WORKING PAPERS

PRELIMINARY FORMULATION OF ALTERNATIVE PLANS FOR THE LAKE PONTCHARTRAIN, LOUISIANA AND VICINITY HURRICANE PROTECTION PROJECT

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Date Prepared: June 1980

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BACKGROUND

The Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project, was authorized by the Flood Control Act of 1965. The authorized project provides for construction of a combination of levees, floodwalls, and flood control structures at various locations along the shores of Lakes Pontchartrain and Borgne as well as along the banks of adjacent waterways to protect the Greater New Orleans Metropolitan Area from hurricane flooding. Features of the authorized project and progress of work to date are shown on plate 1.

Federal construction of the project was initiated in 1967. On 30 December 1977, the Honorable Charles Schwartz, Jr., United States District Judge for the United States District Court, Eastern District of New Orleans, issued an injunction against further construction of the Chef Menteur Pass, Rigolets, New Orleans East and Chalmette portions of the project until such time as deficiencies in the August 1974 final environmental impact statement (Final EIS) were corrected. During the spring of 1978, Judge Schwartz modified his injunction in separate actions to exclude the Chalmette and New Orleans East Lakefront Levee features, i.e., to allow construction to proceed on these portions of the project.

Since issuance of the 30 December 1977 injunction, the New Orleans District has engaged in studies to correct the inadequacies of the 1974 Final EIS. These studies, as per the court order, include consideration of alternatives to the authorized plan.

PURPOSE

The purpose of this study is to make a preliminary determination of the comparative viability of various approaches to complete the Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project. This document is intended as a planning aid for decision makers concerned with the future direction of the revised EIS studies currently underway.

SCOPE

This report summarizes the results of preliminary investigations.

An in-house report, "Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project Alternative Plans Study," prepared by NOD Engineering Division in February 1980, served as the primary source for cost data (inclosure 1). That report contains a description of the alternative features which can be combined to form various plans and cost estimates (1 March 1979 price levels) for both preproject (1965) conditions and present (cost to complete) conditions.

This study used a "zero-based budgeting approach," that is, sunk costs or costs of common features were not of interest, nor were the impacts associated with these features; only differences between plans were analyzed and displayed.

FORMULATION OF PLANS

MANAGEMENT MEASURES

The formulation of a primarily nonstructural plan which could meet the planning objective, i.e., protection of life and property from hurricane-related flooding events, is not applicable to the Metropolitan New Orleans Area.

There are two basic types of structural approaches which can meet the planning objective. One approach would be to provide protection solely by conventional construction of levees and floodwalls to protect areas from hurricane surges. This type of approach is referred to as "Hi-Level" hereafter. A second type of approach would be to construct control structures at the tidal entrances to Lake Pontchartrain which could be operated to reduce lake inflows during storm events and thus reduce the extent and cost of levee/floodwall construction necessary to provide adequate protection. This approach, utilized in the authorized plan, is referred to as "Barrier" hereafter.

PLAN FORMULATION RATIONALE

The following criteria, assumptions, and constraints were applied in formulating plans:

a. As previously stated, only differences in viable plans were considered. Features common to any plan as to alinement, method of construction and costs, which were excluded from analysis; include: (1) all completed work; (2) Citrus Back Levee (IHNC to Michoud Canal); (3) East Bank of IHNC (MR-GO to Lake Pontchartrain); (4) West Bank of IHNC; (5) Mandeville Seawall; (6) Chalmette Area Plan; and (7) Seabrook Complex--It should be noted that cost-sharing could vary between plans for this item, but this is not a plan formulation consideration. See plate 1.

b. In order to compare plans on an equal basis, only Hi-Level Plans providing SPH protection were formulated, since all Barrier Plans provide SPH protection.

c. It was assumed that the New Orleans District will continue to administer its Section 404 permits program in accordance with existing National policy. Executive Orders 11988 and 11990 prohibit Federal agencies from encouraging or supporting development in flood plains or wetland areas when viable alternatives to such activities exist. The Water Resource Council (WRC) recently published Procedures for evaluation of NED Benefits and Costs. This document disallows any Federal agency from claiming project location benefits by development of wetlands or flood plains if other sites are available. Therefore, it was assumed that avoidable development of wetlands and flood plains within the project area would be prohibited throughout the 100-year life of the project.

d. Annual charges were computed using both the authorized and current interest rates (3 1/8 percent and 7 1/8 percent, respectively).

e. It was assumed that flood control benefits were equal for like leveed areas under both Hi-Level and Barrier Plans. It should be pointed out that, based on the 1962 Interim Survey Report, Barrier Plans would provide annual

benefits to the north shore area of about ~~$800,000~~ $1,000,000 (October 1979 price levels and 3 1/8 percent interest rate) which would not accrue to any Hi-Level Plan. It should be pointed out that these "incremental" north shore benefits amount to less than 2 percent of those annual benefits which are expected to accrue to the authorized plan.

FIRST ITERATION OF PLANS

As a "first cut" a NED and an EQ plan were developed for both the Hi-Level and Barrier options, respectively, to aid in trade-off analyses. As was previously noted, only features which differed from plan to plan were analyzed and displayed. NED plans were formulated strictly on the basis of cost, i.e., the least costly alternative method of construction was chosen for each project reach. EQ plans were formulated strictly on the basis of least damage to the environment, i.e., the least environmentally damaging method of construction was chosen for each project reach. Plate 2 displays the alternative alinements considered. Tables 1 through 3 display summaries of the environmental impacts associated with construction of alternative features. Table 4 displays replacement costs associated with alternative features. Data relating to first costs and annual O&M charges are contained in inclosure 1. Tables 5 through 8 display the "incremental first costs to complete" associated with the Hi-Level and Barrier NED and EQ Plans.

SECOND ITERATION OF PLANS

During the second iteration of plans, the candidate NED and EQ plans and their impacts were analyzed and trade-offs between economic and environmental values were made to formulate "optimal" plans.

HI-LEVEL (SPH) PLANS. First, the candidate NED and EQ plans were compared to determine if they contained any common elements. It was found that the Citrus Lakefront levee I-wall alternative was common to both plans. However, the consideration of potential barge impacts associated with this alternative necessitated further study. Upon further investigation it was found that the next preferable alternative from both the NED and EQ standpoints would be the

I-wall with barge berm alternative, which would assure the desired level of protection (Citrus Lakefront is adjacent to the IHNC ~~lock~~ which is heavily used by barge traffic). Construction of the barge berm would require an additional first cost of $8,600,000 and result in the additional loss of 35 acres of lake bottom. From the standpoint of safety, this seemed a valid trade-off. Therefore, the Citrus Lakefront levee alternative consisting of I-wall on levee with barge berm was considered "optimal."

Next, alternative alinements were considered. There are two areas where the plan's basic configuration can be altered without affecting protection to existing development--St. Charles Parish and the New Orleans East area east of Maxent Canal. These areas are related in that the wetland acreages which would be encompassed by the authorized alinements are potential sites for alteration/development.

According to Executive Orders 11988 and 11990, the development of wetlands should not be encouraged if alternative sites for development are available. An exact determination of the amount of land required for future development has not been made at this time. However, it is anticipated that applying the criteria contained in the WRC's latest guidelines will not allow the claiming of project benefits for development of wetlands in either the New Orleans East or St. Charles Parish areas (the wetland acreage inclosed by the proposed St. Charles Parish Lakefront alinement is 29,440 acres and the approximate wetland acreage inclosed by existing levees in New Orleans East between the Maxent Canal and the South Point to GIWW levee is 19,020 acres).

For both the St. Charles Parish area and the New Orleans East area, the alinements which encompass the largest area are the most economical to construct. Of the alternative St. Charles Parish levee alinements, the Lakefront alinement would be the least expensive to construct, primarily due to the low unit cost of embankment associated with its hydraulic fill method of construction. Of the alternative levee alinements considered for the New Orleans East area, the New Orleans East Lakefront/South Point to GIWW alinement would be the least expensive to construct, because this alinement would use existing levees as a base, thereby reducing embankment costs. Hence, selection of an alternate alinement for either site which would encompass a lesser amount of

wetlands, i.e., a more expensive alinement, should be predicated upon environmental considerations.

The authorized levee alinement in the New Orleans East area follows existing levees, and provides for structures to maintain the normal hydrologic regime of the wetlands it would encompass. Because of the criteria stated before, no avoidable alteration of wetlands, except for wetlands directly affected by levee construction, should be attributable to this alternative. Implementation of this alinement would also keep planning options open, i.e., if a demonstrable need arises in the future to develop the area, or portions of the area, the development could be accomplished without realining the levee system. It is concluded that the authorized levee alinement for the New Orleans East area is "optimal."

While the authorized New Orleans East area levee alinement is considered "optimal," it should be noted that there are two alternative methods of construction available for the New Orleans East Lakefront levee, hauled clay fill or I-wall on levee. The latter method of construction is cheaper both on the basis of first cost, by $5,000,000, and annual charges. Also, the I-wall alternative affects less wetland acreage. However, there is the consideration of potential barge impacts which affects the viability of the I-wall alternative. It is concluded that for the New Orleans East Lakefront levee, the hauled clay fill method of construction is "optimal."

The authorized levee alinement in St. Charles Parish is located along the lakefront. This alinement would encompass about 29,440 acres of wetlands and alter the normal overflow regime of this area. Thus, this plan would lower the habitat value of these wetland areas. In addition, because this alternative would be built using hydraulic fill, adjacent lake bottoms would be temporarily affected due to layering by dredge effluents and the adjacent lake would be subject to turbidity during construction.

When comparing the St. Charles Parish Lakefront alinement to the North of Airline Highway alinement, it is seen that the latter alinement would cost about $15,000,000 more, but encompass about 26,240 acres less of wetlands.

This alternative represents an incremental investment of about $572/acre of wetlands to avoid altering 26,240 acres of wetlands. Also, temporary construction impacts on the lake could be avoided. This seems a reasonable investment. In comparing the North of Airline Highway alinement with the South of Airline Highway alinement, the latter alinement would cost about $22,000,000 more, but would encompass about 3,200 acres less of wetlands. This alternative represents an incremental investment of about $6,875/acre of wetlands to avoid altering 3,200 acres of wetlands. This does not seem to be a reasonable investment. In light of the above trade-off analysis it is concluded that the North of Airline Highway alinement is "optimal."

The next project feature considered was the New Orleans Lakefront levee. Three alternative methods of construction were considered, none would directly affect any wetlands or lake bottoms. The least expensive alternative on both the basis of first cost and annual charges is the hauled clay fill alternative, and this alternative is considered "optimal" for this reach.

The last project feature considered was the Jefferson Parish Lakefront levee. Nine alternative construction methods were considered, they were:

Staddle Enlargement	$365,000,000
Hauled Clay Fill	$181,000,000
Hydraulic Clay Fill without Ponding Area	$ 85,000,000
Hydraulic Clay Fill with Ponding Area	$176,000,000
I-Wall on Levee	$118,000,000
I-Wall on Levee with Barge Berm (Hauled Clay Fill)	$202,000,000
I-Wall on Levee with Barge Berm (Hydraulic Fill without Ponding Area)	$103,000,000
I-Wall on Levee with Barge Berm (Hydraulic Fill with Ponding Area)	$193,000,000
T-Wall on Levee	$427,000,000

The least expensive of the nine construction methods considered was the hydraulic clay fill without ponding areas alternative; this method would have a first cost of $85,000,000. However, this alternative would be the most environmentally damaging of the nine methods considered; it would impact about

4,415 acres of lake bottoms (approximately 490 acres would be permanently converted to levee and 3,940 acres would be temporarily affected during construction) and cause temporary turbidity in the immediate vicinity during construction. The next least expensive alternative was the I-wall on levee with barge berm using hydraulic clay fill without ponding areas; this method of construction would cost $103,000,000 and have roughly the same environmental impacts as the hydraulic clay fill without ponding area method except that turbidity during construction would be lessened to an unquantified extent. In comparing the two methods, it was seen that the latter would cost $18,000,000 more than the former, and result in less short term turbidity during construction than the former. The trade-off was not considered reasonable, and the I-wall on levee with barge berm using hydraulic clay fill without ponding areas was eliminated from further consideration.

Next, the hydraulic clay fill without ponding areas alternative was compared to the third least expensive construction method, the I-wall on levee alternative. This alternative would have a first cost of $118,000,000 and have the least environmental impacts of any construction method considered (265 acres of lake bottom would be converted to levee). However, it should be noted that this alternative's I-wall feature would be subject to breeching by barge impact. For purposes of analysis, the differences in design integrity of the two plans were temporarily disregarded, and a trade-off analysis of the two alternatives was performed using only economic costs and environmental impacts. The I-wall on levee method of construction when compared to the hydraulic clay fill without ponding areas method represented an incremental investment of $37,000,000 to avoid converting 225 acres of lake bottoms to levee, temporarily impacting 3,940 acres of lake bottom, and short term turbidity in the vicinity of Jefferson Parish Lakefront. The trade-off was considered excessive and the I-wall on levee alternative was eliminated from further consideration.

Since all of the remaining six methods of construction are more expensive and more environmentally damaging than the I-wall on levee alternative, it is concluded that the hydraulic fill without ponding areas is "optimal" for the Jefferson Parish Lakefront.

BARRIER PLANS. First, the candidate NED and EQ Barrier plans were compared to determine if they contained any common elements. It was found that the Jefferson Parish Lakefront levee (hauled clay fill), New Orleans Lakefront levee (hauled clay fill) and Citrus Lakefront levee (hauled clay fill) were common to both plans and it was thus concluded that these elements should be a part of any "optimal" Barrier Plan.

Next, alternative alinements were considered. A similar type analysis as was used to optimize Hi-Level alinements was employed. It was immediately concluded that the authorized alinement in the New Orleans East area was "optimal". All levees in the New Orleans East area would be constructed using hauled clay fill. In the case of the St. Charles Parish levee alternatives, it was concluded that the North of Airline Highway alinement was both cheaper than the Lakefront alinement, primarily because less embankment would be required for its construction, and less environmentally damaging. The South of Airline Highway alinement would cost about $16,000,000 more than the North of Airline Highway alinement and affect 3,200 acres less of wetlands, representing an incremental investment of about $5,000/ acre of wetland to avoid alteration of the natural environment. This did not seem a reasonable trade-off. It was concluded that the North of Airline Highway alinement is "optimal" for St. Charles Parish.

Lastly, the size of the Chef Menteur and Rigolets structures was considered. Three different-sized openings were considered at each location. The basic reason for increasing the size of the openings at the structures is to minimize potential environmental impacts due to alteration of Lake Pontchartrain's tidal exchange. Since we won't know these potential environmental impacts until the ongoing Transport Contract is completed, it is impossible to make a trade-off analysis at this time. Based on the alternatives considered, there are nine possible combinations of structures at the tidal passes. Rather than presenting nine candidate "optimal" Barrier Plans, one plan is presented with a range of costs for the Chef Menteur and Rigolets structures. The lower and upper limit of costs was developed by computing the combined costs of the smallest structures considered and the combined costs of the largest structures considered, respectively.

COMPARISON OF PLANS

Tables 9 and 10 summarize the incremental economic charges attributable to the "optimal" Hi-Level and Barrier Plan, respectively. It should be noted that since the costs associated with the New Orleans East Back Levee were found to be identical for either plan, they were omitted from the tables. A qualitative assessment of the differences in environmental impacts of the two plans was made; the results of this investigation are displayed in inclosure 2. Table 11 summarizes the major differences between the "optimal" plans. A synopsis of the data contained in tables 9-11 is presented below:

	Plans 1/		
	Hi-Level Plan + 90,000,000 for Barge Berm w/ Ponding		Barrier Plan
First Cost	+($403,686,000)	-	($445,089,000 to $552,465,000)
Annual Costs (@ 3 1/8%)	+($13,792,000)	-	($15,756,000 to $19,680,000)
Annual Benefits (@ 3 1/8%)	-	+	($1,000,000/yr more than Hi-Level Plan)
Benefit/Cost Ratio	+	-	
Environmental Impacts	+	-	
Acceptability	+	-	

1/ (+) denotes plan is preferable for a given category; (-) denotes plan is less preferable for a given category.

Total project impact, including impacts associated with completed work, is displayed in tables 12 and 13; table 12 displays the quantitative environmental impacts of both plans, and table 13 displays total first costs for both plans.

SUMMARY AND CONCLUSIONS

Available data was analyzed, using a "zero-based budgeting approach," to compare differences in impacts which would result from implementing various alternative plans to complete the Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project. Two basic alternative approaches to completing the project were considered, Hi-Level and Barrier.

the standpoint of economic justification, environmental quality, and acceptability. It should be stressed that for purposes of analysis, no long term detrimental environmental impacts were assigned to the barrier structures. Hence, barrier plans received the benefit of the doubt. The reliability of the two approaches was also addressed. Concerns have been expressed that I-walls associated with the Hi-Level approach would be subject to breeching by barge impact; however, this would not be the case for the "optimal" Hi-Level Plan. Also, from an operational standpoint, the Hi-Level approach would be preferable, because levees ~~don't~~ would not require operation, but barrier structures would.

TABLE 1

SUMMARY OF ACREAGES OF WETLANDS DIRECTLY[1/] AFFECTED BY ALTERNATIVE FEATURES

Description	Barrier (acres)	HLP (SPH) (acres)
St. Charles Parish - Lakefront	410	520
- North of Airline Highway	510	635
- South of Airline Highway	660	820
New Orleans East Lakefront - Hauled Clay	126	210
- I-wall		143
Maxent Canal - Little Woods to I-10	173	229
South Point to GIWW	160	200
Chef Menteur	532	N/A
Rigolets	400	N/A
New Orleans East Back Levee	475	475

1/Applies only to future work. Does not include impacts associated with the Citrus Back Levee (IHNC to Michoud Canal), East Bank of IHNC (MR-GO to Lake Pontchartrain), West Bank of IHNC, Mandeville Seawall, Chalmette Area Plan, or Seabrook Lock.

TABLE 2

SUMMARY OF ACREAGES OF LAKE BOTTOM DIRECTLY AFFECTED BY ALTERNATIVE FEATURES

Description[1]		Barrier (acres)	HLP (SPH) (acres)
Jefferson Parish	- Straddle Enlargement	N/A	305
	- Hauled Clay (in-the-lake)	-0-	495
	- Hydraulic Clay (in-the-lake)	N/A	490[2]
	- I-Wall	N/A	265
	- I-Wall with barge berm[3]	N/A	470
	- T-Wall	N/A	265
Citrus Lakefront	- Hauled Clay (in-the-wall)	-0-	276
	- Hauled Clay (with barge berm)	N/A	55
	- Hydraulic Clay (in-the-lake)	N/A	1,576
	- I-Wall	N/A	-0-
	- I-Wall with barge berm	N/A	35
Chef Menteur and Rigolets Complexes		219	N/A

[1] Does not include undetermined acreage affected by St. Charles Parish Lakefront alinement.

[2] An additional 3,940 acres would be affected only during construction.

[3] Data reflects hauled clay fill construction only; data not available at this time for I-wall using hydraulic clay fill bases.

TABLE 3

SUMMARY OF ACREAGES OF WETLANDS INDIRECTLY AFFECTED BY ALTERNATIVE LEVEE ALINEMENTS

Description	Acreage (approximate)
St. Charles Levee	
Lakefront Alinement	29,440
North of Airline Highway	3,200
South of Airline Highway	-0-
New Orleans Lakefront Levee, South Point to GIWW Levee, New Orleans East Back Levee, and Maxent Canal Loop:	19,020

Note: Any Barrier Plan would also indirectly affect to an as yet undetermined extent the entire Lake Pontchartrain ecosystem (Lake Pontchartrain has a surface area of approximately 400,000 acres).

TABLE 4

SUMMARY OF ANNUALIZED REPLACEMENT COSTS
($/YR)

Description of Item	Interest Rate 3 1/8%	7 1/8%
Hi-Level Plan		
St. Charles Parish-Lakefront	26,500	16,500
St. Charles Parish-North of Airline Highway	2,400	1,500
St. Charles Parish-South of Airline Highway	2,400	1,500
Jefferson Parish Lakefront Levee 1/	700	400
Orleans Parish Lakefront Levee	15,900	10,100
Citrus Lakefront Levee-Landside	11,800	7,500
Citrus Lakefront Levee-In the Lake	14,800	10,500
South Point to GIWW Levee	5,000	3,800
Maxent Canal Levee	400	200
Barrier Plan		
St. Charles Parish-Lakefront	26,500	16,500
St. Charles Parish-North of Airline Highway	2,300	1,500
St. Charles Parish-South of Airline Highway	2,300	1,500
Orleans Parish Lakefront	14,500	9,400
Citrus Lakefront Levee-Landside	11,400	7,300
South Point to GIWW Levee	5,500	3,800
Maxent Canal Levee	300	200
Chef Menteur Control Sructure (43% opening)	11,300	3,700
Chef Menteur Control Structure (50% opening)	13,300	4,300
Chef Menteur Control Structure (90% opening)	23,300	7,600
Chef Menteur Navigation Structure	4,900	1,600
Rigolets Control Structure (35% opening)	24,300	7,900
Rigolets Control Structure (50% opening)	26,700	8,700
Rigolets Control Structure (90% opening)	46,900	15,200
Rigolets Lock	12,000	3,900

1/ Incomplete data.

TABLE 5

ESTIMATE OF FIRST COSTS FOR HI-LEVEL (SPH) NED PLAN[1/]

Item	First Cost ($)
St. Charles Parish (Lakefront Alinement)	$ 98,240,000
Jefferson Parish Lakefront Levee (Hydraulic Clay Fill without Ponding Area)	85,073,000
New Orleans Lakefront Levee (Hauled Clay Fill)	152,010,000
Citrus Lakefront Levee (I-Wall on Levee)	25,048,000
New Orleans East Lakefront Levee (Hauled Clay Fill)	27,774,000
South Point to GIWW Levee	3,916,000
New Orleans East Back Levee	11,704,000
TOTAL	$403,765,000

[1/] Applies only to future work. Does not include impacts associated with the Citrus Back Levee (IHNC to Michoud Canal), East Bank of IHNC (MR-GO to Lake Pontchartrain), West Bank of IHNC, Mandeville Seawall, Chalmette Area Plan, or Seabrook Lock.

TABLE 6

ESTIMATE OF FIRST COSTS FOR HI-LEVEL (SPH) EQ PLAN[1/]

Item	First Cost ($)
St. Charles Parish (South of Airline Highway Alinement)	$135,807,000
Jefferson Parish Levee (I-Wall)	118,173,000
New Orleans Lakefront Levee (I-Wall)	152,586,000
Citrus Lakefront Levee (I-Wall)	25,048,000
Maxent Canal Levee	84,125,000
New Orleans East Back Levee	5,600,000
TOTAL	$521,339,000

1/Applies only to future work. Does not include impacts associated with the Citrus Back Levee (IHNC to Michoud Canal), East Bank of IHNC (MR-GO to Lake Pontchartrain), West Bank of IHNC, Mandeville Seawall, Chalmette Area Plan, or Seabrook Lock.

TABLE 7

ESTIMATE OF FIRST COSTS FOR BARRIER NED PLAN 1/

Item	First Costs ($)
St. Charles Parish Levee (North of Airline Highway Alinement)	$ 70,129,000
Jefferson Parish Levee (Hauled Clay Fill)	7,323,000
New Orleans Lakefront Levee (Hauled Clay Fill)	126,798,000
Citrus Lakefront Levee (Hauled Clay Fill)	8,449,000
New Orleans East Lakefront Levee (Hauled Clay Fill)	10,773,000
South Point to GIWW Levee	432,000
New Orleans East Back Levee	11,704,000
Chef Menteur Structure (43% opening)	79,107,000
Rigolets Structure (35% opening)	142,078,000
TOTAL	$456,793,000

1/ Applies only to future work. Does not include impacts associated with the Citrus Back Levee (IHNC to Michoud Canal), East Bank of IHNC (MR-GO to Lake Pontchartrain), West Bank of IHNC, Mandeville Seawall, Chalmette Area Plan, or Seabrook Lock.

TABLE 8

ESTIMATE OF FIRST COSTS FOR BARRIER EQ PLAN[1/]

Item	First Cost ($)
St. Charles Parish Levee (South of Airline Highway Alinement)	$ 86,152,000
Jefferson Parish Levee (Hauled Clay Fill)	7,323,000
New Orleans Lakefront Levee (Hauled Clay Fill)	126,798,000
Citrus Lakefront Levee (Hauled Clay Fill)	8,449,000
Maxent Canal Levee	51,317,000
New Orleans East Back Levee	6,910,000
Chef Menteur Structure (90% opening)	106,497,000
Rigolets Structure (90% opening)	222,064,000
TOTAL	$615,510,000

1/Applies only to future work. Does not include impacts associated with the Citrus Back Levee (IHNC to Michoud Canal), East Bank of IHNC (MR-GO to Lake Pontchartrain), West Bank of IHNC, Mandeville Seawall, Chalmette Area Plan, or Seabrook Lock.

TABLE 9

SUMMARY OF INCREMENTAL CHARGES TO COMPLETE[1/]
"OPTIMAL" HI-LEVEL PLAN (SPH) IN DOLLARS

Description of Item	First Costs ($1,000)	Annual O&M $	Annual Replacement @ 3 1/8% $	Annual Replacement @ 7 1/8% $
St. Charles Parish Levee (N. of Airline Hwy.)	113,561	119,000	2,400	1,500
Jeff. Parish Lakefront Levee (Hydraulic Clay Fill w/o Ponding Areas)	85,073	72,000	700	400
N.O. Lakefront Levee-Hauled Clay Fill	152,010	206,000	15,900	10,100
Citrus Lakefront Levee (I-Wall with Barge Berm)	33,606	64,500	11,800	7,500
N.O. East Lakefront Levee (Hauled Clay Fill)	27,774	55,000	0	0
South Point to GIWW Levee	3,916	14,000	5,500	3,800
Totals	415,940	530,500	36,300	23,300

	Annual Charges @ 3 1/8 Percent	@ 7 1/8 Percent
I&A	$13,626,194	$29,664,841
O&M	530,500	530,500
Replacements	36,300	23,300
Totals (rounded)	$14,193,000	$30,219,000

[1/] Excludes display of the following items: Completed work, Citrus Back Levee, East Bank of IHNC, West Bank of IHNC, Mandeville Seawall, Chalmette Area Plan, Seabrook Complex and New Orleans East Back Levee

TABLE 10

SUMMARY OF INCREMENTAL CHARGES TO COMPLETE-1/
"OPTIMAL" BARRIER PLAN IN DOLLARS

Description of Item	First Costs ($1,000)	Annual O&M $	Annual Replacement @ 3 1/8% $	Annual Replacement @ 7 1/8% $
St. Charles Parish Levee (N. of Airline Hwy.)	70,129	92,000	2,400	1,500
Jeff. Parish Levee (Hauled Clay Fill)	7,323	31,000	-	-
N.O. Lakefront Levee (Hauled Clay Fill)	126,798	192,000	14,500	9,400
Citrus Lakefront Levee (Hauled Clay Fill)	8,449	33,400	11,400	7,300
N.O. East Lakefront Levee (Hauled Clay Fill)	10,773	12,000	-	-
South Pt. to GIWW Levee	432	13,000	5,500	3,800
Chef Menteur and Rigolets Structures (Range of Costs)	221,185 to 328,561	715,000 to 1,087,000	52,500 to 87,100	17,100 to 28,300
Totals	445,089 to 552,465	1,088,400 to 1,460,400	86,300 to 120,900	39,100 to 50,300

Annual Charges (range)

	@ 3 1/8 percent	@ 7 1/8 percent
I&A	$14,581,116 - $18,098,753	$31,743,747 - $39,401,804
O&M	1,088,400 - 1,460,400	1,088,400 - 1,460,000
Replacement	86,300 - 120,900	39,100 - 50,300
Totals (rounded)	$15,756,000 - $19,680,000	$32,871,000 - $40,912,000

1/Exludes display of the following items: Completed work, Citrus Back Levee, East Bank of IHNC, West Bank of IHNC, Mandeville Seawall, Chalmette Area Plan, Seabrook Complex and New Orleans East Back Levee.

TABLE 11

SUMMARY COMPARISON OF DIFFERENCES IN "OPTIMAL" PLANS

EVALUATION CRITERIA	ALTERNATIVES HI-LEVEL	BARRIER
A. PLAN DESCRIPTION		
1. Common Features[1]	Mandeville Seawall, Seabrook Complex, Chalmette Area Plan, New Orleans East Back Levee, Citrus Back Levee, East Bank of IHNC (MR-GO to Lake Pontchartrain), West Bank of IHNC	Same as Hi-Level Plan.
2. Features That Differ	St. Charles Parish Levee--North of Airline Highway Jefferson Parish Lakefront Levee-hydraulic clay fill without ponding areas New Orleans Lakefront Levee-hauled clay fill Citrus Lakefront Levee- I-wall with barge berm New Orleans East Lakefront Levee-Hauled Clay Fill South Point to GIWW Levee-hauled clay fill	St. Charles Parish Levee--North of Airline Highway Jefferson Parish Lakefront Levee-hauled clay fill New Orleans Lakefront Levee-hauled clay fill Citrus Lakefront Levee-hauled clay fill New Orleans East Lakefront Levee-hauled clay fill South Point to GIWW Levee-hauled clay fill Chef Menteur and Rigolets Complexes[2]
B. RELATIONSHIP TO FOUR NATIONAL ACCOUNTS		
1. NED		
(a) Average Annual Benefits	Not quantified at this time-It is assumed that they exceed average annual costs.	Same as Hi-Level except that North Shore will receive some subsidiary benefits estimated at $1,000,000/year (based on updating information contained in the 1962 Interim Survey Report to October 1979 price levels using a 3 1/8% interest rate).

TABLE 11 (Continued)

(b) Average Annual Costs	@ 3 1/8% Interest	@ 7 1/8% Interest	@ 3 1/8% Interest (Range of Costs)	@ 7 1/8% Interest	
	I&A $13,626,000	$29,665,000	I&A	$14,581,000-$18,099,000	$31,743,000-$39,402,000
	O&M 567,000	554,000	O&M	1,175,000- 1,581,000	1,128,000- 1,510,000
	Totals $14,193,000	$30,219,000	Totals	$15,756,000-$19,680,000	$32,871,000-$40,912,000

(c) Incremental B/C ratio

Individual Plans' overall B/C ratios have not been quantified at this time; however, the incremental B/C ratio, i.e., the differences in incremental benefits and costs between the Hi-Level and Barrier Plans can be estimated as follows:

Incremental Benefits: The Barrier Plan would generate about $1,000,000/year (@ 3 1/8% Interest, Oct 79 price levels) more than the Hi-Level Plan.
Incremental Costs: The Barrier Plan would have annual costs exceeding those associated with the Hi-Level Plan of between $1,563,000/year to $5,487,000/year (Mar 79 price levels @ 3 1/8% Interest)
Therefore the incremental B/C ratio is computed as falling between $\frac{1,000,000}{1,563,000}$ and $\frac{1,000,000}{5,487,000}$ or 0.64 to 0.18

2. EQ

Project construction of those features not common to both plans would result in the destruction of 1,510 acres of wetlands, the destruction of 525 acres of lake bottoms, and the short term alteration of 3,940 acres of lake bottoms and high turbidity during the construction of the first two lifts of the Jefferson Parish Lakefront Levee. According to a modified HES type of analysis, the average annual habitat units lost over the project life would amount to 33,505.
It should be noted that this plan offers the opportunity to restore, to some extent, approximately 1,124 acres of wetlands which have already been impacted by the construction of the GIWW bypass.

Project construction of those features not common to both plans would result in the destruction of 2,203 acres of wetlands and 219 acres of open water. High turbidity would occur in the vicinity of the tidal passes during construction of the closure structures. Also, project implementation could potentially alter to some unquantified extent, the entire ecosystem of Lake Pontchartrain (surface area = approximately 400,000 acres).
According to a modified HES type of analysis, the average annual habitat units lost over the project life would amount to 41,963. (Disregarding potential barrier structures' impacts).

TABLE 11 (Continued)

3. SWB		
(a) Beneficial	Project will provide protection to human life from the Standard Project Hurricane for the Greater New Orleans Metropolitan Area.	Same as Hi-Level Plan.
(b) Adverse	Loss of environmental values will cause a corresponding loss of recreational opportunities and esthetic values. The extensive raising of the net grade of the New Orleans Lakefront Levee, which obscures the view of the lake, has a net grade 5.5 feet higher than the Barrier Plan.	Loss of environmental values and corresponding loss in recreational and esthetic values will be greater than Hi-Level Plan. It should be noted that if the Barrier's effect upon biological transport is significant then correspondingly related social impacts will be severe. Levees associated with this plan would also obscure the view of the lake.
4. RD	Would allow continued growth of the Greater New Orleans Metropolitan Area.	Same as Hi-Level.
C. PLAN RESPONSE TO EVALUATION CRITERIA		
1. Acceptability	Local interests better able to meet their cost sharing responsibilities than under Barrier Plan. Limited environmental opposition.	Local interests less able to meet their responsibilities than under Hi-Level Plan. Plan perceived as unacceptable by environmental "community." Objectionable to navigation interests.
2. B/C	Not quantified-Assumed greater than unity.	Less than Hi-Level Plan.
3. Reliability	Concerns about potential breeching of I-walls by barge impact are not valid for this plan.	There are potential operational difficulties associated with the barrier structures.

TABLE 11 (Continued)

D. IMPLEMENTATION RESPONSIBILITIES		
1. Federal	Total average annual Federal costs will consist of 70% of the interest and amortization on $415,940,000 in first costs as follows: $9,538,000 @ 3 1/8% Interest $20,766,000 @ 7 1/8% Interest	Total average annual Federal costs will consist of 70% of the interest and amortization on $445,089,000 to $552,465,000 in first costs as follows: $10,207,000-$12,669,000 @ 3 1/8% Interest $22,220,000-$27,581,000 @ 7 1/8% Interest
2. Non-Federal	Total average annual non-Federal costs will consist of 30% of the interest and amortization on $403,686,000 in first costs and all project O&M costs (including replacements) as follows:	Total average annual non-Federal costs will consist of 30% of the interest and amortization on $445,089,000 to $552,465,000 in first costs and all project O&M costs (including replacements) as follows:

	@ 3 1/8% Interest	@ 7 1/8% Interest
I&A	$4,088,000	$8,899,000
O&M	$ 567,000	$ 554,000
Totals	$4,655,000	$9,453,000

	@ 3 1/8% Interest	@ 7 1/8% Interest
I&A	$4,374,000-$5,430,000	$9,523,000-$11,821,000
O&M	$1,175,000-$1,581,000	$1,128,000-$1,510,000
Totals	$5,549,000-$7,011,000	$10,651,000-$13,331,000

1/ The costs and impacts of these features are not displayed herein, because they are the same under either plan.

2/ The size of the flow control structures at these locations has not been decided upon.

TABLE 13

SUMMARY OF TOTAL FIRST COSTS FOR "OPTIMAL" PLANS

Work Item	Plan Hi-Level	Barrier
Sunk Costs[1/]	$119,336,000	$119,336,000
Common Features[2/]	131,138,000	131,138,000
Differing Features	415,940,000[3/]	445,089,000 to 552,465,000[4/]
Totals	$666,414,000	$695,563,000 to $802,939,000

1/Non-escalated costs through 30 Sep 79.
2/Based on Mar 79 price levels
3/Taken from table 9
4/Taken from table 10

LAKE PONTCHARTRAIN, LOUISIANA AND VICINITY HURRICANE PROTECTION PROJECT ALTERNATIVE PLANS STUDY

INCLOSURE 1
(Plates 1-17 and
Appendixes A-C
withdrawn)

ERATA SHEET

The following revised cost estimates (tables 1 and 2)*, relating to the Hi-Level Plan SPH Protection - Jefferson Parish Lakefront levee were furnished informally by Engineering Division on 2 June 1980:

*Note: Revision to tables 3 and 4 were not provided; however, tables 3 and 4 were not used in the preliminary formulation of alternative plans, so this omission is unimportant at this time.

Supplement to

TABLE 1

SUMMARY ESTIMATES OF FIRST COST

DESCRIPTION		COST BARRIER PLAN SPH PROTECTION	COST HIGH LEVEL PLAN SPH PROTECTION	COST HIGH LEVEL PLAN 100-YEAR PROTECTION[1/]
Jefferson Parish Lakefront Levee	ALL EARTHEN LEVEE:			
	a. Hauled Clay Fill (Straddle)	N/A	368,893,000	172,666,000
	b. Hauled Clay Fill	10,952,000	185,400,000	118,952,000
	c. Hydraulic Fill w/o Ponding Area	N/A	89,020,000	61,636,000
	d. Hydraulic Fill w/ Ponding Area	N/A	179,605,000	152,449,000
	I-WALL ON LEVEE WITH BARGE BERM:			
	a. Hauled Clay Fill	N/A	205,269,000	N/A
	b. Hydraulic Fill w/o Ponding Area	N/A	106,556,000	N/A
	c. Hydraulic Fill w/ Ponding Area	N/A	197,217,000	N/A
	I-WALL ON LEVEE:			
	a. Hauled Clay Fill	N/A	122,120,000	N/A
	T-WALL ON LEVEE:			
	a. Hauled Clay Fill	N/A	431,257,000	N/A

[1/] 100-Year Protection Plan was considered only for leveed reaches inside the Barrier System.

Supplement to

TABLE 2

SUMMARY ESTIMATES OF COST TO COMPLETE

DESCRIPTION		COST BARRIER PLAN SPH PROTECTION	COST HIGH LEVEL PLAN SPH PROTECTION	COST HIGH LEVEL PLAN 100-YEAR PROTECTION
Jefferson Parish Lakefront Levee	ALL EARTHEN LEVEE:			
	a. Hauled Clay Fill (Straddle)	N/A	364,946,000	168,721,000
	b. Hauled Clay Fill	7,323,000	181,453,000	115,006,000
	c. Hydraulic Fill w/o Ponding Area	N/A	85,073,000	57,567,000
	d. Hydraulic Fill w/ Ponding Area	N/A	175,613,000	148,228,000
	I-WALL ON LEVEE WITH BARGE BERM:			
	a. Hauled Clay Fill	N/A	201,923,000	N/A
	b. Hydraulic Fill w/o Ponding Area	N/A	102,611,000	N/A
	c. Hydraulic Fill w/ Ponding Area	N/A	193,271,000	N/A
	I-WALL ON LEVEE:			
	a. Hauled Clay Fill	N/A	122,173,000	N/A
	T-WALL ON LEVEE:			
	a. Hauled Clay Fill	N/A	427,309,000	N/A

1/ 100-Year Protection Plan was considered only for leveed reaches inside the Barrier System.

LAKE PONTCHARTRAIN, LOUISIANA AND VICINITY
HURRICANE PROTECTION PROJECT
ALTERNATIVE PLANS STUDY

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LAKE PONTCHARTRAIN, LOUISIANA AND VICINITY
HURRICANE PROTECTION PROJECT
ALTERNATIVE PLANS STUDY

1. Purpose and Extent of Study.

a. General. On 30 December 1977 the United States Fifth District Court enjoined further construction of certain portions of the Lake Pontchartrain Hurricane Protection project pending preparation of a revised environmental impact statement. Modifications to the court order were issued on 8, 10 and 27 March 1978 reducing the scope of the injunction to include only the Chef Menteur and Rigolets Barrier Complexes.

In support of the revised environmental impact statement, this document considers alternatives to the "barrier" concept of protection, as well as alternative levee alinements in the vicinities of wetlands in St. Charles Parish and in New Orleans East. Portions of the project for which alternatives are considered include the barrier complexes and the flood protection works bordering Lake Pontchartrain from the east guide levee of the Bonnet Carre Spillway to the eastern side of New Orleans East. This report is not intended to be a decision making document but rather is intended to present a description of all the feasible engineering alternatives and their respective costs for the Lake Pontchartrain, La. and Vicinity Hurricane Protection Project. The information contained in this document taken in conjunction with the respective environmental assessment and economic analyses of each plan will identify the most cost effective plan of protection for the Lake Pontchartrain area.

b. Agencies Consulted. The following agencies were consulted during the course of the study: U.S. Department of the Interior, Fish and Wildlife Service; U.S. Marine Fisheries Service; U.S. Environmental Protection Agency; and State of Louisiana, Department of Wildlife and Fisheries.

c. Support Data. Support Data, including design methods and procedures used for this study are contained in the attached Appendices A, B and C.

2. Plans of Protection.

a. General.

(1) Chalmette Area. Hurricane protection for the Chalmette area is provided by a levee and floodwall system which starts and ends with the existing Mississippi River levee. The combined effect of the hurricane protection and the Mississippi River levee is to provide a closed loop of flood protection around the Chalmette area. The Chalmette area protection is completely independent of hurricane protection for adjacent land areas. Only standard project hurricane protection and the authorized alinement are presented in this document for the Chalmette area. Plate 1 shows the levee alinement for the Chalmette area plan.

(2) Other Project Areas. Protection for the remaining project areas (New Orleans East, Citrus, New Orleans West of IHNC, Jefferson Parish East of Mississippi River, and St. Charles Parish East of Mississippi River) can be accomplished either with a "barrier" concept of protection or with "high level" levees and floodwalls. Under the Barrier Plan, portions of St. Tammany and Tangipahoa Parishes bordering Lake Pontchartrain receive a degree of protection. This added degree of protection can not be achieved under the high-level plan.

(a) Barrier Plan. The barrier concept provides for a system of controls at the Rigolets, Chef Menteur, and Seabrook inlets to Lake Pontchartrain which limits the tidal rise in Lake Pontchartrain in the event of a hurricane. Protective works bordering the lake are designed accordingly and do not have to be as high as required if the hurricane surge was permitted to enter the lake. Reaches of protection directly affected include St. Charles and Jefferson Parishes, Orleans Lakefront West of IHNC, Citrus Lakefront, New Orleans East Lakefront, and the eastern side of New Orleans East. Reaches of protection not affected by the presence of the barriers are the east and west banks of the IHNC, the Citrus back levee, and the New Orleans East back levee. The repairs presently authorized for the Mandeville Seawall are irrespective of the barrier plan.

(b) High Level Plan. Under this plan the hurricane surge is permitted to enter Lake Pontchartrain and protective works bordering the lake are designed accordingly. This document presents alternative alinements and degrees of protection for protective works bordering the lake and for a portion of the New Orleans East back levee. Except for a portion of the New Orleans East back levee, protective works not bordering the lake are designed only for the standard project hurricane.

b. Alternative Alinements and Degrees of Protection. Alternative alinements and degrees of protection are presented in this document only for protective works bordering Lake Pontchartrain, which are influenced by the presence or nonpresence of the barriers, and for portions of the New Orleans East back levee. Degrees of protection considered include the standard project hurricane (with and without barriers) and the 100 year hurricane (without barriers). Alternative alinements are shown on plates 2 through 10. Cost estimates are summarized in tables 1 and 2, and are presented in detail in appendix A.

(1) St. Charles Parish. Three alinements in St. Charles Parish are considered herein and are shown on plates 2, 3, and 4. The lakefront alinement consists of 5.7 miles of levee and a drainage structure near the Jefferson Parish line. The north of Highway 61 alinement

consists of 8.1 miles of levee, 5.7 miles of floodwall, 4 vehicular gates, and 4 drainage structures. The south of Highway 61 alinement consists of 10.4 miles of levee, 5.7 miles of floodwall, 3 road ramps, 6 vehicular gates, and 4 drainage structures.

(2) Jefferson Parish. Only the existing lakefront alinement in Jefferson Parish is considered herein. The potential for expansion of the existing levee lakeward as well as landward is considered. The lakefront alinement is shown on plate 5. The existing 10.2 miles of levee is incorporated into the proposed alternatives. All alternatives provide for floodwalls in front of the four lakefront pumping stations.

(3) Orleans Lakefront West of IHNC. Only the existing lakefront alinement landside of the seawall is presented herein. This alinement is shown on plate 5 and consists of 5.6 miles of levee, 1.3 miles of floodwall, 18 road ramps, 8 vehicular gates, and 4 drainage structures. All alternatives provide for gated structures and auxiliary pumping stations at the lakeward ends of the three drainage outfall canals.

(4) Citrus Lakefront. The existing levee alinement, which is between the Southern Railway embankment and Hayne Boulevard, is utilized for the barrier plan levee, the high level 100 year protection levee and SPH floodwall plan. The existing alinement is also used for high level SPH protection when coupled with a wave breaker rock dike located on the lakeside of the railroad embankment. The high level SPH protection levee without the rock dike is much wider than the barrier or 100 year levees; therefore, locating it on the existing alinement would entail the relocation either of the railroad or of Hayne Boulevard and bordering businesses/residences. Such relocations are uneconomical and highly undesirable. Therefore, the high level SPH levee without the rock dike is situated in the lake immediately north of the railroad embankment. The barrier plan protection and the 100 year protection consist of 4.8 miles of levee, 0.9 miles of floodwall, 5 vehicular gates, 2 road ramps, and 3 drainage structures. The high level SPH protection with rock dike consists of the foregoing components as well as 4.8 miles of concrete retaining wall and 4.8 miles of rock dike. The high level SPH protection without the rock dike consists of 5.1 miles of levee, 1.3 miles of floodwall, 4 vehicular gates, 2 road ramps, and 7 drainage structures.

The existing levee alinement is shown on plates 6, 7, and 8. The in-the-lake levee alinement is shown on plates 9 and 10.

(5) New Orleans East Lakefront. The lakefront alinement landside of the Southern Railway tracks is presented herein. It is shown on plates 6, 8, and 9 and consists of 6.2 miles of levee. It should be noted that no protection is required on the New Orleans East lakefront for plans using the Maxent Canal alinement.

(6) Lake Pontchartrain to the GIWW. Two alinements are presented herein. The Maxent Canal alinement, shown on plates 7 and 10 is located on the edge of the New Orleans East wetlands (using the wetland limits as defined in March 1978) and excludes all wetlands from the protected area. The Maxent Canal alinement consists of 7.6 miles of levee, 1 vehicular gate, and 2 road ramps. Note, if the Maxent Canal alinement is adopted and full tidal movement is permitted into the wetland area in New Orleans East, then the Interstate Highway 10 would be subject to periodic innundation by non-hurricane tides. The South Point to GIWW alinement, shown on plates 6, 8, and 9 consists of 8.3 miles of levee, 3 road ramps, 1 vehicular gate, and 4 drainage structures.

c. Alternative Designs for Barrier Structures. Three barrier complexes are required under the barrier plan at the following locations: the Rigolets Pass; the Chef Menteur Pass; and Seabrook.

(1) Rigolets Complex. The Rigolets Complex consists of barrier levees, a control structure, a navigation lock, and a closure dam. The complex provides a barrier against tidal influx into Lake Pontchartrain under hurricane conditions, and provides for continuous tidal interchange and navigation movement in non-hurricane conditions. Since the great majority of normal tidal interchange would occur through the control structure, three control structure sizes are presented in this document. A structure 1,088 feet long would provide a cross sectional area for flow equal to approximately 35 percent of the natural cross sectional area of the pass; a structure 1,564 feet long would provide approximately 50 percent of the natural cross section; and a structure 2,856 feet long would provide approximately 90 percent of the natural cross section. The volume of water passed with each size structure compared to that which is passed through the natural pass is discussed in Appendix B, paragraph 2.e. The Rigolets Complex with the 35 percent opening is shown on plate 11. Various structural and alinement alternatives for the Rigolets Complex are discussed below under "Other Plans".

(2) Chef Menteur Complex. The Chef Menteur Complex consists of barrier levees, a control structure, a navigation structure, and a closure dam. The complex provides a barrier against tidal influx into Lake Pontchartrain under hurricane conditions, and provides for continuous tidal interchange and navigation movement in nonhurricane conditions. Since the great majority of normal tidal interchange would occur through the control structure, three control structure sizes are presented in this document. A structure 612 feet long would provide a cross sectional area equal to approximately 41 percent of the natural cross sectional area of the pass; a structure 748 feet long would provide approximately 50 percent of the natural cross section; and a structure 1,360 feet long

would provide approximately 90 percent of the natural cross section. The volume of water passed with each size structure compared to that which is passed through the natural pass is discussed in Appendix B, paragraph 2e. The Chef Menteur Complex with the 41 percent opening is shown on plate 12. Various structural and alinement alternatives for the Chef Menteur Complex are discussed below under "Other Plans".

(3) Seabrook Complex. The Seabrook Complex consists of a navigation lock, a control structure, and a closure dam. The Seabrook Complex is shown on plate 13. The complex serves three functions: during hurricane conditions, the lock and control structure are closed to provide a barrier against tidal influx into Lake Pontchartrain; during nonhurricane conditions the complex provides the means for regulating salinity levels in Lake Pontchartrain ranging from present salinity levels to levels existing prior to the opening of the Mississippi River Gulf Outlet; and the lock provides safe passage for navigation in an area where currents are a hazard to navigation. Due to the multi-purpose nature of the Seabrook Complex, alternative sizes of the control structure are not feasible.

d. Other Plans. Various other plans of protection and alinements were considered and are described below.

(1) Alternative Alinement for Chef Menteur Complex. An alternative alinement for the Chef Menteur Complex is shown in plan on plate 14. This alinement, which was presented in the original project authorization, was considered in detail in Appendix A of General Design Memorandum No. 2, Supplement No. 3, Chef Menteur Pass Complex dated May 1969. The design memorandum is available for review in the New Orleans District office of the Corps of Engineers. This alinement extends generally eastward from the existing New Orleans East levee along the north banks of Bayou Sauvage and Chef Menteur Pass, thence southeast across Chef Menteur Pass to the U.S. Highway 90 embankment. (Note: the alinement in the vicinity of the Rigolets complex is discussed in a later paragraph). This alinement did not compare favorably with that shown on plate 6 principally because it offers no protection to the Venetian Isles subdivision and because it is not as economically justified.

(2) "Plan B" Alternative Alinement for Barrier. An alternative alinement for the entire barrier from the existing New Orleans East levee to Apple Pie Ridge in St. Tammany Parish is shown in plan on plate 15. This alinement was considered in detail in Appendix A of General Design Memorandum No. 2, Supplement No. 3, Chef Menteur Pass Complex dated May 1969 and was referred to as "plan B". The design memorandum is available for review in the New Orleans District office of the Corps of Engineers. This alinement runs essentially along the north bank of the Gulf Intracoastal Waterway to a point east of Lake St. Catherine where it turns north, crosses the Rigolets Pass and ties in with Apple Pie Ridge. This alinement was not as economically justified as the alinement on plate 6.

(3) "Plan C" Alternative Alinement for Barrier Complex. This alternative involves a radical departure from other plans and involves not only modifications in the Lake Pontchartrain barrier, but in the overall Lake Pontchartrain Barrier Plan and the Chalmette Area Plan as well. The alinement is shown on plate 16. This plan was considered in detail in Appendix A of General Design Memorandum No. 2, Supplement No. 3, Chef Menteur Pass Complex dated May 1969 and was referred to as "plan C". The design memorandum is available for review in the New Orleans District office of the Corps of Engineers. The plan moves the primary line of hurricane defense for Orleans and St. Bernard Parishes eastward to the western shore of Lake Borgne. The modified levee alinement crosses both the MR-GO and the GIWW. An opening 400 feet wide by 40 feet deep below mean low gulf is provided where the alinement crosses the MR-GO, with closure during hurricanes to be effected by a floating gate. A navigation lock 110 feet by 1,200 feet with sill at elevation -14, located in a bypass channel, provides for uninterrupted use of the GIWW. This plan eliminates much of the levee required for the Chalmette Area Plan and drastically reduces the grade requirements of the Citrus and New Orleans East back levees and the IHNC. This plan was not as economically justified as the Barrier Plan and Chalmette Area Plan alinements shown on plates 6 and 1, respectively.

(4) "Plan 1" Alternative Location for Rigolets Structure. An alternative location for the Rigolets Control Structure is shown on plate 17. This plan, which was contained in the original project authorization, was considered in detail in Appendix A of General Design Memorandum No. 2, Supplement No. 1, entitled Rigolets Control Structure, Closure Dam, and Adjoining Levees, dated March 1970. The design memorandum is available for review in the New Orleans District office of the Corps of Engineers. The distinguishing features of this plan are the location of the control structure with associated channels in a land cut and the relocation of U.S. Highway 90. In comparison, the alinement shown on plate 6 was found to be less costly, does not require relocation of Highway 90, and eliminates the land cut.

(5) "Plan 2" Change in Sill Elevation Rigolets Structure. A change in the depth of the Rigolets Control Structure was considered in detail in Appendix B of General Design Memorandum No. 2, Supplement No. 1, entitled Rigolets Control Structure, Closure Dam, and Adjoining Levees, dated March 1970. The design memorandum is available for review in the New Orleans District office of the Corps of Engineers. This plan, identical in alinement to that shown on plate 6, considers a sill elevation for the control structure of -20.0 feet mean sea level. When compared against a control structure of the same hydraulic capacity but with a sill elevation of -30.0, this plan was found to be more costly and offered no added advantage.

(6) Navigable Opening in Rigolets Structure. It has been suggested that navigation needs at the Rigolets Pass could be served by constructing a navigable opening in the control structure in lieu of a navigation lock. This matter, among others, was addressed in the "Report on Size Selection, Chef Menteur Navigation Structure and Rigolets and Seabrook Locks", prepared in July 1970. The report is available for review in the New Orleans District office of the Corps of Engineers. In that report the requirement for navigation locks at both Rigolets and Seabrook was justified, as was the need for a navigation structure in lieu of a lock at Chef Menteur. The following excerpt in support of these positions is extracted from the above referenced report:

"Structure types. The Rigolets and the IHNC are both segments of an authorized navigation project. Both provide access to harbors of refuge in time of storms. Any attempt to provide the needed control at either location through a floodgate would result in extensive interruptions to navigation. The need for navigation locks at these two locations is, therefore, clearcut. The situation at Chef Menteur Pass is different. The pass is not part of an authorized navigation project, and the projected existence of alternate uninterrupted routes via The Rigolets and Seabrook obviates the need to provide uninterrupted access. Use of a floodgate, which will allow passage most of the time, is, therefore, appropriate."

(7) "Mouton Plan". In January 1978, Mr. William J. Mouton, Jr., a structural engineer from New Orleans, proposed the use of dual purpose control and navigation structures in both the Chef Menteur and Rigolets Passes. His proposed structures would eliminate the separate navigation structure at Chef Menteur and the lock at Rigolets; it would provide a flow area equal to approximately 90 percent of the natural cross sectional area; it would utilize prestressed concrete construction; it would serve as a potential highway crossing; and it would utilize a "needle" type closure. Plate 18 illustrates the Mouton Plan. Observations relative to Mr. Mouton's proposals are as follows.

(a) For reasons stated in subparagraph (6) above, the proposed combination control and navigation structure at Rigolets does not satisfy project requirements.

(b) The needle type closure in a control structure does not provide the dependability, speed of operation, and ease of handling which is required under hurricane conditions.

(c) The remainder of Mr. Mouton's proposal, when considered from the standpoints of constructability, long life, serviceability, and function, do not meet the project needs as well as the recommended designs.

(8) Floating/Sinkable Barge. A floating/sinkable barge has been proposed for use as a control structure in the Rigolets Pass, Chef Menteur Pass, and the MR-GO/IHNC. The proposal calls for a floating barge (or other type vessel) hinged at one end to be stored parallel to each waterway. In the event of an approaching hurricane, the barges would be swung across the waterways and sunk to form barriers against tidal influx. Observations relative to this proposal are as follows:

(a) The proposal is not suited for the MR-GO/IHNC location since it does not provide the flexibility required for salinity control nor does it reduce the navigation hazard at Seabrook. (See subparagraph c(1) above.)

(b) At Rigolets a lock would be required as stated in subparagraph (6) above.

(c) The massiveness of the floating barge would make closure during an approaching hurricane exceedingly difficult, if not impossible. Such uncertainty cannot be tolerated in a hurricane protection structure.

(d) To form an effective closure, the barge would have to seat on a concrete base slab in the bottom of the channel. Considering irregularities on the base slab surface resulting from siltation and debris accumulation, proper seating of a barge would be uncertain and unsuspendable.

In summary, it was concluded that this proposal cannot satisfy project needs.

(9) Orleans Parish Offshore Breakwater. Breakwaters situated in the lake near the shoreline have been proposed for use on the New Orleans lakefront. The purpose of the breakwaters would be to reduce the height of waves striking the shoreline, thus reducing the height of the required levees and floodwalls. The breakwaters would be constructed of a sand core overlain with riprap stone. They would have a top elevation of 10 feet above mean sea level and would have to be constructed close enough to the shoreline so as to prevent regeneration of the waves. Such breakwaters would cost approximately $2,400 per linear foot or approximately $60 million for the reach from the West End Yacht Harbor to the Inner Harbor Navigation Canal. Breakwaters would adversely impact lakefront aethetics and recreational boating. When compared with the option to raise the lakefront levees and floodwalls, the breakwater plan was found to be inferior.

(10) I-Wall and T-Wall on Levee. The use of concrete capped steel pile (I-Wall) and a pile supported concrete wall (T-Wall) has been proposed as a means of achieving "high level" protection on the lakefront. Located on the shoreline of a large, open body of water (Lake Pontchartrain) where commercial and recreational vessels may be driven against the protection by storm forces, a floodwall does not provide the same degree of reliability as an earthen levee plan would under these conditions. Generally speaking, it is impractical and/or uneconomical to design long reaches of floodwall for such impact forces. However, it must be conceded that the likelihood of a vessel striking the floodwall during the height of a storm is indeed remote. Therefore, the I-wall and T-wall designs and cost estimates were prepared and presented as separate alternative plans in this report. If these plans warrant serious consideration in future plan formulations, then it should be emphasized that the possibility of impact loading on the wall does exist and if this plan is pursued, strict regulatory measures must be drafted requiring the prior removal of all large vessels from the lake in the event of an approaching hurricane. These measures can help minimize the possibility of an errant vessel impacting the wall but can never entirely eliminate the possibility. T-Walls, which are usually more expensive to construct than I-walls were considered because of the extensive amounts of fill required to make the I-wall design section stable. Because of the susceptibility of impact loading, a so called "barge berm" design in combination with the I-Wall concept was designed and costed. This plan is also included as a high level alternative plan.

(11) "No Action Plan". The alternative of "no action" would preserve, for a time, the existing environmental dynamics of the area. It would leave the area subject to massive overflow from hurricanes, with attendant major economic loss, social disruption, and a potential for extensive loss of human life.

3. Estimates of First Cost. Cost estimates for the barrier plan, the high level plan - SPH protection, and the high level plan -100 year protection are presented in tables 1 and 2. These tables reflect the least costly, acceptable solutions for each reach of protection. Detailed estimates of all alinements and degrees of protection are given in appendix A. All estimates are broken down into the following reaches: Chalmette area; St. Charles Parish; Jefferson Parish; New Orleans Lakefront from Jefferson Parish line to the IHNC; West bank of IHNC; East bank of IHNC north of MRGO; Citrus Lakefront; New Orleans East Lakefront; Lake Pontchartrain to GIWW; New Orleans East back levee; Citrus back levee; Seabrook Complex; Chef Menteur Complex; Rigolets Complex; and Mandeville Seawall. All cost estimates were developed using March 1979 price levels. The base condition for estimates contained in table 1 assume flood protection works as they existed in September 1965

just prior to authorization. The base condition for estimates contained in table 2 assumes present day or existing conditions and thus table 2 estimates reflect the "cost to complete" estimate for the various project reaches. All work items that are under contract as of October 1979 were considered to be completed work items.

4. Summary of Findings.

a. General. Although the intent of this report is to present a description of all the feasible engineering alternatives and their respective costs, a certain degree of plan formulating is necessary to compare the "total" first cost of any of the alternative plans with the first cost for the barrier plan. As is the case with any plan formulating process, certain decisions and/or assumptions must be made in arriving at a given plan, i.e. levee alinement, type construction, etc. As was explained in paragraph 3 above, two base conditions were considered for this study, one assumed conditions that existed in 1965, just prior to authorization, the other assumed October 1979 "existing" conditions. In each case the cost of levees and rights-of-ways that existed at the respective times were considered sunk cost and only those costs for additional rights-of-way, design and construction necessary to achieve the project level of protection were charged to the respective alternative plan under consideration. Also, the "total" cost of the modified barrier plan was treated in the same manner so that each plan would have the same bases for comparison. Again, March 1979 price levels were used in estimating the cost of the various plans. For the purposes of comparison, only SPH level of protection was considered in the plan formulating process. Also, since the Chalmette Area plan would be the same for either the high-level or barrier plan, its cost was deleted from consideration in the barrier vs. high-level cost comparison shown in tables 3 and 4.

b. Treatment of Seabrook Complex in Plan Formulation. In developing a plan formulation cost comparison table, the treatment of the cost of the Seabrook complex warrants some explanation. Under the barrier or authorized plan, the cost of the Seabrook complex is cost apportioned such that 50% of its first cost is charged to the Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection project and the remaining 50% is charged to the Mississippi River - Gulf Outlet project (MR-GO). This cost apportionment formulation was recommended by the Bureau of the Budget and approved by the Congress of the United States but as a basis in fact this formula overstates the true degree of hurricane protection afforded by the complex. The cost sharing formula spelled out in the report of the Chief indicated that 93 percent of the Seabrook facility cost should be borne by the MR-GO project as mitigation and the remaining 7 percent chargeable to the hurricane protection project. The question

that comes to mind when formulating a high-level plan is how to treat Seabrook under any high-level plan which is concerned solely with hurricane protection and not navigation. To be sure, the construction of the Seabrook complex under a high-level plan would provide a degree of protection to the unprotected development along the Inner Harbor Navigation Canal (IHNC). The development in question is situated on the floodside of the floodwalls along the IHNC. Hurricane induced flooding from Lake Pontchartrain would be reduced if the Seabrook complex were to be constructed under a high-level plan. It is not within the scope of this report to develop a high-level cost apportionment plan for Seabrook but it seems clear that if the cost of the Seabrook complex were weighed equally for each of the plans being formulated then the results of the cost comparison would not be biased as would be the case by its inclusion in one plan and not in another. This is the approach that has been used in this report and is consequently reflected in the costs shown in tables 1, 2, 3 and 4.

c. Formulated Plans. For the various project reaches listed in tables 1 and 2, selected elements, i.e. type and methods of construction, were used to formulate nine high-level plans. The plans are displayed in tables 3 and 4. The formulated plans on tables 3 and 4 are the same in each table, but the base conditions differ as was explained in paragraph 3 above. A modified barrier plan was also formulated and can be used to compare the relative costs of "barrier plan vs high-level plan". The selected elements for each plan are easily determined by examination of tables 3 and 4. To the extent possible, each plan has the same levee alinement. However, in some cases where high-level haul clay or hydraulic fill construction is involved, it was necessary to move the centerline of the levee lakeward to eliminate extensive relocation costs. For each plan where alinement shifts are required, it has been footnoted. Examination of tables 3 and 4 shows that the high level plans formulated in the tables differ in the types and method of construction employed for project reaches fronting Lake Pontchartrain, i.e. Jefferson Parish lakefront levees, New Orleans lakefront levees, Citrus lakefront levees and the New Orleans East Lakefront levee. The following paragraphs give a brief synopsis of the formulated plans. As the plans shown on tables 3 and 4 are identical, reference to table 3 also applies to table 4.

(1) Plan A-1. This plan comprises all the elements of the authorized barrier plan with the exception of the Chalmette area plan and the levee alinement formulated for St. Charles Parish. All other levee alinements under this plan are the same as under the authorized barrier plan. Paragraph 4-A above explains the reason for the deletion of the Chalmette area plan from table 3. The North of Airline Highway levee alinement was selected for this formulation because it would not

impact as much of the wetland of St. Charles Parish as the authorized alinement and it represents the preferred alinement as expressed in recent congressional correspondence to the District. Plate 3 shows the North of Airline highway levee alinement. As noted in table 3, haul clay fill will be the primary method of levee construction employed under this plan. The exception to this statement are the levee works directly associated with the barrier units at Chef Menteur and Rigolets Passes. There, adjacent borrow sources will be employed.

(2) Plan A-2. This plan is the first of the "High Level Plans". With the exception of the levee works associated with the barrier units at the Rigolets and Chef Menteur Passes, the levee alinements for plan A-2 are the same as for Plan A-1. Levee grades have been increased to provide SPH protection to the development behind the levees. Also, as noted in table 3, some lakeward shifts in levee alinements were necessary in certain areas to prevent extensive relocation. (See table 3.) The method of construction employed under Plan A-2 would be haul clay fill.

(3) Plan A-3. Plan A-3 is identical to plan A-2 except for the Citrus Reach, where a haul clay fill plan employing an in-the-lake alinement has been formulated. This plan would place the levee lakeward of the Southern Railroad tracks. Aesthetically, this plan is perhaps more desirable than the plan employed in the Citrus Reach for Plan A-2.

(4) Plan A-4. Plan A-4 has the same levee alinement and grades as plan A-2; however, hydraulic clay fill construction will be employed in lieu of the haul clay fill method. Under Plan A-4, no provision will be made to retain the dredge effluent in ponding area or settling basins. Effluent will be allowed to run back into Lake Pontchartrain carrying with it entrained sediments. Construction without ponding areas would impact more lake bottom than construction with ponding areas.

(5) Plan A-5. Plan A-5 is identical to Plan A-4 except provision to retain the dredge effluent will be employed. Retention dikes will be constructed approximately 3000 feet lakeward of the proposed levee alinements. The dikes will be constructed using haul clay fill and the ponding areas created between the dikes and the existing shoreline will provide the settling basin for the hydraulic dredge effluent.

(6) Plan A-6. As with the previous plans, this plan uses the same general levee alinement, except I-wall construction is used to achieve the height required for SPH protection. This plan also requires a considerable amount of haul clay fill to produce a stable section. This is particularly true for the Jefferson Parish reach of the project. Paragraph 2d(10), page 9 discusses the reliability of I-wall and T-wall design in regards to possible impact loading.

(7) Plan A-7. Plan A-7 constitutes only a slight variation of Plan A-5. Haul clay fill is used in the New Orleans lakefront reach of the project instead of the I-Wall design.

(8) Plan A-8. Plan A-8 is the same as Plan A-6 except to eliminate the possibility of vessel; impact loading, a "barge berm" has been incorporated. As indicated in table 3, the barge berm is required only for the Jefferson Parish, New Orleans and Citrus portions of the project. Other project reaches fronting on Lake Pontchartrain are not susceptible to vessel impact because of the controlling water depths that would be in front of the walls during the height of a storm. Vessels of a sufficient size and weight to cause damage to the wall on impact would run aground before reaching the wall. This rational is being employed with the so called "barge berm" design.

(9) Plan A-9. Plan A-9 is again similar in design to Plan A-6 in as much as a wall design is employed to achieve SPH protection. However, in this case a T-wall design is employed. The T-wall design has been made to withstand impact loading from an errant barge. This plan is presented primarily to emphasize the impracticality, from a cost standpoint, of designing for this type of loading. The cost for the Jefferson Parish reach alone is over 427 million dollars. Because of the excessive cost of the T-wall design, the design was not made for the other lakefront reaches where barge impact could occur, but rather, a less expensive option which could provide the same degree of protection and reliability as the T-wall was selected. Even so, Plan A-9 was the most expensive plan formulated for this study.

(10) Plan A-10. Plan A-10 employes the same methods of construction and levee alinements as Plan A-2 except in the Jefferson Parish reach. There, a "straddle enlargement" design has been employed. Because of the excessive cost of relocation, the straddle enlargement design is the second most expensive plan formulated for this study.

d. Wet Land Acreages Utilized for Alternatives Considered. Construction in some reaches for which alternatives are considered will utilize the following wetland acreages:

(1) St. Charles Parish, lakefront alinement: approximately 500 acres.

(2) St. Charles Parish, north of Airline alinement: approximately 600 acres.

(3) St. Charles Parish, south of Airline alinement: approximately 700 acres.

(4) New Orleans East, Maxent Canal alinement: approximately 200 acres.

(5) New Orleans East, lakefront levee: approximately 200 acres.

(6) New Orleans East, South Point to GIWW levee: approximately 200 acres.

e. Lake Bottom Acreages Utilized for Alternatives Considered. Construction in some reaches for which alternatives are considered will utilize the following lake bottom acreages:

(1) Jefferson Parish, high level plans (lakeward expansion of existing levee), hauled clay fill: approximately 700 acres.

(2) Jefferson Parish, high level plans (lakeward expansion of existing levee), hydraulic fill with ponding areas: approximately 4,400 acres.

(3) Jefferson Parish, high level plans (lakeward expansion of existing levee), hydraulic fill without ponding areas: affected lake bottom acreage is indeterminate. (See paragraph 4c(3).)

(4) Citrus lakefront, high level SPH plan (in-the-lake alinement), hauled fill: approximately 300 acres.

(5) Citrus lakefront, high level SPH plan (in-the-lake alinement), hydraulic fill with ponding area: approximately 1,500 acres.

(6) Citrus lakefront, high level SPH plan (in-the-lake alinement), hydraulic fill without ponding area: affected lake bottom acreage is indeterminate. (See paragraph 4c(3) above.)

(7) Citrus lakefront, high level SPH plan (existing alinement with rock dike): approximately 40 acres.

f. Operation and Maintenance Cost Estimates. The estimated average annual costs for the Operation and Maintenance (O&M), for the various project reaches are contained in table 5. O&M cost have been prepared only for those reaches where alternatives have been formulated. Because the O&M costs associated with the Seabrook Complex are by law chargeable to the Mississippi River Gulf Outlet project, no O&M costs are shown in table 5 for the Seabrook Complex. O&M cost estimates for other project reaches not contained in table 5 are contained in the applicable GDM's and have not been reproduced here because their cost would be the same

regardless of whether a high-level plan or barrier plan is formulated. It should be pointed out that the rather large difference between O&M cost for the Rigolets Complex and that for the Chef Menteur Complex is due to the O&M costs associated with the proposed navigation lock at the Rigolets. The average annual O&M cost at the Rigolets navigation lock alone is $469,000. This cost is the same regardless of the size opening selected for the barrier structure. It should also be noted that the cost shown in table 5 do not include cost increases due to inflation or "annual" replacement cost for the major structures.

g. Comparison of High Level and Barrier Estimates. The Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection project was formulated during the years of 1955 through 1962. At that time a high level plan of protection was considered as an alternative solution and a cost estimate was developed in 1961/1962. Only a limited amount of detail relative to that estimate is now available due principally to the time lapse involved. However, available records indicate that the estimate was on the order of $98,400,000 and was reported in House Document 231/89, page 57, as being "approximately $100 million". The corresponding Barrier Plan estimate, prepared in the same time frame and likewise reflected in the House Document, was $64,703,000. It should be noted that neither estimate included the cost of the Chalmette Area Plan.

The only identifiable features of the 1962 high level plan which differ significantly from high level plans presented herein occur in the Citrus and New Orleans East Lakefront reaches. The New Orleans East lakefront levee was situated lakeward of the railroad embankment for the 1962 estimate, whereas it is situated landward of the railroad for all current estimates. In addition, the levee was situated lakeward of the railroad in the Citrus lakefront reach for the 1962 estimate, whereas lakeward as well as landward alinements are considered in current estimates for Citrus.

For the barrier plan, the lakefront levee alinements in Citrus and New Orleans East changed from lakeward of the railroad for the 1962 estimate to landward of the railroad for current estimates. Other changes in the barrier plan from 1962 to present which affected the estimate include, but are not limited to, the following items: an increase in the chamber width of the Rigolets Lock from 84 feet to 110 feet; an increase in the size of the Chef Menteur Navigation Structure opening from 56 feet to 84 feet, and an increase in its depth from -12.0 feet to -16.0 feet mean low gulf; an increase in the size of the Rigolets Control Structure opening from 21,120 square feet to 28,800 square feet below zero mean sea level; an increase in the size of the Chef Menteur Control Structure opening from 9,200 square feet to 16,200 square feet; a change in the chamber wall design for the Seabrook Lock from a relatively simple parallel sheet pile wall to a more costly cellular sheet pile wall; and the addition of control structures and pumping stations on the 3 Orleans Parish drainage outfall canals.

In 1962, the high level plan was estimated to be approximately 50 percent more costly than the barrier plan. Considering only those combinations of alternatives shown on table 3 herein, the current high level estimates range from 47 percent more costly to 5 percent less costly than the barrier plan. Any attempt to compare the relative differences in cost between the two plans as determined in 1962 versus 1979 must be tempered by consideration of the above mentioned changes in design. In addition, such factors as more detailed designs, non uniform increases in construction cost indices, and greater allowance for aesthetic considerations have also affected the relative differences in the estimates.

h. Alternative Plans Estimate Versus Budget Estimate for Barrier Plan. No attempt to draw inferences from a comparison between the alternative plans cost estimate for the Barrier Plan and the budget estimate for that plan should be attempted without considering the differences in the bases for the preparation of each. Some of the more significant of those differences are as follows:

(1) The alternative plans estimate is based on March 1979 price levels; whereas, the budget estimate utilizes October price levels.

(2) The alternative plans estimate escalated the costs of completed work to March 1979 price levels; whereas, in the budget estimate the value of completed work remains fixed from the time of expenditure.

(3) The alternative plans estimate provides for gated structures and auxiliary pumping stations at the Lake Pontchartrain ends to the three Orleans Parish drainage outfall canals (estimated cost: $99,072,000), and it provides for floodwalls in front of the four Jefferson Parish lakefront pumping stations (estimated cost: $9,132,000). Since the approved Lake Pontchartrain project currently makes no provision for these protective works, the budget estimate does not include them.

(4) The alternative plans estimate is based on the best available design information which, in some instances, differs from that used for the budget estimate. For instance, the budget estimate includes the Seabrook Lock estimate reflected in the general design memorandum; whereas, the alternative plans estimate reflects a significantly different lock chamber wall design developed in the draft detailed design memorandum.

(5) The alternative plans estimate provides for a levee alinement in St. Charles Parish which parallels US Hwy. 61; whereas, the budget estimate includes the lakefront alinement presented in the general design memorandum.

5. Conclusion. In paragraph 4c. above the costs of the various high level plans were compared to a modified barrier plan. It is perhaps worth pointing out that the area protected by the barrier plan encompasses the whole of the Lake Pontchartrain shoreline and contiguous lands. The various alternative high level plans presented provide hurricane protection only to those areas that are behind the levee systems. Therefore a straight cost comparison of plans is misleading and any conclusion drawn from these cost comparisons should be tempered with the understanding that only part of the "total picture" has been presented in this report. It remains that the "total economics" of each plan must be assessed before the cost effectiveness of a given plan can be determined. The term "total economics" refers to the broad meaning of the terms and must necessarily take into account impacts, environmental as well as social.

ALTERNATIVE [illegible]
SUMMARY ESTIMATE OF FIRST COST

DESCRIPTION		COST BARRIER PLAN SPH PROTECTION (1)	COST HIGH LEVEL PLAN SPH PROTECTION (2)	COST HIGH LEVEL PLAN 100 YEAR PROTECTION (1)
St. Charles Parish	Lakefront Alinement	[illegible]	[illegible]	[illegible]
	Alinement North of Airline Hwy	70,1[illegible],000	111,[illegible]1,000	94,[illegible]4,000
	Alinement South of Airline Hwy	86,15[illegible],000	135,807,000	104,[illegible]6,000
Jefferson Parish Lakefront Levee	(Straddle Enlargement)	N/A	276,152,000	172,[illegible],000
	(Hauled Clay Fill)	10,952,000 new	168,297,000	118,[illegible]3,000
	(Hydraulic Clay Fill w/o Ponding Area)	N/A	82,272,000	61,[illegible],000
	(Hydraulic Clay Fill w/Ponding Area)	N/A	172,933,000	152,[illegible],000
	(I-Wall on Levee)	N/A	122,120,000	N/A
	(I-Wall on Levee w/Barge Berm)	N/A	186,159,000	N/A
	(T-Wall on Levee)	N/A	431,257,000	N/A
New Orleans Lakefront Levee (West of IHNC)	(Hauled Clay Fill)	128,267,000 new	153,123,000	145,[illegible],000
	(I-Wall on Levee)	N/A	153,700,000 new	N/A
	(I-Wall on Levee w/Barge Berm)	N/A	153,979,000	N/A
Citrus Lakefront Levee	(Hauled Clay Fill)	19,275,000	new 49,447,000 2/	31,[illegible],000 5/
	(Hauled Clay Fill)	N/A	78,874,000 3/	40,[illegible],000 6/
	(Hydraulic Clay Fill w/o Ponding Area)	N/A	52,013,000 3/	N/A
	(Hydraulic Clay Fill w/Ponding Area)	N/A	76,647,000 3/	N/A
	(I-Wall on Levee)	N/A	29,600,000 4/	N/A
	(I-Wall on Levee w/Barge Berm)	N/A	38,158,000 5/	N/A
Maxent Canal Levee		51,317,000	84,125,000	64,58[illegible],000
New Orleans East Lakefront Levee	(Hauled Clay Fill)	34,330,000	50,693,000	43,316,000
	(I-Wall on Levee)	N/A	45,341,000	N/A
South Point to GIWW Levee		8,571,000	10,946,000	8,571,000
New Orleans East Back Levee (Michoud Canal to Sta 1006+59) with NOE/S Point to GIWW Levees		30,562,000 new	30,562,000	28,451,000 new
New Orleans East Back Levee (Michoud Canal to Sta 1006+59) with Maxent Canal Levee		22,651,000 new	N/A	N/A
New Orleans East Bank Levee (Michoud Canal to Maxent Canal) with Maxent Canal Levee		N/A	17,749,000 new	16,959,000 new
Citrus Back Levee (IHNC to Michoud Canal)		31,933,000	31,933,000	31,933,000
East Bank of IHNC (MRGO to Lake Pontchartrain)		11,010,000	11,010,000	11,010,000
West Bank of IHNC		44,313,000	44,313,000	44,313,000
Mandeville Seawall		852,000	852,000	852,000
Chalmette Area Plan		136,937,000	136,937,000	136,937,000
Seabrook Complex	(50% of Total Cost)	34,205,000	34,205,000	34,205,000
Chef Menteur Complex:	43% of Natural Opening	79,107,000	N/A	N/A
	50% of Natural Opening	85,646,000	N/A	N/A
	90% of Natural Opening	106,497,000	N/A	N/A
Rigolets Complex:	35% of Natural Opening	142,078,000	N/A	N/A
	50% of Natural Opening	157,040,000	N/A	N/A
	90% of Natural Opening	222,064,000	N/A	N/A

Footnotes
1/ 100 Year Protection Plan was considered only for leveed reaches inside the Barrier System.
2/ Uses "existing" levee alinement, a retaining wall along Hayne Blvd., and a breakwater on the lakeside of R.R. tracks.
3/ In-the-Lake Alinement.
4/ Uses "existing" levee embankment.
5/ Uses "existing" levee alinement with a breakwater on the lakeside of R.R. tracks.
6/ Uses "existing" levee alinement with a retaining wall along Hayne Blvd.