, and they contain numerous bodies of shallow water.

(2) Recent deposits, consisting predominantly of soft clay with zones and strata of fine sand, silt, and shells, comprise the subsurface of the region. These Recent deposits vary in thickness from about 80 feet at New Orleans to about 600 feet at the gulfward margin of the delta. They are underlain by the Prairie formation of Pleistocene age. A predominance of silty and sandy soils comprises the natural levee ridges,the fillings in the abandoned channels, and small accretion areas where the river has meandered. In the marshlands the upper 5 to 10 feet of the subsurface consists of peat and highly organic clays. Marshland in the region is being destroyed both by subsidence and by erosion resulting from wave action.

5. ECONOMIC DEVELOPMENT

a. General. The study area, consisting of that part of St. Bernard Parish downriver from Bayou Dupre, is rural in nature. It is characterized by several small communities located along the state highways extending into the marsh areas along the alluvial banks of former distributaries of the Mississippi River. These communities include Violet, Poydras, Caernarvon, Toca, Verret, Yscloskey, Hopedale,

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[1]Mean sea level. The datum to which all elevations in this report are referenced unless otherwise indicated.

Reggio, and Delacroix. The area includes all of Wards 6 and 7 and a part of Ward 5 of St. Bernard Parish. The populations of these three wards, as shown by the U. S. Census, were:

Date of U. S. Census	Population	Increase from previous census
1930	3,360	-
1940	3,740	11%
1950	4,860	30%
1960	6,500	34%
	Increase in 30 years	93%

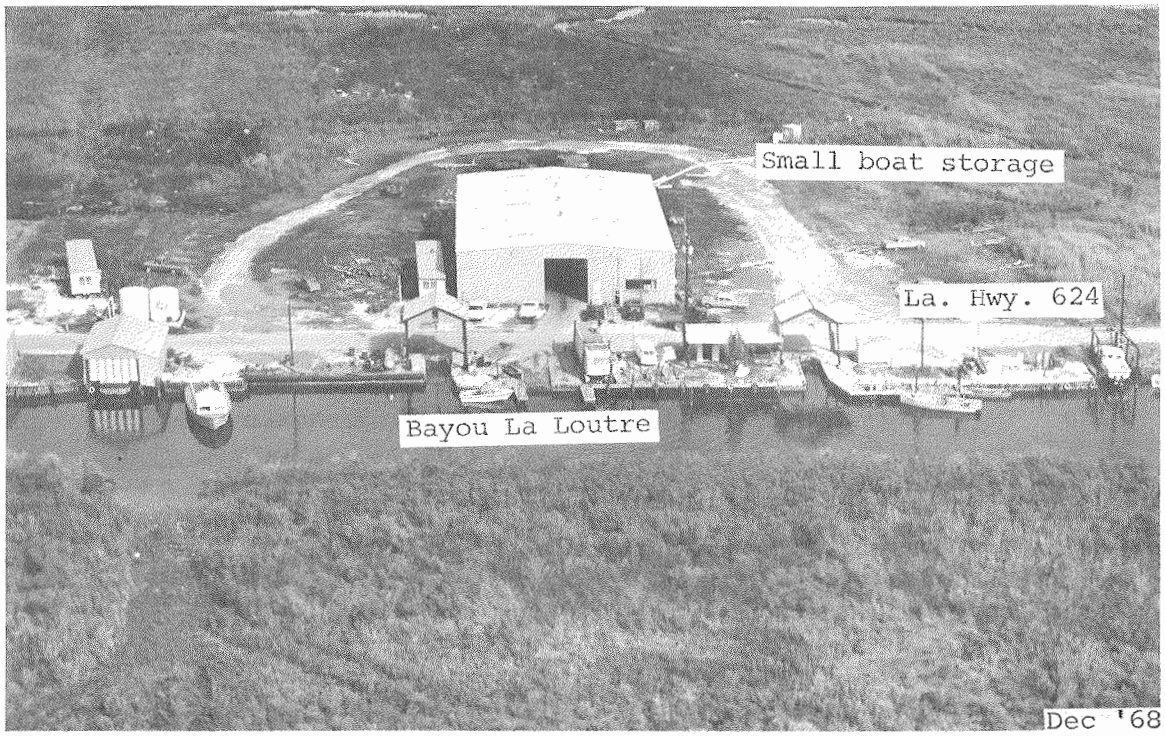
b. Development. Developments in the study area are generally limited to retail type businesses and those developments associated with the petroleum industry and commercial and sport fishery. Two large petroleum processing plants are located at Toca and one near Yscloskey. Several small boat-launching facilities exist on Bayous La Loutre, Yscloskey, and Terre aux Boeufs. Storage facilities for small boats have been constructed at Hopedale and Shell Beach (see photographs 1 and 2). Residences and other facilities have generally been constructed with the flood hazard from hurricanes in mind. Many have been constructed above potential flood levels. The lower levels are used for garages, storage, and parking areas (see photographs 3, 4, and 5).

c. Transportation.

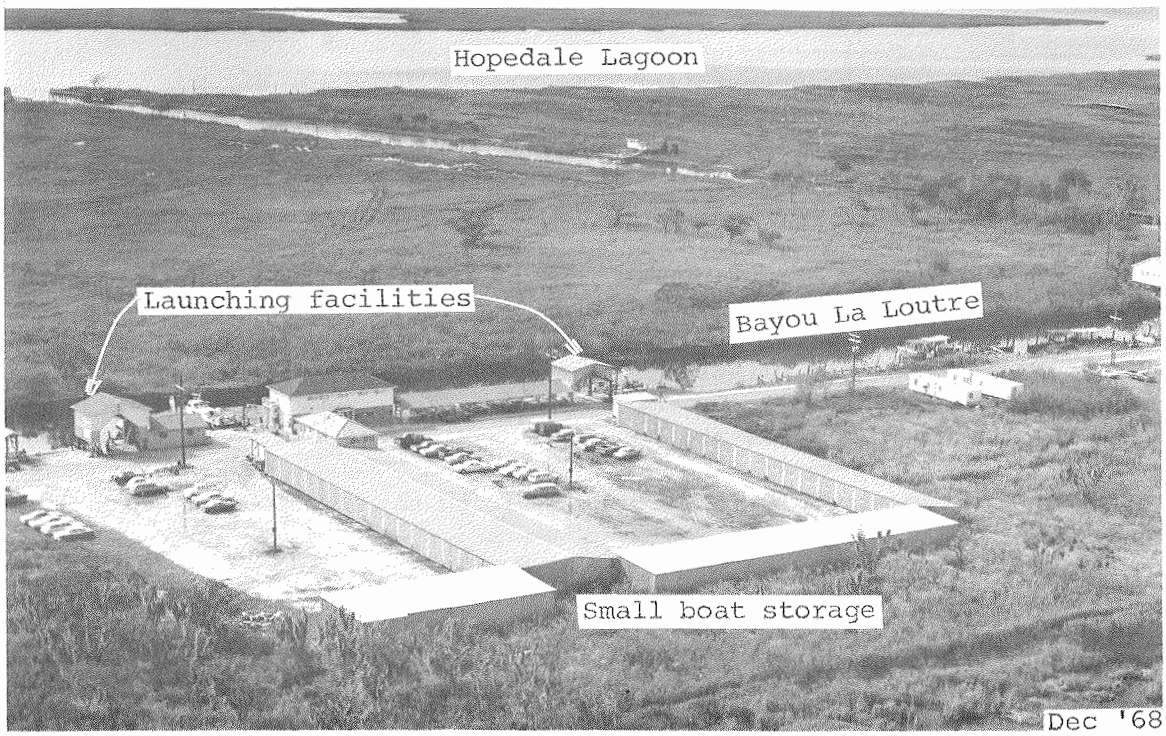
(1) Land transportation. Louisiana Highways 39, 46, 300, and 624 provide all-weather roads along the east bank of the Mississippi River downstream of New Orleans and to Caernarvon, Verret, Hopedale, Yscloskey, Reggio, and Delacroix (see plate 1). Rail transportation to Violet, Poydras, and Toca is provided by the Southern Railway Systems.

(2) Waterways. Ship channels available in the study area are the Mississippi River and the Mississippi River-Gulf Outlet. Shallow-draft channels maintained by the Federal Government are available in Bayous Dupre, La Loutre, and St. Malo. Many other natural channels and lakes are usable by small boats.

(3) No airfield facilities exist in the study area. Such facilities are available in New Orleans.

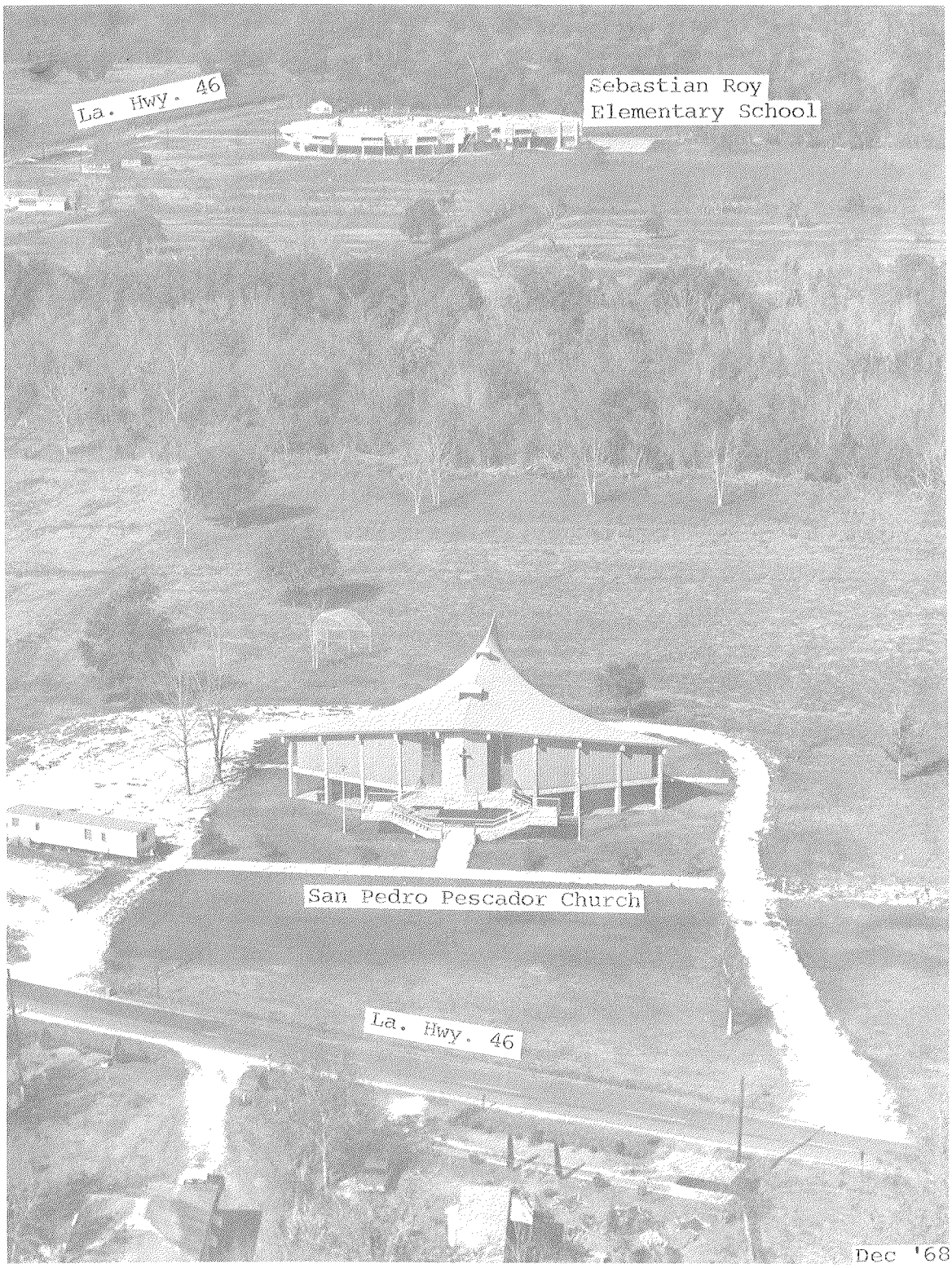


Photograph 1. Molero's Marina, Hopedale



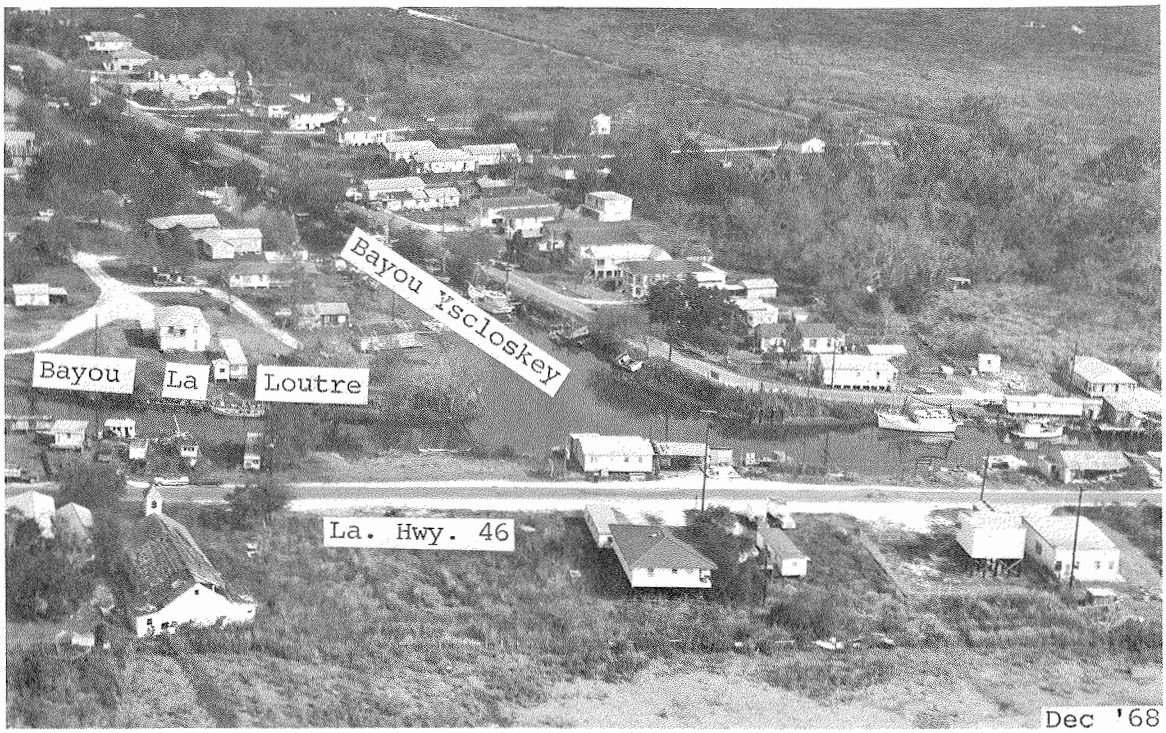
Photograph 2. Pip's Place, Hopedale

AUGUST 1969



Photograph 3. School and church near junction of Louisiana Highways 46 and 300

Photograph 4. Shell Oil Company office building near Yscloskey



Photograph 5. Yscloskey, Louisiana

6. CLIMATOLOGY

a. Climate. The study area is located in a subtropical latitude. It has mild winters and hot and humid summers. During the summer, prevailing southerly winds produce conditions favorable for convective thundershowers. In the colder seasons, the area experiences frontal passages which produce squalls and sudden temperature drops. River fogs are prevalent in the winter and spring when the temperature of the Mississippi River is somewhat colder than the air temperature.

b. Temperature. The first-order weather station in New Orleans has temperature records extending back to 1871. The mean annual temperature is about 70° F. and the recorded extremes are 7° (13 February 1899) and 102° (30 June 1954 and other dates). The average temperatures in summer and winter are 82.3° and 56.1°, respectively.

7. HURRICANES OF RECORD

a. Historical hurricanes. The study area has experienced many severe storms and has suffered often from lesser storms because of the characteristic flatness of the land and its low elevation. Water from the adjacent lakes, sounds, and the Gulf of Mexico is driven over the low marshland into the inhabited areas. There are no official U. S. Weather Bureau records prior to 1893 showing barometric pressures, wind speeds and directions, and heights of tidal surges associated with hurricanes. Consequently, early historical accounts of the effects of the storms on the study area are limited because of the sparse development of the area at that time. A history of hurricane occurrences in and adjacent to the study area is contained in the report, "Mississippi River Delta at and below New Orleans, Louisiana" (House Document No. 550, 87th Congress). The most severe recent storms in the study area in reverse order of occurrence, are:

(1) On 9 September 1965, Hurricane "Betsy" crossed the Louisiana Coastline near Grand Isle and proceeded inland west of the Mississippi River. It is estimated that the hurricane caused inundation of 4,800 square miles of land in Louisiana, the death of 81 persons, about one-quarter million persons to be evacuated, and damages in excess of $350 million. The floodwaters disrupted transportation, communications, and utility services for approximately 1 month. The area east of the Mississippi River up to and including the lower part of New Orleans was particularly heavily damaged by overflow when the local levees were overtopped and/or crevassed. The hurricane damages within St. Bernard Parish were estimated to be about $38 million, of which about $2.9 million was property damage due to tidal overflow. All of the study area, except for a very narrow area along the Mississippi River from Violet to Caernarvon and a narrow area along Louisiana Highway 46 from Poydras to and including Toca, was overflowed. The approximate depth of inundation was as follows: Delacroix, 9.0 feet; Reggio, 7.5 feet; Verret, 6.5 feet; and Yscloskey, 9.5 feet.

(2) Hurricane "Carla," 4-14 September 1961, was one of the major gulf hurricanes of the last century. It entered land on the Texas coast and caused much overflow and substantial damages in the Louisiana coastal area. Areas adjacent to Lake Borgne were flooded by tidal flows which reached elevations of 5 feet in Lake Borgne and 4 feet at Delacroix.

(3) Hurricane "Flossy," 21-30 September 1956, approached the Louisiana coastline from the south. It then turned northeastward, crossed the Mississippi River upstream of the passes and went inland in northwest Florida. Tides were unusually high along the Gulf Coast from central Louisiana to Florida. Tidal elevations in the study area reached 5 feet at Delacroix and 8.5 feet at Yscloskey. Most of the study area was overflowed.

(4) The hurricane of 4-21 September 1947 approached the Gulf Coastline from the southeast and passed directly over the study area and New Orleans. It caused extensive damage and much flooding in the Louisiana coastal area east of the Mississippi River. Tidal elevations at Shell Beach exceeded 11 feet.

(5) The hurricane of 2-10 August 1940 passed just south of the mouth of the Mississippi River and moved inland near the Louisiana-Texas boundary. It caused substantial flooding in the Louisiana coastal area including the lowlands of St. Bernard Parish where tidal elevations reached about 4 feet.

(6) The hurricane of 22 September - 2 October 1915 crossed the Gulf Coastline west of Grand Isle and passed just west of New Orleans. It caused extensive flooding on both sides of the river including most of the study area. Reported tidal elevations at Yscloskey and Shell Beach were 11.6 and 8.3 feet, respectively.

(7) The hurricane of 10-24 September 1909 crossed the Louisiana Coastline west of Grand Isle and continued generally northward passing east of Baton Rouge. It caused extensive flooding of the Louisiana coastal area from Morgan City eastward. Tidal elevations at Yscloskey reached about 5 feet.

(8) The hurricane of 4-17 August 1901 passed inland over the mouth of the Mississippi River and just east of New Orleans. The Yscloskey and Shell Beach areas were flooded to a depth of about 4 feet.

b. Hurricane frequency. The study area has experienced damaging floods caused by hurricane tides on numerous occassions, but due to the scarcity of observed maximum high water elevations it is not possible to compute accurate frequencies using observed data for the entire area. Hurricane tide elevations are available for Shell Beach since 1900 only. A hurricane stage-frequency was computed for that location using the observed data (see plate A-10). As an alternative approach, a synthetic method for computing stage-frequencies was developed by

relating central pressure-frequencies and stages computed for selected hurricane tracks. Hurricane frequencies for Shell Beach were computed, using both the observed data and synthetic methods, and the results obtained by both methods were in close agreement. Consequently, stage-frequencies for flooding from Lake Borgne and Breton Sound, respectively, were determined by using the synthetic method. A detailed discussion of methods used in the computation of hurricane stage-frequencies is presented in appendix A.

8. HURRICANE CHARACTERISTICS

a. General description. A hurricane is a well-developed cyclonic storm, usually of tropical origin. Hurricane characteristics are violent, counterclockwise winds, producing tremendous waves and surges, and torrential rainfall. Size and duration vary with each hurricane. They generally extend over thousands of square miles, reach a height of 30,000 feet or more, and last from 9 to 12 days.

b. Origins and tracks. Hurricanes originate exclusively in the shifting zone of equatorial calms called the "doldrums" which lies between the two trade wind systems. Early in the hurricane season, June and July, there is a tendency for the storms to develop in the western Caribbean Sea, while late in the season, September and October, storms are more likely to develop in the Atlantic Ocean. While still in the initial stages of development, the storms are affected by the trade winds and begin to move toward the west or northwest. In the vicinity of 30° north latitude, they recurve and begin to move in a northeasterly direction at an accelerated speed. This is only a very general path that hurricanes follow and actually there are many deviations, for hurricanes have been known to circle back and cross over their earlier paths.

c. Barometric pressure and winds. Normal barometric pressures in the tropics are about 30 inches of mercury whereas the pressures recorded in hurricane centers range between 29 and 27 inches or sometimes even lower. The wind system of a hurricane follows a counterclockwise circular pattern, with the wind direction deflecting about 30 degrees inward towards the center of the storm. At the storm's outer limits, the winds are light to moderate; at about 30 nautical miles from the center (about 35 statute miles), they reach a maximum velocity, for a 5-minute average, of about 100 m.p.h. (about 87 knots) with gusts as high as 175 m.p.h. (about 152 knots). At the center, they are relatively calm. This calm area which ranges between 7 and 20 miles (between 6 and 17 nautical miles) in diameter is called the "eye" of the storm and here the sky is sometimes clear enough to see the sun in the daytime or the stars at night, while from all sides is heard the roar of the hurricane winds. The point of lowest barometric pressure is located in the vicinity of or within the eye. The lowest recorded barometric pressure for hurricanes occurring along the Gulf Coast is 26.35 inches.

d. Surge. The hurricane surge which inundates low coastal lands is the most destructive of the hurricane characteristics. It alone accounts for three-fourths of the lives lost from hurricanes. It is the product of meteorological, beach, shore, and inland topographic conditions. A higher surge will be produced if the hurricane path is perpendicular to shore, the velocity of forward movement is slow, or the storm's diameter is very large. Maximum surge heights experienced along the Gulf and Atlantic Coasts range between 10 and 16 feet.

e. Waves. The waves generated by hurricane winds cause extensive damage to shore structures. At sea, the waves are high and turbulent, particularly in the right front quadrant and in the eye of the storm. Near shore, wave heights which have diminished some since origin begin to increase again because of the shoaling effect of the shallow water. Further, breaking waves can run up and overtop shore structures whose crowns are higher than the wave heights. However, the force expended when waves break causes the most damage to the shore structures.

f. Rainfall. Rainfall accompanying a hurricane usually is heavy and sometimes torrential. However, its distribution during the passage of a hurricane is not uniform. The rain may begin long before arrival of the storm. Prior to the passage of the eye, rainfall generally reaches its maximum rate, and after the eye has passed it ceases almost entirely. Rainfall is particularly heavy in the right front quadrant. Some hurricanes, however, are accompanied by little or no rainfall over considerable lengths of their paths.

9. STANDARD PROJECT HURRICANE

A standard project hurricane (SPH) is one that may be expected from the most severe combination of meteorological conditions that are considered reasonably characteristic of the region. The general SPH that is characteristic for the Louisiana coast was developed in cooperation with the U. S. Weather Bureau and corresponds to one having a frequency of once in 100 years. This frequency is adjusted for application to the individual study area. A detailed coverage of derivation procedures and frequency computations is presented in appendix A. The specific SPH for the study area has a central pressure index (CPI) of 27.6 inches, maximum wind velocity of about 87 knots (100 m.p.h.) at a radius of 30 nautical miles, a forward speed ranging between 5 and 15 knots, and a recurrence frequency of about once in 200 years. However, each location in the study area requires a particular critical path necessary to produce SPH effects. For the area adjacent to and south of Louisiana Highway 46 to Yscloskey, the SPH path is similar in shape to the September 1915 hurricane, but veering in a more westerly direction, passing west of Lakes Pontchartrain and Maurepas (track C, plate A-11). For the area north of Louisiana Highway 46, the SPH path is similar to that of the September 1956 hurricane ("Flossy")(track D, plate A-11). The September 1956 hurricane was of lesser intensity than an SPH. However, the September 1915 hurricane was equal in intensity to an SPH. The occurrence of a hurricane with SPH characteristics and on

the critical path would produce maximum surge heights of about 14.2 feet at Shell Beach and 15.1 feet at Yscloskey (table A-9). Paths for hurricanes critical to the study area are shown on plates A-4, A-5, and A-11.

10. PROBABLE MAXIMUM HURRICANE

The probable maximum hurricane (PMH) is one that may be expected from the most severe combination of critical meteorological conditions that are reasonably possible for the region. It has an infinite recurrence period. The specific PMH for the study area has a CPI of 26.9 inches, maximum wind velocity of about 127 knots (146 m.p.h.) at a radius of 30 nautical miles, and a forward speed ranging between 5 and 35 knots. Critical hurricane paths are identical to the ones used for the SPH.

11. EXTENT AND CHARACTER OF FLOODED AREA

a. General. Almost all of the lands in St. Bernard Parish except those which will be protected by the levees authorized under the Chalmette area feature of the Lake Pontchartrain and Vicinity project will be flooded during a major hurricane. A a result many of the residences, other buildings, and industrial plants have been constructed in a manner to minimize damages. Floor levels have been established above prospective flood stages and the space below used as a parking area for storage of movable items. For descriptive purposes, the study area has been divided into three parts as follows: the Mississippi River to Verret area which is to be protected by the Chalmette area extension levees (see plate 1); the Reggio, Yscloskey, and Hopedale area; and the Delacroix area.

b. Mississippi River to Verret area. Until the Chalmette area extension levees have been completed, about 17,900 acres of land in this area will be subject to overflow during a major hurricane. This area consists of 3,800 acres of cleared lands, 9,500 acres of wooded lands, and 4,600 acres of marshlands. About 6,300 acres of these lands are partially protected to an elevation of about 5 feet by Louisiana Highway 46 and an existing non-Federal levee along the location of the "Reach E" levees shown on plate 1. Most of the improvements in this area are located along the Mississippi River and Louisiana Highway 46. The improvements consist of two industrial plants at Toca, a few commercial businesses, and residences. Small amounts of land are used for truck crops and for raising cattle. The estimated value of land (1966 prices) is $16,750,000. Improvements are valued at $18,050,000. The value of agricultural production under flood-free conditions is about $250,000 annually. Average annual flood damages, under 1966 conditions, are estimated at $132,700 consisting of $119,600 noncrop and $13,100 crop damages. It is estimated that the population of the area will continue to grow for a period of 50 years and remain constant thereafter and that the value of improvements will increase in proportion to the population. No increase in agricultural production is anticipated.

On this basis, using the present worth method, an interest rate of 3 1/8 percent (the interest rate used for the authorized Chalmette area with which this area was combined), and a 100-year project life, the average annual damages are estimated to increase to $191,700, consisting of $178,600 noncrop and $13,100 crop damages.

c. The Reggio, Yscloskey, and Hopedale area considered for protection (see plate 1) consists of about 14,000 acres (1,000 acres cleared, 9,000 acres of marshland, and 4,000 acres of woodland). All of this land is frequently inundated. The improvements are residences, a few small commercial facilities associated with the operation of small boats (recreational and commercial fishing), and one gas processing plant near Yscloskey. Due to the frequency of flooding, many of the more expensive improvements and residences have been constructed well above the ground (see photographs 3, 4, and 5 on pages 7 and 8) with a view to minimizing water damages. The estimated (1968) values of the land and improvements are $5,200,000 and $8,500,000, respectively. Agricultural production in the area is negligible. Due to the extreme exposure and peril to life and property from tidal overflow, mass evacuation is necessary on approach of hurricanes. The estimated average annual flood damages, under 1968 conditions, in the Verret to Hopedale area are $107,000. Based on an examination of growth trends in the New Orleans metropolitan area and the increasing demand for homes and campsites which have access to water frontage available for water-oriented recreation, it is estimated that the population will double in about 50 years and remain relatively constant thereafter. On this basis, using the present worth method, a 4 5/8 percent interest rate and a 100-year project life, the average annual damages will increase to about $150,000.

d. The Delacroix area extends along Bayou Terre aux Boeufs for about 7 miles from Reggio. Land access to the area is provided by Louisiana Highway 300 located on the left bank of the bayou. Improvements in the area consist of widely scattered residences, a few commercial retail establishments, and several boat-launching facilities near the southern end of the area, all on the left bank of the bayou. Most of the residences are constructed well above the existing ground level. The extent of the damages caused by Hurricane "Betsy" in September 1965 is shown on photographs 14 and 15, page 27. Bayou Terre aux Boeufs is used extensively by fishermen and hunters from the New Orleans, Chalmette, and other areas to reach the coastal marsh waters between the Mississippi River and the Mississippi River-Gulf Outlet.

12. EXISTING CORPS OF ENGINEERS' PROJECTS

a. A description of the Corps of Engineers' projects pertinent to the study area is given in subsequent subparagraphs. Additional information on each of them may be found in the "Annual Report of the Chief of Engineers, U. S. Army on Civil Works, 1968" and/or prior years.

b. Flood Control, Mississippi River and Tributaries. This project, as authorized by the Flood Control Act of 15 May 1928 and subsequent amendments, provides for flood control and navigation improvements in the alluvial valley of the Mississippi River by a system of levees, floodways, channel improvements, and bank stabilization works. The levee along the left bank of the river below New Orleans provides the St. Bernard Parish area protection against headwater floods. This levee is essentially complete. The costs of the levee feature are not separable from other costs under the project.

c. Mississippi River Delta at and below New Orleans. This project, authorized by the Flood Control Act of 1962, provides for hurricane protection by the enlargement of existing non-Federal levees generally paralleling the Mississippi River levees at two locations on the west bank of the river, one on the east bank of the river starting about 25 miles downstream of Caernarvon, and one in St. Bernard Parish designated as "Reach E" and shown on plate 1. Planning and/or construction work are under way on all of the authorized reaches except "Reach E." The extension of the protection under the Lake Pontchartrain and Vicinity project (Chalmette area) to provide protection for the Poydras, Caernarvon, and Verret areas makes "Reach E" unnecessary. The Federal cost for new work to 30 June 1968 was $451,193.

d. Lake Pontchartrain and Vicinity, Louisiana. This project, authorized by the Flood Control Act of 1965, provides for the construction of two independent features to provide hurricane protection for the Lake Pontchartrain and Chalmette areas including Orleans Parish and a part of St. Bernard Parish. These separable units are the Lake Pontchartrain barrier plan and the Chalmette area plan. Only the latter plan is of importance to this study. The plan of protection for the Chalmette area, as modified during the preconstruction planning stage (see plate 1), provides for the improvement of the existing protection along the east side of the Innner Harbor Navigation Canal, the extension of this protection along the Inner Harbor Navigation Canal, and the construction of a new levee along the Mississippi River-Gulf Outlet ship channel spoil bank to the vicinity of Verret and thence across the marsh east and south of Verret to the Mississippi River levee at Caernarvon (see plate 1). The improvements consist of floodwalls and earth levees to be constructed in lifts with major drainage structures at Bayous Bienvenue and Dupre. The grade of the protective works has been established to provide protection against a standard project hurricane. The modification during the preconstruction stage, to include the additional area from Bayou Dupre southward to Caernarvon and Verret, was the result of evaluations made as a part of this study. The Federal cost for new work to 30 June 1968 was $4,795,132.

e. Mississippi River-Gulf Outlet. This project, authorized by the River and Harbor Act of 29 March 1956, provides for a ship channel 36 feet deep and 500 feet wide from the Inner Harbor Navigation Canal along the southwest shore of Lake Borgne to the Gulf of Mexico with

protective jetties at the shoreline, a permanent dike across Breton Sound, a turning basin at the landward end of the waterway, and a highway bridge at Louisiana Highway 47 (Paris Road). The plan further provides for an alternative connecting lock and channel to the Mississippi River. Consideration is being given to making this alternative connection via the Inner Harbor Navigation Canal. The ship channel, jetties, and bridge have been completed, the retention dike is under construction, and planning is under way on the alternate connection. The Federal costs for new work and maintenance to 30 June 1968 were $61,072,190 and $8,970,695, respectively.

f. Bayou Dupre. This project, authorized in 1937 and completed in 1939, provides for a 6- by 80-foot navigation channel from the highway at Violet to Lake Borgne. The Federal costs for new work and maintenance to 30 June 1968 were $38,915 and $104,131, respectively.

g. Bayous La Loutre, St. Malo, and Yscloskey. This project was authorized in 1937, modified in 1945 and completed in 1956. It provides for a 5- by 40-foot channel in Lake Borgne at the mouth of Bayou Yscloskey; a 6- by 40-foot channel from Lake Borgne through Bayou St. Malo; a 5- by 30-foot channel in Bayou La Loutre from Hopedale to Bayou St. Malo; and a 6- by 40-foot channel in Bayous La Loutre and Eloi. The Federal costs for the new work and maintenance to 30 June 1968 were $96,916 and $207,316, respectively.

h. Flood Plain Management Services Program. The Flood Control Act of 1960, in recognition of the increasing use of flood plains, the need for information on flood hazards, and that future flood hazards could be avoided by regulation by states and municipalities of the use of flood plains and the developments therein, authorized the Chief of Engineers to complete and disseminate information on floods and flood damages including identification of areas subject to inundation by floods of various magnitudes and frequencies, and general criteria for guidance in the use of flood plain areas and to provide engineering advice to local interests for their use in planning to ameliorate the flood hazard. The Act further provided that the necessary surveys and studies be made and information and advice furnished for specific localities only upon request of a state or a responsible local governmental agency and after approval of the Chief of Engineers.

13. IMPROVEMENTS BY OTHER FEDERAL AND NON -FEDERAL AGENCIES

Local agencies have constructed a levee from Violet to Verret north of Louisiana Highway 46. Enlargement of this levee was authorized as "Reach E" of the "Mississippi River Delta at and below New Orleans" project (see plate 1). Private canals have been constructed from Federally maintained project channels where needed for oilfield operations.

SECTION III - PROBLEMS UNDER INVESTIGATION

14. IMPROVEMENTS DESIRED

This study was initiated with a public hearing in Chalmette, Louisiana on 15 December 1965 about 3 months after the occurrence of Hurricane "Betsy" (9-10 September 1965). Approximately 80 representatives of Federal, state, and local agencies, industry, and individuals attended. Public officials business and industrial representatives, and individuals pointed out the severe damages to the St. Bernard Parish area from Hurricane "Betsy" and prior storms, and that the plan of protection to be provided under the Chalmette area feature of the "Lake Pontchartrain and Vicinity" and "Mississippi River Delta at and below New Orleans" projects was not adequate hurricane protection for the St. Bernard Parish area. They requested that additional protection be provided by the construction of levees from the Mississippi River at Caernarvon generally eastward to the Mississippi River-Gulf Outlet and thence northwestward to the protection levee for the Chalmette area at Bayou Dupre. They specifically requested that the levee loop encompass Caernarvon, Verret, Delacroix, Yscloskey, and Hopedale (see plate 1). Representatives of the Louisiana Department of Public Works recommended that all of the above except the Delacroix area be considered and that protection be provided for the maximum area in St. Bernard Parish that could be justified.

15. HURRICANE FLOOD PROBLEMS, RELATED PROBLEMS, AND SOLUTIONS CONSIDERED

a. Hurricane flood problems.

(1) Tropical storms and/or hurricanes in the Gulf of Mexico frequently cause high tides that overflow the unprotected lowlands of St. Bernard Parish. The more severe storms cause tides that overflow developed area along Bayous La Loutre, Yscloskey, and Terre aux Boeufs to a depth of several feet. These inundations create hazards to life and health; damage public and private property; disrupt businesses; and require the expenditure of public and private funds for evacuation, care, and rehabilitation of residents from the overflowed areas.

(2) Hurricane "Betsy" (Sept 1965) caused great damage throughout St. Bernard Parish and adjacent areas. Local levees were breached and all of the parish except a narrow fringe of high ground along the Mississippi River was flooded. The damages in St. Bernard Parish from hurricane tidal overflow was estimated at about $34,500,000 including $27,000,000 to residential property and its contents and about $3,000,000 to commercial establishments. The estimated wind damages in St. Bernard Parish exceeded $3,500,000. Much of the damages from tidal overflow would have been prevented had the authorized levees for the Chalmette area and the Chalmette area extension been in place.

b. Protective measures considered. The only practicable means of preventing overflow of the exposed lowlands of St. Bernard Parish is the construction of levees or floodwalls and other appurtenant works. The height of protection required and cost of its construction makes it obviously unfeasible to protect any but highly developed areas. The spoil from the excavation of the Mississippi River-Gulf Outlet ship channel has been confined in an area along its southwest side in a manner to form the base for a levee. The higher lands along the former distributaries provide a better base for levees and also are best sites for improvements. Therefore, it was deemed appropriate to consider the protection of additional areas in St. Bernard Parish in increments as shown on plate 1. The first would be the area bounded by the levee A-B-C-D. The second increment is the levee loop B-E-F-G-H-C. If both of these increments were found justified, then protection levees along Bayou Terre aux Boeufs, where developments are less extensive also would be considered. Ring levees around a smaller area such as at Yscloskey also would be a practical solution.

c. Recreation. A large part of the existing developments along Bayous La Loutre, Yscloskey, and Terre aux Boeufs is based on recreational fishing. Numerous commercial launching facilities are located in vicinity of Shell Beach, Yscloskey, Hopedale, and Delacroix. Small boat storage facilities have been constructed along the banks of the streams. Two commercial onland small boat storage facilities at Hopedale are shown in photographs 1 and 2, page 6. The existing small boat-launching facilities are extensively used and adequate to meet the present demand. Should additional facilities be required in the future, the requirements will be met by the construction of commercial facilities.

16. HURRICANE FLOOD CONTROL PLANS

a. Structural measures. The only practical structural means of providing flood protection to additional areas in St. Bernard Parish is the ocnstruction of earth levees or floodwalls to the height necessary to prevent overtopping during storms of frequent occurrence. Since the levees to be considered are incremental to the authorized plan of improvement for the Chalmette area, they should provide the same degree of protection. The plan of improvement for the Chalmette area provides for protection against the "Standard Project Flood" which has a frequency of occurrence of about once in 200 years in the vicinity of Chalmette. Substantial studies have been made of the plan of protection for Chalmette and its extension to include Caernarvon and Verret. The results of these studies are contained in design memoranda prepared under the Lake Pontchartrain and Vicinity, Louisiana project.

(1) Hydraulic design. Hydraulic studies (appendix A, paragraph A-5) show that the net grades for levees of the typical section shown on plate 1 required to extend the authorized plan for the Chalmette area are:

Location (see plate 1)	Net levee grade feet m.s.l.
D to C	17.5
C to B (Verret)	17.5
B to A	17.5 to 16.0
B to E	17.5 to 19.0
E to G	19.0
G to H	19.0 to 19.5
H to I	19.5
I to C	19.5 to 17.5

(2) Levees considered.

(a) The location of the levee loops to best meet the desires of local interests and also having the best probability for economic justification is shown on plate 1. These levees were considered as incremental additions to the authorized plan of improvement for the Chalmette area as follows:

First increment, Chalmette area extension-levee A-B-C-D
Second increment, Reggio, Yscloskey, and Hopedale-levee B-E-F-G-H-I-C

(b) The typical cross sections considered for all of the levees except A-B are shown on plate 1.

(3) Construction. Extensive soils investigations have been made of the Mississippi River-Gulf Outlet channel and spoil area, the Chalmette area levees and the Chalmette area extension (levee A-B-C-D). These investigations and the geology of the area indicate that poor levee foundation conditions exist and that construction in lifts will be required for all of the levees considered. The material for construction of the levee along and adjacent to the Mississippi River-Gulf Outlet will be obtained from the ship channel by hydraulic dredging. Design memoranda studies for the levee from Caernarvon to vicinity of Verret show that it is economical to use sandfill pumped from the Mississippi River for the base fill. Material to blanket the sand core will be obtained from adjacent borrow areas. Material for the other levees will be obtained from interior borrow pits adjacent to the levee thus providing additional storage capacity for interior drainage.

(4) Levee toe protection. The Chief of Engineers authorized the modification of the plan of improvement for the Mississippi River-Gulf Outlet to include protection of the toes of levees for the Chalmette area constructed along the ship channel against erosion caused by wave

action on the ship channel. The proposed protection is shown on the typical levee cross section on plate 1. Similar toe protection would be required for the additional levee being considered from C to H. The toe protection would be constructed concurrent with final levee shaping.

b. Non-structural measures.

(1) General. Improvements in the unprotected areas of St. Bernard Parish are subject to damages from both hurricane winds and tidal overflow. It is extremely difficult and usually impossible to determine whether the initial damage during a major hurricane was from tidal overflow or from winds. Improvements in the exposed area should be designed to minimize damages from both tidal surges and hurricane winds or for their replacement after each storm. Adequate hurricane proof shelters are necessary for personnel. Movable property should be evacuated on the approach of the storm. Adequate warning systems and police action by local authorities are necessary to accomplish the evacuation before roads become impassable from high tides.

(2) Existing warning systems.

(a) U. S. Weather Bureau. This Bureau is responsible for issuing warnings of the formation of hurricanes and their impending approach to the mainland of the United States. The warnings, called "advisories," are issued throughout the day and night usually at 6-hour intervals. As the hurricane approaches the coastline "hurricane watch" notices are included in the advisories. The hurricane watch indicates that the hurricane is close enough that everyone within the watch area should listen for further advisories and be prepared to take precautionary action in the event it becomes necessary. The hurricane watch is followed by a "hurricane warning" indicating the area where winds of 75 miles per hour (65 knots) or greater are anticipated, and that precautionary measures should be initiated at once. In addition to the advisories and hurricane warnings, "bulletins" are issued for the press, radio, and television at frequent intervals to keep the public advised of the progress of the storm. Special communication facilities are established between the U. S. Weather Bureau offices and the news media, American Red Cross Civil Defense, and local governmental agencies, so that information may be quickly disseminated to everyone concerned. The information provided in the warnings issued includes an estimate of tides and identification of lowlands that should be evacuated.

(b) Local agencies. St. Bernard Parish officials recognize the hazards to the unprotected areas and have prepared to take emergency action in connection with other disaster relief agencies as appropriate on the approach of a hurricane. The Civil Defense agency of the parish plans to establish several water level gages at strategic locations including Delacroix, Shell Beach, the Louisiana

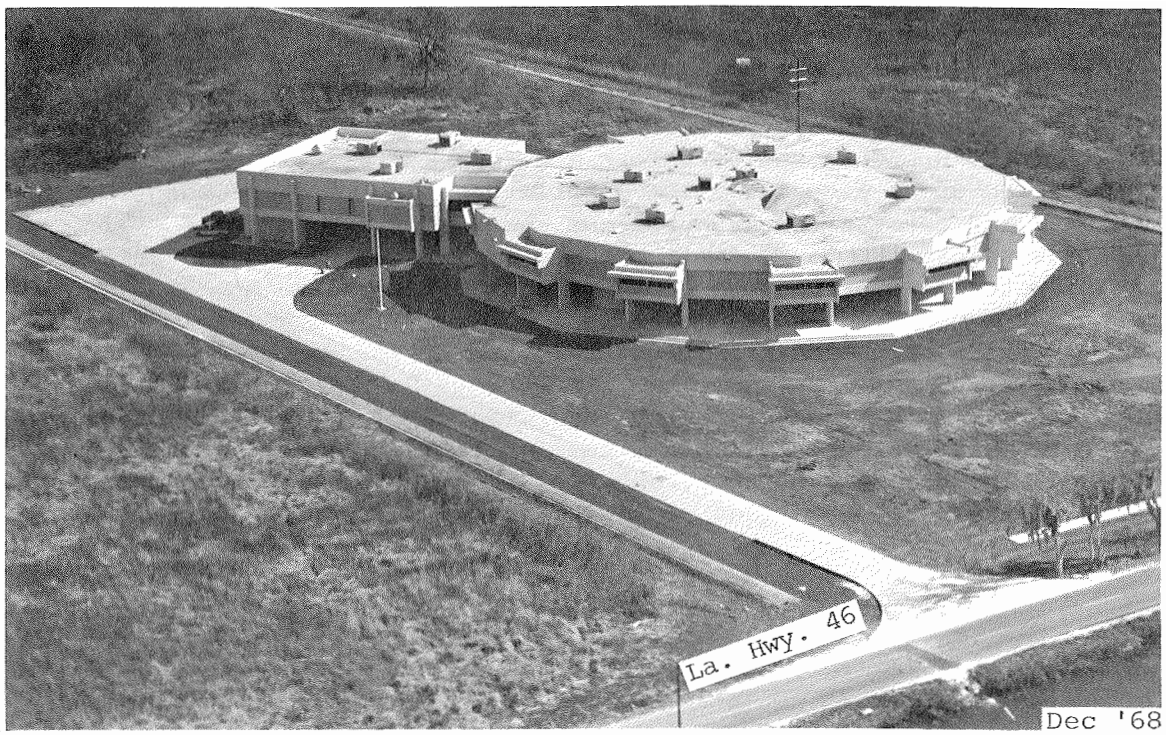
Highway 47 crossing of the Mississippi River-Gulf Outlet, and Bayou Dupre (also called Violet Canal). Water levels at these gages will be furnished at frequent intervals to a central location by telephone and/or "ham" radio. The information from these gages and from the U. S. Weather Bureau will be evaluated and an order issued, before the roads to Hopedale and Delacroix are impassable, to evacuate the unprotected areas except for those buildings that may have been designed and constructed as hurricane shelters. School buses will be used, as necessary, to accomplish the evacuation since these vehicles can operate in water up to a depth of about 18 inches.

(3) Proposed non-structural measures.

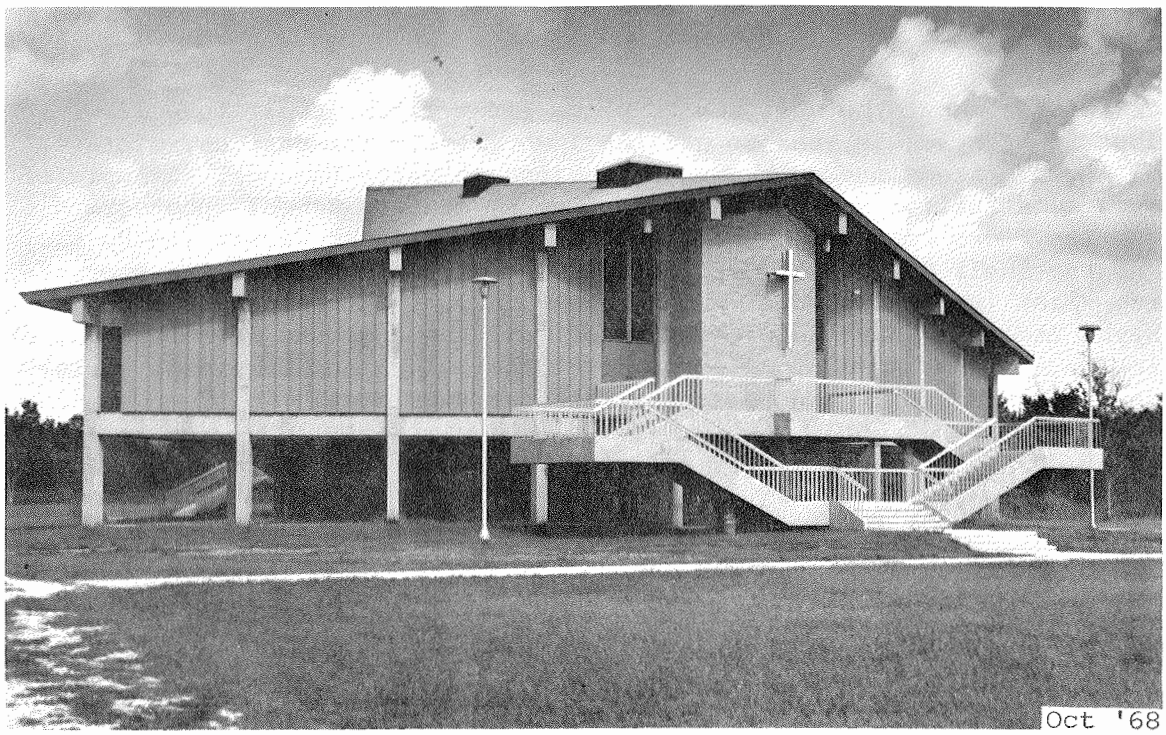
(a) Construction. Hydrologic and hydraulic studies indicate that tropical storms and hurricanes will result in water levels at Hopedale, Yscloskey, and Reggio of the elevations and frequencies shown below: (See plate A-12.)

Frequency of storm	Estimated water level in feet mean sea level	
	Hopedale and Yscloskey	Reggio
Once in 10 years	6.0	6.0
Once in 25 years	10.4	10.6
Once in 50 years	11.6	12.0
Once in 100 years	12.5	13.0
Once in 200 years	13.3	14.0

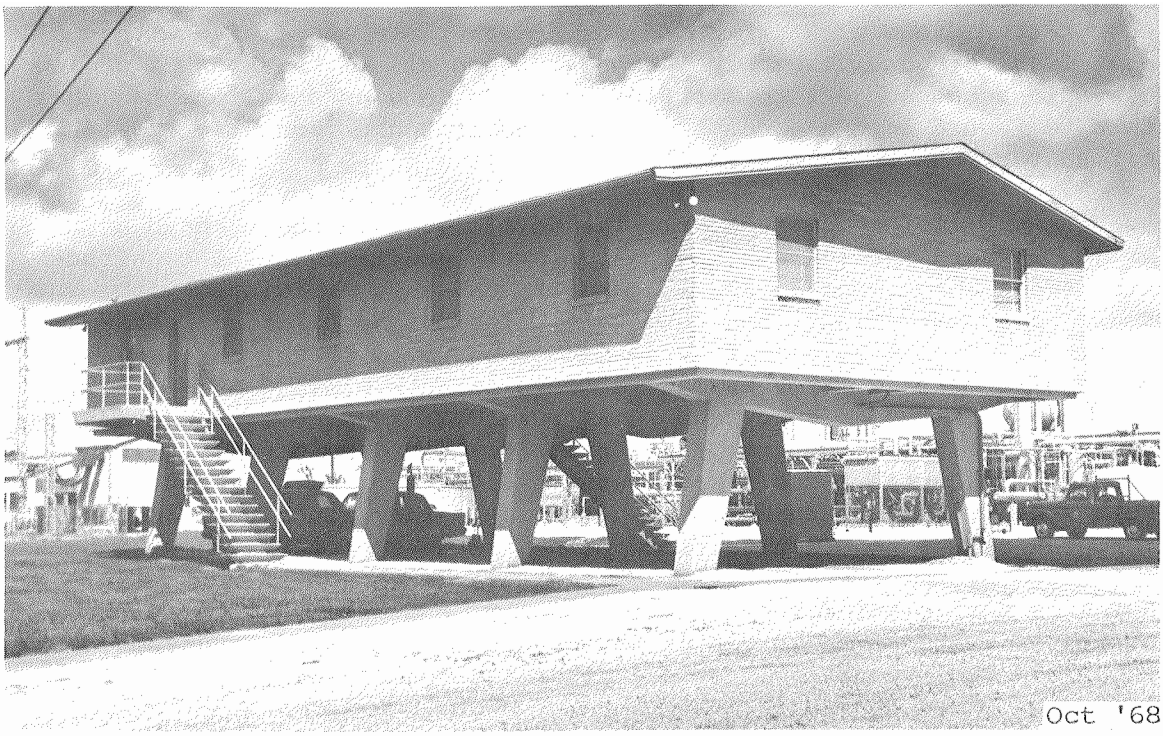
Structures should be designed to place first floor level above 12.0 feet if practicable, and to utilize lower levels for garages, storage of movable items and/or those not subject to water damages. Example of such construction are the Sebastian Roy Elementary School (photograph 6), the San Pedro Pescador Church (photograph 7) between Verret and Reggio, and the Shell Oil Company office building at the Yscloskey Gas Processing Plant (photograph 8). Photograph 9 shows that residences along Bayou Yscloskey have been constructed well above ground level. A building code requiring minimum floor level elevations and hurricane resistant construction would be appropriate for this area.



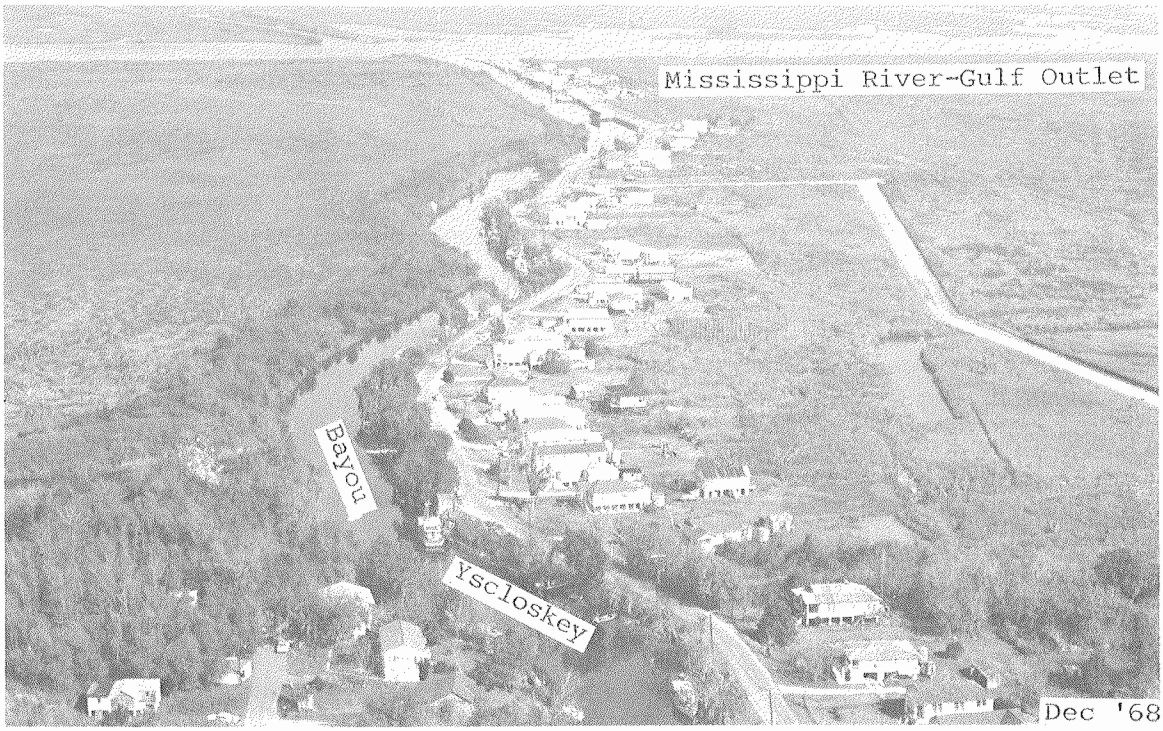
Photograph 6. Sebastian Roy Elementary School near Verret



Photograph 7. San Pedro Pescador Church near Verret



Photograph 8. Shell Oil Company office building near Yscloskey



Photograph 9. Bayou Yscloskey

(b) Flood plain zoning. Developments in the remaining unprotected areas of St. Bernard Parish are those associated with small boat fishing and oilfield operations. Since all of the area is at low elevations and subject to overflow, restrictions on developments other than to insure adequate construction (see preceding subparagraph) are not appropriate to this area.

(c) Evacuation. The development in the exposed areas of St. Bernard Parish is principally lower-type residential construction (see photographs 9, 10, 11, and 12) and that associated with small boat recreational and commercial fishing and oilfield operations. It is unlikely that buildings constructed in this area except for public use and large industrial developments will be of adequate strength to serve as hurricane shelters. Therefore, evacuation to a safe area must be a part of any plan for hurricane protection in St. Bernard Parish. The recent Hurricane "Betsy" was a disaster to this area (see photographs 13, 14, and 15). Many lives were lost through failure to evacuate flood prone areas, some of which will be protected by the levees now authorized. It is essential that local agencies keep plans for evacuation current, and also keep those to be evacuated aware of their danger and the need for early evacuation. The plans for evacuation should include the following:

1. Methods to be used to determine when evacuation will be required, who will order evacuation, how residents will be informed, and how orders to evacuate will be enforced;

2. The estimated number of residents in exposed areas and the estimated number that may require assistance;

3. Means of evacuation including vehicles available, both land and waterborne, and operators;

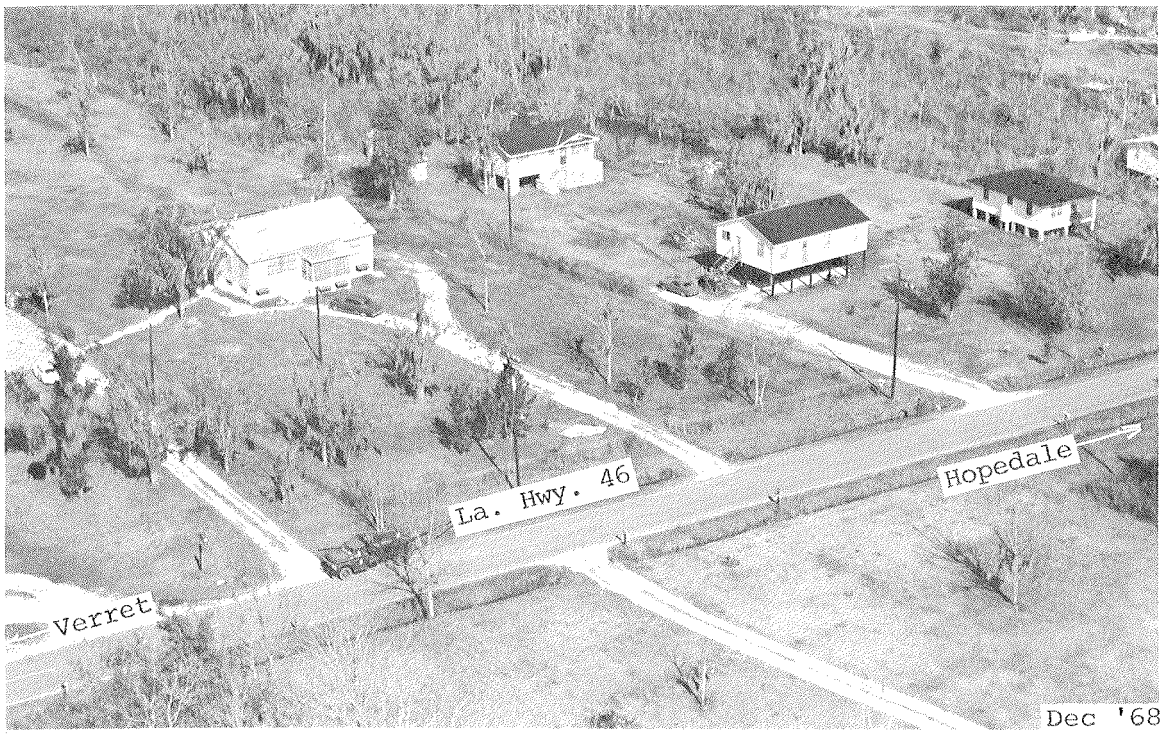
4. Water levels at which the existing highways become impassable by the land vehicles proposed for evacuation;

5. Methods to be used to control traffic on the highways in exposed areas and to keep unnecessary traffic from entering areas being evacuated;

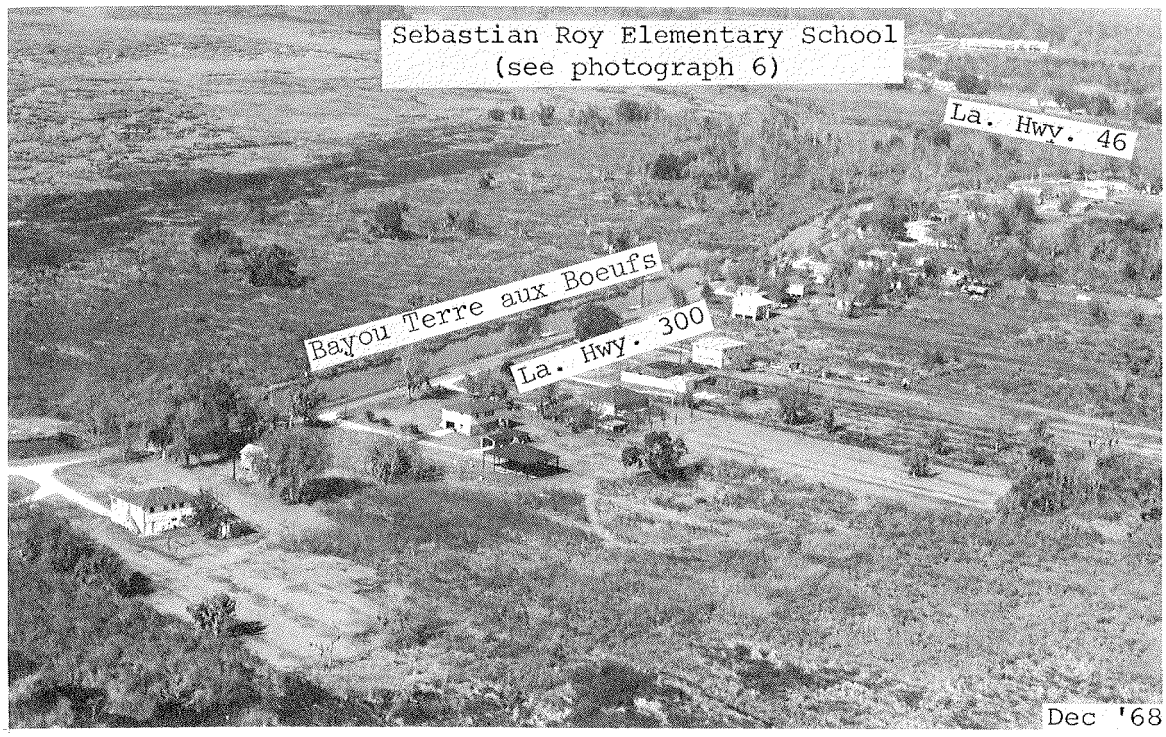
6. Estimated time required for evacuation including lead time to notify evacuees and for vehicles to reach loading points;

7. Location of shelters to be used including provisions for food, water, bedding, and sanitary facilities; and

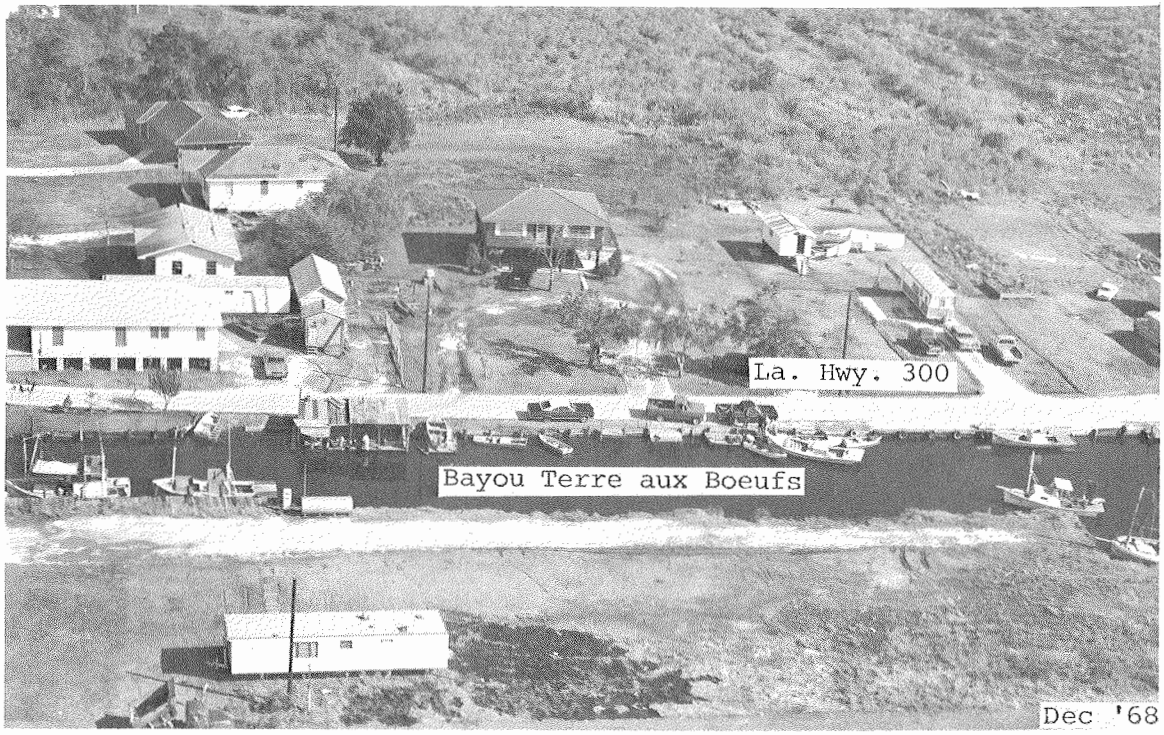
8. Plans for return of evacuees when emergency has passed.



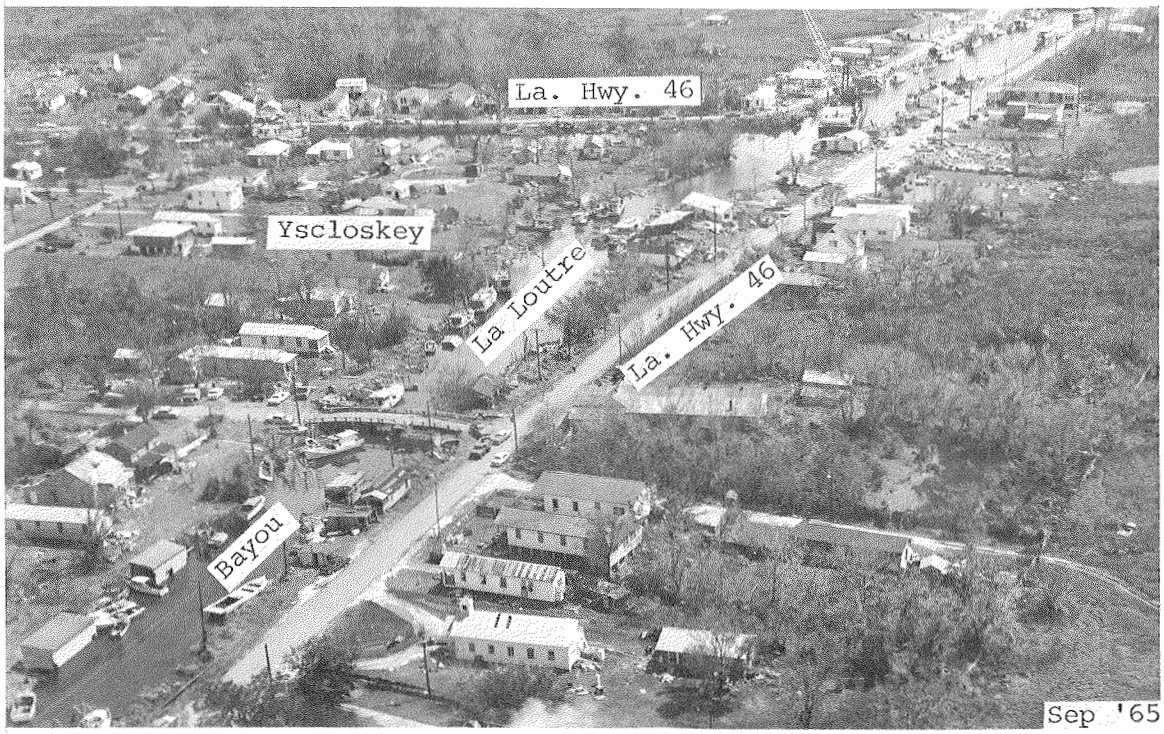
Photograph 10. Residences along Louisiana Highway 46 between Verret and Hopedale



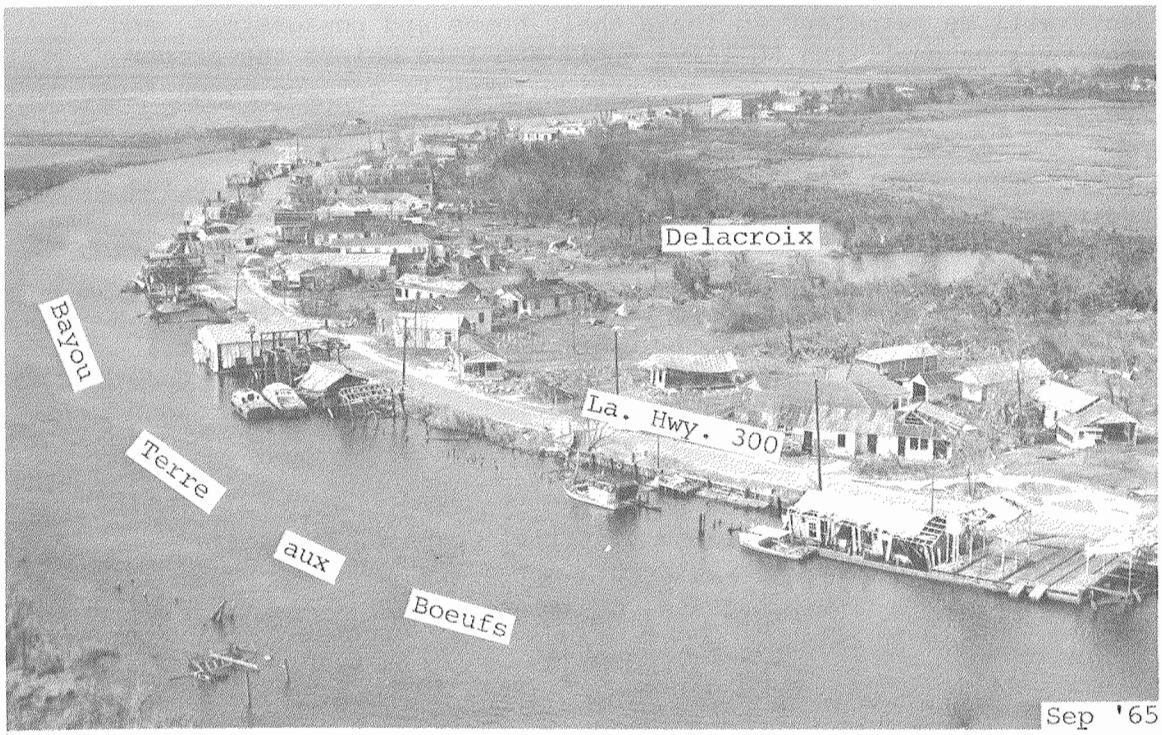
Photograph 11. Bayou Terre aux Boeufs at Reggio



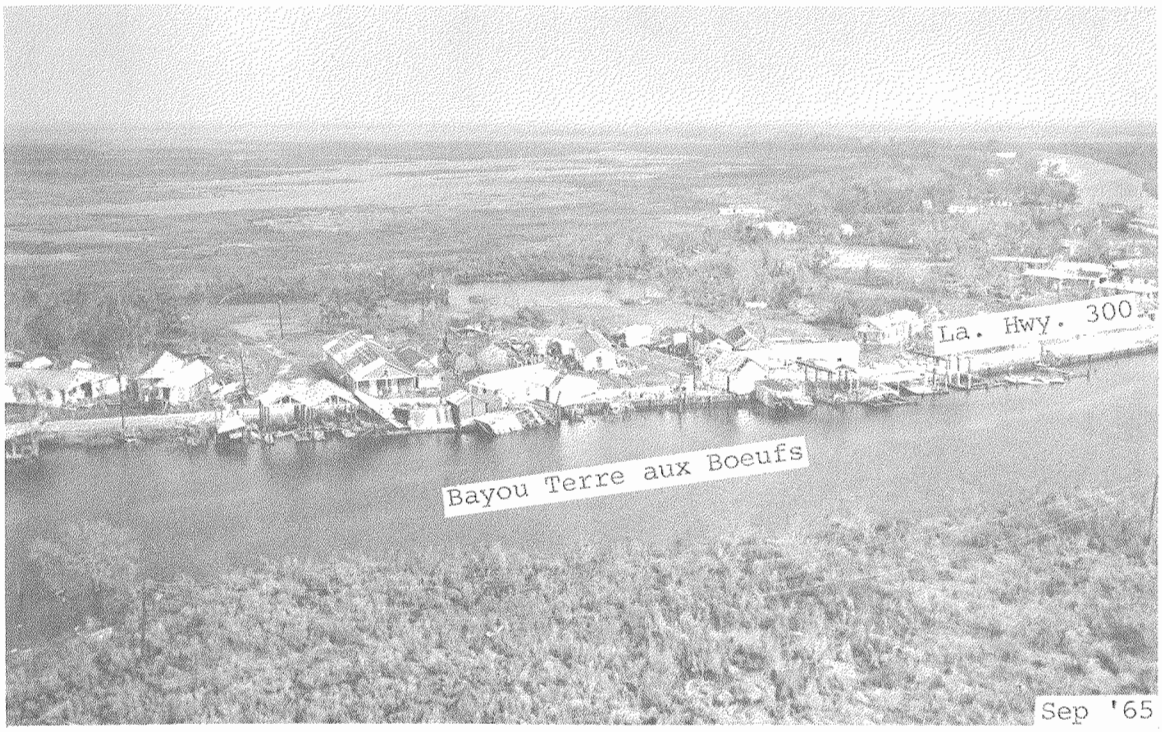
Photograph 12. Bayou Terre aux Boeufs south of Reggio



Photograph 13. Yscloskey and vicinity after Hurricane "Betsy"



Photograph 14. Delacroix after Hurricane "Betsy"



Photograph 15. Bayou Terre aux Boeufs after Hurricane "Betsy"

In all of the plans for evacuation it should be remembered that residents will be reluctant to leave their homes and possessions, and many will be unwilling to leave until too late unless the proper legal authority is provided and action taken to enforce evacuation orders.

(d) Flood Plain Management Services of the Corps of Engineers. The St. Bernard Parish Police Jury and other responsible state and local agencies should avail themselves of the information and technical assistance of the Corps of Engineers authorized under section 206 of the Flood Control Act of 1960 (see par 12h). This service will be provided, on request, by the New Orleans District to the extent of funds available. Requests for information beyond that contained in this report and technical assistance should be addressed as follows:

District Engineer
New Orleans District, Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

SECTION IV - ECONOMIC ANALYSIS

17. ESTIMATE OF FIRST COSTS

a. Chalmette area levee extension. Under the authority for the Lake Pontchartrain and Vicinity, Louisiana project to reexamine the levee alignment to inclose larger areas, the plan of improvement for the Chalmette area has been extended from Bayou Dupre southward to include Caernarvon and Verret (levee A-B-C-D on plate 1). The incremental cost of extending this plan is:

Chalmette area project	
Cost of levee A-B-C-D	$21,800,000
Less saving of levee from Violet to D	7,212,000
Incremental cost to Chalmette area	$14,588,000
Mississippi River-Gulf Outlet	
Toe protection for levee C-D	707,000
Total incremental cost of the additional protection	$15,295,000

This levee was authorized as a result of studies made for this report (see appendix D). It will not be discussed further under the Economic Analysis.

b. Verret to Hopedale levee. If the hurricane protection for the Chalmette area were extended from Verret to Hopedale by the construction of a levee generally along the alignment shown on plate 1 (B-E-F-G-H-I-C), the levee B-C in the presently approved plan could be eliminated as unnecessary. The estimated total cost for this levee is $5,900,000. The estimated incremental first cost for the levee from Verret to Hopedale, based on applicable designs and estimated unit costs for similar work in the adjacent Chalmette area extension and the nearby Chalmette area, a general knowledge of the area, and unit prices experienced for similar work in the New Orleans District, is $37,000,000. Details of the estimate are contained in table 1.

TABLE 1

Estimated First Cost Verret to Hopedale Levee Loop
(1968 prices)

Cost account No.	Item	Estimated first cost
11	Levees	$32,100,000
15	Drainage and navigation structures (3)	4,300,000
02	Relocations	500,000
	Subtotal	$39,900,000
30	Engineering and design	2,200,000
31	Supervision and administration	2,900,000
	Total construction cost	$42,000,000
01	Rights-of-way and easements	900,000
	Total first cost for levee	$42,900,000
	Saving on levee B-C	5,900,000
	Incremental cost for adding the levee to the plan for Chalmette area	$37,000,000

In addition to the above costs, toe protection would be required for the levee H-I-C along the Mississippi River-Gulf Outlet. Such protection upstream of point C has been accomplished under the Mississippi River-Gulf Outlet project. The estimated cost of the toe protection as shown on the typical levee cross section on plate 1 is $1,800,000. Details of the estimate are contained in table 2.

TABLE 2

Estimated Cost for Levee Toe Protection

Cost account No.	Item	Quantity	Unit cost	Cost
11	Excavation and backfill	270,000 cu.yds.	$1.00	$ 270,000
	Shell blanket	27,000 cu.yds.	3.50	94,500
	Riprap	120,000 tons	8.00	960,000
	Contingencies			255,500
	Subtotal			$1,580,000
30	Engineering and design			94,000
31	Supervision and administration			126,000
	Total cost for toe protection			$1,800,000

18. ESTIMATE OF ANNUAL CHARGES

a. Project life. The Verret to Hopedale area being considered for protection against hurricane tides is within commuting distance of industrial complexes along the Mississippi River downstream of New Orleans. A substantial part of the future development in the area protected will be for residential use. A 100-year project life is considered appropriate.

b. Operation and maintenance. The structures would be operated infrequently to prevent entrance of hurricane tidal surges. The three structures would be similar to structures approved at Bayous Bienvenue and Dupre of the Chalmette area levee. The estimated costs for each structure are $700 for operation and $2,000 for maintenance. The average annual cost for replacement of operating machinery, gates, and miscellaneous equipment is $5,000 per year for each structure.

c. Construction period. Due to the multiple lift construction required for the levees, it is anticipated that 8 to 10 years probably would be required to complete the levees. However, a high degree of protection will have been provided when the structures and the hydraulic base fill have been completed. The estimated incremental cost for lands, relocations, structures, and the hydraulic base fill is $33,000,000. It is further estimated that this work can be accomplished in a 5-year construction period.

d. The estimated average annual charges, based on an interest rate of 4 5/8 percent and a project life of 100-years, are shown in Table 3 below.

TABLE 3

Estimated Average Annual Charges

Item		Estimated amount
Summary of project costs		
Levees, structures, relocations, and rights-of-way (incremental cost)		$37,000,000
Levee toe protection (MR-GO)		1,800,000
Interest during construction (on $33,000,000 for 5-year construction period)		3,800,000
Initial investment		$42,600,000
Annual charges		
Interest		$ 1,970,000
Amortization		21,700
Operation and maintenance		
Levees (22 miles @ $5,000)	$ 110,000	
Structures (3 @ $2,700)	8,100	118,100
Replacements (3 str @ $5,000)		15,000
Total estimated annual costs for additional hurricane protection		$ 2,124,800

19. ESTIMATE OF BENEFITS

a. Flood damages prevented. The flood damages from hurricane tides in the Verret to Hopedale area considered for protection under existing conditions and projected for a 100-year project life are described in paragraph 11. The levee grades were established to protect against hurricane tidal surges having a frequency of about once in 200 years. Residual flood damages would be negligible. The average annual flood damages prevented in the Verret to Hopedale area are:

Existing conditions	$107,000
Projected for 100-year project life	150,000

b. Enhancement. The proposed levee loop encompassing Verret, Reggio, and Hopedale (B-E-F-G-H-I-C) will provide protection to about 14,000 acres of which 1,000 acres are cleared, 4,000 acres are woodland, and 9,000 acres are marshlands. The present value of the land is estimated at $5,200,000. It is estimated that the value would increase to about $6,200,000 if protected against hurricane tidal overflow. The annual benefits at a 5 percent return on the $1,000,000 increase in land value are $50,000.

c. Summary of benefits. The average annual benefits for protection of the area from Verret to Hopedale as shown on plate 1 are:

Flood damages prevented	$150,000
Land enhancement	50,000
Total estimated benefits	$200,000

20. PROJECT FORMULATION AND ECONOMIC JUSTIFICATION

a. The estimated average annual benefits for the Verret to Hopedale area are $200,000 (paragraph 19c). The annual charges are $2,124,800 (paragraph 18d). The resulting benefit-cost ratio is 0.1. Consideration was given to protecting the area from Verret to Yscloskey only (levee B-E-F-I-C). This would reduce the levee length by about one-third and the annual charges to about $1,000,000. Protection of the smaller area also is not economically justified.

b. The protection of the more developed areas, such as Yscloskey (see photographs 5, 9, and 13) by a local ring levee, would require several miles of levee well back in the marsh. Drainage and navigation structures would be required at the stream crossings. Based on the studies for the Verret to Hopedale levee annual charges would be about $100,000/mile. A minimum of about 4 miles of levee would be required for the Yscloskey area. Since the benefits would be greatly reduced from those estimated for the Verret to Hopedale levee, it is obvious that the local ring levee also would lack economic justification.

SECTION V - COORDINATION AND LOCAL COOPERATION

21. PROPOSED LOCAL COOPERATION

Several hurricane protection projects have been authorized as a result of studies made under Public Law 71, 84th Congress. Two of these projects are adjacent to the study area. They are the Chalmette Area of Lake Pontchartrain and Vicinity and Mississippi River Delta at and below New Orleans projects. Local cooperation required for additional hurricane protection improvements in St. Bernard Parish should be the same as for the nearby hurricane protection projects. The appropriate local cooperation consists of the following:

a. Provide all lands, easements, and rights-of-way necessary for construction of the project;

b. Accomplish all alterations and relocations to roads, railroads, pipelines, cables, wharves, drainage structures, and other facilities required for the construction of the project;

c. Contribute in cash or equivalent work not less than 30 percent of the total project cost, said 30 percent to include the fair market value of lands and relocations required under subparagraphs a and b above, and the remainder in cash or equivalent work specifically undertaken as an integral part of the project after authorization and in accordance with construction schedules approved by the Chief of Engineers;

d. Provide all interior drainage and pumping plants required for reclamation and development of the protected areas;

e. Hold and save the United States free from damages due to the construction works;

f. Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army; and

g. Provide assurances that encroachment on improved channels or ponding areas will not be permitted, and that, if ponding areas and capacities are impaired, substitute storage capacity or equivalent pumping capacity will be provided without cost to the United States.

22. ALLOCATION OF COSTS AMONG PURPOSES

All of the costs are allocated to hurricane protection, the only purpose served.

23. APPORTIONMENT OF COSTS AMONG INTERESTS

The total project first costs would be apportioned to Federal and non-Federal interests at 70 percent to the Federal Government and 30 percent to non-Federal interests in accordance with policies established by laws which authorized other hurricane protection projects. All of the costs for maintenance and operation would be a non-Federal responsibility. Since the improvements considered do not approach economic justification, a monetary division has not been made.

24. COORDINATION WITH OTHER AGENCIES

a. Initial. The initiation of the study was widely publicized through copies of the notice of public hearing to Federal, state, and local agencies, members of the Louisiana Congressional delegation, public officials, postmasters, news media, industrial representatives, and individuals. Special letters requesting a reply indicating their interest in the study were sent to those Federal agencies listed in the pamphlet "Policies and Procedures for Distribution and Coordination of Reports by Agencies Represented on the Inter-Agency Committee on Water Resources," July 1958.

b. Fish and Wildlife agencies. The proposed plan of improvements under consideration was furnished to the U. S. Fish and Wildlife Service and the Louisiana Wild Life and Fisheries Commission for their review, recommendations as to additional improvements to be considered in the study for enhancement of fish and wildlife values or as mitigation measures, and comments. The report of the U. S. Fish and Wildlife Service dated 23 November 1966 including a letter dated 9 November 1966 from the Louisiana Wild Life and Fisheries Commission is attached hereto in appendix C. These agencies find that the extension of the plan of protection for the Chalmette area to include Caernarvon and Verret will indirectly damage fish and wildlife resources by hastening urbanization and industrialization of valuable marshes. This extension has been authorized (see paragraph 12d). Further comments of the U. S. Fish and Wildlife Service are included in subparagraph 24d below.

c. Local interests.

(1) Subsequent to the completion of the study and review of the draft of the report by the Division Engineer, the Louisiana Department of Public Works was requested to suggest a time and place agreeable to them, other interested officials and agencies, and members of the Louisiana Congressional delegation for a public hearing for discussion of the study. Inquiries of representatives of the Louisiana Department of Public Works resulted in the St. Bernard Police Jury, by letter dated 8 July 1969, requesting that they be furnished the information for review in lieu of a public hearing.

Copies of the draft of the proposed report were forwarded to the Police Jury on 16 July 1969. In response to their request the Police Jury was granted an extension of time to 31 August for furnishing their comments.

(2) On 17 August 1969 hurricane "Camille" passed near the mouth of the Mississippi River and went inland on the Mississippi Gulf Coast. This hurricane, although small in area, was one of the most intense storms to strike the coastline of the United States. It caused great damage particularly on the Mississippi coast and downstream of New Orleans. Although St. Bernard was on the west side of the hurricane, water stages at Shell Beach approached those of hurricane "Betsy" (9-10 September 1965). Stages at lesser exposed locations were substantially lower than for hurricane "Betsy". After several telephone calls by representatives of the New Orleans District and Louisiana Department of Public Works, and a discussion on 6 October 1969 between representatives of the Louisiana Department of Public Works and the Police Jury, the comments of the Police Jury were forwarded on 20 October 1969 (see appendix C). The Police Jury stated in a resolution, adopted 7 October 1969, that it was not in agreement with the conclusions and recommendations in the report and recommended that the report not be approved. They further requested that the Federal Government reconsider and recognize that it has the primary obligation to protect the residents of St. Bernard Parish from flooding caused by the Federal project creating the Mississippi River-Gulf Outlet (see paragraph 12).

(3) Subsequent to hurricane "Betsy" and local interest contention that the Mississippi River-Gulf Outlet had caused severe flooding in St. Bernard Parish and a part of New Orleans, a contract was awarded to the National Engineering Science Company for a study to determine the effects, if any, of the Mississippi River-Gulf Outlet on storm surges. The study was made under the supervision of Dr. Charles L. Bretschneider, a world-renowned expert on tidal hydraulics. It was completed in September 1966. The conclusions reached in the study were:

(a) The Mississippi River Gulf-Outlet has very little effect on maximum storm surges for hurricanes that produce slow-rising tides, the normal type of hurricane occurring along the Gulf of Mexico Coast (example - hurricane "Betsy" 9-10 September 1965).

(b) The Mississippi River has more effect on maximum storm surges for hurricanes that produce fast rising tides. This type hurricane is rare and produces much lower storm surges than hurricanes that produce slow rising tides.

The first conclusion stated above is borne out by the fact that stages at the head of the Mississippi River-Gulf Outlet were about the same for hurricane "Betsy" and a similar hurricane, that occurred in September 1915, both in track and severity. Development in the area

subject to overflow was much less in 1915 and consequently the actual damage, although severe, was much less in 1915.

(4) Hurricane "Camille" (17 August 1969), although producing higher maximum winds than hurricane "Betsy", covered a much smaller area. The U. S. Weather Bureau as a result of hurricane "Betsy" reevaluated the maximum probable and standard project hurricanes upward. The revised storm has been used for this study (see appendix A). A reexamination of the maximum probable and standard project hurricanes to consider data collected during hurricane "Camille" is underway. Inclusion of the effects of hurricane "Camille" in the study would not change the conclusions that the only practicable means for hurricane protection in the area outside the authorized levees is the construction of hurricane proof improvements and the early evacuation of people and moveable property from the exposed area.

(5) Copies of the draft of the report were furnished the Regional Planning Commission for Jefferson, Orleans, and St. Bernard Parishes by letter dated 16 July 1969. This agency held a public hearing (6 October 1969) on hurricane protection at which the major concern was the early construction of the authorized Lake Pontchartrain and Vicinity, Louisiana project and early completion of a hurricane protection study (now underway) for the areas on the West Bank of the Mississippi River opposite New Orleans. The St. Bernard Parish hurricane study was not discussed. Although considerable discussions of the authorized hurricane protection improvements and of the hurricane protection studies for St. Bernard Parish and for the West Bank of the Mississippi River at and in the vicinity of New Orleans have taken place between members of the staffs of the New Orleans District and the Regional Planning Commission, the latter has not made any official comments on this report.

d. Other. Copies of the draft of the report were furnished to the following Federal agencies for review and field level comments.

Fish and Wildlife Service, Atlanta, Georgia
Bureau of Mines, Bartlesville, Oklahoma
Federal Water Pollution Control Administration, Dallas, Texas
Geological Survey, Baton Rouge, Louisiana
Bureau of Outdoor Recreation, Atlanta, Georgia

No unfavorable comments were received. The replies of the above agencies are attached hereto in appendix C.

SECTION VI - RESULTS OF THE INVESTIGATION

25. DISCUSSION

a. St. Bernard Parish is located in the coastal marsh area of southeast Louisiana. Except for areas within small non-Federal levee systems and the high ground along the Mississippi River, all of the parish is exposed to inundation during major hurricanes. Much of the parish is at such low elevation, 1 to 2 feet, that it is frequently overflowed during moderate storms. The plan of improvements authorized for the Chalmette area under the Lake Pontchartrain and Vicinity project now under construction will provide protection against hurricane tidal overflow for the area between the Mississippi River-Gulf Outlet and the Mississippi River upstream of Bayou Dupre. Studies made under the resolution quoted in paragraph 1 showed that extension of the plan of improvement for the Chalmette area gulfward to encompass Caernarvon and Verret was economically justified provided the levee from Violet to the Mississippi River-Gulf Outlet was eliminated.

b. The authorization for the Lake Pontchartrain and Vicinity project provided for the reexamination of the levee alignment to protect additional lands. On 31 January 1967 the Chief of Engineers approved the recommendations of the District and Division Engineers that the plan of improvement for the Chalmette area be extended to include Poydras, Caernarvon, and Verret in the protected area (Chalmette area extension on plate 1.)

c. The remainder of St. Bernard Parish is sparsely populated and extremely vulnerable to tidal overflow. Most of the developments are along Bayous La Loutre, Yscloskey, and Terre aux Boeufs. The principal occupations are those associated with sport and commercial fishing and servicing the petroleum industry. Developments are subject to damages from high winds as well as tidal overflow. As a result most of the permanent-type buildings have been constructed above frequent tidal overflow level or are of less costly construction that would not withstand high winds and are considered expendable.

d. Studies of extending the modified plan of improvement for the Chalmette area to inclose Reggio, Yscloskey, and Hopedale indicate that the benefit-cost ratio is about 0.1. The area along Bayou Terre aux Boeufs, between Reggio and Delacroix, is sparsely settled and has less extensive developments than at Yscloskey and Hopedale. Protection against overflow would require levees on both sides of the bayou. Protection for this area would have less justification than for the Yscloskey and Hopedale areas.

e. The most practicable plan for reduction of potential damages from hurricane tidal overflow is the construction of buildings and other improvements with floor levels above 12 feet or to sustain a minimum damage by such water stages. If hurricane-proof structures are not constructed in the exposed areas, early evacuation to protected areas is necessary on the approach of tropical disturbances.

f. The New Orleans District, Corps of Engineers will provide the local interests additional information and technical assistance under section 206 of the F. C. Act of 1960.

g. Additional information called for by Senate Resolution 148, 85th Congress adopted 28 January 1958 is contained in a supplement appended to this report.

26. CONCLUSIONS

a. As a result of this study an existing project has been extended to provide hurricane protection to a significantly larger area in St. Bernard Parish.

b. Further extension of the levee system to provide hurricane protection for additional areas in St. Bernard Parish is not economically justified under existing conditions or in the foreseeable future. Consequently no further authorization by Congress is appropriate at this time.

c. However, much can be accomplished to reduce the threat to the life and health of people and to reduce flood damages from tidal overflow in the remaining unprotected parts of St. Bernard Parish. The hazards to life and health of the residents of the unprotected area and flood damages from hurricane tidal overflow can be minimized by the early evacuation of people and movable property and the construction of structures capable of withstanding hurricane winds and with floor levels above anticipated water levels (about 12 feet mean sea level for the 50-year storm).

d. The Corps of Engineers should accelerate its work with state and local agencies and people through the Flood Plain Management Service Program, by providing information and technical services regarding the flood hazard and non-structural measures, including flood proofing of public buildings, that would be helpful in alleviating flood problems. Funds for these services should be provided annually under the Flood Plain Management Service Program.

e. Local governmental agencies should develop and keep current a plan for evacuation of people and movable property from the unprotected areas of St. Bernard Parish. Such plans should recognize the vulnerability of the area to tidal overflow; the stages at which the roads and highways become impassable to the vehicles to be used; the

reluctance of residents to leave their homes and property; location of shelters for the evacuees including provision of food, water, bedding, medical assistance, and sanitary facilities; and plans for return of the evacuees when the emergency has passed and the area is again habitable.

27. RECOMMENDATION

It is recommended that no further modification of the existing project for hurricane protection in St. Bernard Parish be authorized at this time.

HERBERT R. HAAR, JR.
Colonel, CE
District Engineer

CORPS OF ENGINEERS

U.S. ARMY

LAKE PONTCHARTRAIN

NEW ORLEANS

INNER HARBOR NAVIGATION CANAL

GULF INTRACOASTAL WATERWAY

12'X150'

ORLEANS PARISH

ST. BERNARD PARISH

Bayou Bienvenue

LAKE BORGNE

Chalmette

CHALMETTE AREA

Bayou Dupre 6'X 80'

CHALMETTE AREA EXTENSION

REACH "E" LEVEE (authorized)

Violet

Verret

Poydras

Caernarvon

Bayou Terre aux Boeufs

GULF INTRACOASTAL WATERWAY EXISTING 12'X125' AUTHORIZED 16'X150'

MISSISSIPPI RIVER - GULF OUTLET 40' X 1000'

MISSISSIPPI RIVER - GULF OUTLET 36'X 500'

Shell Beach

Bayou La Loutre

Bayou Ycloskey

Ycloskey

Reggio

Hopedale

Bayou La Loutre

to Bayou Eloi

REQUESTED BY LOCAL INTERESTS

LAKE LERY

IMPROVEMENTS CONSIDERED BUT NOT RECOMMENDED

Delacroix

Bayou Terre aux Boeufs

ST BERNARD PARISH

PLAQUEMINES PARISH

Lake Jean Louis Robin

Lake Coquille

Lake of Second Trees

Lake CoteBasse

Lake Machias

Jetties

SCALE OF MILES

0 1 2 3

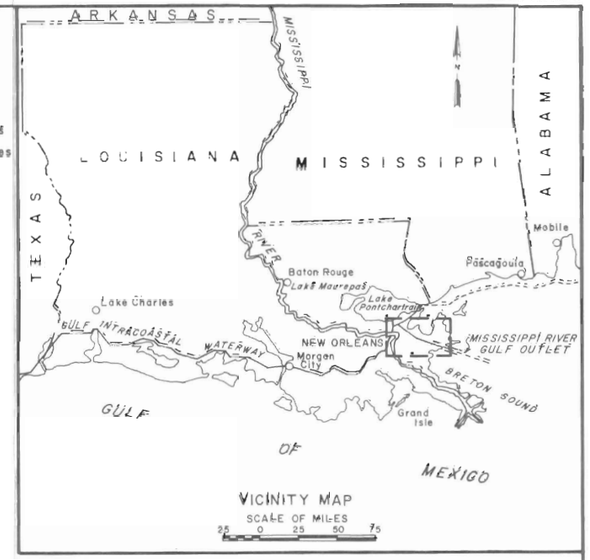
N

LEGEND

- Existing Mississippi River levees
- Authorized Chalmette Area levees prior to extension of plan.
- Authorized Chalmette Area extension levees.
- Authorized Reach "E" levees
- Existing locks
- Authorized floodgates

IMPROVEMENTS CONSIDERED BUT NOT RECOMMENDED

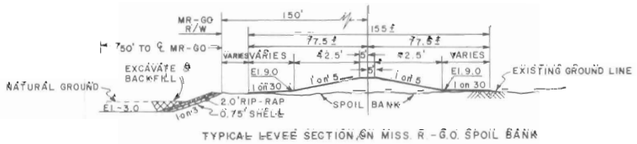
- Levees
- Floodgates



VICINITY MAP

SCALE OF MILES

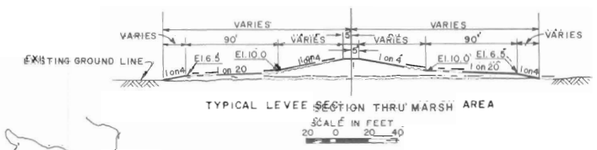
25 0 25 50 75



TYPICAL LEVEE SECTION ON MISS. R.-G.O. SPOIL BANK

SCALE IN FEET

20 0 20 40



TYPICAL LEVEE SECTION THRU MARSH AREA

SCALE IN FEET

20 0 20 40

ST. BERNARD PARISH LOUISIANA

GENERAL MAP

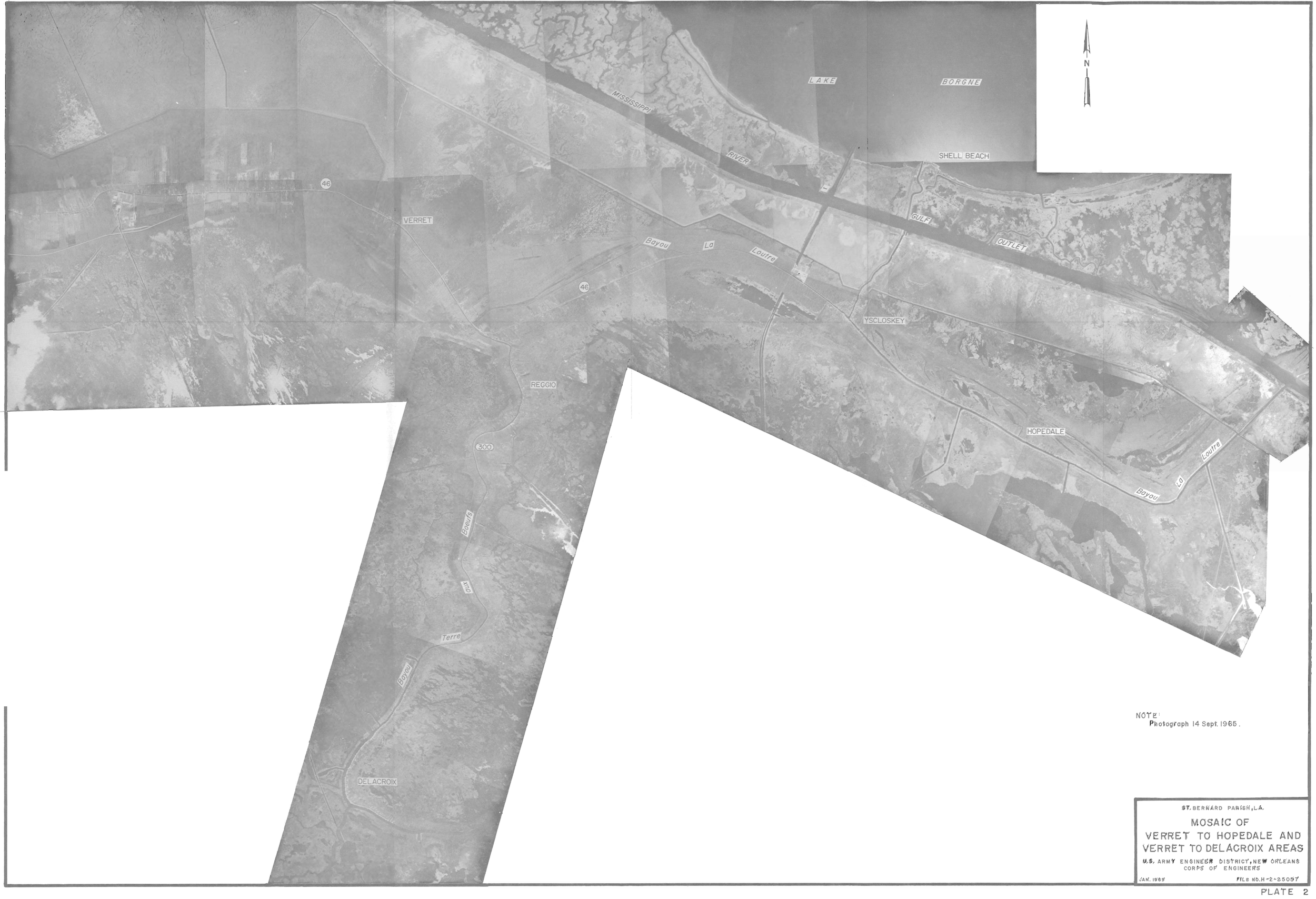
SCALES AS SHOWN

OFFICE OF THE DISTRICT ENGINEER, NEW ORLEANS, LA

SUBMITTED:	APPROVAL RECOMMENDED:	APPROVED:
Walter S. Mask	Thomas G. Bush	Herbert Hoard
CHIEF, PLANNING AND REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COL, C.E. DISTRICT ENGINEER

DRAWN	TRACED	CHECKED	TO ACCOMPANY REVIEW OF REPORTS	FILE NO.
S.S.	M.S.W.	H.W.H.	DATED: 18 NOVEMBER 1969	H-2-25057

PLATE I



NOTE:
Photograph 14 Sept. 1965.

ST. BERNARD PARISH, LA.

MOSAIC OF VERRET TO HOPEDALE AND VERRET TO DELACROIX AREAS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

JAN. 1966 FILE NO. H-2-25097

PLATE 2

REVIEW OF REPORTS
ON
ST. BERNARD PARISH, LOUISIANA

APPENDIX A

HYDROLOGY AND HYDRAULICS

REVIEW OF REPORTS
ON
ST. BERNARD PARISH,
LOUISIANA

APPENDIX A

HYDROLOGY AND HYDRAULICS

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APPENDIX A

HYDROLOGY AND HYDRAULICS

SECTION I - ANALYSES

1. CLIMATOLOGY

a. Climate. The project area is located in a subtropical latitude, having mild winters and hot, humid summers. During the summer, prevailing southerly winds produce conditions favorable for convective thundershowers. In the colder seasons, the area experiences frontal passages which produce squalls and sudden temperature drops. River fogs are prevalent in the winter and spring when the temperature of the Mississippi River is somewhat colder than the air temperature. Climatological data for the area are contained in monthly and annual publications by the U. S. Department of Commerce, Weather Bureau, titled "Climatological Data for Louisiana," and "Local Climatological Data, New Orleans, La."

b. Temperature. The first-order weather station in New Orleans has temperature records extending back to 1871. The normal temperature is about 70° F. and the recorded extremes are 7° and 102°. The normal temperature in summer and winter is 83.1° and 57.1°, respectively. Detailed temperature records and station locations are shown in table A-1 and on plate A-1, respectively.

TABLE A-1

Temperature at New Orleans

	Degrees Fahrenheit				Degrees Fahrenheit		
Month	Normal[1]	Maximum[2]	Minimum[2]	Month	Normal[1]	Maximum[2]	Minimum[2]
Jan	56.0	67.2	41.2	Jul	83.4	91.7	71.5
Feb	58.2	67.2	38.6	Aug	83.5	89.9	70.3
Mar	62.8	75.3	48.1	Sept	80.2	86.2	66.0
Apr	69.7	83.0	60.4	Oct	72.6	80.0	52.6
May	76.8	85.5	63.8	Nov	62.0	76.7	48.1
Jun	82.3	91.1	69.2	Dec	57.1	66.6	46.4

Extreme minimum 7° F., 13 February 1899
Extreme maximum 102° F., 30 June 1954 (also earlier dates)

[1] U. S. Weather Bureau normals 1931-1960
[2] Based on records from 1871 through 1968

c. Rainfall. Precipitation is generally heavy in two fairly definite rainy periods. Summer showers occur from about mid-June to mid-September, and heavy winter rains generally occur from mid-December to mid-March. Based on the records from U. S. Weather Bureau Station in New Orleans, the normal annual precipitation is 63 inches, with extreme variations of 85.7 inches in 1875 and 31.1 inches in 1899. Extreme monthly rainfalls exceeding 12 inches are not uncommon, and as much as 25 inches have been recorded in a single month. Normal monthly rainfalls range from 7.9 inches in July to 3.2 inches in October. Several stations have experienced calendar months in which no rainfall was recorded, the latest being October 1963. Snow occurs infrequently in the area. An 8.2-inch fall occurred in New Orleans on 14-15 February 1895. The last measurable snowfall occurred on 31 December 1963 when 4.5 inches fell in New Orleans. Detailed precipitation records and station locations are shown in table A-2 and on plate A-1, respectively.

TABLE A-2

Rainfall at New Orleans

	Inches				Inches		
Month	Normal[1]	Maximum[2]	Minimum[2]	Month	Normal[1]	Maximum[2]	Minimum[2]
Jan	4.42	12.69	0.61	Jul	7.92	18.16	2.02
Feb	4.69	13.85	0.04	Aug	6.34	22.74	0.87
Mar	6.22	21.09	0.04	Sept	5.99	16.57	0.24
Apr	5.41	14.94	0.04	Oct	3.22	25.11	0.00
May	5.11	18.68	0.02	Nov	3.74	14.41	0.10
Jun	5.49	16.01	0.59	Dec	4.70	14.43	0.67

[1]U. S. Weather Bureau normals 1931-1960
[2]Based on records from 1870 through 1968

d. Wind.

(1) Wind records are available adjacent to the St. Bernard area for various periods. Periods of records for anemometers are shown in table A-3.

TABLE A-3

Meteorologic Stations

Map index No. on plate A-1	Station	Length of record in years (thru 1968)		Collecting agency[1]
	COMPLETE METEOROLOGICAL STATIONS			
1	New Orleans	97		WB
2	New Orleans International Airport, Moisant Field	22		WB
	RECORDING BAROGRAPH STATIONS			
3	Lake Pontchartrain at Frenier (discontinued Sept 1965)	8		NOD
4	Lake Pontchartrain near Madisonville	12		NOD
5	Lake Pontchartrain at West End (New Orleans)	12		NOD
	RECORDING RAINFALL STATIONS			
6	New Orleans - Algiers	69		S&WB
7	New Orleans - Dublin Street	75		S&WB
8	New Orleans - Jefferson	75		S&WB
9	New Orleans - Jourdan Avenue	35		S&WB
10	New Orleans - London Avenue	75		S&WB
	NON-RECORDING RAINFALL STATIONS			
11	Metairie	20		WB
12	New Orleans - Citrus	14		WB
13	Pearl River (disc. Jan 1963)	56		WB
14	Pearl River, Lock 1	20		WB
15	Violet	13		WB
	RAINFALL (NON-RECORDING) AND TEMPERATURE STATIONS			
		Rainfall	Temp.	
16	New Orleans Airport (disc. Jul 1954)	15	17	WB
17	New Orleans - Audubon Park	78	78	WB
18	Greater New Orleans Expressway Bridge	12	12	WB
19	Slidell	12	12	WB

TABLE A-3 (continued)

Meteorologic Stations

Map index No. on plate A-1	Station	Length of record in years (thru 1968)	Collecting agency[1]
	RECORDING ANEMOMETER STATIONS		
20	GIWW at Paris Road bridge (disc. Jul 1968)	9	NOD
21	Greater New Orleans Expressway bridge near Metairie	12	WB
22	Lake Pontchartrain near north end of U. S. Hwy. 11 bridge	10	NOD
5	Lake Pontchartrain at West End (New Orleans)	12	NOD
23	Mississippi River at H.P. Long Bridge (U.S. Hwy. 90)	31	NOPBRR
4	Lake Pontchartrain near Madisonville	12	NOD

[1] WB = U. S. Weather Bureau
NOD = U. S. Army Engineer District, New Orleans
S&WB = New Orleans Sewerage and Water Board
NOPBRR = New Orleans Public Belt Railroad

(2) The U. S. Weather Bureau anemometer at the New Orleans International Airport, Moisant Field, installed in 1949 is the nearest station which provides the longest wind record available for the St. Bernard Parish area. A 16-year summary of winds at Moisant Field is shown in table A-4. Hourly summaries of wind direction and velocities were not published by the U. S. Weather Bureau subsequent to 1964. The average wind velocity is 8.6 m.p.h. (7.4 knots) but winds over 100 m.p.h. (87 knots) are experienced occasionally in hurricanes. The predominant wind directions are south to southeast from January through July, and northeast to east-northeast from September through November.

TABLE A-4

Wind Summaries, New Orleans International Airport, Moisant Field
(1949-1964)

Wind direction (or velocity)	Percent of time												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
N	7.36	7.04	5.99	4.77	4.62	4.02	3.57	5.21	5.83	7.64	9.19	7.48	6.05
NNE	7.07	7.12	5.81	4.61	4.23	3.39	3.01	4.53	7.26	8.64	8.82	8.74	6.09
NE	8.13	8.93	7.78	5.33	5.52	5.00	4.90	7.07	13.30	12.39	9.94	10.11	8.19
ENE	8.30	7.64	7.15	5.64	5.04	5.14	4.47	6.49	15.95	12.53	10.12	9.48	8.16
E	5.67	6.11	5.08	4.70	4.61	4.40	4.60	5.66	8.30	7.61	6.12	7.03	5.82
ESE	3.55	3.72	4.66	5.13	4.84	3.72	3.07	3.07	4.18	4.50	3.75	4.24	4.04
SE	4.75	5.00	6.33	8.23	7.12	5.42	4.65	3.60	4.84	4.39	5.22	4.44	5.33
SSE	10.32	8.15	9.53	13.32	11.38	8.91	5.64	4.94	4.45	4.15	6.93	6.80	7.87
S	10.17	9.05	11.36	13.92	13.22	11.62	9.40	6.19	4.48	3.15	6.08	7.40	8.83
SSW	5.54	7.38	7.35	6.95	7.92	11.10	8.93	6.89	2.64	1.74	3.68	4.72	6.23
SW	2.81	5.07	4.14	4.51	6.19	7.22	8.59	7.18	2.02	1.44	1.93	2.43	4.46
WSW	2.09	2.74	2.66	2.48	3.13	4.17	5.71	4.70	1.44	1.38	1.54	1.71	2.82
W	2.58	3.11	2.60	2.41	3.13	3.98	6.01	5.48	1.86	2.00	2.70	2.58	3.21
WNW	3.06	3.36	3.25	3.04	2.21	3.12	4.93	3.91	1.88	2.52	3.12	2.87	3.11
NW	4.13	3.71	4.08	3.04	2.71	3.26	3.77	4.07	2.18	3.27	4.12	4.30	3.56
NNW	7.46	6.19	5.76	4.45	3.96	3.66	3.99	4.60	3.75	6.04	7.02	7.35	5.35
Calm	7.01	5.68	6.46	7.46	10.16	11.87	14.76	16.41	15.64	16.62	9.73	8.30	10.88
0-3 m.p.h.	12.33	10.14	10.95	12.38	16.00	19.58	23.53	25.82	22.73	23.54	15.89	14.31	17.32
4-7	24.67	23.29	21.19	23.49	29.63	36.42	39.54	38.03	29.16	27.60	26.55	24.86	28.74
8-12	33.41	32.83	32.55	33.64	34.27	32.86	28.71	28.11	29.25	28.76	30.20	32.93	31.45
13-18	22.29	25.85	27.09	24.77	17.32	10.39	7.45	7.38	15.78	16.12	20.54	21.83	18.01
19-24	6.01	6.74	6.69	4.60	2.42	0.63	0.64	0.56	2.51	3.34	5.39	5.02	3.69
25-31	1.16	1.12	1.40	1.04	0.33	0.10	0.09	0.09	0.39	0.58	1.33	0.99	0.72
32-38	0.11	0.03	0.13	0.06	0.02	0.02	0.02	0	0.11	0.06	0.10	0.05	0.06
39-46	0.03	0.02	0	0.02	0.01	0	0.02	0.01	0.05	0.01	0	0	0.01
47 and over	0	0	0	0	0	0	0	0	0.01	0	0	0	0

2. HYDROLOGY

The water levels in Lake Borgne and Breton Sound are subject to variations from wind-driven water movements and tidal variations originating in the Gulf of Mexico. The line of demarcation between fresh and salt water marsh is not defined. Marsh floods result from heavy rainfall which ponds in numerous lakes and inland bays. These floods tend to freshen the brackish and salt marsh for short periods. Marshes are reverted to a completely saline environment by occasional tidal overflow. The principal streams interlacing the area are Bayous La Loutre, Terre aux Boeufs, Yscloskey, and St. Malo, and the Mississippi River-Gulf Outlet ship channel. These streams are the major avenues of tidal flow. The area is protected from major fresh water flooding by the mainline levees along the Mississippi River. Locations and periods of records of hydrologic stations are shown in table A-5.

TABLE A-5

Hydrologic Stations, Lake Borgne and Vicinity

Map index No.	Station	Period of Record: Type of water level gage	Period of Record: Records available through 1968	Collecting[1] agency
24	Rigolets at U.S. Hwy. 90 bridge	Staff prior to June 1949. Recorder June 1949 to date. Crest indicator.	Gage heights, Sept 1931 to date. Salinity, Jul 1957 to date.	NOD
25	Chef Menteur U.S. Hwy. 90 bridge	--	Salinity, Mar 1957 to date.	NOD
26	Lake Borgne at Rigolets	Recorder	Gage heights, Feb-Mar 1950; Dec 1957 to Sept 1965; Jul 1967 to date.	NOD
27	Lake Borgne at Chef Menteur Pass	Recorder	Gage heights, April and Jun 1945; Feb & March 1950; Jul 1957 to Sept 1965; Oct 1967 to date.	NOD
28	Lake Borgne at Shell Beach	Recorder Crest indicator	Gage heights, Jul 1949 to Jun 1961. Salinity, Aug 1948 to Jul 1961.	NOD
28	Miss. River-Gulf Outlet at Shell Beach	Recorder Crest indicator	Gage heights, Jun 1961 to date.	NOD
29	Lake Borgne at Doulluts Canal east of Shell Beach	--	Salinity, Feb 1957 to May 1960.	NOD
20	Gulf Intracoastal Waterway at Paris Road	Staff gage Apr 1948-Feb 1964. Recorder Jun-Oct 1944, Jun-Aug 1945 & May 1959 to date. Crest indicator.	Gage heights, Apr 1948 to date. Salinity, Aug 1948 to date.	NOD

[1]NOD = U. S. Army Engineer District, New Orleans

3. DESCRIPTION AND VERIFICATION OF PROCEDURES

a. Hurricane memorandums. The Hydrometeorological Branch (HMB), U. S. Weather Bureau, cooperated in the development of hurricane criteria for experienced and potential hurricanes in the project area. The HMB memorandums provided frequency data, isovel and rainfall patterns, pressure profiles, hurricane paths, and other parameters required for the hydraulic computations. Those relative to experienced hurricanes are based on reevaluation of historic meteorologic and hydrologic data. Those relative to potential hurricanes contain generalized estimates of hurricane parameters that are based on the latest research and concept of hurricane theory. Hurricane memorandums pertinent to the project area are listed in Section II - Bibliography. They are identified in this presentation by references in parentheses.

b. Historical storms used for verification. Two observed storms, with known parameters and effects, were used to establish and verify procedures and relationships for determining surge heights. These two storms occurred in September 1915 and September 1947. Isovel patterns for the hurricanes of September 1915(1) and September 1947(2) are shown on plates A-2 and A-3, respectively.

(1) The hurricane of 28 September to 1 October 1915 had a central pressure index (CPI) of 27.87 inches, an average forward speed of 10 knots, and a maximum windspeed[1] of 99 m.p.h. (86 knots) at a radius of 29 nautical miles. This hurricane approached the mainland from the south. At the Lake Borgne entrance to the Rigolets, a high water elevation of about 10 feet m.s.l.[2] was experienced.

(2) The hurricane of 4 to 21 September 1947 had a CPI of 28.57 inches, an average forward speed of 16 knots, and a maximum windspeed of 100 m.p.h. at a radius of 33 nautical miles. The direction of approach of this hurricane was approximately from the southeast. In Lake Borgne, at the entrance of the Rigolets, the maximum water surface elevation was 10 feet.

c. Synthetic storms. Computed flood elevations, resulting from synthetic storms, are necessary for frequency and design computations. Parameters for certain synthetic storms and methods for derivation of others were furnished by the U. S. Weather Bureau. The standard project hurricane (SPH) was used for all locations in the project area changing track and forward speed as appropriate. The probable maximum hurricane (PMH) and moderate hurricane (Mod H) were derived from the SPH and differ from it only in wind velocities and CPI's.

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[1]Windspeeds represent a 5-minute average 30 feet above the water surface unless otherwise indicated.

[2]Mean sea level, the datum to which all elevations are referenced unless otherwise indicated.

(1) The SPH used in the St. Bernard area was derived by the U. S. Weather Bureau from a study of 42 hurricanes that occurred in the region over a period of 57 years. Based on subsequent studies of recent hurricanes, the U. S. Weather Bureau revised the SPH wind field patterns[3][4][5]. Other characteristics of the SPH were not changed. The SPH tracks critical to the St. Bernard area and isovel patterns at the critical hours are shown on plates A-4 and A-5.

(a) The SPH has a frequency of once in 100 years for the Louisiana coastal region. The CPI that corresponds to this frequency is 27.6 inches. CPI probabilities are based on the following relationship[6]:

$$P = \frac{100\ (M-0.5)}{Y}$$

where P = percent chance of occurrence per year
M = number of the event (rank)
Y = number of years of record

(b) Radius of maximum winds is a parameter of hurricane intensity. The average radius of 12 hurricanes occurring in the New Orleans area is 36 nautical miles. From relationships of CPI and radius of maximum winds of gulf coast hurricanes[6], a radius of 30 nautical miles is considered representative for an SPH having a CPI of 27.6 inches.

(c) Different forward speeds are necessary to produce SPH effects at various locations within the study area. An average forward speed of 5 knots was used for the SPH along the west shores of Lake Borgne and Breton Sound.

(d) Maximum theoretical gradient wind[6] is expressed as follows:

$$V_{gx} = 73 \sqrt{P_n - P_o} - R\ (0.575\ f)$$

where V_{gx} = maximum gradient windspeed in miles per hour

P_n = asymptotic pressure in inches

P_o = central pressure in inches

R = radius of maximum winds in nautical miles

F = coriolis parameter in units of $hour^{-1}$

The estimated windspeed (V_x) [7] in region of highest speeds is obtained as follows:

$$V_x = 0.885\ V_{gx} + 0.5T$$

where T = forward speed in miles per hour.

From these relationships, an average windspeed of approximately 100 m.p.h. was obtained for the SPH.

(2) A CPI OF 26.9 inches was recommended for the PMH by the U. S. Weather Bureau[8][9]. A hurricane with this CPI actually occurred at 33° N. latitude. Other synthetic storms of different frequency and CPI are derived from the SPH. With the exception of the PMH, other CPI's for desired frequencies are obtained from the graph shown on plate A-6. V_{gx}'s corresponding to any other CPI are determined similarly by use of the method described for the SPH. Variations in CPI's of historic storms were accomplished by the same procedure[6]. Characteristics of synthetic storms and some historic storms are listed in table A-6.

TABLE A-6

Hurricane Characteristics

Hurricane	CPI inches	Radius of max. winds nautical miles	Forward speed knots	V_x m.p.h.
Sept 1915	27.87	29	10	99
Sept 1947	28.57	33	16	100
Sept 1956	28.76	30	10	80
Sept 1965	27.79	32	20	122
PMH	26.9	30	5	146
SPH	27.6	30	5	100
Mod H	28.3	30	5	83

d. Surges.

(1) Maximum hurricane surge heights for the study area were obtained from computations made for ranges extending from the shore out to the continental shelf by use of a general wind tide formula that is based on the steady state concept of water super-elevation[10][11][12]. In order to reach agreement between computed maximum surge heights and observed high water marks, it was necessary to introduce a calibration coefficient or surge adjustment factor into the general equation which, in its modified form, is as follows:

$$S = 1.165 \times 10^{-3} \frac{V^2 F}{D} N Z \cos \theta$$

where S = wind setup in feet
V = windspeed in statute miles per hour
F = fetch length in statute miles
D = average depth of fetch in feet
θ = angle between direction of wind and the fetch
N = planform factor, generally equal to unity
Z = surge adjustment factor

(2) Water surface elevations along a range were determined by summation of incremental wind setup above the water elevation at the gulf end of the range. The low strip of marshland between Lake Borgne and the gulf was considered already submerged prior to the time of maximum elevation at shore. Initial elevation at the beginning of each range was determined from predicted normal tide and the setup due to atmospheric pressure anomaly. Typical tidal cycles for the project area are shown on plate A-7. An adjustment was made at the shoreward end of the range to compensate for the difference in pressure setup between both ends of the range. This procedure for the determination of surge heights at the coastline was developed for an area along the Mississippi gulf coast where reliable data were available at several locations for more than one severe hurricane. The procedure was then used for the entire coastal Louisiana region. Due to dissimilar shoreline configurations, different surge adjustment factors were required at each location, but identical factors were used at a particular location for each storm. The value of the factor is apparently a function of the distance between the shoreline and deep water and varies inversely with this distance. Comparative computed maximum elevations and observed high water elevations for the locations of the 1915 and 1947 hurricanes that were used in the development of the procedure are shown in table A-7.

TABLE A-7

Hurricane Surge Heights

Location	Surge adjustment factor (Z)	1915		1947	
		Observed	Computed	Observed	Computed
		feet m.s.l.		feet m.s.l.	
Bay St.Louis, Miss.	0.46	11.8	11.8	15.2	15.1
Gulfport, Miss.	0.60	10.2[1]	9.9	14.1	14.3
Biloxi, Miss.	0.65	10.1[1]	9.8	12.2[1]	12.6

[1]Average of several high water marks.

(3) The incremental step computation was used to check experienced maximum hurricane surge heights at several locations within the project area. Verification of these surge heights and the surge adjustment factors used in the computations are shown in table A-8.

TABLE A-8

Verification of Hurricane Surge Heights

Location	Surge adjustment factor	Sep 1915 Observed	Sep 1915 Computed	Sep 1947 Observed	Sep 1947 Computed	Sep 1956 Observed	Sep 1956 Computed
		feet m.s.l.		feet m.s.l.		feet m.s.l.	
Shell Beach	0.30	8.3	8.4	11.2	10.5	10.9	10.7
Violet	0.30	-	-	7.3	7.9	6.5	7.7
Michoud	0.30	11.0	11.4	-	-	-	-
Long Point	0.21	9.8	9.6	10.0	10.1	-	-

(4) Computed surge heights for Hurricane "Betsy," September 1965, at the locations listed in table A-7 and using the same Z factors, averaged about 2.2 feet higher than the observed surge heights. This apparently was the effect of the high forward speed of "Betsy." A fast moving hurricane does not allow enough time for the surge heights to approach the steady state of water super-elevation[10][11][12]. However, it was determined that the Z factors derived from the slow moving hurricanes should be used for design purposes because this type of hurricane is more nearly representative of hurricanes in the project area, and the resulting design elevations are conservative (high).

(5) An example of the setup computation for one increment (ΔF) along a range radiating from the vicinity of Shell Beach for an SPH along Track D at two hours after landfall of the hurricane is as follows:

(a) Initial elevation:

Normal pressure	=	30.14 inches of mercury
Pressure at beginning of range, 80 miles from center	=	29.25 inches of mercury
Deviation from normal pressure	=	0.89 inches of mercury
Pressure setup 0.89 x 1.14 feet	=	1.01 feet of water
Normal predicted tide	=	1.60 feet above mean low water (m.l.w.)
Initial elevation	=	2.61 feet (m.l.w.)

(b) Incremental setup (for setup between adjacent stations on range):

Sta. mile	ΔF miles	V m.p.h.	Cos Θ	V^2Cos Θ	Avg. V^2Cos Θ	Depth feet m.l.w.	D=ΣS+ Av.D+2.61 +ΔS/2	ΔS feet	ΣS feet
3.3		91	0.819	6782		5			11.14
	3.3				6536		16.48	0.46	
0.0		92	0.743	6289		0			11.60

$$s = 1.165 \times 10^{-3} \times \frac{6536 \times 3.3}{16.48} \times 1 \times 0.30 = 0.46'$$

(c) Setup for pressure differential:

Normal pressure	=	30.14 inches of mercury
Pressure at end of range, 34.5 miles from center	=	28.71 inches of mercury
Deviation from normal	=	1.43 inches of mercury
(1.43 x 1.14 feet)	=	1.63 feet of water
Deviation at beginning	=	1.01 feet of water
Differential setup	=	0.62 foot

(d) Final surge height:

Pressure setup at beginning of range	=	1.01 feet
Normal predicted tide	=	1.60 feet m.l.w.
Correction m.l.w. to m.s.l.	=	-0.60 foot
S (wind setup)	=	11.60 feet
Pressure differential setup	=	0.62 foot
Surge height at shore	=	14.23 feet m.s.l.

(6) The storms under consideration are accompanied by strong winds. The average windspeed and average depth were determined from isovel and hydrographic charts for each surge computation. The storm isovel patterns were furnished by the U. S. Weather Bureau[13][14][15].

(7) Surge heights for the Standard Project Hurricane were computed for Shell Beach and Yscloskey, respectively. These heights represent the range of surge expected for the study area, and are shown in table A-9.

TABLE A-9

Surge Heights for Standard Project Hurricane

Range	Track	Surge adjustment factor	Time[1] to maximum surge hours	Maximum surge height feet
Yscloskey	C	0.48	+4	15.1
Shell Beach	D	0.30	+2	14.2

[1]Referenced to landfall

e. Wave runup.

(1) Wave runup on a protective structure depends on the characteristics of the structure (i.e., shape and roughness), the depth of water at the structure, and the wave characteristics. The vertical height to which water from a breaking wave will run up on a given protective structure determines the top elevation to which the structure must be built to prevent wave overtopping and resultant flooding of the area to be protected. Wave runup is considered to be the ultimate height to which water in a wave ascends on the proposed slope of a protective structure. This condition usually occurs when the surge is at the maximum elevation.

(2) The parameters which determine wave characteristics are the fetch length, the windspeed, duration of wind, and the average depth of water over the fetch. In determining the design wave characteristics, it was assumed that steady state conditions prevail; that is, the windspeed is constant in one direction over the fetch and blows long enough to create a fully developed sea. The windspeed (U) is an average velocity over the fetch (F) and is obtained from the isovel patterns for synthetic hurricanes critical to the levee locations. The depth of fetch (d) is the average surge height minus the average elevation of prominent topographic features over the fetch. The average elevation of the top of marsh grass[16] was taken as the prominent feature. This resulted in decreasing the effective depth of fetch.

(3) In order to compute wave runup on a protective structure, the significant wave height (H_s) and wave period (T) in the vicinity of the structure must be known. They were determined according to Bretschneider[17] and as described in paragraph 1.25 of reference[18]. The windspeed and depth used in determining H_s and T are average values over a 5-mile fetch. Data used to determine design hurricane wave characteristics in the vicinity of the protective structures are shown in table A-10.

TABLE A-10

Data Used to Determine Wave Characteristics
for Design Hurricane

Parameters	Levee location	
	Yscloskey	Shell Beach (MR-GO)
F - Length of fetch, in miles	5	5
U - Windspeed in m.p.h.	84	89
swl - Stillwater level, in feet	13.9	13.3
d - Average depth of fetch, in feet	8.8[1]	15.6
d_t - Depth at toe of levee, in feet	9.4	11.3

[1]Marsh grass plus natural ground = 4.0'

(4) Wave runup was calculated by use of model study data developed by Saville[19][20][21][22] which relate relative runup (R/H_o'), wave steepness (H_o'/T^2), and relative depth (d/H_o'). The significant wave height (H_s) and wave period (T) can be determined from the data in table A-10. The deep water wave length (L_o) is determined from the equation:

$$L_o = 5.12\ T^2$$

The equivalent deep water wave height (H_o') can be determined from table D-1 of reference [18], which relates d/L_o to H/H_o'. When determining runup from the significant wave, H in the term (H/H_o') is equal to H_s.

(5) With the terms d/H_o' and H_o'/T^2 known, runup on a protective structure can be computed if the slope of the structure is known. The levee configurations used in these computations had stabilizing berms on the water side (see plate A-8). These berms broke the continuity of the levee slope and Saville's[22] method of determining wave runup on composite slopes was used (see plate A-9). In using this method, the actual composite slope is replaced by a hypothetical single constant slope. This hypothetical slope is computed by estimating a value of wave runup and then determining the slope of a line from the point where the wave breaks to the estimated point of runup. The breaking point may be located by subtracting the breaking depth d_b from the still water elevation and extending the resulting elevation horizontally to intersect the composite slope. The breaking depth is determined from the equation:

$$d_b = \frac{0.667\ H_o'}{(H_o'/T^2)1/3}$$

Using the slope of this line, which is the hypothetical slope, a value of runup is determined. If the value of runup determined is different from the estimated runup, the process is then repeated using the new value of runup to obtain a new hypothetical slope, which, in turn, determines a new value of runup. This process is repeated until the estimated value of runup agrees with the computed value of runup.

(6) Protective structures exposed to wave runup will be constructed to an elevation that is sufficient to prevent all overflow from the significant wave and waves smaller than the significant wave accompanying the design hurricane. Waves larger than the significant wave will be allowed to overtop the protective structures but such overtopping will not endanger the security of the structures or cause excessive interior flooding. During the time of maximum surge height, the berms on the water side of the levees become submerged and waves of lesser height than the significant wave, but of the same period, break farther up the levee slope. Sometimes runup from these smaller waves reach an elevation higher than that from the significant wave; therefore, runup resulting from these smaller waves must also be computed. The equivalent deep water wave height for the smaller waves breaking on the berms was computed by the equation:

$$H_o' = \frac{1.84}{T} \quad (d_b)^{3/2}$$

Runup was computed for the significant wave and for smaller waves breaking on each berm and the required levee height was determined by adding the highest computed runup value to the maximum stillwater elevation. Wave characteristics used in computing runup from the significant wave and smaller waves are shown in table A-11.

TABLE A-11

Wave Characteristics - Design Hurricane

Characteristic	Levee location (Bayou La Loutre) Yscloskey	Shell Beach (MR-GO)
H_S - Significant wave height, in feet	3.90	6.30
T - Wave period, seconds	4.80	6.20
L_o - Deep water wave length, in feet	118.0	196.8
D/L_o - Relative depth	0.07458	0.07926
H_S/H'_o - Shoaling coefficient	0.9631	0.9558
H'_o - Deep water wave height, in feet	2.95	2.20
H'_o/T^2 - Wave steepness	0.128	0.570

f. Residual flooding. Protective structures were designed to prevent wave overtopping from the significant or any lower wave that would be experienced during an occurrence of the design hurricane. However, 14 percent of the waves in a spectrum are higher than the significant wave and the maximum wave height to be expected is about 1.87 times the significant wave height. Thus, the protective structures therein will be overtopped by those waves of the spectrum which exceed the significant wave. Studies indicate that no significant flooding will result from such overtopping.

4. FREQUENCY ESTIMATES

a. Procedure.

(1) Prior to 1900, information of record dealt primarily with loss of life and damage in the more densely populated areas, with practically no reference to water surface elevations caused by hurricanes. Only since 1900 has detailed information been available on flooding in coastal Louisiana and adjacent areas. Subsequent to the widely destructive September 1915 hurricane, Charles W. Okey, Senior Drainage Engineer, Office of Public Roads and Rural Engineering, U. S. Department of Agriculture, made a thorough survey of the coastal areas between Biloxi, Mississippi, and Palacios, Texas. The 1915 investigation is the only known area-wide study containing reliable stages prior to the investigation of Hurricane "Flossy", September 1956. The data indicate that there is no locality along the Louisiana coast which is more prone to hurricane attack than other localities.

(2) A procedure was developed to establish synthetic stage-frequency relationships for the study area. The only location within the project area where a sufficient number of observed hurricane stages

are available to compute a dependable observed stage-frequency curve for comparison with the results of the synthetic method of computing frequencies is Shell Beach. Probabilities for historical data on the curve shown on plate A-10 were calculated by means of the formula:

$$P = \frac{100\ (M - 0.5)}{Y}$$ (see Par. A-3c(1)(a))

(3) The first requirement in the development of synthetic frequency relationships for localities within the project area was to select representative critical hurricane tracks for the particular locale in question. Track C (shown on plates A-4 and 11) is the critical path for tidal surges in the study area from the Breton Sound area. Track D (shown on plates A-5 and 11) is the critical path for tidal surges in the study area from Lake Borgne.

(4) Surge heights were then developed for at least three storms of different CPI values for each track. Each hurricane selected for the representative tracks was assumed to have the same radius of maximum winds, the same speed of translation, and the same adjustment for any land effects. Conversion of wind fields of hurricanes of different CPI's requisite to computing surge heights is covered in paragraph A-3c(2). Surge elevations for storms with other CPI values were obtained graphically by plotting the above data and reading from the resulting curves.

(5) Hurricane characteristics of area-representative storms were developed in cooperation with the U. S. Weather Bureau. This agency made a generalized study of hurricane frequencies for a 400-mile zone along the central gulf coast, Zone B, from Cameron, La., to Pensacola, Fla., and presented the results in a memorandum(6). Frequencies for hurricane central pressure indexes that were presented in the report, as shown on plate A-6, reflect the probability of hurricane recurrence from any direction in the midgulf coastal area. In order to establish frequencies for the localities under study, it was assumed that a hurricane whose track is perpendicular to the coast will ordinarily cause high tides and inundation for a distance of about 50 miles along the coast. Thus, the number of occurrences in the 50-mile subzone would be 12.5 percent of the number of occurrences in the 400-mile zone, provided that all hurricanes traveled in a direction normal to the coast. However, the usual hurricane track is oblique to the shoreline as shown in table 2 of the HMB memorandum(6). The average projection along the coast of this 50-mile swath for the azimuths of 42 Zone B hurricanes is 80 miles. Since this is 1.6 times the width of the normal 50-mile strip affected by a hurricane, the probability of occurrence of any hurricane in the 50-mile subzone would be 1.6 times the 12.5 percent, or 20 percent of the probability for the entire midgulf Zone B. Thus, 20 percent of the Zone B frequencies shown on plate A-6 was used to represent the CPI frequencies in the 50-mile subzone that is critical for each study locality.

(6) The azimuths of tracks observed in the vicinity of landfall were divided into quadrants corresponding to the four cardinal points. In Zone B, 24 tracks were from the south, 14 from the east, 3 from the west, and 1 from the north. Hurricanes with tracks having major components from the southeast, south, and southwest generate critical or near-critical surges for the study area. Hurricanes having tracks approaching between azimuths of 90° and 220° were selected and used to develop a curve representing a synthetic probability of stages for hurricanes approaching from these directions. Thirty-eight Zone B hurricane tracks are evident between the azimuths selected, and, therefore, 90 percent of the frequencies of hurricanes in the critical 80-mile subzone was used for probabilities. Tracks C and D used in computing surge heights for Yscloskey (south of La. Hwy. 46) and Shell Beach (north of La. Hwy. 46), respectively, had asimuths which fell within the 90° to 220° limits.

(7) Table A-12 illustrates the synthetic frequency computations for Track C (Yscloskey) and Track D (Shell Beach).

TABLE A-12

Stage-Frequency South and North of La. Hwy. 46

			TRACK C South of La. Hwy.46		TRACK D North of La.Hwy.46	
CPI in.	Zone B occ/100 yrs.	80 mi.Subzone occ/100 yrs.	WTL ft. m.s.l.	Freq[1] (90% Col.3) occ/100 yrs.	WTL ft. m.s.l.	Freq[1] (90% Col.3) occ/100 yrs.
27.6	1	0.2	15.1	0.18	14.2	0.18
27.8	2	0.4	14.5	0.36	13.7	0.36
28.3	10	2.0	12.3	1.80	11.8	1.80
29.0	40	8.0	8.2	7.20	8.2	7.20

[1] Freq. = $\frac{100}{\text{Return period in years}}$

(8) Since there were no observed hurricane stages available at Yscloskey to compute a dependable stage-frequency curve, the shape of the Shell Beach experienced frequency curve was used to finalize the frequency curves for south and north of La. Hwy. 46. These curves are shown on plate A-12.

(9) It was assumed that for other localities within the study area, a Zone B hurricane of a particular frequency would have the same recurrence period for any locale in the area since all are within the same subzone.

b. Relationships. Based on the above described procedures, elevation-frequency relationships were established for the areas north and south of La. Hwy. 46.

5. DESIGN HURRICANE

a. Selection of the design hurricane. The area under study is adjacent to an already authorized hurricane protection project. This report is a study of the feasibility of extending the same degree of protection to the communities of Hopedale, Reggio, Yscloskey, and Shell Beach, La. Therefore, a hurricane with an estimated return frequency of once in 200 years and capable of producting stages approximately equal to those of the design hurricane of the adjacent authorized project was chosen as the design hurricane (Des H). Selection of hurricane of lesser intensity which would require a lower levee grade and a greater frequency of occurrence would expose both protected areas to hazards to life and property that would lower the total degree of protection and would be disastrous in the event of the occurrence of a hurricane of the intensity and destructive capability of the Des H.

b. Characteristics. The central pressure of the Des H's for the proposed plan of protection is 27.9 inches of mercury. Hurricanes approaching from a southerly direction are most critical to both Yscloskey or the area below La. Hwy. 46, and Shell Beach or the area above La. Hwy. 46. The tracks of the Des H's were located successively along the length of the proposed protective structures. Although the Des H's are actually theoretical, they represent hurricanes of similar intensities that have been experienced in the past. The maximum wind velocity is 94 m.p.h. at a radius of 30 nautical miles from the storm center with a forward speed of 5 knots. Table A-13 gives a summary of the Des H characteristics.

TABLE A-13

Design Hurricane Characteristics

Location	CPI inches	Max winds m.p.h.	Radius of max. winds naut.miles	Forward speed knots	Direction of approach	Track
Yscloskey	27.9	94	30	5	SE	C
Shell Beach	27.9	94	30	5	SW	D

c. Normal predicted tides. The average tidal ranges in Lake Borgne and Breton Sound are 1.0 ft. and 1.5 ft., respectively. The average elevation of the two bodies of water differs very little. In determining the elevation of design surges, the mean normal predicted tide was assumed to occur at the critical hour.

d. Design tide. The hurricane surge height is the maximum stillwater surface elevation experienced at a given location during the passage of a hurricane. It reflects the combined effects of the hurricane surge, and where applicable the overland flow of the surge. Design surges were computed for conditions reflecting proposed protective works or improvements. The resultant elevations are the same for existing or project conditions in the study area. Design hurricane surge heights are shown in table A-14.

e. Design waves and runup. Hurricane surges and tides usually are accompanied by violent wave action at the coastline and in unprotected bays. As the surge moves inland over marshlands and natural ridges, the waves deteriorate rapidly, and wave heights are attenuated by thick growths of marsh grasses. In summer and fall, when hurricanes are most likely to occur, these grasses reach heights of from 3 to 4 feet above ground. Therefore, effective depth, used in forecasting wave heights and computing runup on levees located along marshland was considered equal to the difference in elevations between surge height and the top of the marsh grass[16]. Wave heights were then computed using the procedures described in paragraph A-3d. The entire length of the proposed protective works for the study area is vulnerable to wave action. A freeboard allowance equal to the design wave runup in feet above the surge height or stillwater elevation was considered sufficient to prevent serious overtopping of the exposed levees. Wave data, runup elevations, and required elevations of protective structures are shown in table A-14.

TABLE A-14

Wave Runup and Proposed Elevations of Protective Structures for Design Hurricane

Location	Average depth ft.	H_S ft.	T sec.	Surge height ft.,m.s.l.	Wave runup ft.	Levee grade ft.,m.s.l.
Above La. Hwy. 46 (Shell Beach)	15.6	6.30	6.20	13.3	6.4	19.5
Below La. Hwy. 46 (Yscloskey)	8.8	3.90	4.80	13.9	5.3	19.0

f. Design rainfall. Hurricanes usually are accompanied by intense rainfalls. The mean 24-hour maximum point precipitation depth is 9.4 inches, based on data available on over 50 gulf region hurricanes[23][24]. Complete precipitation records, including but not limited to hurricane induced rainfall, indicate maximum 24-hour point depths of 21 inches for a standard project rainfall and 40 inches for the probable maximum rainfall. Estimates of point depth

precipitation likely to be experienced with a standard project hurricane are 14 inches for moderately high and between 8.6 and 9.8 inches for moderate rainfalls. A moderate hurricane rainfall of 9.4 inches in 24 hours, based on the observed average value, was used in the determination of residual damages for hurricanes, both under present conditions and after construction of the project.

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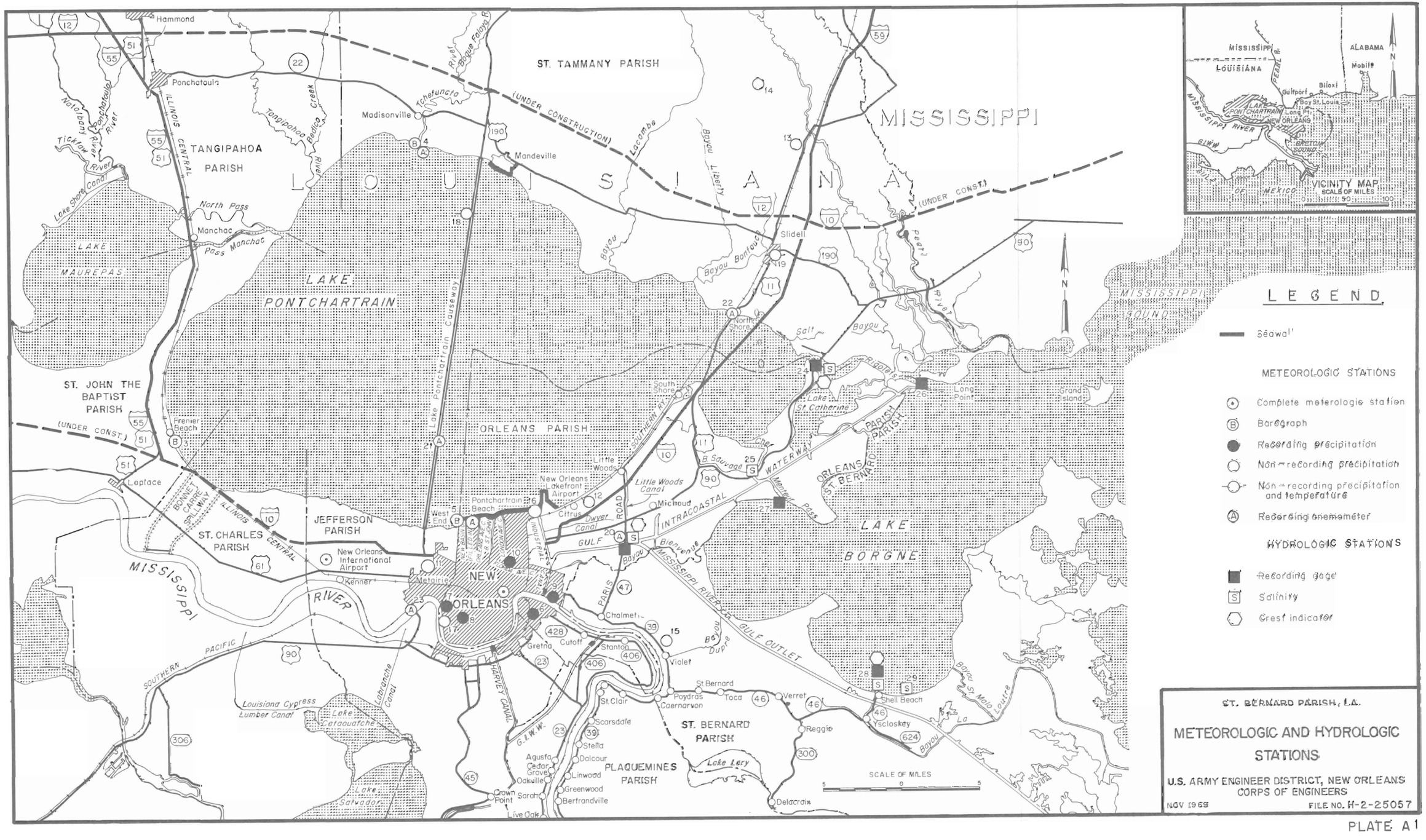


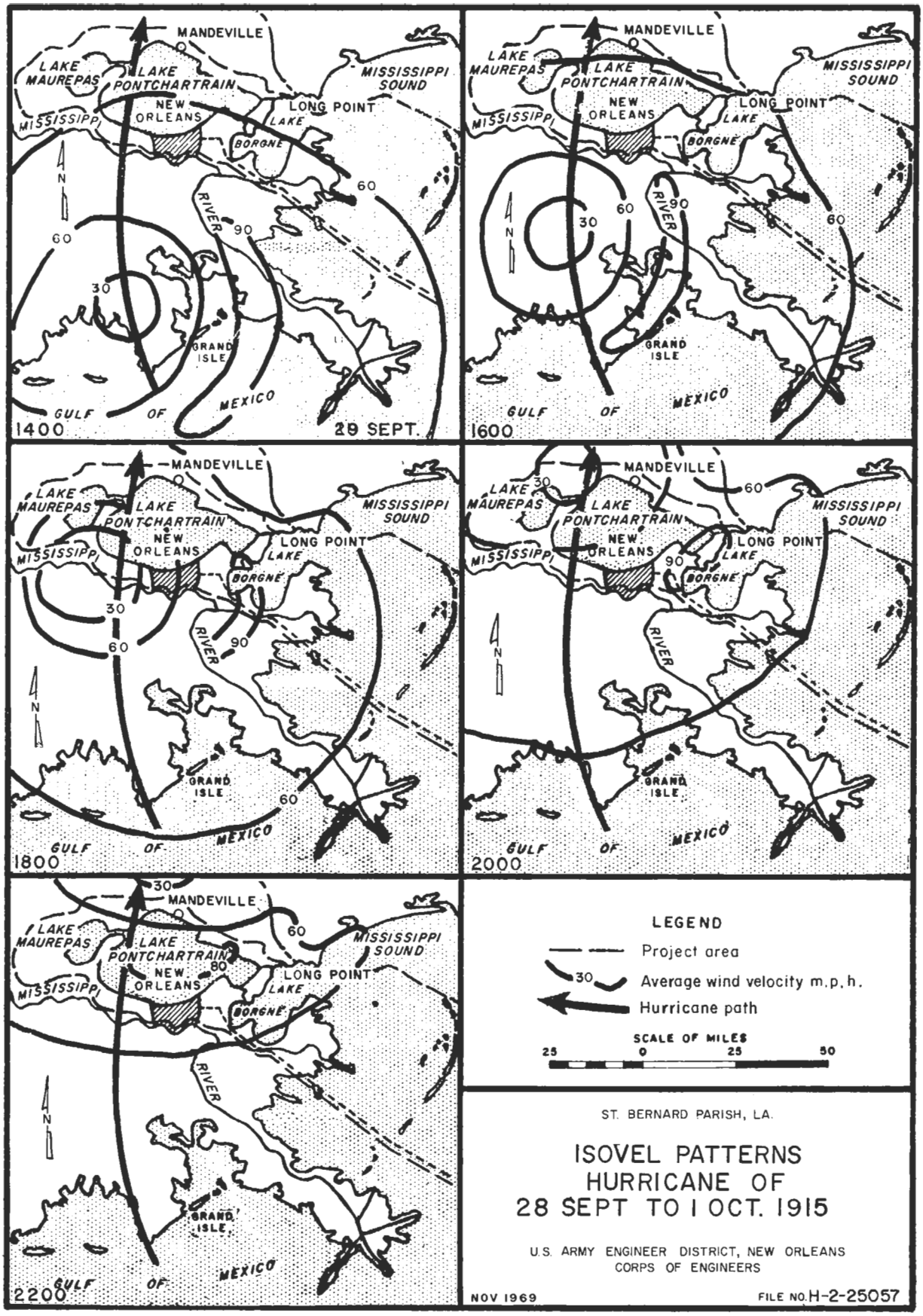
ST. BERNARD PARISH, LA.

METEOROLOGIC AND HYDROLOGIC STATIONS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

NOV 1968 FILE NO. H-2-25057

PLATE A1



LEGEND

Project area

30 Average wind velocity m.p.h.

Hurricane path

SCALE OF MILES

25 0 25 50

ST. BERNARD PARISH, LA.

ISOVEL PATTERNS HURRICANE OF 28 SEPT TO 1 OCT. 1915

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969

FILE NO. H-2-25057

PLATE A2

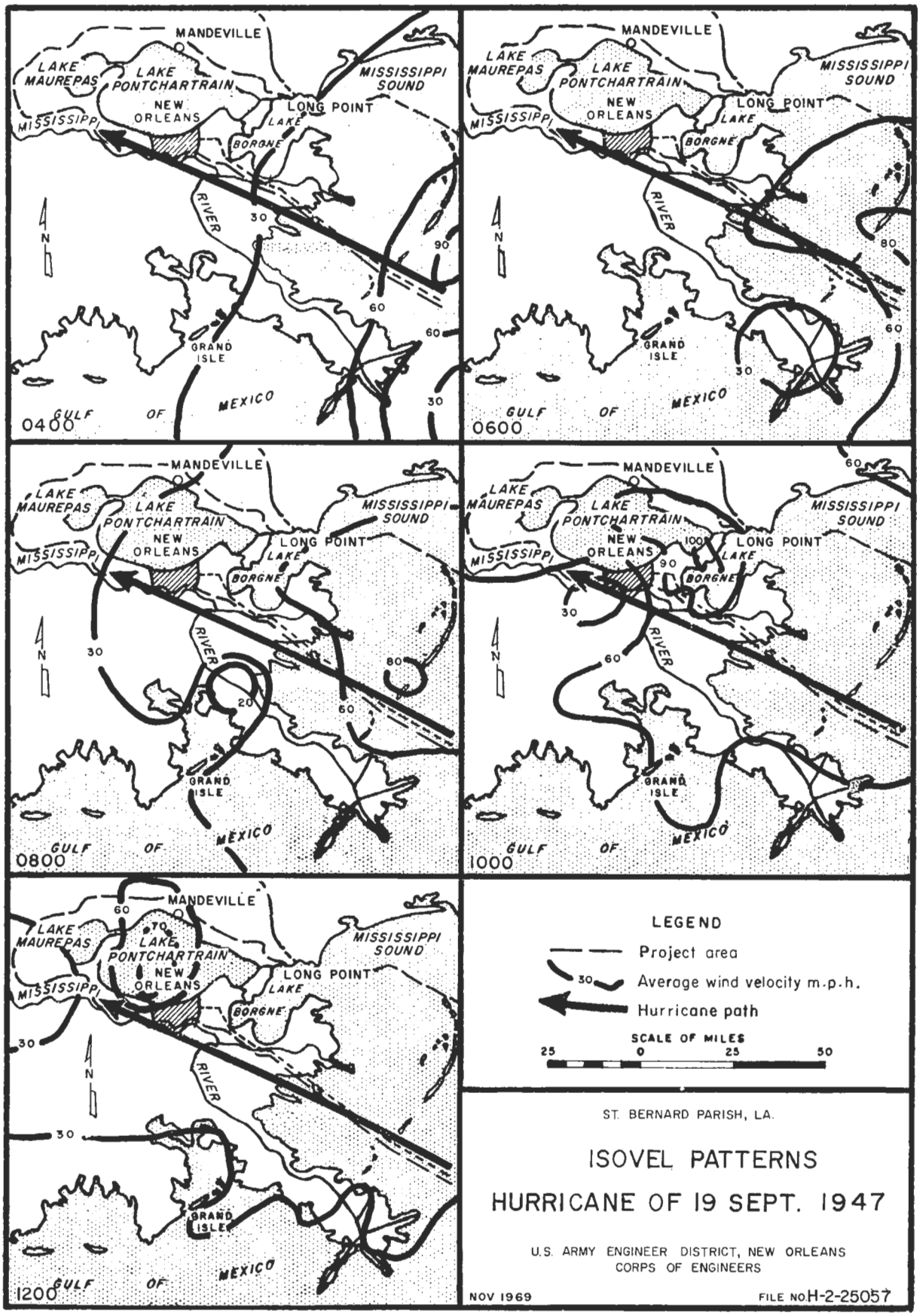
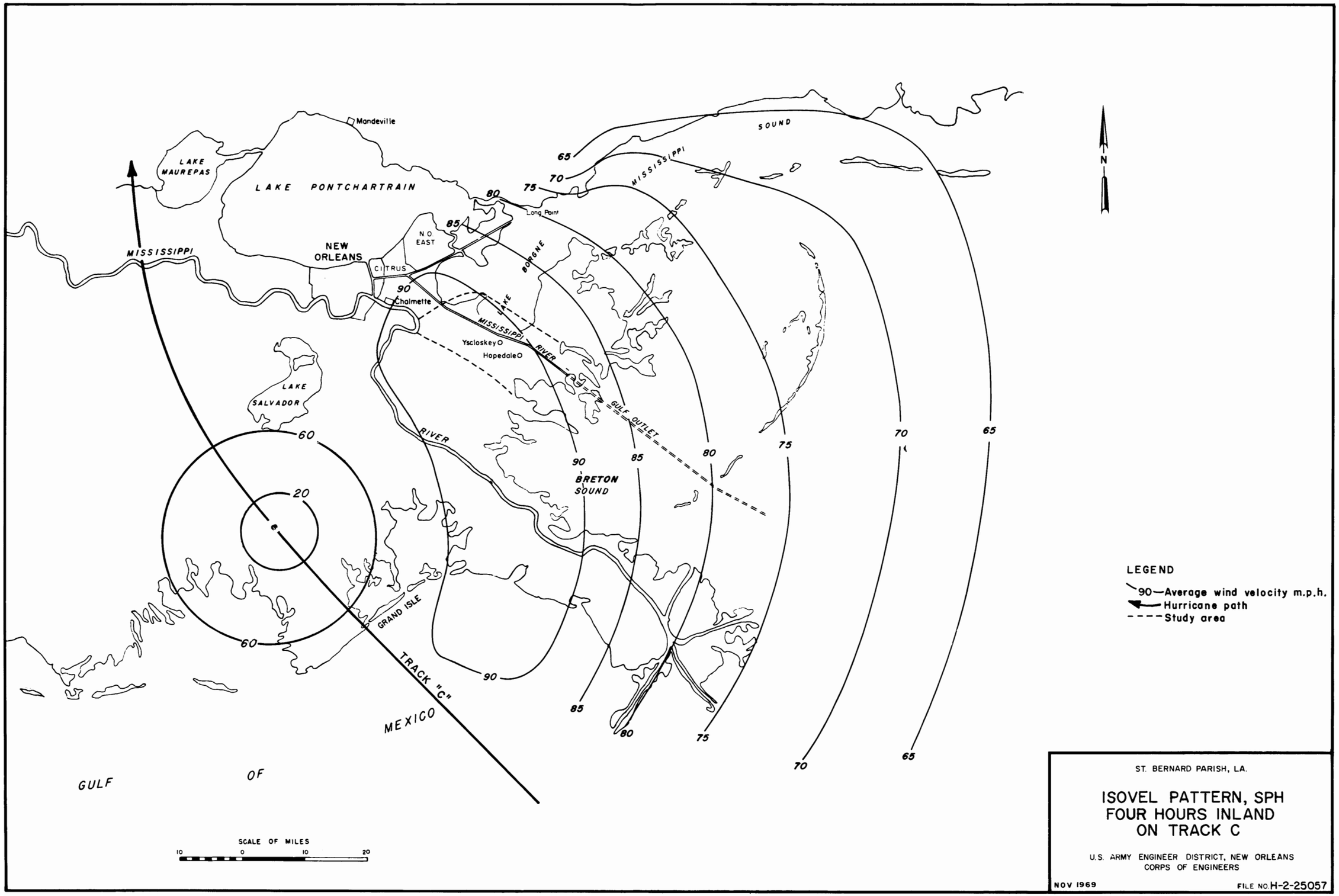

MANDEVILLE
LAKE MAUREPAS
LAKE PONTCHARTRAIN
MISSISSIPPI SOUND
NEW ORLEANS
LONG POINT
MISSISSIPPI
LAKE BORGNE
RIVER
GRAND ISLE
GULF OF MEXICO
0400
0600
0800
1000
1200
LEGEND
Project area
Average wind velocity m.p.h.
Hurricane path
SCALE OF MILES
25 0 25 50
ST. BERNARD PARISH, LA.
ISOVEL PATTERNS
HURRICANE OF 19 SEPT. 1947
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NOV 1969
FILE NO. H-2-25057

PLATE A3



ST. BERNARD PARISH, LA.

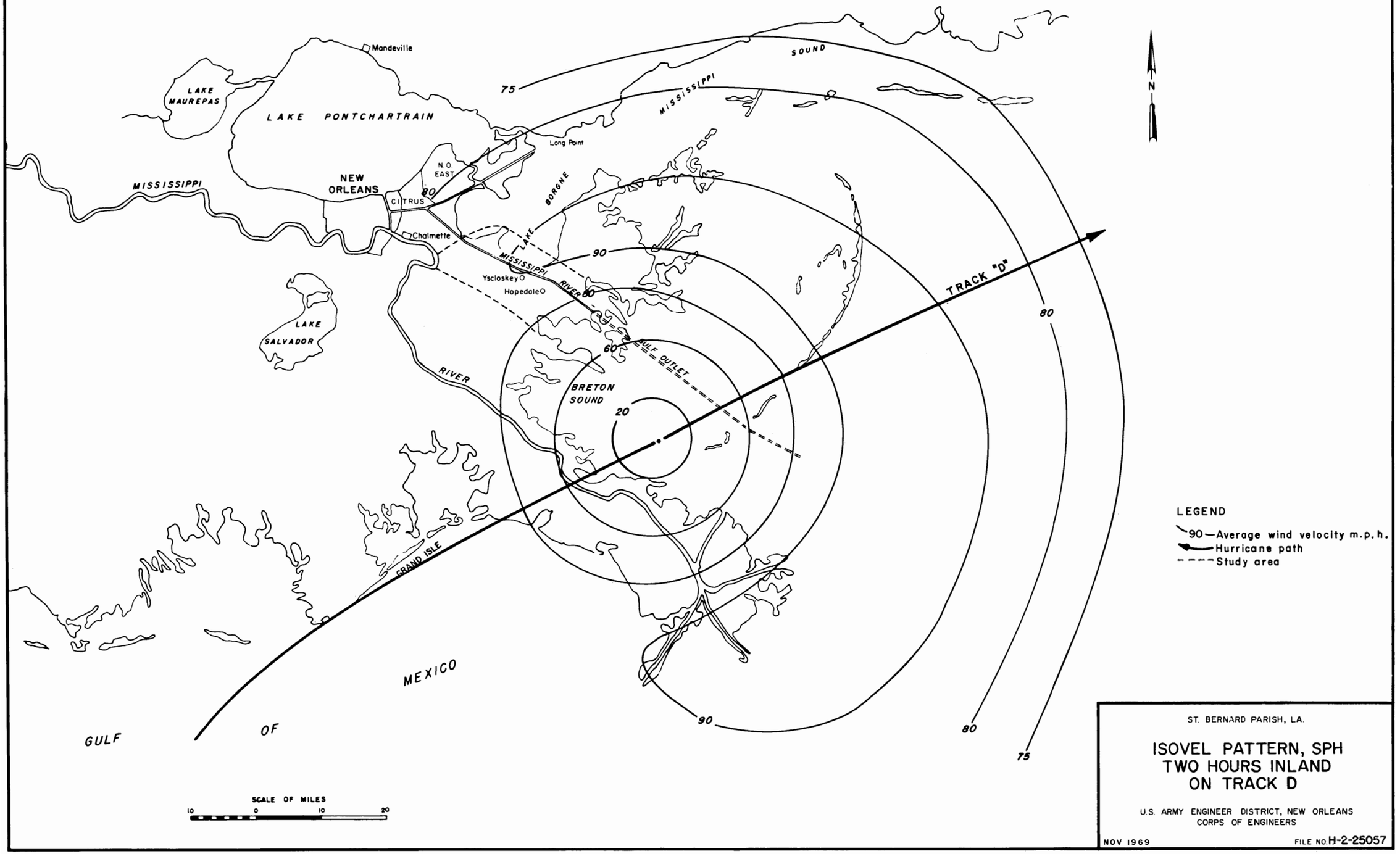
ISOVEL PATTERN, SPH FOUR HOURS INLAND ON TRACK C

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969

FILE NO. H-2-25057

PLATE A4



ST. BERNARD PARISH, LA.

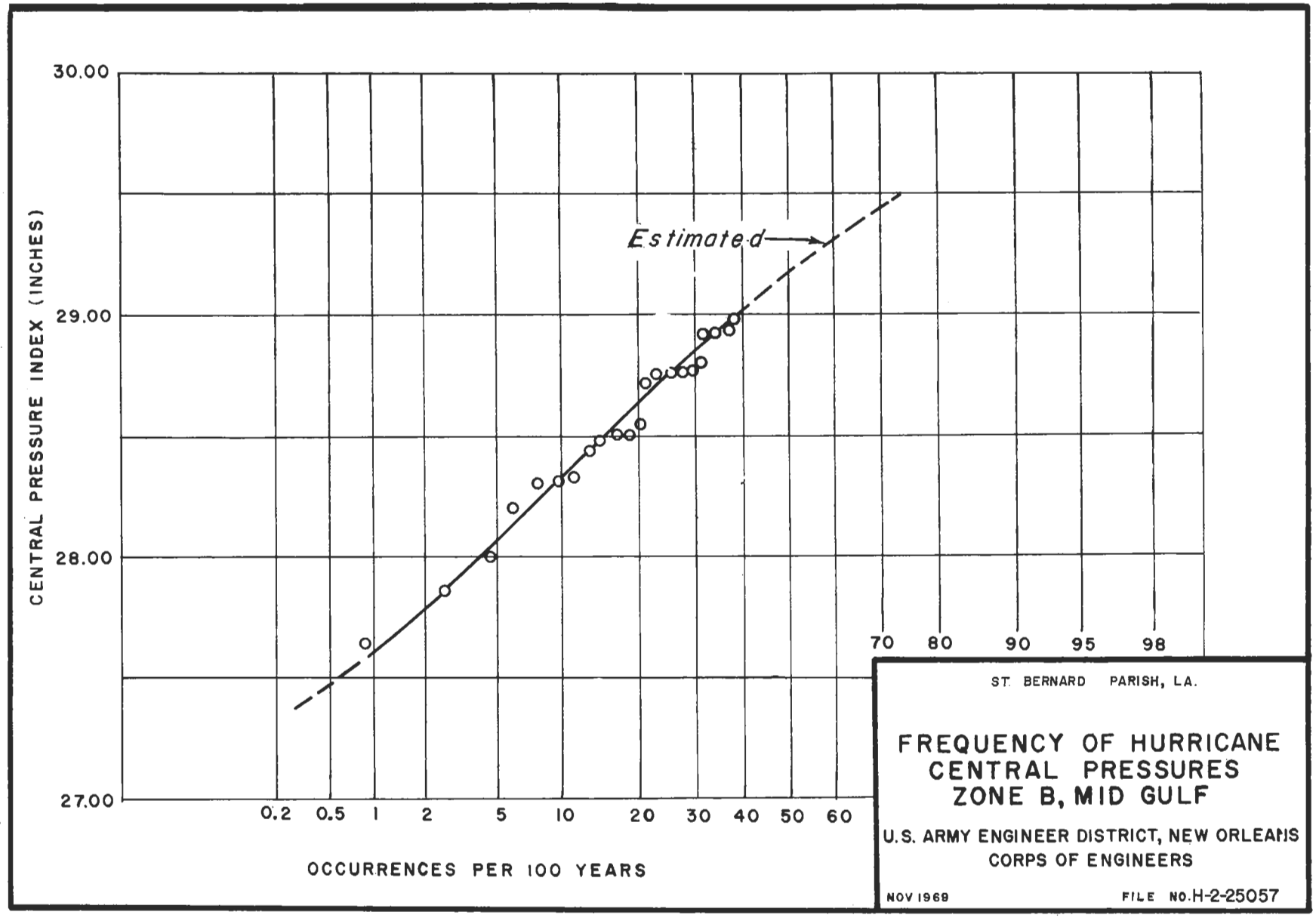
ISOVEL PATTERN, SPH TWO HOURS INLAND ON TRACK D

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969

FILE NO. H-2-25057

PLATE A5



ST. BERNARD PARISH, LA.

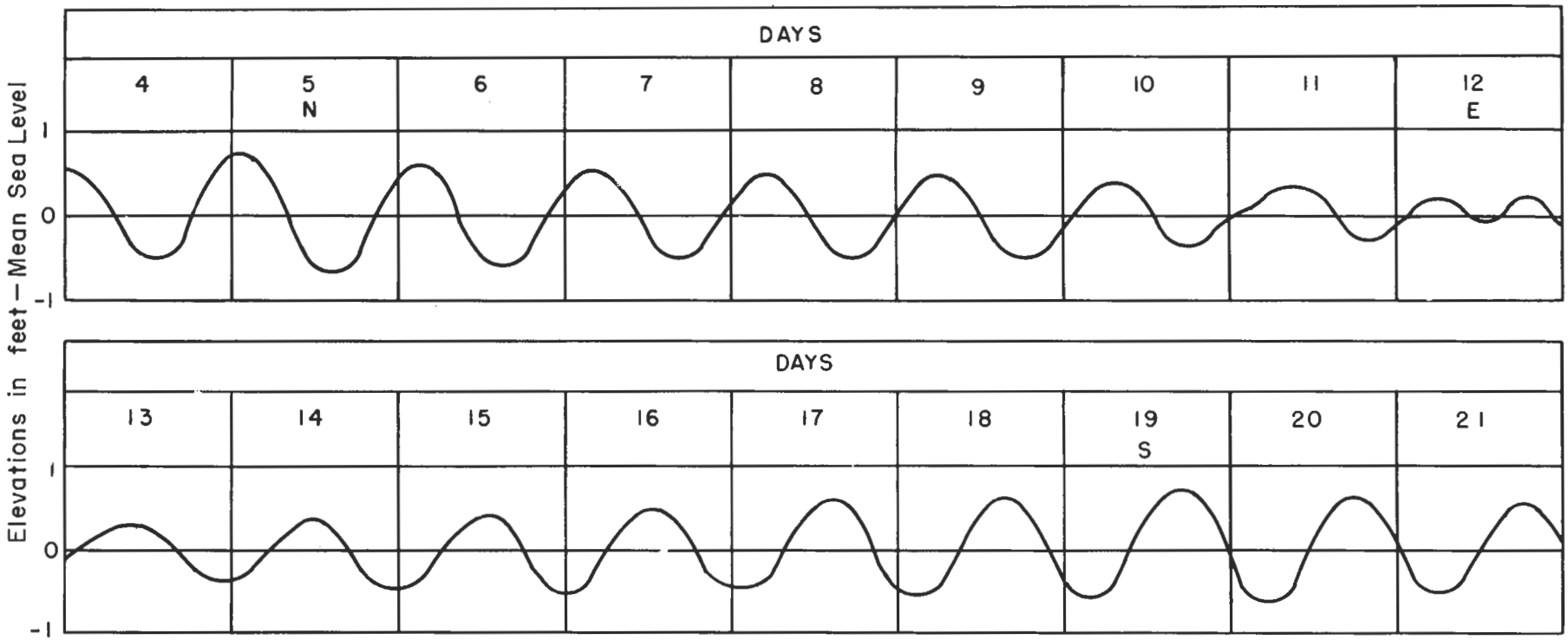
FREQUENCY OF HURRICANE CENTRAL PRESSURES ZONE B, MID GULF

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969 FILE NO. H-2-25057

PLATE A6

PLATE A6



LEGEND

E, moon on the equator
N, S, moon farthest north or south of the equotor

ST. BERNARD PARISH, LA.

TYPICAL TIDAL CYCLES LAKE BORGNE AND BRETON SOUND

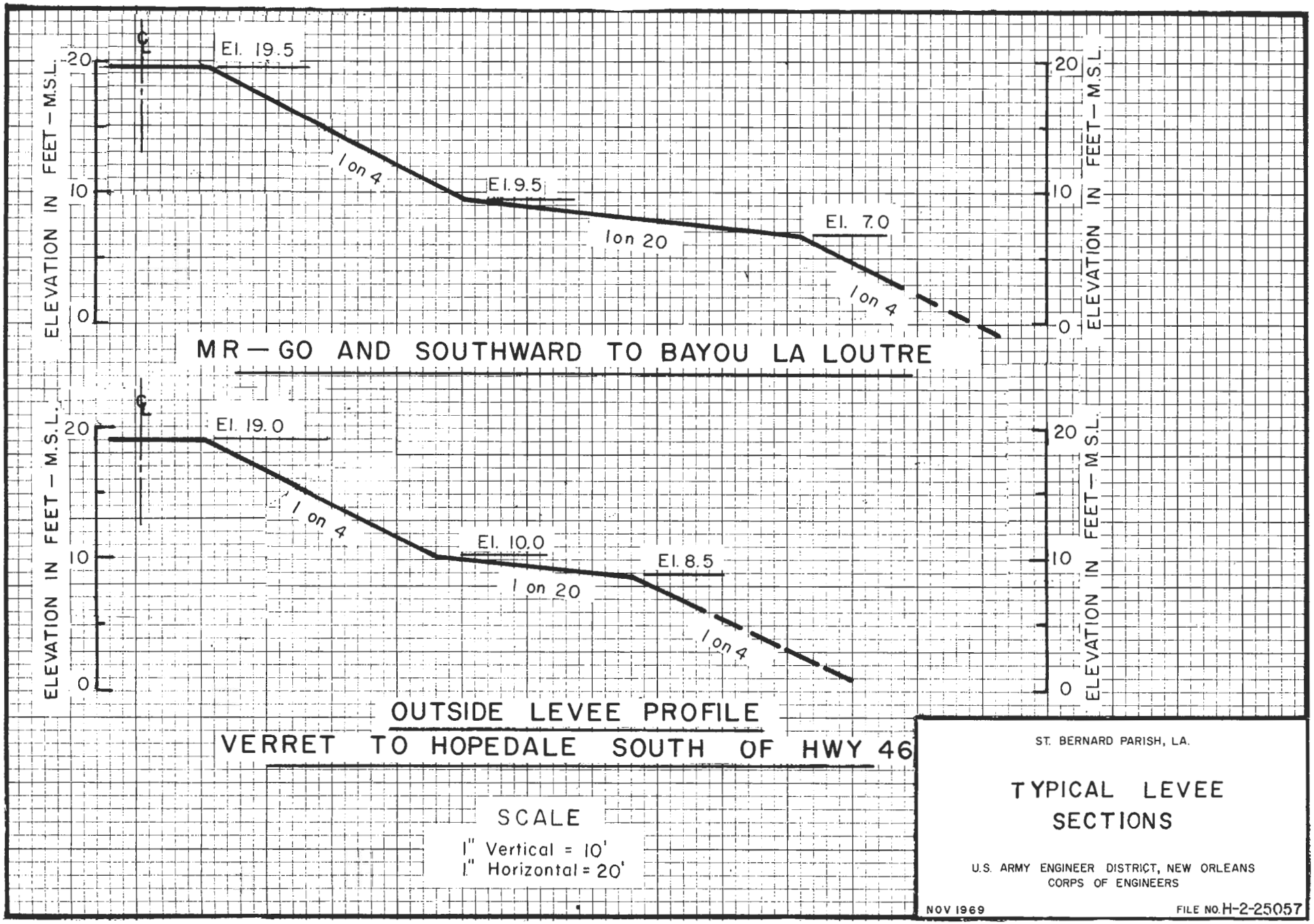
U.S. ARMY ENGINEER DISTRICT NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969

FILE NO. H-2-25057

PLATE A7

PLATE A7



ST. BERNARD PARISH, LA.

TYPICAL LEVEE SECTIONS

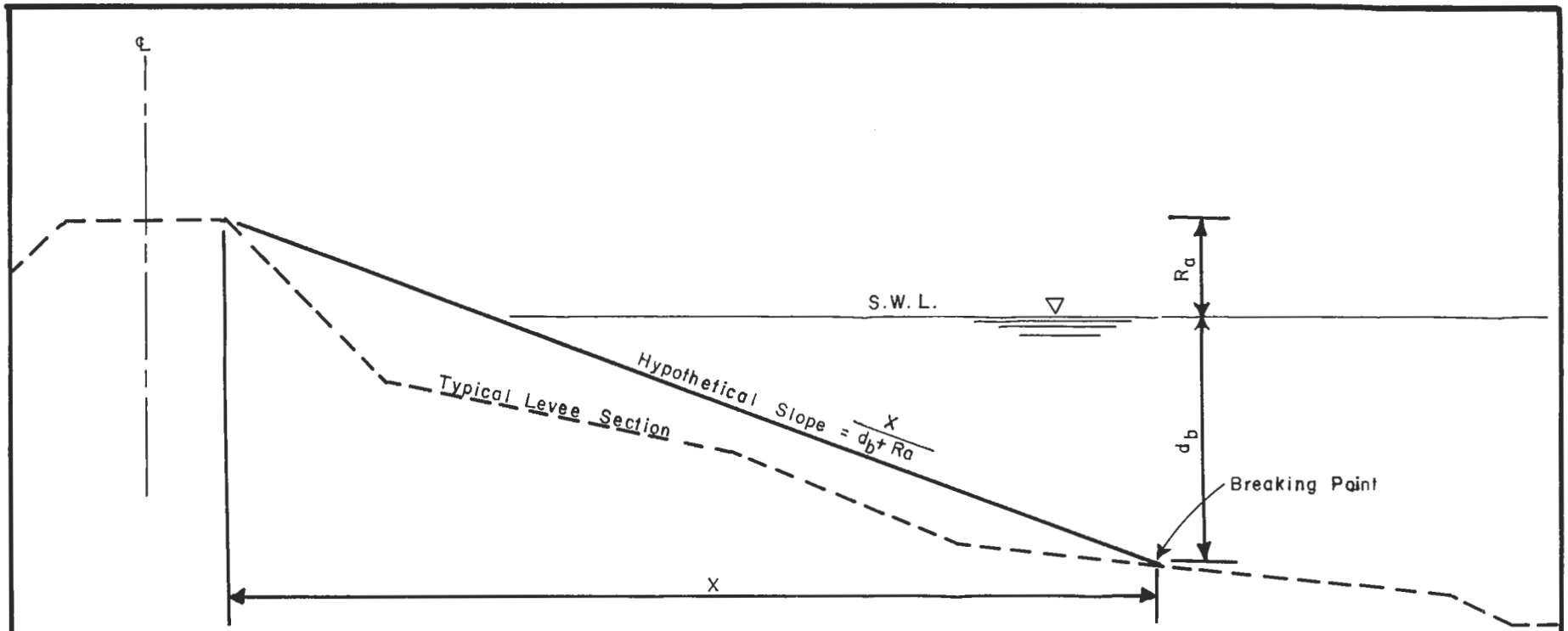
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969

FILE NO. H-2-25057

PLATE A8

PLATE A8



LEGEND

R_a = assumed runup

d_b = breaking depth of wave

X = horizontal distance from breaking point to elevation at runup

S.W.L.= stillwater level

ST. BERNARD PARISH, LA.

DETERMINATION OF HYPOTHETICAL SLOPE

U.S. ARMY ENGINEER DISTRICT NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969

FILE NO. H-2-25057

PLATE A9

PLATE A9

ST. BERNARD PARISH RESTUDY

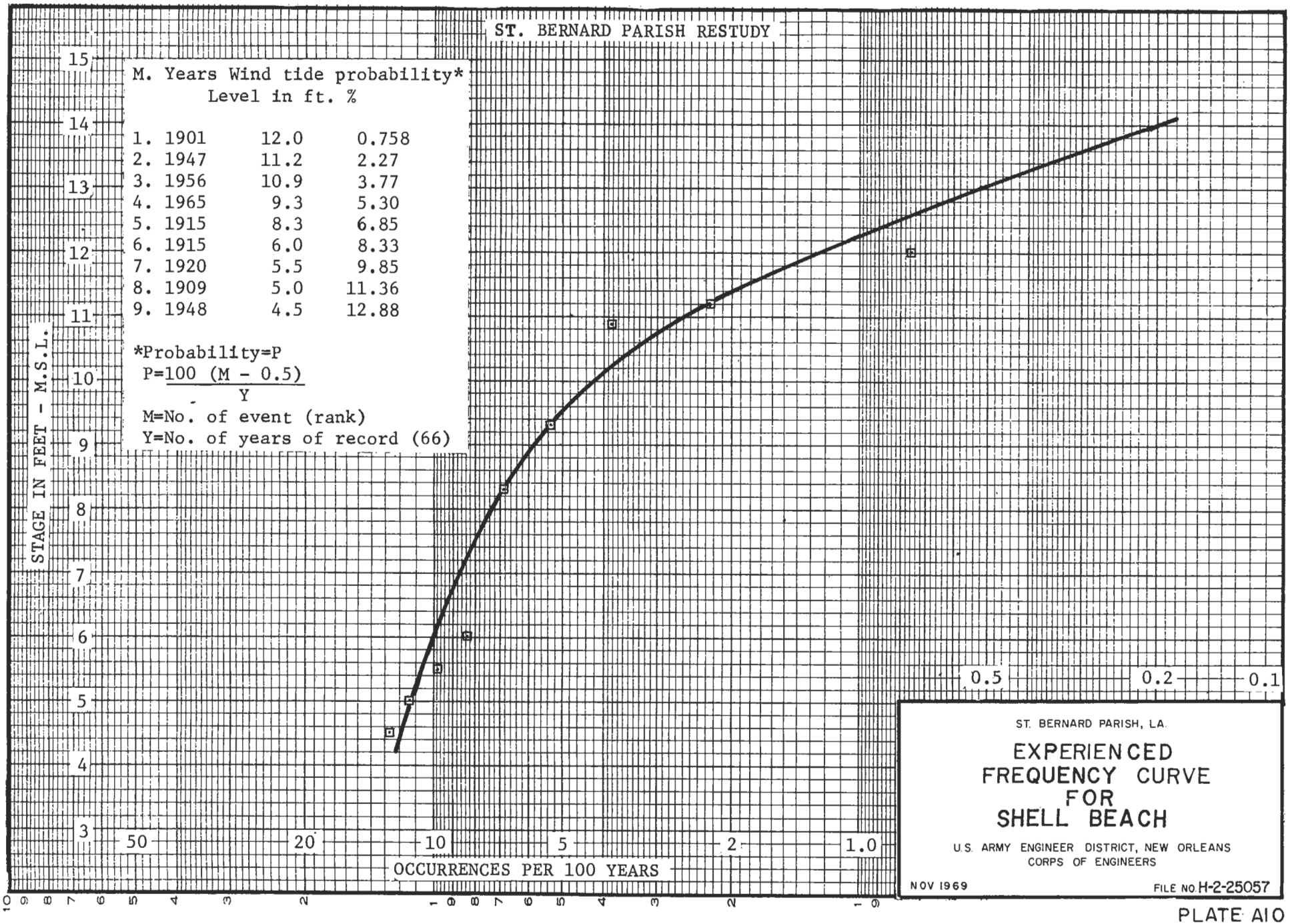
M.	Years	Wind tide Level in ft.	probability* %
1.	1901	12.0	0.758
2.	1947	11.2	2.27
3.	1956	10.9	3.77
4.	1965	9.3	5.30
5.	1915	8.3	6.85
6.	1915	6.0	8.33
7.	1920	5.5	9.85
8.	1909	5.0	11.36
9.	1948	4.5	12.88

*Probability=P

$$P=\frac{100\ (M - 0.5)}{Y}$$

M=No. of event (rank)

Y=No. of years of record (66)



ST. BERNARD PARISH, LA.

EXPERIENCED FREQUENCY CURVE FOR SHELL BEACH

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969

FILE NO. H-2-25057

PLATE A10

PLATE A10

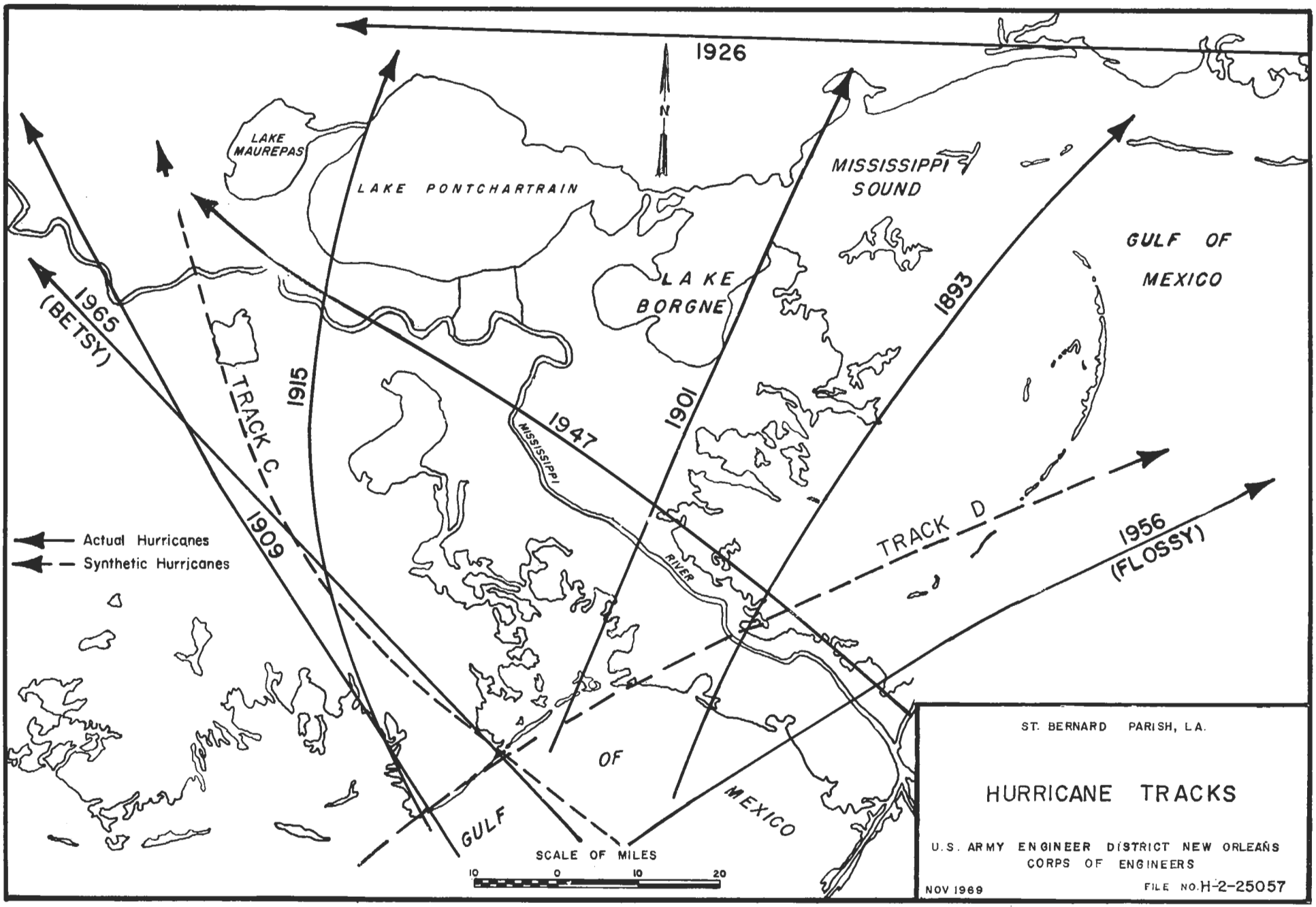
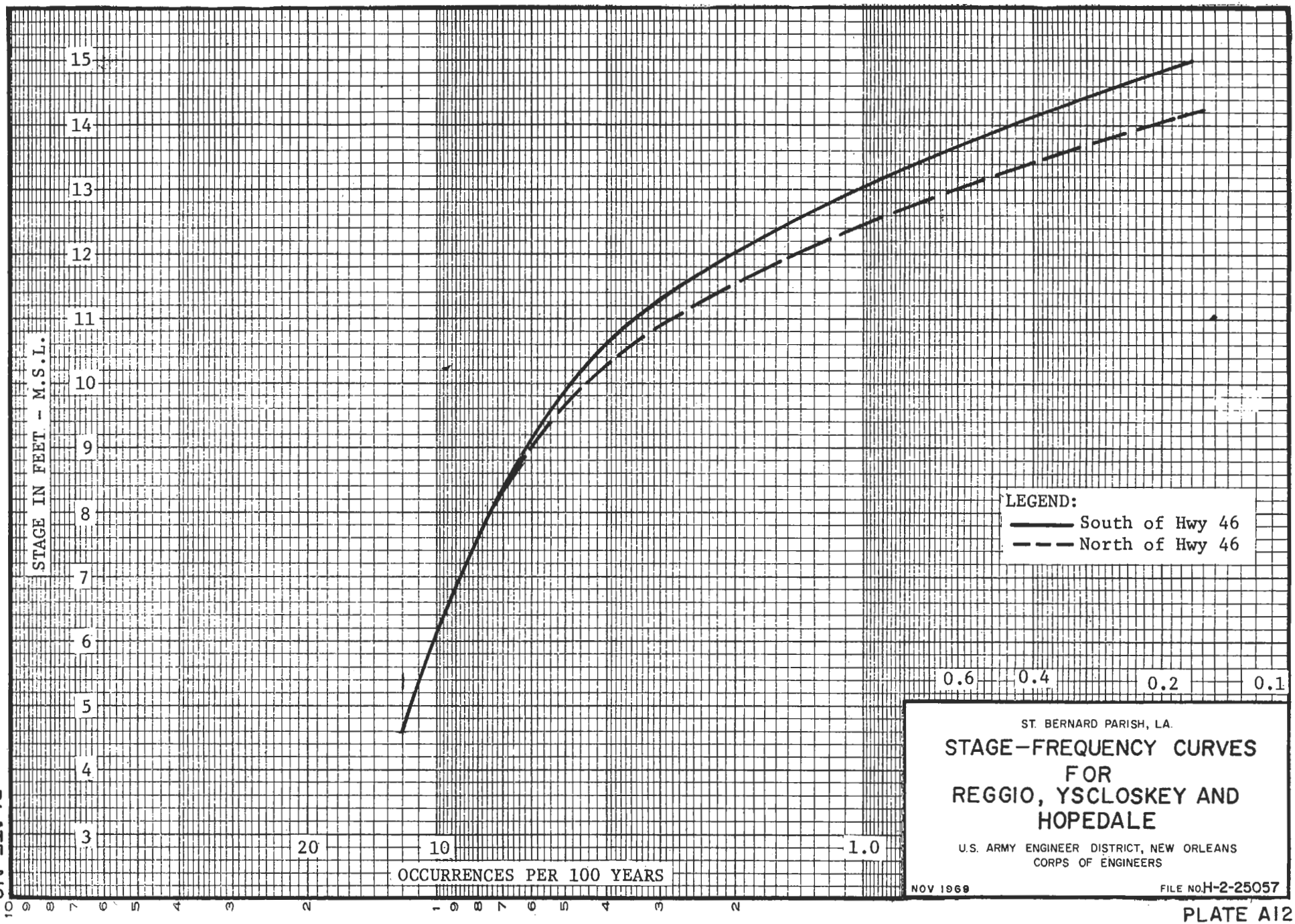


PLATE A11

PLATE A11



ST. BERNARD PARISH, LA.

STAGE–FREQUENCY CURVES FOR REGGIO, YSCLOSKEY AND HOPEDALE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

NOV 1969

FILE NO. H-2-25057

PLATE A12

PLATE A12

REVIEW OF REPORTS
ON
ST. BERNARD PARISH, LOUISIANA

APPENDIX B

ESTIMATE OF FIRST COST

REVIEW OF REPORTS
ON
ST. BERNARD PARISH, LOUISIANA

APPENDIX B

ESTIMATE OF FIRST COST

The detailed estimate of quantities, unit costs, and estimated cost (1968 price levels) shown in the table below is based on design memorandum studies for the Chalmette area and the Chalmette area extension, unit costs for that part of the Chalmette area levee now under contract, soils data from the Mississippi River-Gulf Outlet channel and spoil areas, and experienced prices for similar work elsewhere in the New Orleans District. The detailed estimate of cost is contained in the following table.

TABLE B-1

Estimated First Cost
for

Levee to inclose Reggio, Yscloskey, and Hopedale
(B-E-F-G-H-I-C on plate 1)

Cost Acct. No.	Item	Quantity	Estimated Unit cost	Estimated cost
11	Levees and floodwalls			
	Hydraulic fill	30,000,000 cu.yds.	$0.80	$24,000,000
	Retaining dikes for fill	1,400,000 cu.yds.	0.40	560,000
	Shaping	4,000,000 cu.yds.	0.50	2,000,000
	Fertilizing and seeding	1,200 acres	150.00	180,000
	Subtotal			$26,740,000
	Contingencies (20% ±)			5,360,000
	Total for levees			$32,100,000
15	Flood control and diversion structures			
	Drainage and navigation structures			
	Bayou Terre aux Boeufs	Lump sum		$ 1,200,000
	Bayou La Loutre	do.		1,200,000
	Bayou Yscloskey	do.		1,200,000
	Subtotal			$ 3,600,000
	Contingencies (20% ±)			700,000
	Total for drainage structures			4,300,000
02	Relocations			
02.1	Hwy. 300 at Reggio	Lump sum		$ 50,000
.3	Pipelines			
	30" gas pipelines	2	$ 85,000.00	170,000
	36" gas pipelines	2	100,000.00	200,000
	Subtotal			$ 420,000
	Contingencies (20% ±)			80,000
	Total for relocations			500,000
	Subtotal all items			$36,900,000
30	Engineering and design (6% ±)			2,200,000
31	Supervision and administration (8% ±)			2,900,000
	Total construction costs			$42,000,000

TABLE B-1 (cont'd)

Estimated First Cost
for

Levee to inclose Reggio, Yscloskey, and Hopedale
(B-E-F-G-H-I-C on plate 1)

Cost Acct. No.	Item	Quantity	Unit cost	Estimated cost
01	Lands and damages			
	Rights-of-way	20 acres	$6,000	$ 120,000
	do.	1,100 acres	300	330,000
	do.	1,350 acres	200	270,000
	Severance			none
	Improvements			50,000
	Subtotal lands & improvement			$ 770,000
	Contingencies (15%+)			115,000
	Acquisition costs	(about 45 tracts)		15,000
	Total for lands and damages			$ 900,000
	Total costs for additional levee			$42,900,000

REVIEW OF REPORTS
ON
ST. BERNARD PARISH, LOUISIANA

APPENDIX C

COMMENTS OF OTHER FEDERAL AGENCIES

REVIEW OF REPORTS
ON
ST. BERNARD PARISH,
LOUISIANA

APPENDIX C

COMMENTS OF OTHER FEDERAL AGENCIES

TABLE OF CONTENTS

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
PEACHTREE-SEVENTH BUILDING
ATLANTA, GEORGIA 30323

November 23, 1966

District Engineer
U. S. Army, Corps of Engineers
New Orleans, Louisiana

Dear Sir:

Your letter of September 23, 1966, presented the proposals under consideration for possible modification of plans for Hurricane Study Area II, Reach E, St. Bernard Parish, Louisiana. Our comments on these modifications, submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), have been prepared in cooperation with the Louisiana Wild Life and Fisheries Commission.

The modified plan, which has been proposed by local interests, provides for enclosing a larger area extending along the Mississippi River-Gulf Outlet navigation channel from Violet to the vicinity of Hopedale. The Corps of Engineers' alternate plan encompasses a smaller area, extending generally from Violet to Verret. The authorized and proposed levee alignment ties to the protective works for the Chalmette area plan of the project for Lake Pontchartrain and Vicinity, Louisiana. Both modifications of the authorized project are depicted on plate 1.

The Bureau provided you with a letter, dated September 26, 1960, relative to your original plan for Hurricane Study Area II. The project as proposed at that time would have had no significant effect on fish and wildlife resources which are of considerable value. The area in question is important both because of the habitat it furnishes and the contribution it makes to nearby estuarine areas.

Our study of the modified plan indicates that under either proposal the existing brackish water circulatory system will be essentially maintained. It does not, therefore, appear that the modified hurricane levee alignments will directly affect fish and wildlife resources to any great extent. Both plans will indirectly damage these resources by hastening urbanization and industrialization of valuable marshes through providing basic features for further flood protection and reclamation.

Should major changes or alterations in project plans be considered, the Bureau requests the opportunity for further review in the interest of fish and wildlife conservation. Early notice of such planning will aid in appropriate scheduling of any additional study or comment which may be required.

This report has been reviewed and concurred in by the Bureau of Commercial Fisheries and the Louisiana Wild Life and Fisheries Commission. Please note the comments in the attached copy of Director Glasgow's letter.

Sincerely yours,

W. L. Towns
Acting Regional Director

Attachments 2

PROJECT LOCATION
MISSISSIPPI RIVER
LA.
LAKE BORGNE
MISSISSIPPI RIVER GULF OUTLET
SHELL BEACH
BAYOU YSCLOSKEY
YSCLOSKEY
HOPEDALE
BAYOU LA LOUTRE
REGGIO
VERRET
AUTHORIZED LEVEE
REACH E (F.C. ACT 1962)
LAKE BORGNE CANAL
VIOLET
BAYOU LA LOUTRE
MISSISSIPPI RIVER
LEGEND
AUTHORIZED HURRICANE PROTECTION LEVEE
IMPROVEMENT REQUESTED
USCE ALTERNATE LEVEE ALIGNMENT
FLOODGATE
HURRICANE STUDY AREA II, REACH E
ST. BERNARD PARISH, LOUISIANA
1 0 1 2 MILES
UNITED STATES DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife

PLATE 1

LOUISIANA WILD LIFE AND FISHERIES COMMISSION
CAPITOL STATION
BATON ROUGE, LOUISIANA 70804

November 9, 1966

Mr. James R. Fielding
Assistant Regional Director
Bureau of Sport Fisheries and Wildlife
Peachtree-Seventh Building
Atlanta, Georgia

Dear Mr. Fielding

Reference is made to your letter dated October 14, 1966 and enclosed report on the Hurricane Study Area II, Reach E, St. Bernard Parish, Louisiana.

My staff has reviewed your proposed report and is in general agreement with its contents. We realize that the project will hasten urbanization and industrialization of valuable marshes; however, we feel that the following comments might be appropriate:

In conjunction with the alternate plan the requested improvements from Hopedale, Shell Beach, Yscloskey, Reggio, Caernarvon and fronting the South side of the Gulf Outlet would give even better wildlife potentials. The requested improvement plan merely shows floodgates on Bayou LaLoutre, Bayou Yscloskey, Bayou Terre Bouet and Violet Canal. This would mean that the only drainage in the Shell Beach, Yscloskey, Hopedale area would be from two to three existing culverts on Highway 46 between Yscloskey and Hopedale. If this marsh were to be managed properly, additional drainage controls might become necessary. As this segment is now subject to tidal fluctuations from the access canal 3/4 mile south of the Gulf Outlet, a levee system as requested could result in an impoundment. We do not recommend this.

We presume that the floodgates would remain open at all times, with the exception of times of hurricane warnings. This is not indicated in the enclosed plat.

The opportunity to review and comment on this project is appreciated.

Sincerely

Leslie L. Glasgow

Leslie L. Glasgow, Director
La. Wild Life and Fisheries Comm.

LLG/pc

Police Jury
St. Bernard Parish
St. Bernard Courthouse Annex
CHALMETTE, LOUISIANA

271-0421

July 8, 1969

Colonel Herbert J. Haar, Jr.
District Engineer, Dept. of the Army
New Orleans District, Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

Dear Colonel Haar:

We have been requested by the Department of Public Works to designate a location and date for an informational hearing on the recent St. Bernard Hurricane Study, the previous hearing having been held in the Courthouse at Chalmette on December 15, 1965.

The St. Bernard Parish Police Jury requests that the documents or reports to be discussed at this requested informational hearing be sent to the Police Jury for its study in lieu of an immediate hearing.

Your sympathetic consideration of our request would be appreciated.

Yours very truly,

ST. BERNARD PARISH POLICE JURY

R. M. McDougall

R. M. MC DOUGALL
SECRETARY-TREASURER

RM:up

cc- Mr. Hu B. Myers, Dept. of Public Works

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P. O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

C O P Y

LMNED-PR

16 July 1969

Mr. R. M. McDougall, Secretary-Treasurer
St. Bernard Parish Police Jury
St. Bernard Courthouse Annex
Chalmette, Louisiana 70043

Dear Mr. McDougall:

Inclosed as requested in your letter of 8 July 1969 is a draft copy of our proposed report on the St. Bernard Parish Hurricane Study.

The contents of this report should not be disclosed to the news media or to the public until you have received a notice that the report has been completed and forwarded to the Board of Engineers for Rivers and Harbors.

It is requested that any comments on the draft of the proposed report be furnished this office not later than 1 August 1969.

Consideration is being given to your request to forego the public hearing. You will be informed further in this matter when a decision has been reached.

Sincerely yours,

1 Incl
Draft St. Bernard Report

HERBERT R. HAAR, JR.
Colonel, CE
District Engineer

Police Jury

St. Bernard Parish

St. Bernard Courthouse Annex
CHALMETTE, LOUISIANA

271-0421

October 20, 1969

U. S. Army Engineer District
N. O. Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

Attention: Herbert R. Haar, Jr.,
Colonel, C. E.,
District Engineer

Dear Colonel Haar:

The Police Jury, upon meeting with representatives of the Louisiana Department of Public Works, has taken an official position on the "REVIEW OF REPORTS ON ST. BERNARD PARISH, LOUISIANA", dated January 24, 1969, submitted by the U. S. Corps of Engineers.

The Police Jury is not in agreement with the report, and recommends that this report not be approved. The Public Officials of St. Bernard Parish consider the Federal Government as having the prime responsibility for hurricane protection along the Mississippi River Gulf Outlet, as the Mississippi River Gulf Outlet was built as a Federal Project, without any considerations or approval being given by the people of St. Bernard.

I have enclosed a certified copy of the Police Jury's Motion.

Yours very truly,

ST. BERNARD PARISH POLICE JURY

R. M. MC DOUGALL
SECRETARY-TREASURER

RM:ms

Enclosure: Certified Motion

Police Jury

St. Bernard Parish

St. Bernard Courthouse Annex
CHALMETTE, LOUISIANA

271-0421

EXTRACT OF THE OFFICIAL PROCEEDINGS OF THE POLICE JURY OF THE PARISH OF ST. BERNARD, STATE OF LOUISIANA, TAKEN AT THE REGULAR MEETING OF THE POLICE JURY, HELD IN THE POLICE JURY ROOM OF THE COURTHOUSE ANNEX, AT CHALMETTE, LOUISIANA, ON TUESDAY, OCTOBER 7, 1969.

By joint motion of Mr. Molero, seconded by Mr. Melerine, and unanimously carried, it was moved to officially record that the St. Bernard Parish Police Jury is not in agreement with the conclusion and recommendations of the "REVIEW OF REPORTS ON ST. BERNARD PARISH, LOUISIANA", dated January 24, 1969, by the U. S. Corps of Engineers, and that the Police Jury recommends that this Report not be approved.

IT WAS FURTHER MOVED, that the Federal Government re-consider and recognize that it has the primary obligation to protect the residents of St. Bernard Parish from flooding, caused by the Federal Project creating the Mississippi River Gulf Outlet.

And the motion was declared adopted on the 7th day of October, 1969.

C E R T I F I C A T E

I CERTIFY THAT the above is a true and correct copy of a motion adopted by the St. Bernard Parish Police Jury at a Regular Meeting held at Chalmette, Louisiana, in the Police Jury Room on the 7th day of October, 1969.

Witness my hand and the Seal
of the St. Bernard Parish
Police Jury this 20th day
of October, 1969.

R. M. MC DOUGALL
SECRETARY-TREASURER

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
PEACHTREE-SEVENTH BUILDING
ATLANTA, GEORGIA 30323

July 11, 1969

District Engineer
U.S. Army, Corps of Engineers
P.O. Box 60267
New Orleans, Louisiana 70160

Dear Sir:

This is in reply to your letter of June 16, 1969, transmitting a draft of your proposed report on St. Bernard Parish, Louisiana, for our review and comment.

As stated in our report of November 23, 1966, the modified levee alignments will not directly affect fish and wildlife to any great extent. Levee protection will indirectly damage these resources by inducing urban and industrial growth in an area of valuable marshlands. The recommended modification will tend to lessen these effects since it will encompass a smaller area than that proposed by local interests.

The opportunity to review and comment on the report is appreciated.

Sincerely yours,

W. L. Towns
Acting Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

ROOM 204 FEDERAL BUILDING
BARTLESVILLE, OKLAHOMA 74003

July 28, 1969

Colonel Herbert R. Haar, Jr.
District Engineer
Department of the Army
New Orleans District, Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

Refer to: LMNED-PR

Dear Colonel Haar:

We have reviewed the Review of Reports on St. Bernard Parish, Louisiana for relationship to mineral resources and installations.

An examination of office material without benefit of field examination revealed that St. Bernard Parish mineral deposits yielded natural gas liquids, petroleum, natural gas and clays valued at about $32.2 million during 1968.

One oilfield, one gasfield, one crude oil pipeline, six natural gas pipelines and one gasoline plant are located within the area of the proposed improvement. Clay was produced from an undisclosed source.

Because the Project has been considered infeasible at this time, it obviates a detailed consideration of mineral involvement in construction. If, at some future date, additional construction for hurricane protection in St. Bernard Parish is authorized, the Bureau of Mines would appreciate the opportunity to review the plans.

Sincerely yours,

Floyd D. Everett

Floyd D. Everett, Chief
Bartlesville Office of
Mineral Resources

UNITED STATES
DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

SOUTH CENTRAL REGION
1402 ELM STREET, 3RD FLOOR
DALLAS, TEXAS 75202

June 20, 1969
Your Reference:
LMNED-PR

District Engineer
Dept. of the Army
New Orleans District,
Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

Dear Sir:

Thank you for the opportunity to review your report on the restudy of the hurricane protection project for St. Bernard Parish, Louisiana, as requested in your letter of June 16, 1969.

Your investigation indicates that extension of the authorized Chalmette Area of the Lake Pontchartrain and Vicinity protection project to encompass the communities of Caernarvon and Verret was justified. Construction of this extension is underway by virtue of existing authorization. Also, since authorized "Reach E" levee of the Mississippi River Delta at and below New Orleans project is encompassed by the levees of the modified Chalmette Area feature, you recommend this project be deauthorized. Further, investigations of hurricane protection for the area from Verret to Hopedale show that the benefit-cost ratio is extremely low, 0.1.

This office does not anticipate any impact on water quality in the area as a result of the extension of the Chalmette Area project.

Sincerely yours,

WILLIAM C. GALEGAR
Regional Director

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division
6554 Florida Blvd.
Baton Rouge, Louisiana 70806

July 22, 1969

Colonel Herbert R. Haar, Jr.
District Engineer
Department of the Army
Corps of Engineers, N.O. District
P. O. Box 60267
New Orleans, Louisiana 70160

Dear Colonel Haar:

The report on "St. Bernard Parish, Louisiana" has been reviewed. We presently have no active project work in the study area and have no comments concerning the report.

Thank you for the opportunity to review this report.

Sincerely yours,

FOR THE DISTRICT CHIEF

V. B. Sauer
Hydrologist

United States Department of the Interior
BUREAU OF OUTDOOR RECREATION
SOUTHEAST REGIONAL OFFICE
810 New Walton Building
Atlanta, Georgia 30303

IN REPLY REFER TO:

D6427 (LM)

JUL 2 1969

District Engineer
U.S. Army Engineer District,
New Orleans
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Sir:

Reference is made to your letter of June 16, 1969, transmitting a draft copy of "Review of Reports on St. Bernard Parish, Louisiana" for our review.

The report examines the economic feasibility of additional hurricane protection for authorized and existing projects--in particular the Chalmette area of Lake Pontchartrain and vicinity, and Reach E of the Mississippi River Delta at and below New Orleans, Louisiana. An unfavorable benefit-cost ratio was determined by the study. It is recommended that no additional improvements for hurricane protection be authorized and that Reach E be deauthorized.

We have no comments on this report at this time.

The opportunity to review this report is appreciated.

Sincerely yours,

Roy K. Wood
Regional Director

REVIEW OF REPORTS

ON

ST. BERNARD PARISH,
LOUISIANA

APPENDIX D

EXTENSION OF CHALMETTE AREA PLAN
LETTER OF 29 NOVEMBER 1966 AND INDORSEMENTS

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P. O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

IN REPLY REFER TO
LMNED-PR

29 November 1966

SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

TO: Acting Division Engineer, Lower Mississippi Valley
ATTN: LMVED-TD and LMVPD-F

1. Reference is made to the following:

a. Flood Control Act of 1965 authorizing subject project.

b. Project document for subject project (H.Doc. 231/89th Congress).

c. Design Memorandum No. 3, General Design for Lake Pontchartrain, La. and Vicinity, Chalmette Area Plan, submitted 1 November 1966.

d. Flood Control Act of 1962 authorizing hurricane protection for the Mississippi River Delta Area at and below New Orleans, Louisiana, and Reach E, Violet to Verret, in particular.

e. Project document for Mississippi River Delta at and below New Orleans, La. (New Orleans to Venice, La.) (H.Doc. 550/87th Congress).

f. Resolution adopted 8 May 1964 by the House Public Works Committee authorizing a restudy of hurricane protection in St. Bernard Parish.

g. Paragraph 2 of 1st Ind file LMVED-PR dated 25 February 1966 to NOD letter of 21 February 1966 subject "Review of St. Bernard Parish, Louisiana - Plan of Survey."

h. Paragraph 9.b. of ER 1110-2-1150 dated 1 July 1966.

2. Hurricane protection for the Chalmette area was authorized as an item of the "Lake Pontchartrain, Louisiana and Vicinity," project by the Flood Control Act of 1965 (page 5 of PL 89-298) "...substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 231, Eighty-Ninth Congress, except that the recommendations of the Secretary of the Army in that document shall apply with respect to the Seabrook Lock feature of the project...."

3. The recommendations of the Board as stated in paragraph 4 of the report are as follows:

> "Subject to re-examination of the levee alignment in the preconstruction stage with a view to protecting additional lands, and to certain requirements of local cooperation, the Board recommends authorization for construction of the improvements, essentially as planned by the reporting officers, provided...."

The Chief of Engineers concurred in the recommendations of the Board subject to certain modifications pertaining to the Rigolets lock as a result of a change in the interest rates.

4. The present plan of improvement for the Chalmette area is shown in Design Memorandum No. 3, General Design (reference 1.c.). This plan, also shown on the attached map, provides for protection of the Chalmette area against a standard project hurricane (described in paragraph 14 of the DM) having an estimated frequency of about once in 200 years.

5. Protection for the Reach E area, Violet to Verret, against a hurricane having a frequency of about once in 100 years was authorized as a feature of the project "New Orleans to Venice, La.," by the Flood Control Act of 1962. The plan of improvement provided for raising existing back levees from the Mississippi River at Violet to the highway at Verret (see attached map).

6. St. Bernard Parish interests were dissatisfied with this plan and secured authorization for a restudy (reference 1.f.) which was initiated in FY 1966 and is being continued in FY 1967. At the public hearing in Chalmette on 15 December 1965, the Parish Police Jury, State of Louisiana, Department of Public Works, and others requested hurricane protection for a much larger area in St. Bernard Parish including the settlements of Caernarvon, Reggio, Delacroix, Yscloskey, and Hopedale. The locations of the levees proposed by the sponsors at the public hearing are shown on the attached map.

7. After preliminary examination of the requested levee alignment, previous studies, and damages caused by hurricane "Betsy" (9 September 1965), it was deemed advisable to move the levee about halfway between the requested location and the highway from Poydras to Verret because of better levee construction conditions (Reach A-B on the inclosed map). The area thus deleted from the proposed protected area is entirely undeveloped marsh in which only minor enhancement benefits would be

obtained from hurricane protection. It was also deemed advisable to consider the initial plan as protection for the Poydras to Verret area which, if added to the Chalmette area, would eliminate the need for the return levee between the Mississippi River-Gulf Outlet spoil bank and the Mississippi River levee at Violet, a very expensive section of levee to construct and maintain (see reference 1.c.). The remainder of the requested levees would be considered as increments thereto. The plan of survey recommending this approach was submitted 21 February 1966 and approved 25 February 1966 (see reference 1.g.).

8. Initial studies of the additional protection requested for St. Bernard Parish have been essentially completed. Maximum utilization has been made of the data developed during preparation of the design memorandum for the Chalmette area. The levee sections and estimated construction requirements and unit prices for comparable areas in the Chalmette plan have been used for cost estimates. Hydraulic studies have been made to estimate levee grades. Field reconnaissance and hydraulic studies have been made for benefit estimates.

9. The net levee grade for the Chalmette area plan levee along the spoil banks of the Mississippi River-Gulf Outlet gulfward of Paris Road is 17.5 feet m.s.l. (plates 10 through 15 of design memorandum, reference 1.c.). Hydraulic studies have been made and levee grades established for the additional area under study as follows: along the entire spoil bank, 17.5 feet m.s.l.; Caernarvon to the highway at Verret, 16.5 feet; Verret to spoil bank, 17.5 feet; and Verret to Reggio, and thence along Bayou LaLoutre to the Mississippi River-Gulf Outlet spoil bank, 17.0 feet. Levees to these grades would provide the same degree of protection for the entire area as that under the existing Chalmette area plan.

10. The estimated cost of modifying the Chalmette area plan to include the settlements of Caernarvon, Poydras, and Verret (by levees A, B, C, D) in the protected area is as shown below. A detailed estimate of the costs is inclosed.

Item	Estimated cost
Levee construction	$ 9,548,500
Foreshore protection along MR-GO	703,000
Drainage structure	146,000
Relocations	
Highway crossings(2)	93,800
Pipelines(7)	295,000
Subtotal	$10,786,300
Contingencies (20%+)	2,157,700
Subtotal	$12,944,000
Engineering and design	776,000
Supervision and administration	1,099,000
Total construction cost	$14,819,000
Rights-of-way	537,000
Total estimated cost of additional levees	$15,356,000(1)
Less levee from Bayou Lawler (Point D) to Violet made unnecessary	7,212,000(2)
Total increased cost for additional protection	$ 8,144,000(1)

(1) Includes $966,000 for foreshore protection along Mississippi River-Gulf Outlet, Reach C-D on the inclosed map.
(2) Section IV, pages 52-53 of D.M. reference 1.c.

11. The estimated annual charges based on the increased costs in the preceding paragraph, a 100-year life, and an interest rate of 3-1/8% are:

Item		Amount
Interest		$255,000
Amortization		12,000
Maintenance and operation		
16 miles levee @ $5,000/mile	80,000	
Less: maintenance levee--Bayou Lawler to Violet(par. 65 D.M. ref. 1)	42,000	
Increased levee maintenance		38,000
Increased annual charges		$305,000

12. The benefits from the additional protection are estimated at $359,200 average annually, consisting of $13,100 crop, $178,600 non-crop, and $167,500 land enhancement. A detailed computation of the benefits is inclosed.

13. Based on annual charges in paragraph 11 and annual benefits in paragraph 12, the benefit-cost ratio for the protection of the additional area is 1.2.

14. Consideration was given to extending the protection eastward and southward of Verret generally as requested by the local sponsors and shown on the attached map. However, these studies indicate protection for a larger area cannot be justified in the foreseeable future. The length of levee required would be relatively large in relation to the levee eliminated and the increased area protected. The area is sparsely inhabited and the improvements are of low value. Reconnaissance scope studies show that the estimated incremental first costs and annual charges for extending the hurricane protection from the Poydras-Verret area to include Yscloskey (excludes Hopedale and Delacroix), generally as shown on the inclosed map (levees B, E, F, I, C), are $18,000,000 and $670,000, respectively. The estimated incremental first costs and annual charges for extending the hurricane protection from Verret to Hopedale (levees F, G, H, I) are $28,000,000 and $1,000,000, respectively. The average annual benefits for extending the hurricane protection from Verret to Hopedale are only $195,000 (exclusive of Delacroix) ($5,000 crop, $140,000 non-crop,and $50,000 land enhancement). In view of the very small benefit-cost ratio for the area from Verret to Yscloskey (less than 0.2), no studies were made of the levees along Bayou Terre aux Boeufs to include Delacroix in the protected area.

15. A survey of the highway from Poydras to Verret shows the controlling elevation to be about 5 feet mean sea level. Over two miles of the highway have a controlling elevation of less than 6.0 feet m.s.l. Hurricane "Betsy" produced stillwater elevations in excess of 10.0 feet m.s.l. in the Poydras-Verret-Hopedale area. The protection to be provided under the authorized project "Reach E" is obviously inadequate for a residential area. In recognization of this, the State of Louisiana, Department of Public Works, at the request of the Board of Commissioners of the Lake Borgne Levee District, has recently (about 1 November 1966) initiated the construction of a small levee to elevation 10.0 feet m.s.l. (by dragline) from Caernarvon to Verret generally along the alignment proposed herein and shown on the attached map. The alignment and levee section have been examined in this office. The work being accomplished, unless enlarged and raised, will soon settle

until it would provide only a small amount of additional protection. However, it will be of substantial value in expediting the construction of the levee to the full grade and section recommended herein. Local interests should be given credit for the work accomplished on their Caernarvon to Verret levee.

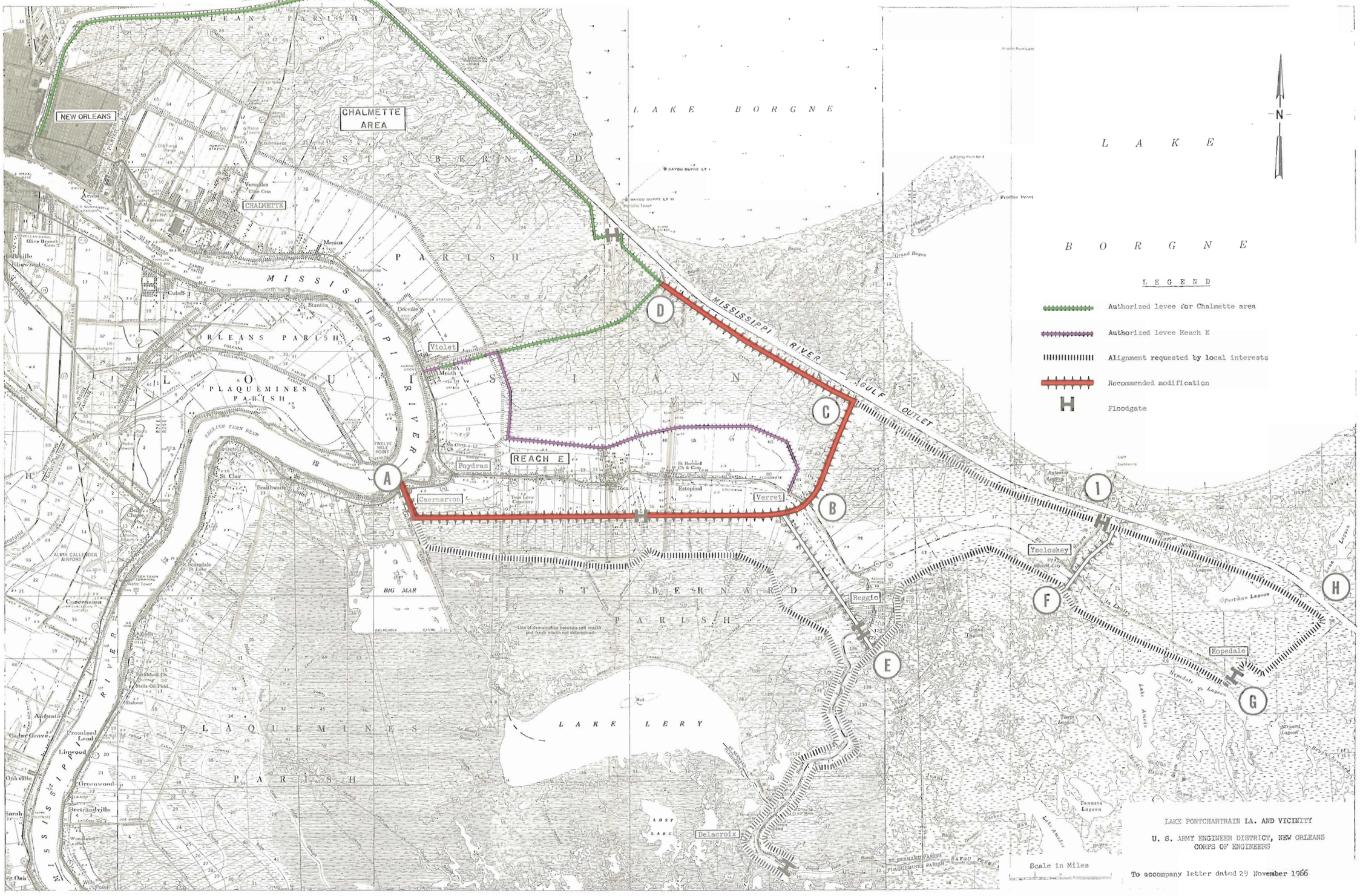
16. It is recommended that the presently approved plan of hurricane protection for the Chalmette area contained in the general design memorandum (reference 1.c.) be modified under the authority quoted in paragraphs 2 and 3 to provide for the construction of the levee from Caernarvon via Verret and the Mississippi River-Gulf Outlet spoil bank to the approved plan levee at Bayou Lawler (Point D) generally along the alignment shown on the attached map and for the elimination of the levee in the approved plan from Bayou Lawler to Violet (Section IV in reference 1.c.). This modification will increase the total estimated cost of the Chalmette area plan from $29,552,200 to $37,697,000, which includes $4,337,400 for foreshore protection along the Mississippi River-Gulf Outlet (an increase of $966,000). The estimated Federal cost will be increased from $21,697,952 to $27,689,000 and the estimated non-Federal cost from $7,854,236 to $10,008,000.

17. It is further recommended that, when the modification in the authorized plan is approved, this District be authorized to proceed with work necessary to prepare a supplement to the general design memorandum for the Chalmette area (reference 1.c.) on the modified plan.

Thomas J. Bowen

THOMAS J. BOWEN
Colonel, CE
District Engineer

4 Incl (quint)
1. Map
2. Cost est.
3. Benefit est.
4. Apportionment of costs


NEW ORLEANS
CHALMETTE AREA
ORLEANS PARISH
ST BERNARD PARISH
PLAQUEMINES PARISH
LAKE BORGNE
LAKE
BORGNE
MISSISSIPPI RIVER
MISSISSIPPI RIVER GULF OUTLET
REACH E
Chalmette
Violet
Poydras
Caernarvon
Verret
Reggio
Ycloskey
Hopedale
Delacroix
LAKE LERY
BIG MAR
A
B
C
D
E
F
G
H
I
N
LEGEND
Authorized levee for Chalmette area
Authorized levee Reach E
Alignment requested by local interests
Recommended modification
Floodgate
LAKE PONTCHARTRAIN LA. AND VICINITY
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
Scale in Miles
To accompany letter dated 29 November 1966

Inclosure 1

DETAILED ESTIMATED FIRST COST
FOR
ADDING POYDRAS-VERRET AREA TO THE
CHALMETTE AREA PLAN

1. ESTIMATES OF FIRST COSTS

The estimates of first cost for the plan of improvement for the Poydras to Verret area, based on October 1966 prices, are as follows:

a. REACH A-B

Estimated first cost

Cost acct. no.	Item	Quantity	Unit cost	Estimated cost
	FEDERAL CONSTRUCTION			
11	Levees and floodwalls			
	Levee			
	Hydraulic fill	8,212,000 cu.yd.	$ 0.60	$4,927,200
	Shape up	1,026,000 cu.yd.	0.40	410,400
	Cast fill for dikes	385,000 cu.yd.	0.30	115,500
	Haul fill for levee	313,000 cu.yd.	1.50	469,500
	Seeding	264 acre	75.00	19,800
	Subtotal			$5,942,400
	Contingencies (20%)			1,188,600
	Subtotal			$7,131,000
15	Floodway control and division structures			
	Drainage structure	job		$ 146,000
	Contingencies (20%)			29,000
	Subtotal			$ 175,000
30	Engineering and design (6%)			$ 438,000
31	Supervision and administration (8%)			620,000
	Total estimated Federal construction first cost			$8,364,000

Incl 2

a. REACH A-B (cont'd)

Cost acct. no.	Item	Quantity	Unit cost	Estimated cost
		RELOCATIONS		
02.3	Relocation of pipelines			
	3-20" gas pipeline	L.S.		$ 161,000
	2-16" gas pipeline	L.S.		86,000
	1-12" gas pipeline	L.S.		32,000
	1-6" gas pipeline	L.S.		16,000
	Subtotal			$ 295,000
	Contingencies (20%)			59,000
	Subtotal			$ 354,000
02.1	Relocation of roads			
	La. Hwy. 39 (Caernarvon)			
	Earthfill	26,200 cu.yd.	$ 1.50	$ 39,300
	Asphalt ramp	630 ft.	12.00	7,600
	Subtotal			$ 46,900
	Contingencies (20%)			9,100
	Subtotal			$ 56,000
30	Engineering and design (6%)			25,000
31	Supervision and administration (8%)			35,000
	Total estimated cost of relocations			$ 470,000
01	Lands and damages			
	Fee area	928 acres		$ 269,000
	Improvements			20,000
	Severance			10,000
	Contingencies (15%)			45,000
	Acquisition costs (83 tracts)			17,000
	Total cost for rights-of-way			$ 361,000
	TOTAL ESTIMATED COST FOR REACH A-B			$9,195,000

b. REACH B-C.

Estimated first cost

Cost acct. no.	Item	Quantity	Unit cost	Estimated cost
		FEDERAL CONSTRUCTION		
11	Levees and floodwalls			
	Levee			
	Hydraulic fill	3,032,000 cu.yd.	$ 0.60	$1,819,200
	Shape up	379,000 cu.yd.	0.40	151,600
	Cast fill for dikes	142,000 cu.yd.	0.30	42,600
	Haul fill for levee	313,000 cu.yd.	2.50	782,500
	Seeding	140 acre	75.00	10,500
	Subtotal			$2,806,400
	Contingencies (20%)			561,600
	Subtotal			$3,368,000
30	Engineering and design (6%)			$ 202,000
31	Supervision and administration (8%)			285,000
	Total estimated Federal construction first cost			$3,855,000
		RELOCATIONS		
02.1	Relocations			
	La. Hwy. 46 (Verret)			
	Earthfill	26,200 cu.yd.	$ 1.50	$ 39,300
	Asphalt ramp	630 ft.	12.00	7,600
	Subtotal			$ 46,900
	Contingencies (20%)			9,100
	Subtotal			$ 56,000
30	Engineering and design (6%)			4,000
31	Supervision and administration (8%)			5,000
	Total estimated first cost for relocation			$ 65,000
01	Lands and damages			
	Fee area	306 acres		$ 85,000
	Improvements			3,000
	Severances			5,000
	Contingencies (15%)			14,000
	Acquisition costs			1,000
	Total costs for rights-of-way			$ 108,000
	TOTAL COST FOR REACH B-C			$4,028,000

c. REACH C-D

Estimated first cost

Cost acct. no.	Item	Quantity	Unit cost	Estimated cost
		FEDERAL CONSTRUCTION		
11	Levees and floodwalls			
	Levee			
	Hydraulic fill	1,198,000 cu.yd.	$ 0.60	$ 718,800
	Shape up	150,000 cu.yd.	0.40	60,000
	Cast fill for dikes	56,000 cu.yd.	0.30	16,800
	Seeding	54 acres	75.00	4,100
	Subtotal			$ 799,700
	Contingencies (20%)			160,300
	Subtotal			$ 960,000
30	Engineering and design (6%)			57,000
31	Supervision and administration (8%)			82,000
	Total estimated cost of levee			$1,099,000
11	Foreshore protection along MR-GO			
	Excavation & backfill	121,000 cu.yd.	1.00	121,000
	Riprap	54,000 ton	10.00	540,000
	Shell	12,000 cu.yd.	3.50	42,000
	Subtotal			$ 703,000
	Contingencies (20%)			141,000
	Subtotal			$ 844,000
30	Engineering and design (6%)			50,000
31	Supervision and administration (8%)			72,000
	Total estimated costs for foreshore protection			$ 966,000
	Total estimated Federal construction cost			$2,065,000
01	Lands and damages			
	Fee area	116 acres		$ 58,000
	Improvements			None
	Severance			None
	Contingencies (15%)			9,000
	Acquisition costs			1,000
	Total estimated costs for rights-of-way			$ 68,000
	TOTAL ESTIMATED COST REACH C-D			$2,133,000

d. Summary.

	A-B	B-C	C-D	Total
Federal construction	$8,364,000	$3,855,000	$2,065,000	$14,284,000
Relocations	470,000	65,000	None	535,000
Lands & damages	361,000	108,000	68,000	537,000
Total	$9,195,000	$4,028,000	$2,133,000	$15,356,000

ESTIMATE OF BENEFITS
FOR
POYDRAS-VERRET AREA

DESCRIPTION

The study area is rural in nature and is characterized by several small communities located along the highways which traverse the area. Along La. State Highway 39 are the settlements of Violet, Poydras, and Caernarvon. St. Bernard, Toca, Estopinal, and Verret are situated along La. State Highway 46. Estimated total population (1960 census) is 3,100 representing a growth rate of approximately 34% in the last decade. Improvements are generally located on high ground along the alluvial banks of the Mississippi River and Bayou Terre aux Boeufs, a former distributary of the Mississippi River at Poydras.

ECONOMIC DEVELOPMENT

Railway transportation is provided by the Louisiana Southern Railroad track (Southern Railway System) running along the west side of La. State Highway 39 and south of La. State Highway 46 as far east as the community of Toca. The Mississippi River-Gulf Outlet, a tide-water channel deep enough to accommodate seagoing vessels, borders on the northeastern boundary of the study area; to the north, Bayou Dupre and connecting Lake Borgne Canal afford a shallow navigation channel for smaller boats.

Economic activity in the area is primarily agricultural with truck crops and the production of beef cattle predominating. One industrial natural gas plant and one petroleum plant are in operation of Toca; no mineral production exists at this time. A few small, local business establishments are scattered along the highways. A large part of the income enjoyed by residents is derived outside of the area; primary sources include business and industrial establishments in metropolitan New Orleans, nearby oil production facilities, commercial fishing, sport fishing services, and fur trapping.

Development within the area has shown consistent gains over the past 25 years despite inadequate flood protection; its geographic position within the Greater New Orleans area indicates sustained future growth.

EXTENT AND CHARACTER OF FLOODED AREA

Within the project area are some 17,900 acres of land subject to inundation, including 3,800 acres cleared, 9,500 acres woods, and 4,600 acres marshland. About 6,300 acres lying north of La. State Highway 46 receive some protection from flooding as a result of the Bayou Terre aux Boeufs alluvial ridge to the south and a protection levee up to +8 feet above mean sea level to the north. Nearly all improvements in the

area are residential, with a few small commercial businesses and two industrial plants. These improvements are generally located on the alluvial ridges at elevation +5 feet to +10 feet above mean sea level. Agricultural production is based primarily on small farm truck crop production and the raising of beef cattle.

The present estimated land value within the project area is $16,750,000 and the improvements are valued at $18,050,000 for a total valuation of $34,800,000. Annual value of agricultural production, under flood-free conditions, is about $250,000.

Due to the extreme peril to life and property in the area because of possible tidal overflow, it becomes necessary for a mass evacuation whenever there is an indication of approaching hurricanes of severe tropical disturbances. Highway and railway access is subject to disruption during these periods.

FLOOD DAMAGES

As a result of hurricane tidal overflows, damages are sustained by residences, house trailers, small business establishments, two industries, schools, churches, utilities, highways, and the railroad. Additional losses are suffered to truck crops, pastures, drowned livestock, fowl, and wildlife. Mass evacuation costs, flood fighting costs, business and personal income losses are also incurred.

Flood damages determined during surveys following hurricanes "Flossy" (September 1956) and "Betsy" (September 1965) were adjusted to reflect present conditions and used as a basis for developing stage-damage curves for agricultural and non-agricultural damages. In turn, average annual damages were determined by combining stage-damage and stage-frequency curves to obtain damage-probability curves.

Under present conditions, average annual losses within the project area are estimated at $13,100 crop and $119,600 non-crop for a total of $132,700.

Analysis of the growth trend for the metropolitan New Orleans area indicates continued growth for the next 50 years in this region. It was assumed that future improvements would take place in proportion to population increases and that the population within the study area would double by the end of a 50-year period and remain constant thereafter. No increase for agricultural production was assumed. On this basis of future development, average annual damages discounted for a 50-year growth and 100-year project life are estimated to be $13,100 crop and $178,600 non-crop for a total of $191,700.

ESTIMATES OF BENEFITS

Protection of the area from storms up to SPH frequency (about 200 years) will be afforded by the proposed works. Residual damages with the improvement are considered to be negligible; therefore, average annual flood damages prevented are estimated to be $13,100 crop and $178,600 non-corp or a total of $191,700.

The present appraised value of lands in the study area are estimated at $16,750,000; with protection from tidal overflow the value is anticipated to approximate $20,100,000 or an increase of $3,350,000. Annual value of land enhancement is estimated (at a 5 percent interest rate) to be $167,500.

Total average annual benefits attributable to the proposed project are $359,200, composed of $191,700 flood damage prevented and $167,500 enhancements.

Apportionment of Increased First Costs
for
Poydras to Verret Area

Project first cost	
Increased first cost (including riprap foreshore protection along MR-GO)	$ 8,144,000
Less foreshore protection	966,000
Total cost for additional levees	$ 7,178,000

Spportionment of costs

Item	Federal	Non-Federal
Levees	$ 5,024,600 (70%)	$ 2,153,400 (30%)
Foreshore protection	966,000 (100%)	-
Total incremental cost	$ 5,990,600	$ 2,153,400
Existing plan (cost from p. 40 of ref. l.c.)	$21,697,952	$ 7,854,236
Total for modified project	$27,688,552	$10,007,636
Round to	$27,689,000	$10,008,000
Cost for lands & relocations	(orig. project modification)	3,968,755 1,072,000
		$ 5,040,755 *
Contribution required for modified project		$ 4,966,881
Round to		$ 4,967,000

*This is in error in that it includes $1,393,400 for lands & damages and relocations (MR-GO to Violet) which will be eliminated under the modification. Correct total should be $3,647,355.

Incl 4

LMVED-TD (NOD 29 Nov 66) 1st Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, Lower Miss. Valley Div, CE, Vicksburg, Miss. 39180 13 Dec 66

TO: Chief of Engineers, ATTN: ENGCW-V/ENGCW-E

1. The recommendations of the District Engineer in paras 16 and 17 of basic communication are concurred in, subject to the comments below. General Design Memorandum No. 3 (reference 1c) was forwarded to OCE by our 1st Ind, LMVED-TD, dated 1 Dec 66, on NOD letter, dated 1 Nov 66, subject: Lake Pontchartrain, La. and Vicinity, General Design Memorandum No. 3, Chalmette Area Plan.

2. Para 1f, basic letter. In connection with studies being made in response to referenced resolution, present indications are that the part of the area below Verret will probably have a very low B/C ratio.

3. Para 16, basic letter. The estimate of $29,552,200 is that shown in General Design Memorandum No. 3 and has not been approved in a Project Cost Estimate (PB-3). The estimate of $37,697,000 should be designated as approximate in view of the comment in para 5 below.

4. Incl 1. a. Location of drainage structure should be shown.

b. Upon approval of enlarged Chalmette Area, consideration should be given to locating the east-west portion of levee A-B approximately 2,000 feet north of the recommended alignment in order to provide a slightly better foundation and to place the levee on somewhat higher ground.

5. Incl 2. It should be noted that levee fill volumes and costs are based on data furnished in General Design Memorandum No. 3. As pointed out in para 5 of our 1st Ind dated 1 Dec 66, cited in para 1 above, the data and analyses presented in the GDM are not completely adequate to permit the levee to be constructed in stages to final grade without additional studies. As a result, at this time we do not actually know the volume of levee fill required to construct the levee to an ultimate grade taking into account all future settlement and displacement. Thus, the cost estimate for the levee is based on the best information available at this time.

6. Incl 4. Upon approval of the modified plan, local interests should be apprised of the plan including the increase in required

LMVED-TD (NOD 29 Nov 66) 1st Ind 13 Dec 66
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

non-Federal contribution and their views discussed in the proposed supplement to the general design memorandum.

FOR THE DIVISION ENGINEER:

A. J. DAVIS
Chief, Engineering Division

4 Incl (quad)
wd 1 cy ea

Copy furnished:
NOD, ATTN: LMNED-PR

ENGCW-EZ 2nd Ind

SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

Da, CofEngrs, Washington, D.C. 20315, 31 January 1967

TO: Division Engineer, Lower Mississippi Valley Division

1. References:

a. 2nd Indorsement, ENGCW-EZ, 27 October 1966, on letter LMNED-PP, 18 August 1966, subject: "Lake Pontchartrain, Louisiana and Vicinity, Design Memorandum No. 1, Hydrology and Hydraulic Analysis, Part I - Chalmette."

b. 2nd Indorsement, ENGCW-EZ, 31 January 1967 on letter LMNED-PP, 1 November 1966, subject: "Lake Pontchartrain, Louisiana and Vicinity, General Design Memorandum No. 3, Chalmette Area Plan."

2. The modification recommended by the District Engineer in paragraph 16 of the basic letter is approved subject to the comments of the Division Engineer, the comments in OCE 2nd indorsement referenced in paragraph 1a above, and the following additional comment.

3. Since the modification involves a significant increase in the project cost, the Appropriations Committees of Congress will have to be notified by this office. For this purpose the views of local interests on the plan and the increase in the non-Federal contribution is necessary. It is requested that the modification be discussed with local interests and this office be advised of the results thereof.

4. Cost for Reach E, shown in orange on Inclosure No. 1, should be stated in the supplement mentioned below, since the levee ABCD will replace this authorized levee as well as that shown in green.

5. Preparation of the supplement recommended in paragraph 17 of the basic letter is approved.

FOR THE CHIEF OF ENGINEERS:

David D. Hall

wd incl

DANIEL D. HALL
Major, Corps of Engineers
Assistant Director of Civil Works
for Mississippi Valley

LMVED-TD (NOD 29 Nov 66) 3d Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, Lower Miss. Valley Div, CE, Vicksburg, Miss. 39180 9 Feb 67

TO: District Engineer, New Orleans District, ATTN: LMNED-PR

1. Referred to note approval, subject to comments of 1st and 2d Indorsements.

2. Early action should be taken in regard to para 3, 2d Ind so that OCE may be furnished required information prior to impending Appropriations Hearings. In addition to a statement setting forth the views of local interests on the proposed modification and the increase in local costs, the submittal should clearly show that the modification of the Chalmette Area levee plan will obviate the need for the "Reach E" feature of the New Orleans to Venice hurricane protection project at a saving of $_____ to that project. Furthermore, the modified levee plan will eliminate the Bayou Lawler to Violet segment of the Chalmette Area as now planned at a saving of $_____. This proposed addition to the Chalmette Area will provide protection to all areas in St. Bernard Parish that can be economically justified at this time.

FOR THE DIVISION ENGINEER:

George B. Davis
for A. J. DAVIS
Chief, Engineering Division

LMNED-PP (NOD 29 Nov 66) 4th Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, New Orleans District, CE, New Orleans, La. 70160 23 Feb 67

TO: Division Engineer, Lower Miss. Valley, CE, ATTN: LMVED-TD

1. In accordance with paragraph 3 of the 2d Indorsement, the State of Louisiana, Department of Public Works, which was designated by the Governor of Louisiana on 2 November 1965 as "...the agency to coordinate the efforts of local interests and to see that the local commitments are carried out promptly....," was requested to comment on the acceptability of the subject modification to local interests and their willingness to provide an additional local contribution therefor of approximately $2,150,000, inclusive of the value of lands, damages, relocations, and a cash contribution (or equivalent work) amounting to $1,080,000. A copy of our telegraphic request is inclosed.

2. By letter dated 13 February 1967, the Department of Public Works concurred in the modification and gave assurance that "...the requirements made of local interests will be carried out by the appropriate local governmental units." A copy of this response is inclosed.

3. The modified Chalmette Area Plan will extend hurricane protection to all areas in St. Bernard Parish for which such protection can be economically justified at this time. Since the entire Reach "E" feature of the "New Orleans to Venice, La.," project is located within the protected area of the modified Chalmette Area Plan, construction of this plan will, in addition to producing other benefits, generate all of the benefits realizable through construction of the Reach "E" feature, thus obviating the need for construction of the feature at a saving of $1,316,000 ($921,900 Federal, $394,100 non-Federal, based on PB-3 approved 2 June 1966). In addition, the return levee along Bayou Dupre, a segment of the Chalmette Area Plan as originally authorized, is not required with the modified plan, and its elimination results in an additional saving of $7,212,000 ($5,048,400 Federal and $2,163,600 non-Federal, based on DM No. 3, 1 November 1966).

Thomas J. Bowen

THOMAS J. BOWEN
Colonel, CE
District Engineer

2 Incl (dupe)
5. NOD telegram LMNED-PP-6, 7 Feb 67
6. DPW ltr dtd 13 Feb 67

LMVED-TD (NOD 29 Nov 66) 5th Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, Lower Miss. Valley Div, CE, Vicksburg, Miss. 39180 27 Feb 67

TO: Chief of Engineers, ATTN: ENGCW-EZ

Information requested by OCE 2d Ind is forwarded for your information. To avoid misinterpretation of the last sentence of para 3, 4th Ind, and to correct minor discrepancies, a summary of costs rounded to nearest $1,000 is furnished below.

Cost of Modifying Chalmette Area Plan

Total Const. Cost	$14,819,000
Right of Way	537,000
Total Cost	$15,356,000
Less Levee Violet to Point D	7,212,000
Total Cost of Modifying Plan	$ 8,144,000

Cost of Chalmette Area Plan as Modified

Total Cost of Modified Plan	$37,697,000
Previous Estimate	29,553,000
Increase	$ 8,144,000
Federal Cost of Modified Plan	$27,689,000
Previous Estimate	21,698,000
Increase	$ 5,991,000
Non-Federal Cost of Modified Plan	$10,008,000
Previous Estimate	7,854,000
Increase	$ 2,154,000

Additional Saving

Elimination of Reach E of New Orleans to Venice Hurricane Protection Project

Total Savings	$ 1,316,000
Federal Cost	$ 922,000
Non-Federal Cost	$ 394,000

FOR THE DIVISION ENGINEER:

George B. Davis
GEORGE B. DAVIS
Acting Chief, Engineering Division

2 Incl
Dupe cy wd

Copy furnished:
NOD, ATTN: LMNED-PP

ENGCW-EZ (LMNED-PR, 29 Nov 66) 6th Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, CofEngrs, Washington, D.C. 20315, 12 April 1967

TO: Division Engineer, Lower Mississippi Valley Division

1. Reference is made to letter, LMVED-A, 21 March 1966, subject: "Hurricane Protection - Lake Ponchartrain and Vicinity - Chalmette Area" and 1st indorsement, ENGCW-OM, 15 April 1966 thereon.

2. The construction costs presented in the 4th and 5th indorsements and in the GDM (DM #3) include costs for riprap foreshore protection along the Mississippi River - Gulf Outlet reach of the project. 1st indorsement ENGCW-OM, 15 April 1966, referenced in paragraph 1 above, directed that these costs be charged to the navigation project (MR-GO) as a Federal cost for wave protection. These costs, including the modified plan, are in excess of $4,000,000. The estimated costs should be adjusted by the District and revised estimates submitted to OCE, together with draft of letters to Congressional Committees. Since the riprap should be included in the Gulf Outlet (MR-GO) project, the necessary revisions to the design memorandum for the Gulf Outlet project should be made, or a supplement be prepared, and furnished OCE.

FOR THE CHIEF OF ENGINEERS:

wd incl

WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

LMVED-TD (NOD 29 Nov 66) 7th Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, Lower Miss. Valley Div, CE, Vicksburg, Miss. 39180 2 May 67

TO: District Engineer, New Orleans, ATTN: LMNED-PR

1. Referred for necessary action.

2. The question of charging the cost of riprap protection along the GIWW has been submitted to OCE by letter, LMVBC, SUBJECT: Hurricane Protection, Lake Pontchartrain and Vicinity, 24 Apr 67 for guidance. You will be advised when a decision is reached.

FOR THE ACTING DIVISION ENGINEER:

George B. Davis

GEORGE B. DAVIS
Acting Chief, Engineering Division

LMNED-PP (NOD 29 Nov 66) 8th Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, New Orleans District, CE, New Orleans, La. 70160 14 Jul 67

TO: Division Engineer, Lower Miss. Valley, CE, ATTN: LMVED-TD & LMVBC

1. In addition to the prior elements of this chain, reference is made to LMVBC letter dated 24 April 1967, subject "Hurricane Protection - Lake Pontchartrain and Vicinity," and 1st through 3d Indorsements thereto.

2. Forwarded herewith are the following:

a. Draft of proposed letter from the Chief of Engineers to the Special Assistant to the Secretary of the Army for Civil Functions explaining the inclusion of foreshore protection costs in the "Mississippi River-Gulf Outlet, La.,"project.

b. Draft of proposed letter from the Special Assistant to the Director, Bureau of the Budget, transmitting a draft of proposed letters to the Public Works and Appropriations Committees of the United States Congress notifying them of the increase in cost of the "Mississippi River-Gulf Outlet, La.," project as a result of including foreshore protection in the plan of improvement, and requesting information as to whether there is any objection by the Bureau to the submission of the proposed letters to the respective committees.

c. Draft of proposed letter to the Committees.

3. Design for a portion of the foreshore protection has been covered in the general design memorandum (No. 3) for the Chalmette Area Plan. Inasmuch as the foreshore protection is more or less integral to and must be coordinated with the levee construction, it is planned to cover the design of the remaining foreshore protection in the general design memorandum for the Lake Pontchartrain Barrier Plan (No. 2) and in Supplement No. 1 to the general design memorandum for the Chalmette Area Plan. In addition a very brief letter-type supplement to the general design memorandum for the Mississippi River-Gulf Outlet (MR-GO) will be prepared and submitted for approval. This supplement, which will present the bases for inclusion of foreshore protection in the MR-GO project, the location of such protection, and a revised cost estimate for the overall project, will be prepared and submitted for approval after the notification of the Congressional Committees has been effected.

LMNED-PP (NOD 29 Nov 66) 8th Ind (contd) 14 Jul 67
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

4. Approval of the course of action outlined in paragraph 3. above is recommended.

3 Incl (dupe)
7, 8, & 9 as listed w/d

GEORGE H. HUDSON
Acting District Engineer

LMVED-TD (NOD 29 Nov 66) 9th Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, Lower Miss. Valley Div, CE, Vicksburg, Miss. 39180 14 Aug 67

TO: Chief of Engineers, ATTN: ENGCW-EZ

1. In our opinion the drafts of letters as prepared by the New Orleans District, mentioned in paragraph 2, 8th Ind, are not fully responsive to the request of the Chief of Engineers in his 2d and 6th Ind. Actually there are 3 projects being modified under the discretionary authority of the Chief of Engineers. Modification of the Chalmette Area affects both the Lake Pontchartrain and Vicinity project and the New Orleans to Venice project. Modification of the Mississippi River-Gulf Outlet project includes levee protection affecting the Lake Pontchartrain and Vicinity project. In addition the New Orleans to Venice project is being modified because of need to change net levee grade and construct levees on modified alignments. Thus, it is our opinion that each of these projects should be covered separately but concurrently. For this reason we are forwarding for each of the three projects the following:

a. Draft of proposed letter from the Chief of Engineers to the Special Assistant to the Secretary of the Army for Civil Functions.

b. Draft of proposed letter from the Special Assistant to the Director, Bureau of the Budget.

c. Draft of proposed letter to the Committees.

2. The course of action outlined in paragraph 3 of 8th Ind is concurred in except we recommend proceeding with preparation of the supplement to the general design memorandum for the Mississippi River-Gulf Outlet project without waiting for notification of the Congressional Committee.

ACTING
FOR THE/DIVISION ENGINEER:

A. J. DAVIS
Chief, Engineering Division

9 Incl (dupe)
wd Incl 7, 8, and 9
Added: 10 thru 18, as listed

Copy furnished:
NOD, ATTN: LMNED-PP

ENGCW-EZ (LMNED-PR, 29 Nov 66) 10th Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, CofEngrs, Washington, D. C., 20315, 16 November 1967

TO: Division Engineer, Lower Mississippi Valley Division

1. The action indicated in paragraph 2 of the 9th indorsement is satisfactory.

2. It is proposed to notify the Committees of Congress at an early date of the modifications of the projects, indicated in paragraph 1 of the 9th indorsement, which are considered to be within the discretionary authority of the Chief of Engineers.

FOR THE CHIEF OF ENGINEERS:

wd Incls

WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

LMVED-TD (NOD 29 Nov 66) 11th Ind
SUBJECT: Lake Pontchartrain, Louisiana and Vicinity - Modification of the Chalmette Area Plan to Include Larger Area

DA, Lower Miss. Valley Div, CE, Vicksburg, Miss. 39180 22 Nov 67

TO: District Engineer, New Orleans, ATTN: LMNED-PP

Referred to note approval of action indicated in 9th Indorsement.

FOR THE DIVISION ENGINEER:

George B. Davis Jr.
A. J. DAVIS
Chief, Engineering Division

REVIEW OF REPORTS

ON

ST. BERNARD PARISH, LOUISIANA

SUPPLEMENT

INFORMATION CALLED FOR BY SENATE RESOLUTION 148, 85TH CONGRESS, ADOPTED 28 JANUARY 1958

REVIEW OF REPORTS
ON
ST. BERNARD PARISH, LOUISIANA

SUPPLEMENT

Information Called for by Senate Resolution 148,
85th Congress, Adopted 28 January 1958

1. PROJECT DESCRIPTION AND ECONOMIC LIFE

The structural improvements under consideration consist of extension of the hurricane protection levees in St. Bernard Parish eastward along Bayou LaLoutre to encompass Shell Beach, Hopedale and Reggio, and southward along Bayou Terre aux Boeufs to Delacroix (see plate 1 of the report). A project life of 100 years has been used for economic evaluation since the development of the protected area for residential use is forecast.

2. PROJECT COSTS AND ANNUAL CHARGES

a. First cost. The estimated first cost for a levee to encompass Shell Beach, Hopedale, and Reggio is $38,800,000 including $1,800,000 for toe protection of the levee along the Mississippi River-Gulf Outlet ship channel. In view of the lack of justification for the more developed areas, a cost estimate was not made for the levee to Delacroix.

b. Annual charges. The estimated average annual charges for the levee to Hopedale are:

ESTIMATED ANNUAL CHARGES

Item	Project life 100-year	Project life 50-year
	$	$
Interest	1,970,000	1,970,000
Amortization	21,700	229,400
Maintenance	118,100	118,100
Replacements	15,000	15,000
Total annual charges	2,124,800	2,232,500

3. BENEFITS

The average annual benefits for the Verret to Hopedale area based on a project life of 100 years and an interest rate of 4-5/8 percent is $200,000 consisting of $150,000 for flood damages prevented and $50,000 for land enhancement. Details of the estimate

are given in paragraph 19 of the report. In view of the very small benefit-cost ratio benefits were not estimated for a 50-year project life.

4. BENEFIT COST RATIO

The benefit-cost ratio for a 100-year project life as shown in the report is 0.1.

5. PHYSICAL FEASIBILITY AND COST OF PROVIDING FOR FUTURE NEEDS

Construction of levees in the coastal marsh area such as St. Bernard Parish is a difficult and time consuming process. Due to weak foundation and poor construction materials it is necessary to construct the levees to an unusually large section and in several lifts with approximately 2 years for consolidation between lifts. The extension of the Chalmette area plan (under Lake Pontchartrain and Vicinity, Louisiana project) resulted in the saving of construction costs for the levee from Violet to the Mississippi River-Gulf Outlet and for Reach E of the Mississippi River Delta at and below New Orleans project. Further extension of the levee system at this time could result in similar savings by eliminating levees in the existing plan that would be replaced by levees in the modified plan. However, in view of the very low elevations of the marsh and limited room along the ridges at the bayous for development, it is very unlikely that any substantial additional development will take place in the next 50 years. The extension of the Chalmette area plan, already authorized by the Chief of Engineers, provides an adequate area for future development.

6. EXTENT OF INTEREST IN THE PROJECT

Hurricanes "Betsy" (September 1965), "Camille" (August 1969), and threat of "Laurie" (October 1969) has made residents of the exposed areas and parish and state officials very aware of the threat of hurricane tidal overflow in St. Bernard Parish and other coastal marsh areas. There has been much public discussion since hurricane "Camille" of the existing hurricane protection projects in Orleans, St. Bernard, and Plaquemines Parishes. The St. Bernard Parish Police Jury requested that they be allowed to review the report in lieu of a public hearing. This request was granted. In their comments (see paragraph 24 and appendix C of the report) the Police Jury stated that they were not in agreement with the conclusions and recommendations in the report. They did not furnish any information to rebut the findings in the report.

7. EFFECTS OF PROJECT ON STATE AND LOCAL GOVERNMENTS

The improvements under study are estimated to increase the costs for hurricane protection in St. Bernard Parish by about $37,000,000 (see paragraph 17b of the report) of which a minimum

of 30 percent or about $11,000,000 would have to be born by non-Federal interests. In view of the local requirements for the Chalmette area hurricane protection, estimated to exceed $9,000,000, the St. Bernard Parish Police Jury would probably have difficulty in raising additional funds for participation in a more extensive project. Development of additional areas would increase the tax base and increase the parish income but would also require additional expenditures for service facilities such as roads, schools, water, etc.