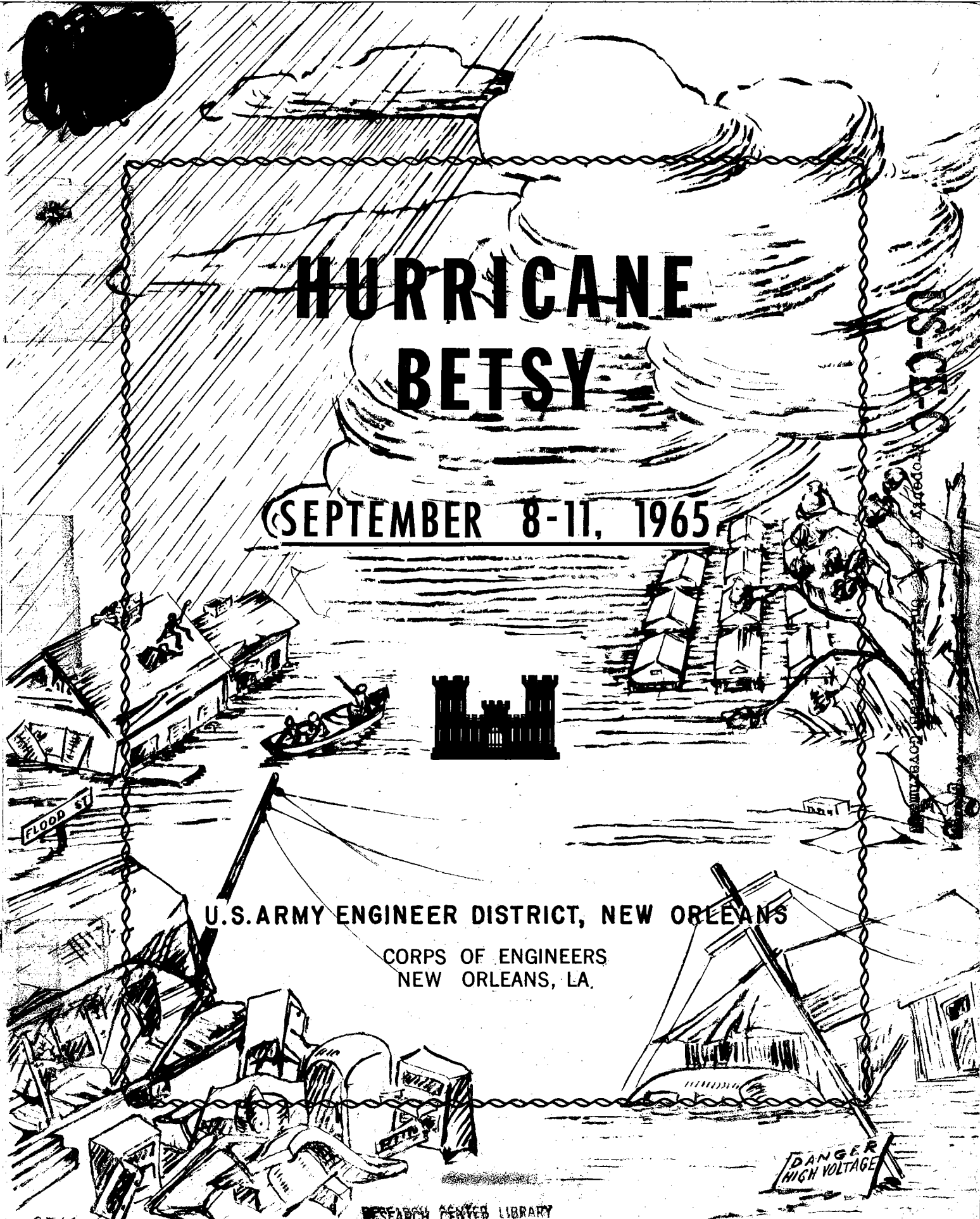
HURRICANE BETSY

SEPTEMBER 8-11, 1965



U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS

CORPS OF ENGINEERS
NEW ORLEANS, LA.

SERIAL NO.

REPORT
ON
HURRICANE BETSY
8-11 SEPTEMBER 1965
IN THE
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS

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

NOVEMBER 1965

REPORT
ON
HURRICANE BETSY
8-11 SEPTEMBER 1965
IN THE
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS

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HIGH TIDE FLOODING EAST OF INNER HARBOR NAVIGATION CANAL IN ORLEANS PARISH
NEW ORLEANS, LA., 11 SEPTEMBER 1965

FOREWORD

At 5:00 p.m., c.s.t., on 26 August 1965 a tropical depression, destined to become "one of the most destructive hurricanes of the 20th century," was located approximately 675 miles east-northeast of the isle of Trinidad. The squalls that spawned this hurricane moved in a west-northwesterly direction and were identified by a reconnaissance aircraft in the morning of the 27th. By 4:00 p.m., c.s.t., of that same day gale warnings were issued along the Lesser Antilles and the depression was then "Tropical Storm Betsy." By 29 August the tropical storm had developed into "Hurricane Betsy," with winds of 80 m.p.h. On 7 September 1965 "Betsy" stalled off the southern tip of Florida and on 8 September 1965 moved west through the Florida Keys and into the Gulf of Mexico. By early evening of 9 September 1965--9:00 p.m., c.s.t.--the eye of hurricane "Betsy" crossed the Louisiana coast just west of Grand Isle, Louisiana, with winds reported to have velocities ranging from 70 to 105 m.p.h. and gusts of better than 160 m.p.h. which produced tides up to 16 feet above m.s.l. "Betsy," the most destructive hurricane on record to strike the Louisiana coast, inundated an area of some 4,800 square miles, killed 81 persons within the state, caused about 250,000 persons to be evacuated, and disrupted transportation, communication, and utilities service throughout the eastern coastal area of Louisiana for weeks.

The purpose of this report is to record meteorologic and hydrologic phenomena of the storm and to evaluate the damages to physical property within the areas inundated in the U. S. Army Engineer District, New Orleans, by hurricane "Betsy." All data and evaluations given in this report are as accurate as possible for the time available to collect field data.

HIGH TIDE FLOODING EAST OF INNER HARBOR NAVIGATION CANAL IN ORLEANS PARISH

NEW ORLEANS, LA., 11 SEPTEMBER 1965

REPORT
ON
HURRICANE BETSY
8-11 SEPTEMBER 1965
IN THE
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS

I - AUTHORITY

1-01. Authority.- This final report on hurricane phenomena and damages has been prepared in accordance with the instructions contained in EM 500-1-1 dated 1 August 1961, paragraphs 172.10e and 172.82, and the authorization of the Chief of Engineers, by teletype dated 17 September 1965. An after-action report on Public Law 875 activities will be submitted at a later date.

1-02. Scope.- The report contains information on the meteorologic and hydrologic features of the hurricane "Betsy" that swept across the Louisiana coast in the New Orleans District on 8-11 September 1965. Presented also are estimates of the damages sustained in the stricken areas from the tidal inundation, hurricane winds and rainfall that attended the storm, and some information of an engineering nature. Estimates of damages are, however, limited to the area inundated by tidal overflow in the parishes of Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. John the Baptist, St. Tammany, Tangipahoa, and Terrebonne. These parishes are shown on plate 1. The tidal overflow areas within these parishes are shown on plate 5. The estimate of damages also includes the damage sustained by the offshore oil and gas industries. Included in this report are the following features:

a. Pertinent hydrological, meteorological, and other engineering data collected.

b. Description of flooded areas and extent of damages caused by tides, wind, and rain.

c. Description of damage survey performed, and monetary estimates of damages by tidal overflow, wind, and rain.

d. Estimates of flood damages prevented by existing Federal flood control works.

HIGH TIDES AND WIND, GRAND ISLE, LA.
23 SEPTEMBER 1965

II - HISTORY OF HURRICANE

2-01. "Betsy," one of the great hurricanes of this century and the most destructive of record on the Louisiana coast, was first located by a Navy hurricane reconnaissance aircraft in the Atlantic Ocean at 9:30 a.m., c.s.t.[1] on 27 August 1965. It was identified as a moderate tropical disturbance with maximum surface winds of about 44 m.p.h. At this time it was approximately 2,200 miles southeast of the Louisiana coast. From the time of its inception until it reached the Louisiana coast on 9 September "Betsy" moved generally along three distinct paths, each having the similar characteristic of beginning on a westerly course that veered to the northwest.

2-02. The first path of "Betsy" had started as squalls in the Atlantic Ocean some 18 hours before discovery by the reconnaissance plane at 9:30 a.m. of the 27th. At that time, the maximum surface winds were about 44 m.p.h. making it a "tropical depression." By 4:00 p.m. of that same day the storm that had started as a "moderate depression" had intensified to a tropical storm stage and was named "Betsy." Gale force winds had extended about 250 miles in the semi-circle to the north of center. "Betsy" was then centered 300 miles east-southeast of Barbados and was moving west-northwest at 15 m.p.h. As a tropical storm, "Betsy" moved through the Lesser Antilles in a northwesterly direction at 21 m.p.h. By the 29th "Betsy" had intensified to hurricane strength, with winds of 80 m.p.h. and was now centered 200 miles north-northeast of San Juan, Puerto Rico. The next 2 days found "Betsy" stalling by making a gradual loop about 275 miles north of Puerto Rico, and the winds decreased from 85 to 65 m.p.h.

2-03. The second path began the next day, 1 September, when "Betsy" began moving westward and regained hurricane intensity with winds increasing from 80 to 150 m.p.h. By the 2d of September "Betsy" had moved on a northwesterly course and was moving at 10 m.p.h. On the 3d she skirted east of the Bahamas and by evening of the next day the forward movement had slowed down, had come to a standstill, and then gradually performed another loop reaching its most northerly location in the Atlantic Ocean some 430 miles south of Cape Hatteras, North Carolina. A large high pressure area over the eastern United States had effectively blocked any further northward movement of the hurricane.

2-04. "Betsy," after having stalled again almost all day 5 September, began an unusual southward movement at 8 m.p.h. and started its third and last path. The center was then located northeast of

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[1] Central standard time, to which all times are referenced unless otherwise noted.

Great Abaco Island, Bahamas, with winds of 125 m.p.h., and the hurricane measuring 450 miles from north to south. By morning of the next day "Betsy" was moving in a southwesterly course at 8 m.p.h. and had winds of 85 m.p.h. The hurricane continued to intensify in strength and by midafternoon, gusts of 147 m.p.h. were measured at Great Abaco. On Tuesday morning, 7 September, the wall cloud with an open eye of 40 miles in diameter swept over the northern tip of Nassau, moving on a westerly course. Nassau received a severe pounding from violent winds and high tides.

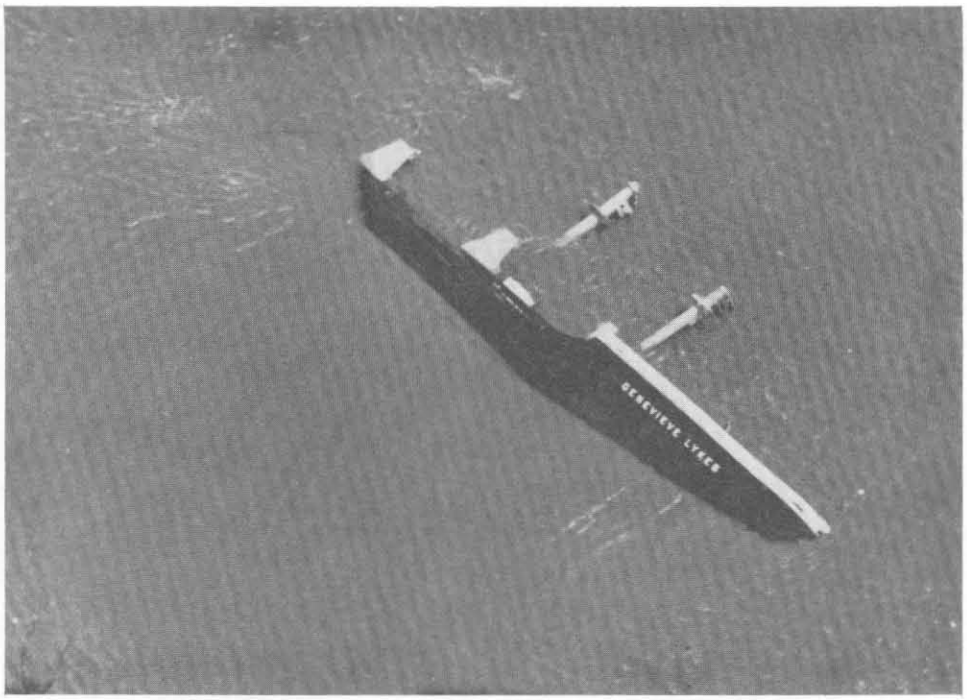
2-05. Hurricane warnings had been issued for extreme southern Florida at 10:00 a.m. on the 7th; however, at 1:00 p.m. of the following day, the warnings were extended on the Florida east coast as far north as Fort Pierce and on the Florida west coast to Venice. By midnight, winds of hurricane force were lashing the Miami area and continued for about 12 hours with peak gusts up to 105 m.p.h. High winds, tidal flooding, and beach erosion caused damage along the lower Florida east coast estimated to be $139,330,000. On the morning of the 8th, hurricane "Betsy" moved westward across the Upper Keys at about 10 m.p.h., and gales extended 300 miles from the center, in all quadrants. Wind speeds reached 140 m.p.h. as it passed over the Keys and the rainfall reached from 4 to 6 inches in the area of strong winds.

2-06. By daybreak on 9 September "Betsy" was well into the Gulf of Mexico and moving on a northwesterly course. At 6:00 a.m. on 9 September, hurricane warnings were issued from the mouth of the Mississippi River westward to Galveston, Texas. Land-based radar stations picked up the storm center at noon about 225 miles south of Mobile, Alabama. In the afternoon of the same day, the forward speed had increased to 15 m.p.h. At that time, Navy reconnaissance aircraft indicated the storm was intensifying and had a central pressure of 28.00 inches. Reports at 8:00 p.m. indicated a gradual change of direction from west-northwest to northwest and a corresponding increase in forward speed from 17 to 22 m.p.h.

2-07. As the storm approached the coast winds were estimated at 150 m.p.h. At 5:00 p.m., the Coast Guard station on Grand Isle, Louisiana, reported winds of 70 to 105 m.p.h. with gusts better than 160 m.p.h. At 10:00 p.m., the hurricane center crossed the coast just west of Grand Isle with a tide of 8.8 feet above mean sea level and a barometer reading of 28.00 inches. By 10:20 p.m. winds in New Orleans had exceeded 100 m.p.h. The center passed 35 miles southwest of New Orleans by midnight and just west of Baton Rouge at 4:00 a.m. on 10 September. "Betsy" then turned northwest and winds decreased to below hurricane force as it moved into northeast Louisiana. During the night of the 10th and the morning of the 11th, "Betsy" became an extratropical storm as it moved over eastern Arkansas and continued into the Ohio River Valley. The path of the hurricane is shown on plate 2.

BEACHED VESSELS, NEW ORLEANS VICINITY, LA.
11 SEPTEMBER 1965

BEACHED VESSELS, NEW ORLEANS VICINITY, LA.
11 SEPTEMBER 1965



THE GENEVIEVE-LYKES

THIS VESSEL IS LYING ON TOP OF ANOTHER LYKES SHIP IN THE MISSISSIPPI RIVER NEAR NEW ORLEANS, LA., 21 SEPTEMBER 1965

BEACHED VESSEL

THE WORLDOVER ST-1 AND TUG ON THE MISSISSIPPI RIVER LEVEE ABOVE PORT SULPHUR, LA., 13 SEPTEMBER 1965

III - EMERGENCY OPERATIONS

3-01. New Orleans District.- The Operations Division of the New Orleans District began plotting the course of the storm upon its inception in the Atlantic Ocean. The Weather Bureau furnished information at 2- to 6-hour intervals while the storm was in the Atlantic Ocean and the southern Gulf of Mexico, and hourly as the storm approached the Louisiana coast. On 7 September, as the storm moved westward and threatened the eastern coast of Florida, personnel of the New Orleans District were alerted for possible emergency action.

3-02. On Thursday morning, 9 September, it became apparent that the hurricane would strike somewhere along the Louisiana coast. Precautionary measures were put into effect by the District Engineer for the protection of Government property and installations, including the establishment of a 24-hour-per-day hurricane watch by the Operations Division. The unusually high forward speed of the storm, and its erratic course, limited the time available for prestorm preparations. The emergency measures were put into effect at 8:00 a.m. and hurricane winds struck the Louisiana coast at Grand Isle at approximately 6:00 p.m., a period of only 10 hours.

3-03. Since it was anticipated that commercial power would be lost during the storm, emergency generators were placed at critical locations on the District Reservation, load tested, and found to be in proper operating condition. An around-the-clock radio watch was set up and maintained throughout the emergency. At 8:50 p.m. Thursday, commercial power failed and for the next 5 days the District Reservation operated on emergency power. Radio communications at the District Headquarters were available throughout the storm. Most of the field units in southeastern Louisiana, however, could not be reached Thursday night because their communication equipment was rendered inoperative by failure of electrical power or by flooding.

3-04. From 4:00 p.m. Thursday until communications were lost, field units reported hourly on weather conditions at their locations. These reports included gage heights, barometric pressure, wind direction and velocity, and rainfall. These data were recorded and evaluated and sent to all District elements involved. Liaison with local officials and Civil Defense agencies was established prior to and maintained throughout the period of the emergency.

3-05. Field installations wasted no time in securing their physical plant and completing preparations to ride out the storm. All floating plant was either tied up securely or moved to safe harbor. The District fleet at New Orleans was moved from the Mississippi River to the boat pen in the Harvey Canal. This fleet consisted of

20 boats, ranging in length from 35 to over 100 feet, and six 500-ton barges.

3-06. Since the Schooner Bayou control structure is located in a very low coastal area, all personnel were evacuated and moved to the Vermilion Lock. The hopper dredge "Langfitt," working in the Calcasieu River, was ordered to proceed to a safe harbor and at 2:45 p.m. was secured at Lake Charles.

3-07. By Thursday night, 9 September, all possible precautions had been taken; continuous radio liaison was being maintained, where possible; necessary evacuation had been completed; and, all stations had been advised to expect extremely high winds and high tides. A small crew remained on duty at the District Reservation to make emergency repairs, and during the storm three members were sent to the Industrial Canal to sandbag a leak that had developed in the levee. This group continued to work until the winds make it impracticable to continue the sandbagging.

3-08. As the storm abated on Friday morning, the initial phase of the operation came to a successful conclusion. This phase was to protect Government property and personnel. There were no deaths or injuries to Government personnel, and damage to Government installations and plants had been held to a minimum. Only two pieces of floating plant, the survey boat "Giles" and an office barge at Venice, Louisiana, suffered any major damage.

3-09. On Friday morning, personnel and boats were sent into the flooded area near the Industrial Canal to assist in the rescue operations. The Corps of Engineers' personnel were the first employees of any Governmental agency to begin rescue operations in the area. By Friday night, over 1,200 persons had been evacuated to higher ground by the Corps.

3-10. Restoration and repair of levees below New Orleans under Public Law 84-99 were initiated to end the threat of additional flooding, and this work is continuing at the present time.

3-11. Vast areas of Orleans, Plaquemines, and St. Bernard Parishes were inundated by the tidal surge that accompanied the storm. This surge either overtopped or breached the non-Federal levee protecting these areas. Because of the low elevation of the flooded areas, it was necessary to pump out the floodwaters. The Corps mobilized eight dredges to aid in relieving the flooding. Two dredges and a booster barge operated in the Venice, Louisiana, area and six operated in the vicinity of New Orleans. These dredges worked continually until the area was essentially dry. In addition, the Corps furnished and installed pumps at various locations in the flooded area. The largest installation was at the Citrus Canal in New Orleans where three large pumps were placed on a pile-supported platform to aid in draining the Citrus area. In addition, two small skid-mounted pumps were used nearby.

HIGH TIDE FLOODING EAST OF INNER HARBOR NAVIGATION CANAL
NEW ORLEANS, LA., 11 SEPTEMBER 1965

EVACUATION CENTER (IN NEW ORLEANS SCHOOL)
NEW ORLEANS, LA., 11 SEPTEMBER 1965

WIND DAMAGE, ORLEANS MARINA
NEW ORLEANS, LA., 11 SEPTEMBER 1965

WATER AND WIND DAMAGE
NEW ORLEANS, LA.

3-12. On 10 September, the Corps initiated damage surveys in all parishes affected by the hurricane. Thirty-five inspections teams--each of which was led by an engineer--were dispatched to the parishes within the declared disaster area. These teams set up temporary offices in each parish and began working with state, parish, and municipal governmental agencies in long-term clean-up and rehabilitation activities. Over 200 people were sent from Corps' offices all over the country to supplement the New Orleans District staff.

3-13. This same day the President of the United States came to New Orleans to survey the damages. He declared that a major natural disaster had occurred in Louisiana and pledged all possible Federal assistance to the people of the areas. Upon this declaration, the Office of Emergency Planning (OEP) was given the authority to coordinate the relief and rehabilitation activities of all Federal agencies. OEP assigned the Corps of Engineers the responsibilities for debris removal and restoration of levees, dikes, and drainage facilities. Over 300 Corps' personnel have been engaged in flood-fighting, debris removal, demolition, and repair activities.

3-14. Activity of other agencies.- Upon President Johnson's declaration that 10 counties in Florida, 12 counties in Mississippi, and 35 parishes in Louisiana be declared disaster areas, the Office of Emergency Planning began coordinating the work of the Federal agencies involved in rescue and rehabilitation activities. Federal agencies, acting under authority from the OEP and supplemented by specific authorities available to them, state and local agencies, private companies and individuals greatly reduced the amount of suffering and damage resulting from the storm.

3-15. The OEP established disaster field offices at West Palm Beach, Florida; Gulfport, Mississippi; and Baton Rouge and New Orleans, Louisiana to coordinate activities in each area, and as of 6 October the President had allocated $1,500,000 for OEP operations in Florida, $400,000 in Mississippi, and $2,000,000 in Louisiana under Public Law 875, 81st Congress.

3-16. The Department of Agriculture has initiated programs in Louisiana to sustain stranded livestock in Jefferson, Orleans, Plaquemines, St. Bernard, and St. John the Baptist Parishes, Louisiana. In excess of 2,500 tons of Government-owned food was made available to sustain the population in the disaster area, while some 500 tons of feed was distributed to over 4,000 head of cattle. Under these programs, the Government-owned food was distributed through the OEP, the Red Cross, and other relief agencies.

3-17. The Department of Commerce has worked with local highway officials in estimating damages to roads, streets, and bridges. Damage has been relatively light with no major highways severely damaged. Full cooperation is being rendered by the Bureau of Public

Roads to state and local agencies. The Maritime Administration has worked as technical advisors to the Board of Commissioners, Port of New Orleans, and has distributed stockpiled emergency supplies to various public agencies.

3-18. The Department of Defense aided in rescue and relief activities both prior and subsequent to the storm. The U. S. Army, Air Force, Navy, and Marine Corps performed a variety of missions ranging from rescue and evacuation of persons from the flooded areas to airlifting personnel, food, medicine, clothing, and other essential items into the area from all sections of the country.

3-19. The U. S. Coast Guard (Treasury Department) evacuated over 12,000 people from the disaster area and buoyed obstructions to navigation in the Mississippi River and other streams where required.

3-20. The Department of Health, Education, and Welfare has provided inspection services to OEP on sewerage systems, waterworks, insect-infested areas, and other matters relating to the public health. In addition to this, measures were taken to control the population of flying insects in areas considered to constitute a health hazard.

3-21. The Federal Bureau of Investigation (Justice Department) sent teams of specialists to aid local officials in identifying the bodies of hurricane victims.

3-22. The Department of Labor is sponsoring the Neighborhood Youth Corps program in the disaster areas and over 1,500 youths, between the ages of 16 and 21, have been employed to aid in the relief and rehabilitation activities of various public and nonprofit organizations.

3-23. Independent Federal agencies assisting in the rehabilitation of the devastated areas included the Housing and Home Finance Agency who sent 23 teams of inspectors into the area to estimate damage to public buildings and related equipment including publicly-owned utility systems. A need for considerable emergency housing developed immediately after the storm. This agency surveyed the available housing to determine its adequacy and to date has purchased 350 mobile homes which were distributed through GSA. The General Services Administration distributed food, clothing, water, emergency generators, and other essential items to local agencies which were used throughout the disaster areas. Office space was leased to other Federal agencies as required while automobiles and other supplies were procured to meet the needs of an expanded operation. The Orleans Parish School Board was allowed to use a surplus Federal building to replace a school building destroyed by the storm. The Small Business Administration initiated a program of rehabilitation loans to individuals, small and large businesses, and

nonprofit organizations. These loans carry an interest rate of 3 percent and a maturity period of up to 30 years. Losses to buildings, furniture, equipment, inventory, and automobiles caused directly by the storm can be covered by this type of loan. The work is being coordinated with the financial assistance program of the Red Cross.

3-24. The Red Cross has assigned over 250 staff workers to assist local Red Cross chapter volunteers in emergency relief work and the feeding of some 60,000 persons in emergency shelters plus another 65,000 persons being fed from mobile canteens placed throughout the disaster areas. The Red Cross relief expenditures are expected to exceed $14 million.

3-25. Private utility companies did an outstanding job in restoring services in the damaged area. Electric and telephone services were the most severely damaged. Telephone repair crews were sent in from all over the country to aid in the restoration and repair work. The Southwestern Power Pool, an organization of private utility companies, very effectively coordinated the repairs to disrupted electrical services. The restoration of telephone communications and electric service is essentially complete. As of 6 October 1965, Federal, state, and local governmental agencies, private companies, and disaster relief organizations are continuing to work on an emergency basis to alleviate as much as possible the hardships and suffering brought about by the storm.

3-26. Evacuation.- The rapid forward movement of "Betsy" after entering the Gulf of Mexico reduced the hurricane warning time to less than 12 hours and thus made the job of evacuating the coastal areas of southeast Louisiana a more difficult problem. ("Betsy" was one of the fastest moving Gulf of Mexico hurricanes on record.) The relatively low incidence of fatalities is creditable to the willing cooperation of the general public, local police, Civil Defense officials, and other disaster relief agencies in one of the largest evacuations of danger areas accomplished in the continental United States. It is estimated that 90 percent of the population in the southeastern Louisiana coastal area--approximately 250,000 persons--was evacuated and moved to safe shelters on high ground. It is believed that, except for this mass evacuation, the number of fatalities would have been greater than that of the 1915 hurricane when 272 persons were killed. The tentative count of casualties in the state of Louisiana attributable to hurricane "Betsy" has been placed at 81 persons killed and some 17,600 persons injured.

HIGH TIDES, WIND, AND RIVER, SUNSET, LA.
22 SEPTEMBER 1965

IV - POST STORM COLLECTION OF DATA

4-01. General.- On 14 September 1965, after the water in the inundated areas had begun to subside, eight damage and five hydrology survey teams were dispatched to the devastated areas. This group, composed of 26 men experienced in storm and flood damage survey work, had been mobilized from U. S. Army Engineer Districts within the Lower Mississippi Valley and Southwest Divisions. Because of the contamination and unsanitary conditions of the disaster areas, it was necessary for each man to receive tetanus and typhoid injections before he could make the survey. During the initial stages of the survey, roads along the coast were blocked, telephone and power lines were down, and emergency measures to protect life and property were still in effect. The surveys were programed so that the investigations began in the accessible inland areas. Later, as conditions permitted, the survey was extended into the delta and coastal areas. Nevertheless, the survey was substantially completed in 30 days after hurricane "Betsy" crossed the Louisiana coastal area. In addition to the damage survey and hydrological teams, engineering surveys and inspections of structures and navigation channels were made by personnel from the New Orleans District and its area offices.

4-02. The survey teams canvassed some 50 cities, towns, and communities, and traveled an aggregate distance of some 52,000 miles. The survey encompassed an area extending 75 to 80 miles inland from the Louisiana coast in order to include those inundated areas on the north and west shores of Lake Pontchartrain.

4-03. Collection of hydrologic data.- Each hydrology team was made responsible for an area whose size was dependent on its proximity to the major damage area and the extent of its development. The primary assignment of these teams was the location and identification of high water marks and the location and identification of debris lines. The hydrology teams obtained all available miscellaneous information on tides, waves, winds, barometric pressures, and rainfall through interrogation of local citizens and officials.

4-04. The high water marks were located and levels were then run from known bench marks to establish their mean sea level elevation. A full description of the high water marks and their locations has been recorded.

4-05. Accuracy of the hydrology survey.- The hydrologic data are as accurate as could be determined by experienced men in the short time available. It was necessary for the teams to cover as much area as possible before the evidence of the storm effects were removed by clean-up and repair crews. The local citizens were extremely cooperative. The hydrology teams experienced no difficulty whatsoever in obtaining permission to go into privately-owned areas.

Valuable information was contributed also by parish and city officials, industrial plants, business establishments, navigation and drainage districts, newspapers, and private citizens. This information was especially helpful to the hydrology teams in their research for documental evidence of the effects of the storm. Some estimates and opinions based on observations without actual measurements are included in this report.

4-06. Records of all known recording tide gages and maximum stage gages operated by the Corps of Engineers, the U. S. Coast and Geodetic Survey, and industries in the area were obtained and the reference datum verified. These records are made a part of this report. All elevations refer to mean sea level datum as established by the U. S. Coast and Geodetic Survey in 1929, based on 1951 leveling.

4-07. Collection of storm damage data.- Damages sustained by all types of real and personal properties in the study area were estimated by field inspection and appraisal. These estimates include evaluation of damages to residences, recreation buildings, summer homes, commercial establishments, schools, churches, and public buildings. The field survey was augmented by personal interviews and direct correspondence with other Federal agencies, central offices of companies, and political subdivisions, to develop the estimates of damages to transportation facilities, industrial installations, communications, utilities, and public buildings. Liaison was maintained with the Salvation Army, the Louisiana National Guard, the American Red Cross, ecclesiastical organizations, Federal and State Civil Defense organizations, and other agencies to develop the costs incurred by these units in the care and relief of hurricane victims, as well as direct hurricane losses to property and equipment owned and operated by other organizations.

4-08. Estimates of losses to agriculture and farm buildings were obtained from county agents while damages to movable property, such as house trailers, automobiles, trucks, heavy equipment, boats, and barges, were estimated from field inspection. Insurance underwriters were contacted for damage appraisals and damage estimates were furnished by navigation interests, drainage districts, and fleet operators.

4-09. Accuracy of damage survey.- The limitations of time and manpower available to accomplish a survey of the effects of a storm the magnitude of "Betsy" permit certain inaccuracies to slip into the data obtained. Known inaccuracies include errors in sampling, in classification of data, lack of specific and accurate statistical information (i.e., installed worth of heavy industrial plants, etc.), lead time required in compilation of major agency data (Red Cross, National Guard, etc.) and the variation between individual surveyors in estimating damages to similar properties. It is pertinent to highlight a major difficulty encountered in the identification and

classification of damages. There is no after-the-fact criterion that can be applied to a structure that has been materially damaged or destroyed that will reconstruct the sequence of destruction. Thus, surveyors must use judgment based on available evidence to decide whether a structure was blown apart before hurricane surge waters reached it, whether waters floated the structure and the winds subsequently demolished it, or whether floating debris driven by wave action in an area of high surges pounded the structure, or if a combination of two or more of these factors constituted the force of major destruction.

4-10. Collection of engineering data.- Data were gathered by visual inspection, by both air and ground photography, and by topographic and hydrographic survey methods. Beach erosion and other large areas of damage were inspected by means of helicopters. Some additional data, including maps and photographs, were obtained from private interests. At the request of local interests, structures constructed by non-Federal agencies also were inspected in some instances.

HIGH TIDES, WINDS, AND RIVER, BURAS VICINITY, LA.
22 SEPTEMBER 1965

V - SUMMARY OF DATA

5-01. General.- This section contains various information on hydrology, economics, and engineering as pertinent to hurricane "Betsy."

5-02. Hydrologic and meteorologic data.- The following paragraphs contain hydrologic data and the related meteorologic data on barometric pressure, winds, rainfall and temperatures. Additional miscellaneous meteorologic and hydrologic data are included in Exhibits 1 through 19.

5-03. Barometric pressures.- About 10:00 p.m. on 9 September 1965 hurricane "Betsy" crossed the coast of Louisiana near Grand Isle. At this time the Coast Guard station on the island reported a central pressure of 28.00 inches. Houma, on the path of the hurricane and located approximately 50 miles inland, also reported a minimum pressure of 28.00 inches. Other low pressures reported were 28.02 inches at Thibodaux and 28.26 inches at Schriever. These cities are all located in Louisiana and in the immediate vicinity of the storm path. New Orleans, which is located about 35 miles to the northeast of the storm path, reported a minimum barometric pressure of 28.75 inches. Minimum barometric pressures observed at various locations along with the time of observation are shown in table 1. Continuous recordings of barometric pressure at specific locations are illustrated in the above exhibits.

5-04. Winds.- The eye of hurricane "Betsy" passed 30 miles to the west of Burrwood, Louisiana, located near the mouth of the Mississippi River at 8:00 p.m. on 9 September. At that time, Pilottown, Louisiana, reported that winds were gusting to over 100 miles per hour. However, 3 hours earlier, at 5:00 p.m., the Grand Isle Coast Guard station reported winds of 70 to 105 m.p.h. with gusts to 160 m.p.h. By 10:20 p.m., the winds at New Orleans had exceeded 100 m.p.h. Winds in New Orleans reached a maximum of 125 m.p.h. at 10:46 p.m., at which time the power failed at the Weather Bureau office. When the center passed over Houma, Louisiana, between 12 midnight and 1:00 a.m., surface winds gusting to 130 m.p.h. were recorded. At 4:00 a.m. on the 10th, the center was located 20 miles to the west of Baton Rouge and the wind velocity was estimated at 100 m.p.h. By the time the storm reached the Louisiana-Arkansas border, the wind had diminished to 50 m.p.h. Highest winds and peak gusts for various locations are shown in table 1. Generally, wind damages throughout the overflow area were exceedingly severe.

5-05. Rainfall.- Heavy rainfall, generally 4 to 7 inches, occurred over most of the lower Mississippi and lower Ohio Valleys on Friday and Saturday. In Louisiana, the rainfall varied from 3 inches to nearly 6 inches and though there was serious flooding, very

little could be attributed to rainfall. Schriever, in the hurricane path, reported 5.80 inches, Morgan City to the west of the path reported 5.7 inches, and New Orleans to the east experienced 5.10 inches. Storm rainfall for other locations are shown on plate 4.

5-06. Storm tide heights.- Hurricane "Betsy" produced the greatest tidal surge ever recorded on the Mississippi River and over vast coastal areas of southeastern Louisiana. The rapid forward movement of the storm as it approached and crossed the Louisiana coast on 9 September 1965 caused extremely rapid buildup of waters in low-lying areas of the Louisiana and Mississippi coasts. The fast rising waters exceeded previously established high water records on the Mississippi River from Pointe-a-la-Hache to the mouth of the river, the west adjacent landside areas between the river levee and the back levee from Point Michel to Venice, coastal and inland areas along Breton and Chandeleur Sounds at least as far eastward as Bayou LaLoutre, and portions of Lake Borgne and Lake Pontchartrain. Table 5 shows all-time maximum water elevations for selected locations in the Louisiana-Mississippi coastal areas, and identifies the storms that produced them.

5-07. Hurricane "Betsy" crossed the Louisiana coastline near Grand Isle about 10:00 p.m. on 9 September. The Corps of Engineers' gage at the U. S. Coast Guard station on Grand Isle recorded the water heights for the portion of the surge cycle above 4.26 feet. This level was reached at 9:10 p.m. A maximum water level of 8.8 feet was recorded on the gage at 10:50 p.m., and at 1:00 a.m. on 10 September, the water had receded to an elevation of 4.27 feet. Exhibit 7 shows the variation in water surface elevation for the short period near the maximum water level. Exhibits 6 through 19 present hydrographs showing tidal surges at other coastal and inland gages.

5-08. The storm, as it approached the Louisiana coastline, affected the coastal waters as far eastward as Mobile, Alabama, and as far westward as West Cote Blanche Bay. However, the maximum water elevations on the west side of the hurricane path were much less than those on the east side. At Mobile the highest stage was 4.9 feet, and at West Cote Blanche Bay, it was 2.9 feet. The water at Biloxi, Mississippi, rose to 8.6 feet, and at Gulfport, Mississippi, it reached a level of 10.7 feet. The maximum water elevations along the coastline east of the Mississippi River, in Breton and Chandeleur Sounds, have not been determined. Recording gages that were located in these waters, at Quarantine Bay near Ostrica Lock and at Gardner Island near the Mississippi River-Gulf Outlet, were destroyed by the storm, and the records were not recovered. At Ostrica Lock, about 1.2 miles inland from the coast and 2.8 miles from the Quarantine Bay gage site, a maximum water elevation of 13.6 feet was determined from a still high water mark. At Bohemia, Louisiana, about 45.5 miles above the Head of Passes, a still high water mark of 15.7 feet was observed inside a residence, about 250 feet landside of the Mississippi River levee. This water elevation was 1.5 feet above the

top of the river levee. Plate 12 shows the maximum water elevations produced at typical locations along the central Gulf Coast by hurricane "Betsy."

5-09. The major tidal surge in the Mississippi resulted from massive overtopping of the east bank below Bohemia on top of an upriver surge from the mouth; the effects of this combined surge were felt some 400 miles above the river mouth. The gage at West Point-a-la-Hache, 49 miles above the Head of Passes (AHP), recorded an elevation of 15.2 feet which was an increase of 13.6 feet above the low tide registered at 8:00 p.m. on 8 September. Between 5:00 p.m. and 10:40 p.m. on the 9th, the rise was 11.2 feet. A 1-hour rise of 4.0 feet occurred between 7:00 p.m. and 8:00 p.m.

5-10. On 8 September, at New Orleans, mile 103 AHP, the water rose steadily from 3.2 feet at 8:00 a.m. to 4.4 feet at 8:00 p.m.; then on the 9th, the surge increased and reached an elevation of 12.4 feet at midnight. A rise of 3.6 feet was recorded between 9:00 p.m. and 10:00 p.m. Farther up the river at Baton Rouge, mile 228 AHP, and at St. Francisville, mile 266 AHP, the rise above the expected stage was approximately 8 feet. Beyond this point, the surge dropped off rapidly due to diminishing wind velocity and headwater flow from a small rise upstream. The river surge was reported to have overtopped levees as far upstream as river mile 54.5 AHP on the east bank and river mile 52.5 AHP on the west bank. Exhibit 5 shows the maximum elevations obtained within the New Orleans District for the surge along the Mississippi River and adjacent areas.

5-11. Plate 5 shows the maximum water elevations observed at various locations within the New Orleans District and eastward along the Gulf Coast to Pascagoula, Mississippi. Plates 6 through 11 show the depths of water over the natural ground in the inundated areas.

5-12. Hurricane surge overflow.- High tides, resulting from hurricane "Betsy" inundated some 3,060,000 acres of coastal lands in southeastern Louisiana. The flooded area covered portions of 18 parishes within the New Orleans District and is shown on plate 5. Also shown on that plate are maximum water levels and various sources used in obtaining them. In order of their reliability, they are:

a. River gages - recording (includes stream gages)
b. Tide gages - recording
c. High water indicators and still water marks (generally obtained inside buildings)

5-13. The limits of flooding shown on plates 5 through 11 represent the approximate limits of inundated area. The limits of inundation were determined generally from the limits of debris left

after the water receded and from high water marks. While elevations shown on plate 5 are in feet above mean sea level, plates 6 through 11 show the depth of water above natural ground (ANG). Basic data for these latter plates are recorded.

5-14. Salt water intrusion.- Intrusion of salt water from the Gulf of Mexico is a seasonal occurrence in the Mississippi River below New Orleans and in the Louisiana coastal streams and marshes. The unusually high Mississippi River discharge during the month of September retarded the September salt-wedge progression above Port Sulphur, Louisiana. The river surge created by hurricane "Betsy" apparently did not alter the surface water quality above New Orleans, Louisiana. Surface water chlorides remained below 34 p.p.m. Cl^- during the month of September 1965. The sudden increase of raw water turbidity after 10 September 1965 suggests channel scour attributed to the turbulent upstream surge current and the subsequent rapid drawdown. The influence of tidal inflows on salinities in Lake Pontchartrain and the coastal streams surrounding the hurricane path are shown on table 4. Records from the salinity recorders installed in the Inner Harbor Navigation Canal at Lake Pontchartrain for the period 3-16 September are shown on exhibit 20. These records indicate salt water intrusion associated with hurricane inflows which began on the 9th about 6:00 p.m., increased by 11:00 p.m. to a maximum value of 6,100 p.p.m.Cl^-, and continued until 2:00 p.m. on 10 September.

5-15. Comparative cross sections taken at a discharge range located in the Inner Harbor Navigation Canal at Seabrook Bridge illustrate the scour produced by the hurricane tide inflows. These sections are included as exhibit 21.

5-16. Salinity samples taken in the Bayou Barataria Waterway on 28 September indicated the areas north of Lafitte, Louisiana, had chlorides within a range of 1,400 to 1,800 p.p.m.Cl^-. South of Lafitte, Louisiana, the chloride gradients increased to 2,200 p.p.m.Cl^- near Bayou Dupont, 5,000 p.p.m.Cl^- near Mud Lake, 9,500 p.p.m.Cl^- near Manila Village, and upward to 13,400 p.p.m.Cl^- near Grand Isle. During these observations tidal elevations in the Lafitte area averaged 1.75 feet for high tide and 1.55 feet for low tide and similar tidal elevations occurred on 8 September. As the eye of the hurricane approached Grand Isle before 10:00 p.m. on 9 September, northerly winds drove the slightly saline water below the Gulf Intracoastal Waterway (GIW) southward lowering the water surface elevation to 0.0 feet. The reduced water elevation was replaced by a tidal surge of highly saline water as the hurricane moved inland. The intrusion inundated the coastal marshes south of the Gulf Intracoastal Waterway from Bayou Blue west of Larose, Louisiana, to Bayou Villars near Lafitte. The GIW experienced about a 3-day duration of high chlorides. Salinity profiles along the Barataria Waterway before and after the hurricane are shown on exhibit 22.

5-17. Economic data.- The tide resulting from "Betsy" caused flooding of parts of 18 parishes in Louisiana. The parishes include Ascension, Assumption, Iberia, Iberville, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Martin, St. Mary, St. Tammany, Tangipahoa, and Terrebonne.

5-18. The economy of the region is highly diversified and ranges from various types of agriculture, including truck crops, orange groves, sugarcane, and cattle, through commercial fishing and fur trapping to highly industrialized and commercial use in thickly populated urban areas. The largest concentration of the state's petroleum and natural gas production is located on the coastal marshland and in the offshore areas of the Gulf of Mexico. The area is served by the deep draft navigation channels in the Mississippi River and the Mississippi River-Gulf Outlet. Shallow draft navigation is provided by the Gulf Intracoastal Waterway and numerous other improved channels. The area is also served by railroads, pipelines, connecting Federal and state highways, and both national and international air transportation.

5-19. General storm data.- This section presents the general storm data by parishes and covers 11 of the 18 parishes within the inundated area and both offshore and onshore petroleum industries. The most significant flooding occurred in Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. John the Baptist, St. Tammany, Tangipahoa, and Terrebonne parishes. A substantial portion of the area inundated is comprised of marshland where ground elevations vary from 1 to 2 feet above mean sea level. The following tabulation shows the number of acres flooded in each parish and the population in the areas affected by flooding.

DEGREE OF INUNDATION RESULTING FROM
HURRICANE "BETSY" BY PARISHES

Parish	Total land area in parish (acres)	Estimated land area flooded (acres)	Total population of parish (1960)	Population within area flooded (1960)
Jefferson	389,100	146,500	208,800	2,800
Lafourche	740,500	527,700	55,400	500
Livingston	425,600	69,100	27,000	0
Orleans	177,400	77,600	627,500	141,600
Plaquemines	629,800	596,800	22,500	21,500
St. Bernard	326,400	273,100	32,200	19,500
St. Charles	194,600	127,100	21,200	0
St. John the Baptist	144,000	107,400	18,400	0
St. Tammany	581,100	33,800	38,600	300
Tangipahoa	513,900	85,900	59,400	0
Terrebonne	890,200	574,900	60,800	1,700
Totals	5,012,600	2,619,900	1,171,800	187,900

ORLEANS PARISH

5-20. General.- Orleans Parish depends almost entirely on levees and other structures for protection against storm tides, since a considerable portion of the parish lies below mean sea level. All of the parish is within the corporate limits of the city of New Orleans and is situated on both banks of the Mississippi River. The major part of the city lies on the left descending bank while a small section (Algiers) lies on the right bank. Inundation in the most highly developed parts of Orleans Parish occurred in the areas to the west and east of the Inner Harbor Navigation Canal, the Citrus area, the New Orleans East area, lower New Orleans, and within the levees of the Inner Harbor Navigation Canal.

5-21. New Orleans.- The portion of the older part of the city of New Orleans between Jefferson Parish and the Inner Harbor Navigation Canal is protected from tides generated in Lake Pontchartrain and Lake Borgne by a system of levees, a seawall, bulkheads, and embankments. A seawall extends along the shore of Lake Pontchartrain from the Jefferson-Orleans Parish line to the Inner Harbor Navigation Canal and is backed by a low levee which provides secondary protection. The area back of the levee is protected on the west by a levee on the east bank of the Metairie Relief outfall canal and on the east by a levee along the Inner Harbor Navigation Canal.

PERSONAL BELONGINGS DESTROYED
EAST OF INNER HARBOR NAVIGATION CANAL
NEW ORLEANS, LA., 11 SEPTEMBER 1965

HIGH TIDE FLOODING EAST OF INNER HARBOR NAVIGATION CANAL
NEW ORLEANS, LA., 11 SEPTEMBER 1965

HIGH TIDE FLOODING
EAST OF INNER HARBOR NAVIGATION CANAL
NEW ORLEANS, LA., 11 SEPTEMBER 1965

HIGH TIDE FLOODING
EAST OF INNER HARBOR NAVIGATION CANAL
NEW ORLEANS, LA., 11 SEPTEMBER 1965

5-22. Flooding in the New Orleans area west of the Inner Harbor Navigation Canal and south of Gentilly Boulevard resulted from a tidal surge which overtopped the Inner Harbor Navigation Canal west levee, in the vicinity of the intersection of the canal and the Mississippi River-Gulf Outlet. Subsequent levee breaks and/or overtopping southward along the canal caused additional flooding in this portion of New Orleans. After the low lying areas adjacent to the canal were flooded, this water backed up into the area west of the Inner Harbor Navigation Canal and north of Gentilly Boulevard by way of drainage canals and subsurface drains. Water also overtopped the seawall along Lake Pontchartrain; however, the secondary levee prevented inundation of areas behind this levee. In the area west of the Inner Harbor Navigation Canal and north of Gentilly Boulevard, approximately 210 homes and 12 commercial establishments were inundated with water depths inside the buildings ranging up to 2.5 feet. In the area west of the Inner Harbor Navigation Canal and south of Gentilly Boulevard, 6,350 homes and 396 businesses had water as high as 7.0 feet above first floor level. Losses in this vicinity were especially severe to homes, businesses, and automobiles.

5-23. Inner Harbor Navigation Canal.- The development along the canal consists of concentrated industrial establishments (approximately 40 in number), such as cement plants, steel fabricating and sales companies, marine services, coffee processing, etc. The industrial property is located between the canal levees and, therefore, is not protected against flooding from the canal; however, the ground elevation of the area has been raised to about elevation 5 feet m.s.l., with spoil from the canal.

5-24. Citrus and New Orleans East.- The area designated Citrus and New Orleans East consists of the area within Orleans Parish which is east of the Inner Harbor Navigation Canal. This portion of Orleans Parish is protected on the west by a levee along the Inner Harbor Navigation Canal, on the east by a levee that extends from South Point to the GIW, and on the south by a levee along the GIW. Partial protection from Lake Pontchartrain is provided by the embankment of the Southern Railroad. This area is not developed to the extent of the rest of Orleans Parish; however, the Citrus area consists primarily of residential and small commercial property. Of the 14,800 acres in the area, 1,610 acres are residential development, 1,210 acres commercial and industrial development, 540 acres other development, 2,335 acres open land, and 9,105 acres swamp, woodland, and marsh. The development in the New Orleans East area is characterized by sparsely located industrial establishments, such as industrial gas companies, a cement plant, and the National Aeronautics and Space Administration facilities for production of the Saturn Rockets; both of these areas are presently under development for residential, commercial, and industrial purposes.

5-25. The flooding in the Citrus area and New Orleans East is attributed to a surge overtopping the levee along the GIW and the Inner Harbor Navigation Canal which resulted in a considerable amount of water being ponded between U. S. Highway 90 and the levee along the GIW. As the storage capacity of this artificial ponding area began filling, water flowed northward through culverts under the highway embankment. When the area to the south of the highway filled, the floodwaters overtopped the highway, inundating a large portion of the developed area. The maximum depth of water in some 1,330 homes and 140 industrial and commercial units was estimated at 3 feet. However, stages of about 10 feet m.s.l. were recorded along the canal. Physical property damages to industrial facilities were severe. Loss of production and income was also a major item. Industries have found it necessary to suspend operations or operate below normal production rates for weeks, while trying to recover from the effects of hurricane "Betsy."

5-26. Lower New Orleans.- This is a densely inhabited section of the city consisting mainly of concentrated residential and light commercial development; protection from floodwaters in Lake Borgne is provided by a levee that extends along the Inner Harbor Navigation Canal on the west and a levee built in conjunction with the Southern Railroad embankment on the north. A back levee, lying along the edge of the marsh in St. Bernard Parish, ties into the railroad embankment near the Orleans Parish line. A mainline Mississippi River levee protects this area on the south.

5-27. Overflow in the lower New Orleans area resulted from levee failures and overtopping in several locations along the Inner Harbor Navigation Canal and the Southern Railroad; water depths over house floors to a maximum of 8 feet were experienced. Some 6,285 homes and 175 commercial establishments suffered generally severe flood damages; most of the Jackson Barracks installation (headquarters for the Louisiana National Guard) also was under water.

5-28. Orleans Parish - unprotected area.- In the eastern part of New Orleans, U. S. Highway 90 extends east across the unprotected marsh of Orleans Parish. This highway is on a relatively high fill except for two openings, one at Chef Menteur Pass, and the other at the Rigolets, and this provides a formidable barrier against moderate tidal surges from the Gulf and Lake Borgne. U. S. Highway 11 which is inland and follows a more northerly course to a bridge crossing at South Shore on Lake Pontchartrain is lower and more vulnerable than U. S. Highway 90 and, consequently, becomes inundated frequently from rain squalls or tropical storms.

HIGH TIDE, WIND, AND RIVER, POINTE A LA HACHE, LA.
13 SEPTEMBER 1965

HIGH TIDE FLOODING TWO BLOCKS FROM ORLEANS AND
ST. BERNARD PARISH LINE
ARABI, LA., 11 SEPTEMBER 1965

EAST BANK OF MISSISSIPPI RIVER (NORTH OF POINTE A LA HACHE)
PLAQUEMINES PARISH, LA., 13 SEPTEMBER 1965

5-29. The flood damages from hurricane "Betsy" to camps along U. S. Highway 11 and the north side of U. S. Highway 90 were considerably less than those which occurred to the exposed camps on the south side of U. S. Highway 90. There were 77 camps flooded up to a depth of 3 feet along U. S. Highway 11. Similarly, only 53 of the 291 camps suffered moderate flooding on the north side of U. S. Highway 90. A recent residential development outside of the protected area, known as Venetian Isles and located on the north side of U. S. Highway 90 at Chef Menteur Pass, had flooding in the streets and in one of the 14 homes. Of the 248 camps in the unprotected area south of U. S. Highway 90 subjected to the unrestricted tidal surge of hurricane "Betsy," 79 were completely destroyed, 140 received major water damage, and 72 suffered minor to moderate flood damages.

PLAQUEMINES PARISH

5-30. General.- Plaquemines Parish is divided into two parts by the Mississippi River. The area on the left descending bank includes the small communities of Braithwaite, Scarsdale, Phoenix, Davant, and Pointe-a-la-Hache; major communities in the area on the right bank consist of Belle Chasse, Myrtle Grove, Port Sulphur, Empire, Buras, Triumph, Boothville, and Venice. Inundation in Plaquemines Parish extended from the vicinity of Myrtle Grove on the west bank and Davant on the east downstream to the mouth of the Mississippi River. The land area of this parish is predominately marsh or wooded swamp. The majority of the developed property is situated along the east and west banks of the Mississippi River and is generally protected from flooding by the mainline Mississippi River levees and by low tidal back levees adjacent to the marsh areas.

5-31. Economic activity in the parish includes agricultural production--citrus, sugarcane, truck crops, and beef cattle production on pastureland and marsh range pasture--extensive oil and gas production, base facilities for the offshore oil and gas industries, sulphur production, facilities for commercial and sport fishing, and service facilities for water oriented recreational activities. Approximately 95 percent of the total land area of 629,800 acres in this parish was flooded and of this flooded area 34,000 acres were developed land while the remaining area consisted of woods and marshland.

5-32. Flooding of the protected area along the east bank of the river resulted from a surge of some 15 feet which overtopped the levees and flooded the area between the levees to a depth of some 5 to 16 feet. In the inundated portion east of the Mississippi River, approximately 502 homes and 22 commercial establishments were wholly or partially destroyed and were inundated with water depths inside the buildings ranging up to 11 feet. In that

portion of Plaquemines Parish west of the Mississippi River, approximately 2,561 homes and 337 commercial establishments were inundated with water depths inside the buildings ranging up to 10 feet above floor. Physical property damage to homes, industrial and commercial facilities, trailer homes, personal property, and utility systems was severe. More than 70 percent of the homes in the devastated area on the west side of the Mississippi River will require some repairs before they are habitable while another 20 to 25 percent are totally destroyed. The agricultural, commercial, and manufacturing industries all suffered property damages and loss of business.

ST. BERNARD PARISH

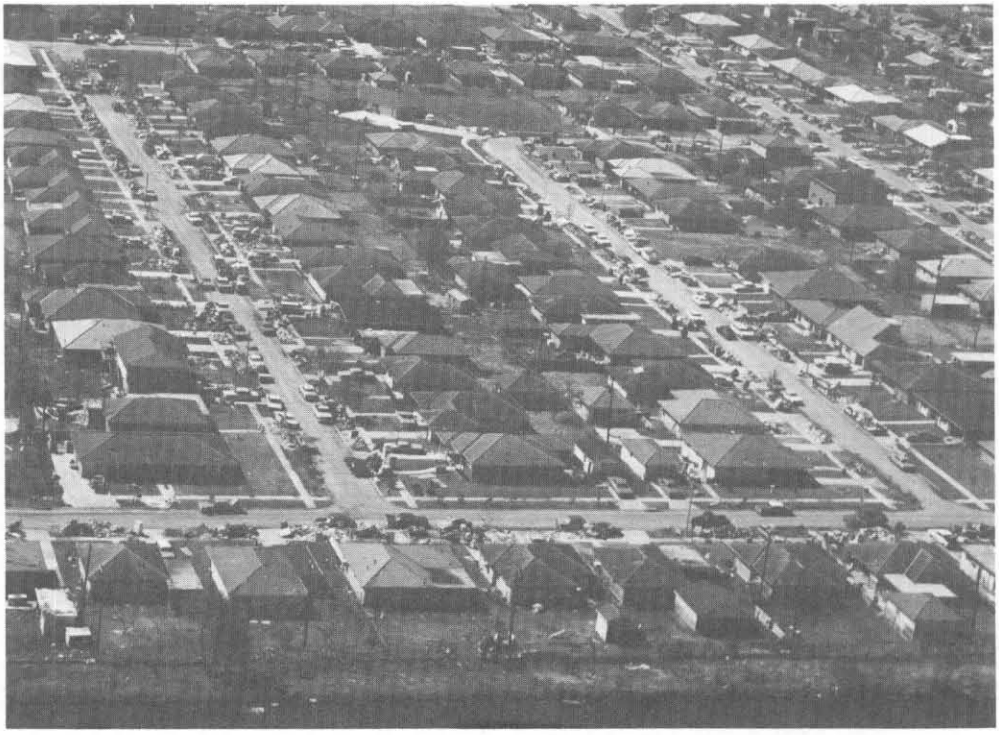
5-33. General.- The major portion of this parish was inundated and damages were substantial. The area that was not flooded extends along the high left bank of the Mississippi River between Chalmette and Violet. The major flood damages occurred in the communities of Arabi, Versailles, Chalmette, St. Bernard, Toca, Verret, Yscloskey, Delacroix, and Hopedale.

5-34. St. Bernard Parish above Violet.- The developed area northwest of Violet is protected from tides generated in Lake Borgne and the Gulf of Mexico by a system of levees and embankments. A back levee on the east extends along the edge of the marsh from the Orleans and St. Bernard Parish line to the Lake Borgne Canal at Violet, while on the west the area is protected by a mainline levee on the east bank of the Mississippi River. This area consists primarily of residential property with a substantial amount of commercial and industrial property. The reach includes 10,600 acres of developed area, of which 6,700 acres were inundated.

5-35. Flooding in the area above Violet resulted from a tidal surge which overtopped the back levee and the Inner Harbor Navigation Canal east levee, in the vicinity of the intersection of the Industrial Canal-Gulf Intracoastal Waterway. Subsequent levee breaks and overtopping along the Industrial Canal and the back levee caused flooding in the low areas above Violet. In the area surveyed above Violet, approximately 3,830 homes and 108 commercial establishments were inundated with water depths inside the buildings ranging up to 8 feet. Damages to homes and automobiles were very severe in this reach.

5-36. St. Bernard Parish area between Violet and Verret.- The developed area between Violet and Verret is protected from tides generated in Lake Borgne by a back levee extending from Violet to the embankment of State Highway 46 near Verret. The area from Violet to Poydras experienced only a small amount of damage to a few houses. Flooding in the area from Poydras to Verret resulted from a tidal surge which overtopped and crevassed the back levee at a few locations, and a tidal surge which entered the area from the south and overflowed the highway. Approximately 257 homes and 9 commercial establishments were inundated with water depths inside the buildings ranging up to 5 feet.

ARABI AREA FLOODED, ST. BERNARD PARISH, LA.
11 SEPTEMBER 1965



ARABI AREA AFTERMATH, ST. BERNARD PARISH, LA.
24 SEPTEMBER 1965

HIGH TIDE AND WIND, DELACROIX ISLAND, LA.
(THIS HOME IS APPROXIMATELY 7 MILES FROM ITS ORIGINAL LOCATION.)
22 SEPTEMBER 1965

HIGH TIDE AND WIND ALONG BAYOU TERRE AUX BOEUFS
DELACROIX ISLAND AND VICINITY, LA.
22 SEPTEMBER 1965

5-37. East of Verret.- The areas south and east of Verret do not have protection from tides generated in Lake Borgne or the Gulf of Mexico. The economy of the area along State Highways Nos. 300 and 46 east of Verret is aligned with marine related activities, such as commercial fishing, shrimping, oyster dredging, and sports-fishing. A gas pipeline pumping plant and a liquefied petroleum extraction plant furnish employment for some of the residents. The damages below Verret in St. Bernard Parish resulting from hurricane "Betsy" occurred in the Delacroix, Reggio, Yscloskey, and Hopedale areas. Some of these homes were found several miles away from their prestorm locations, while boat renting facilities were generally destroyed beyond repair. Losses to commercial fishing boats and pleasure craft were most severe in this area. Damage to industrial facilities was relatively light which was probably due to prudent design and construction of these facilities; however, there were approximately 1,070 homes and 74 commercial establishments inundated with water depths inside the buildings ranging up to 8.5 feet. Agricultural damages were light as it was off season for truck crops and only a few head of livestock were lost; pastureland was damaged by salinity and it may take 2 to 3 years before the salt leaches out of the ground.

JEFFERSON PARISH

5-38. General.- Jefferson Parish is bordered by Lake Pontchartrain on the north, Plaquemines and Orleans Parishes on the east, the Gulf of Mexico on the south, and St. Charles and Lafourche Parishes on the west. This parish is also divided by the Mississippi River. While no significant damages were recorded on the "East" Jefferson Parish (that portion on the left bank of the Mississippi River), the damages caused by the storm and tidal surge at Grand Isle and Cheniere Caminada were quite extensive.

5-39. Grand Isle and Cheniere Caminada.- Included within the corporation limits of the town of Grand Isle are that part of Cheniere Caminada within Jefferson Parish and the entire island of Grand Isle, which extends some 7-1/2 miles in length and approximately 3/4 mile in width. Elevations on the island vary from 2 to about 7 feet above mean sea level, while those on the Cheniere lie generally below 5 feet. Cheniere Caminada is located on the southern tip of Jefferson Parish directly across the bay from Grand Isle; the only connection to the mainland from the island is via the vehicular bridge, State Highway No. 1. The economy of the area depends primarily on services to the oil industry, commercial fishing, and water oriented recreation.

HIGH TIDES AND WIND, GRAND ISLE, LA.
11 SEPTEMBER 1965

5-40. The community of Grand Isle, consisting of some 1,090 camps or homes and 49 commercial establishments, was almost completely devastated by a 9-foot surge that crossed the unprotected island. Some 750 families who made their permanent residences on Grand Isle were homeless following the storm. The major portion of the commercial establishments, which were located parallel to the beach along the state highway, were completely destroyed. Only a few buildings, such as churches, a school, and the installations of a major oil company escaped "Betsy's" fury with moderate damages. The sand beach was eroded almost up to the highway for the entire length of the island. It is estimated that the damages in the Grand Isle area are at least 85 percent of the total value of the community.

ST. TAMMANY PARISH

5-41. General.- St. Tammany Parish lies north of Lake Pontchartrain and Lake Borgne; the low-lying lands adjacent to the lakes were inundated by the storm tides causing damage to 73 houses, 207 camps, and 9 businesses. The railroad near the shoreline suffered damage to the roadbed and associated equipment along the right-of-way. Sections of the protective seawall fronting on Lake Pontchartrain at Mandeville suffered undermining by wave action and colapsed. Damages to utilities in the area were mainly caused by wind. The land area inundated was chiefly marsh or wooded swamp with minor fringes of cleared and developed land in the communities of Slidell, Mandeville, and Madisonville.

LAFOURCHE PARISH

5-42. Lafourche Parish is predominately marsh or wooded swamp with the majority of the developed land situated along the banks of several bayous, the largest of which is Bayou Lafourche. The bayou ridges vary in elevation from about 2.5 feet above mean sea level in the southern end of the parish to 10 to 18 feet in the northern section. There are two areas in the middle latitude of the parish where land has been reclaimed from the marsh by construction of levees and installation of drainage pumps. Numerous oil and gas fields are located throughout the area, together with shore-based supporting facilities for both on land and offshore drilling. The inundated area of Lafourche Parish extended from a point about 6 miles south of Golden Meadow to the Gulf Coast and included the town of Leeville. The center of the storm passed to the east of the town resulting in a reduced tidal surge; however, the low-lying areas of the parish were inundated. Approximately 71 percent of the 740,500 acres of land area in Lafourche Parish was flooded. Of the flooded area, 2,600 acres was cleared land and 525,100 acres marsh and woods.

5-43. The economic activity within the inundated area of this parish consists of crude oil production, commercial fishing, and supporting facilities for these activities. Physical property damage to these facilities, commercial establishments, and homes of Lafourche Parish were light to moderate. Approximately 104 homes and 21 commercial establishments were inundated by water up to 2 feet above the floor.

TERREBONNE PARISH

5-44. The land area of the parish is predominately marsh or wooded swamp with higher lands consisting of relatively narrow ridges along the numerous bayous, which course through the area. These ridges have elevations of 3 to 4 feet m.s.l. near their southern limits with a gradual rise toward the northern limits where elevations of 7 to 9 feet m.s.l. and in some cases 9 to 15 feet are found.

5-45. The economy of the flooded area includes numerous oil and gas producing wells with their supporting base facilities; sulphur mining operations are conducted at Lake Pelto with base facilities at Cocodrie; trapping of fur-bearing animals; extensive commercial and sport fishing activities; agricultural activities include cattle raising, the production of sugarcane, corn, and truck crops. Flooding was confined to the low lands and unpopulated area of this parish and the damages by water were negligible; however, some wind damage was sustained.

PARISHES RECEIVING PARTIAL INUNDATION INCLUDING LIVINGSTON, ST. CHARLES, ST. JOHN THE BAPTIST, AND TANGIPAHOA

5-46. General.- These parishes are provided some flood protection by lying inland from the Gulf of Mexico. However, they have shorelines along Lake Pontchartrain and Lake Maurepas which are subject to some inundation. The estimated land flooded in each parish is shown in paragraph 5-19.

5-47. General storm data for the subject parishes are as follows:

Livingston.- Tidal flooding in this parish was over the marshland along its southern boundary and caused no known damage.

St. Charles.- This parish is divided by the Mississippi River and bound on the south by Lake Salvador and on the north by Lake Pontchartrain. A portion of the marsh area on both sides of the river was inundated by the storm tide, resulting in considerable damage to the railroad beds, utilities, and bridges. These damages

were confined to an area along the northern edge of the parish, adjacent to Lake Pontchartrain and were the result of a tidal surge which eroded the roadbed and facilities along the railroad right-of-way.

St. John the Baptist.- This parish also is divided by the Mississippi River. Tidal flooding was generally confined to low-lying undeveloped areas and caused minor damage to the railroad and utilities. The damages resulted from rising tides and wave action in Lake Pontchartrain washing the railroad bed causing damage to the tracks, bridges, and the telephone, telegraph, and signal systems along the railroad right-of-way.

Tangipahoa.- Tangipahoa Parish lies north of the Mississippi River and adjacent to Lake Pontchartrain and Lake Maurepas. A portion of the undeveloped low-lying lands was inundated by storm tides from Lake Pontchartrain and Lake Maurepas causing a small amount of damage to utility systems.

5-48. Petroleum industry.- Hurricane "Betsy" caused extensive damages to the oil and gas industries in southeastern Louisiana. Offshore and onshore installations incurred losses because of physical damage to equipment, loss of production, cost of evacuation, reoccupation of their facilities, and standby costs. "Betsy" crossed the Louisiana coast right in the heart of the Louisiana oil industry, that is, South Pass, Main Pass, West Delta, and Grand Isle. It is estimated that approximately 8,000 oil wells producing in excess of 600,000 barrels of oil per day and representing an investment of over $2 billion were located in the area affected by "Betsy." Peak waves offshore were estimated to be 38 feet in height causing much of the damage by battering installations directly or indirectly with floating debris or boats and barges that were adrift or had parted some of their moorings. Wind gusts estimated at 170 m.p.h. crumbled derricks, lifted housing, and damaged platforms. Wave action and strong tidal currents caused considerable damage to transporters' pipelines which lie on the bottom of the Gulf and bays. A considerable number of boats, barges, and drilling tenders were blown inshore and grounded. Repairs to facilities were delayed because of the rough seas after the storm and because a number of employees of the oil industry suffered significant personal losses and were unable to return to work immediately.

5-49. It is estimated that oil production for the month of September fell about 7.1 million barrels under the normal production rate for the month. The Louisiana State Conservation Department did increase allotments so that most of this $22 million loss of production could be made up in 1965. It is anticipated that approximately 90 percent of the lost production will be recovered. Damages resulting from loss of production were considered to be only the interest on the income which the oil industry would have

had if hurricane "Betsy" had not interrupted operations, plus the estimated 10 percent loss of production. This production will not be recovered due to physical loss of wells and because production capabilities of many wells will not allow the loss to be recovered by increasing the rate of outflow.

5-50. Tabulation of damages.- Estimates of hurricane damages presented in this report are tabulated by the primary cause of injury. For example, estimates are tabulated as tidal overflow and wind damages. "Tidal overflow damage" incorporates destruction caused by high tides, wave action, and river flooding, or a combination of these destructive agents, while "wind damage" refers to a loss from direct blasts of hurricane winds, rainfall entering structural breaks, and windblown debris smashing into structures. These damage estimates are divided into 12 major classifications and are presented in the following order: agriculture, residential, mobile homes, commercial, industrial, governmental, utilities, schools, churches, transportation, marine, and other losses.

5-51. The property classifications contained therein are self-explanatory in the cases of commercial, residential, mobile homes, schools, churches, and industrial properties. The "agriculture loss" classification includes such items as crop loss, damage to cropland, loss of pasture, and livestock. The "utilities loss" takes into account the losses suffered by power companies, telephone and telegraph companies, gas companies, and water and sewerage treatment plants. "Marine loss" includes damage to vessels, wharves, and piers. "Petroleum industry" includes damages to drilling rigs, production platforms, pipelines, and other direct supporting oilfield suppliers. "Other losses" contains estimates of cost of debris removal, combating insects and disease, policing to prevent looting, and business losses. There were also "inseparable damages" which could not be classified as to cause or restricted to a political subdivision: petroleum, Louisiana State Highway, evacuation, relief to flood victims, fish and wildlife, plus the marine, agricultural, governmental, and utility losses not incorporated in the items above.

5-52. Estimate of damages.- Only 9 of the 18 parishes inundated by hurricane "Betsy," sustained flood damages of sufficient magnitude to be incorporated in this report. These parishes are Jefferson, Lafourche, Orleans, Plaquemines, St. Bernard, St. Charles, St. John the Baptist, St. Tammany, and Tangipahoa. The losses are summarized by parishes in tables 6 through 14. Table 15 presents those inseparable damages not contained in the above tables, while table 16 summarizes the data contained in tables 6 through 14 by class. Table 17 itemizes the overflow and wind damages by parish and summarizes the total damages presented in this report attributable to hurricane "Betsy."

5-53. Estimate of storm damages prevented by Federal projects.- Existing Federal projects in the New Orleans District and within the

area of the tidal surge, which prevented extensive overflow of highly developed areas, include the Lake Pontchartrain levee in Jefferson Parish and the Mississippi River levees. The former project prevented overflow of major parts of Jefferson Parish east of the Mississippi by floodwaters from Lake Pontchartrain and protected that area from damages estimated at $70 million. The tidal surge came up the Mississippi River causing a noticeable elevation of stages in the river for a distance of about 400 miles above the Head of Passes and overtopping the levees as far upstream as about 55 miles above the Head of Passes. Had the levees not been in place, the surge would have flowed over the banks of the river as far upstream as Algiers, about 90 miles above the Head of Passes. Information from which to make a monetary evaluation of the damages which would have resulted from such overtopping is not available; such damages would, however, have been extreme since intensive urban and industrial development is characteristic of both banks of the river in this 30-mile reach.

5-54. Two Federal projects are authorized for construction in the area of the tidal surge. One is the "New Orleans to Venice, Louisiana" project, which is designed to protect communities on the lower Mississippi River Delta from hurricane surge. The levees which comprise the project were designed for a hurricane having an expected recurrence frequency of once in 100 years. The design grades of the levees are less than the surge heights reached in hurricane "Betsy" and the levees would have been overtopped had they been in place. Thus, this project would not have prevented damaging overflow in the Delta area, but would have operated to reduce the depth of flooding and moderated the destructive effect of the surge in the existing protected area on the east bank of the river between the towns of Phoenix and Bohemia. It is estimated that, had the authorized project been in place, the overall damages would have been reduced by $500,000. The other authorized Federal project is "Lake Pontchartrain, Louisiana, and Vicinity." This project, had it been in place, would have eliminated flooding of developed areas in the city of New Orleans, the Chalmette area of St. Bernard Parish, and the lakeside parishes of St. Tammany, Tangipahoa, Livingston, St. John the Baptist, and St. Charles. It is estimated that the total reduction in damages would have been $85 million.

5-55. Damages to flood protection structures.- Many publicly- and privately-owned flood control structures have been inspected for damages incurred as a result of hurricane "Betsy." Preliminary estimates of the damages have been made for the Mississippi River mainline levees, the back levees below New Orleans, including drainage facilities, and for other flood control projects which were damaged. These damages consisted of erosion and washout of levee crowns, embankments, and slopes; rupture of existing asphalt and concrete slope pavement and displacement of existing riprap, and

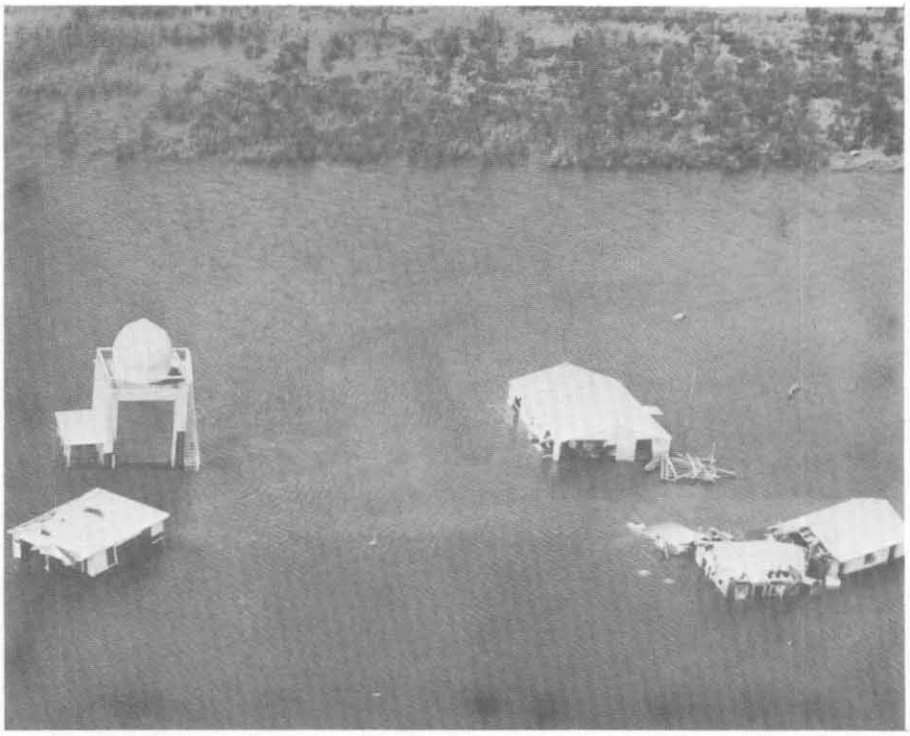
the deposit of tons of drift and debris along the river. Damages to flood control projects within the New Orleans District were estimated to be approximately $3,903,000.

5-56. Damages to navigational facilities.- Hurricane "Betsy" caused considerable damages to operations, maintenance, and general navigation projects of the New Orleans District, Corps of Engineers. One of the major problems resulting from the storm was shoaling of the entrance channels to harbors and waterways along the coast. To restore project depths dredging is considered necessary on the Atchafalaya River, Barataria Bay Waterway, Bayou Bonfouca, Bayou Lacombe, Calcasieu River and Pass, Chefuncte River, Bogue Falia, Houma Navigation Canal, Mississippi River, and waterway from Empire to Gulf of Mexico. Other expenditures required to revert navigational facilities to their prestorm conditions include repairs to jetties, rock groins, dredging targets, directional signs, and other navigational aids, clearing and snagging of waterways, cost of investigating for sunk vessels, cost of hydrographic surveys, removal of sunk vessels and other obstructions to navigation. Damages to the above navigational projects are estimated to be approximately $3,220,000.

5-57. Summary of hurricane damages.- The total damages within the New Orleans District from all causes attributable to hurricane "Betsy" and covered in this report amount to an estimated $371,960,000. Of this amount, total damages from tidal overflow are estimated to be $167,960,000; from wind damage exclusively, $49,700,000, and from a combination of wind and flood losses that are inseparable, $154,300,000. While the tidal surge caused by this hurricane inundated some 18 parishes, only 9 parishes had any appreciable damage from tidal overflow and are included in this report. The total damages prevented by existing Federal projects amount to an estimated $70 million, while the loss that could have been prevented by authorized but not built projects amounts to an estimated $85-1/2 million.

HIGH TIDE, WIND, OR BOTH, GRAND ISLE, LA.
22 SEPTEMBER 1965

BEACH EROSION ALONG HIGHWAY NO. 1, GRAND ISLE, LA.
22 SEPTEMBER 1965



U. S. WEATHER STATION, BOOTHVILLE VICINITY, LA.
16 SEPTEMBER 1965

HIGH TIDES AND WINDS, GRAND ISLE, LA.
23 SEPTEMBER 1965

HIGH TIDE, NEW ORLEANS, LA.

POWER AND TELEPHONE LINE DAMAGES BELOW LEEVILLE, LA.

WIND DAMAGE, BAYOU LAFOURCHE, LA.

HIGH TIDES, WIND, AND RIVER, VENICE VICINITY, LA.
22 SEPTEMBER 1965

TABLE 1

HURRICANE BETSY
8-11 SEPTEMBER 1965
METEOROLOGICAL DATA

Station	Lowest Barometric Pressure		Date	Highest Wind (mph)	Peak Gusts (mph)	Storm Rainfall (inches)
	Inches	Time (cst)				
Louisiana						
Alexandria	28.99	0855	10	N 46	N 62	3.07
Amite	28.80	0330	10	SE 75*	SE 110*	2.95
Baton Rouge	28.53	0356	10	ENE 58	NNE 92	3.99
Baldwin	29.00	0215	10	-	NW 100*	3.98
Bayou Sorrel Lock						2.35
Bunkie	28.84	0700	10	NNW 63	NNW 85*	3.84
Calcasieu Lock						0.36
Catfish Point						0.54
Carville					N 130*	5.10
Clinton	28.93	0545	10			3.83
Covington				E 70*	E 100*	3.00
Franklinton					E 95*	3.05
Gramercy	28.30	0145	10	NNE 88+#		4.53
Grand Isle	28.00	2151	9		160+	
Hammond	28.97	0230	10		NE 115*	2.65
Houma	28.00	0130	10		130	5.71
Jennings	29.08	0330	10	NE 45	NE 70	0.97
Lafayette	28.93	0348	10	WNW 52	NW 76	3.87
Lake Charles	29.48	0356	10	NW 26	NW 36	0.28
Melville	28.65	0630	10	NW 60*	NW 90*	5.30
Monroe	29.03	1430	10	NNE 35	NNE 61	4.37
Morgan City	28.68	2400	9	N 100*	N 128	5.70
New Iberia				NE 80*	NW 85*	3.20
New Orleans						
W.B. City Office	28.75	2340	9	E 125*		5.13
Moisant Airport	28.63	2347	9	E 85	E 112	4.09
Causeway (south)				ENE 90	ENE 105+	
Huey Long Bridge				95#	128#	Instrument out at 2315
New Roads				NE 90	NE 100	5.21
Opelousas	29.03	0450	10	NW 60	NW 75	4.00
Old River Lock	28.92	0730	10	NNE 70		4.50
Port Sulphur	28.66	2200	9	150*	166	
Pilottown				120+#		
Schriever	28.26	0015	10	N 95*	NNE 110*	5.80
Simmesport					NE 85*	5.33
Shreveport	29.32	1458	10	NW 26	NW 39	0.56
Thibodaux	28.02		10			
Vermilion Lock						1.34
Mississippi						
Bay St. Louis				E 80*		
Biloxi (Keesler AFB)						
Columbia	29.43	0500	10	SE 50	SE 67	1.03
McComb	29.34	0457	10		63	3.93
Pascagoula	29.63	2230	9	SE 45	SE 60	0.90
Picayune				65	85	3.98
Vicksburg	29.27	0635	10	SE 35		2.23
Arkansas						
El Dorado	29.14	1653	10	NW 23	NW 37	1.81
Alabama						
Mobile	29.83	1100	9	SE 32	SE 44	2.19

*Estimated
#Incomplete record
+Probably exceeded

TABLE 2

HURRICANE BETSY
8-11 SEPTEMBER 1965
TEMPERATURE DATA

Station	Date	Temperature			Departure From Normal
		Max.	Min.	Avg.	
Alexandria, La.	8	93	62	78	+1
	9	94	59	77	0
	10	82	73	78	+1
	11	94	73	83	+6
Baton Rouge, La.	8	88	66	77	0
	9	88	64	76	-1
	10	82	73	78	+1
	11	91	78	85	+8
Lafayette, La.	8	88	68	78	0
	9	89	67	78	0
	10	83	71	77	-1
	11	87	75	81	+3
Lake Charles, La.	8	90	69	80	+1
	9	92	63	78	-1
	10	87	71	79	0
	11	91	73	82	+3
Monroe, La.	8	92	63	78	+1
	9	91	62	77	0
	10	81	74	78	+1
	11	89	73	81	+4
New Orleans International Airport, La.	8	85	67	76	-4
	9	85	64	75	-5
	10	81	67	74	-6
	11	87	76	82	+2
Shreveport, La.	8	93	69	81	+3
	9	94	69	82	+4
	10	78	72	75	-3
	11	89	72	81	+3
McComb, Miss.	8	89	64	77	0
	9	90	63	77	0
	10	80	71	76	-1
	11	85	72	79	+2
Keesler AFB, Miss.	8	86	67	77	-1
	9	83	71	77	-1
	10	84	76	80	+2
	11	85	79	82	+4
Vicksburg, Miss.	8	88	71	80	+2
	9	90	68	79	+1
	10	81	72	77	-1
	11	86	73	80	+2
El Dorado, Ark.	8	92	66	79	+2
	9	92	65	79	+2
	10	76	73	75	-2
	11	84	71	78	+1
Mobile, Ala.	8	86	63	75	-3
	9	87	70	79	+1
	10	86	77	82	+4
	11	88	78	83	+5

TABLE 3

HURRICANE BETSY
8-11 SEPTEMBER 1965
TIDE GAGE DATA FROM CORPS OF ENGINEERS RECORDING GAGES (M.S.L. DATUM)
ALONG THE LOUISIANA-MISSISSIPPI COAST

	DATE AND TIME: 8 SEPTEMBER 1965																								
	0001	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Approximate position of storm (Lat. and Long.)				25.1-80.2						25.1-81.5						25.4-83.1						25.6-84.7			
LOCATION	GULF STATIONS																								
South Pass, Miss. River																									
Port Eads, La.	2.7	2.8	2.9	3.0	3.1	3.2	3.2	3.1	3.1	3.0	2.8	2.6	2.4	2.2	2.2	2.1	2.0	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.6
Approx. miles to eye				600 ESE						540 ESE						440 ESE						370 SE			
Bayou Rigaud																									
Grand Isle, La.	No record																								
Approx. miles to eye																									
Gulf of Mexico																									
Biloxi, Miss.	0.5	0.8	1.1	1.4	1.6	1.7	1.8	1.8	1.9	1.9	1.8	1.6	1.4	1.2	1.0	0.6	0.4	0.1	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.2
Approx. miles to eye				630 ESE						580 ESE						480 SE						410 SE			
East Cote Blanche Bay																									
Lukes Landing, La.	1.2	1.6	1.8	2.0	2.0	2.0	1.8	1.6	1.6	1.7	1.6	1.6	1.6	1.5	1.3	1.1	1.0	0.8	0.7	0.5	0.4	0.3	0.4	0.5	0.7
Approx. miles to eye				710 ESE						680 ESE						580 ESE						490 ESE			
	INLAND STATIONS																								
Mississippi River																									
Head of Passes, La.	2.1	2.3	2.4	2.5	2.6	2.7	2.8	2.8	2.9	2.9	2.8	2.7	2.6	2.4	2.3	2.1	2.0	1.9	1.8	1.7	1.8	1.8	1.9	2.0	2.1
West Pointe-a-la-Hache, La.	1.9	2.1	2.3	2.4	2.4	2.6	2.7	2.8	2.8	2.9	2.9	2.8	2.7	2.6	2.4	2.3	2.1	2.0	1.8	1.7	1.6	1.7	1.8	1.9	2.0
Algiers Lock, La.	2.3	2.4	2.5	2.8	2.8	2.9	3.1	3.2	3.3	3.4	3.4	3.4	3.4	3.3	3.2	3.1	2.9	2.8	2.6	2.5	2.4	2.4	2.4	2.4	2.5
Chalmette, La.	2.5	2.6	2.7	3.0	3.0	3.1	3.3	3.4	3.5	3.6	3.6	3.6	3.6	3.6	3.5	3.4	3.2	3.1	2.9	2.8	2.6	2.5	2.5	2.6	2.6
New Orleans, La.	2.2	2.2	2.3	2.5	2.7	2.8	2.9	3.0	3.1	3.2	3.2	3.3	3.3	3.3	3.2	3.2	3.0	2.9	2.7	2.6	2.5	2.4	2.3	2.2	2.3
Inner Harbor Navigation Canal																									
Seabrook Bridge (New Orleans)	1.8	1.9	2.0	2.0	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.6	2.6	2.7	2.7	2.6	2.5	2.5	2.4	2.2	2.2	2.1	2.0	2.1	2.0
Lake Pontchartrain																									
West End (New Orleans)	2.1	2.0	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.2	2.2	2.2
Mandeville, La.	2.0	2.0	1.9	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.2	2.2	2.2	2.2	2.3	2.4	2.4	2.4	2.4	2.3	2.2	2.2	2.1	2.0
Causeway (Midlake)	2.1	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.2	2.2	2.2
Rigolets, Hwy. 90	No record																								
Miss. River-Gulf Outlet																									
Paris Road (New Orleans)	1.6	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.5	2.6	2.8	2.9	2.9	2.9	2.9	2.7	2.4	2.3	2.1	1.9	2.0	1.9	1.9	1.9	1.8
Shell Beach, La.	1.5	1.8	1.9	2.0	2.1	2.2	2.4	2.5	2.6	2.7	2.8	2.8	2.8	2.8	2.7	2.5	2.3	2.0	1.8	1.6	1.6	1.6	1.7	1.7	1.7
Bayou LaLoutre																									
Alluvial City, La.	1.6	1.7	1.8	1.9	2.0	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.5	2.5	2.5	2.4	2.3	2.1	1.9	1.8	1.8	1.7	1.8	1.7	1.7
Lower Atchafalaya River																									
Morgan City, La.	0.5	0.9	1.2	1.6	1.9	2.1	2.2	2.1	1.9	1.7	1.5	1.4	1.4	1.4	1.4	1.2	1.1	0.9	0.7	0.5	0.3	0.2	0.1	0.1	0.2
Charenton Drainage Canal																									
Mud Lake, La.	0.5	0.8	1.0	1.3	1.4	1.5	1.6	1.6	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.1	1.0	0.8	0.7	0.6	0.5	0.3	0.2	0.1	0.1

TABLE 3

HURRICANE BETSY
8-11 SEPTEMBER 1965
TIDE GAGE DATA FROM CORPS OF ENGINEERS RECORDING GAGES (M.S.L. DATUM)
ALONG THE LOUISIANA-MISSISSIPPI COAST

	DATE AND TIME: 9 SEPTEMBER 1965																								
	0001	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Approximate position of storm (Lat. and Long.)				26.1-86.3						26.8-87.8						28.0-88.8						29.2-90.1			
LOCATION												**GULF STATIONS**													
South Pass, Miss. River																									
Port Eads, La.	2.6	2.8	2.9	3.0	3.2	3.3	3.4	3.5	3.6	3.6	3.6	3.5	3.5	3.4	3.4	3.6	4.0	5.1	[A]5.3	5.2	5.2	4.8	4.7	4.5	4.4
Approx. miles to eye				270 SE						170 SSE						80 SSE						60 WNW			
Bayou Rigaud																									
Grand Isle, La.																						[B]4.3	6.7	[C]8.2	6.0
Approx. miles to eye																120 SE						0-			
Gulf of Mexico																									
Biloxi, Miss.	0.2	0.4	0.6	0.8	1.1	1.3	1.6	1.8	1.9	2.1	2.2	2.2	2.2	2.3	2.5	2.6	2.6	2.8	3.0	3.3	3.8	4.4	5.2	6.9	8.1
Approx. miles to eye				330 SSE						260 SSE						170 S						110 SW			
East Cote Blanche Bay																									
Lukes Landing, La.	0.7	0.8	1.0	1.1	1.2	1.4	1.4	1.4	1.4	1.5	1.5	1.4	1.4	1.3	1.1	1.0	0.7	0.5	0.3	0.0	-0.4	-0.8	-1.2	-1.1	-0.8
Approx. miles to eye				390 ESE						290 SE						200 ESE						90 ESE			
INLAND STATIONS																									
Mississippi River																									
Head of Passes, La.	2.1	2.2	2.4	2.5	2.7	2.8	3.0	3.2	3.2	3.3	3.4	3.4	3.5	3.5	3.5	3.5	3.7	3.8	4.3	4.9	5.3	6.6	Gage failed		
West Pointe-a-la-Hache, La.	2.0	2.1	2.2	2.4	2.5	2.7	2.8	3.0	3.1	3.2	3.3	3.4	3.5	3.5	3.5	3.6	3.8	4.0	4.6	7.1	11.1	13.4	[D]15.0	Gage failed	
Algiers Lock, La.	2.5	2.5	2.7	2.8	2.9	3.1	3.3	3.4	3.5	3.7	3.8	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.3	4.7	7.1	10.6	12.1	[E]12.2	10.9
Chalmette, La.	2.6	2.7	2.8	2.9	3.1	3.2	3.3	3.5	3.7	3.8	3.9	4.0	4.1	4.2	4.2	4.2	4.2	4.3	4.4	4.6	5.4	8.0	11.6	[F]12.5	11.6
New Orleans, La.	2.3	2.3	2.4	2.5	2.6	2.8	2.9	3.0	3.2	3.2	3.5	3.6	3.7	3.8	3.8	3.9	3.9	3.9	4.0	4.1	4.3	5.8	9.4	11.6	[G]12.3
Inner Harbor Navigation Canal																									
Seabrook Bridge (New Orleans)	2.0	2.0	1.9	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.7	2.9	3.0	3.2	3.2	3.4	3.5	3.7	4.0	4.4	4.9	5.4	6.2	6.2	5.6
Lake Pontchartrain																									
West End (New Orleans)	2.2	2.1	2.2	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.3	2.3	2.4	2.5	2.7	2.8	3.0	3.3	3.6	4.1	4.8	5.1	4.3	5.8
Mandeville, La.	2.0	2.0	1.9	1.8	1.8	1.8	1.9	1.9	1.9	2.1	2.1	2.2	2.3	2.2	2.2	2.3	2.2	2.2	2.1	1.8	1.7	1.0	0.8	1.8	2.5
Causeway (Midlake)	2.2	2.1	2.1	2.1	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.8	2.9	3.1	3.1	3.4	3.3	3.1
Rigolets, Hwy. 90												No record													
Miss. River-Gulf Outlet																									
Paris Road (New Orleans)	1.8	1.8	1.8	2.0	2.1	2.2	2.3	2.4	2.6	2.8	3.0	3.2	3.5	3.7	3.9	4.1	4.4	4.6	5.1	5.9	6.9	8.2	9.2	9.5	9.7
Shell Beach, La.	1.7	1.8	1.9	2.0	2.2	2.3	2.5	2.6	2.9	3.0	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.8	6.0		Gage failed				
Bayou LaLoutre																									
Alluvial City, La.	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.0	3.1	3.2	3.4	3.6	3.8	4.1	4.3	4.5	4.7	5.8	8.4
Lower Atchafalaya River																									
Morgan City, La.	0.2	0.4	0.6	0.8	1.0	1.2	1.3	1.4	1.5	1.6	1.6	1.5	1.5	1.4	1.3	1.2	1.1	0.8	0.7	0.4	0.1	-0.5	-0.8	-1.0	-1.0
Charenton Drainage Canal																									
Mud Lake, La.	0.1	0.3	0.4	0.6	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.3	0.0	-0.2	-0.6	-1.0	-1.3	-1.4

A-5.5 at 1820 B-Time 2110 C-8.8 at 2250 D-15.2 at 2240 E-12.4 at 2240 F-12.6 at 2310 G-12.4 at 2350

TABLE 3

HURRICANE BETSY
8-11 SEPTEMBER 1965
TIDE GAGE DATA FROM CORPS OF ENGINEERS RECORDING GAGES (M.S.L. DATUM)
ALONG THE LOUISIANA-MISSISSIPPI COAST

	DATE AND TIME: 10 SEPTEMBER 1965																							
	0001	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Approximate position of storm (Lat. and Long.)				30.4-91.4							31.7-92.1						32.9-92.2								
LOCATION												GULF STATIONS													
South Pass, Miss. River																									
Port Eads, La.	4.4	4.4	4.3	4.3	4.2	4.2	4.0	3.9	3.8	3.6	3.5	3.3	3.2	3.0	2.9	2.9	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.2	3.2
Approx. miles to eye					160 NW						260 NW						330 NNW								
Bayou Rigaud																									
Grand Isle, La.	6.0	4.3																							
Approx. miles to eye					110 NW																				
Gulf of Mexico																									
Biloxi, Miss.	8.1	[A]8.5	8.0	7.3	6.7	6.4	6.1	6.2	6.1	6.0	5.5	5.3	4.9	4.0	3.6	3.2	2.9	2.8	2.6	2.4	2.3	2.3	2.2	2.2	2.1
Approx. miles to eye					140 W						210 NW						270 NW								
East Cote Blanche Bay																									
Lukes Landing, La.	-0.8	0.1	1.2	2.2	2.6	2.4	3.0	[B]3.6	3.7	3.7	3.4	3.3	3.4	3.4	3.3	3.3	3.0	2.5	2.2	1.8	1.6	1.4	1.3	1.3	1.8
Approx. miles to eye					60 NNE						150 N						240 N								
												INLAND STATIONS													
Mississippi River																									
Head of Passes, La.												No record													
West Pointe-a-la-Hache, La.												No record													
Algiers Lock, La.	10.9	9.6	9.4	9.0	8.4	8.0	8.0	7.7	7.4	7.0	6.9	6.7	6.4	6.3	6.1	5.8	5.6	5.4	5.2	Gage failed					
Chalmette, La.	11.6	10.3	9.8	9.6	9.0	8.4	8.3	7.9	7.7	7.4	7.2	7.0	6.8	6.6	6.5	6.2	6.0	5.7	5.5	5.4	5.2	5.1	5.0	4.9	4.8
New Orleans, La.	12.3	11.0	9.9	9.7	9.3	8.7	8.1	8.0	7.6	7.0	7.0	6.7	6.5	6.3	6.2	6.0	5.8	5.6	5.4	5.2	5.0	4.9	4.8	4.7	4.6
Inner Harbor Navigation Canal																									
Seabrook Bridge (New Orleans)	5.6	4.8	5.3	5.7	5.5	5.5	5.8	5.9	5.4	5.5	5.1	5.3	5.1	5.1	5.1	5.0	4.9	4.6	4.7	4.5	4.4	4.4	4.2	4.2	4.1
Lake Pontchartrain																									
West End (New Orleans)	5.8	[C]7.1	6.2	5.8	5.6	5.6	4.5	3.8	3.8	3.3	3.4	3.1	2.9	3.2	2.8	3.0	2.8	3.1	3.2	3.1	3.4	3.2	3.4	3.5	3.5
Mandeville, La.	2.5	3.8	5.3	5.8	6.4	[D]6.4	6.0	6.0	6.0	5.6	6.1	5.6	5.8	5.7	5.7	5.6	5.4	5.5	5.2	5.1	5.1	4.8	4.8	4.8	4.7
Causeway (Midlake)	3.1	3.3	3.6	4.0	4.5	4.7	5.0	5.0	5.1	5.1	5.3	5.5	5.4	5.4	5.5	5.4	5.4	5.2	5.2	5.0	5.0	5.0	4.8	4.8	4.7
Rigolets, Hwy. 90		3.0	4.0	4.6	5.4	7.0	6.4	6.3	6.1	6.1	5.4	5.3	5.2	5.4	5.1	4.7	4.8	4.7	4.7	4.5	4.4	4.2	4.2	4.2	4.0
Miss. River-Gulf Outlet																									
Paris Road (New Orleans)	9.7	10.0	9.8	9.8	9.7	9.3	8.8	8.0	7.2	6.7	6.1	5.7	5.5	5.3	5.1	4.6	4.5	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.5
Shell Beach, La.												No record													
Bayou LaLoutre																									
Alluvial City, La.	8.4	11.1	[E]11.6	11.2	10.5	9.9	9.4	9.0	8.7	8.4	7.9	7.6	7.4	7.2	6.9	6.7	6.5	6.3	6.2	6.0	5.8	5.7	5.5	5.4	5.2
Lower Atchafalaya River																									
Morgan City, La.	-1.0	-0.8	-0.1	0.9	2.0	2.7	3.4	3.7	4.1	4.4	4.5	4.4	4.3	4.2	4.1	4.1	4.0	3.8	3.6	3.4	3.1	2.8	2.4	2.2	1.9
Charenton Drainage Canal																									
Mud Lake, La.	-1.4	-1.3	-0.6	0.4	1.9	2.5	2.1	2.1	2.4	2.5	2.6	2.5	2.6	2.9	2.9	2.9	2.9	2.8	2.6	2.2	1.8	1.7	1.5	1.4	1.3

A-8.6 at 0105 B-3.8 at 0720 C-7.6 at 0055 D-6.5 at 0505 E-11.7 at 0215

TABLE 3

HURRICANE BETSY
8-11 SEPTEMBER 1965
TIDE GAGE DATA FROM CORPS OF ENGINEERS RECORDING GAGES (M.S.L. DATUM)
ALONG THE LOUISIANA-MISSISSIPPI COAST

	DATE AND TIME: 11 SEPTEMBER 1965																							
	0001	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Approximate position of storm (Lat. and Long.)																									
LOCATION												GULF STATIONS													
South Pass, Miss. River																									
Port Eads, La.												No record													
Approx. miles to eye																									
Bayou Rigaud																									
Grand Isle, La.												No record													
Approx. miles to eye																									
Gulf of Mexico																									
Biloxi, Miss.	2.1	1.9	1.8	1.7	1.6	1.5	1.6	1.8	2.1	2.2	2.2	2.2	2.2	2.1	2.0	1.9	1.7	1.6	1.6	1.7	1.9	2.0	2.0	2.1	2.1
Approx. miles to eye																									
East Cote Blanche Bay																									
Lukes Landing, La.	1.8	2.0	2.3	2.6	2.8	2.8	2.7	2.6	2.3	2.2	2.1	2.0	2.2	2.4	2.5	2.7	2.7	2.7	2.4	2.2	1.9	1.6	1.6	1.7	2.0
Approx. miles to eye																									
												INLAND STATIONS													
Mississippi River																									
Head of Passes												No record													
West Pointe-a-la-Hache, La.												No record													
Algiers Lock, La.									*4.4																
Chalmette, La.	4.8	4.8	4.8	4.7	4.7	4.7	4.6	4.6	4.6	4.6	4.7	4.6	4.6	4.6	4.5	4.5	4.4	4.2	4.1	3.9	3.8	3.7	3.7	3.6	3.6
New Orleans, La.	4.6	4.6	4.6	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.2	4.1	3.9	3.8	3.7	3.6	3.5	3.4	3.4
Inner Harbor Navigation Canal																									
Seabrook Bridge (New Orleans)	4.1	4.0	4.0	3.8	3.8	3.8	3.7	3.6	3.6	3.4	3.4	3.3	3.3	3.2	3.3	3.1	3.2	3.3	3.3	3.1	3.1	3.0	2.9	2.9	2.8
Lake Pontchartrain																									
West End (New Orleans)	3.5	3.7	3.7	3.8	3.8	3.8	3.9	4.0	3.9	3.8	3.8	3.7	3.6	3.6	3.3	3.5	3.5	3.5	3.4	3.3	3.3	3.3	3.2	3.2	3.1
Mandeville, La.	4.7	4.7	4.6	4.5	4.4	4.2	4.2	4.2	4.0	4.0	3.9	3.8	3.8	3.7	3.8	3.4	3.6	3.6	3.4	3.5	3.3	3.3	3.3	3.2	3.2
Causeway (Midlake)	4.7	4.6	4.5	4.4	4.4	4.3	4.2	4.2	4.1	4.0	3.9	3.8	3.8	4.6	4.6	4.6	4.6	4.5	4.5	4.4	4.4	4.3	4.3	4.3	4.2
Rigolets, Hwy. 90	4.0	3.9	3.9	3.8	3.8	3.7	3.6	3.5	3.4	3.4	3.3	3.3	3.3	3.2	3.2	3.3	3.2	3.1	3.0	3.0	2.9	2.8	2.8	2.8	2.7
Miss. River-Gulf Outlet																									
Paris Road (New Orleans)	3.5	3.4	3.3	3.2	3.2	3.1	3.0	3.0	2.9	2.8	2.7	2.6	2.6	2.6	2.8	2.8	2.8	2.8	2.8	2.7	2.6	2.5	2.4	2.4	2.4
Shell Beach, La.												No record													
Bayou LaLoutre																									
Alluvial City, La.	5.2	5.1	4.9	4.8	4.6	4.5	4.3	4.1	4.0	3.9	3.8	3.6	3.5	3.4	3.4	3.3	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.7
Lower Atchafalaya River																									
Morgan City, La.	1.9	2.0	2.1	2.3	2.4	2.6	2.7	2.8	2.8	2.7	2.5	2.4	2.3	2.3	2.4	2.5	2.6	2.7	2.8	2.7	2.6	2.3	2.1	1.9	1.8
Charenton Drainage Canal																									
Mud Lake, La.	1.3	1.5	1.8	2.1	2.3	2.4	2.4	2.5	2.4	2.3	2.1	2.0	1.9	2.0	2.1	2.2	2.4	2.5	2.4	2.2	2.0	1.8	1.6	1.5	1.6

*Wire weight reading

TABLE 4

HURRICANE BETSY
8-11 SEPTEMBER 1965
SALINITY STATION DATA

STATION LOCATION	SEPTEMBER 1965									
	6	7	8	9	10	11	12	13	14	15
	Chlorides as Cl^- in parts per million									
LAKE PONTCHARTRAIN AND VICINITY:										
North Shore at U. S. Hwy. 11	4,600	5,600	5,500	5,400	4,400	4,400	4,600	4,700	4,100	4,100
Expressway Bridge, North Bascule	2,700	2,600	3,000	2,900				2,400	1,900	2,600
South Bascule	3,300	3,400	3,400	3,400		3,400	2,200	2,300	2,900	3,200
Little Woods	3,100	3,500	4,000	4,030	5,200	5,500	4,900	4,800	4,000	4,000
Paris Road Bridge	6,000	5,400	5,900	5,800	7,300				8,000	7,500
BAYOU BARATARIA:										
Lafitte, La.	1,900	2,100	1,900	1,800	5,600	5,900	5,500	3,300	2,600	2,400
BAYOU LAFOURCHE:										
LaRose, La.			420	480	180	4,700	4,700	4,500	360	250
Golden Meadow, La.		3,200	3,300		480	610	540	500	370	370
Leeville, La.			10,500	9,100	7,400	7,400	7,700	7,600	7,500	8,400
GULF INTRACOASTAL WATERWAY AND VICINITY:										
Houma, La.	210	230	160	220	100	90	710	180	170	110
Bayou Grand Caillou, near Dulac, La.	150	150	150	140	140	110	600	700	700	700

TABLE 5

RECORD HIGH WATER ELEVATIONS
RESULTING FROM TROPICAL STORMS
1909-1965
HURRICANE BETSY 8-11 SEPTEMBER 1965

Gage or Location	Water Height in Feet, Mean Sea Level				
	Hurricane Betsy			Record High	
	Highest Recorded	Date	Hour	Elevation	Cause of High Water
Gulf of Mexico					
Biloxi	8.56	10	1:05 AM	10.80	C
Gulfport	10.70	I	I	14.0	C
Port Eads	5.50	9	6:20 PM	D	D
Grand Isle	8.84	9	10:50 PM	9.0	E
East Cote Blanche Bay	3.82	10	7:20 AM	6.00	F
Lake Borgne					
Rigolets	10.62	I	I	D	D
Lake Catherine					
Greens Ditch	9.17	I	I	9.6	E
Lake Pontchartrain					
Rigolets at Hwy. 90	7.01	10	5:10 AM	7.4	E
Mandeville	6.53	10	5:05 AM	7.3	G
Manchac	4.1	10	I	5.0	E
Ruddock	10.17	10	I	D	D
Frenier	12.09	10	I	12.92	E
West End	7.55	10	12:55 AM	D	D
Little Woods	I	I	I	7.0	H
Causeway (mid Lake)	5.53	10	11:00 AM	D	D
Mississippi River and Vicinity					
Chalmette	12.61	9	1:10 PM	17.58	J
Pointe a la Hache (east landside)	14.42	I	I	D	D
W. Pointe a la Hache	15.25[A]	9	10:40 PM	D	D
Bohemia (E. landside)	15.7	I	I	D	D
Empire (W. landside)	10.4	I	I	D	D
Ostrica Lock	13.61	I	I	D	D
Buras (W. landside)	7.7	I	I	D,E	D
Head of Passes	6.57	9	9:00 PM	D	D

TABLE 5

RECORD HIGH WATER ELEVATIONS
RESULTING FROM TROPICAL STORMS
1909-1965
HURRICANE BETSY 8-11 SEPTEMBER 1965

Gage or Location	Water Height in Feet, Mean Sea Level				
	Hurricane Betsy			Record High	
	Highest Recorded	Date	Hour	Elevation	Cause of High Water
Mississippi River-Gulf Outlet					
Shell Beach	9.34	I	I	11.2[B]	C
Paris Road	10.34	I	I	D	D
Bayou LaLoutre					
Alluvial City	11.72	10	2:15 AM	D	D
Delacroix	10.96	I	I	D	D
Bayou Barataria					
Barataria	2.75	11	4:05 PM	3.60	K
Lafitte	3.35	10	3:25 PM	4.04	K
Bayou Lafourche					
Golden Meadow	2.83	10	5:00 PM	5.5	E
Leeville	5.45	9	I	9.0	E
Intracoastal Waterway					
Houma	3.03	10	2:10 AM	3.27	K
Vermilion Lock	I	I	I	8.1	F
Calcasieu Lock	I	I	I	7.21	F
Bayou Boeuf Lock					
Morgan City (W. gage)	4.7	10	9:00 AM	8.4	F
Lower Atchafalaya River					
Morgan City	4.46	10	10:00 AM	8.46	F
Sweet Bay Lake	I	I	I	8.05	F
Wax Lake East Control Structure (FWS)					
South gage	4.03	10	2.40 PM	8.52	F
Wax Lake West Control Structure (FWS)					
South gage	3.32	10	2:00 PM	7.35	F
Charenton Drainage Canal					
Baldwin (Mud Lake)	2.93	10	3:35 PM	5.22	L

TABLE 5

RECORD HIGH WATER ELEVATIONS
RESULTING FROM TROPICAL STORMS
1909-1965
HURRICANE BETSY 8-11 SEPTEMBER 1965

Gage or Location	Water Height in Feet, Mean Sea Level				
	Hurricane Betsy			Record High	
	Highest Recorded	Date	Hour	Elevation	Cause of High Water
Schooner Bayou					
Control structure	I	I	I	5.85	L
Mermentau River					
Catfish Point Control Structure	I	I	I	7.5	F
Grand Cheniere	I	I	I	12.2	F
Calcasieu River					
Lake Charles	I	I	I	9.2	M
Hackberry	I	I	I	6.70	F
Cameron	I	I	I	12.1	F

Footnotes:

A Gage failed at or near crest. Record estimated.
B Bayou Yscloskey (Lake Borgne) at Shell Beach.
C Hurricane, 19 September 1947.
D Established by hurricane "Betsy."
E Hurricane, 29 September 1915.
F Hurricane Audrey, 27 June 1957.
G Hurricane, 20 September 1909.
H Hurricane Flossy, 24 September 1956.
I Not determined.
J High water, 25-26 April 1927.
K Hurricane Hilda, 4 October 1964.
L Hurricane Carla, 11 September 1961.
M High water, 22 May 1953.

TABLE 6

ESTIMATED DAMAGES IN ORLEANS PARISH
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Class	Damage to fixed property		Damage to movable property		Other losses	Total damages
	From tidal overflow	From wind	From tidal overflow	From wind		
	$	$	$	$	$	$
Residential	31,531	6,533	-	-	-	38,064
Mobile homes	-	-	178	161	-	339
Commercial	12,116	4,607	-	-	-	16,723
Industrial	7,936	8,530	-	-	-	16,466
Governmental	7,453	11,130	-	-	-	18,583
Schools	2,159	2,567	-	-	-	4,726
Churches	275	33	-	-	-	308
Utilities	50	150	-	-	-	200
Transportation	-	-	18,510	279	-	18,789
Marine	-	-	42	140	-	182
Other losses	-	-	-	-	7,160	7,160
Total damages	61,520	33,550	18,730	580	7,160	121,540

TABLE 7

ESTIMATED DAMAGES IN PLAQUEMINES PARISH
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Class	Damage to fixed property		Damage to movable property		Other losses	Total damages
	From tidal overflow	From wind	From tidal overflow	From wind		
	$	$	$	$	$	$
Agriculture	4,007	1,633	-	-	-	5,640
Residential	14,530	1,468	-	-	-	15,998
Mobile homes	-	-	4,152	140	-	4,292
Commercial	5,671	874	-	-	-	6,545
Industrial	3,963	3,406	-	-	-	7,369
Governmental	3,720	120	-	-	-	3,840
Schools	1,460	1,460	-	-	-	2,920
Churches	385	88	-	-	-	473
Utilities	254	1,701	-	-	-	1,955
Transportation	-	-	445	4	-	449
Marine	-	-	113	66	-	179
Other losses	-	-	-	-	2,890	2,890
Total damages	33,990	10,750	4,710	210	2,890	52,550

TABLE 8

ESTIMATED DAMAGES IN ST. BERNARD PARISH
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Class	Damage to fixed property		Damage to movable property		Other losses	Total damages
	From tidal overflow	From wind	From tidal overflow	From wind		
	$	$	$	$	$	$
Agriculture	1,067	-	-	-	-	1,067
Residential	21,748	1,198	-	-	-	22,946
Mobile homes	-	-	247	70	-	317
Commercial	2,886	389	-	-	-	3,275
Industrial	405	38	-	-	-	443
Governmental	1,110	424	-	-	-	1,534
Schools	1,446	1,276	-	-	-	2,722
Churches	43	5	-	-	-	48
Transportation	25	-	4,380	-	-	4,405
Marine	-	-	1,103	280	-	1,383
Total damages	28,730	3,330	5,730	350	-	38,140

TABLE 9

ESTIMATED DAMAGES IN JEFFERSON PARISH
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Class	Damage to fixed property		Damage to movable property		Other losses	Total damages
	From tidal overflow	From wind	From tidal overflow	From wind		
	$	$	$	$	$	$
Residential	8,094	205	-	-	-	8,299
Mobile homes	-	-	297	-	-	297
Commercial	1,489	112	-	-	-	1,601
Industrial	1,104	73	-	-	-	1,177
Governmental	733	-	-	-	-	733
Schools	65	15	-	-	-	80
Utilities	215	25	-	-	-	240
Transportation	-	-	8	-	-	8
Marine	-	-	75	-	-	75
Total damages	11,700	430	380	-	-	12,510

TABLE 10

LAFOURCHE PARISH

Residential	129	22	-	-	-	151
Commercial	111	30	-	-	-	141
Industrial	923	163	-	-	-	1,086
Governmental	2	-	-	-	-	2
Utilities	35	25	-	-	-	60
Total damages	1,200	240	-	-	-	1,440

TABLE 11

ESTIMATED DAMAGES IN ST. TAMMANY PARISH
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Class	Damage to fixed property		Damage to movable property		Other losses	Total damages
	From tidal overflow	From wind	From tidal overflow	From wind		
	$	$	$	$	$	$
Residential	297	75	-	-	-	372
Commercial	95	18	-	-	-	113
Governmental	100	-	-	-	-	100
Utilities	2	13	-	-	-	15
Transportation	356	74	-	-	-	430
Total damages	850	180	-	-	-	1,030

TABLE 12

ST. CHARLES PARISH

Residential	3	2	-	-	-	5
Commercial	1	1	-	-	-	2
Transportation	206	27	-	-	-	233
Total damages	210	30	-	-	-	240

TABLE 13

ESTIMATED DAMAGES IN ST. JOHN THE BAPTIST PARISH
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Class	Damage to fixed property		Damage to movable property		Other losses	Total damages
	From tidal overflow	From wind	From tidal overflow	From wind		
	$	$	$	$	$	$
Utilities	5	10	-	-	-	15
Transportation	205	30	-	-	-	235
Total damages	210	40	-	-	-	250

TABLE 14

TANGIPAHOA PARISH

Utilities	-	10	-	-	-	10
Total damages	-	10	-	-	-	10

TABLE 15

INSEPARABLE DAMAGES
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Classes	Damages $
Marine damage	61,255
Onshore petroleum	5,860
Offshore petroleum	18,880
State Highway Department	460
Evacuation and relief to flood victims	16,000
Fish and wildlife	8,850
Governmental	9,983
Utilities	22,500
Transportation	462
Total	144,250

TABLE 16

SUMMARY OF ESTIMATED DAMAGES BY CLASSES
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Classes	Damage to fixed property		Damage to movable property		Other losses	Total damages
	From tidal overflow	From wind	From tidal overflow	From wind		
	$	$	$	$	$	$
Agriculture	5,074	1,633	-	-	-	6,707
Residential	76,332	9,503	-	-	-	85,835
Mobile homes	-	-	4,874	371	-	5,245
Commercial	22,369	6,031	-	-	-	28,400
Industrial	14,331	12,137	-	-	-	26,468
Governmental	12,385	11,747	-	-	-	24,132
Schools	5,798	5,303	-	-	-	11,101
Churches	768	126	-	-	-	894
Utilities	561	1,924	-	-	-	2,485
Transportation	792	156	23,343	283	-	24,574
Marine	-	-	1,333	486	-	1,819
Other losses	-	-	-	-	10,050	10,050
Total damages	138,410	48,560	29,550	1,140	10,050	227,710

TABLE 17

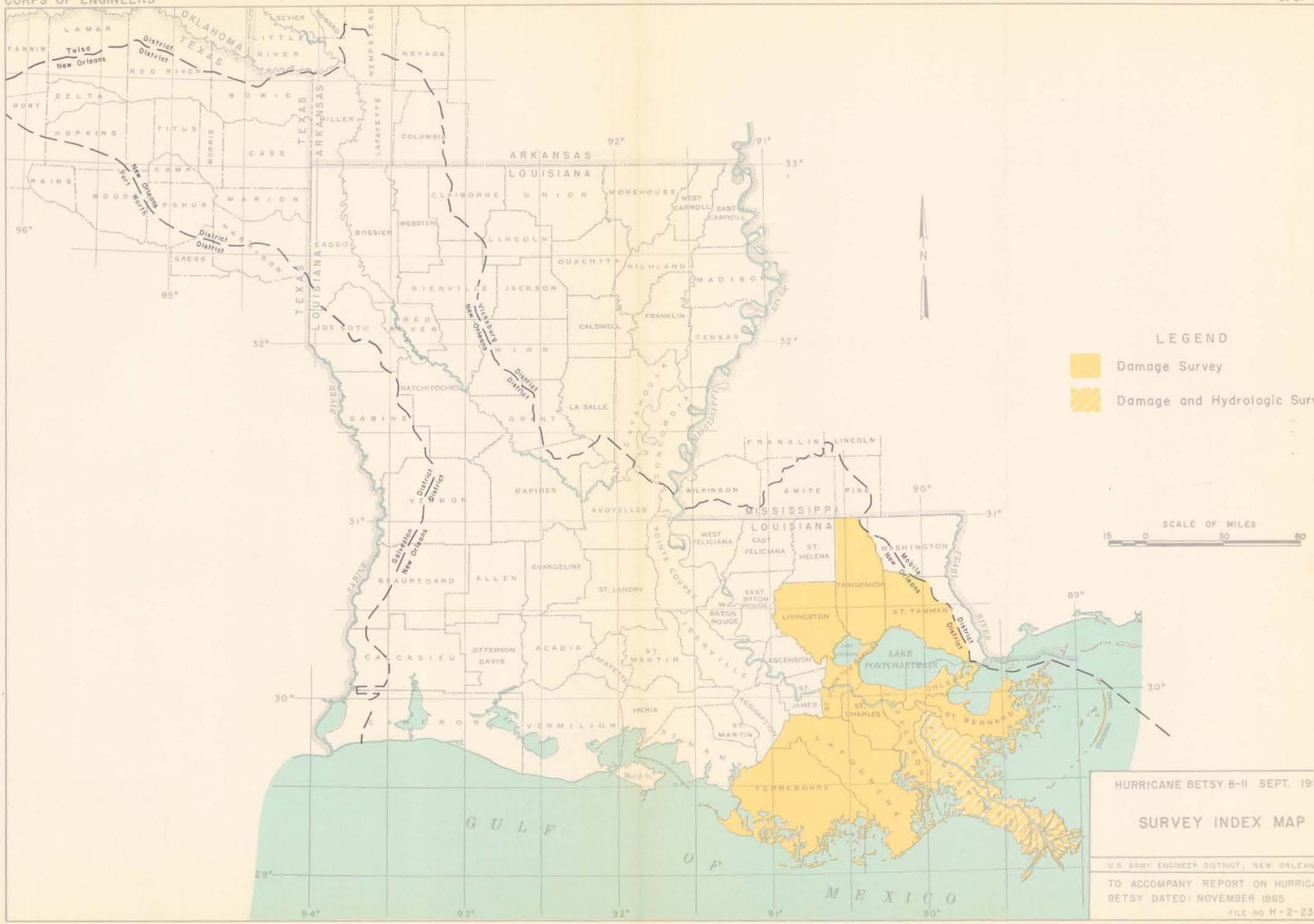
SUMMARY OF ESTIMATED DAMAGES BY PARISHES
HURRICANE BETSY 8-11 SEPTEMBER 1965
(Damages in thousands of dollars)

Parish	Damage to fixed property		Damage to movable property		Other losses	Total damages
	From tidal overflow	From wind	From tidal overflow	From wind		
	$	$	$	$	$	$
Orleans	61,520	33,550	18,730	580	7,160	121,540
Plaquemines	33,990	10,750	4,710	210	2,890	52,550
St. Bernard	28,730	3,330	5,730	350	-	38,140
Jefferson	11,700	430	380	-	-	12,510
Lafourche	1,200	240	-	-	-	1,440
St. Tammany	850	180	-	-	-	1,030
St. Charles	210	30	-	-	-	240
St. John the Baptist	210	40	-	-	-	250
Tangipahoa	-	10	-	-	-	10
Totals	138,410	48,560	29,550	1,140	10,050	227,710
Inseparable					144,250	144,250
TOTAL					154,300	371,960

Total	Damages from tidal overflow	$167,960
Total	Damages from wind	49,700
Total	Other damages	154,300
	GRAND TOTAL	$371,960

CORPS OF ENGINEERS

U.S. ARMY



HURRICANE BETSY 8-11 SEPT. 1965

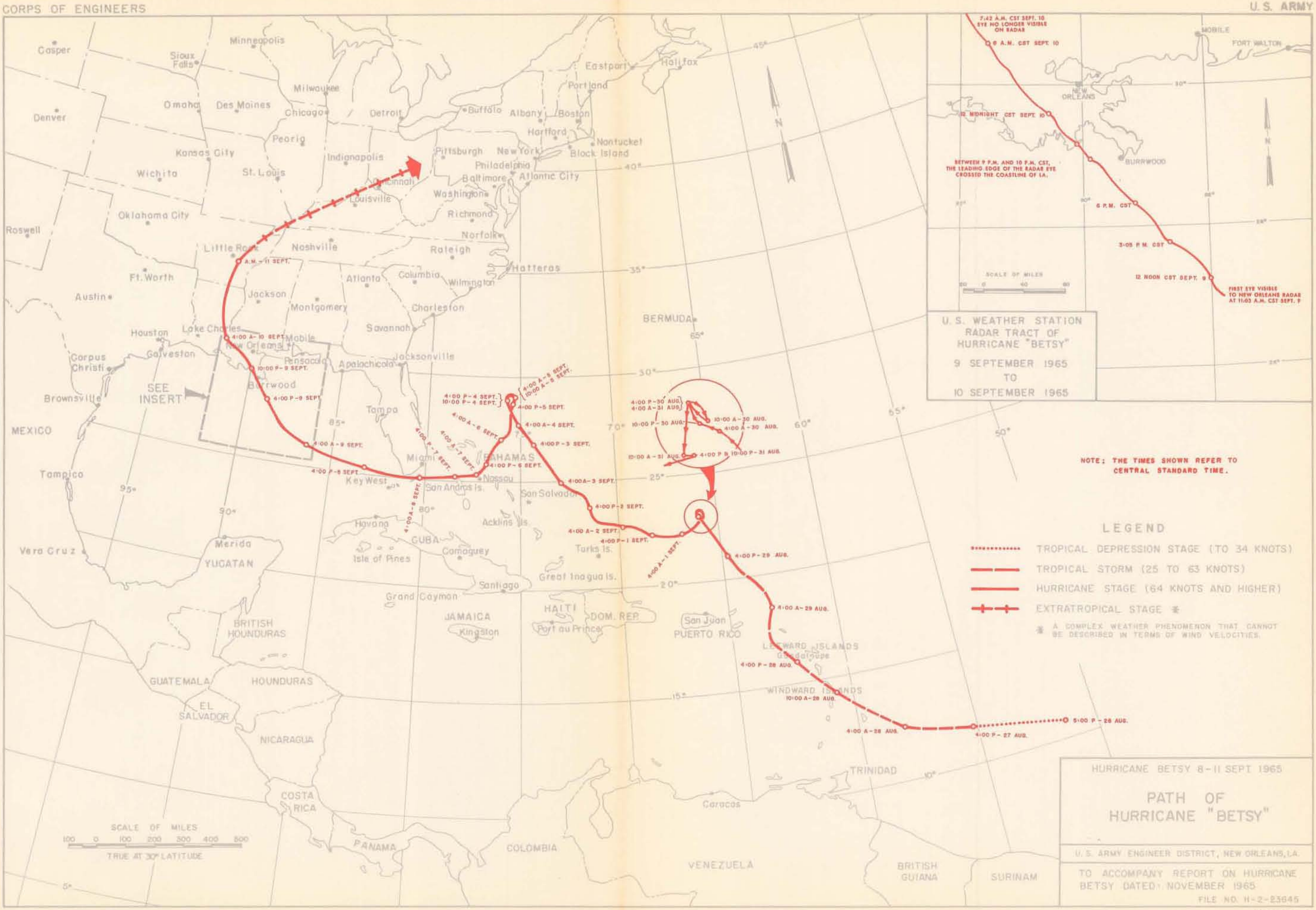
SURVEY INDEX MAP

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO H-2-23645

PLATE 1



U. S. WEATHER STATION
RADAR TRACT OF
HURRICANE "BETSY"
9 SEPTEMBER 1965
TO
10 SEPTEMBER 1965

NOTE: THE TIMES SHOWN REFER TO CENTRAL STANDARD TIME.

LEGEND

- TROPICAL DEPRESSION STAGE (TO 34 KNOTS)
- TROPICAL STORM (25 TO 63 KNOTS)
- HURRICANE STAGE (64 KNOTS AND HIGHER)
- EXTRATROPICAL STAGE *

* A COMPLEX WEATHER PHENOMENON THAT CANNOT BE DESCRIBED IN TERMS OF WIND VELOCITIES.

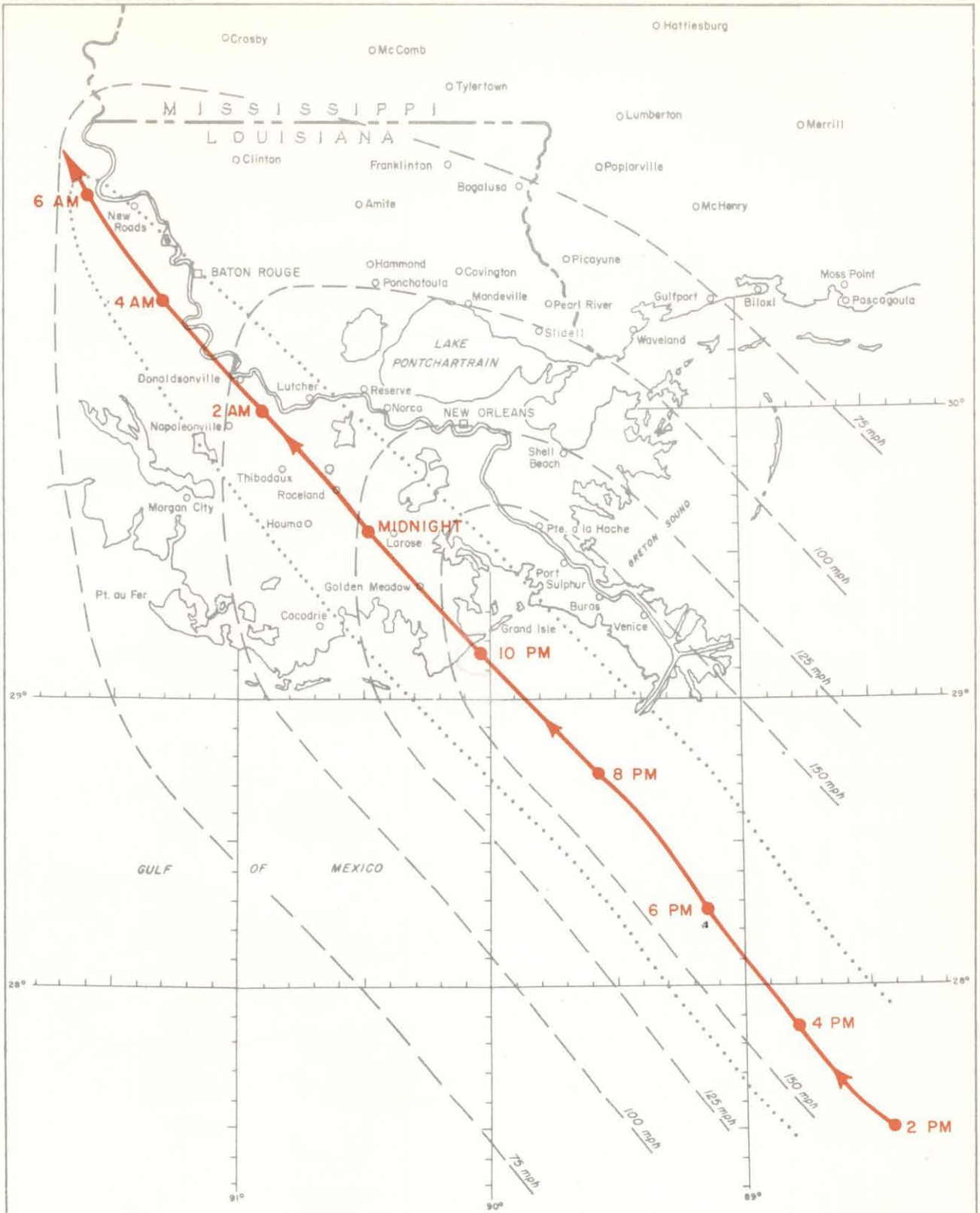
HURRICANE BETSY 8-11 SEPT 1965

PATH OF HURRICANE "BETSY"

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645



LEGEND

Storm track

Radar eye

Estimated wind field

NOTE:
Basic information provided by U.S. Weather Bureau, New Orleans, La.

HURRICANE BETSY 8-11 SEPT. 1965

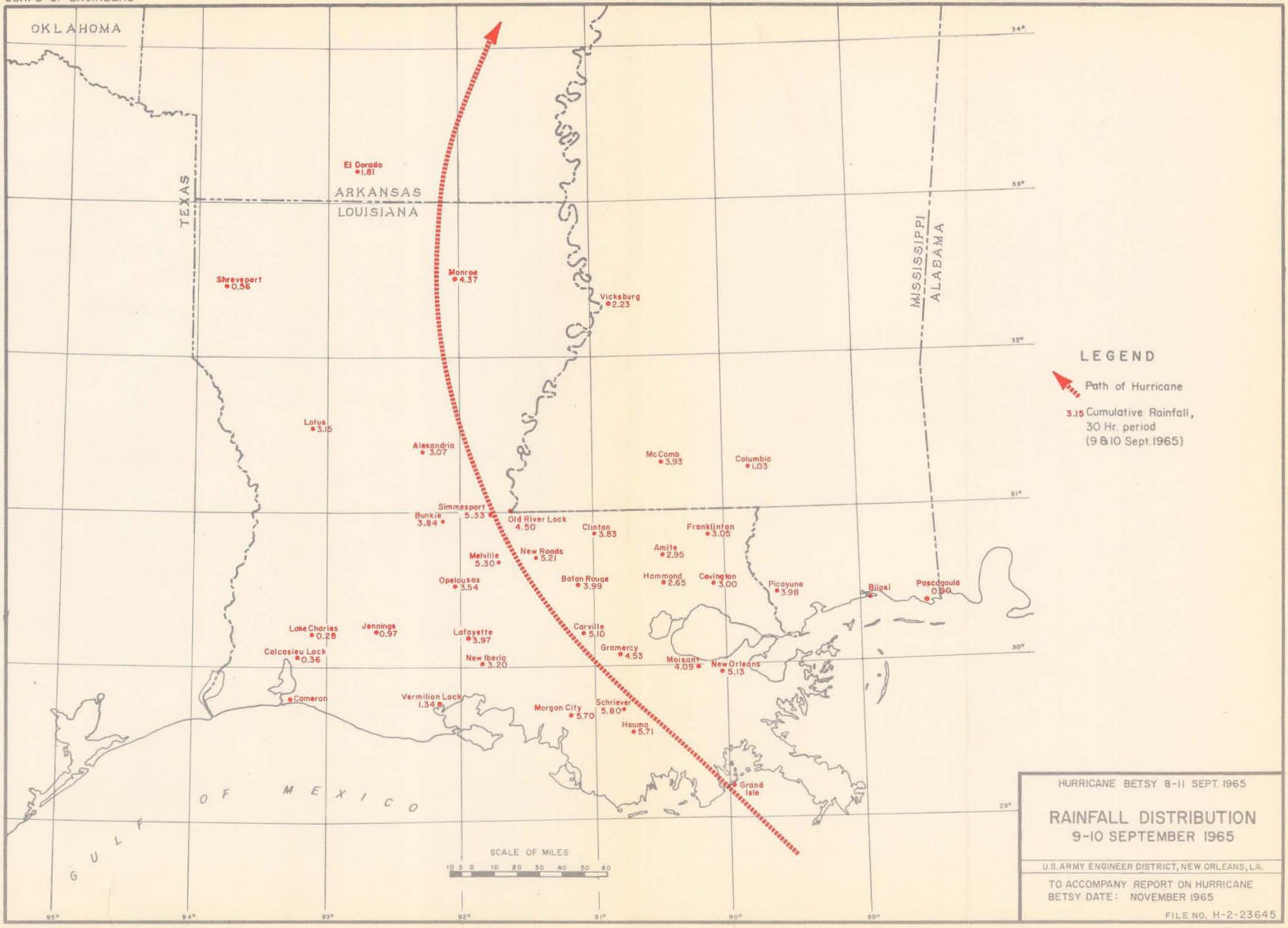
ESTIMATED WIND FIELD
9-10 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

PLATE 3



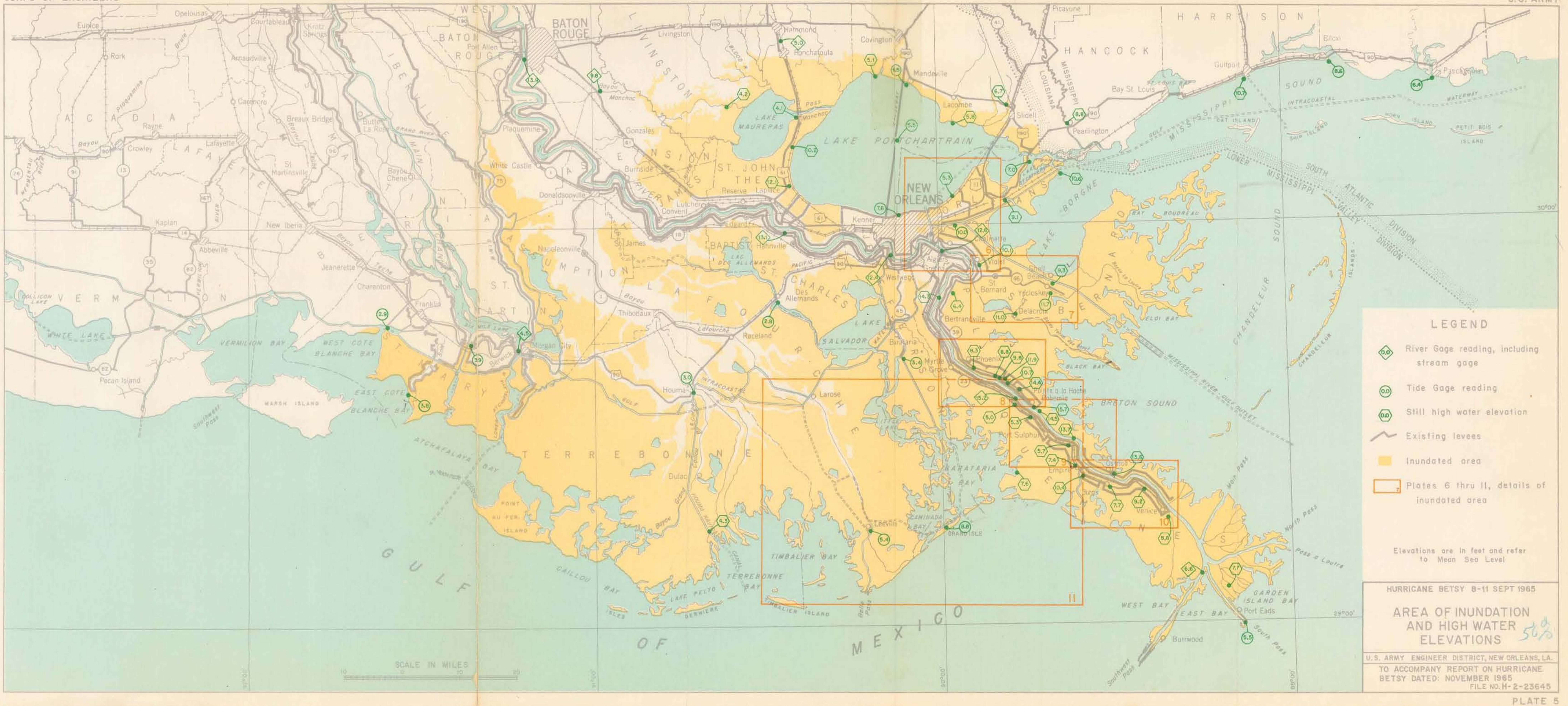
HURRICANE BETSY 8-11 SEPT. 1965

RAINFALL DISTRIBUTION 9-10 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATE: NOVEMBER 1965

FILE NO. H-2-23645


LEGEND
River Gage reading, including stream gage
Tide Gage reading
Still high water elevation
Existing levees
Inundated area
Plates 6 thru 11, details of inundated area
Elevations are in feet and refer to Mean Sea Level
HURRICANE BETSY 8-11 SEPT 1965
AREA OF INUNDATION AND HIGH WATER ELEVATIONS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645
SCALE IN MILES
GULF OF MEXICO
LAKE PONTCHARTRAIN
NEW ORLEANS
BATON ROUGE

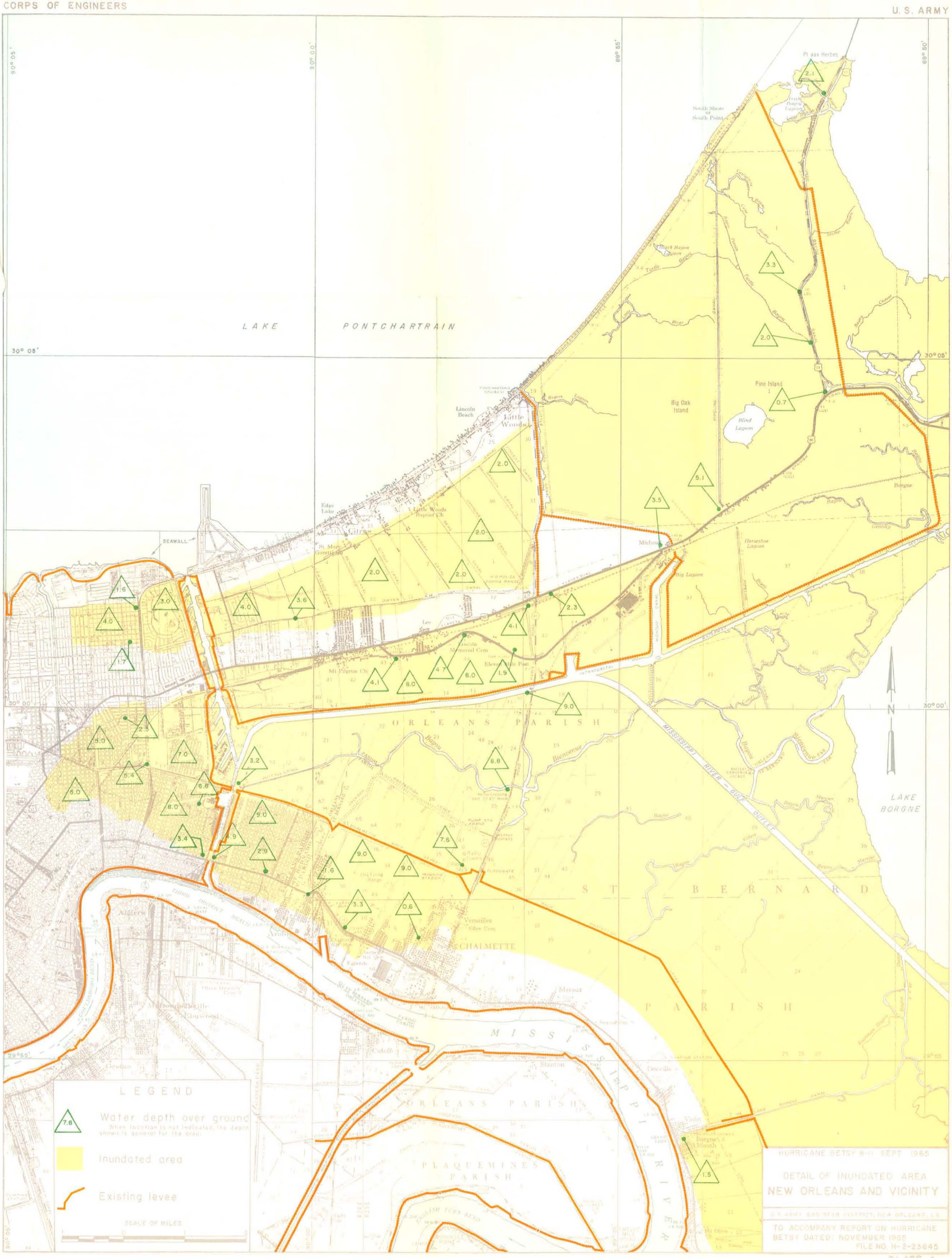
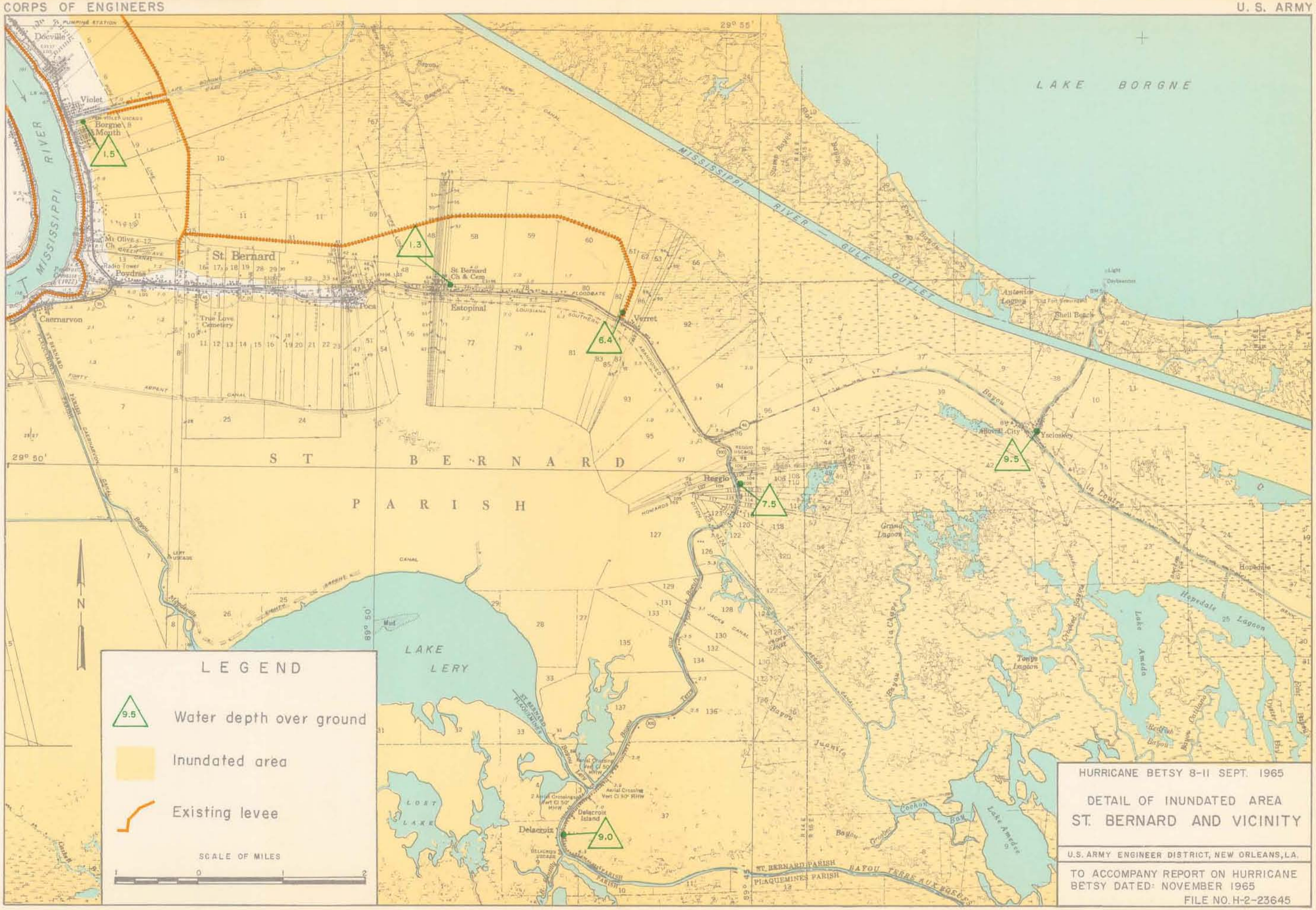

LAKE PONTCHARTRAIN
LAKE BORGNE
ORLEANS PARISH
ST BERNARD PARISH
PLAQUEMINES PARISH
MISSISSIPPI RIVER
MISSISSIPPI RIVER – GULF OUTLET
SEAWALL
Pt aux Herbes
South Shore or South Point
Lincoln Beach
Little Woods
Edge Lake
Citrus
Big Oak Island
Pine Island
Blind Lagoon
Michoud
Big Lagoon
Horseshoe Lagoon
Borgne
Gentilly
Lee
Mt Pilgrim Ch
Lincoln Memorial Cem
Eleven Mile Post
Algiers
Arabi
CHALMETTE
Versailles
Meraux
Stanton
Violet
Borgne Mouth
Caernarvon
90° 05'
90° 00'
89° 55'
89° 50'
30° 05'
30° 00'
29° 55'
LEGEND
Water depth over ground
When location is not indicated, the depth shown is general for the area.
Inundated area
Existing levee
SCALE OF MILES
HURRICANE BETSY 9-11 SEPT 1965
DETAIL OF INUNDATED AREA
NEW ORLEANS AND VICINITY
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

PLATE 6



HURRICANE BETSY 8-11 SEPT. 1965

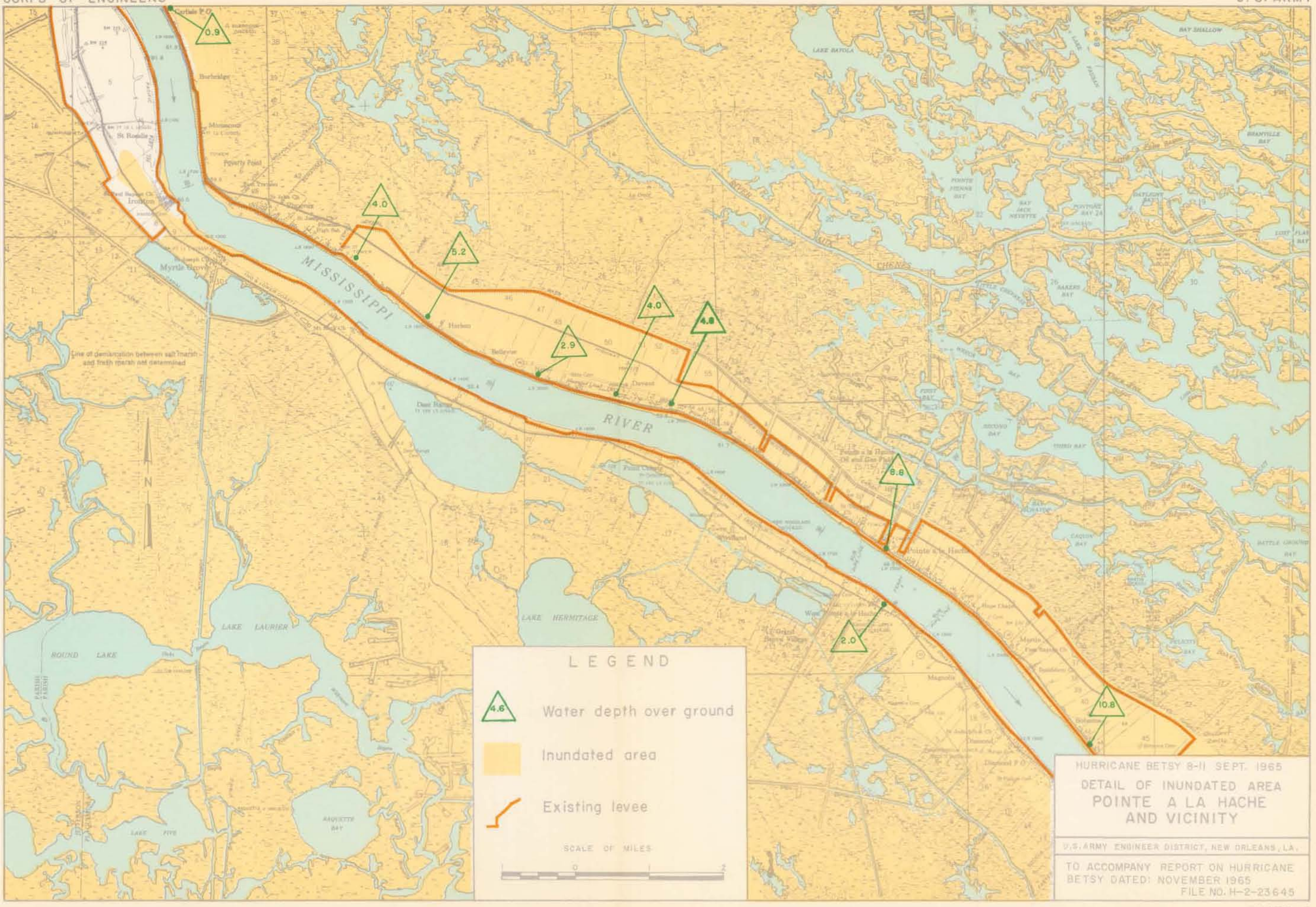
DETAIL OF INUNDATED AREA
ST. BERNARD AND VICINITY

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

4.6 Water depth over ground

Inundated area

Existing levee

SCALE OF MILES

0 2

HURRICANE BETSY 8-11 SEPT. 1965

DETAIL OF INUNDATED AREA
POINTE A LA HACHE
AND VICINITY

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

PLATE 8

CORPS OF ENGINEERS

U. S. ARMY

HURRICANE BETSY 8-11 SEPT. 1965

DETAIL OF INUNDATED AREA

PORT SULPHUR AND VICINITY

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

PLATE 9

CORPS OF ENGINEERS

U.S. ARMY

HURRICANE BETSY 8-11 SEPT. 1965

DETAIL OF INUNDATED AREA .BURAS-VENICE AND VICINITY

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

PLATE 10

HURRICANE BETSY 8-11 SEPT. 1965

DETAIL OF INUNDATED AREA

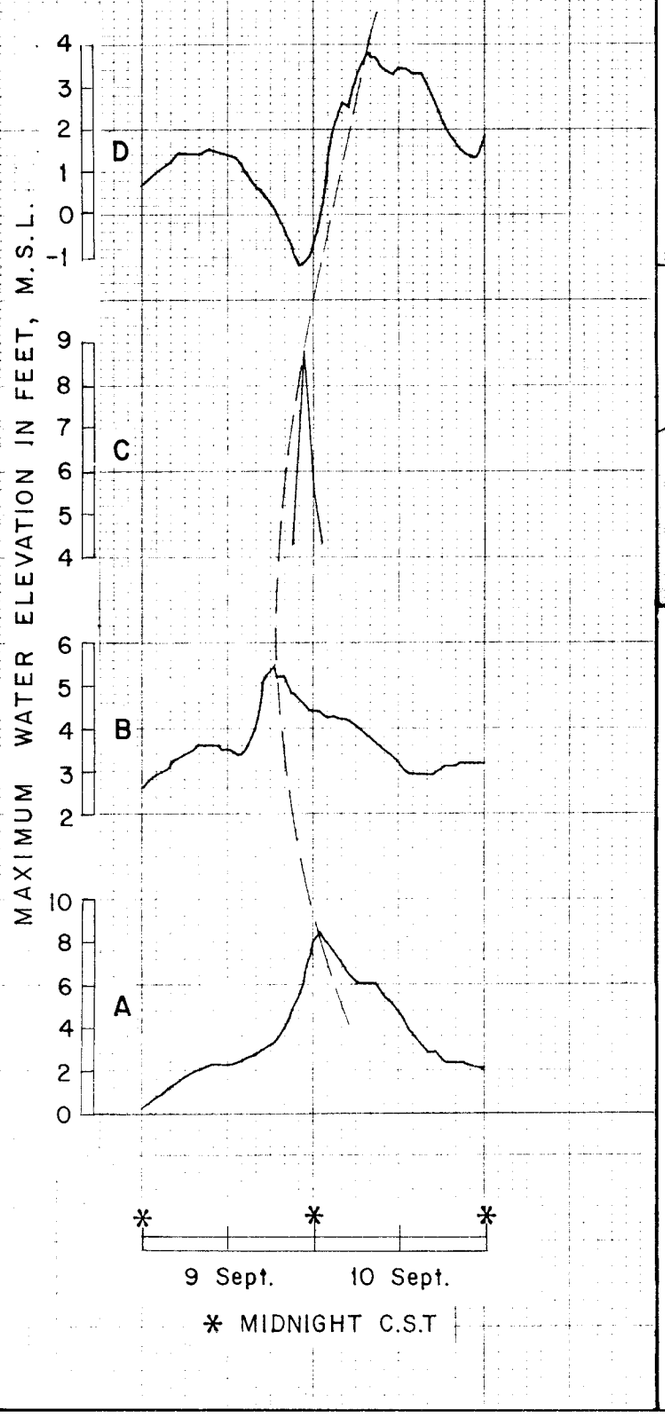
GRAND ISLE AND VICINITY

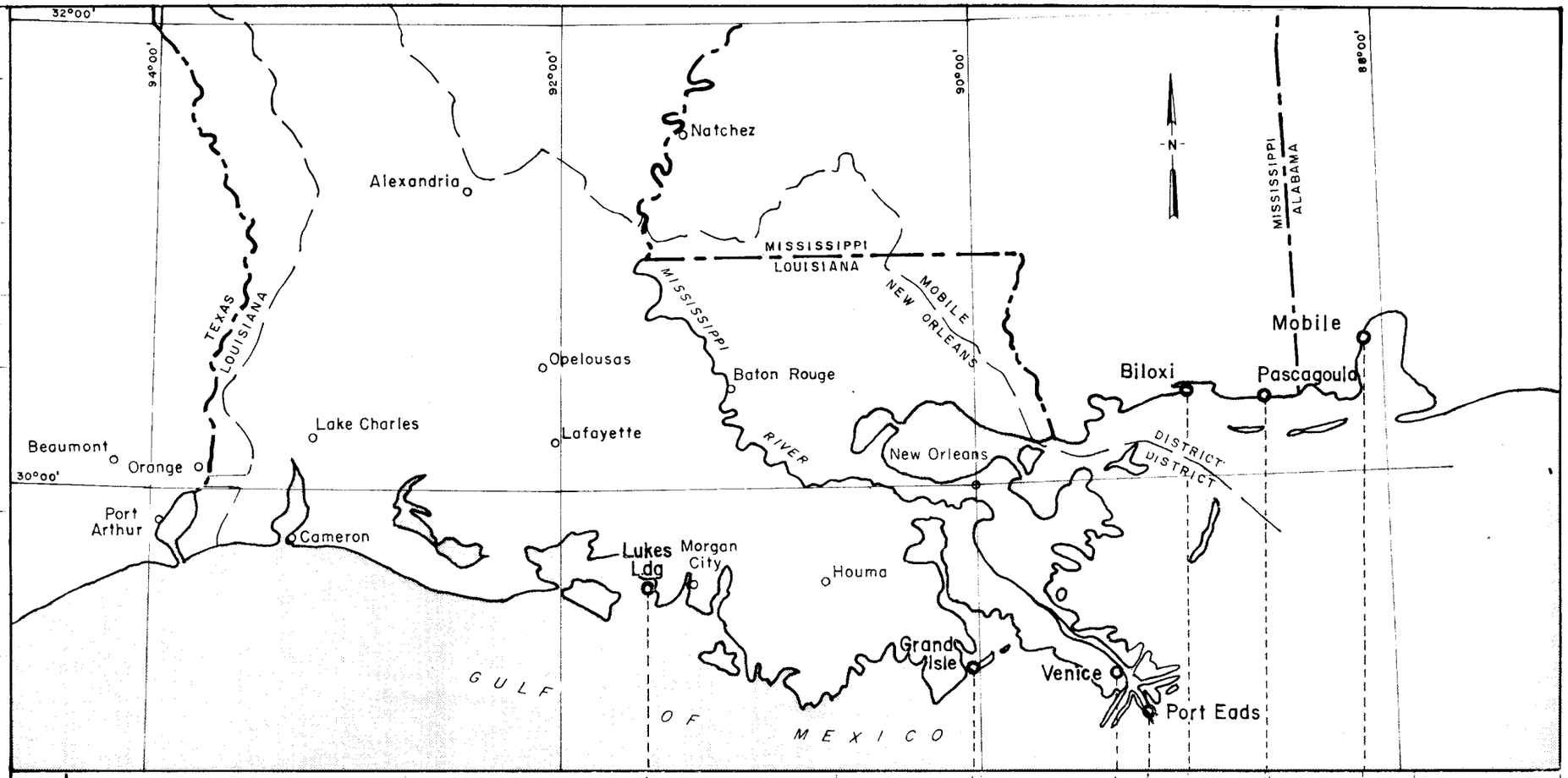
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

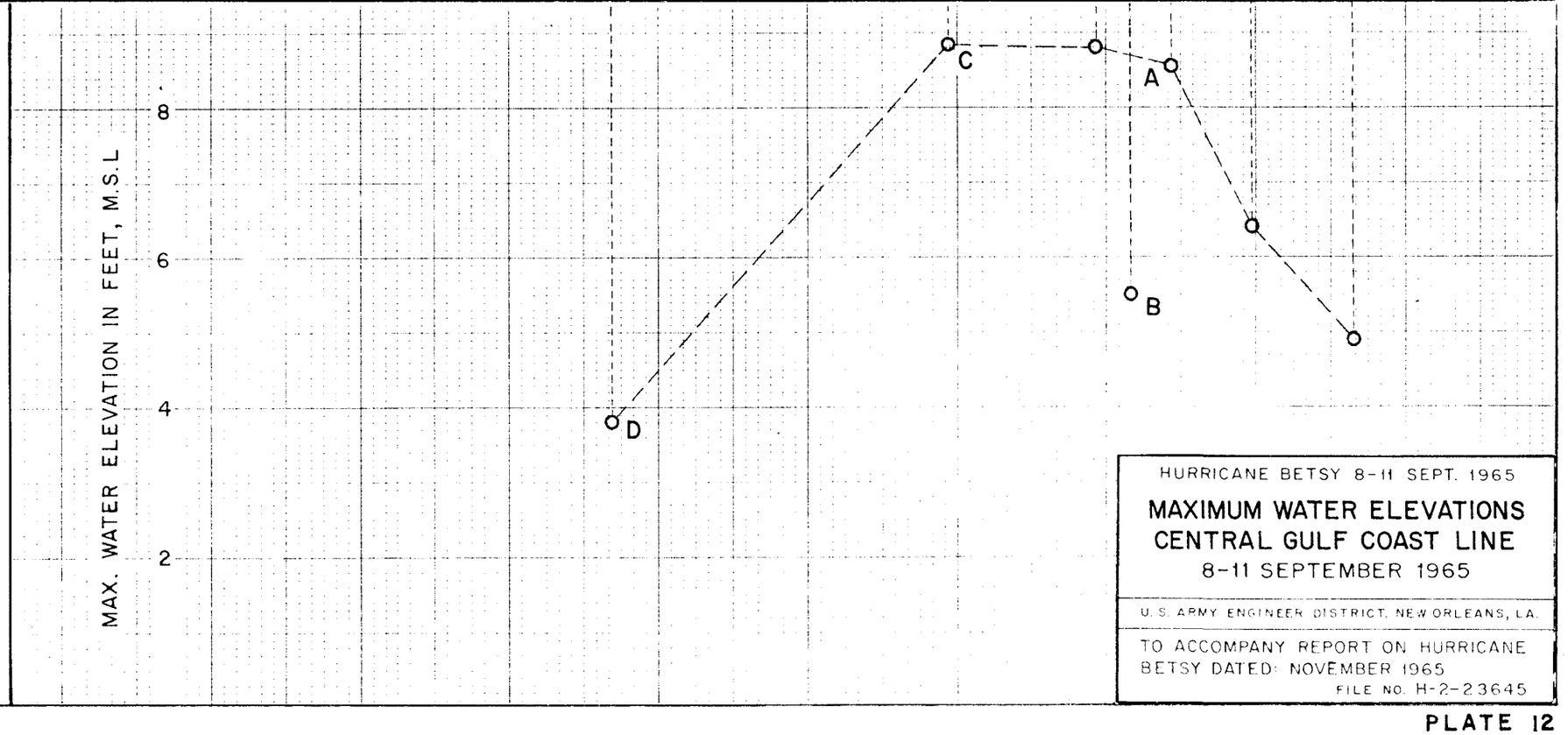
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

MAXIMUM WATER ELEVATION AND TIME







HURRICANE BETSY 8-11 SEPT. 1965

MAXIMUM WATER ELEVATIONS
CENTRAL GULF COAST LINE
8-11 SEPTEMBER 1965

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

PLATE 12

CORPS OF ENGINEERS

U. S. ARMY

LEGEND

EXISTING IMPROVEMENTS

- Levee
- Seawall

AUTHORIZED IMPROVEMENTS

- New Levee
- Levee Enlargement
- Control Structure
- Drainage Structure
- Lock
- Floodgate
- Navigation Channel
- Floodwall
- Seawall Strengthening
- Rock Fill

Mandeville

Seawall

190

PASS MANCHAC

LAKE MAUREPAS

LAKE PONTCHARTRAIN CAUSEWAY

LAKE PONTCHARTRAIN

South Point

10

11

90

N

THE RIGOLETS

NEW ORLEANS EAST

WATERWAY

CHEF MENTEUR PASS

New Orleans Lakefront Airport

Seabrook Lock

Seawall

CITRUS

INTRACOASTAL

GULF

BONNET CARRE' SPILLWAY

ST CHARLES PARISH

JEFFERSON PARISH

NEW ORLEANS

INNER HARBOR NAVIGATION CANAL

CHALMETTE

EXISTING LOCK

MISSISSIPPI RIVER - GULF OUTLET

LAKE BORGNE

MISSISSIPPI RIVER

EXISTING LEVEE

EXISTING LEVEE

Chalmette

Violet

Bayou Dupre

SCALE OF MILES

1 0 1 2 3 4

HURRICANE BETSY 8-11 SEPT. 1965

LAKE PONTCHARTRAIN AND VICINITY, LA.

(HURRICANE PROTECTION)

AUTHORIZED IMPROVEMENTS

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

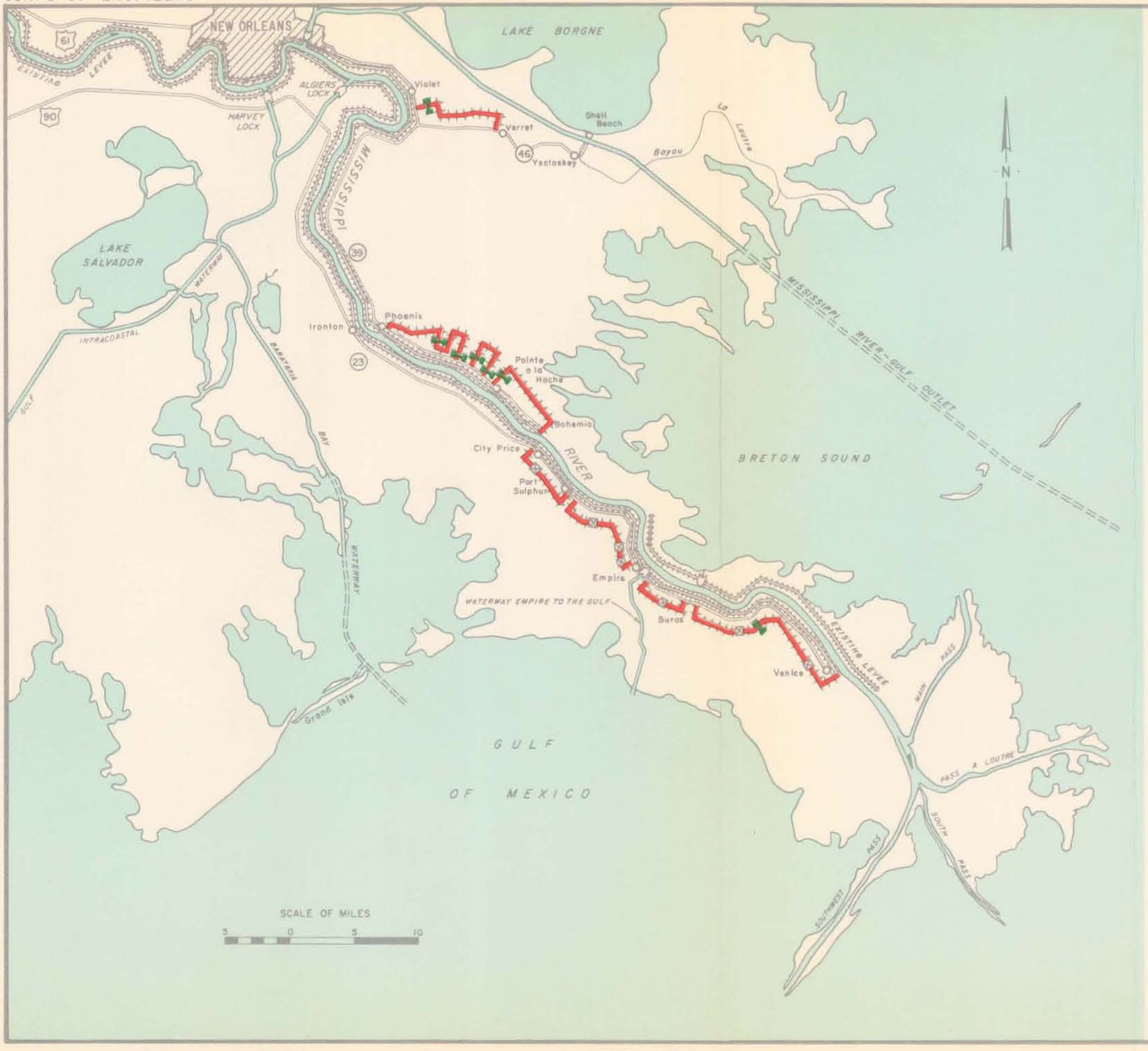
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

PLATE 13

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

AUTHORIZED IMPROVEMENTS

- Levee Enlargement
- Drainage Structure

EXISTING IMPROVEMENTS

- Levee
- Pumping Station
- Lock

HURRICANE BETSY 8-11 SEPT. 1965

NEW ORLEANS TO VENICE, LA.
(HURRICANE PROTECTION)
AUTHORIZED IMPROVEMENTS

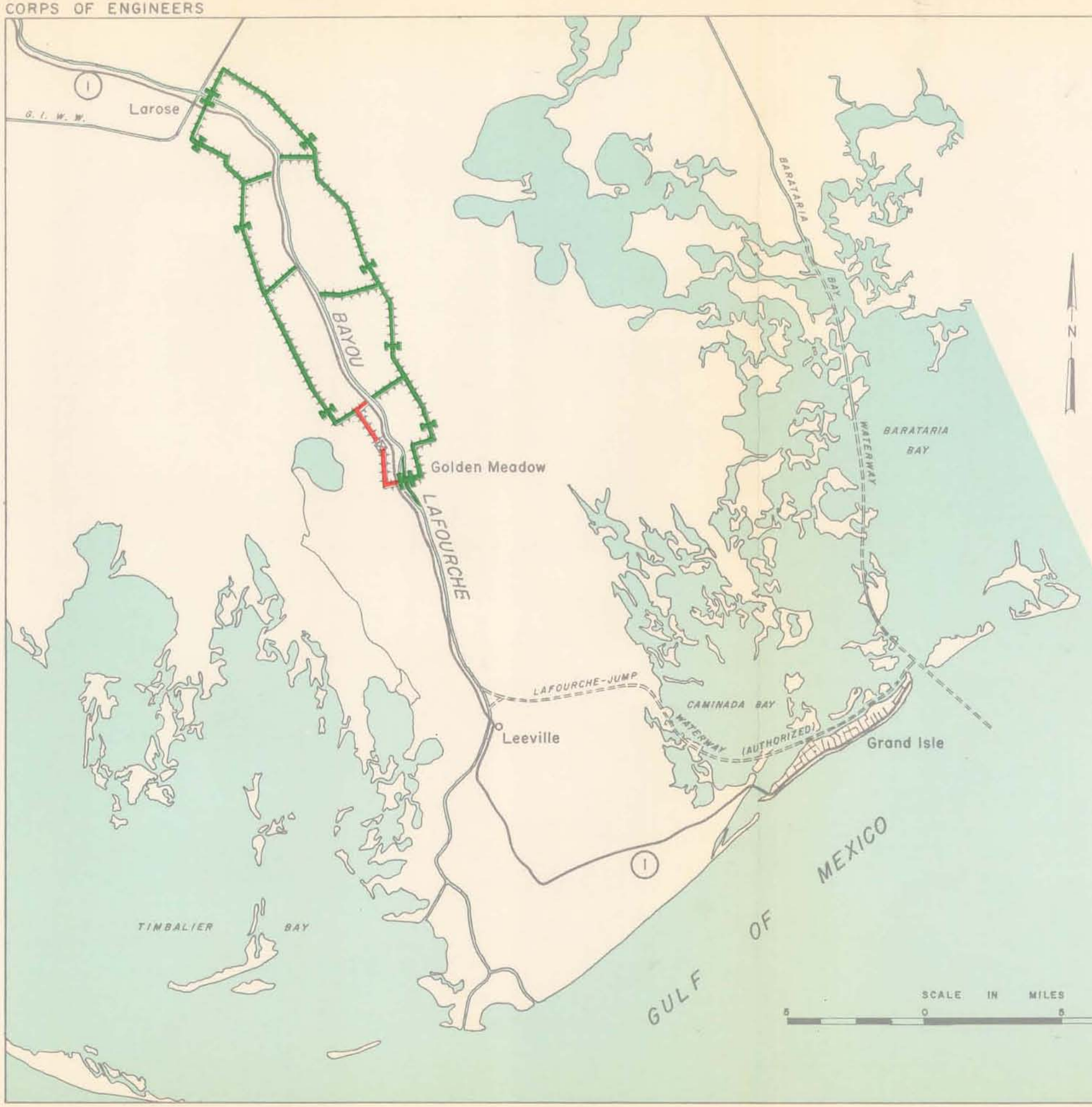
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

PLATE 14

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

AUTHORIZED IMPROVEMENTS

- New Levee
- Levee Enlargement
- Flood Gate (Control Structure)
- Drainage Structure
- Channel

EXISTING IMPROVEMENTS

- Pumping Station

HURRICANE BETSY 8-11 SEPT. 1965

GRAND ISLE, LA. AND VICINITY

(HURRICANE PROTECTION)

AUTHORIZED IMPROVEMENTS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

PLATE 15

LEGEND

AUTHORIZED IMPROVEMENTS

- New Levee
- Levee Enlargement
- Control Structure
- Drainage Structure

EXISTING IMPROVEMENTS

- Levee
- Control Structure
- Drainage Structure
- Pumping Station
- Floodwall
- Lock

Baldwin
FRANKLIN AND VICINITY
Franklin
Bayou Teche
Centerville
Verdunville
Maryland
North Bend
Calumet
Patterson
PATTERSON AND VICINITY
Berwick
Morgan City
MORGAN CITY AND VICINITY
Bayou Boeuf Lock
Ellerslie
LOWER BAYOU SALE
EAST COTE BLANCHE BAY
GRAND LAKE
SIX MILE LAKE
FLAT LAKE
LAKE PALOURDE
WABPL
CHARENTON DRAINAGE AND NAVIGATION CANAL
FRANKLIN CANAL
HANSON CANAL
GULF INTRACOASTAL WATERWAY
THIBODEAUX CANAL
YELLOW BAYOU DRAINAGE CANAL
LAKE OUTLET
LOWER ATCHAFALAYA RIVER
BERWICK BAY
EABPL
N

SCALE OF MILES
1 0 1 2 3 4

HURRICANE BETSY 8-11 SEPT. 1965

MORGAN CITY, LA. AND VICINITY
(HURRICANE PROTECTION)
AUTHORIZED IMPROVEMENTS

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

CORPS OF ENGINEERS

U. S. ARMY

HURRICANE BETSY 8-11 SEPT. 1965

WEATHER STATION DATA

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

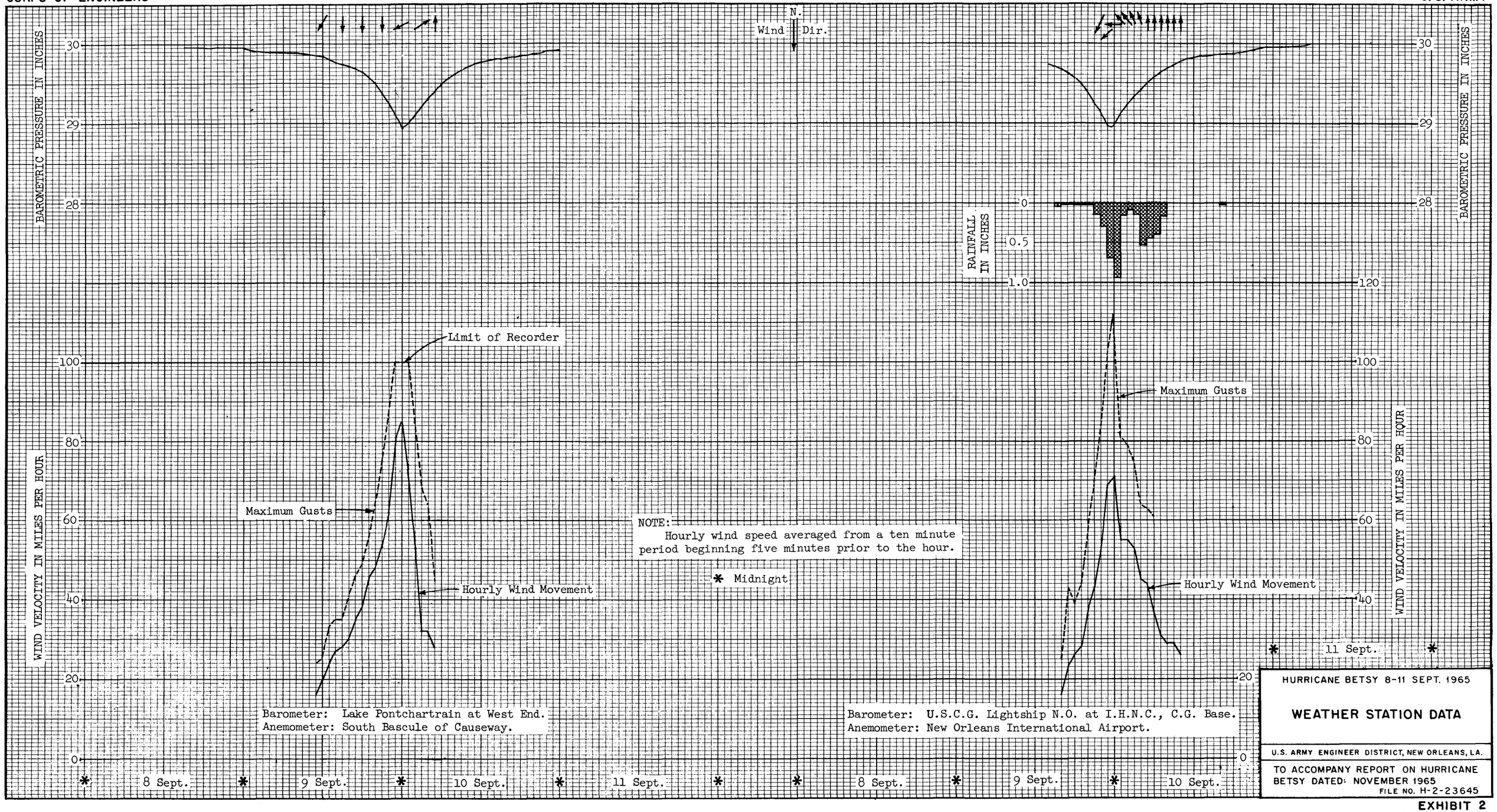
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 1

CORPS OF ENGINEERS

U.S. ARMY



NOTE: Hourly wind speed averaged from a ten minute period beginning five minutes prior to the hour.

* Midnight

Barometer: Lake Pontchartrain at West End.
Anemometer: South Bascule of Causeway.

Barometer: U.S.C.G. Lightship N.O. at I.H.N.C., C.G. Base.
Anemometer: New Orleans International Airport.

HURRICANE BETSY 8-11 SEPT. 1965

WEATHER STATION DATA

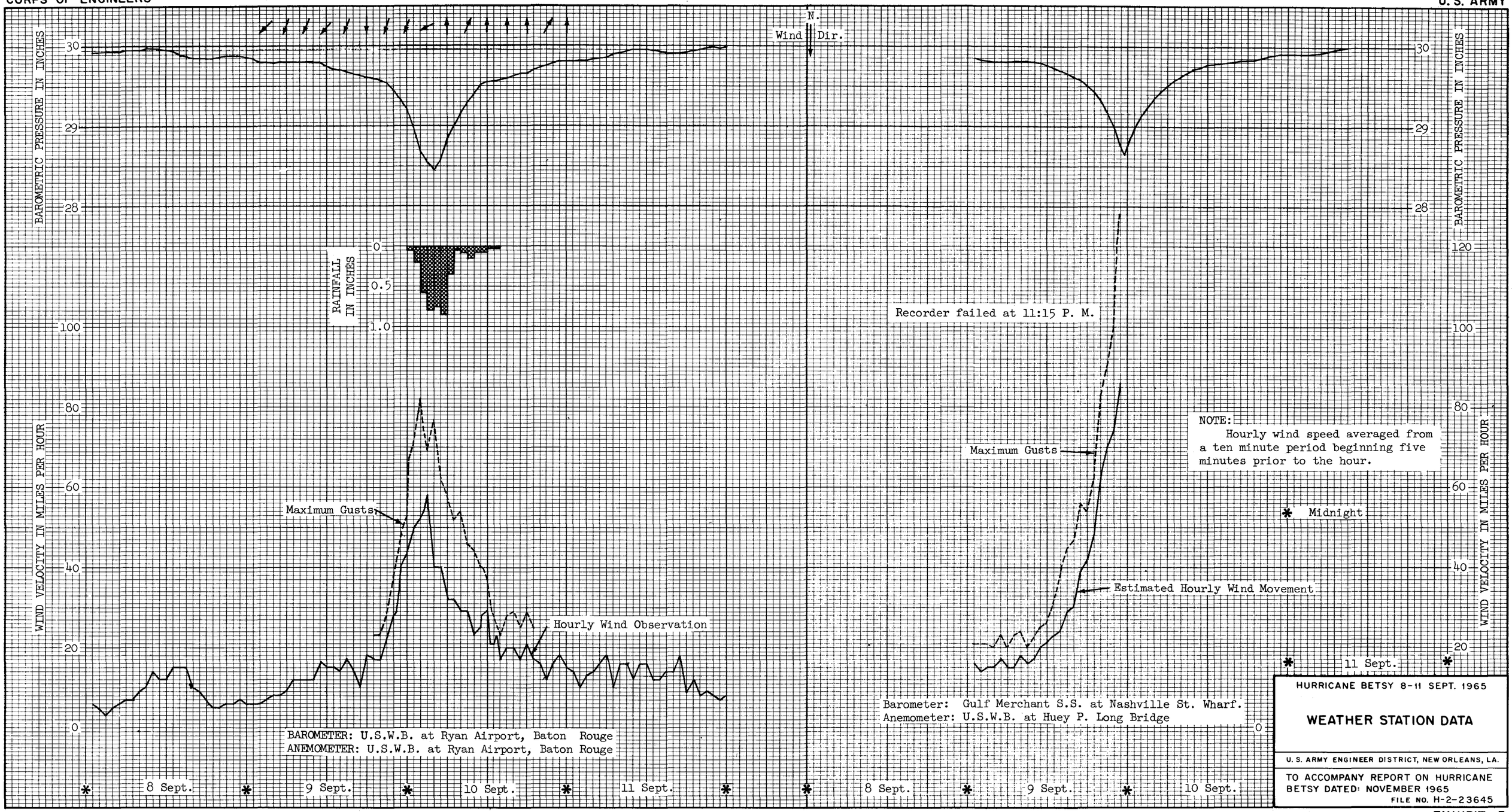
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

EXHIBIT 2

CORPS OF ENGINEERS

U. S. ARMY



HURRICANE BETSY 8-11 SEPT. 1965

WEATHER STATION DATA

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

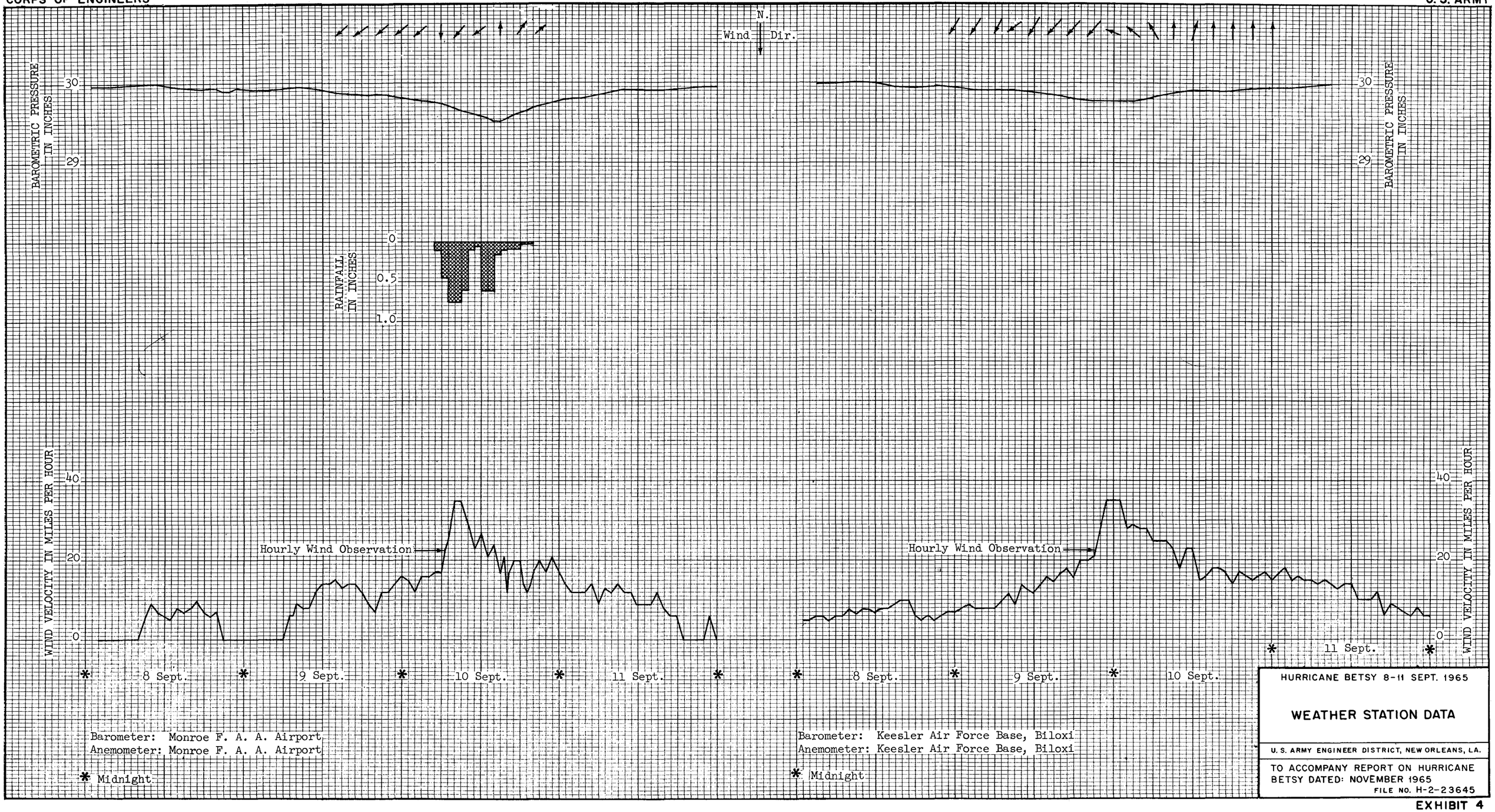
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 3

CORPS OF ENGINEERS

U.S. ARMY



HURRICANE BETSY 8-11 SEPT. 1965

WEATHER STATION DATA

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

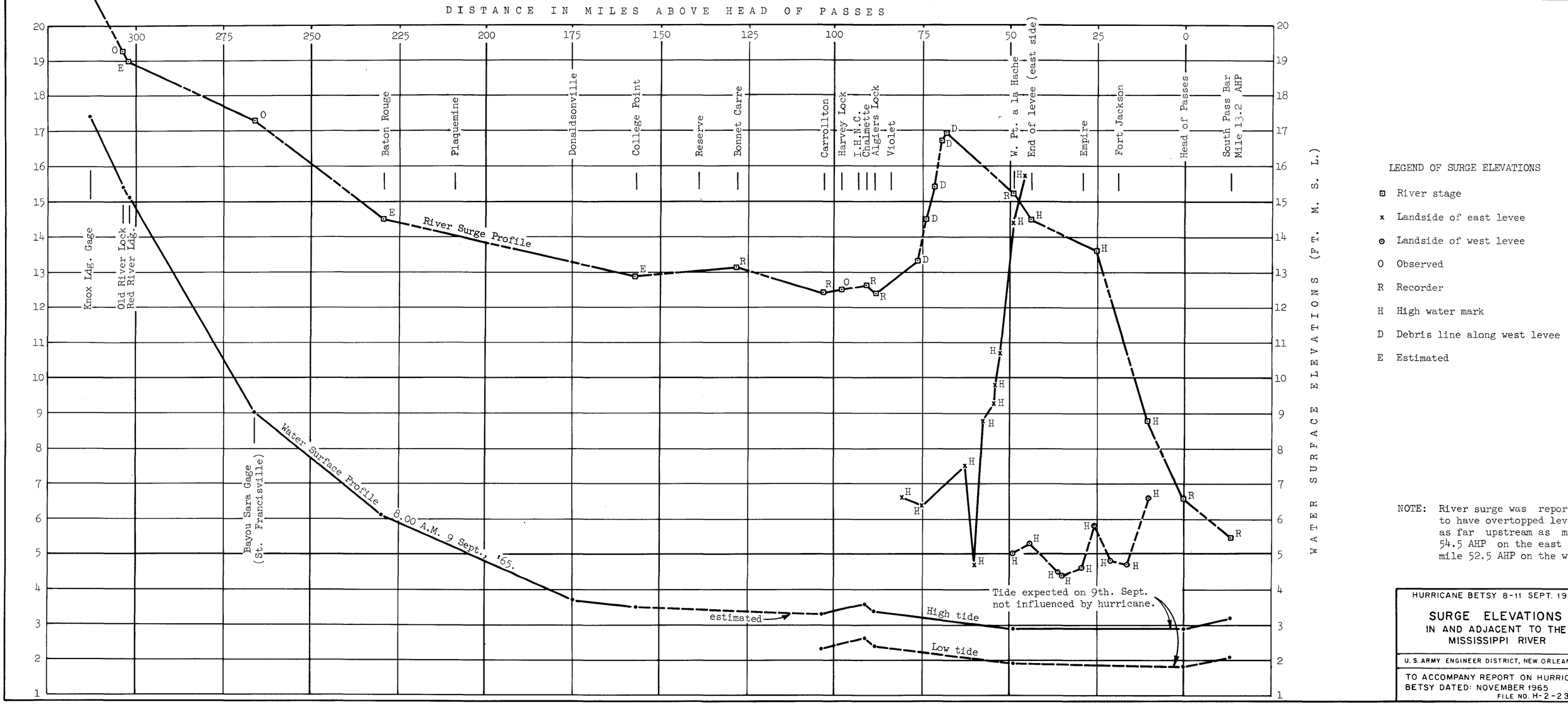
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 4

CORPS OF ENGINEERS

U. S. ARMY



LEGEND OF SURGE ELEVATIONS

- River stage
- x Landside of east levee
- ⊙ Landside of west levee
- O Observed
- R Recorder
- H High water mark
- D Debris line along west levee
- E Estimated

NOTE: River surge was reported to have overtopped levees as far upstream as mile 54.5 AHP on the east and mile 52.5 AHP on the west.

HURRICANE BETSY 8-11 SEPT. 1965

SURGE ELEVATIONS IN AND ADJACENT TO THE MISSISSIPPI RIVER

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

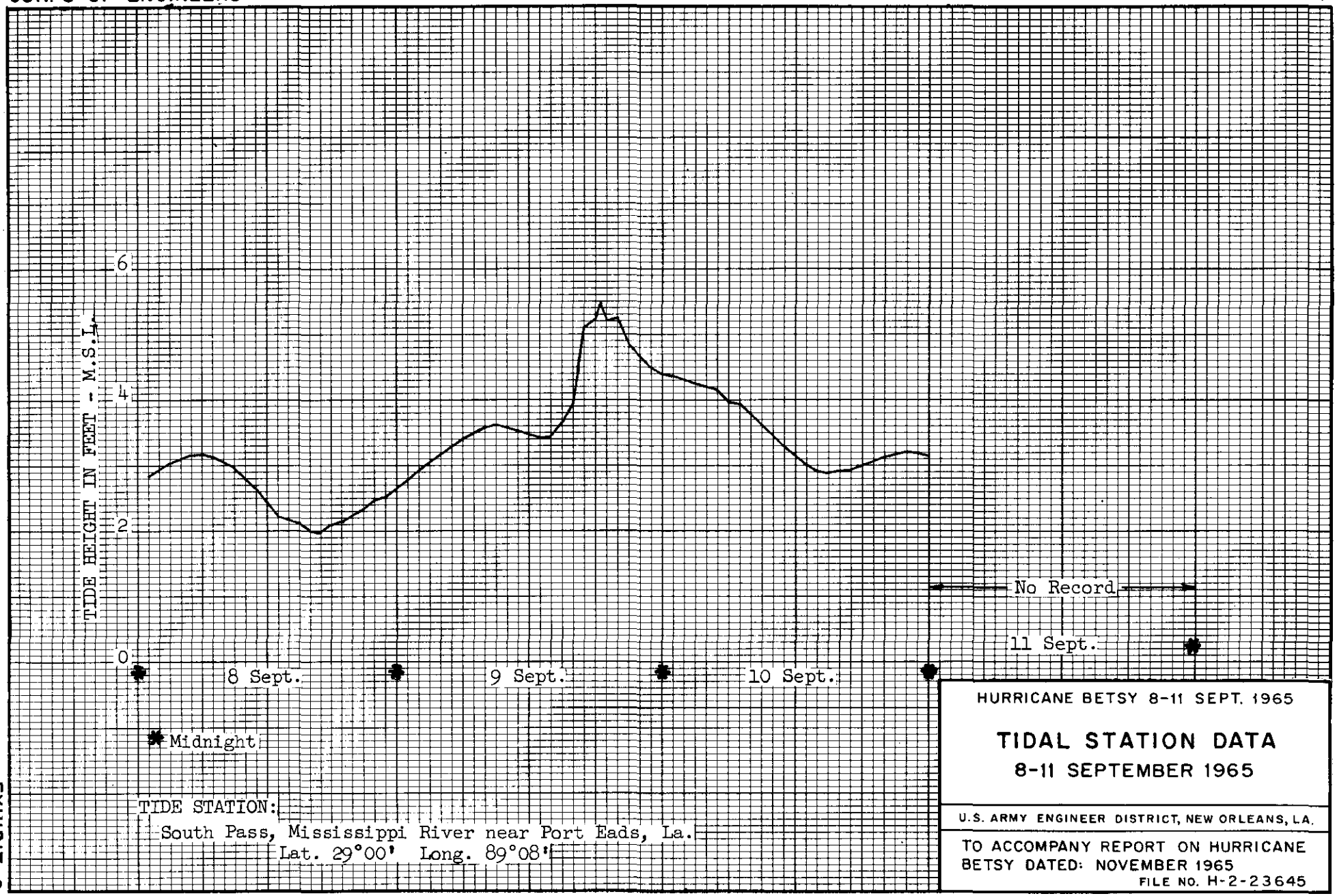
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 5

CORPS OF ENGINEERS

U. S. ARMY



TIDE STATION:
South Pass, Mississippi River near Port Eads, La.
Lat. 29°00' Long. 89°08'

HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA
8-11 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

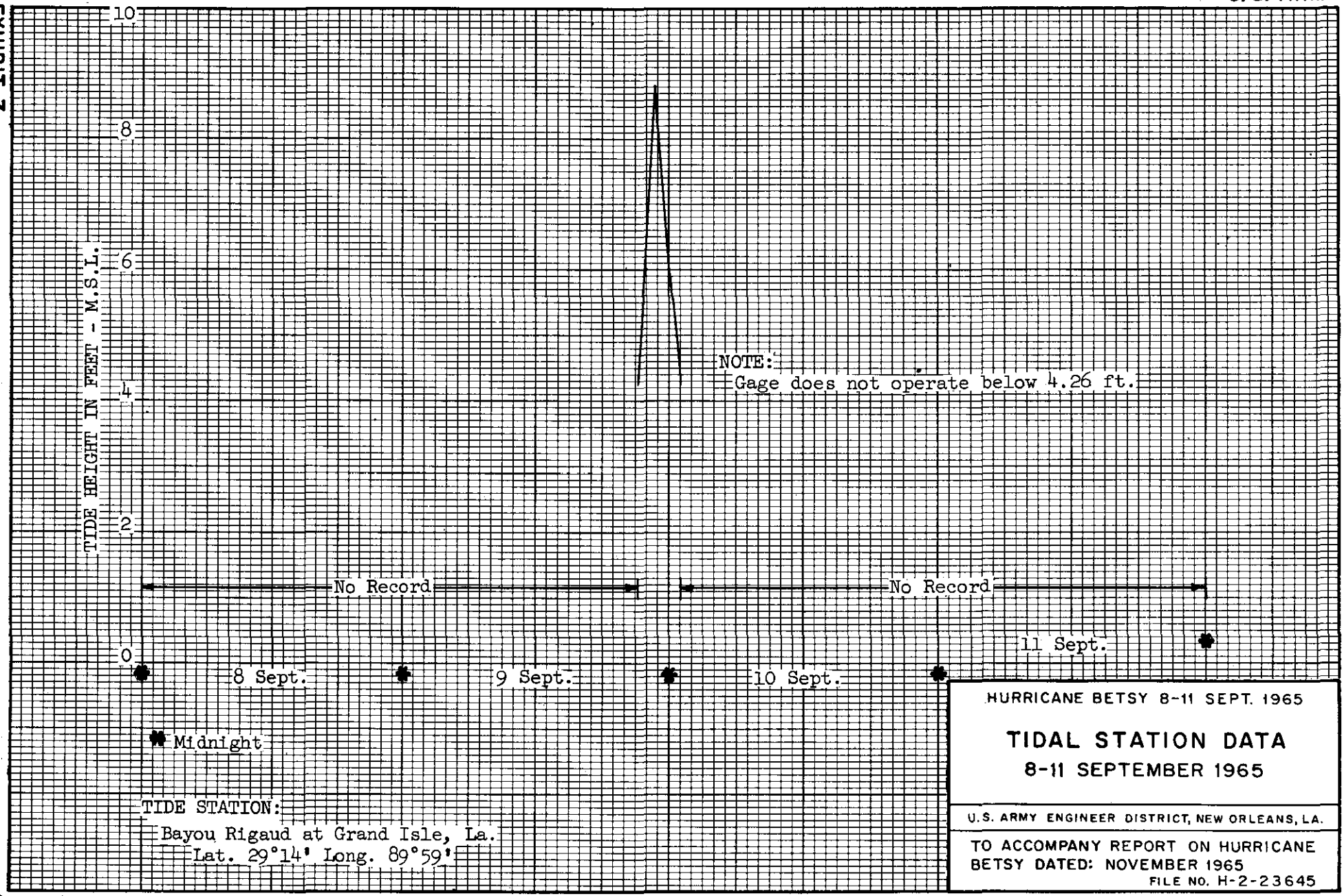
EXHIBIT 6

EXHIBIT 6

CORPS OF ENGINEERS

U. S. ARMY

EXHIBIT 7



HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA
8-11 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

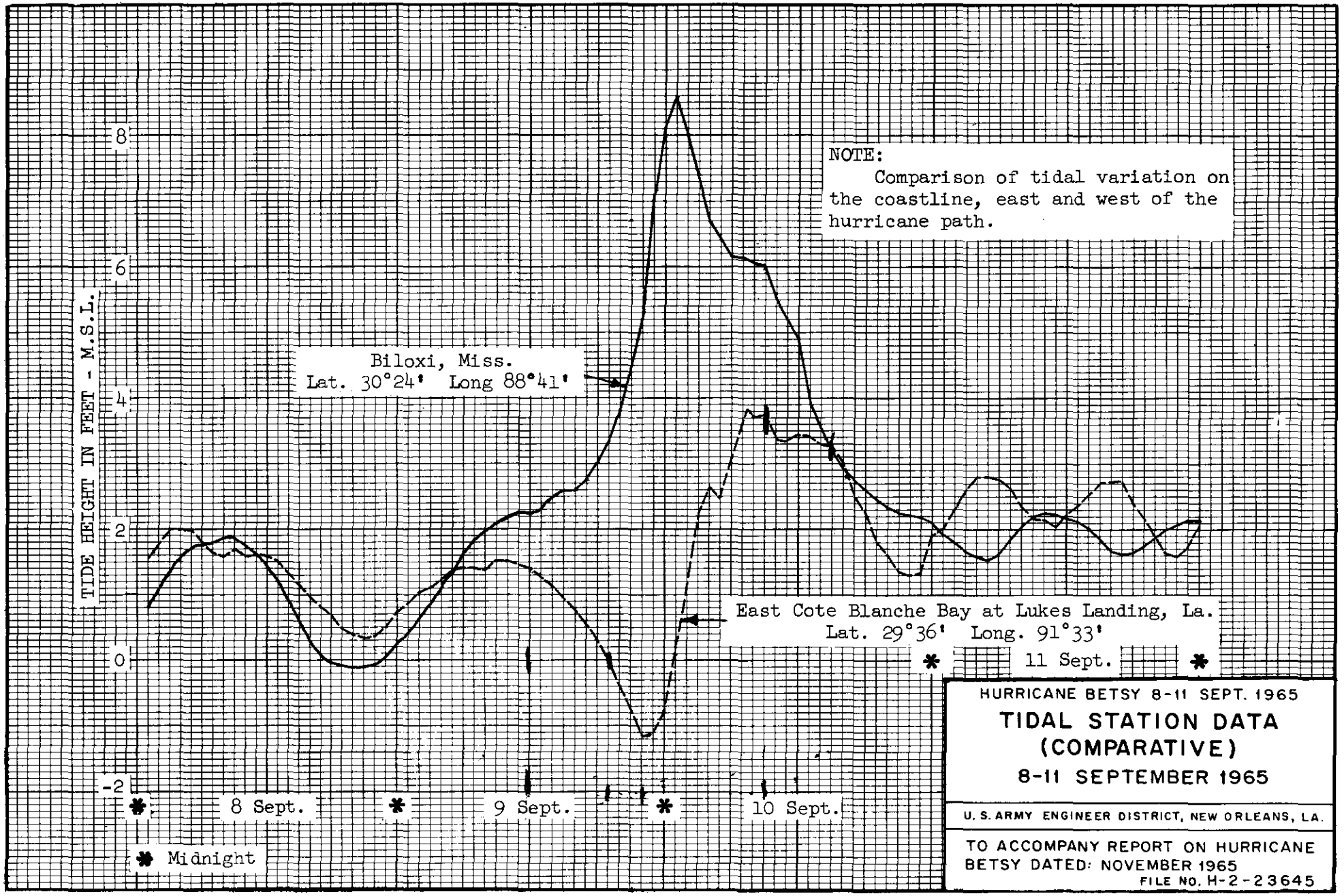
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 7

CORPS OF ENGINEERS

U. S. ARMY



HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA (COMPARATIVE)

8-11 SEPTEMBER 1965

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

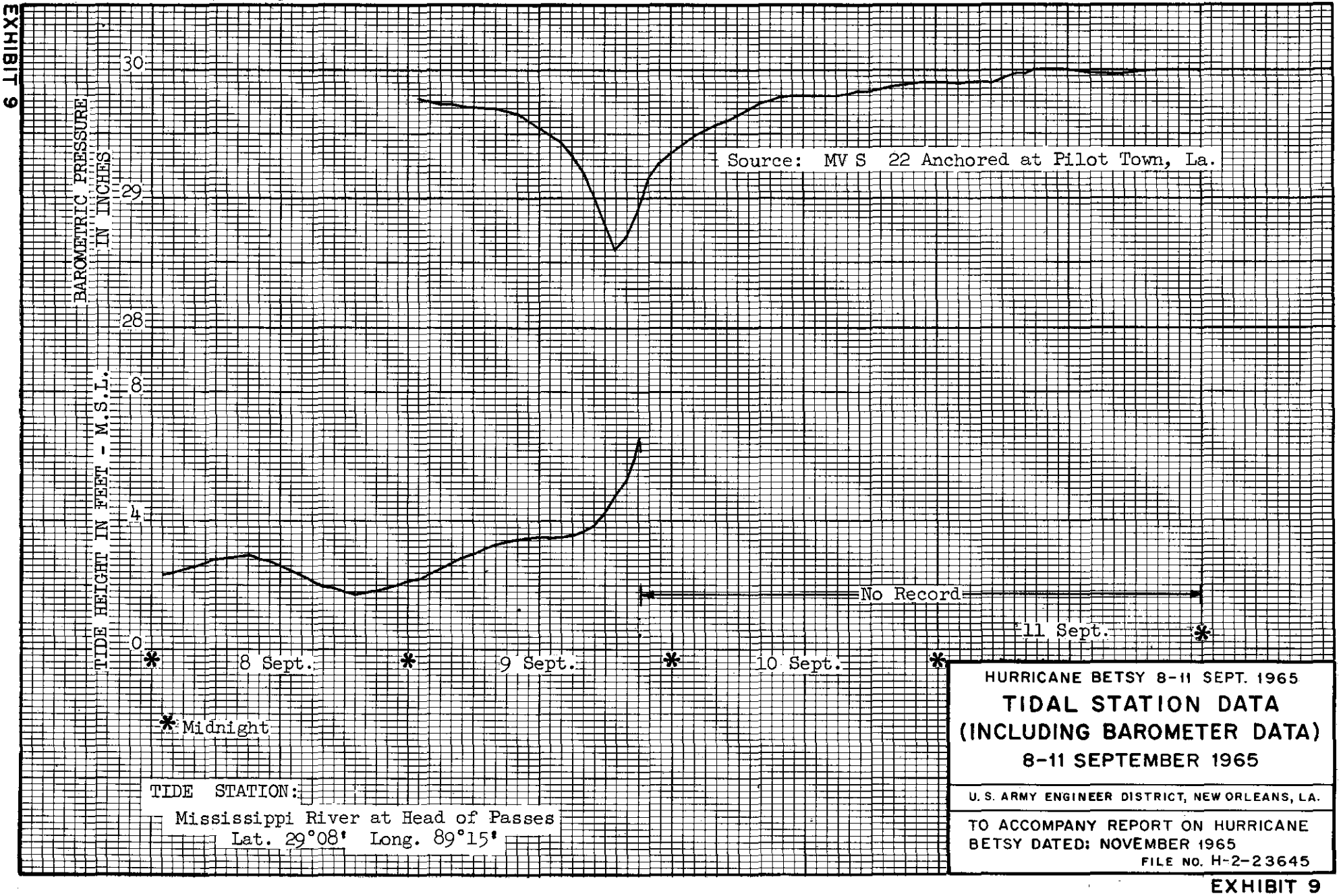
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 8

EXHIBIT 8

EXHIBIT 9



HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA (INCLUDING BAROMETER DATA)

8-11 SEPTEMBER 1965

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

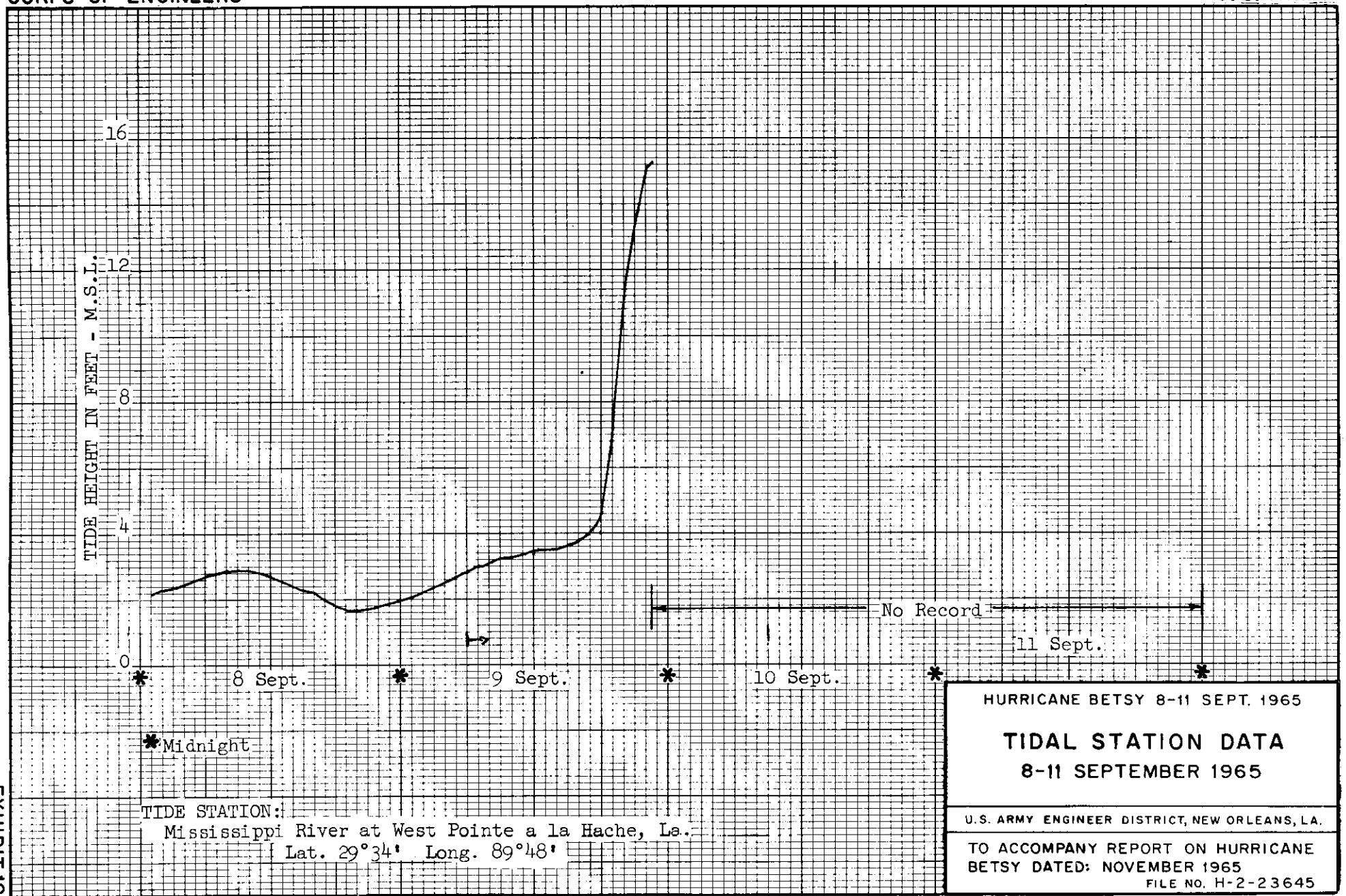
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 9

CORPS OF ENGINEERS

U. S. ARMY



HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA
8-11 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

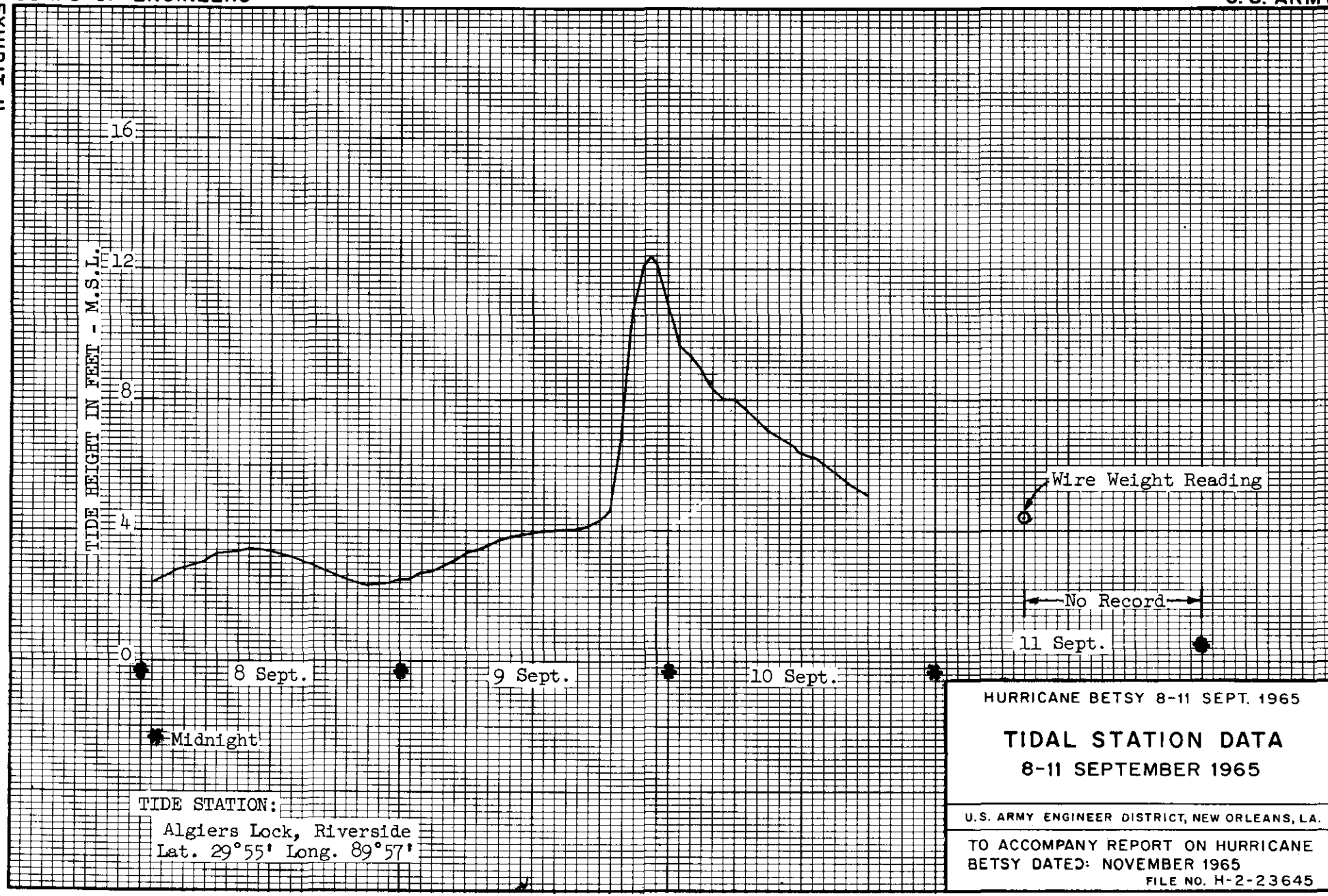
EXHIBIT 10

EXHIBIT 10

CORPS OF ENGINEERS

U. S. ARMY

EXHIBIT II



HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA

8-11 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

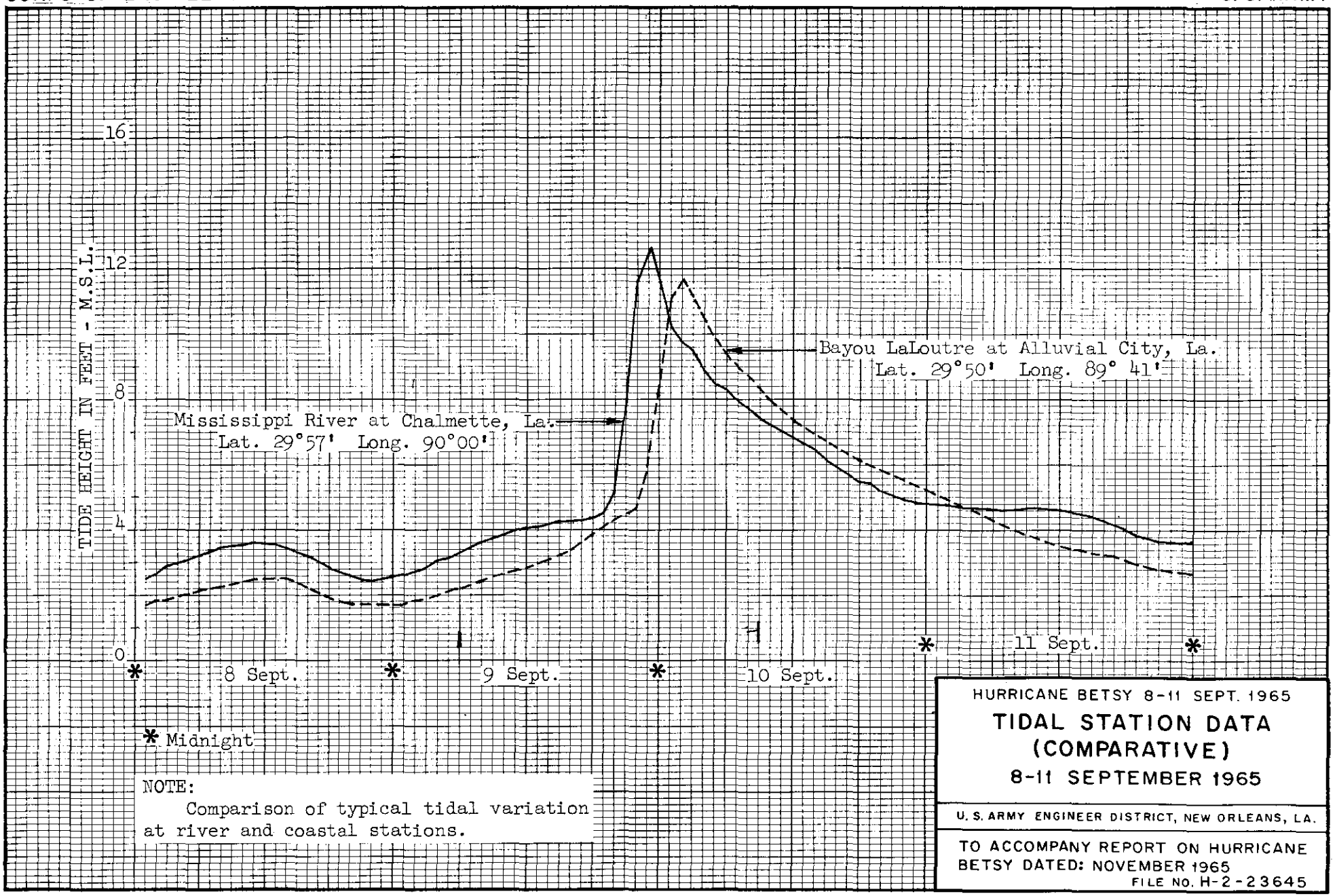
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT II

CORPS OF ENGINEERS

U. S. ARMY



NOTE:

Comparison of typical tidal variation at river and coastal stations.

HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA (COMPARATIVE)

8-11 SEPTEMBER 1965

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

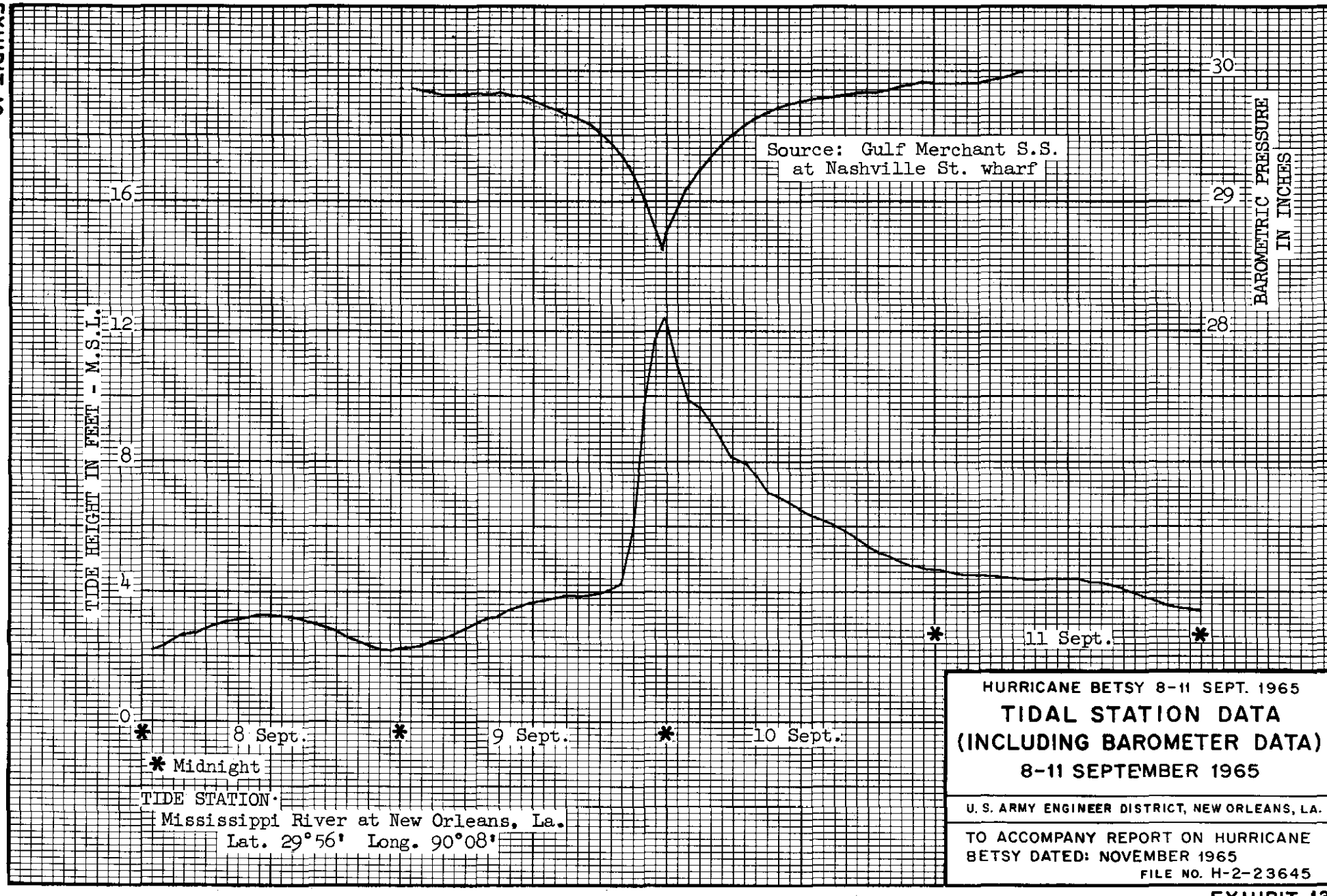
EXHIBIT 12

EXHIBIT 12

CORPS OF ENGINEERS

U. S. ARMY

EXHIBIT 13



HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA (INCLUDING BAROMETER DATA)

8-11 SEPTEMBER 1965

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

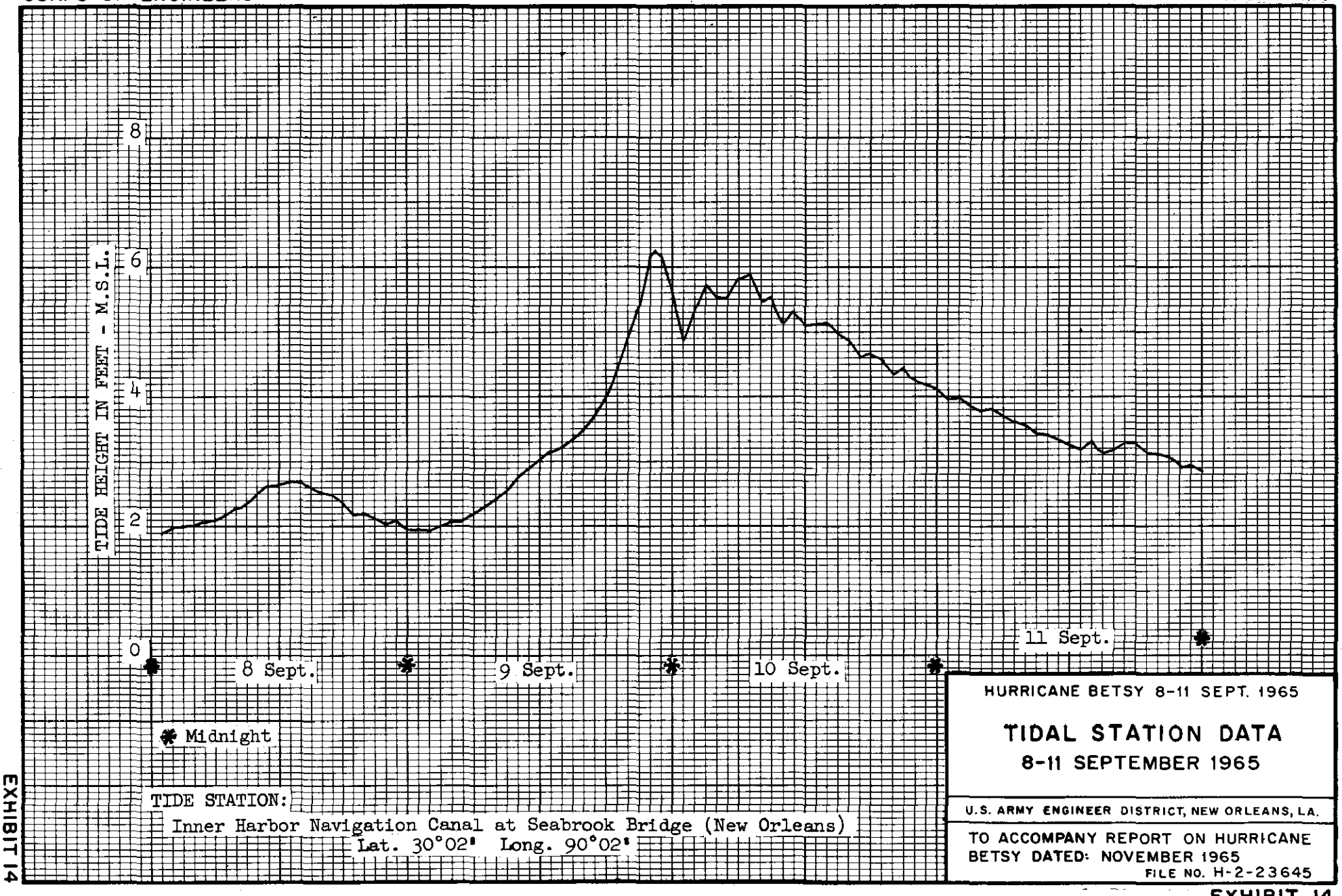
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 13

CORPS OF ENGINEERS

U. S. ARMY



TIDE STATION:
Inner Harbor Navigation Canal at Seabrook Bridge (New Orleans)
Lat. 30°02' Long. 90°02'

HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA
8-11 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

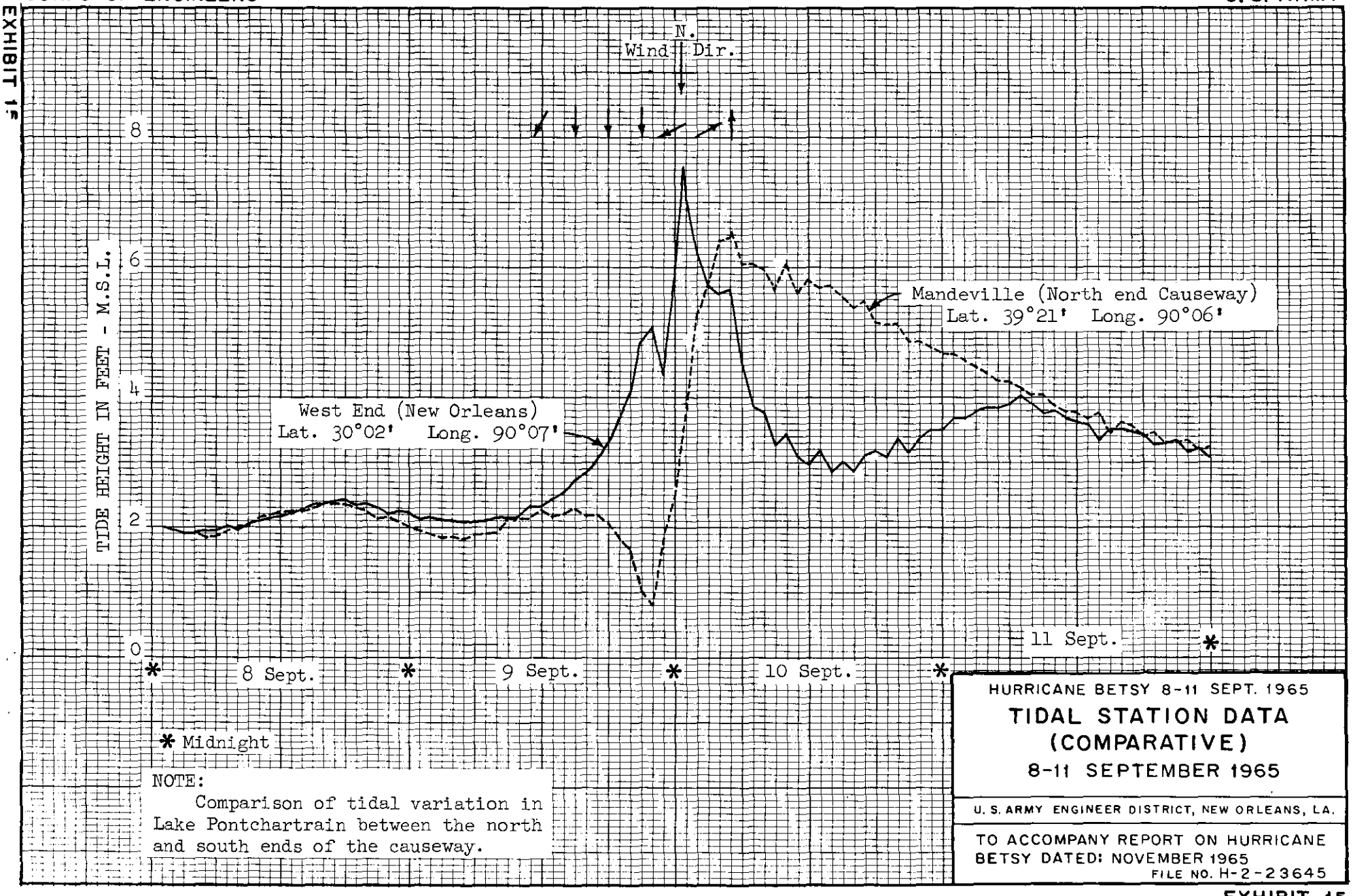
EXHIBIT 14

EXHIBIT 14

CORPS OF ENGINEERS

U. S. ARMY

EXHIBIT 15



NOTE:

Comparison of tidal variation in Lake Pontchartrain between the north and south ends of the causeway.

HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA (COMPARATIVE)

8-11 SEPTEMBER 1965

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

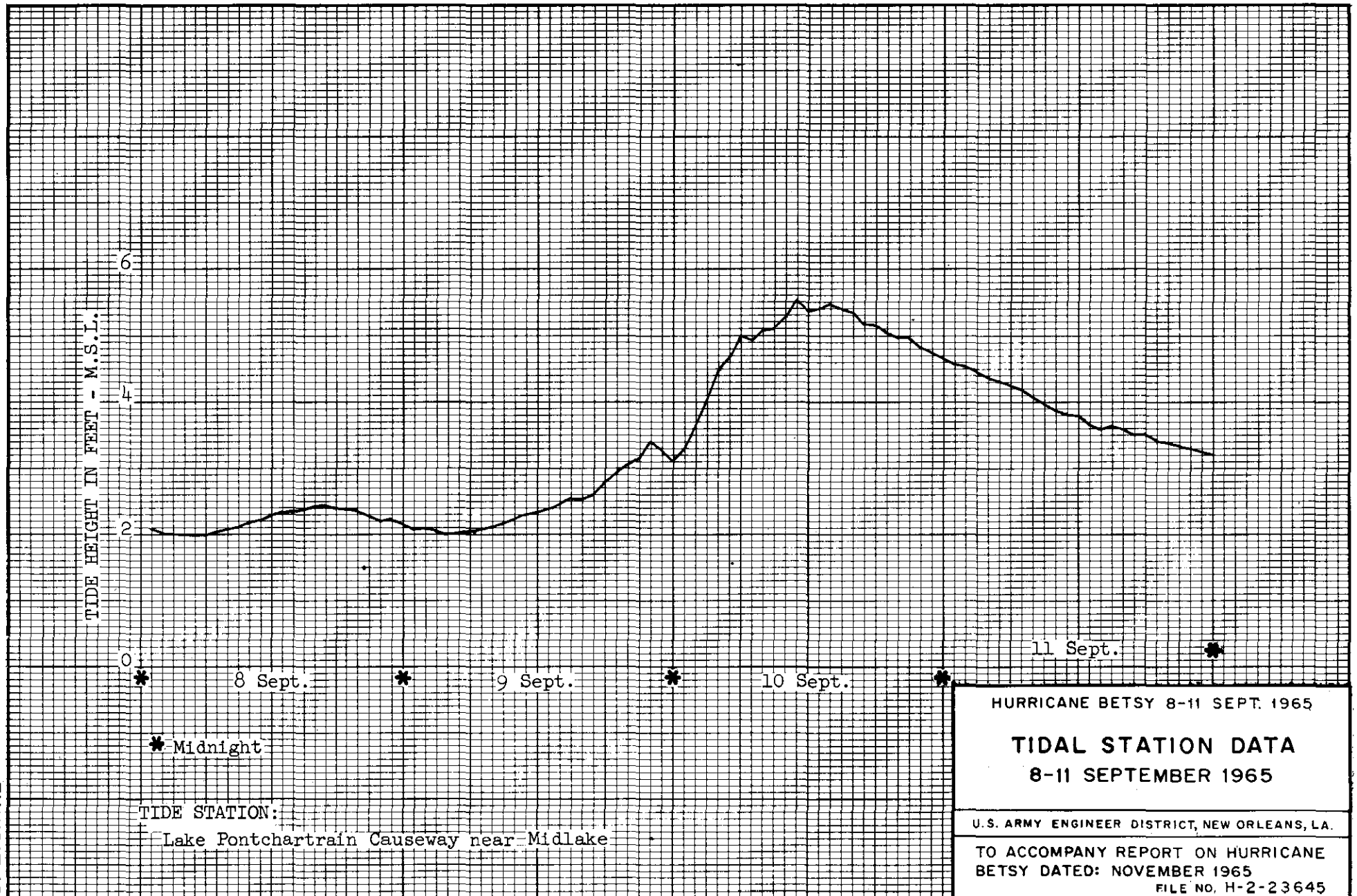
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 15

CORPS OF ENGINEERS

U. S. ARMY



HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA
8-11 SEPTEMBER 1965

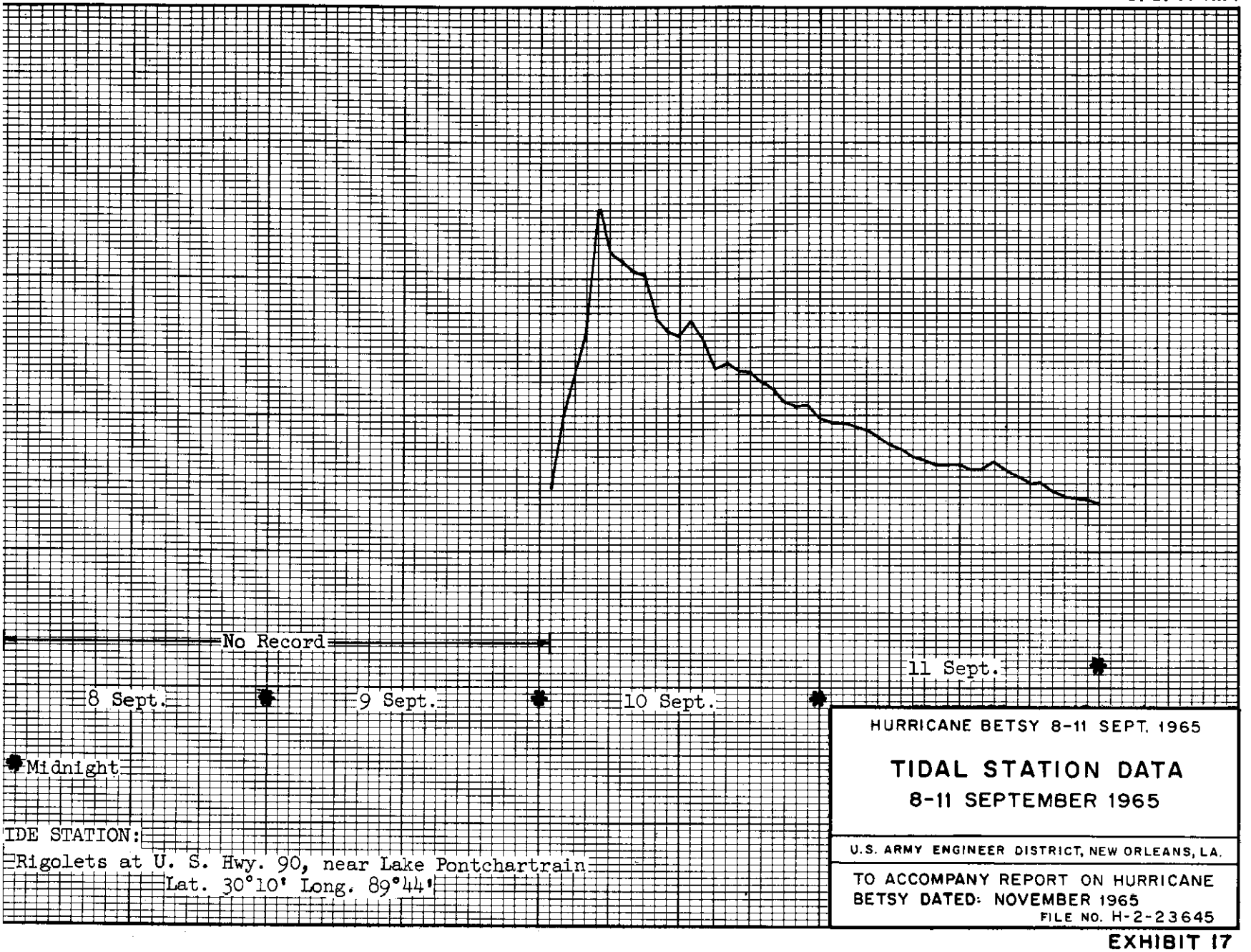
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 16

EXHIBIT 16



HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA

8-11 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

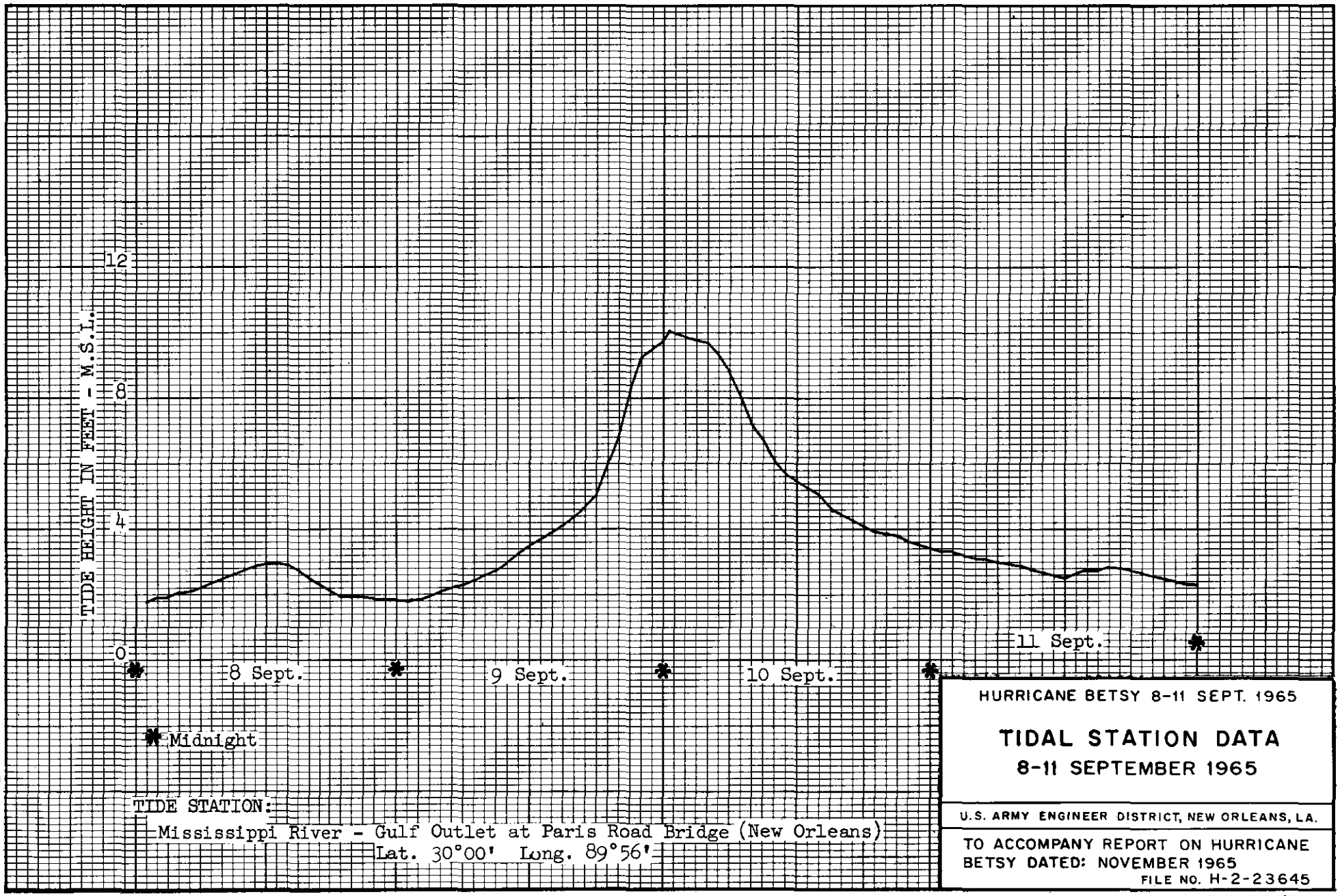
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 17

CORPS OF ENGINEERS

U. S. ARMY



TIDE STATION:
Mississippi River - Gulf Outlet at Paris Road Bridge (New Orleans)
Lat. 30°00' Long. 89°56'

HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA
8-11 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

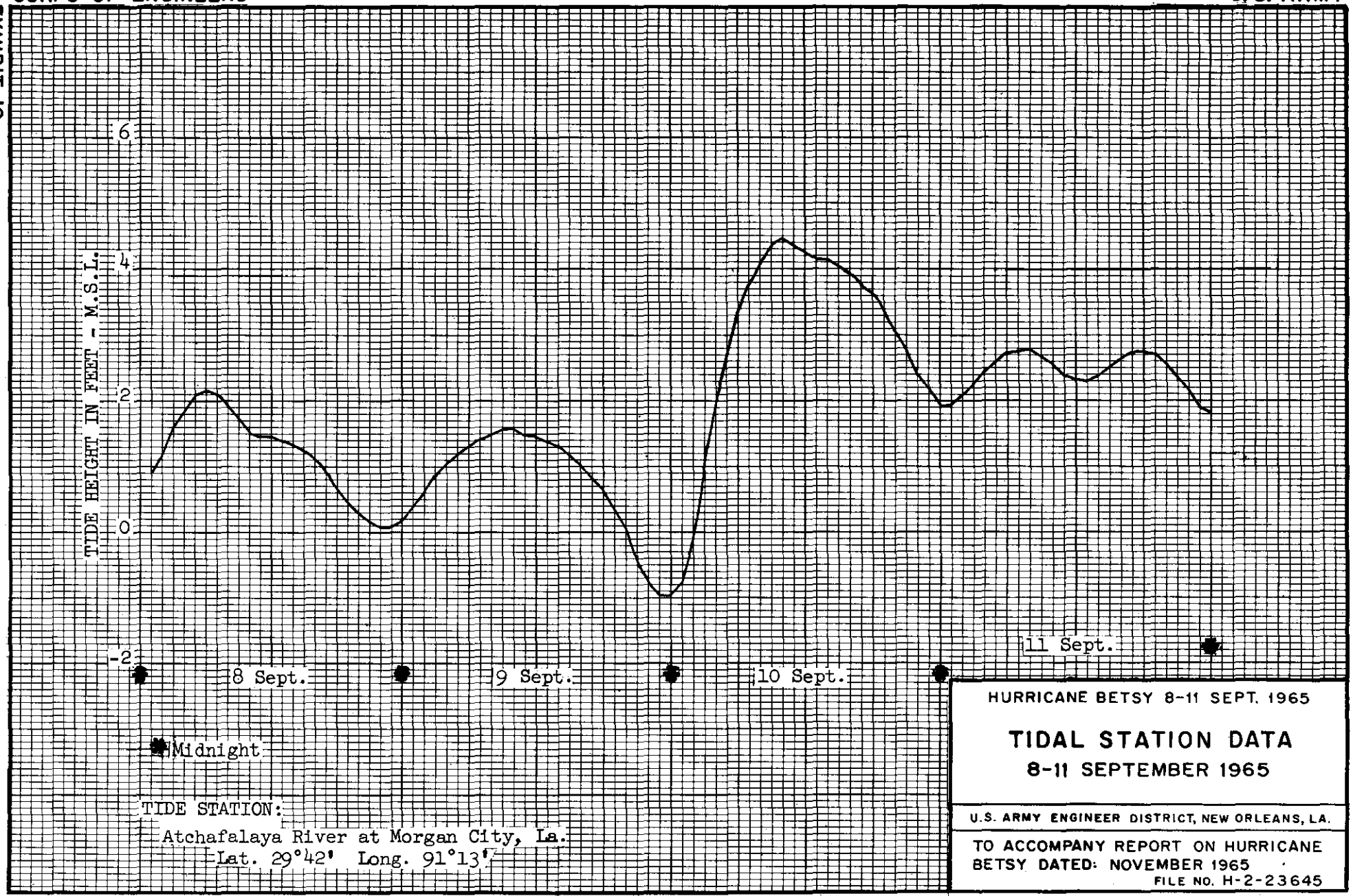
EXHIBIT 18

EXHIBIT 18

CORPS OF ENGINEERS

U. S. ARMY

EXHIBIT 19



TIDE STATION:
Atchafalaya River at Morgan City, La.
Lat. 29°42' Long. 91°13'

HURRICANE BETSY 8-11 SEPT. 1965

TIDAL STATION DATA
8-11 SEPTEMBER 1965

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

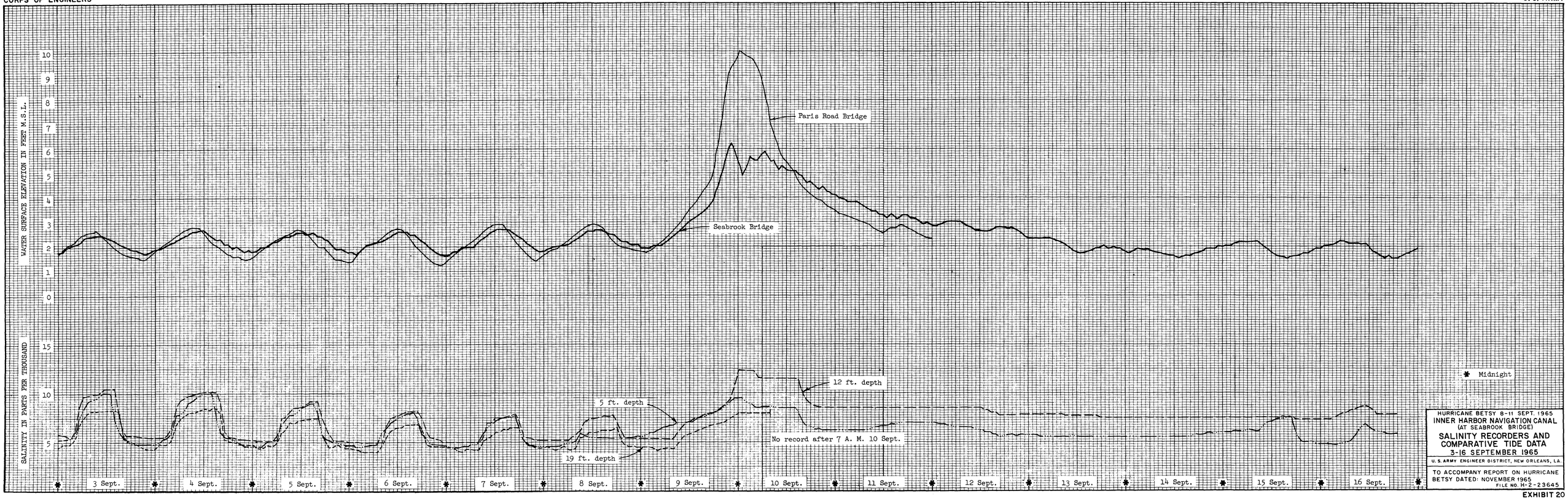
TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 19

CORPS OF ENGINEERS

U. S. ARMY



HURRICANE BETSY 8-11 SEPT. 1965
INNER HARBOR NAVIGATION CANAL
(AT SEABROOK BRIDGE)

SALINITY RECORDERS AND COMPARATIVE TIDE DATA
3-16 SEPTEMBER 1965

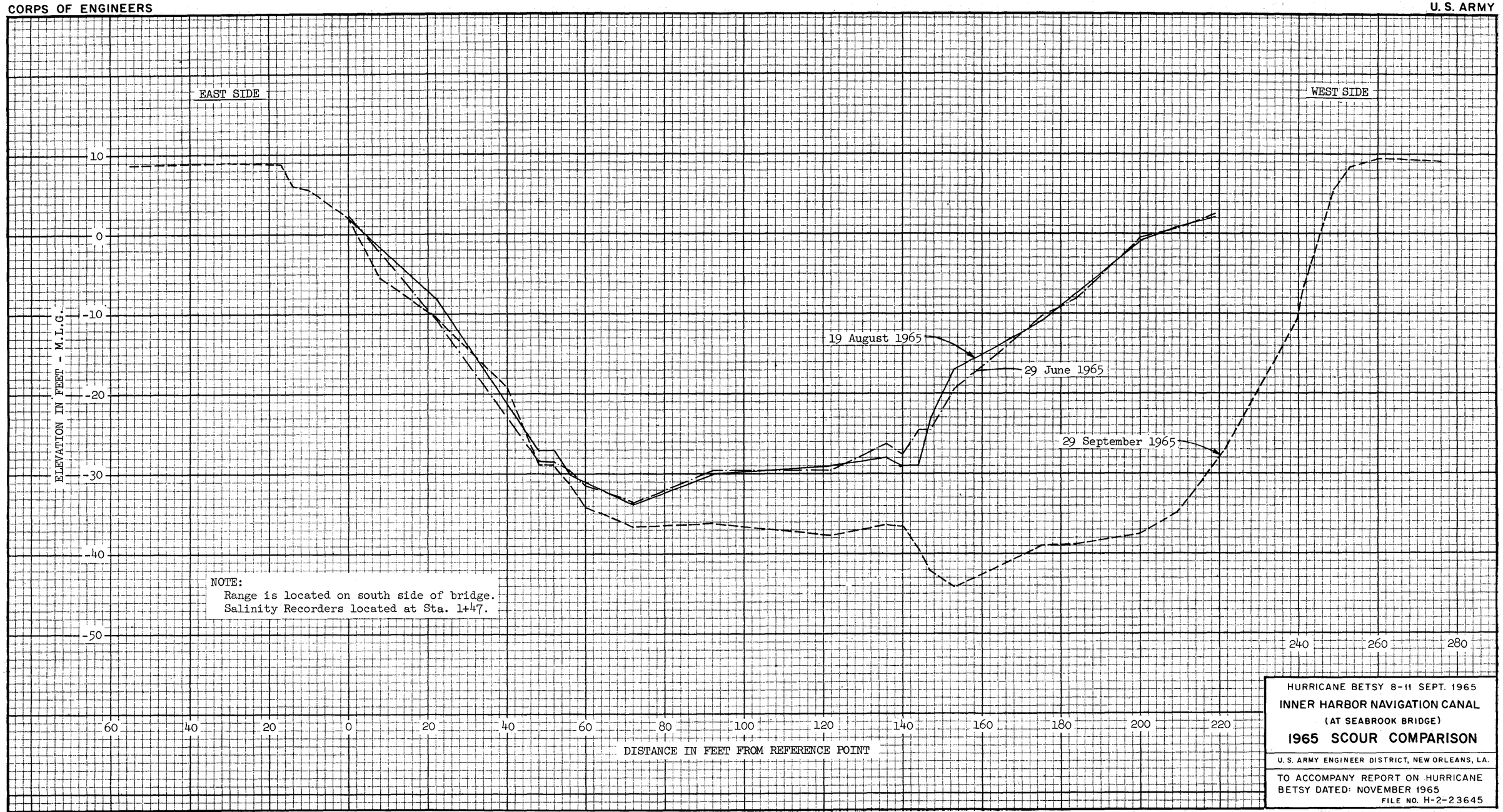
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965
FILE NO. H-2-23645

EXHIBIT 20

CORPS OF ENGINEERS

U. S. ARMY



HURRICANE BETSY 8-11 SEPT. 1965

INNER HARBOR NAVIGATION CANAL

(AT SEABROOK BRIDGE)

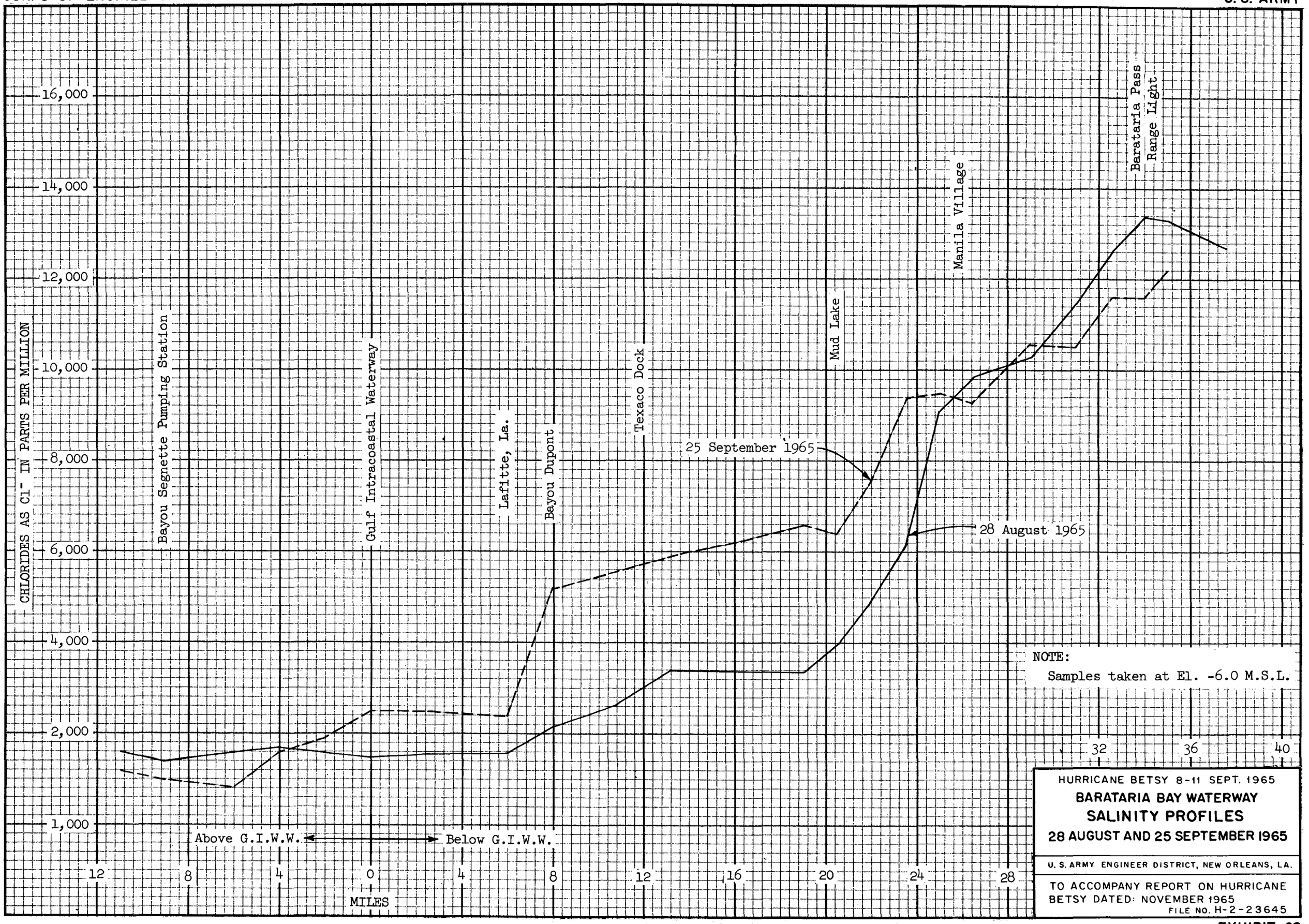
1965 SCOUR COMPARISON

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 21



NOTE:
Samples taken at El. -6.0 M.S.L.

HURRICANE BETSY 8-11 SEPT. 1965

BARATARIA BAY WATERWAY

SALINITY PROFILES

28 AUGUST AND 25 SEPTEMBER 1965

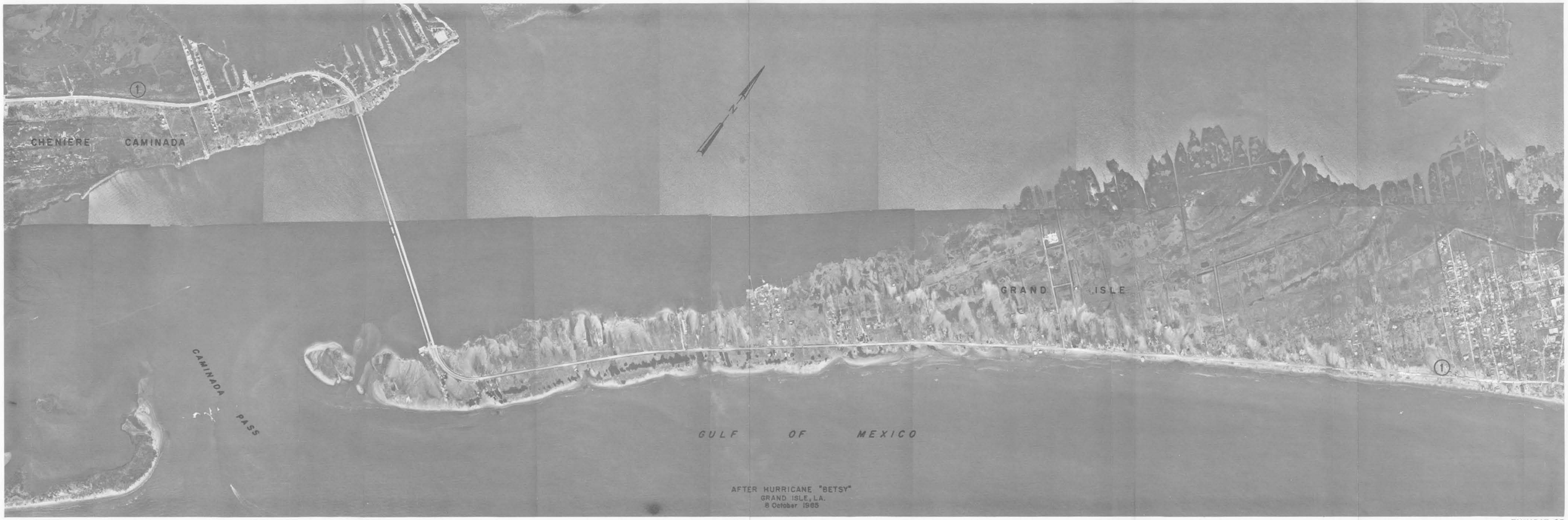
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS, LA.

TO ACCOMPANY REPORT ON HURRICANE BETSY DATED: NOVEMBER 1965

FILE NO. H-2-23645

EXHIBIT 22

BEFORE HURRICANE "BETSY"
GRAND ISLE, LA.
7 October 1964



AFTER HURRICANE "BETSY"
GRAND ISLE, LA.
8 October 1965

EXHIBIT 23

CORPS OF ENGINEERS

U. S. ARMY

BEFORE HURRICANE "BETSY"
GRAND ISLE, LA.
7 October 1964

AFTER HURRICANE "BETSY"
GRAND ISLE, LA.
8 October 1965

EXHIBIT 24

CORPS OF ENGINEERS

U. S. ARMY

BEFORE HURRICANE "BETSY"
GRAND ISLE, LA.
7 October 1964

AFTER HURRICANE "BETSY"
GRAND ISLE, LA.
8 October 1965

EXHIBIT 25

CORPS OF ENGINEERS

U. S. ARMY

BEFORE HURRICANE "BETSY"
GRAND ISLE, LA.
7 October 1964

AFTER HURRICANE "BETSY"
GRAND ISLE, LA.
8 October 1965

EXHIBIT 26