US Army Corps
of Engineers
New Orleans District

West Bank Hurricane Protection, Lake Cataouatche, La.

Reconnaissance Study

February 1992

SYLLABUS

The Lake Cataouatche study area is located on the west bank of the Mississippi River in Jefferson Parish, Louisiana. The study area encompasses 12,000 acres, including the unincorporated communities of Avondale, Kennedy Heights, Bridge City, Live Oak Manor, and Waggaman and the western portion of the city of Westwego. Population of the area is approximately 23,800.

The Lake Cataouatche Levee, which was built by the Lafourche Basin Levee District in the 1960's, provides protection to the area from tidal flooding. Elevations of the levee range from 5.5 to 12 feet NGVD. Hurricane surges on the southern, unprotected side of the levee are estimated at 3.9 feet NGVD for a hurricane expected to recur on an average every 10 years (a 10-year hurricane), 4.8 feet for a 25-year hurricane, 5.5 feet NGVD for a 50-year hurricane, 6.0 feet NGVD for a 100-year hurricane, and 7.5 feet NGVD for a standard project hurricane, which has an average return frequency of greater than 200 years.

The Lake Cataouatche levee is structurally unstable. The levee is founded on soils with high organic content and has been raised beyond its original design elevation in an effort to improve the level of hurricane protection to the area. The levee is flanked on each side by drainage and borrow canals and was raised without increasing the width of the levee berm. The levee is plagued by high subsidence rates and has failed in at least one location. The levee is projected to fail for a hurricane surge approaching that for a 100-year hurricane.

The failure of the Lake Cataouatche levee during a 100-year or greater hurricane would cause extensive flooding in the study area, particularly in that portion of the Avondale community located south of U. S. Highway 90 where approximately 1,300 residences and other structures would be flooded. Expected average annual damages in the area are estimated at $8,997,000.

The construction of levees and floodwalls was considered for improving hurricane protection in the Lake Cataouatche area. Several alternative plans were developed from two alternative alignments, various combinations of levees and floodwalls, and two levels of protection. One of the plans considered was found to be economically justified. The plan provides for a combination of a levee/floodwall generally along the existing Lake Cataouatche levee alignment to provide protection from overtopping from surges produced by hurricanes up to a 100-year frequency.

The estimated construction cost of this plan is $13,173,000, of which $8,562,400 is Federal and $4,610,600 is non-Federal. The average annual cost is estimated at $1,238,000. The estimated average annual benefits that would accrue to the construction of the plan total $1,530,000, including $1,022,000 for flood damages prevented to existing development. Additional benefits of $4,260,000 would result from the saving in construction cost to the authorized Westwego to Harvey Canal hurricane protection project. The Lake Cataouatche plan would tie into the western end of the project and reduce the construction cost on the protected side of the tie-in. The ratio of average annual benefits to average annual costs is 1.2. Average annual net benefits are estimated a $292,000.

The plan utilizes the existing levee rights-of-way thereby reducing direct impacts to the environment during construction. Induced development as a result of increased hurricane protection would be mitigated for by the acquisition of degraded habitat to be appropriately converted to offset environmental losses. The first costs of mitigation was estimated at $167,000.

The recommendations of this reconnaissance report are that the study proceed into the feasibility phase, contingent upon the execution of an agreement with a non-Federal sponsor to share one-half of the feasibility study cost.

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INTRODUCTION

STUDY AUTHORITY

The study was authorized by four resolutions: two adopted by the Committee on Public Works of the United States Senate at the request of the late Senator Allen J. Ellender and Senator Russell B. Long, and two adopted by the Committee on Public Works of the United States House of Representatives at the request of the late Representative Hale Boggs.

The Senate Committee resolutions adopted November 10, 1965, and May 6, 1966, respectively, read as follows:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers, on the Mississippi River Delta at and below New Orleans, Louisiana, published as House Document Numbered Five Fifty, Eighty Seventh Congress, and other pertinent reports, with a view to determining if the existing project should be modified in any way at this time with particular reference to improvements for hurricane protection, flood control, and related purposes in that part of Jefferson Parish, Louisiana, between the Mississippi River and Bayou Barataria and Lake Salvador."

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Mississippi River Delta at and below New Orleans, Louisiana, published as House Document Numbered 550, Eighty-seventh Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time, with particular reference to improvement for hurricane protection, flood control, and related purposes in the area on the West Bank of the Mississippi River at and in the vicinity of New Orleans, Louisiana."

The House Committee resolutions adopted on May 5, 1966, and October 5, 1966, respectively, read as follows:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports on the Mississippi River Delta at and below New Orleans, Louisiana, to determine if the

existing project should be modified at this time with respect to improvements for hurricane protection, flood control, and related purposes in that part of Jefferson Parish, Louisiana, between the Mississippi River and Bayou Barataria and Lake Salvador."

"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on the Mississippi River Delta at and below New Orleans, Louisiana, published as House Document Number 550, Eighty-seventh Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time, with particular reference to improvement for hurricane protection, flood control, and related purposes in the area on the West Bank of the Mississippi River in the vicinity of New Orleans, Louisiana, including Plaquemines, Orleans, Jefferson, and St. Charles Parishes."

STUDY PURPOSE

The purpose of this reconnaissance study is to determine the feasibility of providing hurricane surge protection to that portion of the west bank of the Mississippi River in Jefferson Parish between Bayou Segnette and the St. Charles Parish line (see Plate 1). The reconnaissance study is the first phase of the two-phase process used by the Corps of Engineers for implementation studies of water resource projects. The purpose of the reconnaissance phase of a study is to develop and present sufficient information to determine if one potential solution to the problems, needs, and opportunities in a study area (1) will likely be in the Federal interest to implement, (2) will be in accordance with current policies and budgetary guidance, (3) can be implemented in accordance with environmental laws and statutes, and (4) will be supported by a non-Federal sponsor. If these conditions are not met, no further studies will be conducted under this authority for this area unless there is a change in conditions upon which the study conclusions were based. This study is in partial response to the authorizing resolution.

SCOPE OF THE STUDY

This reconnaissance study investigates the preliminary feasibility of constructing hurricane protection for a portion of the west bank of the Mississippi River in Jefferson Parish protected by the Lake Cataouatche levee. The engineering analyses consists of developing design and cost estimates for floodwalls and/or levee systems to provide protection against hurricane surge flood waters. The economic analyses estimates the reduction in residential and commercial flood damages resulting from the project. The environmental analyses lists environmental habitats in the area and the possible project-related impacts.

OTHER STUDIES CONDUCTED UNDER THIS AUTHORITY

This is the third study conducted under this authority. The other two are described below.

The "West Bank of the Mississippi River in the Vicinity of New Olreans, Louisiana," project was authorized by the Water Resources Development Act of 1986 (Public Law 99-662). The project provides hurricane surge protection to that portion of the west bank of the Mississippi River in Jefferson Parish between the Harvey Canal and Westwego and south to the vicinity of Crown Point, Louisiana. Construction was initiated in early 1991.

The "West Bank of the Mississippi River in the Vicinity of New Olreans, Louisiana, (East of the Harvey Canal)" feasibility study is addressing the feasibility of providing hurricane surge protection to that portion of the west bank of the Mississippi River in the Parishes of Orleans, Jefferson, and Plaquemines bounded by the Harvey Canal on the west, the Mississippi River on the north and east, and the Hero Canal on the south. The study is scheduled for completion in April 1993.

PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

A number of studies and reports concerning water resources development in coastal Louisiana have been prepared by the U. S. Army Corps of Engineers, other Federal, state, and local agencies, research institutes, and individuals. Some of these reports have resulted in the construction of projects which have had a significant effect on the study area. Pertinent studies, reports, and projects are discussed below.

A report entitled "New Orleans to Venice, Louisiana, Hurricane Protection," was published as House Document No. 550, 87th Congress, 2nd Session. This report resulted in the authorization of a project providing hurricane protection to developed areas in Plaquemines Parish along the Mississippi

River. The locally constructed back levee from City Price to Venice on the west bank would be enlarged and the existing levee from Phoenix to Bohemia on the east bank would be brought up to grade. Work on these features is underway. The General Design Memorandum Supplement No. 5, dated October 1983, provides for the creation of 297 acres of marsh in the Delta-Breton National Wildlife refuge as mitigation for marsh loss caused by the levees.

The U. S. Army Corps of Engineers prepared a final feasibility report, "Louisiana Coastal Area, Freshwater Diversion to Barataria and Breton Sound Basins," in September 1984. The report recommends diverting Mississippi River water near Caernarvon into the Breton Sound Basin and near Davis Pond into the Barataria Basin to enhance habitat conditions and improve fish and wildlife resources. The report also recommends that the plan be implemented under the authorized Mississippi Delta Region Project, which is identical in purpose. The diversions would reduce land loss and save about 99,200 acres of marsh. The construction of the Caernarvon structure was completed in early 1991. Advanced engineering and design studies on the Davis Pond feature are underway.

The U. S. Army Corps of Engineers prepared a reconnaissance report, "Louisiana Coastal Area Hurricane Protection" in March 1988. The report presented the findings of a reconnaissance scope investigation of the increased hurricane induced surge elevations associated with the anticipated future losses in coastal wetlands and barrier islands in the coastal zone of Louisiana. The report recommended continuation of study to the feasibility level for the Barataria Basin only. Feasibility studies were terminated at the request of the local sponsor in January 1991.

The U. S. Army Corps of Engineers prepared an initial evaluation report on Shore and Barrier Island Erosion in September 1984. The "Shore and Barrier Island Feasibility Study", which is currently inactive, investigated the causes and consequences of the reduction and loss of the barrier islands and adjacent shores resulting from the combined forces of erosion and subsidence.

A report entitled "Barataria Bay, Louisiana," was published as House Document No. 82, 85th Congress, 1st Session. This report resulted in the authorization, by the River and Harbor Act of July 3, 1958, a project which provides for a 12 by 125-foot channel approximately 37 miles long from the Gulf Intracoastal Waterway (GIWW) to Grand Isle, Louisiana. All work was completed in December 1967.

The Mississippi River and Tributaries project, the comprehensive flood control project for the lower Mississippi Valley below Cairo, Illinois, has had a significant impact on the water and land resources in the study area. This project was authorized by the Flood Control Act of 1928 and subsequent amendments. Features of the project pertinent to the study are:

(a) The Mississippi River levees extend from Baton Rouge, Louisiana, to Bohemia, Louisiana, on the east bank and from above the study area to Venice, Louisiana, on the west bank. They provide protection from the standard project flood on the Mississippi River and Tributaries system. These levees are essentially complete in the study area.

(b) The Bonnet Carre Spillway is located upstream of New Orleans, Louisiana, on the east bank of the Mississippi River in the vicinity of Norco, Louisiana. The purpose of the spillway is to divert Mississippi River flows into Lake Pontchartrain to lower flood stages on the Mississippi River in the New Orleans area. The spillway was completed in 1932.

(c) Revetments and foreshore protection have been constructed along the Mississippi River in the study area. Revetments are constructed where levees or development is threatened by bank caving or where unsatisfactory alignment and channel conditions are developing. Foreshore protection is constructed where levees are threatened by the erosion of the batture. Construction of these features is continuing as needed.

The U. S. Fish and Wildlife Service published the "Proceedings of the Conference on Coastal Erosion and Wetland Modification in Louisiana: Causes, Consequences, and Options," edited by D. F. Boesch (1982). The proceedings provide a current compendium of information on the natural and man-induced causes of land loss, their impacts on natural resources production and man's use of the area, and possible means of reducing land loss.

The Louisiana Department of Natural Resources published a report entitled "Louisiana's Eroding Coastline: Recommendations for Protection" in June 1982. The report recognizes that future losses of coastal wetlands is unavoidable and will require either retreat of development from the coastal zone or increasingly greater levels of protection. Areas with initial erosion problems were identified and ranked according to severity. The report recommends development and implementation of a shoreline protection plan and proposes a number of pilot projects using water and sediment diversions, dredged material placement, and planting vegetation as a means to reduce erosion. A study to determine future coastal conditions, including changes in shoreline configuration and impacts on developed areas, was also recommended.

The Barataria-Terrebonne National Estuary Program, nominated by Governor Roemer in October 1989, recieved funding under Section 320 of the 1987 Water Quality Act on April 20,1990, to enhance, protect and maintain the water quality, habitat integrity, and natural resources of the

Estuarine Complex. The act authorizes the EPA to develop a Comprehensive Conservation and Management Plan which recommends priority corrective actions and compliance schedules addressing point and non-piont sources of pollution to restore and maintain the chemical, physical, and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish, and wildlife, and recreational activities, and assuring that the designated uses of the estuary are protected.

PROBLEM IDENTIFICATION

NATIONAL OBJECTIVES

The objective of Federal and Federally-assisted water and related land resources planning is to contribute the National Economic Development (NED) consistent with protecting the nation's environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to the NED objectives are accomplished by increasing the value of the national output of goods and services. A positive contribution to the NED objective requires that the benefits attributable to a project exceed the cost (the benefit-cost ratio must be greater than unity).

EXISTING CONDITIONS

LOCATION AND DESCRIPTION OF STUDY AREA

The area addressed in this report is shown on Plate 2. The study area is located on the west bank of the Mississippi River in Jefferson Parish, Louisiana between approximate Mississippi River miles 105 and 114 above Head of Passes. The approximate project boundaries are Bayou Segnette on the east, Lake Cataouatche on the south, the Jefferson/St. Charles Parish line on the west, and the Mississippi River on the north. The communities located in the study area are Live Oak, Waggaman, Avondale, Bridge City, and the western part of Westwego.

Development in the study area has followed the traditional scenario for southeast Louisiana. High ground near the alluvial natural levees of the Mississippi River was developed first. As the population continued to grow, the lower areas further from the river were developed. Local interests built levees and provided forced drainage to facilitate the development of these lower areas. Many of the levees did not provide a high level of protection from hurricane flooding and are structurally substandard based on Corps criteria.

The area is part of the Barataria Bay estuary which is connected to the Gulf of Mexico approximately 50 miles southeast of the study area. Tidal waters can enter the study area through the bays, lakes, and bayous of the estuarine system. The Lake Cataouatche levee was constructed by the Lafourche Basin Levee District in the 1960's to provide storm surge protection to existing and projected development. Levee heights vary from about five feet NGVD to twelve feet NGVD. The levee begins at the Bayou Segnette pump station on the east and sweeps southerly in a trapezoidal configuration to the west encompassing several small communities and approximately 12,000 acres of development and wetlands. Each end of the levee ties in to U.S. HIGHWAY 90 which has an average elevation of approximately five feet NGVD. The area is effectively cutoff from natural drainage and is under forced drainage via three pumping stations with a combined capacity of 2,000 cubic feet per second.

Pumping of the area to an artificially low water table in order to provide sufficient rainfall storage capacity has exposed the insitu soils promoting consolidation and decay of the organic materials. Thus the land elevation inside the protected area is lower than the outside water surface of the bayous and lakes. This subsidence has increased the potential impacts of storm surge on the developed area.

CLIMATOLOGY/HYDROLOGY

Climate. The study area is located in a subtropical latitude. The climate is influenced by the many water surfaces of the lakes, streams, and Gulf of Mexico. Throughout the year, these water areas modify the relative humidity and temperature conditions, decreasing the range between the extremes. When southern winds prevail, these effects are increased, imparting the characteristics of a marine climate. The area has mild winters and hot, humid summers. During the summer, prevailing southerly winds produce conditions favorable for afternoon thundershowers. In the colder seasons, the area is subjected to frontal movements that produce squalls and sudden temperature drops. River fogs are prevalent in the winter and spring when the temperature of the Mississippi River is somewhat colder than the air temperature.

Precipitation. Precipitation is generally heavy in two fairly definite rainy periods. Summer showers last from mid-June to mid-September, and heavy winter rains generally occur from mid-December to mid-March. The annual normal precipitation for New Orleans at Audubon Park is 61.6 inches, with annual variations of plus or minus 50 percent. Extreme monthly rainfalls exceeding 12 inches are not uncommon, and as much as 20 inches have been recorded in a single month. The greatest 24-hour amount of precipitation at this station since 1871 was 14.01 inches on April 15 and 16, 1927. At Belle Chase, 15.4 inches of rain fell on October 2, 1937. Table 1 gives the 30-year normals for New Orleans at Audubon Park station along with the monthly maximum and minimum totals during the 1951-1980 period. Snowfall amounts are generally insignificant, and hail of a damaging nature seldom occurs.

TABLE 1

MONTHLY RAINFALL (INCHES)
NEW ORLEANS AT AUDUBON PARK
30-YEAR NORMALS (1951-1980)

Month	Normal	Maximum	Minimum	Month	Normal	Maximum	Minimum
Jan	4.9	12.69	0.99	Jul	7.17	20.30	2.37
Feb	5.19	12.44	0.54	Aug	6.67	17.82	2.67
Mar	4.68	10.17	T	Sep	5.98	16.91	0.80
Apr	4.68	20.24	0.58	Oct	2.52	8.18	0.0
May	5.06	12.61	0.62	Nov	4.01	10.51	0.49
Jun	5.39	16.98	0.39	Dec	5.30	8.93	1.40
				ANNUAL	61.55	83.54	40.11

LEGEND: T - Trace, a - Jul 1959, b - Oct 1952, Oct 1963, c - 1961, d - 1968

Temperature. Temperature records at New Orleans Audubon Park show that during a year the monthly average temperatures normally vary from 54°F to 83°F. Extremes over the period of record are 7°F and 102°F. Temperature normals (1951-1980) for New Orleans at Audubon Park station are shown in Table 2.

TABLE 2

MONTHLY AVERAGE TEMPERATURE (°F)
NEW ORLEANS AT AUDUBON PARK
30-YEAR NORMALS (1951-1980)

Month	Mean	Maximum	Minimum	Month	Mean	Maximum	Minimum
Jan	53.6	61.8	45.3	Jul	83.0	90.6	75.3
Feb	56.1	64.6	47.6	Aug	82.8	90.3	75.3
Mar	62.6	71.0	54.1	Sep	79.8	87.0	72.6
Apr	69.8	78.3	61.2	Oct	70.8	79.5	62.1
May	76.0	84.2	67.7	Nov	61.6	70.1	53.1
Jun	81.3	89.4	73.2	Dec	56.2	64.5	47.8
				ANNUAL	69.5		

Extreme Minimum: 7°F, 13 February 1899
Extreme Maximum: 102°F, 30 Jun 1954 (also other dates)

Wind. Average wind velocity is 7.8 mph, based on anemometer records at New Orleans Moisant Airport over the period 1966-1983. The predominant wind directions are north-northeast from September through February and south-southeast from March through June. Tables 3 and 3a shows the average monthly wind speeds and the resultant direction for this period.

TABLE 3

WIND SUMMARIES, NEW ORLEANS AT MOISANT AIRPORT (1966-1983)
AVERAGE WIND SPEED (MPH)

YR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
66	9.6	10.5	9.5	10.7	8.7	7.3	6.2	6.4	5.7	7.6	7.4	8.6	8.2
67	8.3	9.5	9.0	9.3	9.1	6.8	6.2	5.9	7.0	7.4	8.0	9.8	8.0
68	9.2	10.0	9.3	9.1	8.4	5.6	5.7	5.2	6.4	6.8	8.9	9.3	7.8
69	9.7	9.8	10.0	8.6	7.3	7.2	6.5	6.8	6.7	9.7	8.0	9.1	8.3
70	9.5	9.2	9.8	9.9	8.5	6.8	5.4	6.0	6.7	7.7	8.0	7.4	7.9
71	8.4	9.8	9.8	8.5	7.9	5.3	5.7	5.0	6.5	4.8	8.0	8.7	7.4
72	8.9	8.6	9.1	10.2	7.3	9.3	7.5	6.4	7.0	8.3	9.9	9.4	8.5
73	9.6	10.2	12.0	11.5	10.0	6.7	6.7	6.3	7.9	7.0	9.6	11.4	9.1
74	9.2	11.0	10.8	10.7	8.2	7.4	5.0	5.2	8.6	7.4	8.5	8.5	8.4
75	9.4	8.6	11.0	10.0	7.4	6.5	6.5	4.9	6.3	6.4	8.0	7.8	7.7
76	9.6	8.8	10.5	7.6	8.4	6.9	5.4	5.7	6.0	8.5	7.9	8.2	7.8
77	9.8	8.5	8.5	7.3	5.7	5.3	4.4	5.5	5.4	6.6	8.1	8.8	7.0
78	9.1	8.9	8.5	8.6	7.9	5.9	5.5	5.3	6.3	6.1	6.7	10.0	7.4
79	10.5	9.0	9.3	8.0	7.2	6.5	6.7	4.4	8.0	6.7	8.1	6.3	7.6
80	7.6	8.0	9.8	8.8	7.5	7.4	5.6	5.7	5.3	5.9	6.4	5.9	7.0
81	7.6	8.3	7.7	7.3	7.8	6.9	5.7	4.8	5.7	7.0	7.3	8.6	7.1
82	9.8	8.3	8.9	9.4	6.5	6.2	4.6	4.4	7.1	7.5	7.6	10.0	7.5
83	8.0	10.0	8.8	10.4	7.8	6.3	5.8	5.3	6.0	6.8	8.3	10.0	7.8
AVG	9.1	9.2	9.6	9.2	7.9	6.7	5.8	5.5	6.6	7.1	8.0	8.8	7.8

TABLE 3a

WIND SUMMARIES, NEW ORLEANS AT MOISANT AIRPORT (1966-1983)
RESULTANT DIRECTION*

YR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
66	02	04	07	16	07	07	23	15	02	03	03	05	05
67	03	02	13	15	16	11	21	02	05	06	05	08	09
68	03	35	12	16	15	19	12	05	06	04	04	06	07
69	07	02	02	13	09	18	24	09	04	05	36	01	05
70	03	03	08	17	19	21	29	12	08	03	32	06	09
71	02	12	13	15	13	23	20	01	07	04	04	12	09
72	07	07	12	15	04	20	14	34	12	06	02	06	08
73	02	36	16	16	20	18	24	04	10	07	13	20	12
74	12	24	16	13	16	16	25	13	05	06	06	16	12
75	09	21	14	11	15	18	25	17	03	05	08	04	04
76	04	19	15	15	15	13	25	01	04	02	02	02	07
77	01	09	13	14	13	21	20	12	15	03	10	13	11
78	01	01	28	15	16	12	19	11	08	03	08	07	07
79	01	04	15	14	14	15	17	13	04	11	03	03	08
80	06	06	09	20	15	22	27	13	09	04	02	02	08
81	02	02	21	15	13	16	22	11	05	06	10	04	09
82	11	01	12	10	13	22	21	21	06	06	06	10	09
83	04	05	29	18	15	12	10	11	07	05	10	03	08

* Wind direction - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm, 09 east, 18 south, 27 west, 36 north. Resultant wind is the vector sum of wind directions and speed divided by number of observations.

Tropical Storms and Hurricanes. Several hurricanes and tropical storms have passed through or near the study area. Some of the major storms include the 1915 hurricane, the 1947 hurricane, and Hurricanes Flossy (1956), Hilda (1964), Betsy (1965), Carmen (1974), Babe (1977), Bob (1979), Danny (1985), and Juan (1985). Hurricane Flossy brought torrential rains and tidal flooding to the study area. Golden Meadow, which is approximately 20 miles south of the study area, received 16.7 inches of rain in a 24-hour period during hurricane "Flossy". Hurricane Hilda raised water levels at Barataria and Lafitte to 3.6 and 4.04 feet NGVD, respectively. Hurricanes Betsy and Carmen also caused flooding to some parts of the study area. Hurricane Juan, generally characteristic of a storm event of approximately 25 years, broke high water records throughout the area (see Table 4-Gage Data). Stages in the Harvey Canal were estimated to be about the 60-year event. On the west bank of the Mississippi River, five local levees were breached in the area east of the study area. These levees are now included in the Westwego to Harvey Canal Hurricane Protection project, which is currently under construction. Due to these levee failures several subdivisions were flooded by tidal inundation. The total storm precipitation for Juan ranged from 8 to 12 inches over the study area.

Stages. Normal astronomical tides at the coastline are diurnal and can have a spring range of 2.0 feet. Inland, this range is on the order of 0.5 feet. Winds with a strong southerly component that are sustained for 30 hours or more yield an increase in tide height of about 1 foot for each 10 miles per hour. Sometimes the passage of a front is delayed and these strong winds that lead to abnormally high tide heights are produced.

Stage records are available at four locations within the study area. Hurricane Juan set record highs at three of these locations. Table 4 gives the period of record and extremes of these stations. Discharge data are not taken due to tidal influence.

TABLE 4
GAGE DATA

Station	Period of Record	Stage Extremes (ft. NGVD) Max	Date	Min	Date
Miss River @ Harvey Lock	Jan '24-date	19.42	24 Apr 27	-0.67	17 Dec 53 18 Dec 53
IWW @ Harvey	Jan '25-date	*4.74	29 Oct 85	-1.28	26 Jan 40 27 Jan 40
Bayou Bara. @ Bara	Jan-Sep '50 & Nov '51-date	*4.25	29 Oct 85	-0.58	9 Sep 65
Bayou Bara.	Oct ,55-Dec Jan '56' 60 & May '63-date	*5.05	29 Oct 85	-0.60	12 Jan 56 13 Jan 56

* Caused by Hurricane Juan

High tides accompanied by heavy rainfall and hurricanes can cause flooding in the study area. Weak hurricanes of extended duration, such as Juan, can produce a storm surge of 4 to 5 feet NGVD that can overtop existing protective embankments and flood the heavily populated developed areas.

In 1973, floodwaters from excessive rainfall and abnormally high tides in Lakes Cataouatche and Salvador and Bayou Barataria prevented the drainage system from operating efficiently resulting in damage to residential areas. High tides caused damage to industries located along the Harvey Canal.

Drainage problems are exacerbated when rainfall is accompanied by high tides. During May 1978 and April 1980, short duration, large accumulation rainfalls occurred in this area. During the rainstorm of May 3, 1978, stages of 2.3 feet NGVD at Barataria on Bayou Barataria, and 2.7 feet NGVD at the Harvey Lock on the Intracoastal Waterway were recorded. On April 13, 1980, Algiers recorded 9.7 inches of rainfall, the accompanying stage at Barataria was 3.8 feet NGVD and at the Harvey Lock, the stage was 3.2 feet NGVD. The pump stations were forced to operate against higher than optimum outside stages during these events thereby reducing the capacity of these stations.

Intense hurricanes such as "Betsy" in 1965 have caused high stages along the coastal area of Louisiana (10.5 ft NGVD at Grand Isle) and moderately high stages inland (3.2 ft NGVD at the Harvey Lock). Detailed hurricane data are presented in a Corps publication entitled, "History of Hurricane Occurrences along Coastal Louisiana." Examination of gage records at the inland gaging stations reveals that Hurricane Juan caused the highest stage of record on October 29, 1985, at Barataria (4.25 ft NGVD), and Lafitte (5.05 ft NGVD) and at Algiers Lock (4.45 ft NGVD) and Harvey Lock (4.74 ft NGVD).

The normal tide in the study area is diurnal and has a mean range of approximately 0.5 feet. However, wind effects can mask the daily ebb and flow variations, and during periods of sustained southerly winds, tides rise in direct response to the duration and intensity of the wind stress. This was demonstrated in 1985 by Hurricane Juan. A relatively weak storm in terms of maximum sustained windspeed, Hurricane Juan caused higher stages in much of the study area than the more intense Hurricane Betsy. This is directly attributable to the hurricane's erratic, almost stationary, path across southern Louisiana. Gale force winds over a period of five days caused tides 3 to 6 feet above normal across the entire coastal area of southern Louisiana.

Water Quality. The waters of the study area have been classified "effluent limited" by the State of Louisiana. The "effluent limited" classification indicates that water quality is meeting and will continue to meet applicable water quality standards, or that water quality will meet those standards in the future after application of effluent limitations required by the Federal Clean Water Act.

The most extensive water quality data in the study area were collected by Jefferson Parish from 1983 to the present. Most of the samples were collected monthly at various locations throughout the drainage canal system on the west bank of the Mississippi River. Four of these sample locations are applicable to the study area. Samples were analyzed for the following; Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, pH, Total Coliforms, Fecal Coliforms, Cadmium, Chromium, Copper, Mercury, Lead, and Arsenic.

Despite the "Effluent Limited" designation, water quality problems have occurred. Water quality standards have not always been met. The worst conditions occur during and shortly after storm events when runoff from the entire area, which is partially urbanized, flows into the drainage canals. This is when elevated levels of metals, nutrients, biochemical oxygen demand, and fecal coliforms most often occur, as well as low levels of dissolved oxygen. The concentrations of most of these constituents return to acceptable levels shortly after storm events. However, fecal coliform concentrations often persist at levels that do not meet the primary contact recreation standard. This is most likely due to treated wastewater effluent and infiltration/inflow, due to infrastructure problems, from the urbanized portion of the area. Cattle grazing in some of the non-urbanized portions of the area also contributes to the fecal coliform problem. Overall, water quality of the study area can be considered only marginally acceptable, primarily due to the high fecal coliform levels.

GEOLOGY

The study area is located in the northeastern portion of the Mississippi River Deltaic Plain, southwest of New Orleans, Louisiana. Dominant physiographic features consist of natural lèvees, point bars, abandoned distributaries, inland swamp and fresh marsh. Natural elevations vary from approximately +12 feet NGVD near the Mississippi River to zero feet NGVD in the marsh areas.

The subsurface consists of Holocene deposits approximately 60 feet thick. These deposits are composed of natural levee clays and silts, point bar clays, silts, and sands, abandoned distributary clays, silts and clays, and swamp clays. The Holocene deposits are underlain by Pleistocene deposits consisting of oxidized clays and silty clays with some sand lenses. These deposits have lower water contents and higher strengths than the overlying Holocene deposits. The Pleistocene deposits were deposited in a fluvial-deltaic environment.

EXISTING PROTECTION AND DRAINAGE

Federal flood control improvements include the mainline Mississippi River and Tributaries levee system. The levee along the west bank of the Mississippi River in the study area has an average elevation of 26.5 feet NGVD. The remainder of the levee system was constructed by local interests, segmentally, as expanding development warranted protection. The Lake Cataouatche levee heights vary from 5.5 to 12.0 feet NGVD and is structurally substandard by Corps criteria.

While preventing high waters from intruding, these levees also prevent any rainwaters that fall within their perimeter from draining onto the adjacent lower lands and lakes. As a solution to this problem, leveed areas are webbed with drainage outfall canals that terminate at pumping stations. These pumps remove the flood waters that are ponded inside the leveed areas. The Lake Cataouatche area is drained by three pump stations having a combined capacity of 2,000 cubic feet per second (cfs). The Bayou Segnette station drains the eastern half of the study area including the western most part of Westwego. This station formerly drained the entire study area and is connected to the whole basin via the drainage canals. It has a present capacity of 900 cfs. The second station, which has a 500 cfs capacity, was installed years later to drain the Avondale community. As the area continued to develop through the 1970's, a second pump station was constructed next to the Avondale station to meet the new runoff requirements. This station has a capacity of 600 cfs. These two stations are together referred to as the

Lake Cataouatche pump station. The addition to the Lake Cataouatche station shares the burden of draining the area with the Bayou Segnette station excluding the Avondale area.

These pumps have artificially lowered the water levels within the study area. This lowering has enabled developers to construct residences with first floor slab elevations below zero feet NGVD. Many of the Avondale homes south of U.S. Highway 90 have floor elevations below zero feet NGVD.

ECONOMIC RESOURCES

Development and Economy. The communities of Avondale, Bridge City, Waggaman, and the city of Westwego, Louisiana, are surrounded by marsh, wetlands, and commercial and industrial development. The west bank of the Mississippi River in Jefferson Parish has grown into a hub of oilfield service related industries, which has correspondingly affected housing in that area. Due to current economic conditions many residences in the study area are either for sale or abandoned. It appears that a very significant upturn in the petroleum industry or a major shift to other labor intensive industries would be required to bring employment levels, and therefore occupancy rates, up to the level that existed a few years ago. Because of current overcapacity in the petroleum industry and related employment sectors, it has been assumed that demand for additional housing in the general area will occur at a slower rate than in more prosperous years.

Income and Employment. During the first half of the 1980's, the growth rate in per capita income in the New Orleans Metropolitan Statistical Area (MSA) averaged 3.4 percent per year. The growth rate in per capita income in recent years has been stagnant, until the economy turned upward in the second half of 1989. According to the University of New Orleans (UNO) Real Estate Market Data Center, the current growth rate in per capita income in the New Orleans MSA is averaging 5 percent. Per capita personal income levels for Jefferson Parish were $13,756 in 1987, $14,441 in 1988, and $15,235 in 1989.

The entire study area of the Lake Cataouatche study area is part of the New Orleans MSA. A September 1989 report prepared by the Louisiana Department of Labor estimated total nonagricultural employment in the New Orleans MSA at 518,700. After nearly a decade of overall declining employment, approximately 3,000 jobs were gained from September 1988 to September 1989.

A significant factor influencing the area's employment opportunities, and economic trends in general, has been the decline of oil production in recent years. The unemployment rate in the New Orleans Metropolitan Statistical Area (MSA), however, appears to have improved recently, declining from 11.5 percent in August of 1986 to 9.0 percent in 1990.

Retail trade, the second largest sector in the New Orleans area, lost workers for the last three quarters, according to "New Orleans Metropolitan Area Economic Outlook - 1991:1993", dated February 1992, by the University of New Orleans. However, the report predicts gains in retail trade employment over the next two years, reflecting a healthy tourist industry and a rebounding local economy. Retail trade employment is predicted to increase by 1.0% in 1992 and by 1.4% in 1993. The expectations for increased population and personal income will provide for consistent growth in food stores and in other retail stores in the next two years.

Measures of the local tourist trade were relatively slow in the third quarter of 1991, according to the University of New Orleans' February 1992 report. Employment in hotels, motels, bars, and restaurants will rise, following a general upward trend in tourist activity. Four factors will contribute to the tourist sector growth that is predicted for the next two years: the recent opening of the second phase of the Convention Center; the continuation of the State of Louisiana tourism marketing effort as well as the promotional activities of the New Orleans Marketing Corporation; the ultimate end of the double-dip national recession; the on-set of riverboat/land-based gaming; and the attraction of two major national sporting events to the Crescent City - the 1992 Olympic Track and Field Trials in June, and the NCAA Men's Final Four basketball Championship in April, 1993.

Property Values and Housing. Census tract data from 1980 was used to determine the estimated value of residential property in the project area. The west bank of the Mississippi River in Jefferson Parish was reported as having 12,692 owner-occupied units with a mean value of $52,830, and 10,869 renter-occupied units with a mean rent of $207. The estimated value of residential property for the project area in 1988 was determined by using information gathered from field surveys and applying the Marshall and Swift Valuation Program. The study area consisted of approximately 4,000 residential units with an average value of $34,000.

Housing prices have fluctuated, but generally moved slightly downward, during the past decade. According to the New Orleans Real Estate Market Analysis by the University of New Orleans, between the 1983 peak in housing values and the trough in 1988, the average house in Jefferson lost 7 percent of its value. However, after years of price declines, housing values have stabilized. Prices have continued to fall for the moderate to low income neighborhoods, but the more affluent areas of the west bank of the Mississippi River are beginning to establish a rising price trend.

According to the University of New Orleans February 1992 report, the outlook for residential construction activity is brighter than it has been in some time. It is anticipated that local population growth caused by overall economic growth will stimulate the demand for housing over the next two years. As a result, residential work in progress will expand consistently in the next two years.

After nearly a decade of falling occupancy rates and rents, the apartment market has also stabilized. The long decline in apartment occupancy which began in 1982 has slowed since 1987. A modest recovery in occupancy levels for larger apartment complexes, especially on the west bank of the Mississippi River in Orleans Parish, was somewhat offset by the continued decline in smaller units. Apartment rents have leveled since the economy began its slight improvement. The housing and apartment markets may be on the road to recovery, but like the economy as a whole, it is occurring at a slow pace.

<u>Economic Activity.</u> The west bank of the Mississippi River in Jefferson Parish is considered rich in commercially important minerals, port activities, and the development of and production of a variety of fish and wildlife resources. As a result, the economy is founded on a base of natural resources. With an extensive system of navigable waterways and a strategic location, the area is a hub for foreign and domestic trade, and harbors a rich cultural and historical heritage.

While less important in recent years, mineral production has contributed greatly to economic growth to the state and Gulf region. While production of lime, sulfur, salt, sand and gravel, cement, stone (shell), and clays have been important, the vast majority of production value has been from the extraction of crude petroleum, natural gas, and natural gas liquids. The production of crude petroleum in Louisiana in 1975 was 935,243,000 barrels. About 95 percent of the state's total extraction was from gulf areas, including 474,521,000 barrels from onshore areas and 415,305,000 barrels from offshore areas. In 1982, the coastal area and offshore waters produced approximately 13 percent of the nation's crude petroleum and 31 percent of the natural gas, which were valued at $27.8 billion.

According to "New Orleans Metropolitan Area Economic Outlook - 1991:1993", dated February 1992, by the University of New Orleans, the price of oil remained relatively stable, but a continued decline in the price of natural gas forced down the rig count to the lowest level in recorded history. The refiners' acquisition cost of a barrel of oil rose slightly from $18.29 in the second quarter of 1991 to $19.00 in the third quarter. The price of crude oil is expected to rise to

$21.00 in the fourth quarter, fall back to $19.00 over the following four quarters, and then rise to $21.50 by the third quarter of 1993.

Industrial expansion, the growth of port and harbor activities, commerce, tourism, and mineral production have tended to overshadow the historic cultural and economic significance of commercial fishing and trapping industries. Nevertheless, the National Marine Fisheries Service (NMFS) of the U.S. Department of Commerce identifies Louisiana as one of the nation's major fish and shellfish producers. From 1983 to 1987, a corrected average of 1.8 billion pounds of commercial fisheries, species valued at $846 million were attributed to Louisiana's marshes. Louisiana's coastal commercial wildlife industry is associated mainly with alligators and furbearers. From 1984 to 1988, about 20,700 alligators worth $6.7 million were taken annually from Louisiana's marsh. From 1979 to 1988 an average of 1.6 million furbearers valued at $12.4 million were caught in Louisiana's marsh. Nutria pelts accounted for approximately 50% of this value.

Population. Table 5 compares historical population trends for the New Orleans MSA, the east and west banks of Jefferson Parish, and population for Census Tracts and blocks of the West Bank study area. As shown in the table, population in the MSA increased by more than 150,000 from 1960 to 1970 and from 1970 to 1980. In part due to the growth patterns occurring in Jefferson, St. Bernard, and St. Tammany parishes, St. John and St. Charles parishes were added to the New Orleans MSA in 1983. During the 1980's, however, structural changes in the New Orleans economy including such things as maturing of the area's petro-chemical industries and declines in the level of employment previously available in port operations have resulted in significant out-migrations and an estimated net decline in total population in the MSA. A study by the University of New Orleans, Division of Business and Economic Research, reported net out-migration from Orleans parish at 102,339 between 1980 and 1990. Net out-migration from Jefferson Parish was reported to be 51,794. The only net in-migration reported was in St. Tammany parish, totaling 19,449 and St. John the Baptist parish totaling 1,778. As indicated in Table 5, total population on the west bank of Jefferson parish increased slightly from 1980 to 1990; however, census data indicate that population within the study area declined from 25,772 in 1980 to 23,795 in 1990. This area included the unincorporated communities of Waggaman and Avondale. From 1980 to 1990, the population of Waggaman increased by 4 percent from 9,004 to 9,405. The population of Avondale declined by 13 percent, from 6,699 in 1980 to 5,813 in 1990.

TABLE 5

POPULATION TRENDS, NEW ORLEANS MSA
AND JEFFERSON PARISH

	1960	1970	1980	1990
New Orleans MSA				
Jefferson Parish	208,769	338,229	454,592	448,306
Orleans Parish	627,525	593,471	557,927	496,938
St. Bernard Parish	32,186	51,185	64,097	66,631
St. Charles Parish	21,219	29,558	37,259	42,437
St. John Parish	18,439	23,813	31,924	39,996
St. Tammany Parish	38,643	63,585	110,869	144,508
TOTAL	946,781	1,099,833	1,256,668	1,238,816
Jefferson Parish				
East Bank	132,950	212,432	274,622	260,709
West Bank	75,819	125,797	179,970	187,597
TOTAL	208,769	338,229	454,592	448,306
Project Area	N/A	16,657	25,772	23,795

ENVIRONMENTAL RESOURCES

Biological. Habitat of the Lake Cataouatche study area was historically wooded swamp, bottomland hardwood, and freshwater marsh associated with the Mississippi River and Lake Cataouatche. Flood protection activities (i.e., leveeing, pumping, and ditching) have caused wooded swamps to convert to bottomland hardwood forests while freshwater marshes of the study area have been supplanted by scrub/shrub habitat. A small lineament stand of bald cypress-tupelo gum still exists. Development within the study area includes residential and commercial sites, as well as roads and levees. Riverine habitat consists of borrow, drainage, and access canals.

The majority of the acreage within the study area is wetland, as indicated by the predominance of hydric soils and wetland vegetation. Resident wildlife of the study area is that typically associated with drained bottomland hardwood forest and scrub/shrub habitats of the region. Habitat types of the study area are discussed below, and are depicted in Plate 10.

Bottomland Hardwood Forest. The majority of the study area can be classified as bottomland hardwood forest. These wooded communities found on frequently flooded soils are normally very productive due to periodic flooding and the deposition of organic matter and nutrients. Such areas are important in that they slow and store flood waters, improve water quality, and provide valuable wildlife habitat.

The swamp is dominated by sugarberry, black willow, and boxelder. These species grow in association with baldcypress, tupelogum, and Drummond red maple on the wetter sites with a midstory of boxelder and elderberry. Chinese tallow is prominent in the sparse understory. Drier sites are dominated by Chinese tallow, black willow, and sugarberry with a dense understory of Chinese tallow and elderberry in association with Rubus sp. and smartweed. Transition sites between these two extremes of wetness include the aforementioned species in association with American elm and red mulberry.

Bottomland hardwood forests in a natural state are extremely productive in terms of wildlife, and although somewhat less diverse in a drained condition, these sites still represent valuable wildlife habitat. Bottomland hardwood forests are highly important to neotropical migrants, including various species of warblers, vireos, thrushes, tanagers, buntings, grosbeaks, and orioles, as they pass through the area during migration. Avian species present year-round include red-shouldered hawk, great-horned owl, eastern screech-owl, red-bellied woodpecker, Carolina wren, tufted titmouse, Carolina chickadee, and blue jay. Reptiles and amphibians present include speckled kingsnakes, green anoles, eastern box turtles, and Gulf Coast toads. Mammals occurring in the study area include white-tailed deer, raccoons, Virginia opossums, nine-banded armadillos, gray squirrels, and rabbits. Non-native mammals present include cattle and feral hogs.

Wooded Swamp (drained). A portion of the study area can be classified as drained wooded swamp, comprised of a nearly pure stand of baldcypress and tupelogum. This community is found in a depression or swale which would normally hold water throughout all or part of the growing season. Thus, vegetation found on these sites previous to flood protection were water-tolerant trees and aquatic understory plants, including baldcypress, tupelogum, Drummond red maple, buttonbush, alligator weed, and duckweed. In its present drained condition, a midstory has developed of elderberry and boxelder while Chinese tallow is prominent in the sparse understory.

Native wildlife present is diverse and include those species previously described under the Bottomland Hardwood Forest section.

Scrub/Shrub. A large portion of the study area can be classified as scrub/shrub habitat. These sites, previous to flood protection, were part of a freshwater marsh system characterized by maidencane, cattail, alligatorweed, bulltongue, buttonbush, and Louisiana blue iris. As this community was removed from Lake Cataouatche's tidal influence, drained, and heavily burned, severe Chinese tallow and roseau cane invasion occurred.

Emergent and aquatic vegetation has been replaced by Chinese tallow, giant ragweed, thistle, elderberry, and Rubus sp., growing in association with roseau cane, goldenrod, and black willow. Smartweed persists in the understory, evidence that the site stills holds water during wet periods. Small areas within this habitat have actually begun to subside and currently remain wet. These sites are characterized by maidencane, Iva annua, Baccharis halimifolia, and roseau cane.

Valuable wildlife habitat was reduced by the altered hydrology of the area and further damaged by the introduction of cattle and feral hogs. Mammalian species expected to occur in this habitat type include white-tailed deer, raccoon, Virginia opossum, nine-banded armadillo, and rabbit, as well as various species of small mammals. Avian species include black and turkey vultures, northern harrier, red-tailed hawk, American kestrel, mourning dove, eastern meadowlark, cattle egret, common grackle, and killdeer. Reptiles and amphibians present include eastern box turtles, rat snakes, and ground skinks.

Developed. Developed areas include roads and levees and residential and commercial sites. Levees within the study area are planted with bermudagrass and are mowed. American kestrels, mourning doves, eastern meadowlarks, black and turkey vultures, and killdeer are known to use these levees. Nine-banded armadillos, Virginia opossums, rabbits, and various species of small mammals are likewise expected to frequent this habitat type.

A portion of the drained freshwater marsh within the Lake Cataouatche levee system has been developed into a sanitary landfill, (see Plate 2). This site is heavily used by large numbers of gulls, crows, and other species of blackbirds.

Riverine. Riverine sites of the study area consist of borrow, drainage, and access canals. These aquatic habitats lack extensive vegetative growth. Water hyacinth, duckweed, and bulltongue can be found growing in sections of the canals. Pumping keeps water levels abnormally contributing to poor water quality (see Water Quality page 12). Fish species expected in this habitat include spotted gar, mosquitofish, killifish, sunfishes, blue catfish, yellow bullhead, and redfin shad. Non-native nutria use the canals and canal banks to feed, travel, and den. Mink and raccoons likewise may forage along the canal banks, as do various species of wading birds.

Endangered and Threatened Species. The only Federally-listed Endangered/Threatened species resident in the general study area is the bald eagle. However, given the habitat available, it is highly unlikely that these birds would utilize the site. American alligators, listed as Threatened under the Similarity of Appearance clause of the Endangered Species Act, may be found in the canals of the study site. Transient species would include the Arctic peregrine falcon (Threatened) and Bachman's warbler (Endangered). Due to reduced habitat quality, however, it is highly unlikely that these birds would use the study area.

CULTURAL RESOURCES

The Lake Cataouatche Levee study area is situated in the Barataria Interlobe Basin portion of the Mississippi Deltaic Plain. The basin formed about 3000 years before present (B.P.) with the progradation of the Lafourche Delta Complex and with the later development of the Plaquemine deltaic complex. This basin provided a rich source of subsistence resources for the prehistoric inhabitants of the area.

Prehistoric sites in the region date from the Tchula Period (250 B.C. to A.D. 0). The adaptive strategy developed during the Tchula Period was maintained by subsequent populations. Prehistoric sites located within the region vary from residential sites to extraction locales. Habitation sites normally occur in linear patterns along the crests of natural levees. Extraction locales were located in proximity to exploitable resources. The major residential site complexes are strategically situated at the confluence of distributary channels with the trunk channel of deltaic complexes. This distribution pattern of major residential sites has been documented for Marksville, Coles Creek, Troyville, and Mississippian sites within the Barataria Basin.

Historically, agricultural and urban developments were dependent on the amount of dry acreage in the study region. Flood control projects and levee construction opened more area for development and wetlands were utilized for the extraction of natural resources. Historic land use of the region focused along the main trunk of the Mississippi River; logging and the raising of livestock were suitable to areas where high water was a threat.

A review of previous investigations and records indicated that no National Register sites, archeological sites or other cultural resources were located within the study area. A portion of the project area considered to possess a potential for containing archeological sites includes the natural levee ridge system of Bayou Segnette. The remainder of the study area has a potential for containing evidence of prehistoric and historic extraction locales.

RECREATIONAL RESOURCES

Bayou Segnette State Park is located in the southeast corner of the study area, (see Plate 2). It is a 580-acre facility which offers 100 improved campsites, 20 fully furnished waterside vacation cabins, a 120 person capacity group camp, a large picnic area with rental pavilions, hiking trails and a 12 lane boat launch. Its proximity to metropolitan New Orleans, and its boating access to Lake Cataouatche, Lake Salvador, the Barataria Waterway and the Gulf of Mexico, the state park is heavily used by campers, fisherman, hunters, and outdoor enthusiasts. Annual park visitation exceeds 160,000 users.

Other recreational attractions in the area, accessible from the state park, are the Barataria Unit of Jean Lafitte National Historic Park, Lake Salvador Wildlife Management Area, and the myriad of lakes and bayous which support some of the best fresh water and salt water fishing in the region. Seasonal hunting throughout the study area includes big game, small game and waterfowl.

The remaining portion of the study area west of the state park is privately owned and is used for private hunting purposes.

Approximately 1.4 miles of the eastern portion of the existing Lake Cataouatche levee is inside the southeastern boundary of the Bayou Segnette State Park where the levee adjoins the Bayou Segnette Pumping Station. The 550 foot levee easement through the park was acquired prior to the parks existence to provide protection from hurricane surge flooding. The existing park roadway parallels and crosses the existing levee providing ingress and egress to the boat ramp, the vacation cabins, and the pump station.

FUTURE CONDITIONS WITHOUT PROJECT

The most probable future condition if no Federal action is taken are determined by projecting conditions that would prevail in the study area over the planning period, 1995 to 2095. All authorized projects adjacent to the study area are considered to be in place (i.e., the Westwego to Harvey hurricane protection) and all existing projects are maintained.

CLIMATOLOGY/HYDROLOGY

Sea Level Rise. The climate, water, and land resources of the study area are significantly influenced by the Gulf of Mexico. The gulf is also influenced by the global rise in sea level caused by global warming which results in thermal expansion of water and the melting of glaciers. The historical rate of sea level rise is estimated at 0.46 foot per century.

Water Quality. Water quality in the study area is expected to change little. Urban development would increase the quantity of water with urban quality characteristics. This would be offset by future improvements in urban runoff quality control and by infrastructure improvements. The fresh water regime would be less stable and more subject to abrupt changes.

HURRICANE PROTECTION AND DRAINAGE

Based on the current economic trends and the maintenance practices of the local levee district and drainage department it appears that the condition of the area will not improve significantly.

Development is projected to continue in the area as it is one of the last protected lands still available for construction of single family residences. As development occurs, drainage capacity will be increased to meet the new runoff demand. Since the development will decrease the available storage area, larger pumps will be added and the drainage canals will be pumped to lower elevations to compensate for the lost storage.

This additional pumping capacity would increase the frequency of levee maintenance by lowering the stage of the interior drainage canals, creating a less stable levee foundation. This increased maintenance would prove troublesome for the levee district from a financial standpoint. More importantly, protection for future development will require increased levee elevation which will require significant changes to original levee design. This requirement is beyond the financial capabilities of the local interests.

ECONOMIC RESOURCES

Economy. Economic growth is expected to continue due to activities related to domestic and foreign trade, fish and wildlife, recreation, and tourism. Employment in services, trade and manufacturing is projected to increase, while employment in mineral production exploration will decline. Activities associated with the fish and wildlife resources are expected to decline as a result of habitat losses.

Population and Growth. Projected population growth and changes to existing land use under without-project conditions are detailed in the Economic Appendix, Indirect Impacts. Briefly, population was assumed to increase at an annual rate of 0.56 percent over the project life, from 1995 to 2095. The approximate census estimate of persons per household in Jefferson Parish in 1990 was 2.70. Additional residential development would require approximately 0.2238 acres per housing unit, with an additional amount of land representing 20 percent needed for servitudes, public and quasi-public purposes, etc., and another additional amount of land, also representing 20 percent of the amount needed for residential purposes, needed for institutional and commercial purposes.

(NOTE: These estimates are based on Herbert/Smolkin's (see Economic Appendix, Indirect Impacts) assumption that almost 80 percent of the future housing demand will be for single-family units and that more than 95 percent of additional residential land will be used for developing single-family units, from 1988 to 2012. In our opinion, these assumptions reflect the optimistic range of probabilities.)

ENVIRONMENTAL RESOURCES

Under most probable future conditions, residential and commercial development would continue at the projected annual future-without-project rate of 0.56 percent. Habitats likely to be initially developed are those currently located near established roads, including wooded swamp and/or bottomland hardwood forest adjacent to the new Nicole Boulevard Extension and U.S. Highway 90. Bottomland hardwood sites adjacent to existing subdivisions will also potentially be developed. Portions of the undeveloped area are subject to the regulatory jurisdiction of the U.S. Army Corps of Engineers under authority of Section 404 of the Clean Water Act of 1972 as amended due to their wetland characteristics and would require Corps approval prior to development. A decline in fish and wildlife resources would correspond with any reduction in wildlife habitat and/or water quality resulting from development.

Land Loss. The sea level rise between the years 1995 and 2095 is predicted to be 0.46 foot. Given the mild slope of the terrain, and lacking any sediment input to facilitate marsh creation, vast areas of marsh between the study area and the gulf would be converted to open water. With higher gulf stages, the line delineating fresh from saline influenced marshes would move further north.

RECREATIONAL RESOURCES

Decreasing accessibility to the marsh areas due to development enhances the value of such areas as the Bayou Segnette State Park. The use of the park will also increase with the increase in population of the metropolitan area it now serves. Although the need is evident, there are no indications at this time that future expansion of the park has been planned for.

The remaining study area west of the state park will probably be developed following the same trends of past and present (i.e., expansion away from the river). With this development, the recreational potential of the area will decline as the resource base declines.

The levee in the state park will probably be maintained to a greater degree than that portion outside the state park mostly due to need for better aesthetics. However, this increased maintenance will help maintain the levee integrity.

PROBLEMS, NEEDS, AND OPPORTUNITIES

Residential and commercial development in the Lake Cataouatche area is subject to flooding from hurricane surges. In the development of plans to address the problems and needs related to hurricane flooding, there is an opportunity to save construction costs for the Westwego to Harvey Canal hurricane protection project by tying into the project protection, thereby eliminating a costly portion of the project. These problems, needs, and opportunities, along with the desires of local interests, are discussed below.

PROBLEMS AND NEEDS RELATED TO HURRICANE FLOODING

Land in the Lake Cataouatche study area ranges in elevation from approximately 1 foot below NGVD in the southern area near the Lake Cataouatche levee to approximately 10 feet near the Mississippi River. House elevations begin at minus 0.5 feet NGVD in the Avondale area, located south of U.S. Highway 90. Surges generated by hurricanes are estimated to produce stages along the southern (unprotected) side of the Lake Cataouatche levee of 3.9 feet NGVD for a hurricane of a magnitude expected to return on the average every 10 years (a 10-year hurricane), 4.8 feet NGVD for a 25-year hurricane, 5.5 feet NGVD for a 50-year hurricane, 6.0 feet NGVD for a 100-year hurricane, and 7.5 feet NGVD for an standard project hurricane, which has an average return frequency of greater than 200 years.

The Lake Cataouatche hurricane protection levee, which is shown on plate 2, provides partial protection for the residential and commercial development in the study area. The crown elevation of the levee ranges from 5.5 to 12 feet, NGVD. This levee ties into the Westwego to Harvey Canal hurricane protection project on the east and, on the west, to the U. S. Highway 90 embankment, which has an elevation of approximately 5 feet NGVD. The Lake Cataouatche levee was constructed by the Lafourche Basin Levee District in the 1960's. The levee is flanked on each side by drainage and borrow canals and is founded on material of high organic content. The crown of the levee has been raised above its original design elevation; however, the berm has not been widened due to the restrictions imposed by the canals on either side. As a result of the burden of the added height and poor foundation conditions, the levee is not structurally sound. Subsidence is a continuing problem, and there has been at least one major slope failure. It is estimated that the levee would fail due to the high differential water elevations that would be caused by the 100-year hurricane.

Failure of the Lake Cataouatche levee during the 100-year or greater hurricane would flood the extensive development in the study area. The limits of overflow for the 100-year and

SPH hurricanes are shown on plate 11. Approximately 2,400 structures would be flooded during the 100-year hurricane and 4,000 during the SPH hurricane. Average annual damages in the study area are estimated at $8,997,000.

OPPORTUNITIES TO REDUCE COST OF WESTWEGO TO HARVEY CANAL PROJECT

Any structural plans developed for improving hurricane protection for the Lake Cataouatche area would include barriers to hurricane surges, that is, levees or floodwalls, that would either be complete loops or tie into other natural or manmade barriers. The line of protection for the Westwego to Harvey Canal at Bayou Segnette project then extends northward across the four-lane Westbank Expressway for approximately 0.5 miles, where it ties into relatively high ground at an elevation 5 feet NGVD. The Westwego to Harvey Canal project includes ramping the Westbank Expressway and approximately 1.1 miles of levees and floodwalls. The total cost of these features is estimated at $5,300,000. They are currently scheduled for construction in 1997. These features are necessary for the SPH level of protection provided by the Westwego to Harvey Canal project to prevent hurricane flooding from the Lake Cataouatche area. In the development of hurricane protection plans for the Lake Cataouatche area, there is an opportunity to tie the proposed line of protection into the Westwego to Harvey Canal project to achieve a savings in construction cost of that project.

IMPROVEMENTS DESIRED

It is the desire of the West Jefferson Levee District and Jefferson Parish to have a Federal project to provide hurricane protection for the study area. The desire for improvements in the study area stems from the natural growth of development on the west bank of the Mississippi River opposite New Orleans that has resulted in the extension of development into lands more vulnerable to flooding from storm tides and local rainfall.

Hurricane Betsy was the impetus for the congressional resolutions that provided authorization for this study. More recently, Hurricane Juan inflicted severe damage on certain portions of the west bank area punctuating the need for an expeditious resolution to the areas hurricane vulnerability. Public officials and residents fear a hurricane on a critical path to their area and desire protection comparable to that provided to the east bank under the Lake Pontchartrain, Louisiana, and Vicinity Hurricane Protection project that was authorized in 1965 which is currently under construction.

PLAN FORMULATION

PLANNING OBJECTIVES

The following planning objectives were established to be responsive to the identified problems, needs, and opportunities:

Provide adequate hurricane protection for the west bank of the Mississippi River in the vicinity of New Orleans from Bayou Segnette at Westwego to the St. Charles Parish line.

Minimize adverse impacts on the natural environment and social well-being.

PLANNING CONSTRAINTS

This study was conducted within the constraints of the Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies, published in March 1983 by the U.S. Water Resources Council, and by applicable Department of Army regulations and other documents which provide guidance on the implementation of these principles and guidelines.

In this study only measures to increase the level of protection from hurricane storm surge flooding and rainfall associated with hurricanes were considered.

PLAN FORMULATION RATIONALE

In the development of plans for addressing the problems and needs relative to hurricane flooding in the study area, structural and non-structural alternatives were considered. Non-structural alternatives were limited to raising existing structures within the protected area to an elevation above the damaging flood stages. These alternatives were not practical since most of the structures are pile founded slab-on-grade construction. Alterations of the foundation of such structures is difficult and expensive. Structural alternatives were limited to barriers to hurricane surges, such as levees and floodwalls.

ALIGNMENTS FOR STRUCTURAL PLANS

Two alternative alignments for hurricane surge barriers were developed, one generally following the alignment of the existing Lake Cataouatche levee, which is referred to as the Plan 1, or the exterior, alignment. The Plan 1 alignment is shown on Plate 3. The Plan 1 alignment would require less additional rights-of-way than a new alignment and would not require the modification of existing drainage facilities. The Plan 1 alignment is also preferred by the West Jefferson Levee District and Jefferson Parish. One major disadvantage of the plan was that raising the existing levee would be costly because one of the canals would have to be filled in to obtain a stable levee cross-section. Another disadvantage of the Plan 1 alignment was that the existing levee enclosed a large undeveloped area comprised primarily of wetlands, and the potential for induced development, and the associated adverse environmental impacts, with this alignment was relatively high.

The other alignment was developed to determine if a less costly plan and/or a plan with less adverse environmental impacts could be achieved. This alignment, referred to as Plan 2, or the interior alignment, followed existing drainage canals to minimize disruptions to drainage facilities. The Plan 2 alignment is shown on Plate 6. This alignment enclosed essentially all developed land in the study area. One advantage of the Plan 2 alignment is that, because of the wooded area between the two alignments, the fetch for producing wave run-up was reduced, and the height of the levee would be lower than the Plan 1 alignment. With the Plan 2 alignment, either guide levees would have to be constructed between the Plan 2 alignment and the Lake Cataouatche pumping station or a new pumping station would have to be constructed. The guide levees were found to be significantly less costly than an additional pumping station. These alternative plans are shown on Plate 6.

Levels of Protection for Structural Plans. Due to the structural instability of the Lake Cataouatche levee, development in the study area is subject to flooding from hurricane surges having a return frequency of 100-years or greater. Therefore, two levels of protection were considered, a 100-year level of protection and an SPH level of protection.

Alternative Designs for Structural Plans. Two alternative designs were considered for each combination of alignment and level of protection; an earthen levee and a levee/floodwall combination. An earthen levee is usually less costly if foundations conditions are satisfactory and suitable borrow is available at a reasonable cost. Earthen levees are generally preferable to floodwalls for aesthetic and environmental reasons. Floodwalls are generally higher in elevation as wave run-up is higher without an high earthen berm. Floodwalls obstruct views and serve as barriers to the movements of people and wildlife. Due to the poor foundation conditions, especially along the Plan 1 alignment where the existing Lake Cataouatche levee is flanked by canals, designs consisting of a levee/floodwall combination were developed for each alignment and level of protection. Floodwalls can also be constructed faster in areas where foundations conditions are poor because levees must be constructed in lifts and allowed to settle between lifts, sometimes increasing the cost of interest during construction.

Eight alternative plans were developed from the combinations of two alignments, two levels of protection, and two types of designs. The plans are as follow:

	Alignment	Level of Protection	Design
Plan 1a	Exterior	SPH	Levee (Plate 4)
Plan 1b	Exterior	100-Year	Levee (Plate 4)
Plan 1c	Exterior	SPH	Levee/Floodwall (Plate 5)
Plan 1d	Exterior	100-Year	Levee/Floodwall (Plate 5)
Plan 2a	Interior	SPH	Levee (Plate 7)
Plan 2b	Interior	100-Year	Levee (Plate 7)
Plan 2c	Interior	SPH	Levee/Floodwall (Plate 8)
Plan 2d	Interior	100-Year	Levee/Floodwall (Plate 8)

A summary of the estimates of the first costs for each plan is presented in Table 6. These costs include the costs of construction; lands, easements, and rights-of-way; relocations; and fish and wildlife mitigation. Operation, maintenance, and rehabilitation costs for each of the plans would be similar. These plans are grouped by 100-year and SPH levels of protection for comparison purposes. As each of the plans that provide a SPH level of protection would have approximately the same economic benefits, and each of the plans that provide a 100-year level of protection would have the same benefits, the plans were screened based on first costs. Plans 1c and 1d were selected for further evaluation.

TABLE 6

COMPARISON OF CONSTRUCTION COST, DOLLARS[1]

SPH LEVEL OF PROTECTION PLANS

PLAN	LEVEE/WALL	REAL ESTATE	MITIGATION	TOTAL
PLAN 1a	50,700,000	100,000	197,300	50,997,300
PLAN 1c	19,000,000	6,000	167,000	19,173,000
PLAN 2a	19,000,000	4,306,000	306,800	23,612,800
PLAN 2c	21,000,000	4,300,000	90,500	25,390,500

100-YEAR LEVEL OF PROTECTION PLANS

PLAN	LEVEE/WALL	REAL ESTATE	MITIGATION	TOTAL
PLAN 1b	39,800,000	93,000	197,300	40,090,300
PLAN 1d	13,000,000	6,000	167,000	13,173,000
PLAN 2b	15,500,000	4,306,000	306,800	20,112,800
PLAN 2d	17,000,000	4,300,000	90,500	21,390,500

[1]Detailed cost estimates are provided in Appendix E.

PLANS EVALUATED FURTHER

The costs, benefits and environmental social impacts of Plans 1c and 1d are discussed in greater detail below.

PLAN 1c - Exterior Alignment/SPH Protection/Levee-Floodwall. Plan 1c utilizes the existing levee rights-of-way from the Bayou Segnette pump station to Hwy 90 on the western end of the levee traverse. New levee rights-of-way are required for the levee closures on both sides of the traverse.

For this alternative the existing levee crown would be degraded to elevation 5.5 feet NGVD and set back away from the unprotected side borrow canal for stability. The unprotected side slope would be graded to have a 1 vertical on 15 horizontal to facilitate wave dissipation. Sheetpile would be driven to have a top elevation of 10.5 feet NGVD to meet the predicted wind tide level (WTL) plus wave runup. The sheetpile would have a 3 to 1 penetration to stick-up ratio to offset overturning forces, (see Plate 5). Where the fetch is limited (i.e., areas of the levee not directly fronting Lake Cataouatche) the top elevation of the sheetpile would be transitioned down about 0.5 foot, (see Plate 9 for transition zones).

The east highway crossing proposed in the Westwego to Harvey Canal project would be eliminated since the east tie-in would be south of the Westbank Expressway. The west closure would cross U.S. Highway 90, which would be ramped over the levee, and continue north within the South Kenner Road right-of-way, (See Plate 3). The roadway would be raised in place approximately 2 feet to elevation 6 feet NGVD. Since the road passes between two landfills a hazardous and toxic waste survey would be required during feasibility study. A short reach, approximately 1,600 feet, of floodwall would be constructed from the Bayou Segnette pump station to the Westwego to Harvey Canal line of protection (see Plate 3). The elevation of this floodwall would transition from the top elevation of the Lake Cataouatche levee to that of the Westwego to Harvey Canal project (the project crown elevation is 9.5).

PLAN 1d Exterior Alignment/100-YrProtection/Levee-Floodwall
This alternative is similar to that of the above alternative except in the level of protection. The levee traverse is the same and the only difference is in the levee configuration.

For this alternative the existing levee crown would also be degraded to elevation 5.5 feet NGVD and set back for stability. The unprotected side slope however, would be graded to have a 1 vertical on 22 horizontal to facilitate wave dissipation. Sheetpile would be driven to have top elevation of 8.5 feet NGVD to meet the predicted Wind Tide Level (WTL) plus wave runup. The sheetpile would have the same penetration to stick-up ratio to offset overturning forces, (see Plate 5). Again, where the fetch is limited (i.e., areas of the levee not directly fronting Lake Cataouatche) the top elevation of the sheetpile would be transitioned down about 0.5 foot, (see Plate 9 for transition zones).

Both closures would be the same except the west closure would be lower having a 5 feet NGVD crown elevation. The east closure would also transition to the authorized project.

ENGINEERING ANALYSES

Hydraulic Analyses. Hurricane design stages and frequencies near the Lake Cataouatche levee were calculated utilizing methods developed by the U.S. Weather Bureau. Based on these calculations the SPH and 100 year hurricane event would produce still water elevations averaging 7.5 and 6.0 feet NGVD respectively at the Lake Cataouatche levee. Maximum wave runup for hurricane winds were calculated using the

Automated Coastal Engineering System (ACES) computer program. (See appendix A for hydraulic investigation details.)

Embankment Design. The design cross-sections presented on Plate 5 were selected as the best for the project area. This design is an all earthen levee up to 5.5 ft NGVD with a sheet pile wall to the required height of the specific design hurricane (i.e.,. 8.5 for the 100-yr storm and 10.5 for the SPH storm.) Foreshore protection is not required along the toe of the levee, since the existing levee will not be disturbed and it has currently reached equilibrium with the normal wave environment. Foreshore protection may be required at some time in the future if Lake Cataouatche encroaches upon the levee.

Heights of the proposed protective work along Bayou Segnette, the north-south portion of the levee west of the Lake Cataouatche pump station, and South Kenner Road, which are subject to only minor wave activity generated by boat traffic or winds across a limited fetch during several hours of superelevated wind tide levels, were designed to include freeboard allowances above the still water level. The height of the remaining levee was designed to prevent overtopping from waves generated in Lake Cataouatche by the design hurricane,(See Plate 9).

Since the authorized Westwego to Harvey Canal Hurricane Protection system provides SPH level of protection, analysis of end around flooding caused by overtopping of those alternatives which provided 100-year level of protection to the Lake Cataouatche area was preformed. It was determined that the overtopping rate for an SPH storm with a 100 year level of protection for the Lake Cataouatche area did not produce a volume of water sufficient to increase stages inside the levee system to generate end around flooding. Therefore the integrity of the level of protection provided by the authorized Westwego to Harvey Canal Hurricane Protection project would not be jeopardized.

Water Quality With Project. Plans 1c and 1d would have little effect on water quality since the existing borrow pits and canals would not be altered. Normal hydrologic conditions would not be changed. This would improve water quality of the area by providing a more stable fresh water regime, less subject to abrupt changes. Induced urban development due to greater hurricane protection would increase the quantity of water with urban quality characteristics. This would be offset by future improvements in urban runoff quality control and by infrastructure improvements.

There would be some water quality impacts associated with the construction phase of the project. Although there are no plans to alter the borrow pits and canals, during excavation activities, soil would enter them through erosion of the material exposed during degrading of the levee. This erosion would cause an increase in turbidity and suspended solids levels in the surrounding canals and borrow pits. This condition would be temporary and would cease when new vegetation becomes established on the degraded levee.

Structural Features. The existing unstable earthen levee, constructed by local authorities, will be degraded to elevation 5.5 feet NGVD and an uncapped steel sheet pile wall, with a net grade of 8.5 feet NGVD will be constructed on the levee crown to provide the 100 year level of protection. At locations which are not subject to wave action, see plate 9, the net grade will transition from El. 8.5 to El. 8.0 by lowering the top of the sheetpile thereby reducing the required amount of penetration. Allowances will be made in the design of the levee and steel sheet pile wall to account for settlement. Also, the sheet piling will be coated with coal-tar epoxy from the top of the pile to a point 2 feet below the water table to prevent corrosion.

The excess material excavated from the existing levee will be stockpiled near the levees for easy access. This material will be used as a source of borrow for the adjacent Westwego to Harvey Canal Hurricane Protection Project. The Lake Cataouatche Levee project will be credited for the cost of this material.

Fronting Protection at Bayou Segnette Pump Station. Foundation conditions at the Bayou Segnette pump station require an inverted T-wall in front of the pump station. The discharge pipes of the pump station will be sleeved through the wall and butterfly valves installed on the lines to provide positive closures.

Vehicular Gates. Two swing gates, with 30 feet clear openings will be constructed on the levee at the existing Bayou Segnette State Park. The gates will provide access to the existing boat launch facilities of the park. The gates will consist of pile supported reinforced concrete monoliths with structural steel swing gates. These gates will be open except during impending hurricanes.

Pedestrian Gates. Two pedestrian gates will be constructed in the vicinity of the existing pumping stations (Bayou Segnette and Lake Cataouatche pump stations). The gates will provide access for maintenance and operation of the pump stations.

Wildlife Crossings. Wildlife crossing will be constructed at approximately 1/2 mile intervals. These crossings will be either ramps over the I-wall or swing gates. Coordination with the resource agencies will determine the type crossing to be utilized.

Utility And Pipeline Crossing. The existing utilities and pipelines crossing the levee will be relocated using the standard utility crossing details developed by the New Orleans District.

South Kenner Road. The west closure for the study area, South Kenner Road, passes between two landfills. Borings will be taken during the feasibility phase of study to determine the disposition of the roadbed material with respect to hazardous and toxic waste.

SUMMARY OF ECONOMIC ANALYSES

The economic justification of the plans given detailed consideration was determined by comparing estimates of the average annual costs and average annual benefits which are expected to accrue over the life of the project. Participation in a project by the Federal Government normally requires that average annual benefits equal or exceed average annual costs.

The values estimated for benefits and costs at the time of accrual were made comparable by conversion to an equivalent time basis using a designated interest rate. The interest rate used in this analysis is 8-1/2 percent. The period of analysis, or project life, utilized in the analysis was 100 years. The benefits and costs are expressed as the average annual value of the present worth of all expenditures and all plan outputs. These expenditures and outputs are measured at a specific point in time (base year). The base year is the year in which the project becomes operational or when significant benefits start to accrue. The construction period for this project is 2 years.

With the project in place, estimated damages would be limited to the effects of rainfall and wave overtopping from storms greater than a 100-year storm event. The total benefits of the project include the benefits anticipated over the 100-year project life after project completion.

The benefits of each plan were matched with the costs of each plan to determine the benefit-cost ratio of 1.2 to 1 for plan 1d (100-yr protection) and 0.96 to 1 for plan 1c (SPH protection) as displayed in Table 7. More detailed information on economic analyses are contained in Appendix B.

TABLE 7

BENEFIT-COST SUMMARY

	PLAN 1d	PLAN 1c
First Costs Construction	$ 13,000,000	$ 19,000,000
Real Estate Costs	6,000	6,000
Mitigation Costs	167,000	167,000
Total First Costs	$ 13,173,000	$ 19,173,000
Interest During Construction	1,131,500	1,647,000
Gross Investment	$ 14,304,500	$ 20,820,000
Average Annual Costs		
Interest & Amortization (0.08502)	$ 1,216,000	$ 1,770,000
Operation and Maintenance	22,000	24,000
Total Average Annual Costs	$ 1,238,000	$ 1,794,000
Average Annual Benefits		
Inundation Reduction	$ 1,022,000	$ 1,210,000
FIA Costs Saved	56,000	56,000
Emergency & Reoccupation	75,000	84,000
Savings to Construction ($ 4,260,000)		
Gross Investment ($ 4,437,000)		
Interest & Amortization (0.08502)	377,000	377,000
Total Average Annual Benefits	$ 1,530,000	$ 1,727,000
Benefit-Cost Ratios	1.2 to 1	.96 to 1
Net Benefits	$ 292,000	($ 67,000)

ENVIRONMENTAL IMPACTS OF PLANS

Biological. Below is a description of environmental impacts associated with Plans 1c and 1d alternatives. Impacts were assessed for the 100-year level of protection. Environmental impacts associated with the SPH level of protection were not significantly different from those relative to 100-year level of protection. Environmental impacts include the destruction of habitat due to levee construction and induced residential and commercial development.

The significant habitat types within the study area are 5050 acres of wet bottomland hardwood, 1150 acres of non-wet bottomland hardwood, 800 acres of wooded swamp, 4600 acres of wet scrub/shrub, 250 non-wet scrub/shrub.

The construction of a sheetpile levee along the exterior alignment would directly impact 14 acres of bottomland hardwood and 34 acres of scrub/shrub habitat. The majority of the impacts would occur along South Kenner Road if it is determined that the roadbed is unsuitable for construction. This is the worst case situation. Wildlife access gates or ramps would be installed in the sheetpile levee at 0.5 mile intervals.

Indirect impacts to habitat due to induced development is projected to adversely affect 330 acres more than that of future-without-project conditions over the 100-year project life. The specific habitat losses are 172 acres of bottomland hardwood, 23 acres of wooded swamp, and 135 acres of scrub/shrub.

Endangered Species. There are no Federally or state-listed threatened or endangered species in the study area which would be affected by levee construction. American alligators, listed as Threatened under the Similarity of Appearance clause of the Endangered Species Act, may occur in drainage and borrow canals of the study area.

Mitigation of Fish and Wildlife Impacts. The following section contains a preliminary estimate of mitigation features that will likely be required for construction of plans evaluated in this study. An estimate of mitigation costs is provided for Plans 1c and 1d. Most of the areas impacted by the alternatives evaluated are potentially wetlands under U.S. Army Corps of Engineers jurisdiction. These habitats include bottomland hardwood, wooded swamp (drained), and scrub/shrub.

Mitigation could be accomplished by the acquisition and management of additional lands. Mitigation by avoidance and minimization would be performed during the Feasibility Stage of study development. A preliminary mitigation analysis was performed based on direct impacts and induced development. Development under future-without-project conditions was projected to occur at an annual rate of 0.56%, while development under future-with-project conditions was projected to occur at an annual rate of 0.61%. Mitigation plans consisted of the purchase of degraded habitats and passive or active management of the area, as necessary. Specific locations were not identified, but sufficient lands exist adjacent and/or near to state property such that these areas could be incorporated into public lands. For bottomland hardwood and scrub/shrub habitat, previously impacted lands would be purchased and planted with mastproducing vegetation. An appropriate conversion was applied to scrub/shrub habitat mitigated with bottomland hardwoods. For drained wooded swamp, the area would be purchased and passively managed. The first costs for mitigation of these plans are $167,000.

CULTURAL IMPACTS

Plans utilizing the existing levee rights-of-way will have little or no impact to archeological sites or cultural resources in the area. Any intact cultural deposits within the study area would have been impacted by previous levee construction. Plans which include areas located outside of the existing levee right-of-way may require additional investigations.

RECREATIONAL IMPACTS

Direct construction impacts to recreation resources outside the state park will be minimal. The higher degree of protection provided by the project may induce clearing and development on land that is presently wooded and used for private hunting purposes, thus reducing its potential value for recreation and wildlife.

Recreational Resources Mitigation. Project construction within Bayou Segnette State Park will be closely coordinated with the Louisiana Office of State Parks. Initial discussions with that office have resulted in recommendations that will be considered during the feasibility studies and construction phases of the project. These recommendations are as follows:

1. Provide sliding gates in the levee at roadway crossings within the park.

2. Provide aesthetic treatment of the sheetpile wall to improve visual resource.

3. Raise the boat ramp parking lot and provide an earthen levee at this location in lieu of a sheetpile wall.

4. Construct the portion of the project through the state park during the off season.

5. Minimize impact to existing paved roadway.

6. Consider acquiring mitigation lands adjacent to the state park and annexing them to the state park for public recreational use.

SUMMARY OF PLAN FORMULATION

The 100-year level of protection sheetpile wall/earth levee is engineeringly feasible, least costly, and utilizes the alignment favored by local interests. The total project cost including construction cost, mitigation cost, and real estate is $13,173,000. The Lake Cataouatche levee will also eliminate the need for the westside closure of the Westwego to Harvey Canal Hurricane Protection Project thereby saving the average annual cost for that portion of the levee. In addition to this benefit, the benefit of stockpiled material from the degraded Lake Cataouatche levee could be used for the construction of the Westwego to Harvey Canal project. The first cost of this saving is $4,260,000 which translates to an average annual benefit of $377,000.

SUMMARY OF PUBLIC INVOLVEMENT

Jefferson Parish in conjunction with the West Jefferson Levee District requested that Congress provide funding to study the feasibility of adding hurricane surge protection to the Lake Cataouatche area located just west of the the authorized Westwego to Harvey Canal Project. This aggressive pursuit of funding for the study resulted in Congress including funds in the fiscal year 1991 Appropriations Act to accomplish the study.

The reconnaissance study was initiated with a public notice dated April 8, 1991. The tentative alternative plans were presented to Parish and State agencies at a meeting at the West Jefferson Levee District office on April 23, 1991, to obtain input to the development of plans. The State Department of Wildlife and Fisheries responded to our request for assistance in identifying threatened and endangered species by letter dated 14 May 1991. The U.S. Fish and Wildlife Service provided a planning-aid report in February 1992. Other state and federal agencies have been involved in the plan development throughout the study.

PRELIMINARY FINANCIAL ANALYSIS

The local sponsor will be required to cost share in both the feasibility study and in construction of the project. Several sources of revenue are available to the local sponsor. These sources include state revenue sharing, special state grants, local ad valorem taxes, interest income, oil and gas royalities, and bond proceeds. Any combination of these sources could be used to provide the required share as a local sponsor.

CONCLUSIONS

Analysis of the national economic development benefits associated with the plans presented herein indicates that there is a Federal interest in continuing the study into the feasibility phase. One potentially feasible plan to provide hurricane surge protection for the study under Federal criteria has been identified.

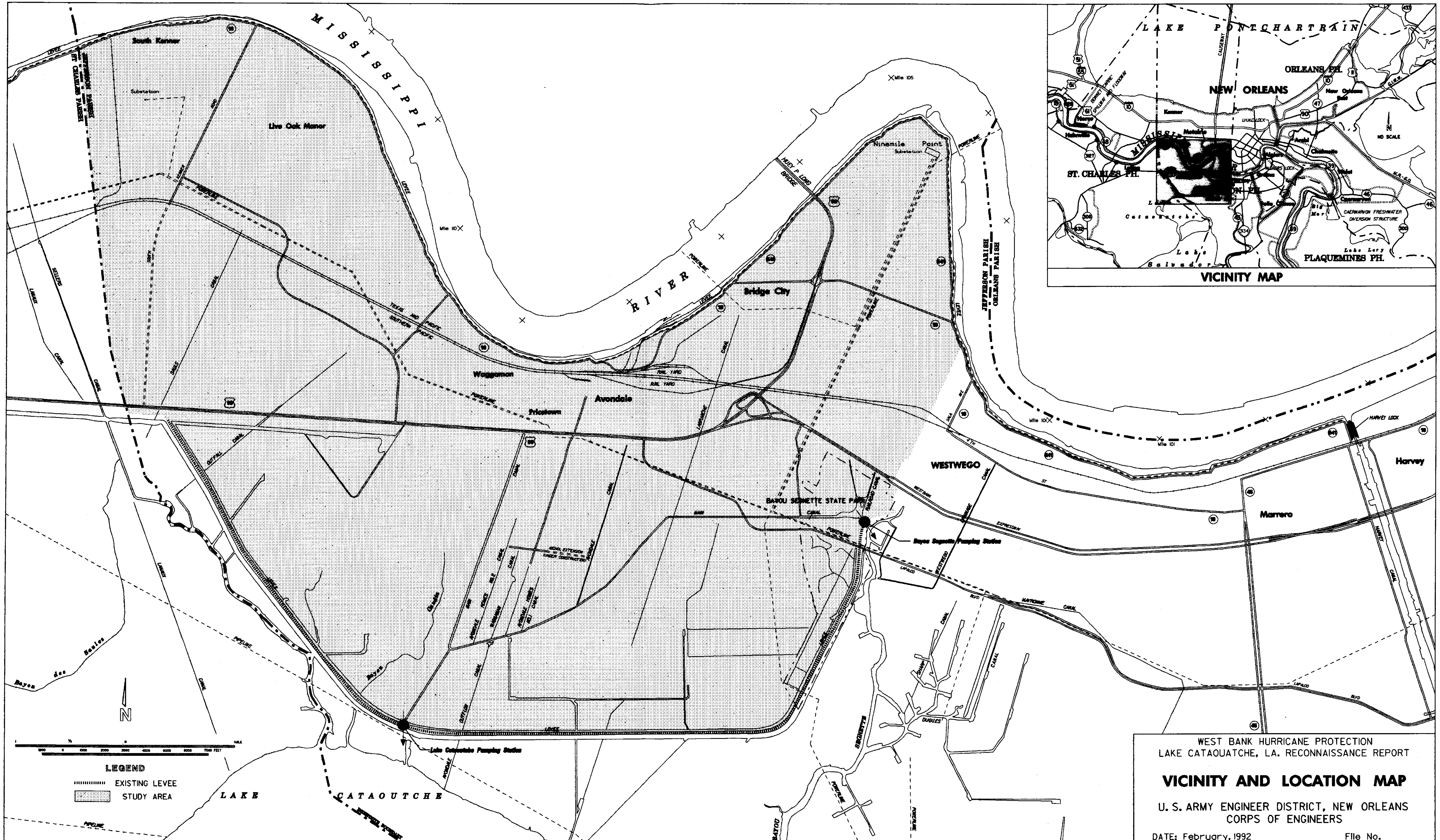
The costs and benefits associated with the most economical plan, Plan 1d, are, $13,173,000 first cost, $1,238,000 average annual costs, and $1,530,000 average annual benefits. The benefit/cost ratio for this plan is 1.2.

Continuation into the feasibility phase will be advisable if the non-federal sponsor agrees to share the cost of the feasibility study. The West Jefferson Levee District in a letter dated March 9, 1992, indicated its intent to participate as the local sponsor, (see Appendix G).

RECOMMENDATIONS

Based on the findings presented in this reconnaissance report, I recommend that the Lake Cataouatche, Louisiana, hurricane protection study proceed into the feasibility phase, contingent upon the execution of a feasibility cost-sharing agreement with a local sponsor.

for James V Hall LTC, EN
MICHAEL DIFFLEY
Colonel, U. S. Army Acting DE
District Engineer



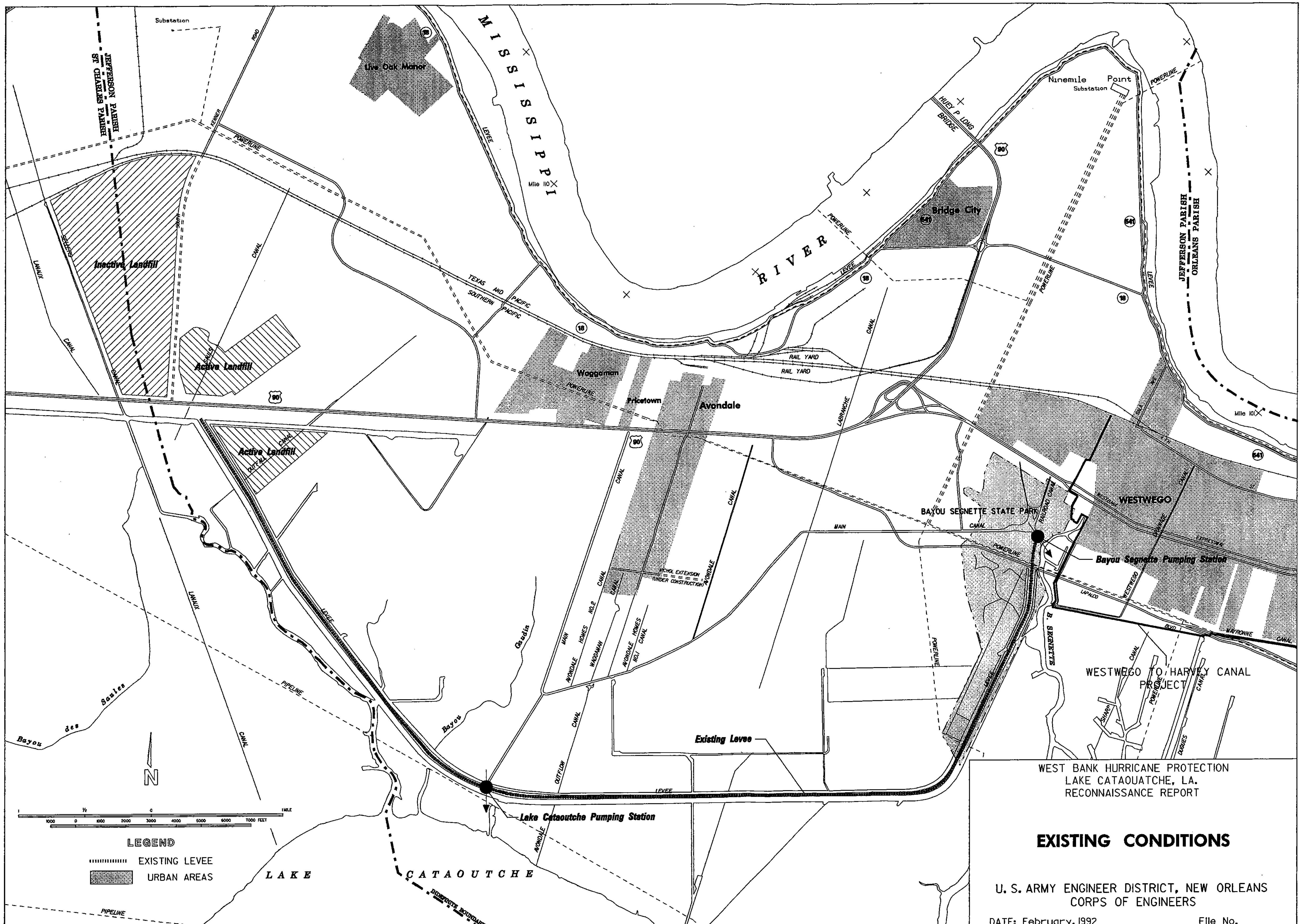
WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA. RECONNAISSANCE REPORT

VICINITY AND LOCATION MAP

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

DATE: February, 1992 File No.

Plate I



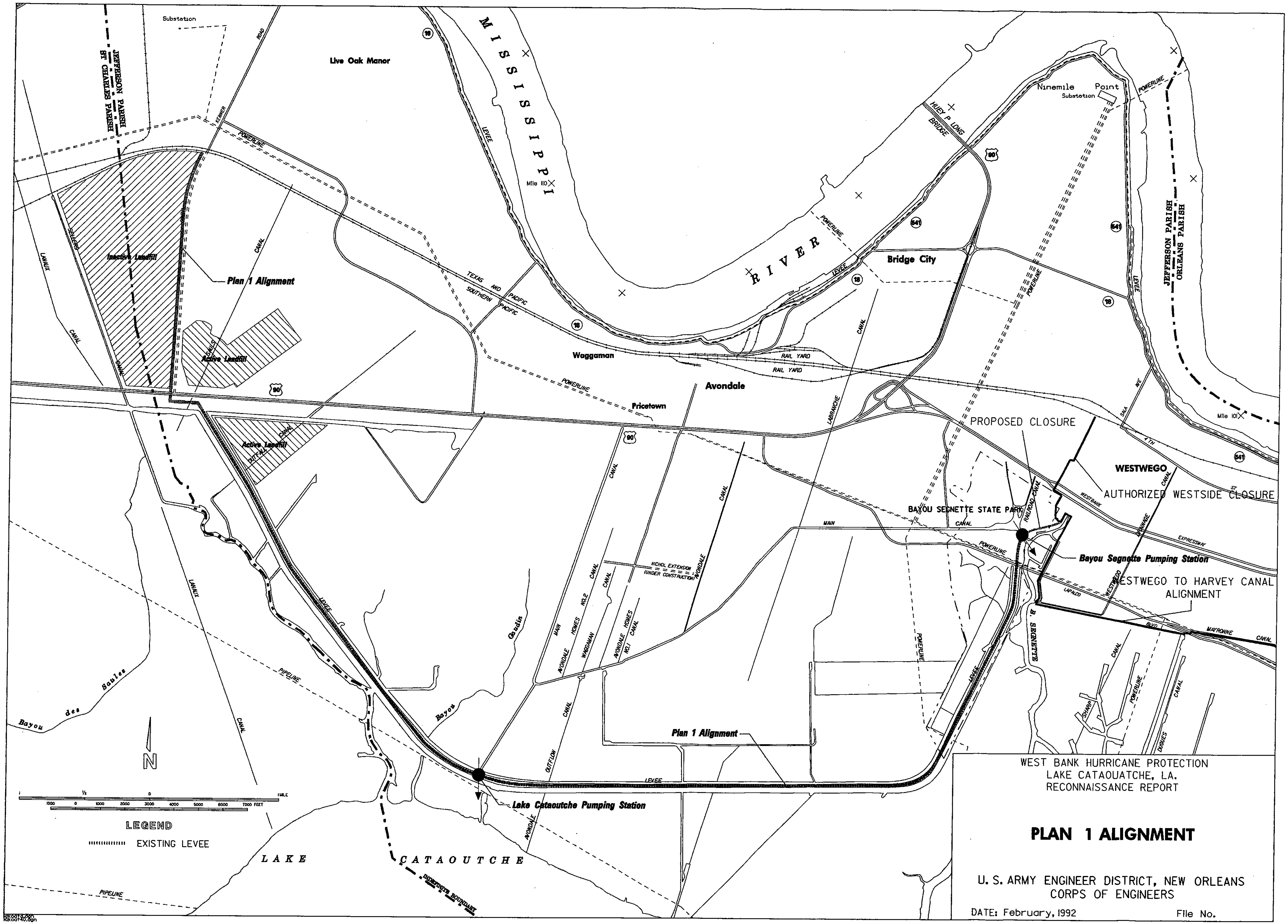
WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA.
RECONNAISSANCE REPORT

EXISTING CONDITIONS

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

DATE: February, 1992 File No.

Plate 2



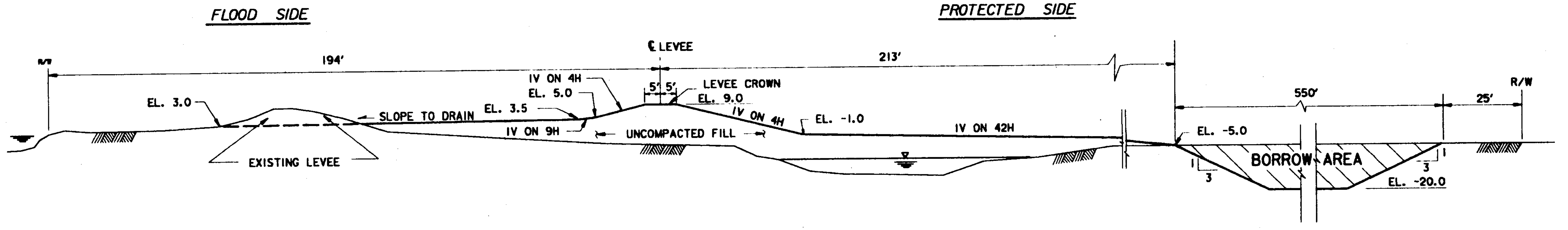
WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA.
RECONNAISSANCE REPORT

PLAN 1 ALIGNMENT

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

DATE: February, 1992 File No.

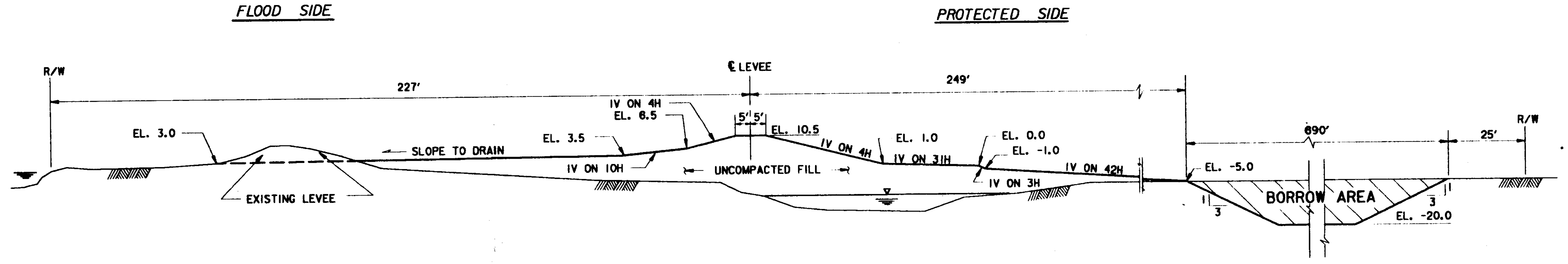
Plate 3



TYPICAL SECTION

100 YR PLAN

NOT TO SCALE



TYPICAL SECTION

SPH PLAN

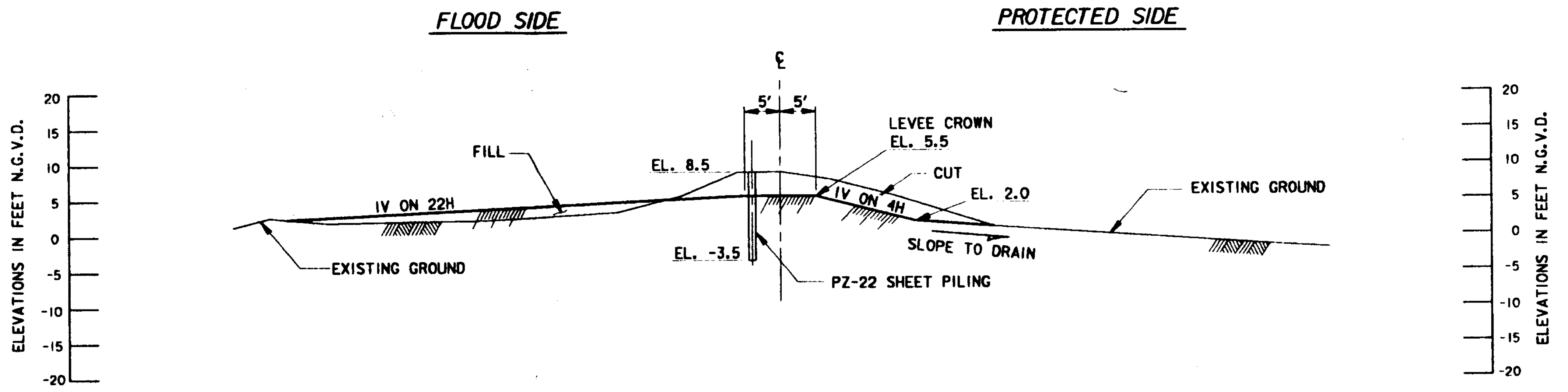
NOT TO SCALE

LAKE CATAOUATCHE, LA. HURRICANE PROTECTION
RECONNAISSANCE STUDY
JEFFERSON PARISH, LOUISIANA
TYPICAL LEVEE
EXTERIOR ALIGNMENT ALERNATIVES

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

DESIGNED BY: R. VELEZ DRAWN BY: R. A. IV CHECKED BY: R. P. LEE	PLOT SCALE: 120	PLOT DATE:	CADD FILE: lkcat.dgn FILE NO.
	DATE: OCT. 1991		LKCAT.DGN

PLATE 4

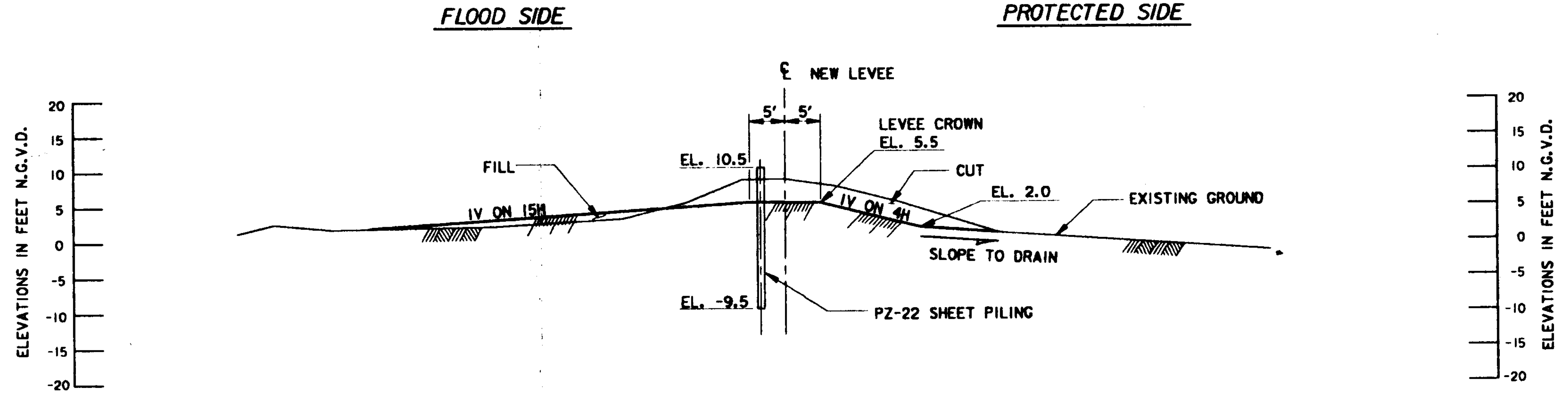


TYPICAL SECTION

100 YEAR PLAN

(RECOMMENDED PLAN)

SCALE: 1" = 10'



TYPICAL SECTION

SPH PLAN

SCALE: 1" = 10'

SCALE: 1" = 10'

10' 0 10' 20' 30' 40'

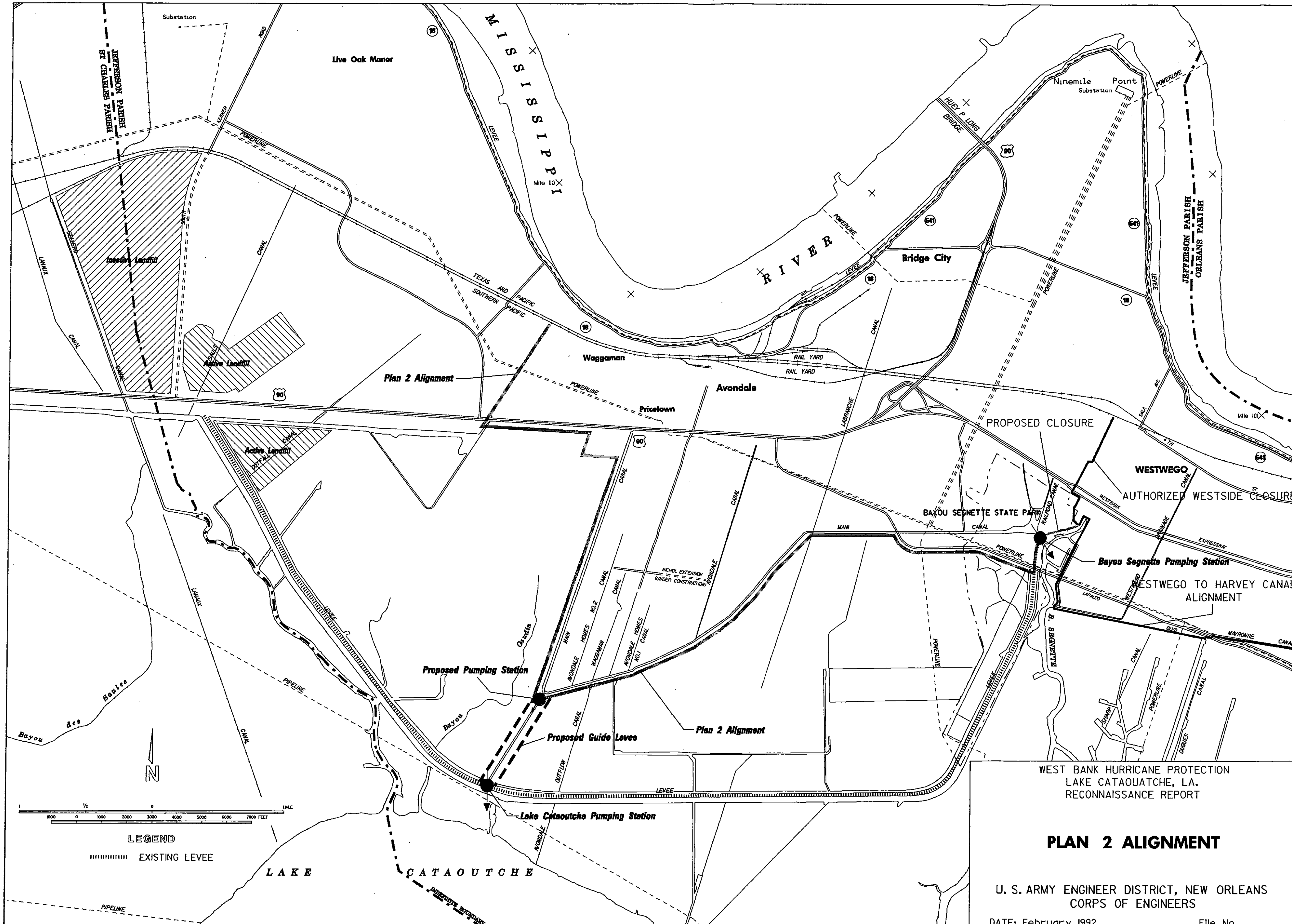
LAKE CATAOUATCHE, LA HURRICANE PROTECTION
RECONNAISSANCE STUDY
JEFFERSON PARISH, LOUISIANA

TYPICAL FLOODWALL IN LEVEE
EXTERIOR ALIGNMENT ALTERNATIVES

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

DESIGNED BY: J. ROMERO DRAWN BY: V. COUVILLION CHECKED BY: J. ROMERO	PLOT SCALE: 120	PLOT DATE: 31 OCT 91	CADD FILE: CATACKTE.DGN FILE NO.
	DATE: OCT 1991		

PLATE 5



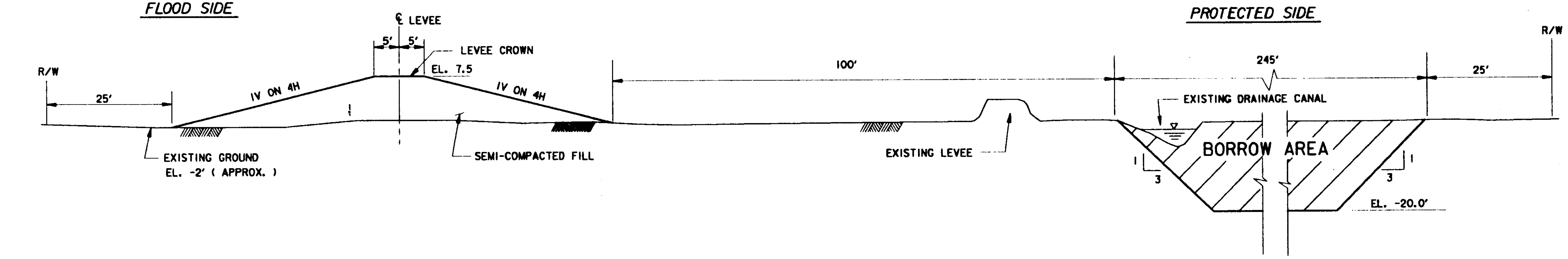
WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA.
RECONNAISSANCE REPORT

PLAN 2 ALIGNMENT

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

DATE: February, 1992 File No.

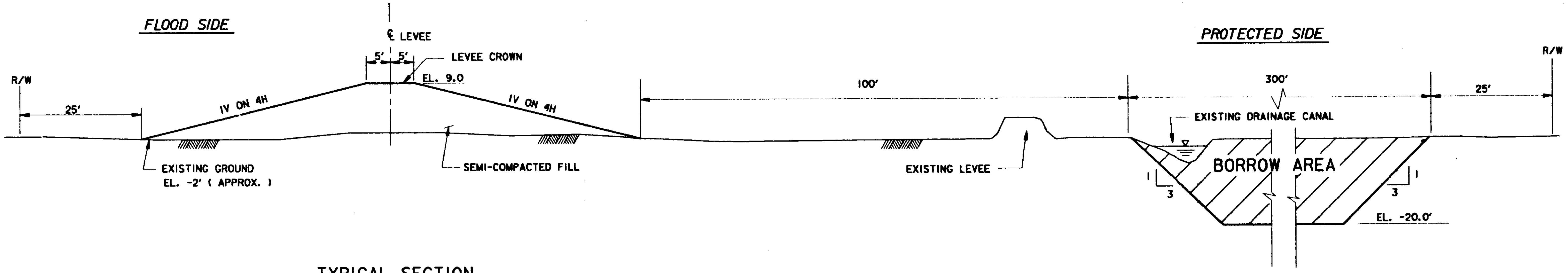
Plate 6



TYPICAL SECTION

100 YEAR PLAN

(NOT TO SCALE)



TYPICAL SECTION

SPH PLAN

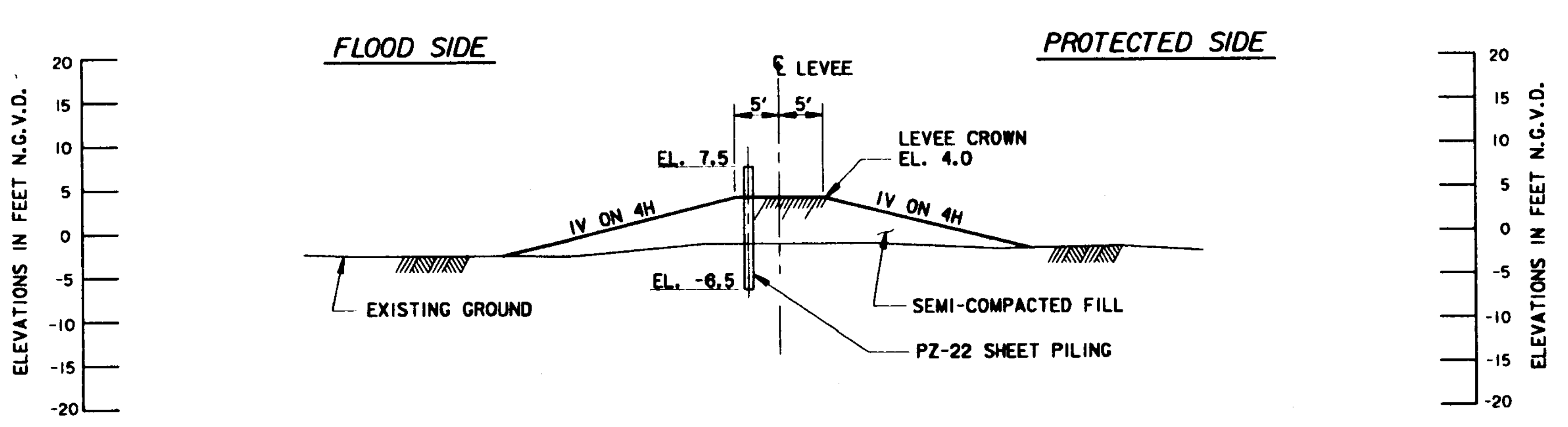
(NOT TO SCALE)

LAKE CATAOUATCHE, LA HURRICANE PROTECTION
RECONNAISSANCE STUDY
JEFFERSON PARISH, LOUISIANA
TYPICAL LEVEE
INTERIOR ALIGNMENT ALTERNATIVES

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

DESIGNED BY: R.P.LEE	PLOT SCALE: 120	PLOT DATE: 31 OCT 91	CADD FILE: CATAINTE.DGN
DRAWN BY: R.A. IV	DATE: OCT 1991		FILE NO. CATAINTE.DGN
CHECKED BY: R.P.LEE			

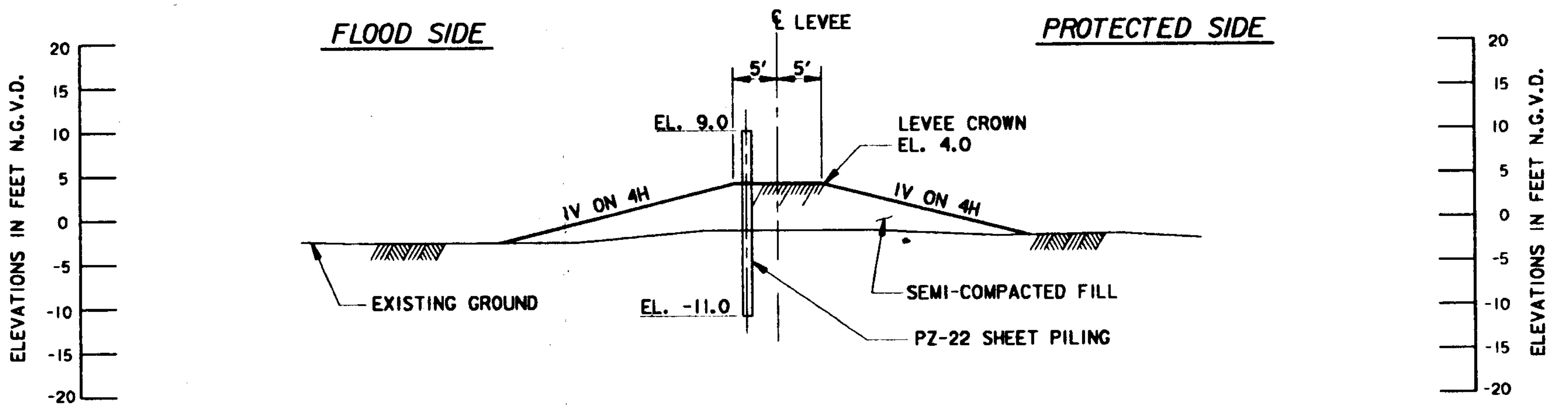
PLATE 7



TYPICAL SECTION

100 YEAR PLAN

SCALE: 1" = 10'



TYPICAL SECTION

SPH PLAN

SCALE: 1" = 10'

SCALE: 1" = 10'

10' 0 10' 20' 30' 40'

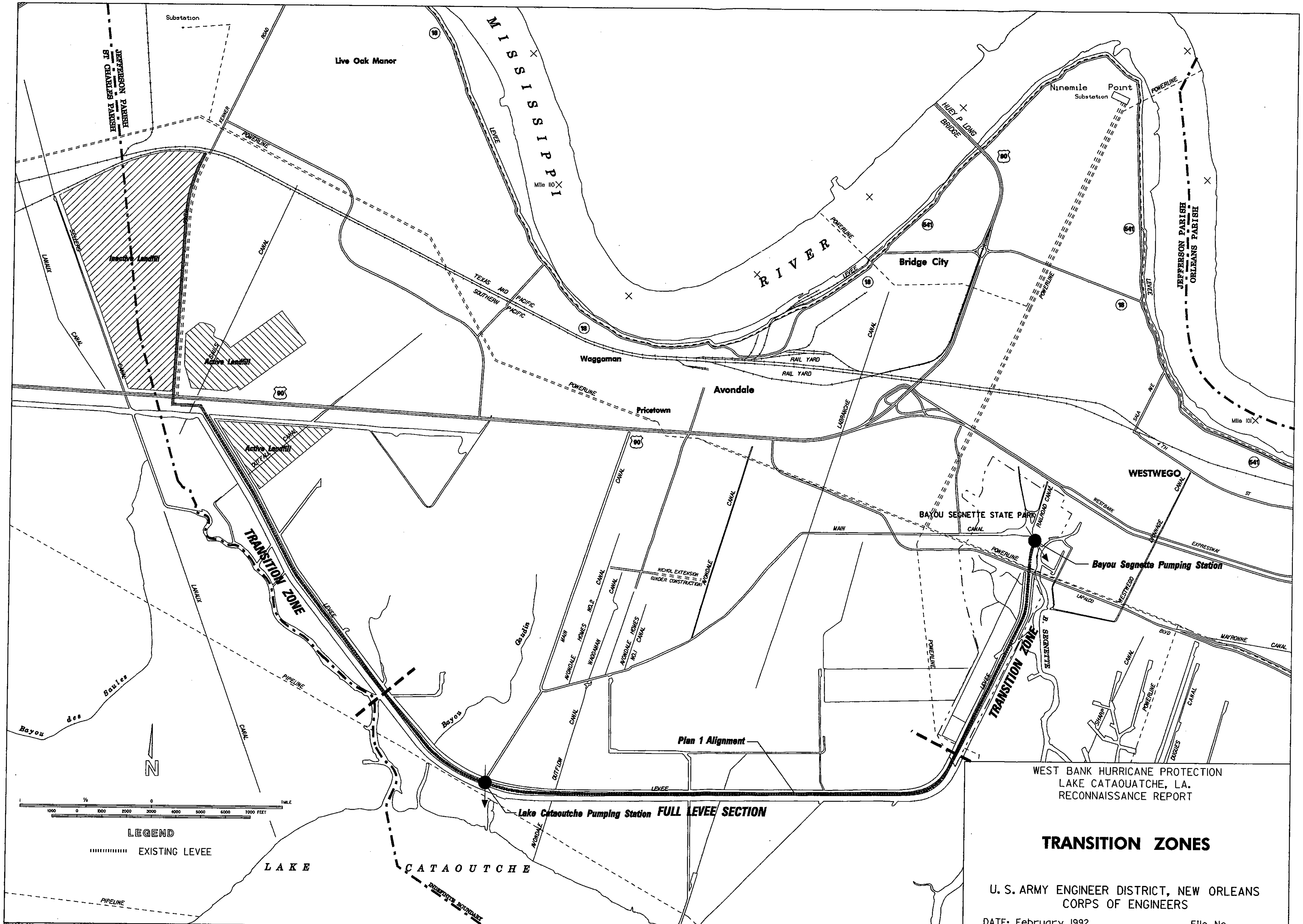
LAKE CATAOUATCHE, LA HURRICANE PROTECTION
RECONNAISSANCE STUDY
JEFFERSON PARISH, LOUISIANA

TYPICAL FLOODWALL IN LEVEE
INTERIOR ALIGNMENT ALTERNATIVES

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

DESIGNED BY: J. ROMERO	PLOT SCALE: 120	PLOT DATE: 31 OCT 91	CADD FILE: CATAINTE.DGN
DRAWN BY: J. ROMERO			FILE NO.
CHECKED BY: J. ROMERO	DATE: OCT 1991		

PLATE 8



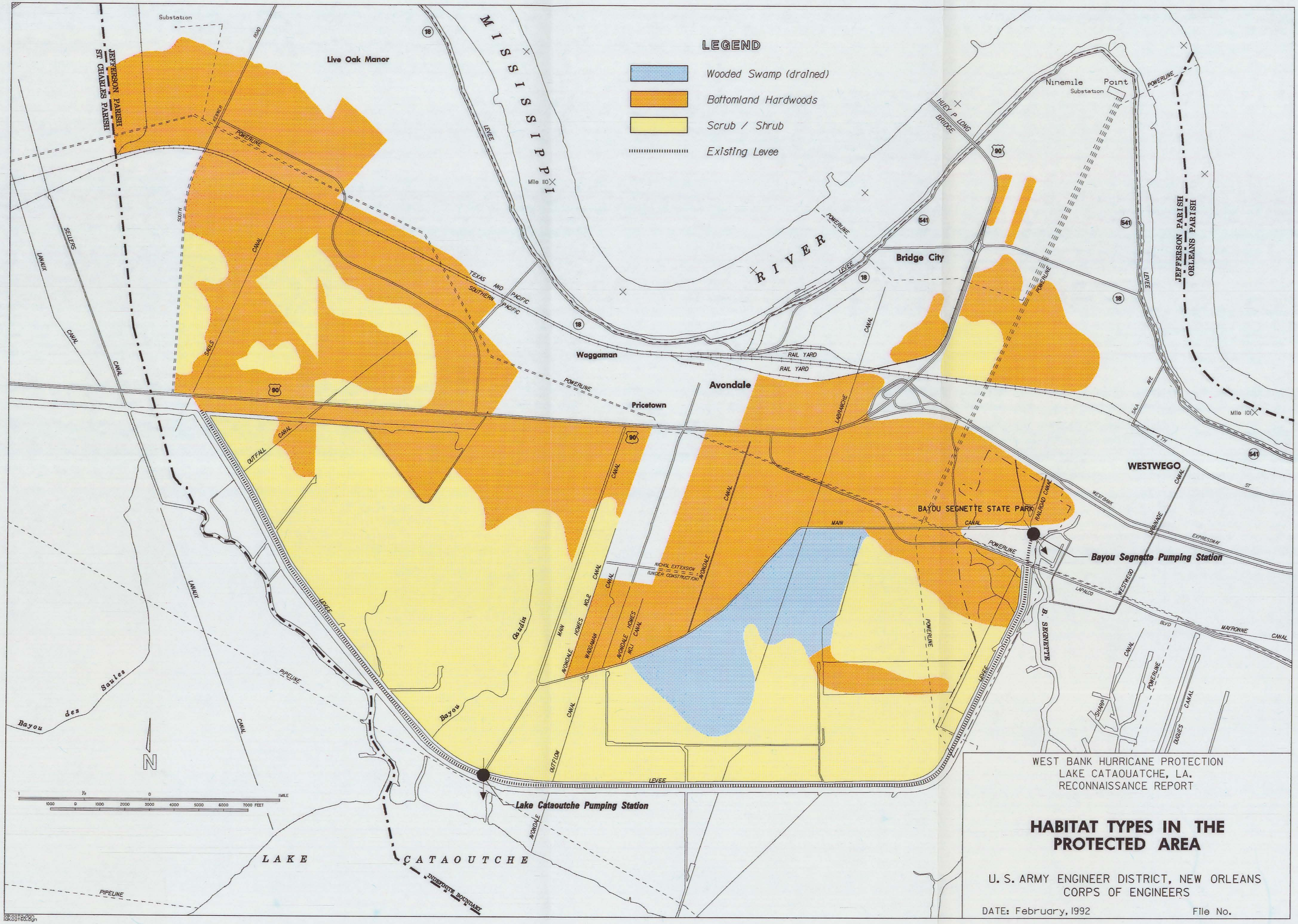
WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA.
RECONNAISSANCE REPORT

TRANSITION ZONES

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

DATE: February, 1992 File No.

Plate 9



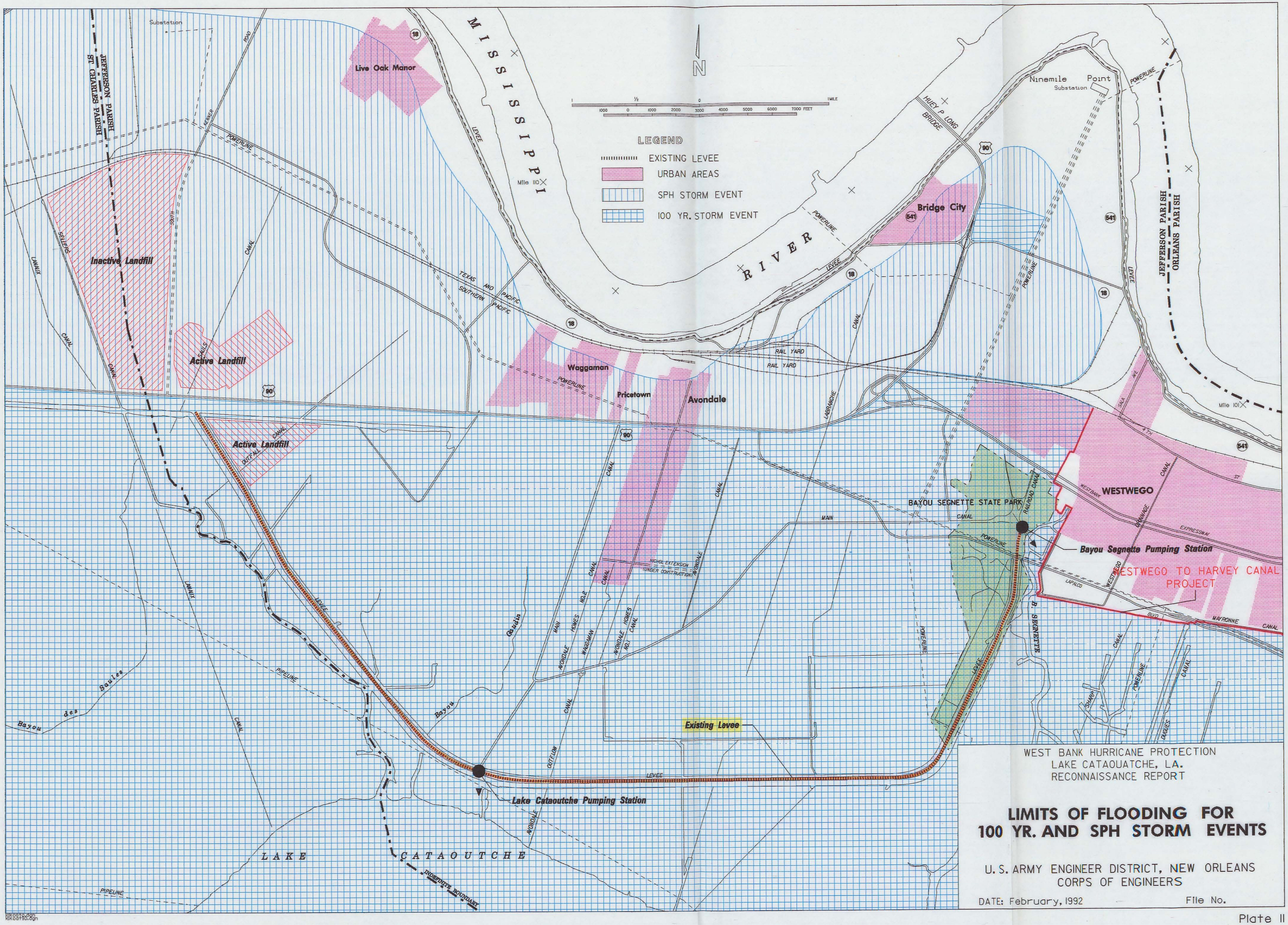
WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA.
RECONNAISSANCE REPORT

HABITAT TYPES IN THE PROTECTED AREA

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

DATE: February, 1992 File No.

Plate 10



WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA.
RECONNAISSANCE REPORT

LIMITS OF FLOODING FOR 100 YR. AND SPH STORM EVENTS

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

DATE: February, 1992

File No.

Plate II

WEST BANK HURRICANE PROTECTION

LAKE CATAOUATCHE, LA.

RECONNAISSANCE REPORT

APPENDIX A

HYDRAULIC INVESTIGATIONS

1. Description and Verification of Procedures

a. Hurricane Memorandums. The Hydrometeorological section (HMS), U.S. Weather Bureau, has cooperated in the development of hurricane criteria for experienced and potential hurricanes in the study area. The HMS memorandums provided isovel patterns, hurricane paths, pressure profiles, rainfall estimates, frequency data, and various other parameters required for the hydraulic computations. A reevaluation of historic meteorologic and hydrologic data was the basis for memorandums relative to experienced hurricanes. Those relative to potential hurricanes were developed through the use of generalized estimates of hurricane parameters based on the most recent research and concepts of hurricane theory. Memorandums applicable to the study area are listed in the attached bibliography.

b. Historical Storms used for Verifications. Three observed storms, with known parameters and effects, were used to establish and verify procedures and relationships for determining surge heights, wind tide levels (WTL's), inflow into Lake Salvador and Cataouatche and ultimately, flood elevations that result from hurricanes. The three storms used for verification occurred in September of 1915 (1)*, September of 1947 (2) and September 1956 (3). Isovel patterns for these storms are shown on Plates 1, 2, and 3, respectively.

(1) The hurricane of 29 September 1915 had a central pressure index (CPI) of 27.87 inches, an average forward speed of 10 knots, and a maximum sustained wind speed of 99 mph at a radius of 29 nautical miles. This hurricane approached the mainland from the south. At Grand Isle a high water elevation of 9 feet was experienced and near Manila Village at the rear of Barataria Bay a stage of 8.0 feet was reported. Destruction was extensive. At Leesville, Louisiana, approximately 13 miles west of Grand Isle only 1 of 100 houses remained standing.

(2) The 19 September 1947 hurricane had a CPI of 28.57 inches, an average forward speed of 16 knots, and a maximum sustained windspeed of 72 mph at a radius of 33 nautical miles. The direction of approach of this hurricane was approximately from the east. A stage of 4.0 feet NGVD was observed at Grand Isle. The Gulf Coast from Florida to Louisiana experienced a tidal surge from the hurricane with the western end of the Mississippi Sound receiving the greatest buildup.

(3) Hurricane Flossy, which occurred on 24 September 1956, had a CPI of 28.76 inches, an average forward speed of 10 knots, and a maximum wind speed of 80 mph at a radius of 30 nautical miles. This hurricane approached the

Louisiana coastline from the southwest, crossing the Mississippi River delta and reentering the Gulf of Mexico. The tide rose to 8.0 feet at Grand Isle. Tides were unusually high from 20 miles west of Grand Isle to western Florida.

c. Synthetic storms. Computed flood elevations resulting from synthetic storms are necessary for frequency and design computations. Parameters for certain synthetic storms and methods for derivation of others were furnished by the National Weather Service. The standard project hurricane (SPH) for the entire Louisiana coast was used for all locations in the study area with changes only in path and forward speed.

(1) SPH for the Louisiana coast was derived by the National Weather Service from a study of 42 hurricanes that occurred in the region over a period of 57 years (4). The SPH path critical to the project location and isovel patterns at critical hour are shown on Plate 1-3. Based on subsequent studies of more recent hurricanes, the National Weather Service has revised the SPH wind field patterns and other characteristics over the years. Wind field patterns were revised after Hurricane Betsy in 1965 to reflect the intensified wind speeds (5), (6), (7). After Hurricane Camille in 1969, the Weather Service completely revised hurricane characteristics for the SPH, including the wind speeds, central pressure, and radii (8). In their latest publication (9) NOAA has expanded and generalized the latest SPH characteristics, previous SPH characteristics fit within the new generalized parameters.

(a) The SPH for the Louisiana coastal region has a frequency of once in 100 years. The CPI that corresponds to this frequency of once in 100 years is 27.6 inches. CPI probabilities are based on the following relationship (10):

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

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

(b) Radius of maximum winds is an index of hurricane size. The radius of 12 hurricanes occurring in the New Orleans area is 36 nautical miles. From relationships of CPI and radius of maximum winds of gulf coast hurricanes (10), a radius of 30 nautical miles is considered representative for an SPH having a CPI of 27.6 inches.

(c) Different forward speeds are necessary to produce SPH effects at various locations within the study area. In Lake Salvador, the forward speed is a critical factor and may be as important as the track itself. Sufficient time must elapse to allow for maximum inflow into the lake. The SPH for the east shore, has an average forward speed of 11 knots.

(d) Maximum theoretical gradient wind (10) is expressed as:

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

where V_{gx} = maximum gradient wind speed in miles per hour
P_n = asymptotic pressure in inches
P_o = central pressure in inches
R = radius of maximum winds in nautical miles
f = coriolis parameter in units of hour $^{-1}$

The estimated wind speed (30 feet above ground level) (V_x) (11) in the region of highest speeds is obtained as follows:

$$V_x = 0.885 \ V_{gx} + 5T$$

where T = forward speed in miles per hour.

From these relationships, a wind speed of approximately 100 mph was obtained.

(2) Other synthetic storms of different frequency and CPI are derived from SPH. Other CPI's for desired frequencies are obtained from the graph shown on Plate 10. V_{gx}'s corresponding to any other CPI are determined similarly by use of the method described for the SPH. Variations in CPI's of historic storms were accomplished by the same procedure (10). Characteristics of synthetic storms and some historic storms are listed in Table 1.

TABLE 1
HURRICANE CHARACTERISTICS

Hurricane	CPI inches	Radius of Max. Winds nautical miles	Forward Speed knots	Vx m.p.h
Sep 1915	27.87	29	10	99
Sep 1947	28.57	33	16	72
Sep 1956	28.76	30	10	80
Sep 1965	27.79	32	20	122
SPH	27.60	30	11	100
Mod H	28.30	30	11	83

Tracks are shown on Plate 4

d. Surges.

(1) Maximum hurricane surge heights along the gulf shores were determined from computations made for ranges extending from the shores out to the continental shelf by use of a general wind tide formula based on the steady state conception of water superelevation (12) (13) (14). The average windspeed and average depth in each range were determined from isovel and hydrographic charts for each computation. The storm isovel patterns were furnished by U.S. Weather Bureau. In order to reach agreement between the computed maximum surge heights and the observed high water marks, it was necessary to introduce a surge adjustment factor or calibration coefficient into the general equation, which in its modified form, was as follows:

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

Where S = wind setup in feet
V = windspeed in m.p.h.
F = fetch length in statute miles
D = average depth of fetch in feet
θ = angle between direction of wind and the fetch
N = planform factor, assumed equal to unity
Z = surge adjustment factor

(2) Hurricane surges at the shore were determined by summation of incremental wind setups along a range above the water surface elevation at the gulf end of the range. A combination of the setup due to atmospheric pressure anomaly and the predicted normal tide was used to determine the initial elevation at the gulf end of the range. Due to the variation in pressure setup between the shoreward end and gulfward end of the range, an adjustment was made at the former to compensate for the difference. This procedure for determining surge heights at the coastline was developed for the Mississippi gulf coast, where reliable data were available at several locations for more than one severe hurricane, and is used for the entire coastal Louisiana region. Due to dissimilar shoreline configurations different factors were required at different locations, but identical factors were used at each location for every hurricane. The value of the factor is apparently a function of the distance from the shoreline to deep water and varies inversely with this distance. Comparative computed surge heights and observed high water marks for the 1915 and 1947 hurricanes at the locations used to verify the respective procedures are shown in Table 2. All elevations in this appendix are in feet and are referred to National Geodetic Vertical Datum of 1929 (NGVD).

TABLE 2

HURRICANE SURGE HEIGHTS

Location	Surge Adjustment factor (Z)	1915 Obs	1915 Comp	1947 Obs	1947 Comp
		(feet NGVD)		(feet NGVD)	
Long Point, La.	0.21	9.8	9.6	10.0	10.1
Bay St.Louis, Ms.	0.46	11.8	11.8	15.2	15.1
Gulfport, Ms.	0.60	10.2(a)	9.9	14.1	14.3
Biloxi, Ms.	0.65	10.1(a)	9.8	12.2(a)	12.6

(a) Average of several high water marks

(3) In those areas where the coastline is characterized by a coastal bay separated from the gulf by an offshore barrier island, such as Grand Isle, or by a shoal, it is necessary to inject an additional step in the normal procedure to verify experienced hurricane tides. The incremental step computation was completed to the gulf shore of the island and the water surface elevation transposed to the inland bay side of the island from whence the incremental computations were continued using a new surge adjustment factor which was considered representative of the shallower depths within the bay. This procedure resulted in a satisfactory verification of hurricane tides along other portions of the Louisiana coast.

(4) The incremental step computation was used to check elevations experienced during the hurricane of 22 September - 2 October 1915 and hurricane Flossy 21-30 September 1956. Verification of surge heights and surge adjustment factors for these hurricanes are shown in Table 3. Surge adjustment factors of 0.80 in open water and 0.48 in Barataria Bay were used for the Manila Village area.

TABLE 3

VERIFICATION OF HURRICANE SURGE HEIGHTS

Location	Sep. 1915 Obs	Sep. 1915 Comp	Sep. 1956 (Flossy) Obs	Sep. 1956 (Flossy) Comp	Surge Adjustment factor (Z)
	(feet NGVD)		(feet NGVD)		
Grand Isle					
Flooding front	9.0	8.8	3.9	4.1	0.80(a)
Flooding rear	-	-	8.0	7.8	0.80(a)
					0.48(b)
Manila	8.0	8.5	-	5.1	0.48(b)

(a) In Gulf of Mexico
(b) In Barataria Bay

e. Routing. Since the major hurricane damage in the study area would result from storm induced effects on Lake Salvador, it was necessary to establish a method to determine the stage in the lake at any time during the hurricane occurrence. This procedure involves the construction of a stage hydrograph for Barataria Bay by calculating simultaneously, the hourly flows and rainfall through Lake Salvador's natural inlet channels.

(1) Prerequisite to any routing is the choice of an actual or hypothetical hurricane of known or designated characteristics. It is then possible to develop surge heights for any point in Barataria Bay for the selected hurricane. For routing purposes, the old fishing settlement of Manila Village which is about 20 miles southeast of Lake Salvador, was selected as the critical point for a hydrograph. It would reflect stages at the mouth of the schematized inlet channel. Such a hydrograph of hourly stages was constructed by computing the incremental setup for each hour and using the maximum surge elevation as the peak of the hydrograph for the critical period. Storm surge hydrographs at Manila Village for other frequencies were determined by identical procedures.

(2) A stage-area was made for the schematized conveyance channel between Manila Village and the entrance to Lake Salvador Basin which consist of Lake Salvador, Lake Cataouatche, and the adjacent marsh area. Since the width of the channel is very large, the depth of the water was used as the hydraulic radius.

(3) The cumulative amount of rainfall coincident with the storm significantly affects the lake elevation and hence the routing procedure. The amount of this rainfall was calculated by the methods described in U.S. Weather Bureau memorandums (15) (16), using a moderate rainfall that would be coincident with a tropical storm. For routing purposes, a moderate rainfall of 8.5 inches in 24 hours was considered as additional inflow into the Lake Salvador Basin. The effect of cumulative rainfall is to raise the average lake level.

(4) With the above mentioned items resolved, the routing procedure was reduced to the successive approximation type problem in which the variable factors were manipulated until a correlation between flows from the gulf through the inlet channel and the rise in the mean elevation of the Lake Salvador Basin was obtained for the incremental time intervals. The use of this method has been illustrated by Bretscheider and Collins (17). A typical routing computation is illustrated on Plate 5. For verification of the method the surge caused by Hurricane Betsy, September 1965, was routed by this procedure. The routed stage for Bayou Barataria at Lafitte (assumed to be the representative stage of the Lake Salvador Basin), was found to be in reasonable agreement with the observed stage for the hurricane. The observed and computed peak stages for Hurricane Betsy are 3.35 and 3.05 ft., respectively. If the average stage between the Lafitte and Barataria, Louisiana, gages was used as the representative stage, the computed and observed stages would be in very close agreement. The computed Lake Salvador Basin average water surface hydrograph for the standard project hurricane and the SPH surge hydrograph at Manila Village are shown on Plate 6.

f. Wind Tides. When strong hurricane winds blow over enclosed bodies of shallow water, they tend to drive large quantities of water ahead of them; therefore, wind tides levels (WTL's) in Lake Salvador and Cataouatche, respectively are needed to determine stage-damages curves and to design protection levee heights.

(1) Lake Salvador and Cataouatche are located in a marsh south and west of the study area and are so situated that volume of incoming flow from the gulf cannot be measured because the water flows over broad areas of ungaged marshland. Therefore, the extensive marshlands which surround both lakes results in an almost unlimited storage area when lake waters overflow their banks. Hourly lake elevations for the various frequencies used in computing wind tide levels for Lake Salvador and Cataouatche were obtained from the routed hydrographs which reflect the average lake level.

(2) To compute wind tide, the lake is divided into three zones that are roughly parallel to wind directions. A nodal line is designated perpendicular to the zones and setup

is calculated for the leeward segment and setdown for the windward. The average windspeed and average depth in each segment were determined from isovel and hydrographic charts for each computation. The storm isovel patterns were furnished by the U.S. Weather Bureau (ESSA) (5). The computation of setup or setdown along each segment was based on the segmental integration method (14) and was calculated by the use of the step method formulas (18) that were modified as follows:

$$\text{Setup} = d_t \{[(0.00266\ u^2\ FN) + 1] / d_t^2\}^{-1/2}$$

$$\text{Setdown} = d_t \{1 - [(1 - 0.00266\ u^2\ FN) / d_t^2)]^{1/2}\}$$

where: setup and setdown in feet is measured above or below mean water level (m.w.l.) of the surge in the lake.

d_t = average depth of fetch in feet below m.w.l.
u = windspeed in mph over fetch.
F = fetch length in miles, node to shoreline.
N = planforn factor, equal generally to unity.

Graphs were constructed from the above formulas to determine setup and setdown quickly about the nodal elevation for storms of varied frequencies. Volumes of water along the zones, represented by the setup and setdown with respect to a nodal elevation, were determined and water surface profiles adjusted until setup and setdown volumes for the lake balanced within 5 percent. Then setup elevations were added to the still water level to yield the WTL (Wind Tide Level.) The time dependent SPH wind tide hydrograph computed for the northern shore of Lake Catouatche in shown on Plate 7.

(3) Observed wind tide elevations at the shorelines of Lakes Salvador and Cataouatche are not available. Therefore, the method of wind tide level computation could not be verified by comparing observed and computed data. However, the above described method has been used successfully for the south shore of Lake Pontchartrain at New Orleans, Louisiana. Observed data were available for this lake and the method verified. (See the series of reports on Lake Pontchartrain and Vicinity, Louisiana, Hurricane Protection Project.)

(4) In order to obtain wind tide levels at the existing back levees, it was necessary to use the relationship between the maximum wind tide level and the distance inland from the shoreline.

(5) Marshlands that fringe the shoreline in certain locations are inundated for considerable distances inland by hurricane wind tides that approach the shores. The limit of overland surge penetration is dependent upon the height of the wind tides and the duration of the high stages at the

lakeshore. The study of available observed high water marks at the coastline and inland indicates a fairly consistent simple relationship between the maximum surge height and the distance inland from the coast, as shown on Plate 8. This relationships exist independently of the speed of the hurricane translation, wind speeds, or directions. The data indicated that the weighted mean decrease in surge heights inland is at the rate of 1.0 foot per 2.75 miles. This relationship remains true even in the western portion of Louisiana where relatively high chenieres, or wood ridges, parallel the coast. Efforts to establish time lags between peak wind tide heights at the shoreline and at inland locations were unsuccessful because of inadequate basic data.

(6) For the purpose of surge routing procedures, the shoreline is define as the locus of points where the maximum WTL's would be observed along fetches normal to the general shore. This synthetic shoreline is assumed to be near the extreme western tip of the proposed Lake Salvador Levee as shown on Plate 9. In order to determine the maximum water surface elevations at inland locations. it was necessary to compute maximum WTL's at the designated points mentioned above. These computed wind tide levels were then adjusted by application of average slope of maximum slope height inland (1 foot/ 2.75 miles, Plate 8) to the location of interest. Hurricane stages were not available for positive verification of the procedures within the area. However, the procedure has given satisfactory results in this area and has verified the observed data in other areas of the study, including the Lake Pontchartrain Basin.

2. FREQUENCY ESTIMATES

a. Procedure

(1) Accounts of inundation by hurricane surges do not appear in the earliest records of the study area. Information on stage is available only for the larger towns or more densely populated areas. After about 1900 when systematic records of hurricane damages were assembled by the U.S. Weather Bureau, more details relative to flooding along the isolated coastline and vicinity are available. However, until recent years, no attempt had been made to determine accurately the maximum height of stages experienced during hurricanes. The only exception is that after the September 1915 hurricane, a thorough survey was made by Charles W. Okey, Senior Drainage Engineer, Office of Public Roads and Rural Engineering, U.S. Department of Agriculture. In this survey, he covered the affected coastal areas which were between central Mississippi and central Texas. His report (19) is the comprehensive record of reliable stages in the study area prior to hurricane "Audry" of June 1957.

(2) The lack of additional data has made the establishment of dependable stage-frequency relationships

impracticable. Records indicate that there is no locality along the Louisiana coast which is more prone to hurricane attack than other localities. The U.S Weather Bureau has made a generalized study of hurricane frequencies and presented the results in a memorandum (10) (20). In a 400 mile zone along the central gulf coast from Cameron, Louisiana, to Pensacola, Florida, (Zone B), frequencies for hurricane central pressure indexes (CPI) presented in the report, shown on Plate 10, reflect the probability of hurricane recurrence in the mid-gulf coastal area. Hurricane characteristics with critical tracks and CPI's representative of the SPH and Moderate Hurricane, were then developed in cooperation with the U.S. Weather Bureau. The CPI's were 27.6 and 28.3 inches for these two hurricanes, respectively. The SPH described in NHRP Report No. 33 (21) was the basis of development of the Design and the Moderate Hurricane used in the study.

(3) Conversion of the SPH wind fields for use as the Mod-H was accomplished in the following manner. A Mod-H was assumed to have a CPI with a Zone B probability of 10 percent. Maximum gradient winds (V_{gx}) were derived for the SPH and Mod-H CPI's in accordance with procedures recommended by the U.S. Weather Bureau (10) (22). An adjustment coefficient equal to the ratio of V_{gx} of the Mod-H to the V_{gx} of the SPH was then used to convert SPH wind velocities to Mod-H velocities. Thus, Mod-H winds were 83 percent of SPH winds for many hurricane paths. It was necessary to use additional synthetic hurricanes of moderate intensity to define in more detail the stage-frequency relationship. When this was required, moderate hurricanes having CPI's of 27.8 and 29.0 inches were used. These hurricanes were of 2 and 40 percent probability, and wind speeds were 96.6 and 59.8 percent of SPH winds, respectively.

(4) Hurricane WTL's were then computed for the theoretical hurricane in accordance with procedures described in paragraph 1-f. Isovels were rotated and the path transposed within allowable limits as necessary to produce maximum surge elevations at the proposed levee near Lake Cataouatche.

(5) A synthetic stage-frequency curve was developed by correlating stages and frequencies for corresponding CPI's, using a procedure developed for the Lake Pontchartrain study area (23). The probability value used for given CPI represents frequency of occurrence from any direction in a 400-mile zone along the central gulf coast. In order to establish frequencies for the locality under study, it was assumed that hurricanes critical to the locality would pass through a 50-mile subzone along the coast. Thus, the number of occurrences in the 50 mile subzone would be 12.5 percent of the number of occurrences in the 400 mile zone, provided that all hurricanes travel in a direction normal to the coast. A hurricane whose track is perpendicular to the coast

ordinarily cause extreme high tides and inundation for a distance about 50 miles along the coast. However, the usual hurricane track is oblique to the shoreline, as shown in Table 2 of HMS memorandum (10). The average projection along the coast of this 50 mile swath for the azimuth of 48 zone B hurricanes is 80 miles. Since this is 1.6 times the width of the normal 50 mile strip affected by a hurricane, the probability of occurrence of any hurricane in the 50 mile subzone would be 1.6 times the 12.5 percent, or 20 percent of the probabilities for the entire mid-gulf Zone B. Therefore, 20 percent of the frequencies for hurricanes for Zone B, mid-gulf, shown in figure 4 of HMS memorandum Hur 2-4 (10), was used to represent the frequencies hurricanes in the critical 50 mile subzone for each study locality.

(6) Since tracks having major components from the southeast create the most critical stages in the Grand Isle area, maximum hurricane surge heights were computed for synthetic hurricanes approaching the area on a track from that direction. Four-fifths (4/5) of all tracks that approached the Grand Isle area were from the southeast. Therefore, a stage-frequency curve was derived using four-fifths of the 50 mile subzone probability for all tracks. Frequencies for observed hurricane stages were then computed on the same basis as the CPI frequencies (10), and a curve plotted. The synthetic frequency curve was then adjusted to the plotted Grand Isle observed data. A frequency curve for Manila Village was then obtained by adding the additional wind tide setup across Barataria Bay to the appropriate stage-frequency value on the adjusted Grand Isle curve. A graphical presentation of this procedure is shown on Plate 11.

(7) There is a direct relationship between the stage-frequency at Manila Village and the average lake stage-frequency in Lakes Salvador and Cataouatche.

(8) The azimuths of tracks observed in the vicinity of the study area were divided into quadrants corresponding to the four cardinal points. Since 1900, 73 storms have affected the Louisiana Coast; 46 had tracks from the south, 18 from the east, 8 from the west, and 1 from the north. Hurricanes with tracks having major components from the south and east generate WTL's that are near critical relative to the study area, while those tracks from the west generate WTL's most critical to the study area. The average azimuth of tracks from the south is 180°. Tracks from the east had an average azimuth of 117°. These azimuths along with the critical track from the west, were used in computing WTL's for Lake Salvador. Of all experienced tracks since 1900 affecting the Louisiana Coast, approximately 63 percent have come from a southerly direction, 24.6 percent from the east, and 11 percent have come from the west. The probabilities of equal stages for the three groups of tracks were then added arithmetically to develop a curve representing a synthetic

probability of recurrence of maximum wind tide levels for hurricanes from all directions.

(9) Table 4 illustrates the synthetic frequency computation for WTL's at the east shore of Lake Salvador.

b. Relationships. Based on the above described procedures, stage-frequency relationships were established under existing conditions for flooding by surges from Lake Cataouatche for the rear areas of Avondale and Waggaman. The stage-frequency curve for the Lake Salvador basin was compared with those developed for the Lake Pontchartrain basin, where stage data for a partially levee rimmed lake basin is more extensive. The Lake Pontchartrain frequency relationship for the south shore was developed from analysis of available stage data and model study results (24) (25). Comparison of the two frequency curves indicates that for the south shore of Lake Pontchartrain the frequency curve is straighter in the less frequent region of the curve, i.e., between the 100-year and SPH frequencies, than the curves for Lake Salvador. Because of the similarity in the topography between the two basins and the large data base available in the Pontchartrain basin, the upper part of the Salvador frequency curve was adjusted to agree with the slope of the curve developed for the South Shore of Lake Pontchartrain. The stage-frequency curve for the north shore of Lake Cataouatche, which is shown on Plate 12, was developed from the Lake Salvador stage-frequency curve. The Lake Cataouatche curve was further refined using results from the WES Implicit Flooding Model (WIFM) and Hurricane Juan.

TABLE 4

STAGE-FREQUENCY COMPUTATION
LAKE SALVADOR

Zone B				50-MILE SUBZONE					
				Tracks from West		Tracks from South		Tracks from East	
	Probability		Probability All Tracks						
CPI in. (1)	years (2)	occ/100 years (3)	occ/100 years (4)	Stage feet ngvd (5)	Probability occ/100 years (6)	Stage feet ngvd (7)	Probability occ/100 years (8)	Stage feet ngvd (9)	Probability occ/100 years (10)
29.0	2.5	40	8.0	2.78	0.88	4.59	5.04	4.37	1.97
28.3	10.0	10	2.0	7.08	0.22	6.47	1.26	6.04	0.49
27.8	50.0	2	0.4	8.56	0.04	7.60	0.25	7.18	0.10
27.6	100.0	1	0.2	9.04	0.02	7.93	0.13	7.48	0.05

Col. 4 20 Percent of Col. 3
Col. 6 11.0 Percent of Col. 4
Col. 8 63.0 Percent of Col. 4
Col. 10 24.6 Percent of Col. 4

3. Design Hurricane

a. Selection of the design hurricane. The standard project hurricane with a return interval of approximately 500 years and the moderate hurricane (Mod-H) with a return interval of 100 years were used in this study. The 100 year hurricane (Mod-H) was selected as the design hurricane (Des-H) due to the available storage in the large sump located south of Hwy. 90 within the protected area. Both the Des-H and the SPH protection designs would provide equivalently the same degree of protection north of Hwy. 90, although the Des-H protection would provide for a lesser degree of protection south of Hwy. 90 than the SPH protection design.

b. Characteristics. The characteristics of the Des-H for the proposed plan of protection are identical to the Mod-H hurricane described in detailed above. However, due to transposition of the regional Mod-H to the smaller study area the design hurricane would have a probability of recurrence of only once in about 100 years in the study area. The path of the Des-H's was located to produce maximum hurricane tides along the entire length of the proposed structures. The Des-H is a theoretical hurricane but ones of similar intensity have been experienced in the area. Table 5 is a summary of the Des-H characteristics.

TABLE 5
DESIGN HURRICANE CHARACTERISTICS

Location	CPI (inches)	Max.Winds (mph)	Radius of max.winds (miles)	Forward Speed (knots)	Direction of Approach
Lake Cataouatche North Shore	28.3	83	30	11	SSW

c. Normal Predicted Tides. The mean tide in the study area is estimated to be approximately 0.2 foot N.G.V.D. the mean tidal range is about 0.35 foot. The difference in height of hurricane tides for occurrence of the Des-H at high or low tide was only a few tenths of a foot. In determining the elevation of design surges, it was assumed that mean normal predicted tide occurs at the critical period of surges.

d. Design Rainfall. Hurricanes usually are accompanied by intense rainfalls. The mean 24-hour maximum point precipitation depth is 9.4 inches, based on data available on over 50 gulf region hurricanes (15) (16). Complete precipitation records, including but not limited to hurricane induced rainfall, indicate maximum 24-hour point depths of 21 inches for a standard project rainfall and 40 inches for the probable maximum rainfall. Estimates of point precipitation depths likely to be experienced with a standard project hurricane are 14 inches for moderately high and between 8.6 and 9.8 inches for moderate rainfalls. A moderate hurricane rainfall of 8.5 inches in 24-hours, based on observed average volume was used in the determination of residual damages for hurricanes, both under present conditions and after construction of the project.

e. Design Tide. The hurricane tide is the maximum still water surface elevation experienced at a given location during the passage of a hurricane. It reflects the combined effects of the hurricane surge, and where applicable, the overland flow of the surge, and wind tide. Design hurricane tides were computed to reflect conditions with authorized protective works or improvements in place, using the procedures described above. Hurricane surges and tides usually are accompanied by violent wave action at the coastline, in unprotected bays, and in inland lakes close to the hurricane path. As the surge moves inland over marshlands and natural ridges, the waves deteriorate rapidly, and wave heights are attenuated by marsh grasses and woodland. Stages were reduced, as described above, using the dropoff rate of 1 foot per 2.75 miles. These hurricane stages were incorporated into the experienced stage frequency curve at the Harvey Canal to arrive at the combined stage frequency curve used in design of these protective works. Table 6 gives a comparison of stages at the surge reference line on the northern side of Lake Cataouatche and in the Harvey Canal for the SPH and 100-year frequency storms.

TABLE 6
STAGE COMPARISON

Frequency (Years)	Stage North Side Lk.Cataouatche feet ngvd	Stage Harvey Canal feet ngvd
SPH	7.5	7.5
100	6.0	5.5

The Lake Cataouatche levee near Hwy. 90 to the levee on Bayou Segnette across from the new Westwego pumping station is subject to waves generated in Lake Cataouatche. This reach is further divided into subreaches delinated by the levee elevation within the subreach. Surge elevations at the levee will vary depending upon the distance to the surge reference line. These design storm elevations at the levee alignment are the same for existing or project conditions. Pertinent data for the design hurricane used to determine wave characteristics is given in Table 7.

TABLE 7

WAVE CHARACTERISTIC-DESIGN HURRICANE

H_s - Significant wave height, feet	3.9
T - Wave period, seconds	4.0
L_o - Deep water wave length, feet	84.0
d/L_o - Relative depth	0.060
H_s/H_o - Shoaling Coefficient	0.994
H_o' - Deepwater wave height, feet	3.9
H_o'/gT^2 -Wave steepness	0.00749

g. Maximum Runup and Overflow.

(1) Hurricanes approaching on paths critical to the north shore of Lake Cataouatche can create a condition whereby protective structures along the project perimeter are overtopped. It was necessary to calculate the magnitude of the heights of wave runup and quantities of overflow by use of established procedures in order to develop improved protective structure designs and to determine damages. This determination was divided into two significant parts for convenience of calculation, namely maximum runup and wave overtopping. Common factors must be resolved in all types of calculations are the WTL, and the geometry and crown elevation of the protective structure.

(2) Wave runup on a protective structure depends upon the physical characteristics (i.e., configuration and surface roughness), the depth of water at the structure, and the wave characteristics. Computation of maximum runup was necessary in order to determine the heights to which existing shore protective structures would have to be raised to prevent all overflow for the significant wave accompanying the 100 year and SPH storms. Wave runup was considered to be the ultimate height to which water in a wave ascended on the proposed slope of a protective structure. This condition occurred when the WTL was at a maximum and was calculated by using the ACES (Automated Coastal Engineering System) computer program based on model study data presented in the 1984 Shore Protection Manual (26), which relates runup (r/H_o'), wave steepness (H_o'/gT^2), relative depth (d/H_o'), and structure slope.

(3) Protective structures exposed to wave runup will be constructed to an elevation and cross-section that is sufficient to prevent all overtopping from the significant wave and waves smaller than the significant wave accompanying the 100 year storm. Waves larger than the significant wave will be allowed to overtop the protective structures; however, such overtopping will not endanger the security of the structure or cause material flooding. Wave data, runup elevation, and required elevation of the protective structure are shown in Table 8.

TABLE 8

WAVE RUNUP AND PROPOSED ELEVATION OF PROTECTIVE STRUCTURE
DESIGN HURRICANE

Location	H (ft)	T (sec)	WTL Elev (ft NGVD)	Elev of Levee (ft NVGD)
Lk Cataouatche	3.9	4.0	6.0	8.5

h. Residual Flooding. The procedures described in SPM (26) are used to determine wave runup and wave overtopping for the significant wave that would be experienced during hurricane occurrences. However, 14 percent of the waves in a spectrum are higher than the significant wave and the maximum wave heights to be expected are about 1.87 times the significant wave height. Thus, a structure designed to prevent all overtopping by a significant wave would be overtopped by the portion of the spectrum that is higher than the significant wave. It was, therefore, necessary to assume that this residual overtopping would not produce flooding and subsequent damage to the extent that only partial protection was afforded to an area for the design hurricane. A determination of the residual overtopping was made for the area and it was concluded that no material flooding results if the designed cross-section is overtopped by waves higher than the significant wave. It was, therefore, concluded that the use of the significant wave runup would result in design grades for protective structures that would permit residual flooding only to a negligible degree.

STAGE-FREQUENCY

DATA

LAKE CATAOUATCHE

STAGE-FREQUENCY DATA
Existing Conditions

FREQUENCY (Years)	3A,C,D	3,B	3G	10W,E	3F	3I,K	3J
	Reaches (FEET NGVD)						
	STAGE (FEET, NGVD)						
1	3.0	-2.9	1.6	-0.7	3.6	2.0	1.4
2	3.0	-2.9	1.6	-0.7	3.6	2.0	1.4
5	3.0	-2.5	1.6	-0.5	3.7	2.0	1.4
10	3.0	-2.2	1.6	-0.3	3.8	2.0	1.4
25	3.0	-1.6	1.6	0.1	4.0	2.0	1.4
50	3.0	-0.8	1.6	0.7	4.2	2.0	1.7
100	3.0	2.1	1.7	2.9	4.9	2.0	2.1
SPH	5.0	5.0	5.0	5.0	5.0	5.0	5.0

LAKE CATAOUATCHE

STAGE-FREQUENCY DATA
100-Year Level of Protection

FREQUENCY (Years)	3A,C,D	3,B	3G	10W,E	3F	3I,K	3J
	Reaches						
	STAGE (FEET, NGVD)						
1	3.0	-2.9	1.6	-0.4	3.6	2.0	1.4
2	3.0	-2.9	1.6	-0.4	3.6	2.0	1.4
5	3.0	-2.5	1.6	-0.4	3.7	2.0	1.4
10	3.0	-2.3	1.6	-0.4	3.8	2.0	1.4
25	3.0	-2.3	1.6	-0.4	3.8	2.0	1.4
50	3.0	-2.3	1.6	-0.4	3.8	2.0	1.4
100	3.0	-2.3	1.6	-0.4	3.8	2.0	1.4
SPH	3.0	1.4	1.6	1.4	3.8	2.0	1.4

LAKE CATAOUATCHE

STAGE-FREQUENCY DATA
SPH Level of Protection

FREQUENCY (Years)	3A,C,D	3,B	3G	10W,E	3F	3I,K	3J
	Reaches						
	STAGE (FEET, NGVD)						
1	3.0	-2.9	1.6	-0.7	3.6	2.0	1.4
2	3.0	-2.9	1.6	-0.7	3.6	2.0	1.4
5	3.0	-2.5	1.6	-0.5	3.7	2.0	1.4
10	3.0	-2.3	1.6	-0.3	3.8	2.0	1.4
25	3.0	-2.3	1.6	-0.3	3.8	2.0	1.4
50	3.0	-2.3	1.6	-0.3	3.8	2.0	1.4
100	3.0	-2.3	1.6	-0.3	3.8	2.0	1.4
SPH	3.0	-2.3	1.6	-0.3	3.8	2.0	1.4

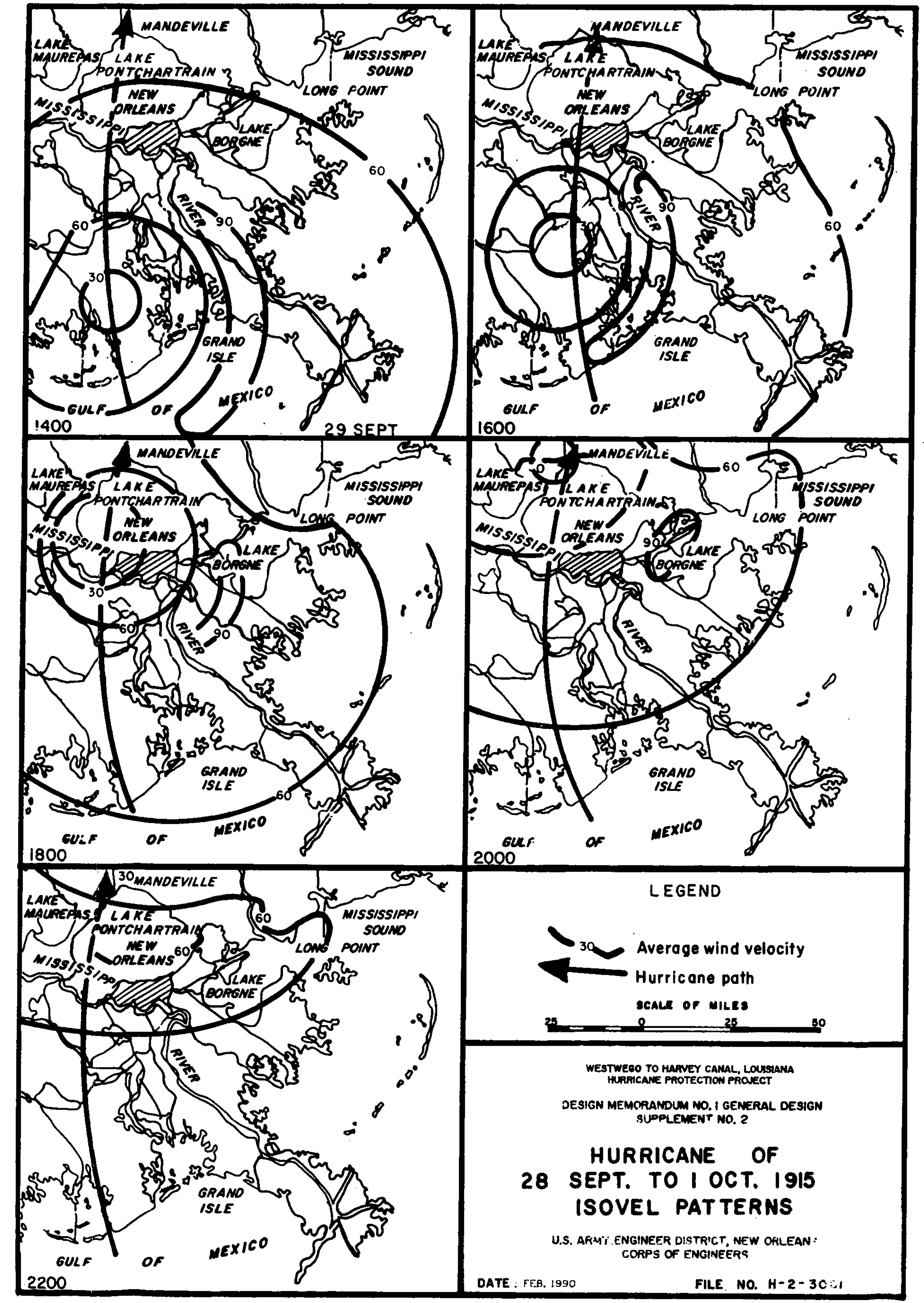
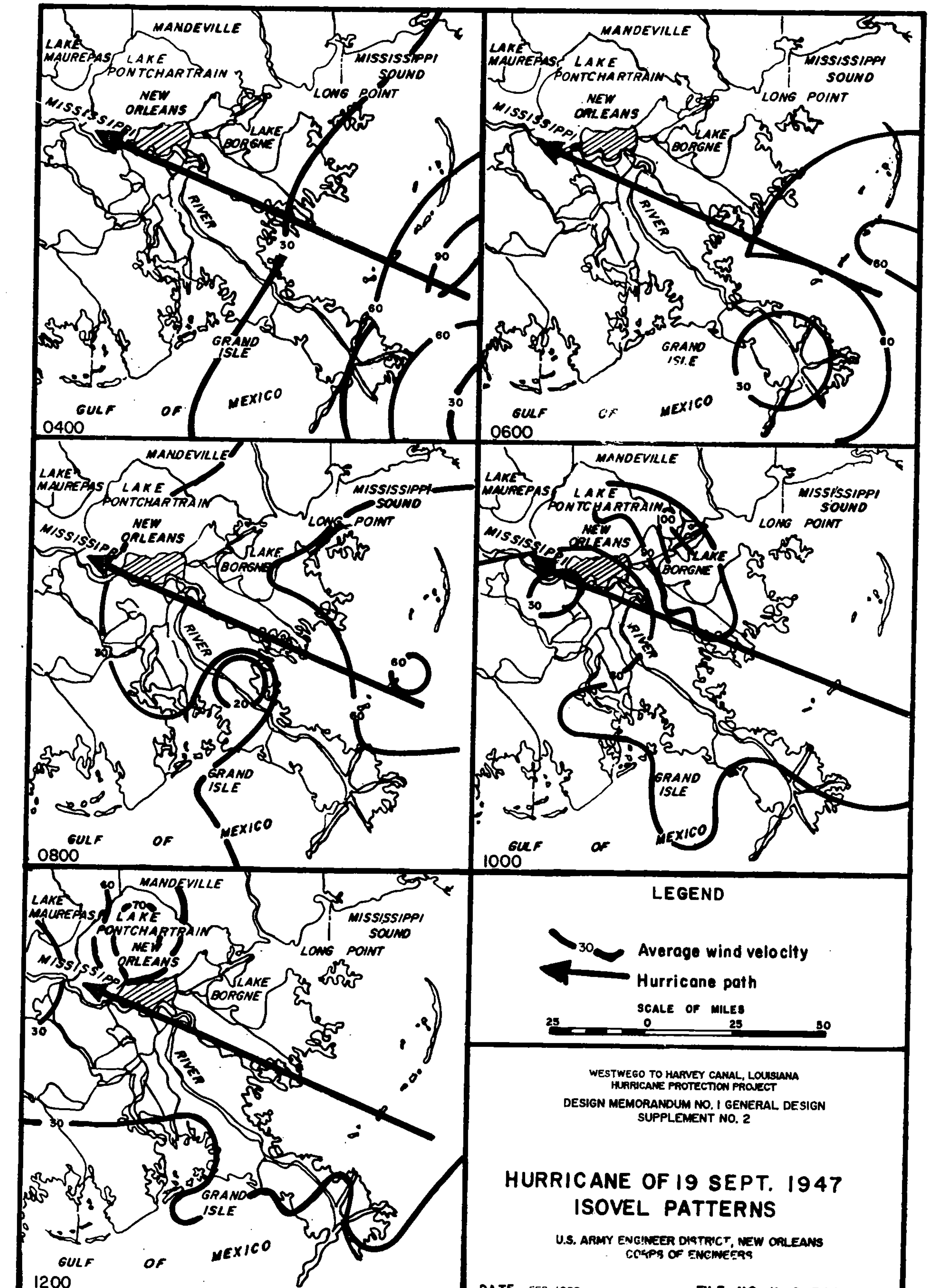

MANDEVILLE
LAKE MAUREPAS
LAKE PONTCHARTRAIN
NEW ORLEANS
MISSISSIPPI
RIVER
LAKE BORGNE
MISSISSIPPI SOUND
LONG POINT
GRAND ISLE
GULF OF MEXICO
1400
29 SEPT
1600
1800
2000
2200
30
60
90
LEGEND
Average wind velocity
Hurricane path
SCALE OF MILES
25 0 25 50
WESTWEGO TO HARVEY CANAL, LOUISIANA
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2
HURRICANE OF
28 SEPT. TO 1 OCT. 1915
ISOVEL PATTERNS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
DATE: FEB. 1990
FILE NO. H-2-3

PLATE 1



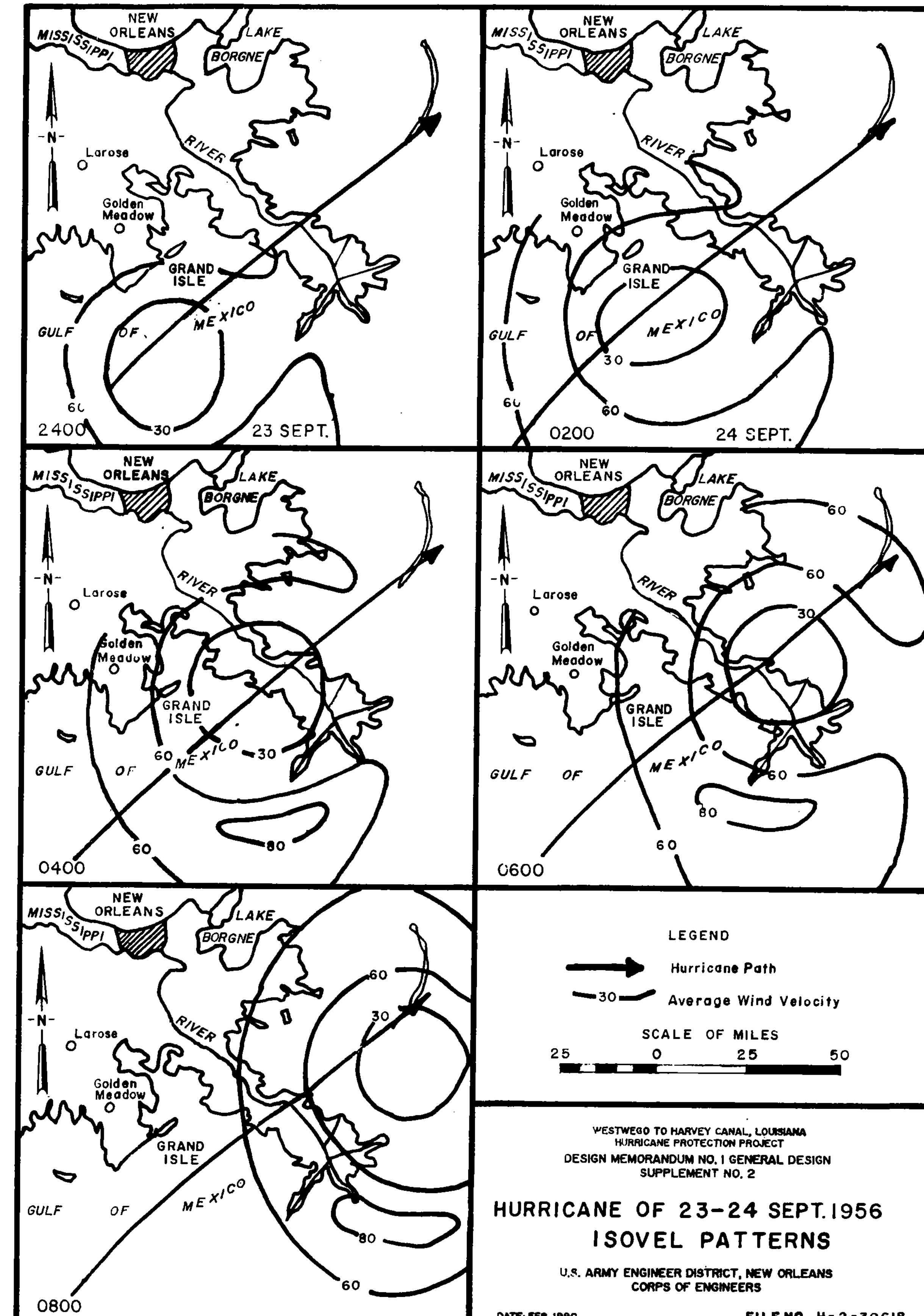
WESTWEGO TO HARVEY CANAL, LOUISIANA
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2

HURRICANE OF 19 SEPT. 1947
ISOVEL PATTERNS

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

DATE: FEB. 1990 FILE NO. H-2-30618

PLATE 2

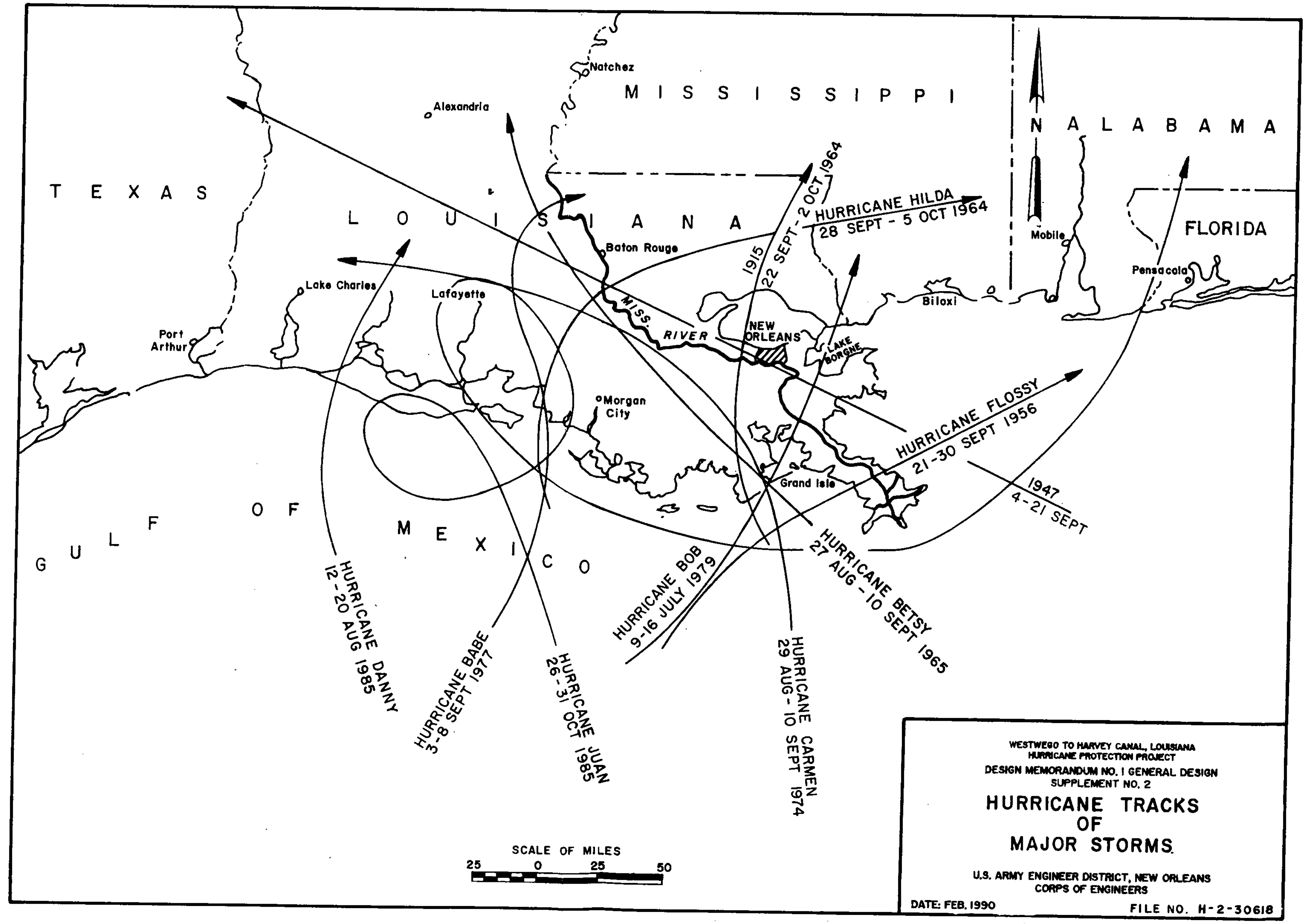


WESTWEGO TO HARVEY CANAL, LOUISIANA
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2

HURRICANE OF 23-24 SEPT. 1956
ISOVEL PATTERNS

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

DATE: FEB. 199C FILE NO. H-2-30618



WESTWEGO TO HARVEY CANAL, LOUISIANA
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2

HURRICANE TRACKS OF MAJOR STORMS

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

DATE: FEB. 1990 FILE NO. H-2-30618

PLATE 4

HOURS REFERENCE TO LANDFALL	AVERAGE GULF ELEVATION	AVG. LAKE SALVADOR BASIN ELEVATION	AVG. WATER SURFACE ELEVATION IN CHANNEL	ΔZ	$\frac{1.49}{NYL}$	CHANNEL AREA	R	$R^{2/3}$	ΔH	$\sqrt{\Delta H}$	Δt	($Q\Delta t$) FLOW INTO LAKE SALVADOR BASIN	ΔZ^*	Δ RAINFALL	MEAN BASIN ELEVATION
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	FT. N.G.V.D	FT. N.G.V.D	FT. N.G.V.D	FEET		1000 Sq. Ft.	FEET	FEET	FEET	FEET	SECONDS	C.F.S.	FEET	FEET	FT. N.G.V.D
0															1.78
	11.18	1.91	6.54	0.26	0.076	1105	6.54	3.497	9.27	3.045	3600	3,219,300	0.25	0.05	
+1															2.08
	11.02	2.20	6.61	0.24	"	1120	6.61	3.522	8.82	2.970	3600	3,205,400	0.25	0.05	
+2															2.38
	10.24	2.59	6.42	0.42	"	1080	6.42	3.451	7.65	2.766	7200	5,641,100	0.43	0.19	
+4															3.00
	8.52	3.15	5.84	0.30	"	985	5.84	3.243	5.37	2.317	7200	4,050,000	0.31	0.16	
+6															3.47
	6.30	3.56	4.93	0.17	"	830	4.93	2.877	2.74	1.655	7200	2,177,600	0.17	0.04	
+8															3.68
	3.98	3.70	3.84	0.04	"	645	3.84	2.452	0.28	0.529	7200	457,800	0.04	0.02	
+10															3.74
	1.98	3.72	2.85	(−) 0.05	0.076	480	2.85	2.010	1.74	1.319	7200	696,400	(−) 0.05	0.02	
+12															3.71

COLUMN

(4) AVERAGE WATER SURFACE ELEVATION BETWEEN LAKE SALVADOR BASIN & MANILA VILLAGE.

(5) (6) ASSUMED INCREMENTAL CHANGE IN LAKE LEVEL FROM MANNING'S FORMULA (n=0.06, L=105,600 or 20MI.)

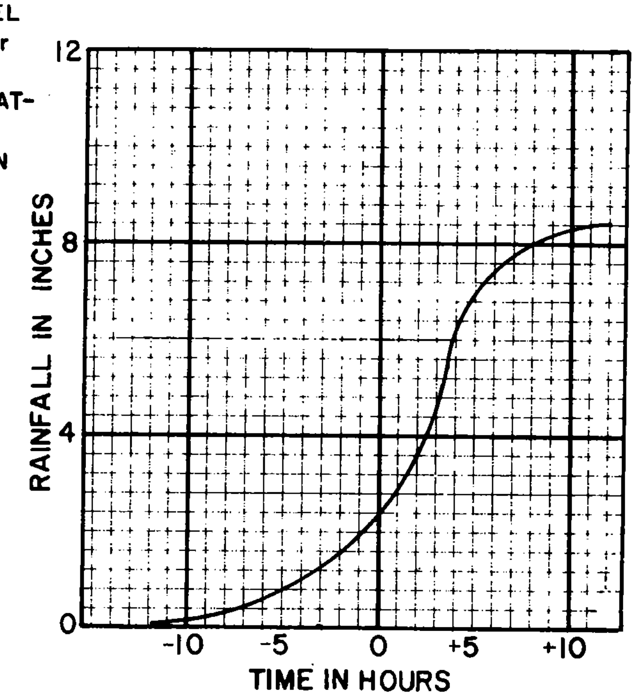
(8) HYDRAULIC RADIUS-SAME AS CHANNEL ELEVATION.

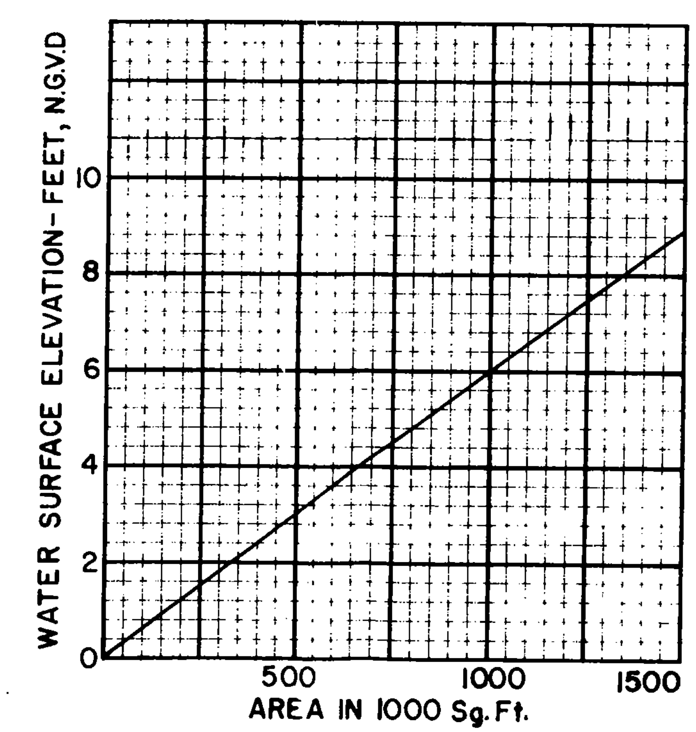
(10) DIFFERENCE BETWEEN LAKE SALVADOR BASIN & MANILA VILLAGE WATER SURFACE.

(13) Q=6x7x9x11x12

(14) COMPUTED

$$\Delta Z^* = \frac{Q}{13{,}034\times10^6 \left(\begin{smallmatrix}\text{BASIN}\\ \text{SURFACE AREA}\end{smallmatrix}\right)}$$





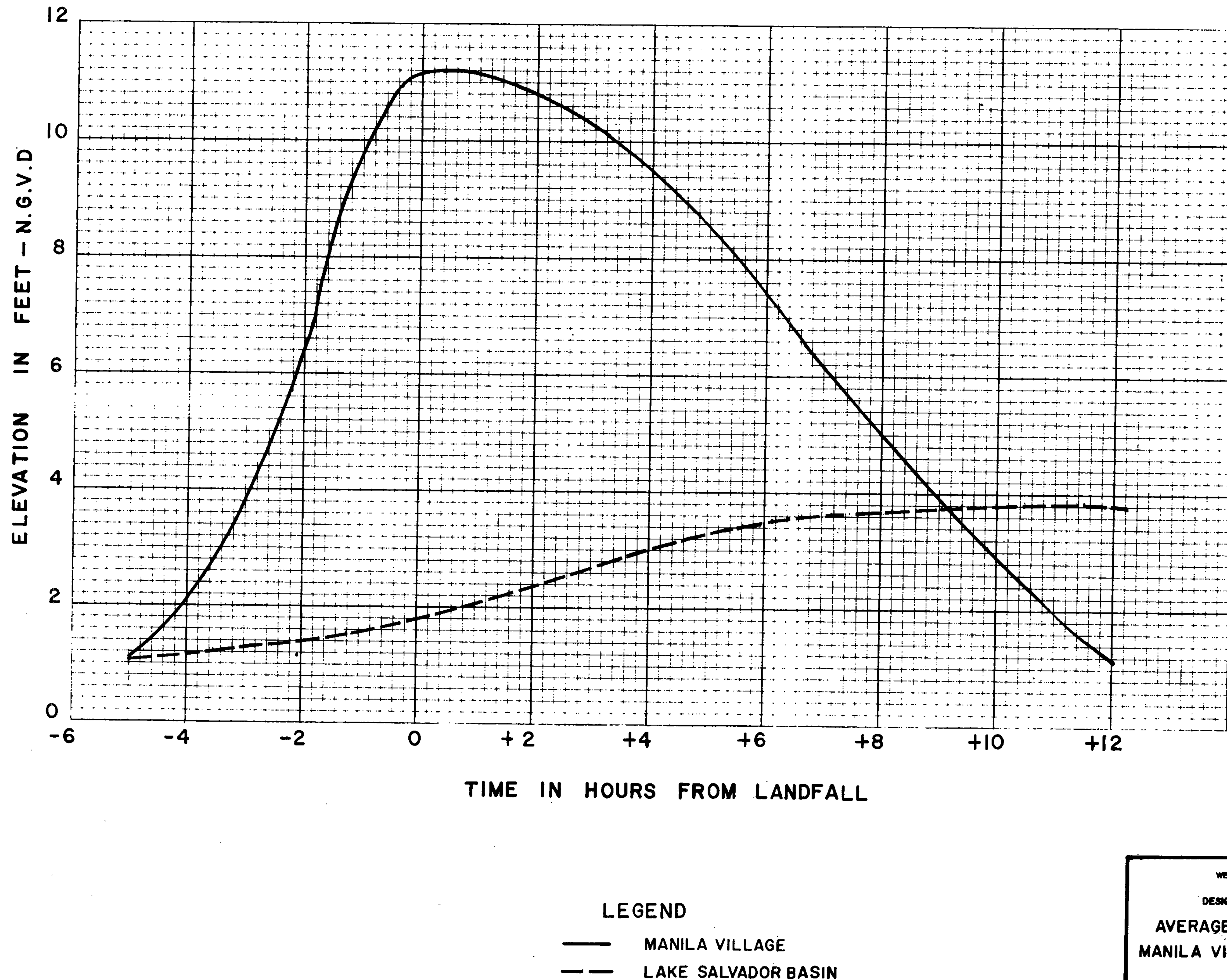
WESTWEGO TO HARVEY CANAL, LOUISIANA
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2

ROUTING INTO LAKE SALVADOR BASIN

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

DATE: FEB. 1990 FILE NO. H-2-30618

PLATE 5



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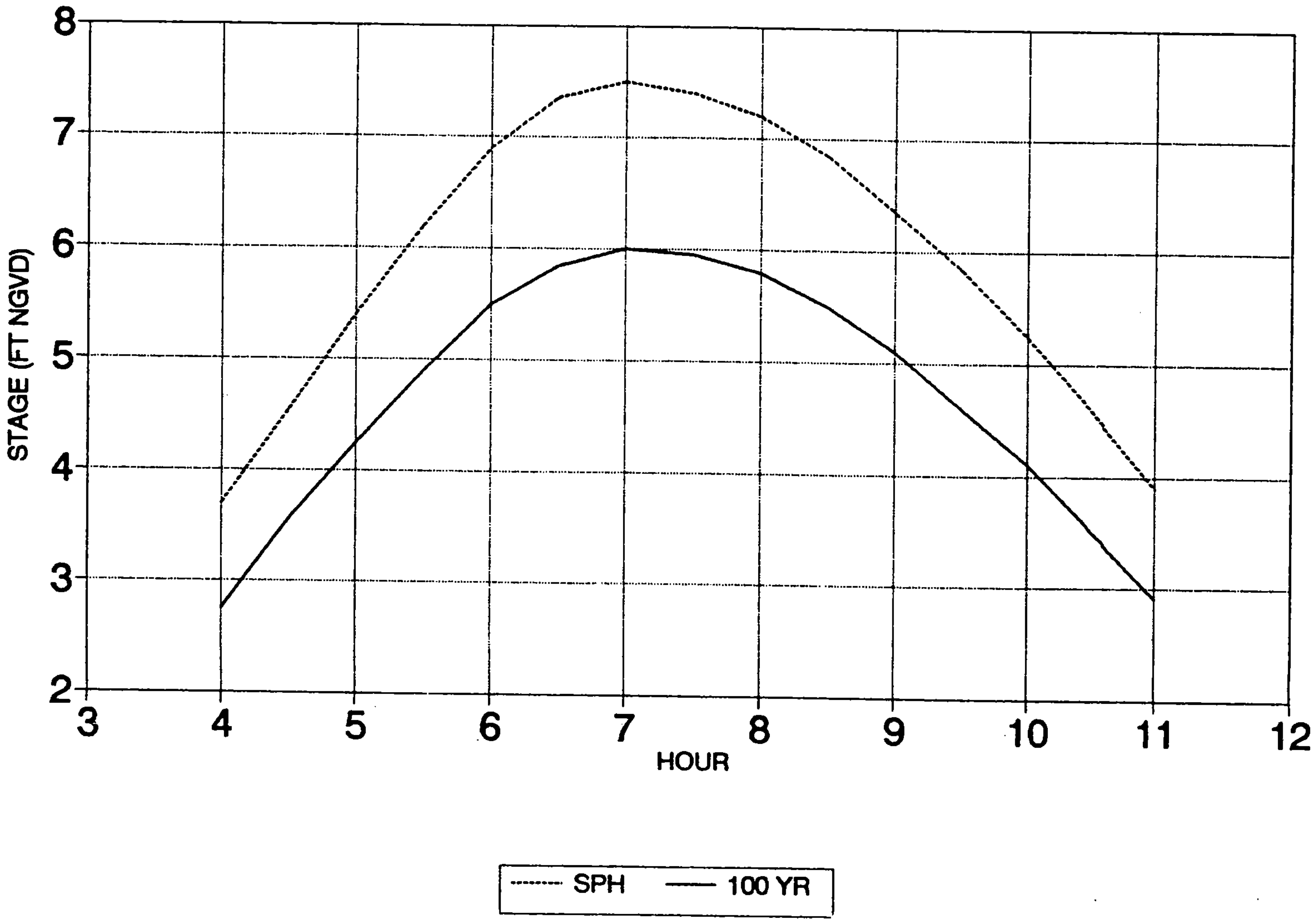
SUPPLEMENT NO. 2

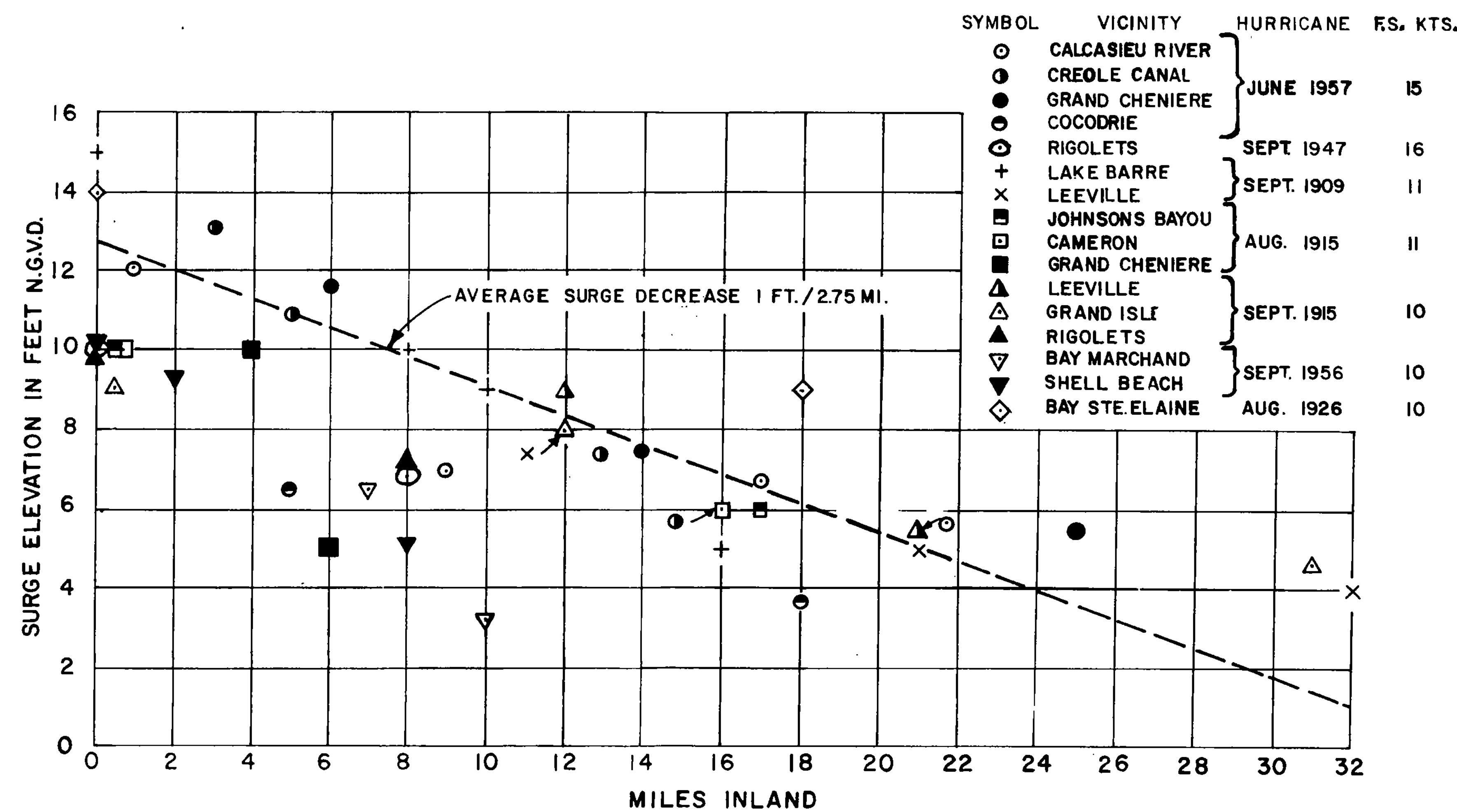
AVERAGE LAKE SALVADOR AND MANILA VILLAGE SPH HYDROGRAPHS

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

DATE: FEB. 1990
FILE NO. H-2-30618

LAKE CATAOUACHE
STAGE-HYDROGRAPH CURVES





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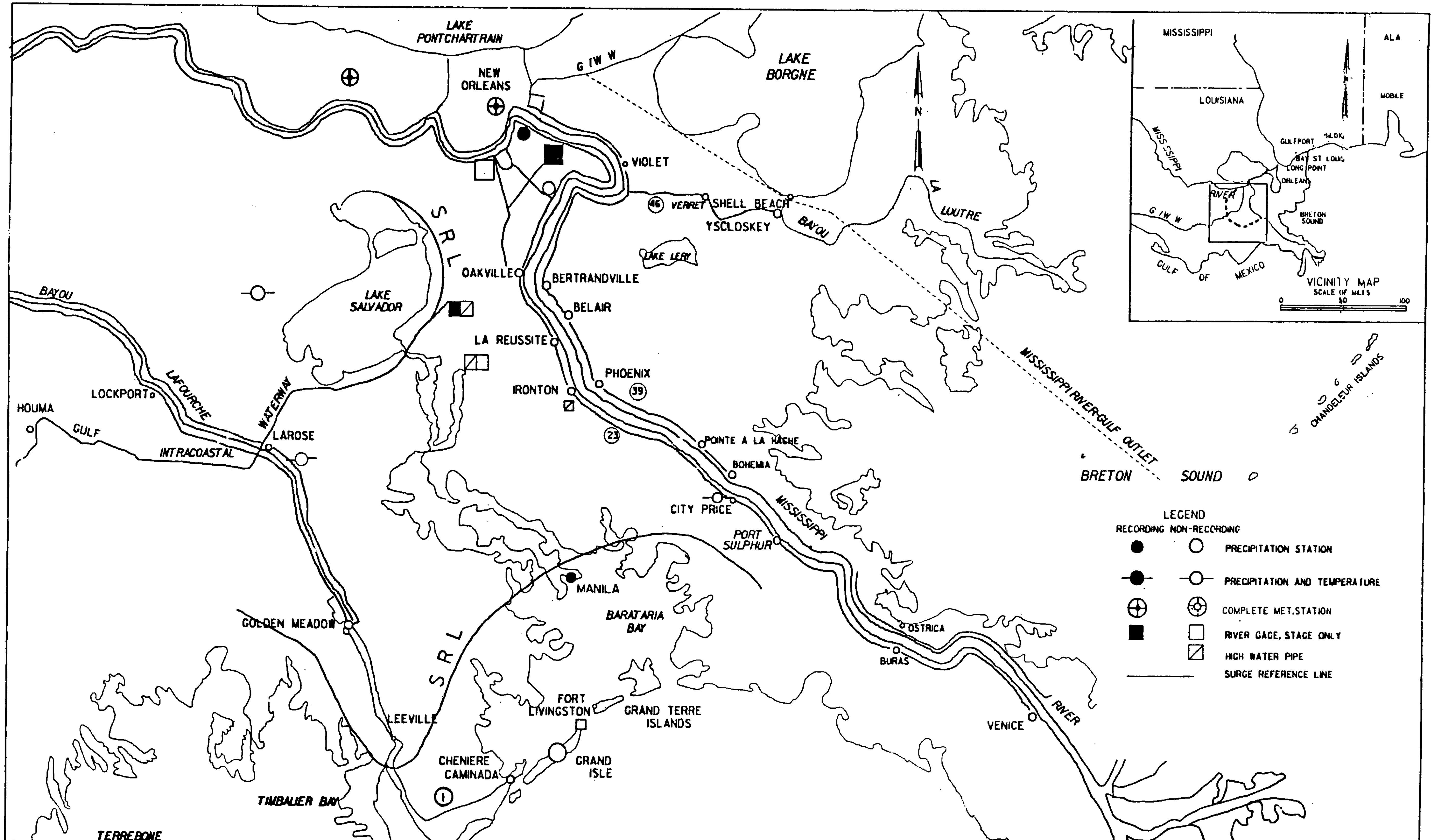
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2

OVERLAND SURGE ELEVATIONS
COASTAL LOUISIANA

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

DATE: FEB. 1990 FILE NO. H-2-30618

PLATE 8



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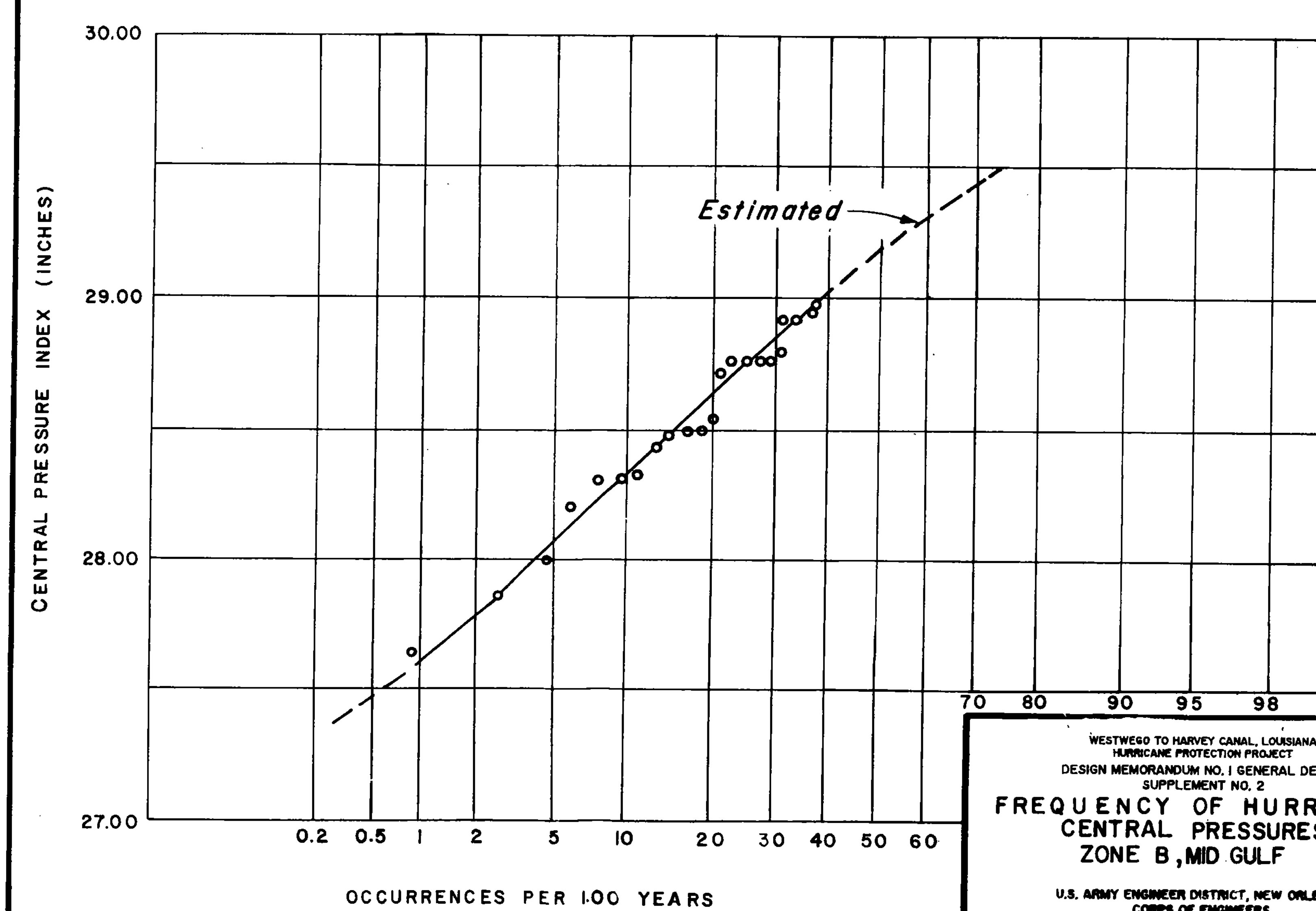
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2

METEOROLOGICAL STATIONS
AND
SURGE REFERENCE LINE

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

DATE: FEB 1990 FILE NO. H

PLATE 9



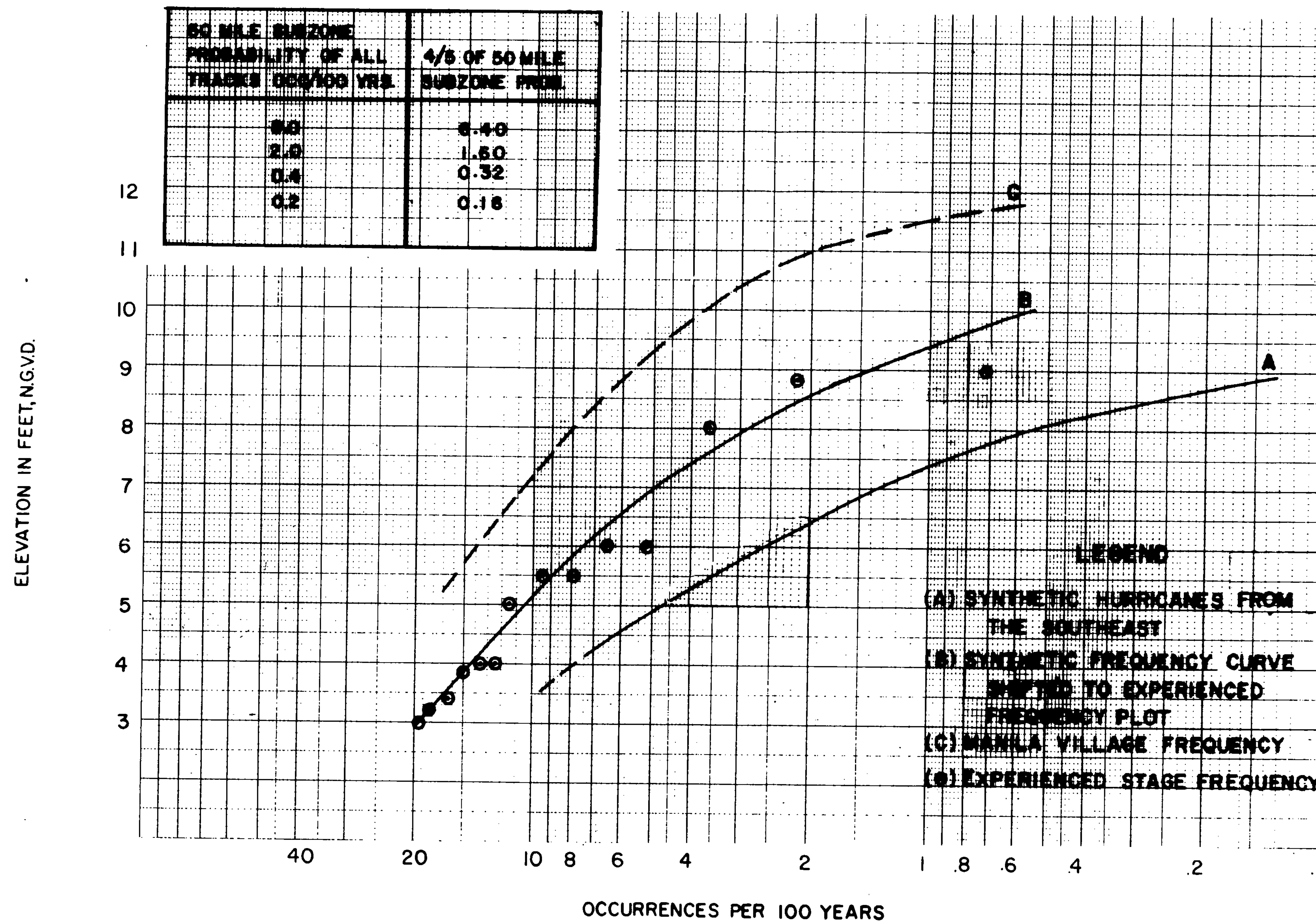
WESTWEGO TO HARVEY CANAL, LOUISIANA
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2

FREQUENCY OF HURRICANE CENTRAL PRESSURES ZONE B, MID GULF

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

DATE: FEB. 1990 FILE NO. H-2-30618

PLATE 10



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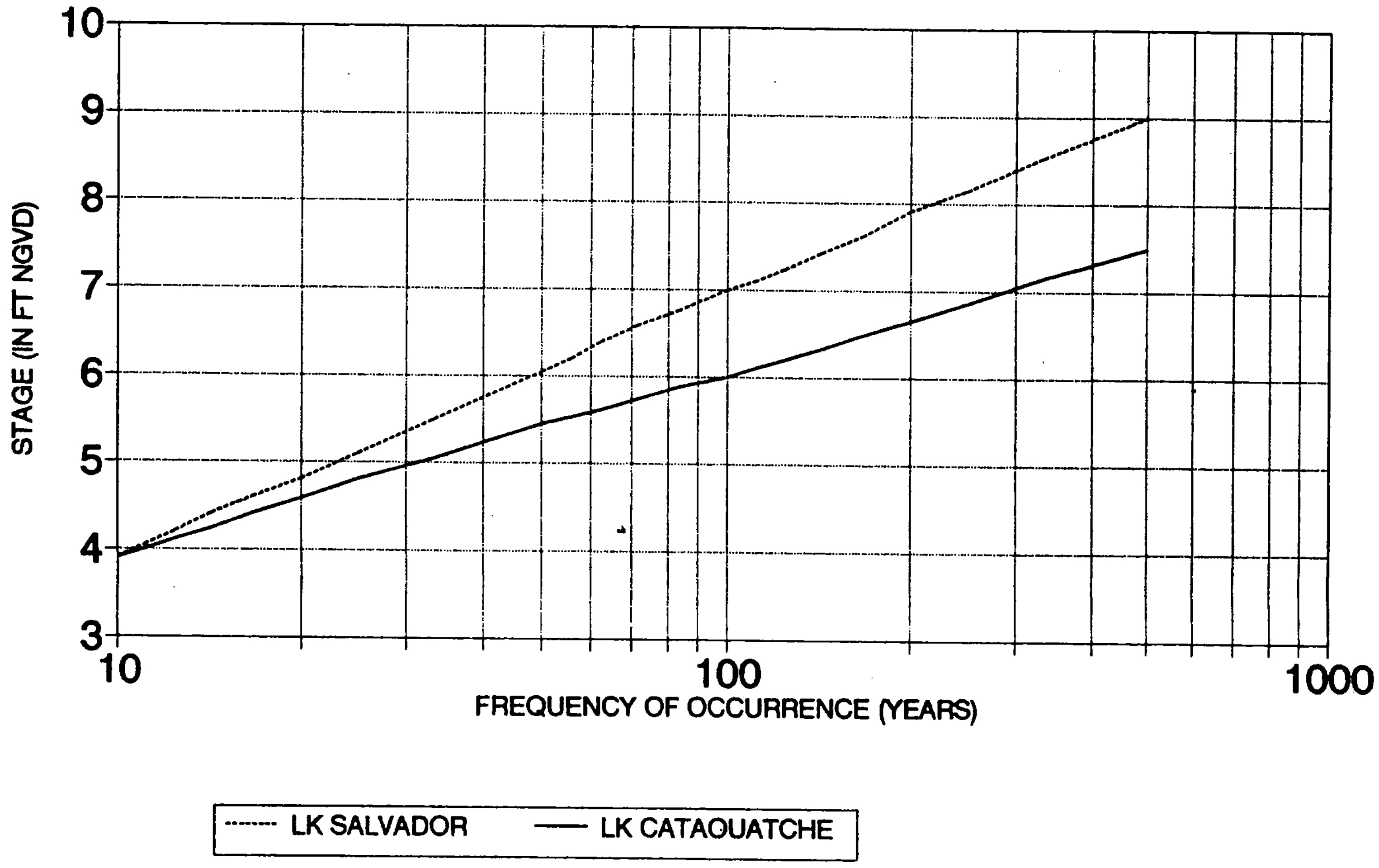
HURRICANE PROTECTION PROJECT
DESIGN MEMORANDUM NO. 1 GENERAL DESIGN
SUPPLEMENT NO. 2

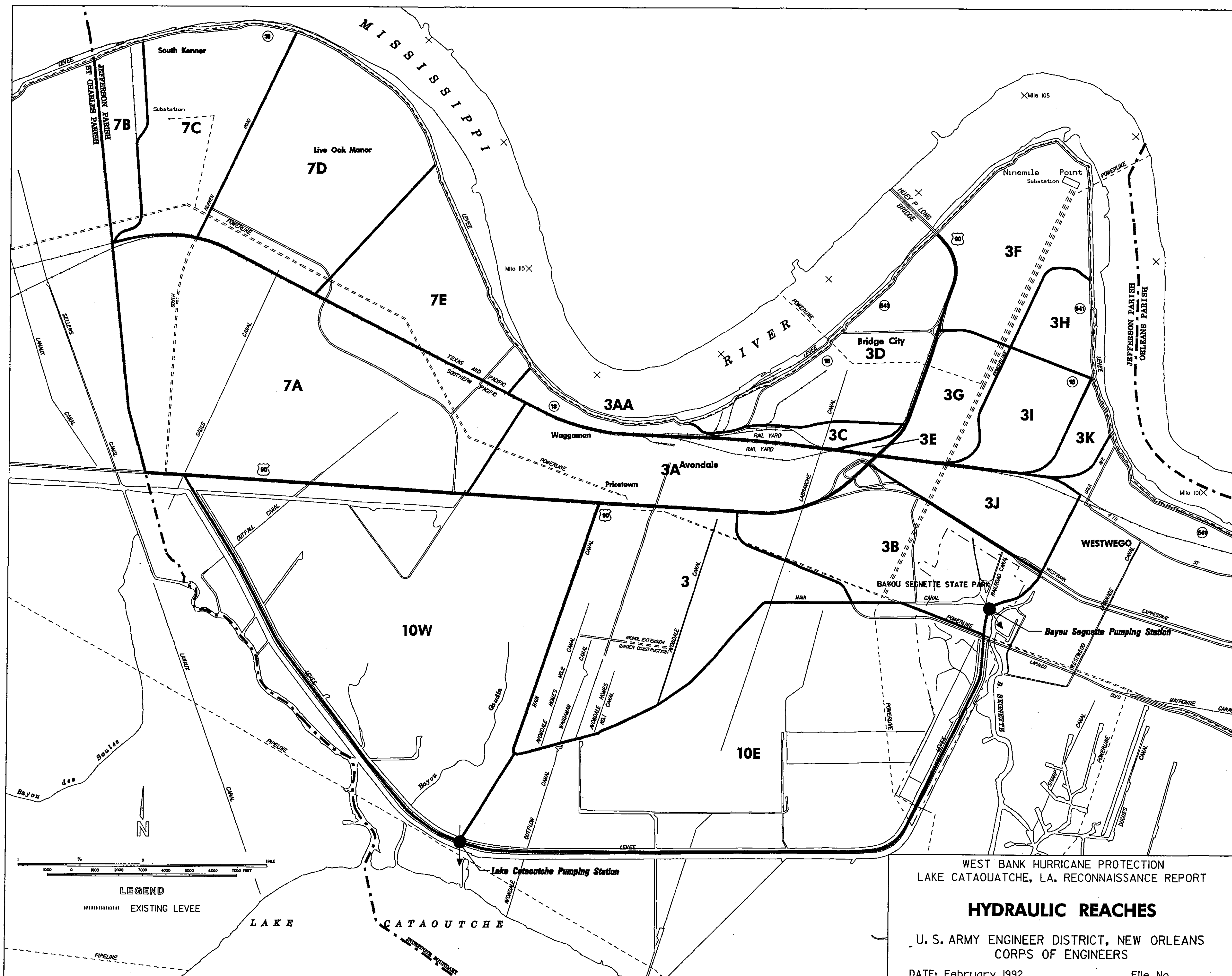
STAGE - FREQUENCY
MANILA VILLAGE

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

DATE FEB. 1990 FILE NO. H-2-30618

LAKE CATAOUATCHE STAGE-FREQUENCY CURVE





WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA. RECONNAISSANCE REPORT

HYDRAULIC REACHES

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

DATE: February, 1992 File No.

Plate 13

WEST BANK HURRICANE PROTECTION

LAKE CATAOUATCHE, LA.

RECONNAISSANCE REPORT

APPENDIX B

ECONOMIC INVESTIGATIONS

NED BENEFITS

The National Economic Development (NED) Procedures described in ER 1105-2-100, dated 28 December 1990, recognize four primary categories of benefits for urban flood control plans: inundation reduction, intensification, location and employment benefits. Jefferson Parish, Louisiana, the project site, does not qualify for inclusion of employment benefits. In addition to the other three primary categories, benefits were also estimated for Federal Insurance Administration costs saved, emergency and reoccupation costs saved, and savings in construction of another authorized project.

INUNDATION REDUCTION BENEFITS

Most benefits from a hurricane protection project result from the reduction of actual or potential damages due to inundation. Physical inundation reduction damages include structural damages to buildings and losses to contents. To the extent that land use is the same with or without a project, benefits accrue primarily through the reduction in actual or potential damages associated with existing and future land use characteristics. Physical damages are evaluated separately for residential and commercial properties.

Survey Of Structures And Methodology

The study area surveyed was delineated based on overflows provided by hydraulics branch. Structures at risk were defined as any structure which would flood in the future without-project condition by the 500-year event (SPH). During July 1991, a comprehensive field survey (100% inventory of structures at elevations up to the 5-foot contour) was conducted to identify every structure at risk in the study area. The surveys revealed the number, value, and elevation of all structures located at or below the 5-foot contour. Ground elevations were determined using Federal Insurance Administration maps with 1-foot contour lines. First floor elevations were determined by adding between 0.0 and 2.0 feet to average ground elevations based on visual observations using hand levels to insure accuracy.

There are four main categories of existing land use in the study area: residential, commercial, industrial, and public. Residential property includes single-family and multi-family residences which are owned by the residents individually or cooperatively, by corporations, by government agencies, or by landlords. Commercial property includes retail, wholesale, and distribution operations, warehousing, office and professional buildings, etc. Public property includes civic centers, court houses, schools, park facilities, and others owned by public jurisdiction. The values were calculated using the Marshall and Swift Residential Estimator Program. This continuously price-adjusted computer program uses cost per square foot, geographically localized by zip code, to calculate replacement cost and depreciated cost for each structure. Structure values derived in this manner were applied to similar structures within the same neighborhood.

Within reaches, homogeneous areas were identified based on houses having similar characteristics. These homogeneous areas were used as a basis for determining structure value for a number of houses. These areas ranged in size from one-half block to as large as several blocks. Mobile homes were valued by using an average value per structure based on size.

Approximately 100 commercial structures were inventoried by field survey. Field teams surveyed these structures by reach for pertinent characteristics (i.e., type of business, number of stories, type of foundation and construction, and the physical condition and dimensions of the structure). The Marshall and Swift Commercial Estimator Program was used to determine cost per square foot based on a number of factors. One factor was the use or occupancy of the structure. Marshall and Swift considers over 100 occupancy categories in their program. Buildings are classified by construction types in order to determine the base cost per square foot. The base cost is then adjusted for factors such as heating and cooling, local construction cost, current cost conditions and age and life expectancy of the building. The price per square foot was multiplied by the square footage size of the building to determine a total value for each commercial structure. Occupancy codes were aggregated into 15 established categories for depth damage purposes.

The data collected on all of the inventoried structures was manually transferred to structure files using the Corps of Engineers Editor (COED) computer program. A summary of the inventory, grouped according to reach and structure type, is displayed in Table 2.

TABLE 2

STRUCTURE INVENTORY

REACH	CATEGORY OF STRUCTURES	NUMBER OF STRUCTURES	VALUE OF STRUCTURES
3F	Residential (1-sty)	440	$ 16,534,000
	Residential (2-sty)	9	959,000
	Commercial	12	1,223,000
Sub-Total		461	$ 18,716,000
3	Residential (1-sty)	1,216	$ 42,026,000
	Residential (2-sty)	38	2,116,000
	Commercial	20	3,481,000
	Mobile Homes	21	42,000
Sub-Total		1,295	$ 47,665,000
3G	Apartments	12	$ 2,400,000
	Commercial	9	427,000
Sub-Total		21	$ 2,827,000
10W	Residential	4	$ 44,000
Sub-Total		4	$ 44,000
3A	Residential (1-sty)	1,803	$ 75,797,000
	Residential (2-sty)	38	1,824,000
	Mobile Homes	23	106,000
	Commercial	22	4,232,000
Sub-Total		1,886	$ 81,959,000
3D	Residential (1-sty)	334	$ 7,002,000
	Residential (2-sty)	2	169,000
	Apartments	17	2,363,000
	Commercial	34	1,692,000
Sub-Total		387	$ 11,226,000
TOTAL INVENTORY		4,054	$162,437,000

Automobile values were included with the data. It was assumed that each residence had two automobiles which were placed at 1/2-foot below first floor level. Information as to the number of automobiles per household is based on statistics supplied by the Louisiana Motor Vehicle Division and Census Data supplied from 1990. The use of only two vehicles per household implies that a percentage of automobiles and trucks are not included in flood damage calculations and is intended to account for the unknown number of vehicles which would be in used for normal or evacuation purposes at the time of a flood, and therefore not subject to flooding. The average value for a used automobile was determined to be $6,320.

Damages

During the course of the Lake Pontchartrain Hurricane Protection Project (LPHPP) study, completed in 1984, a contractor was engaged to analyze in detail the structural components of 15 residential structure types to determine the depth-damage relationships for various residential structures. These were further aggregated into three structure types: single-story, two-story, and mobile homes. Since the range of structure types in the study area is virtually identical to those found in the LPHPP study area, use of these data is appropriate. Damage curves developed for the Lake Pontchartrain Hurricane Protection Study were used for the study area. Saltwater curves were chosen over freshwater curves because freshwater curves were only applicable for rainfall associated with the 10-year, or more frequent events. The level of damage produced using freshwater curves is slightly lower than that of saltwater curves and using them for all frequencies would understate damages.

Damage was calculated using the Hydrologic Engineering Center - Flood Damage Analysis Package, the flood plain structure inventory, depth-damage relationships, and stage-probabilities obtained from stage-frequency curves for each reach. The Structure Inventory for Damage Analysis (SID) computer program was used to calculate elevation-damage curves. Zero damage elevations were established and the appropriate increment established to develop well defined elevation-damage curves which were stored in a random access file, the HEC Data Storage System (DSS) file. They were stored under pathnames matching those stored with the elevation-probability data for each reach in the DSS file. One elevation-damage curve was produced for the existing condition and one for each plan of improvement. A summary of actual damages under existing, 100-year protection, and Standard Project Hurricane (SPH or 500-year event) protection conditions for the 10, 100, and 500-year storms is displayed in Table 3.

TABLE 3

ACTUAL DAMAGE FOR 10, 100 AND 500-YEAR STORMS
(In Thousands $)

EXISTING CONDITIONS

Reach	10-Year	100-Year	500-Year
3F	$ 11,871.1	$ 12,480.0	$ 14,248.1
3	1,392.5	34,210.5	53,028.3
3G	120.1	134.5	2,761.8
10W	0.0	0.0	16.5
3A	6,086.5	6,086.5	47,688.3
3D	1,703.5	1,703.5	7,501.6
SUB-TOTAL	$ 21,173.7	$ 54,615.0	$ 125,244.6

PLAN 1d
(Exterior Alignment 100-Year)

Reach	10-Year	100-Year	500-Year
3F	$ 7,637.5	$ 7,637.5	$ 7,637.5
3	112.7	112.7	30,885.4
3G	120.1	120.1	120.1
10W	0.0	0.0	0.0
3A	6,086.5	6,086.5	6,086.5
3D	1,703.5	1,703.5	1,703.5
SUB-TOTAL	$ 15,660.3	$ 15,660.3	$ 46,433.0

PLAN 1c
(Exterior Alignment SPH)

Reach	10-Year	100-Year	500-Year
3F	$ 7,637.5	$ 7,637.5	$ 7,637.5
3	41.8	41.8	41.8
3G	120.1	120.1	120.1
10W	0.0	0.0	0.0
3A	6,086.5	6,086.5	6,086.5
3D	1,703.5	1,703.5	1,703.5
SUB-TOTAL	$ 15,589.4	$ 15,589.4	$ 15,589.4

The HEC Expected Annual Flood Damage Computation (EAD) computer program was used to access the HECDSS file and weigh the damage corresponding to each magnitude of flooding by the percent chance of exceedance and sum the weighted damage to determine the expected annual damage. Damages were calculated for single-family one and two story homes, mobile homes, commercial structures, apartments, and the contents of each. The stage-damage function for residential structures was adjusted to incorporate damages to automobiles. A summary of the expected annual damage and the damage reductions attributable to the 100-year plan is displayed in Table 4. This information is detailed for the 100-year plan (Plan 1d) only and does not include benefits associated with contents or automobiles; the SPH plan (Plan 1c) is not economically feasible.

TABLE 4

EXPECTED ANNUAL DAMAGE AND DAMAGE REDUCTION WITH PLAN 1d (100-YEAR STRUCTURES ONLY) (In Thousands $)

Category	Damages With Existing Conditions	Damages With Plan 1d	Benefits
REACH 3F			
Residential	$ 2,112.04	$ 2,057.49	$ 54.55
Commercial	113.23	112.41	.81
SUB-TOTAL	$ 2,225.27	$ 2,169.90	$ 55.36
REACH 3			
Residential	$ 343.76	$ 61.70	$ 282.07
Commercial	5.13	.14	4.99
Mobile Homes	.61	.12	.50
SUB-TOTAL	$ 349.50	$ 61.96	$ 287.56
REACH 3G			
Apartments	$ 3.40	$ 0.00	$ 3.40
Commercial	12.47	12.18	.29
SUB-TOTAL	$ 15.87	$ 12.18	$ 3.69
REACH 10W			
Residential	$ .02	$ .00	$ .02
SUB-TOTAL	$ .02	$ .00	$ .02
REACH 3A			
Residential	$ 1,964.50	$ 1,878.40	$ 86.09
Commercial	295.41	293.70	1.71
Mobile Homes	.31	.00	.31
SUB-TOTAL	$ 2,260.22	$ 2,172.10	$ 88.11
REACH 3D			
Residential	$ 318.28	$ 310.47	$ 7.81
Commercial	140.57	140.24	.32
Apartments	.92	0.00	.92
SUB-TOTAL	$ 459.77	$ 450.71	$ 9.05
TOTALS	$ 5,310.65	$ 4,866.85	$ 443.79

The analysis of the stage-frequency and elevation-damage curves for Lake Cataouatche revealed that lowerings associated with the 100-year plan are significant enough to generate a positive benefit-cost ratio. A summary of the number of structures in each flood zone is displayed in Table 5.

TABLE 5

SUMMARY OF RESIDENTIAL STRUCTURES BY FLOOD ZONE
BASED ON FIRST FLOOR ELEVATION
WITHOUT-PROJECT
(Non-Cumulative)

REACH	0-10 YEAR	10-50 YEAR	50-100 YEAR	OVER 100 YEAR	TOTAL
3F	449	0	0	0	449
3	16	961	277	0	1,254
3G	0	0	0	0	0
10W	0	0	0	4	4
3A	142	0	0	1,699	1,841
3D	23	0	0	313	336
TOTALS	630	961	277	2,016	3,884

INTENSIFICATION/LOCATION BENEFITS

Indirect Impacts

Indirect impacts of the Lake Cataouatche project could include a more rapid transition of land use from its current use to other purposes, such as industrial and/or commercial purposes; public purposes, e.g., streets, public facilities and services, and utilities; and, residential purposes.

Previous studies of adjacent areas within the New Orleans Metropolitan Statistical Area (MSA, including Jefferson, Orleans, St. Bernard, St. Charles, St. John the Baptist, and St. Tammany Parishes) assumed that the rate of transition of land use or type from 1956 to 1986 increased by an average of 10 percent in the with-project condition.

Changing economic conditions, national as well as local demographic trends, increasing concerns over environmental quality, and other socio-economic considerations, however, indicate that development trends in the metro area will probably experience significantly slower rates of growth in the future, with or without additional flood protection.

Census data indicate that population at the project site increased from 16,657 in 1970 to 25,772 in 1980, but declined to 23,795 in 1990. Total population for the metro area dropped from 1,256,668 in 1980 to 1,238,816 in 1990. Current Population Reports (series P-25) prepared by the Bureau of the Census indicate that beyond 1995 the population of the United States "may grow more slowly than ever before, more slowly than even during the Great Depression of the 1930's..." due to declining birth rates (Gregory Spencer, "Projections of the Population of the United States, by Age, Sex, and Race: 1988 to 2080"). The highest growth series projected by Spencer indicates population growth rates significantly below those previously experienced in the United States and the New Orleans area.

Based generally on these considerations, it was assumed that development trends in the Lake Cataouatche area could be somewhat lower than those experienced from 1956 to 1986. Table 6 compares historical population trends for the New Orleans MSA, the east and west banks of Jefferson Parish, and for Census Tracts and blocks of the West Bank project area.

TABLE 6

POPULATION TRENDS, NEW ORLEANS MSA
AND JEFFERSON PARISH

	1960	1970	1980	1990
New Orleans MSA				
Jefferson Parish	208,769	338,229	454,592	448,306
Orleans Parish	627,525	593,471	557,927	496,938
St. Bernard Parish	32,186	51,185	64,097	66,631
St. Charles Parish	21,219	29,558	37,259	42,437
St. John Parish	18,439	23,813	31,924	39,996
St. Tammany Parish	38,643	63,585	110,869	144,508
TOTAL	946,781	1,099,833	1,256,668	1,238,816
Jefferson Parish				
East Bank	132,950	212,432	274,622	260,709
West Bank	75,819	125,797	179,970	187,597
TOTAL	208,769	338,229	454,592	448,306
PROJECT AREA	N/A	16,657	25,772	23,795

For purposes of evaluating possible mitigation requirements at the project site, estimates of the amount of additional land likely to be converted from rural to more urban purposes over a 100-year project life were assumed to follow trends indicated by the latest (1990) census of population and projections prepared by the U.S. Department of Commerce ("1985 OBERS BEA Regional Projections, Vol.2 Metropolitan Statistical Area Projections to 2035"). Using the latest population estimate for the Lake Cataouatche area and growth trends projected for the New Orleans metro area, projected population for and the estimated additional amount of land which might be required for residential, public, and commercial/industrial uses under with- and without-project conditions were determined.

Population projections for the Lake Cataouatche area were developed for three separate scenarios. The three scenarios were based on the 1990 census data and OBERS projections. The lowest growth rate scenario predicted that the 1990 population would increase at the growth rates indicated by OBERS from 1990 to 2035 then continue to the year 2090 at the rate OBERS had projected for the period from 2015 to 2035. For the mid-range growth scenario, it was assumed that an economic recovery, sufficient to generate the same level of population in the metro area as indicated by OBERS for the year 2035, would occur; for the period from 2035 to 2090 OBERS' lower (2015 to 2035 period) growth rate was applied. For the high range growth scenario it was assumed that the mid-range growth rate would continue beyond 2035 to 2090. Based on the amount of land already protected, the amount of land available for development, and historical population conditions, selection of this high growth scenario was deemed appropriate. It was assumed that the rate of growth under with-project conditions would be 10 percent higher than under the without-project conditions. Table 7 summarizes population trends under each condition.

TABLE 7

LAKE CATAOUATCHE PROJECT AREA
POPULATION PROJECTIONS
1990 TO 2090

	1990	2000	2015	2035	2090
First Scenario:					
Without-Project	23,795	24,800	26,700	28,000	32,000
With-Project	23,795	24,900	27,000	28,500	33,000
Second Scenario:					
Without-Project	23,795	25,100	27,300	30,500	34,800
With-Project	23,795	25,300	27,700	31,300	36,200
Third Scenario:					
Without-Project	23,795	25,100	27,300	30,500	41,400
With-Project	23,795	25,300	27,700	31,300	43,700

Growth rates ranged from a low of 0.241 percent annually to as much as 0.6107 percent annually during various time periods and under with- and without-project conditions. For example, the second scenario assumes that under without-project conditions population would increase at an annual compound rate of 0.5552 (or 0.56) percent from 1990 to 2035; and under with-project conditions growth would occur at an annual rate of 0.6107 (or 0.61) percent. To predict population growth trends for the 55-year period from 2035 to 2090 under without-project conditions, we applied a lower compound annual growth rate of 0.241 percent (as indicated by OBERS' projection for the New Orleans MSA from 2015 to 2035). A ten percent higher growth rate (1.10 x 0.241 = 0.2651) was applied for the with-project conditions.

To determine the amount of additional land required under these conditions, a land use factor of 0.116 was applied to the population growth trends. This factor was based on the 1990 Census number of persons per household in the New Orleans MSA (2.7); an estimated amount of land required for an average housing unit (0.2238 acres); an additional 20 percent which may be needed for future public facilities, services, and utilities; and another 20 percent for future commercial and industrial development; (0.2238 acres/2.7 persons per housing unit x 140 percent = 0.1160 acres/persons). See also page I-15 of the Hebert/Smolkin Associates, Inc., report "Eight to 25-Year Housing and Land Needs Analysis for West Bank Jefferson" 7 June 1988, unpublished report prepared in conjunction with the CIT Corp permit application. Hebert/Smolkin's analysis assumed that a trend toward lower density levels and more single-family houses will occur. It is felt this future assumption is speculative in view of recent economic conditions, nationally as well as locally. The estimated land requirement per person was then applied to the population trends projected from 1990 to 2090, with and without the project. Table 8 displays additional urban land use requirements at the project area under these conditions. The acreage figures for with- and without-project conditions indicate additional land developed during the previous period; and the "cumulative" figures include acreages projected in previous periods.

TABLE 8

LAKE CATAOUATCHE PROJECT AREA, ADDITIONAL LAND USE FOR URBAN PURPOSES UNDER WITH- AND WITHOUT-PROJECT CONDITIONS
(In Acres)

	1990	2000	2015	2035	2090
First Scenario:					
Without-Project	--	117	220	151	464
(Cumulative)	--	117	337	488	952
With-Project	--	128	244	174	522
(Cumulative)	--	128	372	546	1,068
Second Scenario:					
Without-Project	--	151	255	371	499
(Cumulative)	--	151	406	777	1,276
With-Project	--	175	278	418	568
(Cumulative)	--	175	453	871	1,439
Third Scenario:					
Without-Project	--	151	255	371	1,264
(Cumulative)	--	151	406	777	2,041
With-Project	--	175	278	418	1,438
(Cumulative)	--	175	453	871	2,309

Review of field notes used in previous studies indicate that there are at least 1,700 acres of non-wet undeveloped land within this area. In order to insure that the impacts associated with project induced development would not be understated, the third scenario was chosen to determine mitigation requirements. Over the 100-year project life, the without-project conditions would yield an annual growth rate of .56 percent and the with-project conditions would yield an annual growth rate of .61 percent. By the end of 2090, the additional protection offered by the project was assumed to induce development on approximately 268 acres. Assuming a 100-year project life and 8-1/2 percent interest rate, this translates to approximately 23.4 acres on an average annual basis. Compensation for this impact was fulfilled via the purchase of lands for mitigation purposes ($167,000 first costs.)

Quantification Of Intensification/Location Benefits

Any intensification/location benefits associated with more rapid transition of land use from its current use to other purposes, along with any creditable inundation reduction benefits on future growth, will be fully addressed and quantified during the feasibility phase of the project.

FEDERAL INSURANCE ADMINISTRATION COSTS SAVED

The net cost of the Federal Flood Insurance Program is the cost of administration, which is $77 per policy. Reduction or elimination of this cost is considered an indirect benefit of the project. In order to determine this benefit, all of the one and two-story single family residences and apartment buildings in the project area were considered. The Structure Inventory for Damage Analysis (SID) computer program grouped these structures into the following flood zones based on first floor elevation: 0 to 10 years, 10 to 50 years, 50 to 100 years, and over 100 years. The Federal Insurance Administration (FIA) indicated that the percentage of properties covered by flood insurance in each flood zone was 80, 60, 50, and 0 percent, respectively.

A comparison was then made of the number of structures in each flood zone category under existing conditions and under the 100-year project alternative to determine the number of structures no longer within the 100-year flood plain of each zone. This number was multiplied by the estimated proportion of structures with flood insurance coverage and by the annual administrative cost per policy in order to assign a monetary value to the benefit.

The gross benefit of the project totaled $93,940. However, because the FIA estimates that 30 to 50 percent of the property owners will continue to maintain flood insurance coverage, the benefit was reduced accordingly. The monetary value of the benefit was reduced by 40 percent to $56,364 ($56,000 rounded).

EMERGENCY AND REOCCUPATION COSTS SAVED

Emergency Costs Saved

Benefits attributed to this category are defined as the elimination or lowering of emergency costs. The costs incurred as a result of flooding in the West Bank of Jefferson Parish (see next paragraph) were estimated for the following aspects of emergency operations: (1) Law Enforcement overtime (Sheriff's Office and City Police), (2) Department of Emergency Management overtime and food supplies for persons in the Emergency Operations Center, (3) Department of Public Works overtime for cleanup, placement of barricades, sand, sandbags, etc., and (4) Mosquito and Rodent Control Department overtime and supplies.

During October 1985, Hurricane Juan, after making one loop off the Louisiana coast and another loop onshore, eventually returned to the Gulf and made final landfall in the Florida Panhandle area. The storm affected Louisiana's weather for 4-5 days and the study area received widespread damages and incurred extensive emergency costs. Gages on the Harvey Canal indicated that the hurricane produced stages equivalent to a storm with an annual probability of .0167 (once in 60 years). Although this was not a typical 60-year hurricane, that frequency has been assigned in order to compute average annual emergency costs. The total emergency costs and damages to property for the West Bank of Jefferson Parish for Hurricane Juan was estimated at approximately $5 million. With a total of 21,090 structures on the West Bank of Jefferson Parish, this would mean an average of $237 of emergency costs per structure flooded above first floor elevation.

In order to determine average annual emergency costs, the emergency costs for storms of different frequencies of occurrence must be known. The number of structures flooded above first floor elevation for the 10, 25, 50, 100, and 500-year storm events were provided by SID program outputs for the base and with-project conditions. These numbers were then multiplied by the $237 average emergency cost per structure, in order to establish frequency-damage relationships. Finally, these relationships were entered into the Hydrologic Engineering Center's (HEC) Expected Annual Flood Damage Computation (EAD) program to determine the average annual costs for the project conditions.

Because fewer structures will flood with the project in place, a frequency-damage relationship with lower damages was entered into the EAD program. The portion of the average annual figure that will be reduced by the project is considered the emergency costs saved.

Reoccupation Costs Saved

Benefits attributed to this category are defined as the elimination or lowering of reoccupation costs. These costs result from the flooding of residential structures at or above first floor elevation, and include the many hours that homeowners spend to contract, supervise, and inspect repairs, to clean and disinfect their homes, and to fill out casualty loss forms for flood insurance and other disaster assistance. Interviews with former flood victims in the Amite River and Tributaries project area were used to determine the hours spent on the aforementioned tasks.

According to the President of the Amite River Citizens Organization, the average time spent in flood clean-up per household totaled 170 hours. We reviewed this estimate and reduced it to 115 hours. Because the homeowners were forced to forego other activities, including work time, during the flood aftermath, an opportunity cost was assigned. This was determined to be $11.23 per hour. This is the average hourly wage for SMSA New Orleans for employees covered under the Louisiana Employment Securities Law as of the third quarter of 1990. Thus, the total reoccupation costs for each household is $11.23 x 115 hours or $1,291.

In order to determine average annual reoccupation costs, the reoccupation costs for storms of different frequencies of occurrence must be known. The $1,291 cost per household was multiplied by the number of structures flooded above first floor elevation for events of 5 different frequencies of occurrence in the study area to develop a frequency-damage relationship. The frequency-damage relationship was entered into the EAD program to determine average annual reoccupation costs.

Because fewer structures will flood with the project in place, a frequency-damage relationship with lower damages was entered into the EAD program. The portion of the average annual figure that will be reduced by the project is considered the reoccupation costs saved. These reductions in reoccupation costs and emergency costs for the selected plans are shown in Table 9.

TABLE 9

AVERAGE ANNUAL REOCCUPATION AND EMERGENCY COSTS BENEFITS

	Plan 1d		Plan 1c	
EXISTING CONDITIONS	100-YEAR DAMAGES	DAMAGES REDUCED	SPH DAMAGES	DAMAGES REDUCED
$272,000	$197,000	$75,000	$188,000	$84,000

SAVINGS TO CONSTRUCTION OF AN AUTHORIZED PROJECT

The Lake Cataouatche levee will also eliminate the need for the West Side Closure feature authorized under the Westwego to Harvey Canal, Hurricane Protection Project, thereby saving the average annual costs for that floodwall. The additional benefits attributable to the project associated with the savings to construction amounts to $377,000 on an average annual basis.

AVERAGE ANNUAL BENEFITS AND COSTS

The economic justification of the plans given detailed consideration was determined by comparing estimates of the average annual costs and average annual benefits which are expected to accrue over the life of the project (100 years.) Participation in a project by the Federal Government normally requires that average annual benefits equal or exceed average annual costs.

The values estimated for benefits and costs at the time of accrual were made comparable by conversion to an equivalent time basis using a designated interest rate. The interest rate used in this analysis is 8-1/2 percent. The period of analysis, or project life, utilized in the analysis is 100 years. The benefits and costs are expressed as the average annual value of the present worth of all expenditures and all plan outputs. These expenditures and outputs are measured at a specific point in time (base year). The base year, is the year in which the project becomes operational or when significant benefits start to accrue. The construction period for this project is 2 years.

Guidelines indicate that specific analysis is required for the storm with a frequency of .002 (every 500 years or SPH). This analysis will be presented in the feasibility study. Although implementing less than the SPH level of protection would increase the risk of endangering lives and property in the study area, the SPH plan was not economically feasible.

With the project in place, estimated damages would be limited to the effects of rainfall. The total benefits of the project include the benefits anticipated over the 100-year project life after project completion.

The benefits of each plan were compared with the costs of each plan to determine the benefit-cost ratio as shown in Table 10.

TABLE 10

BENEFIT-COST SUMMARY

	PLAN 1d	PLAN 1c
First Costs Construction	$ 13,000,000	$ 19,000,000
Real Estate Costs	6,000	6,000
Mitigation Costs	167,000	167,000
Total First Costs	$ 13,173,000	$ 19,173,000
Interest During Construction	1,131,500	1,647,000
Gross Investment	$ 14,304,500	$ 20,820,000
Average Annual Costs		
Interest & Amortization (0.08502)	$ 1,216,000	$ 1,770,000
Operation and Maintenance	22,000	24,000
Total Average Annual Costs	$ 1,238,000	$ 1,794,000
Average Annual Benefits		
Inundation Reduction	$ 1,022,000	$ 1,210,000
FIA Costs Saved	56,000	56,000
Emergency & Reoccupation	75,000	84,000
Savings to Construction ($ 4,260,000)		
Gross Investment ($ 4,437,000)		
Interest & Amortization (0.08502)	377,000	377,000
Total Average Annual Benefits	$ 1,530,000	$ 1,727,000
Benefit-Cost Ratios	1.2 to 1	.96 to 1
Net Benefits	$ 292,000	($ 67,000)

SENSITIVITY ANALYSIS

General

Risk and uncertainty are implicit in many aspects of planning for water resource projects such as the West Bank Hurricane Protection Lake Cataouatche, Louisiana, project, even though every attempt is made to project the most probable future for each of the variables which must be considered. Guidance for the evaluation of risk and uncertainty, and the sensitivity analyses to be conducted, is contained in the National Economic Development Procedures Manual, ER 1105-2-100, dated 28 December 1990. This regulation states that "Sensitivity analysis is the technique of varying assumptions about economic, environmental, and other factors, to examine the effects on the resulting benefits and costs. This can include variation of model parameters as well as variation of higher level benefits, cost, and safety components. One of the important uses of sensitivity analysis is to investigate what alternative values of certain critical assumptions and parameters are necessary to change report recommendations or to cause feasible projects to become infeasible, and vice versa." The purpose of this sensitivity analysis was to determine how sensitive plan 1d was to two variables (hydraulic data and structure value) used in the calculation of economic benefits. Other areas where risk and uncertainty may exist will be investigated further in the feasibility phase of this project.

Changes In Hydraulic Data

An analysis was performed for Reach 3 (this reach accounts for approximately 57 percent of the flood damage reduction benefits) to approximate how a given change in stage-frequency data under existing conditions would affect the level of expected annual damages and the level of benefits claimed for Plan 1d.

An upper confidence limit of 5 percent was used along with a lower confidence limit of 95 percent. The use of these limits would mean that any stage that fell within the two limits would have an overall confidence level of 90 percent.

Table 11 shows the results of the analysis. By using the 5 percent confidence limit, benefits are increased by $50,000. Whereas by using the 95 percent confidence limit, benefits are reduced by $64,000. Net benefits for Plan 1d are $229,000 thereby having a minimal overall effect on the feasibility of the plan.

TABLE 11

SENSITIVITY ANALYSIS
CONFIDENCE INTERVAL - EXISTING CONDITIONS
REACH 3
(In Thousands)

Existing Damages	Damages At The 95% Confidence Limit	Reduction In Benefits At The 95% Confidence Limit	Percent Damages Overstated
$ 689.66	$ 626.00	(-$ 63.66)	10%

AVERAGE ANNUAL BENEFITS = $ 1,466,000
BENEFIT/COST RATIO = 1.2 to 1

Existing Damages	Damages At The 5% Confidence Limit	Additional Benefits At The 5% Confidence Limit	Percent Damages Understated
$ 689.66	$ 739.62	$ 49.96	7%

AVERAGE ANNUAL BENEFITS = $ 1,580,000
BENEFIT/COST RATIO = 1.3 to 1

Structure Value Adjustments

Structure value adjustments were made to all residential structures located in Reach 3. By lowering the quality of the structures from Average Quality to Fair to Average Quality, the Marshall & Swift program computed a figure that would lower each structure by approximately $5,000. The new structure values were then re-entered into the Structure Inventory For Damage Analysis (SID) Program. The results are shown in Table 12.

TABLE 12

SENSITIVITY ANALYSIS
Adjustments To Structure Values
Reach 3

Structure Value	Existing Damages	Damages Prevented	Benefits	Difference Between Existing Benefits
Existing	689.64	109.75	579.89	-
+ $5,000	772.86	122.92	649.94	+ 70.05
- $5,000	606.45	94.39	512.06	(- 67.83)

Structure Value	Average Annual Benefits	B/C Ratio
Existing	$1,530,000	1.2 to 1
+ $5,000	$1,600,000	1.3 to 1
- $5,000	$1,462,000	1.2 to 1

By lowering structure values by $5,000 per structure, the total damages under existing conditions were lowered by 14 percent. By raising structure values by $5,000 per structure, the total damages under existing conditions were raised by 12 percent. In both cases, the benefit-cost ratio was not significantly impacted by the results. Therefore, the overall affect of this analysis on the project would be negligible.

WEST BANK HURRICANE PROTECTION

LAKE CATAOUATCHE, LA.

RECONNAISSANCE REPORT

APPENDIX C

FOUNDATIONS INVESTIGATIONS

FOUNDATIONS

General. The investigation and design of the proposed protection covers approximately 50,200 feet of improved levees. The project consists of one reach and one design.

Filed Exploration. Nine borings were made along the existing alignment over a period ranging from 19 March 91 to 8 April 91. All nine were general type borings. The plot of the borings are present on plate 19.

Laboratory Tests. Visual classifications were made on all boring samples and water contents were performed on all cohesive samples. Soil mechanics laboratory tests consisting of consolidated unconfined compression tests (UC), and unit weight determinations were performed on selected samples.

Foundation Conditions. The foundation soils are predominantly fat clays (CH) varying in consistency from very soft to soft. Organic clays exist in some areas down to approximate elevation -16 feet NGVD.

Shear Stabilities.

a. Stability of Levees. Using cross-sections representative of the existing conditions along the proposed alignment, the slopes and berm distance for the proposed levee/I-wall were designed with the existing canal on the floodside and drainage ditch on the protected side. The levee stability was calculated by the "Method of Planes" using design shear strengths determined from "UC" tests and soil strengths in adjacent areas.

A "Factor of Safety" (F.S.) of 1.3 was required for the levee stability and for failures into the canal and ditch. The stability analysis can be seen on Plate C2 & C3.

b. Cantilever I-Wall. I-wall stability and required penetration were determined by the "Method of Planes". A "factor of Safety" was applied to the soil parameters. For the friction angle, the F.S. was applied as follows:

$$\varnothing_d = \arctan(\tan \sigma_a / F.S.)$$

where σ_a = available friction angle
$\varnothing_d$ = developed friction angle

the developed friction angle was used in determining lateral earth pressure coefffficients.

Using the resulting shear strengths, net horizontal water and earth pressure diagrams were determined for movement toward each sheet pile. From the earth pressure diagrams, the summation of overturning moments was determined for various tip penetrations. The depth of necessary penetration is the point of zero summation of moments.

The following design cases were analyzed for determining required penetration:

No significant wave load on the I-wall:

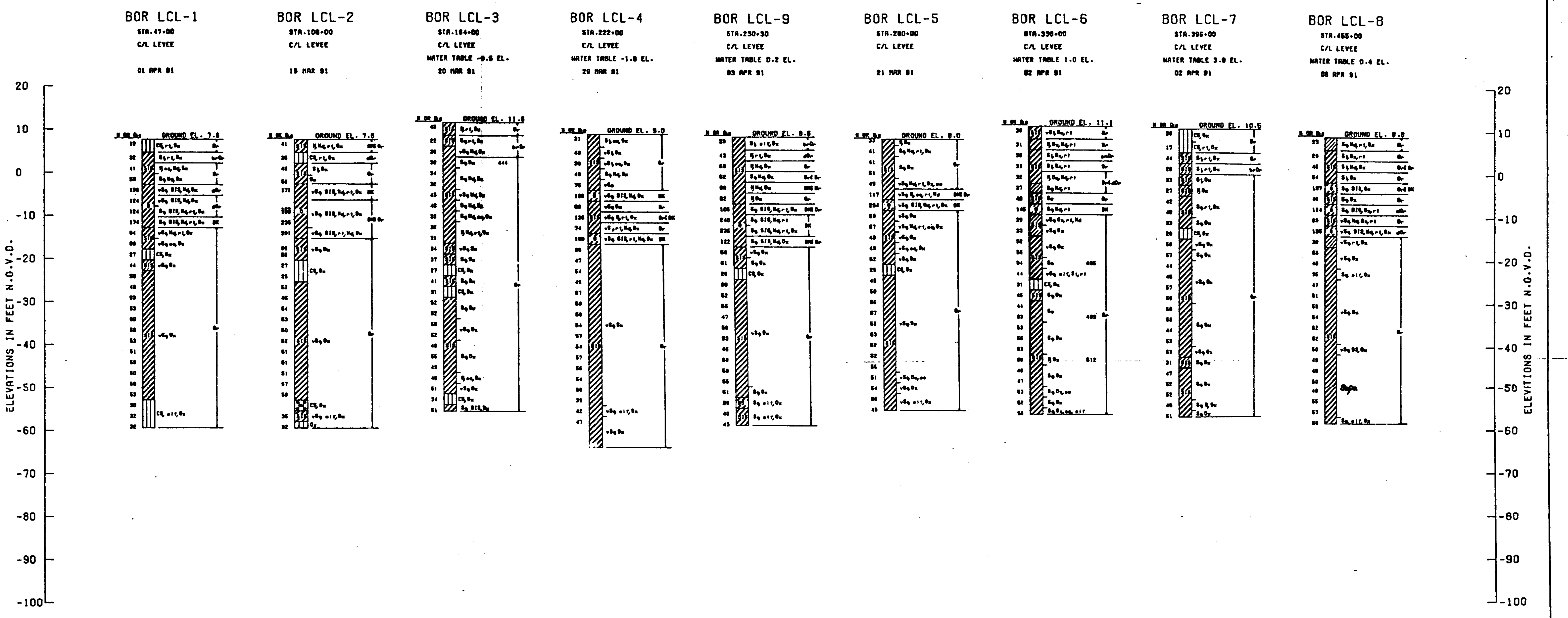
Q-Case

F.S. = 1.5 with static water at a still level (SWL)
F.S. = 1.0 with static water at SWL plus 2 feet
General: If the penetration to head ratio is less than 3:1, then increase it to 3:1.

The most critical design case for the I-wall was the 3:1 penetration to head ratio.

Settlement. The proposed project will be built along the existing levee alignment. This, coupled with the fact that some degrading of the crown will occur for the majority of the job, settlement should be minimal.

Erosion Protection. No protection is considered necessary along the levee other seeding the levees. Any erosion caused by hurricane floods will be restored under normal maintenance.



LAKE CATAOUATCHE, LA. HURRICANE PROTECTION

RECONNAISSANCE STUDY

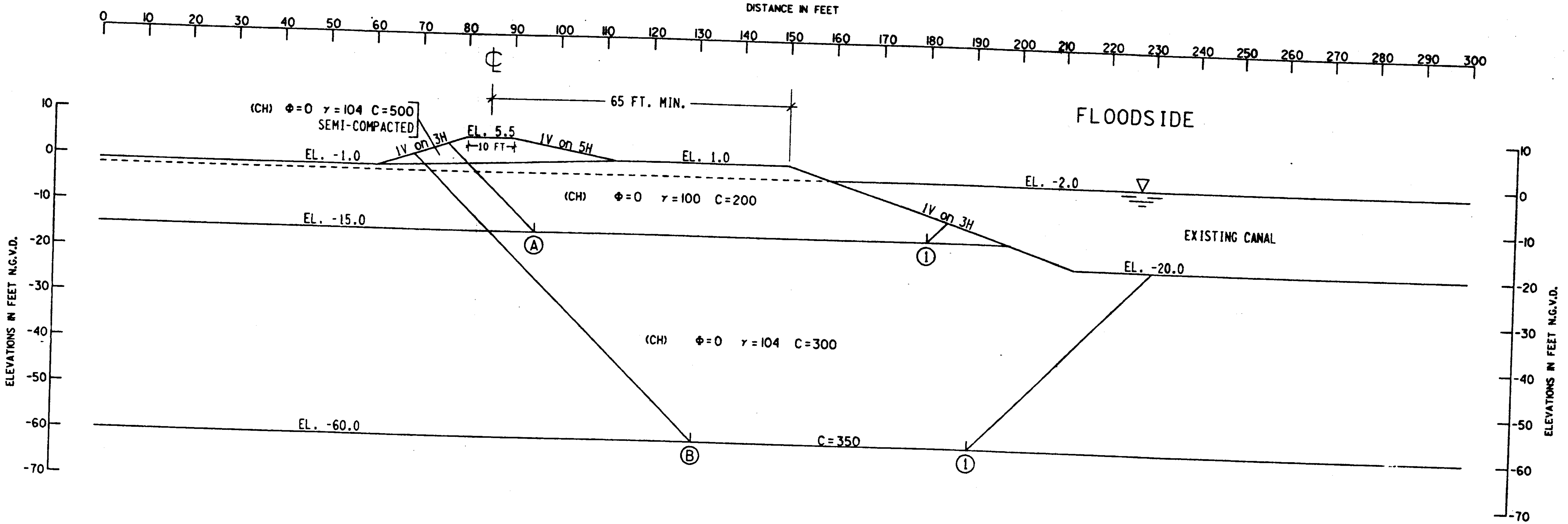
JEFFERSON PARISH, LOUISIANA

SOIL BORINGS

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

DESIGNED BY: DRAWN BY: CHECKED BY:	PLOT SCALE:	PLOT DATE:	CADD FILE: FILE NO.
	DATE: OCT. 1991		

PLATE C1

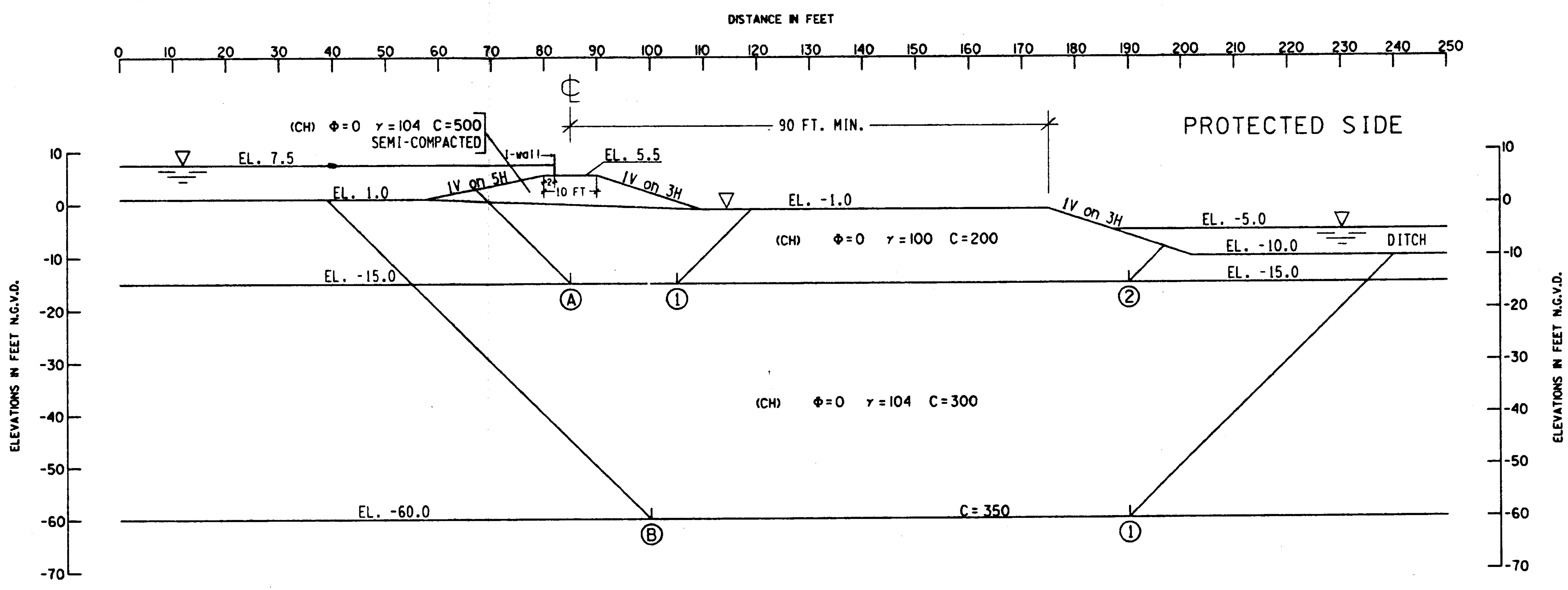


ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
Ⓐ ①	-15.0	10270	17000	1799	20745	5780	29069	14965	1.94
Ⓑ ①	-60.0	34993	21000	24000	203255	141856	79993	61399	1.30

LAKE CATAOUATCHE, LA. HURRICANE PROTECTION
RECONNAISSANCE STUDY
JEFFERSON PARISH, LOUISIANA
SOILS STABILITY
FLOODSIDE ANALYSIS

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

DESIGNED BY: R. VELEZ
DRAWN BY: R. A. IV
CHECKED BY: R. P. LEE
PLOT SCALE: 120
PLOT DATE:
DATE: OCT. 1991
FILE NO.
LKCAT.DGN



ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NO.	ELEV.	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
Ⓐ ①	-15.0	8594	4000	5600	22751	10149	18194	12602	1.44
Ⓐ ②	-15.0	8594	21000	2700	22751	4262	32294	18489	1.75
Ⓑ ①	-60.0	33401	31500	29000	218050	146327	93901	71723	1.31

LAKE CATAOUATCHE, LA. HURRICANE PROTECTION
RECONNAISSANCE STUDY
JEFFERSON PARISH, LOUISIANA
SOILS STABILITY
PROTECTED SIDE ANALYSIS

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

DESIGNED BY: R. VELEZ
DRAWN BY: R. A. IV
CHECKED BY: R. P. LEE
PLOT SCALE: 120
PLOT DATE:
DATE: OCT. 1991
FILE NO. LKCAT.DGN

PLATE C3

WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA.

RECONNAISSANCE REPORT

APPENDIX D
REAL ESTATE COST ESTIMATES

LAKE CATAOUATCHE LEVEE - NO NEW R/W - 26 FEBRUARY 1992

LCPM CHART OF ACCOUNTS - CIVIL WORKS ACTIVITIES
EFFECTIVE 1 OCTOBER 1989

FEDERAL

01---	LANDS AND DAMAGES	4,400
01A--	PRE-AUTHORIZATION PLANNING	
01A1-	Cost Estimates	
01A2-	Acquisition Schedules	
01A3-	Real Estate Design Memorandum	
01A4-	Sponsor Capability Evaluations	
01A8-	All Other	
01B--	POST-AUTHORIZATION PLANNING	400
01B1-	Cost Estimates	100
01B2-	Acquisition Schedules	100
01B3-	Real Estate Design Memorandum	
01B4-	Sponsor Capability Evaluations	
01B8-	All Other	200
01C--	LOCAL COOPERATIVE AGREEMENTS (LCA)	
01C1-	Draft LCA	
01C2-	Final LCA	
01C3-	LCA Negotiations	
01C8	All Other	
01D--	ACQUISITIONS	3,300
01D1-	ATTORNEYS' OPINION OF COMPENSABILITY	2,000
01D11	Document Preparation	2,000
01D12	Document Review	
01D13	LCA Compliance Reviews	
01D18	All Other	
01D2-	MAPPING, SURVEY AND TRACT OWNERSHIP	
01D21	Document Preparation	
01D22	Document Review	
01D23	LCA Compliance Reviews	
01D28	All Other	
01D3-	TITLE EVIDENCE	
01D31	Document Preparation	
01D32	Document Review	
01D33	LCA Compliance Reviews	
01D38	All Other	

01D4-	NEGOTIATIONS AND CLOSINGS	**2,600**
01D41	Document Preparation	1,000
01D42	Document Review	300
01D43	LCA Compliance Reviews	
01D49	All Other	1,300
01D5-	CONDEMNATIONS (PRE-DT FILING)	
01D51	Document Preparation	
01D52	Document Review	
01D53	LCA Compliance Reviews	
01D58	All Other	
01E0-	CONDEMNATIONS (POST-DT FILING)	
01E01	Document Preparation	
01E02	Document Review	
01E03	LCA Compliance Reviews	
01E08	All Other	
01F--	APPRAISALS	
01F1-	STAFF APPRAISALS	
01F11	Document Preparation	
01F12	Document Review	
01F13	LCA Compliance Reviews	
01F18	All Other	
01F2-	CONTRACT APPRAISALS	
01F21	Document Preparation	
01F22	Document Review	
01F23	LCA Compliance Reviews	
01F28	All Other	
01G--	AUDITS	
01G1-	STAFF AUDITS	
01G11	Document Preparation	
01G12	Document Review	
01G13	LCA Compliance Reviews	
01G18	All Other	
01G2-	CONTRACT AUDITS	
01G21	Document Preparation	
01G22	Document Review	
01G23	LCA Compliance Reviews	
01G28	All Other	

01H--	RELOCATION ASSISTANCE	
01H1-	PL 91-646	
01H11	Document Preparation	
01H12	Document Review	
01H13	LCA Compliance Reviews	
01H14	Appeals	
01H18	All Other	
01H2-	Employee Assistance (DARSE)	
01H21	Document Preparation	
01H22	Document Review	
01H32	LCA Compliance Reviews	
01H33	Appeals	
01H38	All Other	
01J--	DISPOSALS	
01J1-	Predisposal Activities	
01J2-	Interim Uses	
01J3-	Excessing Activities	
01J4-	LCA Compliance Reviews	
01J8-	All Other	
01K0-	TEMPORARY PERMITS	**700**
01K01	Document Preparation	300
01K02	Document Review	100
01K03	LCA Compliance Reviews	
01K08	All Other	300
01L--	ENCROACHMENTS AND TRESPASS	
01L1-	Prevention/Detection	
01L2-	Resolution Activities	
01L3-	LCA Compliance Reviews	
01L8-	All Other	
01M--	REAL ESTATE PAYMENTS	
01M1-	Disposal Receipts - Reimbursements (CR) - Lands	
01M2-	Disposal Receipts - General Fund (CR) - Lands	
01M3-	Land Payments	
01M4-	Relocation Assistance Payments (PL 91-646)	
01M5-	Damage Payments	
01M8-	All Other	

LAKE CATAOUATCHE LEVEE - NO NEW R/W - 26 FEBRUARY 1992

LCPM CHART OF ACCOUNTS - CIVIL WORKS ACTIVITIES
EFFECTIVE 1 OCTOBER 1989

NON-FEDERAL

01---	LANDS AND DAMAGES	3,700
01A--	PRE-AUTHORIZATION PLANNING	
01A1-	Cost Estimates	
01A2-	Acquisition Schedules	
01A3-	Real Estate Design Memorandum	
01A4-	Sponsor Capability Evaluations	
01A8-	All Other	
01B--	POST-AUTHORIZATION PLANNING	400
01B1-	Cost Estimates	100
01B2-	Acquisition Schedules	100
01B3-	Real Estate Design Memorandum	
01B4-	Sponsor Capability Evaluations	
01B8-	All Other	200
01C--	LOCAL COOPERATIVE AGREEMENTS (LCA)	
01C1-	Draft LCA	
01C2-	Final LCA	
01C3-	LCA Negotiations	
01C8	All Other	
01D--	ACQUISITIONS	2,600
01D1-	ATTORNEYS' OPINION OF COMPENSABILITY	
01D11	Document Preparation	
01D12	Document Review	
01D13	LCA Compliance Reviews	
01D18	All Other	
01D2-	MAPPING, SURVEY AND TRACT OWNERSHIP	
01D21	Document Preparation	
01D22	Document Review	
01D23	LCA Compliance Reviews	
01D28	All Other	
01D3-	TITLE EVIDENCE	
01D31	Document Preparation	
01D32	Document Review	
01D33	LCA Compliance Reviews	
01D38	All Other	

01D4-	NEGOTIATIONS AND CLOSINGS	**1,300**
01D41	Document Preparation	500
01D42	Document Review	200
01D43	LCA Compliance Reviews	
01D49	All Other	600
01D5-	CONDEMNATIONS (PRE-DT FILING)	
01D51	Document Preparation	
01D52	Document Review	
01D53	LCA Compliance Reviews	
01D58	All Other	
01E0-	CONDEMNATIONS (POST-DT FILING)	
01E01	Document Preparation	
01E02	Document Review	
01E03	LCA Compliance Reviews	
01E08	All Other	
01F--	APPRAISALS	
01F1-	STAFF APPRAISALS	
01F11	Document Preparation	
01F12	Document Review	
01F13	LCA Compliance Reviews	
01F18	All Other	
01F2-	CONTRACT APPRAISALS	
01F21	Document Preparation	
01F22	Document Review	
01F23	LCA Compliance Reviews	
01F28	All Other	
01G--	AUDITS	
01G1-	STAFF AUDITS	
01G11	Document Preparation	
01G12	Document Review	
01G13	LCA Compliance Reviews	
01G18	All Other	
01G2-	CONTRACT AUDITS	
01G21	Document Preparation	
01G22	Document Review	
01G23	LCA Compliance Reviews	
01G28	All Other	

01H--	RELOCATION ASSISTANCE	
01H1-	PL 91-646	
01H11	Document Preparation	
01H12	Document Review	
01H13	LCA Compliance Reviews	
01H14	Appeals	
01H18	All Other	
01H2-	Employee Assistance (DARSE)	
01H21	Document Preparation	
01H22	Document Review	
01H32	LCA Compliance Reviews	
01H33	Appeals	
01H38	All Other	
01J--	DISPOSALS	
01J1-	Predisposal Activities	
01J2-	Interim Uses	
01J3-	Excessing Activities	
01J4-	LCA Compliance Reviews	
01J8-	All Other	
01K0-	TEMPORARY PERMITS	700
01K01	Document Preparation	300
01K02	Document Review	100
01K03	LCA Compliance Reviews	
01K08	All Other	300
01L--	ENCROACHMENTS AND TRESPASS	
01L1-	Prevention/Detection	
01L2-	Resolution Activities	
01L3-	LCA Compliance Reviews	
01L8-	All Other	
01M--	REAL ESTATE PAYMENTS	
01M1-	Disposal Receipts - Reimbursements (CR) - Lands	
01M2-	Disposal Receipts - General Fund (CR) - Lands	
01M3-	Land Payments	
01M4-	Relocation Assistance Payments (PL 91-646)	
01M5-	Damage Payments	
01M8-	All Other	

IDENTIFICATION
NUMBER 11010R

All Earth Levee - SPH

ESTIMATE OF COSTS (Date of Value - October 1991)

		Acres	Unit Value	Total Value
(a)	Lands & Damages			
	Perpetual Levee Right-of-Way Marsh	175	$250	$ 43,750
	Construction Easement (2 years) Marsh	7	250 x .20	350
	Improvements			0
	Severance Damage			0
	Total (R)			$ 44,000
(b)	Contingencies 25% (R)			11,000
(c)	Acquisition Costs (Estimated 10 tracts)			
	Non-Federal			30,000
	Federal			15,000
(d)	PL-91-646			0
(e)	Total Estimated Real Estate Cost			$100,000

1. These preliminary cost estimates are not based on the Chart of Account format. After the most viable alternative is defined, a Chart of Account estimate will be prepared.

2. These estimates are based on the preliminary determination of the existing right-of-way (Inclosure 3) and are subject to change. The local sponsor has been requested to provide data on the existing right-of-way.

3. No estimate is required for the 9.64 acres required for the South Kenner Road Levee. The subject consists of an existing shell road which will be raised in place. Highest and best use has not changed; the after position will be equal to or greater than the before position.

Joseph G. Kopec
JOSEPH G. KOPEC
Appraiser
10 October 1991

Warren E. deSambourg
WARREN E. deSAMBOURG
Review Appraiser
10 October 1991

IDENTIFICATION
NUMBER 11010R

LAKE CATAOUATCHE, LOUISIANA
RECONNAISSANCE STUDY
JEFFERSON PARISH, LOUISIANA

Sheetpile Wall Alternatives

ESTIMATE OF COSTS (Date of Value - October 1991)

		Acres	Unit Value	Total Value
(a)	Lands & Damages			
	Perpetual Levee Right-of-Way Within existing right-of-way			$ 0
	Improvements			0
	Severance Damage			0
	Total (R)			$ 0
(b)	Contingencies 25% (R)			0
(c)	Acquisition Costs *			
	Non-Federal			1,000
	Federal			5,000
(d)	PL-91-646			0
(e)	Total Estimated Real Estate Cost			$6,000

*Nominal hired labor needed for coordination between the local sponsor and the government.

IDENTIFICATION
NUMBER 11105R

LAKE CATAOUATCHE
RECONNAISSANCE STUDY
WESTWEGO TO HARVEY - STATION 0+00 TO STATION 17+45
JEFFERSON PARISH, LOUISIANA

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Industrial	2.39	$43,560	$104,108
	Waterbottoms	0.34	N/A	0
	Improvements			0
	Severance Damage			0
	Total (R)			$104,000
(b)	Contingencies 25% (R)			26,000
(c)	Acquisition Costs (3 Tracts)			
	Federal 3 @ $1,500			5,000
	Non-Federal 3 @ $3,000			9,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$144,000

Judith Y. Gutiérrez
Appraiser
November 5, 1991

Approved By:

Joseph G. Kopec
Review Appraiser
November 5, 1991

IDENTIFICATION
NUMBER 11010R

All Earth Levee - 100-year flood

ESTIMATE OF COSTS (Date of Value - October 1991)

		Acres	Unit Value	Total Value
(a)	Lands & Damages			
	Perpetual Levee Right-of-Way Marsh	150	$250	$37,500
	Construction Easement (2 years) Marsh	11	250 x .20	550
	Improvements			0
	Severance Damage			0
	Total (R)			$38,000
(b)	Contingencies 25% (R)			10,000
(c)	Acquisition Costs (Estimated 10 tracts)			
	Non-Federal			30,000
	Federal			15,000
(d)	PL-91-646			0
(e)	Total Estimated Real Estate Cost			$93,000

IDENTIFICATION
NUMBER 11105R

LAKE CATAOUATCHE
RECONNAISSANCE STUDY
INTERIOR ALIGNMENT
JEFFERSON PARISH, LOUISIANA

I-Wall With New Pump Station, SPH

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Residential	25.77	$130,680	$3,367,624
	Wet Woodland	64.73	$350	22,656
	Perpetual Borrow Easement			
	Marsh	37.0	$250	9,250
	Improvements			0
	Severance Damage			0
	Total (R)			$3,400,000
(b)	Contingencies 25% (R)			850,000
(c)	Acquisition Costs (10 Tracts)			
	Federal 10 @ $1,500			15,000
	Non-Federal 10 @ $3,000			30,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$4,295,000

IDENTIFICATION
NUMBER 11105R

I-Wall With New Pump Station, 100 Year Plan

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Residential	25.77	$130,680	$3,367,624
	Wet Woodland	64.73	$350	22,656
	Perpetual Borrow Easement			
	Marsh	37.0	$250	9,250
	Improvements			0
	Severance Damage			0
	Total (R)			$3,400,000
(b)	Contingencies 25% (R)			850,000
(c)	Acquisition Costs			
	Federal 10 @ $1,500			15,000
	Non-Federal 10 @ $3,000			30,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$4,295,000

IDENTIFICATION
NUMBER 11105R

I-Wall With Existing Pump Station, SPH

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Residential	25.77	$130,680	$3,367,624
	Wet Woodland	78.52	$350	27,482
	Perpetual Borrow Easement			
	Marsh	37.0	$250	9,250
	Improvements			0
	Severance Damage			0
	Total (R)			$3,404,000
(b)	Contingencies 25% (R)			851,000
(c)	Acquisition Costs			
	Federal 10 @ $1,500			15,000
	Non-Federal 10 @ $3,000			30,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$4,300,000

IDENTIFICATION
NUMBER 11105R

I-Wall With Existing Pump Station, 100 Year Plan

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Residential	25.77	$130,680	$3,367,624
	Wet Woodland	78.52	$350	27,482
	Perpetual Borrow Easement			
	Marsh	37.0	$250	9,250
	Improvements			0
	Severance Damage			0
	Total (R)			$3,404,000
(b)	Contingencies 25% (R)			851,000
(c)	Acquisition Costs			
	Federal 10 @ $1,500			15,000
	Non-Federal 10 @ $3,000			30,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$4,300,000

IDENTIFICATION
NUMBER 11105R

Levee Alternative With New Pump Station, SPH

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Residential	25.77	$130,680	$3,367,624
	Wet Woodland	133.43	$350	46,701
	Improvements			0
	Severance Damage			0
	Total (R)			$3,414,000
(b)	Contingencies 25% (R)			854,000
(c)	Acquisition Costs			
	Federal 10 @ $1,500			15,000
	Non-Federal 10 @ $3,000			30,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$4,313,000

IDENTIFICATION
NUMBER 11105R

Levee Alternative With New Pump Station, 100 Year Plan

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Residential	25.77	$130,680	$3,367,624
	Wet Woodland	133.43	$350	46,701
	Improvements			0
	Severance Damage			0
	Total (R)			$3,414,000
(b)	Contingencies 25% (R)			854,000
(c)	Acquisition Costs			
	Federal 10 @ $1,500			15,000
	Non-Federal 10 @ $3,000			30,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$4,313,000

IDENTIFICATION
NUMBER 11105R

Levee Alternative With Existing Pump Station, SPH

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Residential	25.77	$130,680	$3,367,624
	Wet Woodland	117.43	$350	41,101
	Improvements			0
	Severance Damage			0
	Total (R)			$3,409,000
(b)	Contingencies 25% (R)			852,000
(c)	Acquisition Costs			
	Federal 10 @ $1,500			15,000
	Non-Federal 10 @ $3,000			30,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$4,306,000

IDENTIFICATION
NUMBER 11105R

Levee Alternative With Existing Pump Station, 100 Year Plan

Estimate of Costs (Date of Value - November 1991)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Perpetual Levee Easement			
	Potential Residential	25.77	$130,680	$3,367,624
	Wet Woodland	117.43	$350	41,101
	Improvements			0
	Severance Damage			0
	Total (R)			$3,409,000
(b)	Contingencies 25% (R)			852,000
(c)	Acquisition Costs			
	Federal 10 @ $1,500			15,000
	Non-Federal 10 @ $3,000			30,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Costs (R)			$4,306,000

Judith Y. Gutiérrez
Appraiser
November 5, 1991

Approved By:

Joseph G. Kopec
Review Appraiser
November 5, 1991

WEST BANK HURRICANE PROTECTION
LAKE CATAOUATCHE, LA.

RECONNAISSANCE REPORT

APPENDIX E

COST ESTIMATES

Plan 1a

PRELIMINARY COST ESTIMATE
LEVEE (SPH PROTECTION)

WEST BANK OF MISS. RIVER IN THE VIC. OF NEW ORLEANS,
LAKE CATAOUATCHE LEVEE RECONNAISSANCE STUDY

26 AUGUST 91

CODE	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
	1 st. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$75,000.00	$75,000	$22,500	$97,500
11.0.1.B	CLEARING	1,140	AC.	$1,500.00	$1,710,000	$427,500	$2,137,500
11.0.1.B	UNCOMPACTED FILL	5,755,200	C.Y.	$3.00	$17,265,600	$5,179,680	$22,445,280
11.0.1.B	SOUTH KENNER ROAD LEVEE	LUMP SUM	L.S.	$69,000.00	$69,000	$13,800	$82,800
11.0.1.B	FERT & SEEDING	183	AC.	$500.00	$91,500	$22,875	$114,375
02.-.-.-	RELOCATIONS	LUMP SUM	L.S.	$900,000.00	$900,000	$270,000	$1,170,000
	(24" TEXACO H.P. GAS						
	10" SHELL OIL						
	H.V. POWERLINES						
	WATER MAIN						
	2-18" GAS LINES)						
02.-.-.-	ROAD RAMPS @ MARINA	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
02.-.-.-	HWY 90 RAMP	LUMP SUM	L.S.	$100,000.00	$100,000	$30,000	$130,000
11.0.1.B	PUMP STATION TIE-IN	LUMP SUM	L.S.	$153,400.00	$153,400	$38,350	$191,750
	2 nd. LIFT	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
11.0.A.-	MOB & DEMOB	183	AC.	$500.00	$91,500	$22,875	$114,375
11.0.1.B	CLEARING	2,877,600	C.Y.	$2.50	$7,194,000	$2,158,200	$9,352,200
11.0.1.B	UNCOMPACTED FILL	183	AC.	$500.00	$91,500	$22,875	$114,375
11.0.1.B	FERT & SEEDING						
	3 rd. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
11.0.1.B	CLEARING	183	AC.	$500.00	$91,500	$22,875	$114,375
11.0.1.B	UNCOMPACTED FILL	2,267,200	C.Y.	$1.75	$3,967,600	$1,190,280	$5,157,880
11.0.1.B	FERT & SEEDING	183	AC.	$500.00	$91,500	$22,875	$114,375
	R/W COST NOT INCLUDED R/W=1338 ACRES			Sub Total	$32,042,100	$9,489,685	$41,531,785
30.-.-.-	ENGINEERING & DESIGN						$4,999,814
31.-.-.-	SUPERVISION & ADMIN.						$4,168,179
	LCSPH	TOTAL COSTS					$50,700,000

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Plan 1b

PRELIMINARY COST ESTIMATE
LEVEE (100 YR. PROTECTION)

WEST BANK OF MISS. RIVER IN THE VICINITY OF NEW ORLEANS,
LAKE CATAOUATCHE LEVEE RECONNAISSANCE STUDY

26 AUGUST 91

CODE	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
	1 st. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$75,000.00	$75,000	$22,500	$97,500
11.0.1.B	CLEARING	1,069	AC.	$1,500.00	$1,603,500	$400,875	$2,004,375
11.0.1.B	UNCOMPACTED FILL	4,455,500	C.Y.	$3.00	$13,366,500	$4,009,950	$17,376,450
11.0.1.B	SOUTH KENNER ROAD LEVEE	LUMP SUM	L.S.	$62,000.00	$62,000	$12,400	$74,400
11.0.1.B	FERT & SEEDING	126	AC.	$500.00	$63,000	$15,750	$78,750
02.-.-.-	RELOCATIONS (24" TEXACO H.P. GAS 10" SHELL OIL H.V. POWERLINES WATER MAIN 2-18"GAS LINES)	LUMP SUM	L.S.	$800,000.00	$800,000	$240,000	$1,040,000
02.-.-.-	ROAD RAMP @ MARINA	LUMP SUM	L.S.	$50,000.00	$50,000	$12,500	$62,500
02.-.-.-	HWY 90 RAMP	LUMP SUM	L.S.	$100,000.00	$100,000	$25,000	$125,000
11.0.1.B	PUMP STATION TIE-IN	LUMP SUM	L.S.	$147,200.00	$147,200	$36,800	$184,000
	2 nd. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
11.0.1.B	CLEARING	126	AC.	$500.00	$63,000	$15,750	$78,750
11.0.1.B	UNCOMPACTED FILL	2,227,800	C.Y.	$2.50	$5,569,500	$1,670,850	$7,240,350
11.0.1.B	FERT & SEEDING	126	AC.	$500.00	$63,000	$15,750	$78,750
	3 rd. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
11.0.1.B	CLEARING	126	AC.	$500.00	$63,000	$15,750	$78,750
11.0.1.B	UNCOMPACTED FILL	1,716,700	C.Y.	$1.75	$3,004,225	$901,268	$3,905,493
11.0.1.B	FERT & SEEDING	126	AC.	$500.00	$63,000	$15,750	$78,750
	R/W COST NOT INCLUDED R/W=1098 ACRES			Sub Total	$25,192,925	$7,440,893	$32,633,818
30.-.-.-	ENGINEERING & DESIGN						$3,909,058
31.-.-.-	SUPERVISION & ADMIN.						$3,257,382
	LC100	TOTAL COSTS					$39,800,000

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Plan 1c

COST ESTIMATE FOR UNCAPPED SHEETPILE WALL (SPH LEVEL OF PROTECTION) 2ND ALTERNATIVE
WEST BANK OF MISS. RIVER IN THE VIC.OF NEW ORLEANS ,LAKE CATAOUCHE LEVEE,RECONNAISSANCE STUDY

DATE:9 SEPT 91

Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
11.0.A.-	MOBILIZATION & DEMOBILIZATION	LUMP SUM	L.S.	35,000.00	$35,000	$8,750	$43,750
11.0.2.B	CLEARING	182.0	ACRE	2,000.00	$364,000	$91,000	$455,000
11.0.1.B	FILL	149,500.0	C.Y.	1.50	$224,250	$56,063	$280,313
11.0.1.B	STOCKPILE EXCESS MATERIAL (Assume 4 Mile Haul Distance)	75,000.0	C.Y.	3.50	$262,500	$65,625	$328,125
11.0.2.B	SOUTH KENNER ROAD	LUMP SUM	L.S.	69,400.00	$69,400	$13,880	$83,280
11.0.1.B	STEEL SHEET PILING TYPE PZ-22	992,100.0	S.F.	9.50	$9,424,950	$2,356,238	$11,781,188
11.0.2.C	COAL TAR EPOXY	694,470.0	S.F.	1.25	$868,088	$217,022	$1,085,109
11.0.2.C	SWING GATES	2.0	EA	68,000.00	$136,000	$34,000	$170,000
11.0.2.B	FERTILIZING AND SEEDING	175.0	ACRE	500.00	$87,500	$21,875	$109,375
11.0.2.C	T-WALL (NEAR PUMP STATION)	40.0	L.F.	1,075.00	$43,000	$10,750	$53,750
11.0.2.C	PED GATES	2.0	EA	5,000.00	$10,000	$2,500	$12,500
11.0.2.C	FRONT. PROT.(BUTTERFLY VALVE)	LUMP SUM	L.S.	76,000.00	$76,000	$19,000	$95,000
02.-.-.-	RELOCATIONS						
02.3.2.Q	SHELL OIL CO. PIPE LINE	LUMP SUM	L.S.	200,000.00	$200,000	$50,000	$250,000
02.3.2.Q	24"DIA.H.P.TEXACO GAS PIPELINE (AT STA.128+49.94)	LUMP SUM	L.S.	210,000.00	$210,000	$52,500	$262,500
02.3.2.Q	GAS PIPELINES	2.0	EA	70,000.00	$140,000	$35,000	$175,000
02.3.2.Q	(AT STA.45+00)						
02.3.2.Q	HIGHWAY 90 "RAMP"	LUMP SUM	L.S.	100,000.00	$100,000	$25,000	$125,000
02.3.2.Q	TEMP RELOC PWRLINES	LUMP SUM	L.S.	50,000.00	$50,000	$12,500	$62,500
02.3.2.Q	WATER MAIN RELOC	LUMP SUM	L.S.	60,000.00	$60,000	$15,000	$75,000
					$12,361,000	$3,087,000	$15,447,000
30.-.-.-	ENGINEERING & DESIGN						$1,853,640
31.-.-.-	SUPERVISION & ADMIN.						$1,544,700
A:SING51				TOTALS			$19,000,000

Plan 1d

COST ESTIMATE FOR UNCAPPED SHEETPILE WALL (100 YR LEVEL OF PROTTION) EXTERIOR ALIGNMENT - W/ 1 ON 22 WAVE BE
WEST BANK OF MISS. RIVER IN THE VIC.OF NEW ORLEANS ,LAKE CATAOUCHE LEVEE,RECONNAISSANCE STUDY 29 OCT 91

Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
11.0.A.-	MOBILIZATION & DEMOBILIZATION	LUMP SUM	L.S.	35,000.00	$35,000	$8,750	$43,750
11.0.2.B	CLEARING AND GRUBBING	150	ACRE	2,000.00	$300,000	$75,000	$375,000
11.0.1.B	FILL	37,500	C.Y.	1.50	$56,250	$14,063	$70,313
11.0.2.B	SOUTH KENNER RD. LEVEE	LUMP SUM	L.S.	62,000.00	$62,000	$12,400	$74,400
11.0.1.B	STEEL SHEET PILING TYPE PZ-22	572,125	S.F.	9.50	$5,435,188	$1,358,797	$6,793,984
11.0.2.C	COAL TAR EPOXY	487,500	S.F.	1.25	$609,375	$152,344	$761,719
11.0.2.B	FERTILIZING AND SEEDING	150	ACRE	500.00	$75,000	$18,750	$93,750
11.0.2.C	T-WALL AT EXIST PUMP STATION	40	L.F.	1,010.00	$40,400	$10,100	$50,500
11.0.2.C	FRONT. PROT.(BUTTERFLY VALVE)	LUMP SUM	L.S.	76,000.00	$76,000	$19,000	$95,000
11.0.1.C	PEDESTRIAN GATES	2	EA.	5,000.00	$10,000	$2,500	$12,500
11.0.1.C	WILDLIFE CROSSINGS	20	EA.	5,000.00	$100,000	$25,000	$125,000
11.0.1.C	SWING GATES	2	EA.	60,000.00	$120,000	$30,000	$150,000
11.0.1.B	STOCKPILE EXCESS FILL MATERIAL	300,000	C.Y.	3.50	$1,050,000	$262,500	$1,312,500
02.-.-.-	RELOCATIONS						
02.3.2.Q	SHELL OIL CO. PIPELINE	LUMP SUM	L.S.	200,000.00	$200,000	$50,000	$250,000
02.3.2.Q	24" DIA. HP TEXACO PIPELINE (VIC STA 128+50)	LUMP SUM	L.S.	210,000.00	$210,000	$52,500	$262,500
02.3.2.Q	GAS PIPELINES (VIC STA 45+00)	2	EA.	70,000.00	$140,000	$35,000	$175,000
02.3.2.Q	HWY. 90 RAMP	LUMP SUM	L.S.	100,000.00	$100,000	$25,000	$125,000
02.3.2.Q	WATER MAIN RELOCATION	LUMP SUM	L.S.	60,000.00	$60,000	$15,000	$75,000
02.3.2.Q	TEMP. RELOC POWERLINES	LUMP SUM	L.S.	50,000.00	$50,000	$12,500	$62,500
					$8,729,000	$2,179,000	$10,908,000
30.-.-.-	ENGINEERING & DESIGN						$1,309,000
31.-.-.-	SUPERVISION & ADMIN.						$1,091,000
CAT100ON.CAL				TOTALS			$13,000,000

Plan 2a

PRELIMINARY COST ESTIMATE (SPH PROTECTION) — WEST BANK OF MISS. RIVER IN THE VICINITY OF NEW ORLEANS, LAKE CATAOUATCHE LEVEE RECONNAISSANCE STUDY, INTERIOR ALIGNMENT, W/LEVEE EXTENSION — 7 OCTOBER 91

CODE	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
	1 st. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$75,000.00	$75,000	$22,500	$97,500
11.0.1.B	CLEARING	417	AC.	$1,500.00	$625,500	$156,375	$781,875
11.0.1.B	SEMI-COMPACTED FILL (CAST)	1,010,000	C.Y.	$3.50	$3,535,000	$1,060,500	$4,595,500
11.0.1.B	SEMI-COMPACTED FILL (HAUL)*	180,000	C.Y.	$4.00	$720,000	$216,000	$936,000
11.0.1.B	FERT & SEEDING	111	AC.	$500.00	$55,500	$13,875	$69,375
11.0.1.B	LEVEE (NORTH OF HWY 90)	LUMP SUM	L.S.	$89,000.00	$89,000	$26,700	$115,700
11.0.1.B	CANAL CLOSURE	LUMP SUM	L.S.	$10,000.00	$10,000	$3,000	$13,000
02.-.-.-	RELOCATIONS (UTILITIES)	LUMP SUM	L.S.	$510,000.00	$510,000	$153,000	$663,000
11.0.1.B	ROAD RAMPS	LUMP SUM	L.S.	$170,000.00	$170,000	$51,000	$221,000
11.0.1.B	HWY 90 RAMP	LUMP SUM	L.S.	$100,000.00	$100,000	$30,000	$130,000
11.0.1.B	MARINA FLOODWALL	LUMP SUM	L.S.	$360,000.00	$360,000	$72,000	$432,000
	2 nd. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
11.0.1.B	CLEARING	111	AC.	$500.00	$55,500	$13,875	$69,375
11.0.1.B	SEMI-COMPACTED FILL (CAST)	502,000	C.Y.	$3.00	$1,506,000	$451,800	$1,957,800
11.0.1.B	SEMI-COMPACTED FILL (HAUL)*	90,000	C.Y.	$4.00	$360,000	$108,000	$468,000
11.0.1.B	FERT & SEEDING	111	AC.	$500.00	$55,500	$13,875	$69,375
	3 rd. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
11.0.1.B	CLEARING	111	AC.	$500.00	$55,500	$13,875	$69,375
11.0.1.B	SEMI-COMPACTED FILL (CAST)	386,000	C.Y.	$2.25	$868,500	$260,550	$1,129,050
11.0.1.B	SEMI-COMPACTED FILL (HAUL)*	70,000	C.Y.	$4.00	$280,000	$84,000	$364,000
11.0.1.B	FERT & SEEDING	111	AC.	$500.00	$55,500	$13,875	$69,375
11.0.1.B	LEVEE EXTENSION TO EXISTING PUMP STATION	LUMP SUM	L.S.	$2,400,000.00	$2,400,000	$600,000	$3,000,000
	* AVERAGE HAUL 3 MILES R/W COST NOT INCLUDED R/W=552 ACRES			Sub Total	$11,986,500	$3,394,800	$15,381,000
30.-.-.-	ENGINEERING & DESIGN						$1,846,000
31.-.-.-	SUPERVISION & ADMIN.						$1,773,000
	LCINTSPX	TOTAL COSTS					$19,000,000

Plan 2b

PRELIMINARY COST ESTIMATE (100 YR. PROTECTION) — ..ST BANK OF MISS. RIVER IN THE VICINITY OF NE. .RLEANS, LAKE CATAOUATCHE LEVEE RECONNAISSANCE STUDY, INTERIOR ALIGNMENT, W/LEVEE EXTENSION — 7 OCTOBER 91

CODE	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
	1 st. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$75,000.00	$75,000	$22,500	$97,500
11.0.1.B	CLEARING	367	AC.	$1,500.00	$550,500	$137,625	$688,125
11.0.1.B	SEMICOMPACTED FILL (CAST)	800,000	C.Y.	$3.50	$2,800,000	$840,000	$3,640,000
11.0.1.B	SEMICOMPACTED FILL (HAUL)*	134,000	C.Y.	$4.00	$536,000	$160,800	$696,800
11.0.1.B	FERT & SEEDING	98	AC.	$500.00	$49,000	$12,250	$61,250
11.0.1.B	LEVEE (NORTH OF HWY 90)	LUMP SUM	L.S.	$63,000.00	$63,000	$18,900	$81,900
11.0.1.B	CANAL CLOSURE	LUMP SUM	L.S.	$10,000.00	$10,000	$3,000	$13,000
02.-.-.-	RELOCATIONS (UTILITIES)	LUMP SUM	L.S.	$510,000.00	$510,000	$153,000	$663,000
11.0.1.B	ROAD RAMPS	LUMP SUM	L.S.	$170,000.00	$170,000	$51,000	$221,000
11.0.1.B	HWY 90 RAMP	LUMP SUM	L.S.	$100,000.00	$100,000	$30,000	$130,000
11.0.1.B	MARINA FLOODWALL	LUMP SUM	L.S.	$265,000.00	$265,000	$53,000	$318,000
	2 nd. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
11.0.1.B	CLEARING	98	AC.	$500.00	$49,000	$12,250	$61,250
11.0.1.B	SEMICOMPACTED FILL (CAST)	390,000	C.Y.	$3.00	$1,170,000	$351,000	$1,521,000
11.0.1.B	SEMICOMPACTED FILL (HAUL)*	67,000	C.Y.	$4.00	$268,000	$80,400	$348,400
11.0.1.B	FERT & SEEDING	98	AC.	$500.00	$49,000	$12,250	$61,250
	3 rd. LIFT						
11.0.A.-	MOB & DEMOB	LUMP SUM	L.S.	$50,000.00	$50,000	$15,000	$65,000
11.0.1.B	CLEARING	98	AC.	$500.00	$49,000	$12,250	$61,250
11.0.1.B	SEMICOMPACTED FILL (CAST)	300,000	C.Y.	$2.25	$675,000	$202,500	$877,500
11.0.1.B	SEMICOMPACTED FILL (HAUL)*	52,000	C.Y.	$4.00	$208,000	$62,400	$270,400
11.0.1.B	FERT & SEEDING	98	AC.	$500.00	$49,000	$12,250	$61,250
11.0.1.B	LEVEE EXTENSION TO EXISTING PUMP STATION	LUMP SUM	L.S.	$2,000,000.00	$2,000,000	$500,000	$2,500,000
	* AVERAGE HAUL 3 MILES R/W COST NOT INCLUDED R/W=488 ACRES			Sub Total	$9,745,500	$2,757,375	$12,503,000
30.-.-.-	ENGINEERING & DESIGN						$1,500,000
31.-.-.-	SUPERVISION & ADMIN.						$1,497,000
	LCINT10X	TOTAL COSTS					$15,500,000

Plan 2c

COST ESTIMATE FOR UNCAPPED SHEETPILE WALL (SPH LEVEL OF PROTECTION) INTERIOR ALIGNMENT - W/ EXIST PUMP STA. 3 OCT 91
WEST BANK OF MISS. RIVER IN THE VIC. OF NEW ORLEANS ,LAKE CATAOUCHE LEVEE,RECONNAISSANCE STUDY

Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
11.0.A.-	MOBILIZATION & DEMOBILIZATION	LUMP SUM	L.S.	35,000.00	$35,000	$8,750	$43,750
11.0.2.B	CLEARING AND GRUBBING	80	ACRE	2,000.00	$160,000	$40,000	$200,000
11.0.1.B	EMBANKMENT, SEMICOMPACTED FILL	560,000	C.Y.	4.00	$2,240,000	$560,000	$2,800,000
11.0.2.B	LEVEE NORTH OF HWY 90	LUMP SUM	L.S.	90,000.00	$90,000	$18,000	$108,000
11.0.1.B	STEEL SHEET PILING TYPE PZ-22	1,008,000	S.F.	9.50	$9,576,000	$2,394,000	$11,970,000
11.0.2.C	COAL TAR EPOXY	737,400	S.F.	1.25	$921,750	$230,438	$1,152,188
11.0.2.B	FERTILIZING AND SEEDING	80	ACRE	500.00	$40,000	$10,000	$50,000
11.0.2.C	T-WALL AT EXIST PUMP STATION	40	L.F.	1,010.00	$40,400	$10,100	$50,500
11.0.2.C	FRONT. PROT. (BUTTERFLY VALVE)	LUMP SUM	L.S.	76,000.00	$76,000	$19,000	$95,000
02.-.-.-	RELOCATIONS						
02.3.2.Q	POWER LINE ALONG HWY 90	LUMP SUM	L.S.	10,000.00	$10,000	$2,500	$12,500
02.3.2.Q	8" LGS GAS LINE	LUMP SUM	L.S.	100,000.00	$100,000	$25,000	$125,000
02.3.2.Q	8" SHELL OIL PIPELINE	LUMP SUM	L.S.	70,000.00	$70,000	$17,500	$87,500
02.3.2.Q	POWERLINE TO PUMPING STATION	LUMP SUM	L.S.	15,000.00	$15,000	$3,750	$18,750
02.3.2.Q	24" BDG PIPELINE	LUMP SUM	L.S.	200,000.00	$200,000	$50,000	$250,000
02.3.2.Q	POWERLINE TO CAMPS	LUMP SUM	L.S.	15,000.00	$15,000	$3,750	$18,750
02.3.2.Q	SEWER LINE TO CAMPS	LUMP SUM	L.S.	5,000.00			
02.3.2.Q	WATERMAIN ALONG HWY 90	LUMP SUM	L.S.	30,000.00	$30,000	$7,500	$37,500
02.3.2.Q	16" U.G. GAS LINE IN RAMP	LUMP SUM	L.S.	30,000.00	$30,000	$7,500	$37,500
02.3.2.Q	24" LGS LINE (N. OF HWY 90)	LUMP SUM	L.S.	30,000.00	$30,000	$7,500	$37,500
02.3.2.Q	RAMP AT HWY 90	LUMP SUM	L.S.	100,000.00	$100,000	$25,000	$125,000
02.3.2.Q	MISC. ROAD RAMPS (3 EA)	LUMP SUM	L.S.	170,000.00	$170,000	$42,500	$212,500
					$13,949,000	$3,483,000	$17,432,000
30.-.-.-	ENGINEERING & DESIGN						$2,092,000
31.-.-.-	SUPERVISION & ADMIN.						$1,743,000
CATSPHIL.CAL				TOTALS			$21,000,000

Plan 2d

COST ESTIMATE FOR UNCAPPED SHEETPILE WALL (100 YR LEVEL OF PROTTION) INTERIOR ALIGNMENT - W/ EXIST PUMP STA. 3 OCT 91
WEST BANK OF MISS. RIVER IN THE VIC.OF NEW ORLEANS ,LAKE CATAOUCHE LEVEE,RECONNAISSANCE STUDY

Code	Item	Quantity	Unit	Unit Price	Amount	Contingencies	Project Cost
11.0.A.-	MOBILIZATION & DEMOBILIZATION	LUMP SUM	L.S.	35,000.00	$35,000	$8,750	$43,750
11.0.2.B	CLEARING AND GRUBBING	80	ACRE	2,000.00	$160,000	$40,000	$200,000
11.0.1.B	EMBANKMENT, SEMICOMPACTED FILL	560,000	C.Y.	4.00	$2,240,000	$560,000	$2,800,000
11.0.2.B	LEVEE NORTH OF HWY 90	LUMP SUM	L.S.	90,000.00	$90,000	$18,000	$108,000
11.0.1.B	STEEL SHEET PILING TYPE PZ-22	712,800	S.F.	9.50	$6,771,600	$1,692,900	$8,464,500
11.0.2.C	COAL TAR EPOXY	589,900	S.F.	1.25	$737,375	$184,344	$921,719
11.0.2.B	FERTILIZING AND SEEDING	80	ACRE	500.00	$40,000	$10,000	$50,000
11.0.2.C	T-WALL AT EXIST PUMP STATION	40	L.F.	1,010.00	$40,400	$10,100	$50,500
11.0.2.C	FRONT. PROT.(BUTTERFLY VALVE)	LUMP SUM	L.S.	76,000.00	$76,000	$19,000	$95,000
02.-.-.-	RELOCATIONS						
02.3.2.Q	POWER LINE ALONG HWY 90	LUMP SUM	L.S.	10,000.00	$10,000	$2,500	$12,500
02.3.2.Q	8" LGS GAS LINE	LUMP SUM	L.S.	100,000.00	$100,000	$25,000	$125,000
02.3.2.Q	8" SHELL OIL PIPELINE	LUMP SUM	L.S.	70,000.00	$70,000	$17,500	$87,500
02.3.2.Q	POWERLINE TO PUMPING STATION	LUMP SUM	L.S.	15,000.00	$15,000	$3,750	$18,750
02.3.2.Q	24" BDG PIPELINE	LUMP SUM	L.S.	200,000.00	$200,000	$50,000	$250,000
02.3.2.Q	POWERLINE TO CAMPS	LUMP SUM	L.S.	15,000.00	$15,000	$3,750	$18,750
02.3.2.Q	SEWER LINE TO CAMPS	LUMP SUM	L.S.	5,000.00			
02.3.2.Q	WATERMAIN ALONG HWY 90	LUMP SUM	L.S.	30,000.00	$30,000	$7,500	$37,500
02.3.2.Q	16" U.G. GAS LINE IN RAMP	LUMP SUM	L.S.	30,000.00	$30,000	$7,500	$37,500
02.3.2.Q	24" LGS LINE (N. OF HWY 90)	LUMP SUM	L.S.	30,000.00	$30,000	$7,500	$37,500
02.3.2.Q	RAMP AT HWY 90	LUMP SUM	L.S.	100,000.00	$100,000	$25,000	$125,000
02.3.2.Q	MISC. ROAD RAMPS (3 EA)	LUMP SUM	L.S.	170,000.00	$170,000	$42,500	$212,500
					$10,960,000	$2,736,000	$13,696,000
30.-.-.-	ENGINEERING & DESIGN						$1,644,000
31.-.-.-	SUPERVISION & ADMIN.						$1,370,000
CAT100IL.CAL				TOTALS			$17,000,000

WEST BANK HURRICANE PROTECTION

LAKE CATAOUATCHE, LA.

RECONNAISSANCE REPORT

APPENDIX F

U.S. FISH AND WILDLIFE PLANNING AID REPORT

United States Department of the Interior
FISH AND WILDLIFE SERVICE
825 Kaliste Saloom Road
Brandywine Bldg. II, Suite 102
Lafayette, Louisiana 70508

February 10, 1992

Colonel Michael Diffley
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Diffley:

Reference is made to the West Bank Lake Cataouatche, Louisiana, Flood Damage Prevention Study. The Fish and Wildlife Service has prepared the attached planning-aid report to assist your staff in the preparation of a Reconnaissance Report for this study. The attached report addresses the information needs outlined in the Fiscal Year 1991 Scope of Work jointly developed by our respective agencies for the referenced study. This report does not fulfill our total responsibilities under provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

We will continue to work closely with your staff in an effort to develop feasible, ecologically sound measures to provide necessary flood protection in the study area. Please keep Andy Dolan of this office advised as this study progresses.

Your cooperation in this matter is greatly appreciated.

Sincerely yours,

Russell C. Watson
Acting Field Supervisor

cc: EPA, Dallas, TX
NMFS, Baton Rouge, LA
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA
LA Dept. of Natural Resources (CMD), Baton Rouge, LA

PLANNING-AID REPORT

ON

LAKE CATAOUATCHE, LOUISIANA

FLOOD DAMAGE PREVENTION

STUDY

PREPARED BY

ANDREW J. DOLAN

FISH AND WILDLIFE BIOLOGIST

FISH AND WILDLIFE ENHANCEMENT

LAFAYETTE, LOUISIANA

U.S. FISH AND WILDLIFE SERVICE

SOUTHEAST REGION

ATLANTA, GEORGIA

FEBRUARY 1992

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INTRODUCTION

The New Orleans District, Corps of Engineers, is conducting a reconnaissance study to determine the advisability of providing protection from hurricane-induced flooding to those areas in western Jefferson Parish located north of Lake Cataouatche on the west bank of the Mississippi River (Figure 1). The study was authorized by Congressional resolutions adopted by the House Committee on Public Works on July 29, 1971, and the Senate Committee on Public Works on September 20, 1974. This report is provided on a planning-aid basis; it contains a description of the existing fish and wildlife resources of the project area; discusses future without-project habitat conditions; identifies fish and wildlife-related problems, opportunities, and planning objectives; provides a preliminary analysis of the effects of project alternatives on fish and wildlife resources; identifies funding needed for subsequent feasibility-grade input by the Fish and Wildlife Service (Service); and provides preliminary recommendations for mitigation of project impacts on fish and wildlife resources. This document does not constitute the report of the Secretary of the Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act.

DESCRIPTION OF STUDY AREA

The study area is located in southeastern Louisiana, in western Jefferson Parish. The study-area boundaries are an un-named (north-south) road between South Kenner and Live Oak Manor to the west, the Lake Cataouatche Levee to the south, western Westwego to the east, and the Mississippi River to the north. The major communities in this area include Avondale, Bridge City, Kennedy Heights, and the western part of Westwego.

FISH AND WILDLIFE RESOURCES

Description of Habitat Types

Habitat types in the study area can be grouped under the major categories of forested, scrub-shrub, open water, and developed areas. Extensive forced-drainage systems have altered hydrology in all wetland habitat types within the study area.

Forested Habitat Types

Forested habitats in the study area are comprised of two major types: bottomland hardwood forests (BLH) and mostly-drained wooded swamp (WS). BLH habitats are located in the vicinity of Waggaman Pond and Avondale. BLH habitats include both wetlands and, in areas subject to intensive drainage, non-wetlands. Where the duration of flooding

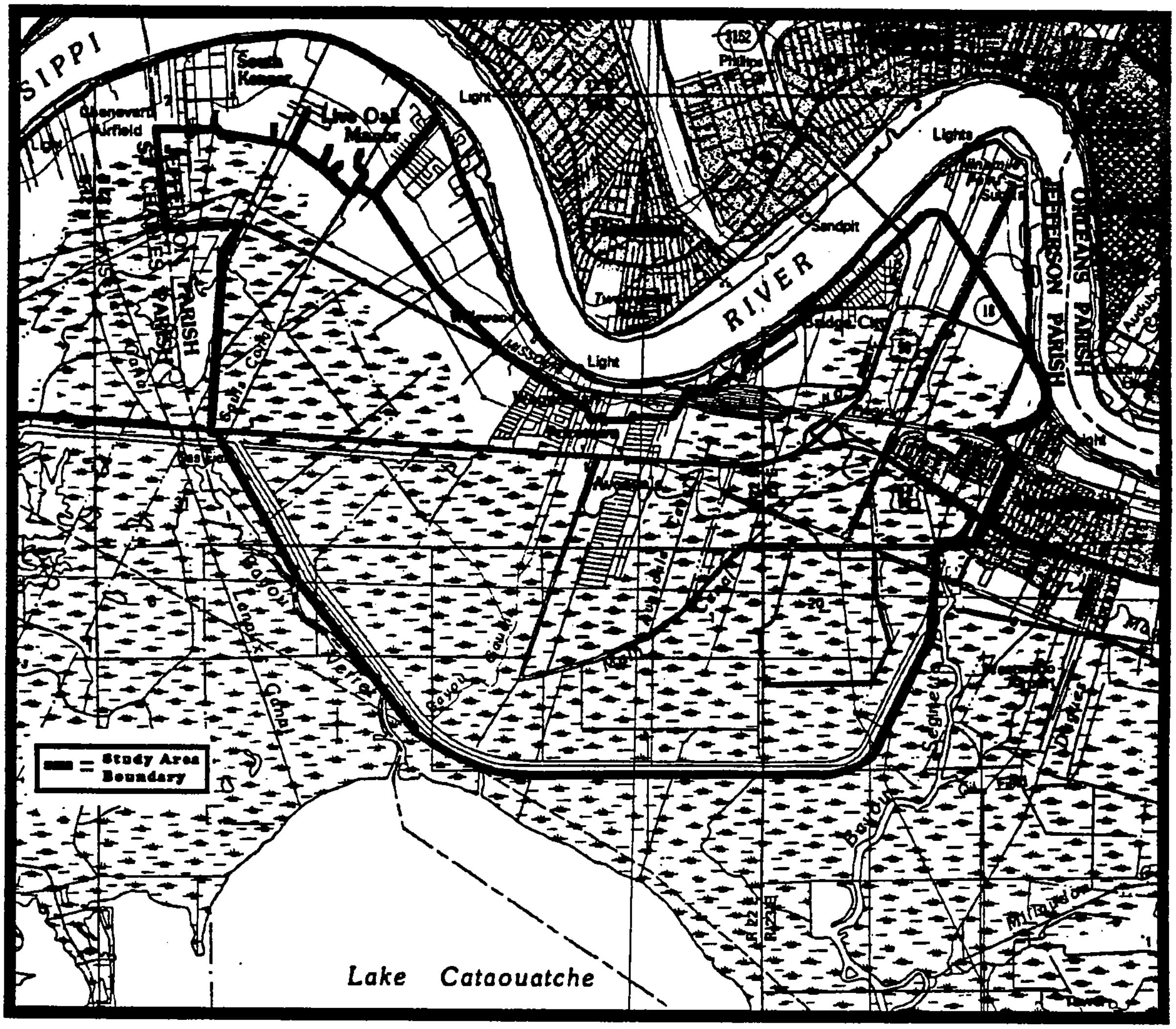

Figure 1. Study Area for Lake Cataouatche, Louisiana, Flood Protection Project.

and/or saturation is sufficient, BLH habitats are defined as intermittently flooded palustrine forested wetlands (according to Cowardin et al. 1979). BLH habitats in the study area are vegetated predominately by species such as sugarberry, black willow, American elm, red maple, Chinese tallow-tree, boxelder, and elderberry. Bottomland hardwoods are among the most productive fish and wildlife habitats in the United States; the acreage of that cover type in the Lower Mississippi Alluvial Plain has declined by more than 80 percent.

An extensive area of mostly-drained wooded swamp is located in the central portion of the study area southeast of Avondale. In its natural (undrained) state, this habitat type is characterized by baldcypress and water tupelo as the dominant tree species, with red maple, green ash, and black willow being present to some extent. Due to forced drainage, species adapted to drier sites, e.g., sugarberry, elderberry, and Chinese tallow-tree, have invaded some areas of wooded swamp.

Scrub-Shrub Habitat Types

Scattered areas of scrub-shrub uplands and scrub-shrub wetlands also occur in the study area. Scrub-shrub communities support woody vegetation less than 20 feet in height and occur locally in partially drained fresh marshes where an invasion of species adapted to drier sites is occurring. The principal difference between upland and wetland scrub-shrub habitats is the extent to which drainage has occurred. Typical scrub-shrub communities in the study area are vegetated with maidencane, goldenrod, Chinese tallow-tree, elderberry, blackberry, thistle, common reed, fall aster, black willow, and smartweed. When meeting the criteria for delineation as wetlands, such habitats are termed palustrine scrub-shrub wetlands, according to Cowardin et al. (1979).

Open Water Habitat Types

Most of the open water in the study area consists of freshwater canals and ditches (riverine lower perennial open water), and borrow pits (lacustrine littoral open water). The shallower open water areas may support submerged and/or floating aquatic vegetation such as coontail, pondweeds, naiads, fanwort, water hyacinth, American lotus, and widgeongrass.

Developed Areas

Developed habitats include residential, commercial, and industrial areas, as well as roads and existing levees. Those areas do not provide important wildlife habitat value. That portion of the study area located immediately adjacent to U.S. Highway 90 in Avondale has been intensively developed for residential, commercial, and industrial purposes. This type of development is becoming particularly extensive north of U.S. Highway 90, as wetlands are filled to accommodate growth. The western portion of the study area, both north and south of U.S. Highway 90, is currently being utilized for extensive landfill operations.

Fishery Resources

The canals and borrow pits of the study area are expected to support some recreationally important fishes and shellfishes. Freshwater sport fishes present probably include largemouth bass, bluegill, redear sunfish, warmouth, channel catfish, and blue catfish. Other fishes likely present include yellow bullhead, freshwater drum, bowfin, carp, buffaloes, and gars. The wetlands of the study area also provide habitat for red swamp crawfish, which are likely harvested recreationally.

Wildlife Resources

Amphibians expected to occur on canal and ditch edges, borrow pits, and forested wetlands of the study area include lesser siren, three-toed amphiuma, Gulf Coast toad, eastern narrow-mouthed toad, Fowler's toad, green treefrog, cricket frog, bronze frog, and bullfrog. Commercially important reptiles found in the canals and borrow pits include American alligator, common snapping turtle, alligator snapping turtle, and softshell turtles. Other reptiles commonly found in the project area include red-eared turtle, painted turtle, Mississippi mud turtle, stinkpot, green anole, broad-headed skink, various water snakes, western ribbon snake, speckled kingsnake, and western cottonmouth.

Several species of waterfowl likely utilize the study area. The canals, borrow pits, and forested wetlands (during periods of inundation) are probably utilized by wood ducks, blue-winged teal, green-winged teal, and mallards. Numerous other game birds are present in or adjacent to the study area, including American coot, rails, gallinules, common snipe, and American woodcock.

Numerous non-game bird species also utilize the study area, including least bittern, pied-billed grebe, killdeer, and various species of gulls, and terns. Martin and Lester (1990) identified two active rookeries in the vicinity of the proposed study area. These rookeries supported nearly 1,000 nesting tricolored herons, little blue herons, cattle egrets, snowy egrets, white ibises, and glossy ibises.

Many resident and transient hawks and owls also use the study area. Permanent residents include red-shouldered hawk, barn owl, common screech owl, great horned owl, and barred owl. Winter residents include red-tailed hawk, marsh hawk, and American kestrel, while the Mississippi kite and broad-winged hawk are common summer residents. In addition, the project area supports many species of resident and migratory passerine birds. According to Lowery (1974), as many as 180 species of songbirds may utilize the study area. Also present are cuckoos, swifts, hummingbirds, goatsuckers, woodpeckers, and the belted kingfisher.

Important game mammals occurring in the project area include white-tailed deer, eastern cottontail, swamp rabbit, gray squirrel, and fox squirrel. Important furbearers include nutria, striped skunk, raccoon, and mink. Other land mammals expected include various species of insectivores, bats, rodents, and the nine-banded armadillo.

Endangered and Threatened Species

The American alligator, which is common in canals on the study area, is listed as threatened under the Similarity of Appearance clause of the Endangered Species Act (Federal Register 1981, Vol. 46, pp. 40664-40669). The bald eagle, an endangered species, likely uses project area wetlands for foraging and is known to nest within 10 miles of the project area.

FISH- AND WILDLIFE-RELATED PROBLEMS, OPPORTUNITIES, AND PLANNING OBJECTIVES

The most significant fish- and wildlife-related problem in the study area and throughout coastal Louisiana is the rapid loss of valuable wetland habitat. According to Bahr et al. (1983), between 1956 and 1978, baldcypress-tupelogum swamp within the Barataria Basin declined by 4,132 acres and fresh marsh declined by 87,300 acres. During that same period, estuarine open water increased by over 57,276 acres. This transition from vegetated wetlands to open water is believed to be associated with navigation and flood control projects, canalization, shoreline erosion, subsidence, and saltwater intrusion.

Deteriorating water quality in the Barataria Basin, at least partially correlated to wetlands loss and a commensurate reduction in the area's waste assimilation capacity, is another major problem affecting fish and wildlife in the study area. According to Bahr et al. (1983), factors currently adversely affecting water quality in the Lake Cataouatche area are those generally related to urban development and associated urban pollution, altered land use patterns, and hydrologic modifications within the lake's watershed. Two major human impacts include eutrophication and increased toxic substance levels.

Water quality deterioration may be at least reduced by preserving remaining wetlands via limiting urban expansion and associated pollution discharges into wetlands. To discourage further wetland development in the study area, flood protection levees should be at, or as close as possible to, the wetland/non-wetland interface. Should some wetlands be unavoidably enclosed, preservation of enclosed wetlands could be ensured via the purchase of non-development easements; enhancement/restoration of such wetlands could then be accomplished.

In order to address the above problems and opportunities, the Service recommends that the following planning objectives and constraints be included in any further planning of flood protection features for the study area:

1. Preserve wetlands in the study area by:

   a. Limiting flood protection to existing urban developments.

   b. Requiring that flood protection levees follow, as closely as possible, the wetland/non-wetland interface.

   c. Acquiring non-development easements on enclosed wetlands to ensure their continued use as floodwater storage areas and to preclude any secondary development.

   d. Implementing measures to compensate for unavoidable losses of wetland habitat values.

ALTERNATIVES UNDER CONSIDERATION

The Corps has, to date, proposed three alternatives under this study, all three of which involve construction of levees to protect Avondale and adjacent areas from 100-year flood events. Alternatives under consideration include:

1. Avondale Ring Levee - This levee would begin at the railroad yard north of U.S. Highway 90, extend south along the eastern side of Avondale, west along southern end of Avondale, and north along the western side of Avondale, to the Missouri Pacific Railroad (Figure 2). Construction materials would include a combination of earthen fill and sheet pile.

2. Interior Alignment - This levee would extend southwest from the Missouri Pacific Railroad (north of U.S. Highway 90) along the western side of Kennedy Heights (a subdivision located west of Avondale) to U.S. Highway 90, east along U.S. Highway 90 to the Main Canal, and would then follow the Main Canal northeast and east to the Bayou Segnette Pump Station (Figure 3). Alternative construction materials would include sheet pile and earthen fill.

3. Exterior Alignment - This levee alignment would extend south from the Missouri Pacific Railroad at South Kenner Road to U.S. Highway 90, east along U.S. Highway 90 to the Lake Cataouatche Levee, and then follow the Lake Cataouatche Levee along its entire length to the Bayou Segnette Pump Station (Figure 4). Alternative construction materials would include sheet pile and earthen fill.

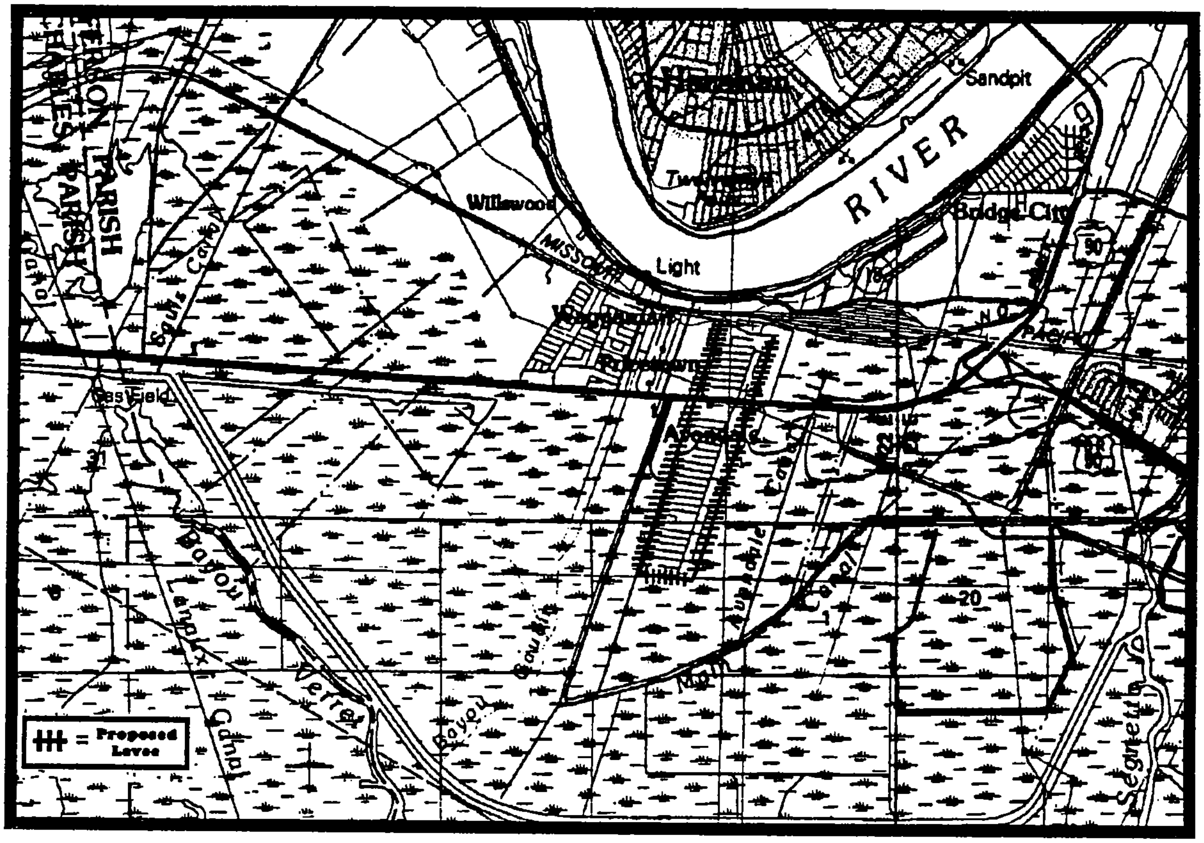

Figure 2. Proposed Avondale Ring Levee for Lake Cataouatche, Louisiana, Flood Damage Prevention Study.

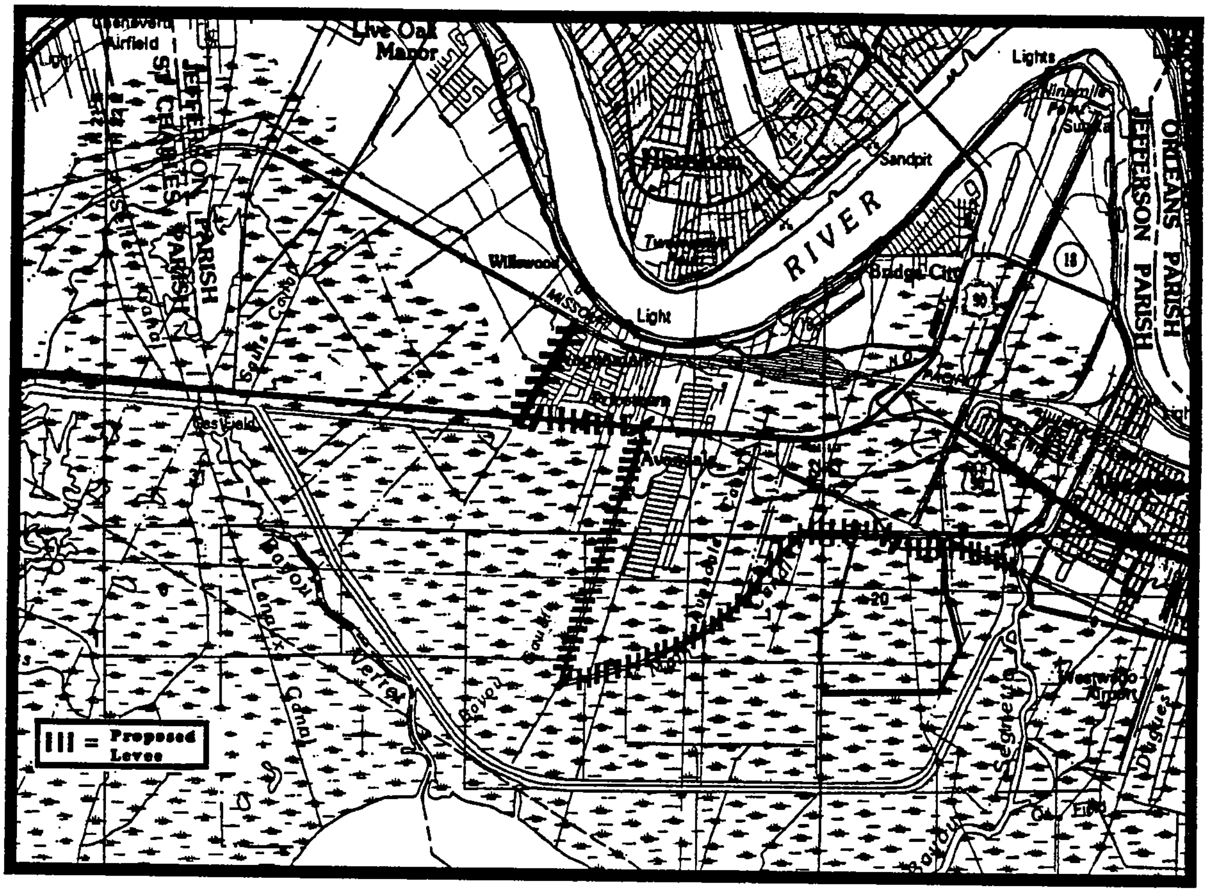

Figure 3. Proposed Interior Levee Alignment for Lake Cataouatche, Louisiana, Flood Damage Prevention Study.

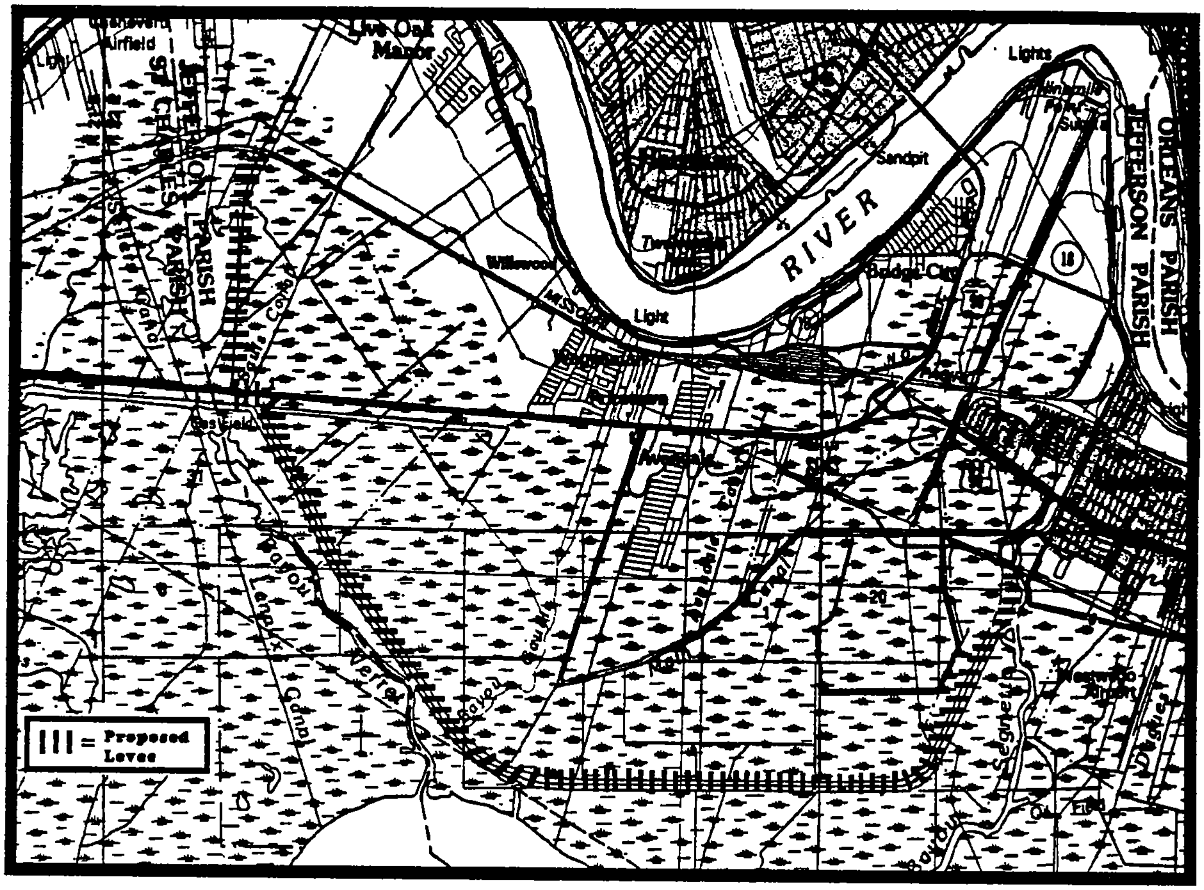

Figure 4. Proposed Exterior Levee Alignment for Lake Cataouatche, Louisiana, Flood Damage Prevention Study.

POTENTIAL SIGNIFICANT IMPACTS

Construction of the Avondale Ring Levee as proposed would result in the direct loss of approximately 102 acres of bottomland hardwoods and 16 acres of scrub-shrub habitat. However, virtually no additional wetlands would be enclosed by the levee alignment.

Construction of the Interior Alignment with earthen material would cause the direct loss of 106 acres of wooded swamp (mostly drained), 146 acres of bottomland hardwoods, and 73 acres of scrub-shrub habitat. Interior levee construction with sheet-pile material would result in the loss of 11 acres of wooded swamp (mostly drained), 15 acres of bottomland hardwoods, and 7 acres of scrub-shrub habitat. An estimated 2,400 acres of bottomland hardwoods and 100 acres of scrub-shrub wetlands would be enclosed by this alignment and would likely be subject to eventual development. An additional 250 acres of non-wetland bottomland hardwoods and 150 acres of scrub-shrub uplands would be enclosed in the Interior Alignment.

Construction of the Exterior Alignment with earthen material would result in the direct loss of approximately 38 acres of bottomland hardwood and 87 acres of scrub-shrub habitat. The Exterior Alignment, if constructed with sheet-pile material, would directly impact 14 acres of bottomland hardwoods, and 34 acres of scrub-shrub habitat. Approximately 1,150 acres of non-wetland bottomland hardwoods and 250 acres of scrub-shrub uplands would be enclosed within the Exterior Alignment. In addition, approximately 800 acres of wooded swamp (mostly drained), 5,050 acres of bottomland hardwood wetlands, and 4,600 acres of scrub-shrub wetlands would be enclosed by the proposed levee alignment. Developmental pressures on these 9,650 acres of wetlands and 1,400 acres of upland habitats are likely to increase with levee construction, due to the reduced flooding threat.

Enclosure of wetlands via the Interior and Exterior levee Alignments would lead to further water quality deterioration in the Barataria Basin by eliminating or reducing the filtering capacity of those wetlands. Wetland habitat losses would substantially reduce populations of resident fish and wildlife, and reduce wintering habitat for waterfowl and other migratory birds.

FISH AND WILDLIFE CONSERVATION MEASURES

It is clear that implementation of the Interior Alignment and Exterior Alignment levee alternatives would have significant secondary impacts on fish and wildlife resources. Our major concern is the potential for loss, via future development, of wetlands to be enclosed by the levees. The Service believes that project plans can be and should be modified to mitigate those negative impacts.

The President's Council on Environmental Quality defined the term "mitigation" in the National Environmental Policy Act regulations to include: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensating for the impact by replacing or providing substitute resources or environments. The Service's Mitigation Policy (Federal Register Volume 46, No. 15, January 23, 1981) supports and adopts this definition of mitigation and considers its specific elements to represent the desirable sequence of steps in the mitigation planning process. That policy identifies four resource categories that are used to insure that the level of mitigation recommended by Service biologists will be consistent with the fish and wildlife resource values involved.

Considering the high value of forested wetlands for fish and wildlife and the relative scarcity of that habitat type, those wetlands have been designated Resource Category 2 habitats. The drained forested wetlands and marsh (now forested uplands and scrub/shrub uplands) in the Study area are placed in Resource Category 3 due to their overall medium value to wildlife and because those habitats are, in their undrained state, becoming scarce. The mitigation goal for habitats in Resource Category 2 is no net loss of in-kind habitat value. The mitigation goal for Resource Category 3 habitats is no net loss of habitat value. This goal could best be achieved via loss avoidance. In this case, loss avoidance would be accomplished by selecting the Avondale Ring Levee alternative so that forested wetlands would not be enclosed within the levee designed to protect existing developments.

Should the Corps determine that enclosure of wetlands within the proposed Interior or Exterior levees is the only feasible means of providing adequate protection from hurricane flooding, measures for protecting enclosed wetlands and for compensating habitat value losses associated with levee construction should be implemented. Maintenance of the enclosed wetlands could be accomplished by purchase of non-development easements on those lands. Compensation for wetland habitat value losses associated with the different levee alternatives could include acquisition, restoration, and management of wooded swamp wetlands in the study area. Mitigation needs would have to be quantified in any subsequent feasibility studies.

FISH AND WILDLIFE COORDINATION ACTIVITIES FOR THE FEASIBILITY STAGE

Data Needs From Corps of Engineers

Should a feasibility study be conducted for this project, the following data will be needed to enable the Service to conduct a detailed analysis of project impacts on fish and wildlife resources and to formulate measures to mitigate any losses to those resources:

and to formulate measures to mitigate any losses to those resources:

1. Identification of all alternatives to be considered for feasibility analysis, including a detailed description of each alternative.

2. An estimate of existing, future with-project and future without-project acreages for each major habitat type in the study area, presented in 10-year intervals for each alternative considered. Those estimates should address direct impacts associated with construction activities, and secondary impacts such as increased development of enclosed wetlands.

Fish and Wildlife Service Tasks and Associated Cost Estimates

Additional Service studies and reports will be necessary if this study proceeds into later stages of planning. Among those requirements would be completion of a Habitat Evaluation Procedures analysis and preparation of a Plan Formulation Stage Planning Aid Report and draft and final Fish and Wildlife Coordination Act reports. The estimated funding requirement for the Plan Formulation Planning Aid Report, and draft and final Fish and Wildlife Coordination Act report (including a Habitat Evaluation Procedures analysis), is $27,100.

RECOMMENDATIONS

The Service does not oppose further study of the project area's hurricane-related flooding problems and possible solutions. It appears that the least damaging study alternative is the Avondale Ring Levee alignment, whereas the most environmentally destructive levee route is the Exterior Alignment proposal (due to secondary impacts). Should project studies proceed to the feasibility stage, the Service will more accurately quantify both the project-induced habitat losses and associated mitigation needs.

The following recommendations are provided in the interest of fish and wildlife conservation:

1. Feasibility-stage planning should incorporate those planning objectives identified above.

2. Any further investigations should consider the feasibility of preserving (via acquisition of fee title or non-development easements) of unavoidably enclosed wetlands, and should include formulation of a mitigation plan to fully offset unavoidable losses of fish and wildlife habitat values.

LITERATURE CITED

Bahr, L.M., Jr., R. Costanza, J.W. Day, J., S.E. Bayley, C. Neill, S.G. Leibowitz, and J. Fruci. 1983. Ecological characterization of the Mississippi Deltaic Plain Region: a narrative with management recommendations. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D. C. FWS/OBS-82/69. 189 pp.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C. FWS/OBS-79/31. 108 pp.

Federal Register. 1981. Reclassification of American alligator in Louisiana. 46(153):40664-40669.

Lowery, A. H. 1974. Louisiana birds. La. State Univ. Press. 651pp.

Martin, R.P., and G.D. Lester. 1990. Atlas and census of wading bird and seabird nesting colonies in Louisiana: 1990. Louisiana Natural Heritage Program, LDWF, Special Publication No. 3. 182 pp.

WEST BANK HURRICANE PROTECTION

LAKE CATAOUATCHE, LA.

RECONNAISSANCE REPORT

APPENDIX G

LETTER OF INTENT

BUDDY ROEMER
GOVERNOR

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FRANCIS BOFFONE
ANTHONY CARAMONTA
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7001 RIVER ROAD
P.O. BOX 608
MARRERO, LA 70072
TEL: (504) 340-0318
FAX: (504) 340-7801

March 9, 1992

Colonel Michael Diffley
District Engineer
U. S. Army Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Diffley:

The West Jefferson Levee District generally concurs with the preliminary findings of the Westbank Hurricane Protection, Lake Cataouatche, Louisiana reconnaissance study.

We would be interested in investigating the opportunity to participate in a feasibility study to provide a federal project for the Lake Cataouatche area. The West Jefferson Levee District understands that the local sponsor should be willing to provide 50 percent of the cost of a feasibility study.

At the present time, we understand the feasibility study may result in an authorized federal project with construction cost currently estimated at 13 million dollars.

We look forward to hearing from you in the near future. If we can be of further assistance, please do not hesitate to call.

Sincerely,

Gerald A. Spohrer
Executive Director

GAS/rlw

xc: Terral Broussard, US COE, NOD
Robert H. Schroeder, US COE, NOD