US Army Corps
of Engineers
New Orleans District

Mississippi River–Gulf Outlet

St. Bernard Parish, La.

Bank Erosion

Reconnaissance Report

February 1988

RETURN TO

PROJECTS ENGINEERING SECTION

If you have questions or need additional information, please contact Mr. J. Warren, Study Manager, U.S. Army Corps of Engineers, New Orleans District, P.O. Box 60267, New Orleans, Louisiana 70160-0267, telephone (504) 862-2543.

CELMN-ED-SP

November 30, 1988

MEMORANDUM FOR RECORD

SUBJECT: Mississippi River - Gulf Outlet, Bank Erosion, GDM Supplement Design Conference

Date of Conference: 18 November 1988

Place of Conference: New Orleans District Office New Orleans, LA

Attendance: List of attendants is attached (Encl 1).

Conference Purpose: The purpose of the Design Conference was to discuss comments that were made on the Reconnaissance Report for the subject project. The responses to these comments are to be incorporated into the GDM supplement.

Brief Summary of Conference: The meeting generally followed the agenda shown on Encl 2 with attendants participation in the form of comments or questions invited at any time during the course of the meeting.

I. Overview

A packet containing copies of the comments on the Reconnaissance Report and a copy of the current GDM schedule was distributed. A copy is attached as Encl 3.

The meeting began with a general overview of the project. A question was asked as to why no Feasibility study was being done for the project. The response was that since the benefits of the project are primarily navigational it was felt that it would be difficult to cost share the feasibility effort. It was also stated that any work that came out of the project could be done as an extension of the unfinished MRGO project and authorization was not needed.

II. Reconnaissance Report, LMVD Comments

All the comments were addressed in the approximate order shown on the agenda. Discussion on these comments is summarized below.

a. Comment 1a. A straight line projection was not used to determine the expected increase in width. Aerial photos were compared then compared to as-built drawings and an erosion rate of 20 ft/yr was obtained. This was reduced to 15 ft/yr for the projections used. The shoreline of Lake Borgne is also retreating toward the channel at 15 ft/yr. Ship waves cause most of the erosion along the channel and wind waves cause most of the erosion in Lake Borgne. A question was asked about the location of the proposed dike. The dike is presently planned to be placed close to the existing marsh line. This location could change depending on GDM studies.

WES studies update. A request was made that an explanation of what the studies that WES is currently performing in conjunction with this project are supposed to do. It was explained that the studies will determine what will happen to the total system, circulation patterns, material, etc. if breaches do occur in the targeted critical areas. A realistic prediction of projected maintenance dredging is the expected outcome of the study. WES will look at incremental widths of breach openings starting with a fairly wide width. If this wide width doesn't have much of an effect, then further studies would be unnecessary. They will use historical data and are obtaining new data on suspended sediments, current velocities, and tides at the expected gap occurrences. They anticipate the first information from these studies should be available around Apr or May 89.

b. Comment 1b. As stated earlier the erosion rate along Lake Borgne is about 15 ft/yr. The proposed plans call for a minimum of 100 ft. of bank nourishment to be placed between the bank protection structure and Lake Borgne.

c. Comment 1c. Studies by the beach erosion board used in MRGO GDM No. 2 stated there was an unlimited supply of fine sediment available to cause shoaling problems. If breaches occur the water can get in, stir the sediment up and take it into MRGO. A question was asked as to whether the WES studies will be able to identify where the sediment comes from; the answer was no. Another question asked was if the structures are built will ships start to erode the opposite bank. WES says that this will not occur since the dikes will dissipate the energy from the ship waves.

d. Comment 1d. The rational for using the varying rates was that, using data gained from a single jetty reach, dredging decreases the further you get from the gaps.

e. Comment 4d. All alternatives will be looked at in more detail in the GDM.

f. Comment 8c. The methodology used to determine these requirements was that a reduced wave height for the slower ship speed was developed using guidance on ship speed and corresponding wave height, and the erosion rate was reduced proportionately. Since it had such a low B/C ratio the reduced ship speed alternative will not be investigated in the GDM. It was stated that a reduced speed - structure combination could be feasible.

g. Comment 12. Answered ~~during discussion of an earlier comment.~~ in previous paragraph.

h. Comment 2. The alternative to completely close the MRGO should be addressed. An alternative of closing it to ship traffic but leaving it open for recreational traffic should also be investigated. Comment 3 and Comment 18 also go along with this comment. It was stated that current studies indicate that there is no justification at this time for the deeper draft ship lock mentioned in comment 18. It was stated that justification for the MRGO should be based on existing traffic and lock conditions. Existing facilities along the MRGO would have to be considered. LMVD stated they would check and see how they think these comment should be handled and provide guidance to NOD.

i. Comment 4a. Other feasible alternatives will be looked at in the GDM and the four recommended alternatives will be investigated more fully.

j. Comment 4b. The 100' length of bank nourishment is the design length to prevent breakthrough under 50 yr hurricane conditions. There is a possibility that dredging specifically for this nourishment will have to be done. This bank nourishment will provide an area for vegetation to grow, provide stability, and protect the back side from erosion. Maintenance of this 100' area will be considered in the GDM. It was recommended that placing dredged material disposal instead of building dikes be investigated in the GDM.

k. Comment 4c. See above. The 100' marsh buffer will help to abate problems from Lake Borgne.

l. Comment 7. At this time it appears that the petition to the Coast Guard to reduce ship speed will be denied. Further action on this may be necessary.

m. Comment 8b. See earlier discussion on comment 8c. This will be looked at in the GDM.

n. Comment 16. The piles are not intended to be used for wave dissipation. The piles are to hold the geotextile fabric in place. This is a different situation than the one is Southwest Pass as we are not trying to eliminate flow into the marsh, but rather trying to reduce wave force. The crest height of each alternative will be determined by economic justification. Maintenance requirements of different plans will be considered.

o. Comment 17. See response to comment 16.

p. Comment 5. The cost estimate in the GDM will be presented in the requested format.

q. Comment 6. This is a problem with terminology. The rationale will be made clear in the GDM.

r. Comment 8a. Cultural resource preservation dollars are tied directly to construction impacts and don't relate to benefits obtained from decreasing erosion.

s. Comment 9. The bottom line figures are correct but there are some errors in the tables. These corrections will be made for the GDM.

t. Comment 10. The number was taken from a recently completed marsh value analysis. This analysis is being forwarded to LMVD. Marsh is defined as emergent vegetative wetlands.

u. Comment 11. This information will be provided for the GDM.

v. Comment 14. The cost includes funds for all these items but it appears at this time that the funds will be inadequate.

w. Comment 15. There is a 500' wide construction easement not 2000 ft. This will be made clear in the GDM.

x. Comment 13. Only those studies required for the 404 will be done.

III. GDM

Milestone Decisions: The need for and detail to which comments relative to the closure of the MRGO will be established by guidance from LMVD.
Decide if there is a viable project or not (probably when the WES studies have produced useful data, APR or MAY 89.

Need a project review meeting with OCE and LMV when the time comes to make a decision on the viability of the project; this meeting will also cover progress on the project up to that time.

There is a need to get more money transferred into the project. This is not a holdup at the present time but could be if difficulties are encountered in getting the money.

IV. Summary and Conclusions

1. The bulk of the comments will be addressed relative to work included in the GDM.

2. LMV will provide guidance on the detail in which comments relative to the closure of MRGO should be addressed.

3. A meeting of decision will be held when the WES model studies have produced useful data (APR/MAY 89).

ATTENDANCE RECORD

DATE(S)	SPONSORING ORGANIZATION	LOCATION
18 NOV 88	CELMN-ED-SP	NOD

PURPOSE DISCUSSION OF LMVD COMMENTS ON THE MRGO BANK EROSION RECONNAISSANCE REPORT (FEB 88)

PARTICIPANT REGISTER *

NAME	ORGANIZATION	TELEPHONE NUMBER
William R. Hill	CELMV-ED-A	601 634 5824
Jim Miskelley	CELMV-ED-PG	601-634-5922
Norwyn Johnson	CELMV-PD-F	601 634-5835
Jesse K McDonald	CELMV-PD-E	601-634-5847
Henry G. Reed	CELMV-ED-PG	601-634-5927
FRED CAVER	CELMV-ED-P	601-634-5904
Van Button	CELMN-PD-RA	
Joe Dicharry	CELMN-ED-PN	504-862-1929
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BUDDY BOREN	CELMV-CO-O	601 634-7148
John Grieshaber	CELMN-ED-FS	504 862 2979
Jean E. McArthur	CELMN-ED-FGS	504-862-1022
RICH MANGUNO	CELMN PD-E	504 862-1923
JESSICA FOX	CELMNPD-E	504 862-1922
Jay Combe	CELMN-ED-HC	504 862-2480
JOE LETTER	CEWES-HE-S	601-634-2845
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CECIL W. SOILEAU	~~CEMN~~-ED-H	504-862-2420
JAMES R TUTTLE	CELMV-ED-W	601-634-5888

LMV FORM 583-R
(replaces LMN 906)
AUG 87

* If you wish to be furnished a copy of the attendance record, please indicate so next to your name.

Encl 1

PROPONENT: CELMV-IM

PARTICIPANT REGISTER (CONTINUED)

NAME	ORGANIZATION	TELEPHONE NUMBER
Cecil W Grisham	CELMV-ED-TC	601-634-5929
Max S. Lamb	CELMV-ED-PL	601-634-5911
Pamela A DeLoach	CELMN-ED-SP	504-862-2621
JAMES WARREN	CELMN-PD-FC	504-862-2543

Mississippi River - Gulf Outlet, Bank Erosion, GDM Supplement
Design Conference
18 Nov 88

Agenda

I. Overview

II. Reconnaissance Report, LMVD Comments

   A. Maintenance Dredging Requirements
   (Comments 1a, 1b, 1c, 1d, 8c)

      1).Model studies (Comment 12)

   B. Design Options and Alternatives
   (Comments 2, 3, 4a, 4b, 4c, 7, 8b, 16, 17)

   C. Economics & Cost Estimates
   (Comments 4d, 5, 6, 8a, 9, 10, 11, 14, 15)

   D. Environmental (Comment 13)

III. GDM Supplement
   A. Design Schedule
   B. Design Milestones
   C. Data Requirements

IV. Summary and Conclusions

Encl 2

LMVD COMMENTS RELATIVE TO
THE MISSISSIPPI RIVER-GULF OUTLET BANK EROSION
RECONNAISSANCE REPORT

1. In view of the sensitivity of project justification to project maintenance dredging requirements, the District should furnish the rationale used for projecting annual maintenance dredging quantities. The discussion on page 24, Future MRGO Channel Maintenance, is inadequate to verify data on Plates 2 and 3. Additional discussion is needed to address the following:

a. The methodology used to project the location of the MRGO north bank by the year 2040. When the waterway was constructed in 1968, it had a top width of 650 feet which increased to approximately 1,500 feet by 1987. If New Orleans District used a straight-line protection using this past observed enlargement trend, then the future enlargement is vastly overstated. Waves from ships will decay in height over distance traveled (from the vessel) and also when they encounter a much shallower top bank than that which was originally constructed.

b. The erosion rate of Lake Borgne shoreline and the impact this erosion will have on the "buffering marshes."

c. The loss of the "buffering marshes" will reduce the erodible material that contributes to the maintenance dredging. However, maintenance dredging requirements are projected to increase significantly with the loss of these marshes. The rational for this increase is inadequate.

d. The projected increase in dredging for critical reaches 1 and 2 (see Table 4) is approximately three times as many cubic yards per mile as that of adjacent reaches. The increase in maintenance dredging quantities for non-critical areas is a substantial increase over present dredging requirements. The logic for determining the various rates of increase dredging quantities should be given.

2. Page 30, Alternative Plans. The alternative to completely close the MRGO waterway should be evaluated and a discussion of the evaluation should be included in the report. The closure should be located in the vicinity of mile 23 and could be constructed of dredged material from the existing waterway. This alternative will control all future channel maintenance problems by controlling bank erosion, preventing the associated biological resources problems, preventing saltwater intrusion, and lessening the recreational losses. In addition to solving the aforementioned problems, it will also reduce the possibility of catastrophic damage to urban areas by a hurricane surge coming up this waterway and also greatly reduce the need to operate (and could possibly eliminate) the control structures at Bayous Dupre and Bienvenue. Furthermore, the salinity level in Lake Pontchartrain will be reduced which, according to some parties, will be a great benefit. Plus, by making this closure the problems/concerns addressed by April 1984 Feasibility Study entitled, Mississippi and Louisiana Estuarine Areas, will be substantially reduced.

3. Page 30, Alternative Plans. Recommend the economic justification of continued maintenance of the existing project be demonstrated.

4. Page 35 (Table 3) and Plates 8-11. The District should furnish the rationale used in the development of the four design options. Additional discussion is required on the following:

a. The design parameters for the four erosion abatement structures (briefly described in Table 3) should be presented. As shown on Plates 8 through 11, these four alternatives differ greatly in their structural configuration. For example, three have riverside berms, whereas one does not, the ones with berms have berm lengths of 6, 9 or 10 feet. The crest elevations are 2.5, 3.0 or 5.0 feet NGVD, and the riverside slope varies 1 on 2 to 1 on 3. Therefore, these structures cannot be expected to produce similar results (bank scour prevention) if the same design parameters are applied uniformly.

b. In the last sentence of the second paragraph on page 36, a statement is made that ". . . bank nourishment would be accomplished as opportunities to do so occur." Plates 8 through 11 show that bank nourishment from MRGO dredged material will have a minimum length of 100 feet. If dredging is not required in a certain reach of the waterway, it will be impossible to provide the "minimum length" unless it is specifically dredged for bank nourishment. These conflicting points should be explained.

c. The foreshore dike along critical reaches 1 and 2 could be subjected to wave erosion from the lakeside. This erosion threat and structural design to counter the threat should be addressed.

d. In Table 6, designs 3 and 4 are shown as producing identical benefits. These two designs represent riprap structures whose crest elevations are 3.0 and 5.0 feet NGVD. The lower crest structure (design 3) will permit more ship wave overtopping, thus it should produce less benefits, when compared to design 4 for maintenance dredging and marsh loss reduction. This needs to be explained.

5. Page 35, Table 3 and Page 47, Table 11. The presentation of construction costs is unacceptable. A cost estimate is not presented to reflect the project first costs. Table 3 should be accompanied by unit prices and quantities used to develop the costs presented. Table 11 should be accompanied by the breakdown of components which make up the first costs shown.

6. Page 36, First Paragraph. In the last sentence, it is stated that the increased cost of using this material to provide bank nourishment is accounted for as a reduction in the savings in future maintenance dredging. The preceding statements indicate that bank nourishment will be a by-product of the maintenance dredging operation and, therefore, not part of the cost of the structure. This discrepancy should be resolved.

7. Page 40. The non-structural alternative of imposition of speed limitation may be implemented by the Coast Guard based on the petition filed in October 1987 (Appendix B). Should GDM Supplement studies be initiated, the status of the petition will impact future alternatives.

8. Page 42, Speed Limitation Alternative.

a. The speed limitation benefits should include (if not included in the estimate) cultural resource preservation dollars. This would be similar to the structural work bank protection benefits.

b. By reducing the vessel speed from 14 to 10 mph, the waves are reduced, thus a smaller structure should meet the design criteria. This design criteria should be presented and also the smaller structural alternative analyzed.

c. An explanation is needed of the methodology used to calculate the maintenance dredging requirements (presented on Plate 15) for the speed limitation alternative.

9. Page 44, Table 7. The average annual maintenance dredging costs for the without project condition should be $2,591,000, not $2,724,000 as presented in the report on Table 7. This changes the savings in average annual maintenance dredging costs for each of the 4 scenarios presented on Table 7. The total average annual benefits for scenario 1 on Table 12 becomes $2,095,000, not $2,228,000, with a benefit-cost ratio of 1.04 to 1 for design 3. Design 4 drops below unity.

10. Page 45, Table 8. There is no explanation for the derivation of the marsh values of $3,500 per acre. Derivation of marsh values require documentation and substantiation.

11. Pages 47 and 48, Table 11. Present values cannot be verified from the data as it is presented in the table.

12. Page 55. A discussion of the model study and what is to be gained from this task should be provided this office. A statement is made on page 15 that little sediment enters MRGO from sources other than bank erosion. Presently, little sediment movement in the relatively shallow confined bay of Lake Borgne should be occurring. Therefore, on the surface, it is not clear as to the need of this study and supporting documentation should be provided.

13. Page 55. Since it has been concluded that water quality will not be significantly affected by bank stabilization measures, why are extensive analyses of historical water quality data and studies of water quality impacts caused by marsh loss and bank erosion required? It appears that water quality studies should be limited to those required for complying with Section 404(b).

14. Page 61, Table 13. Do costs for the EIS line item include funds for preparation of the Section 404(b) evaluation, endangered species assessments, CZM consistency determination, and other environmental analyses?

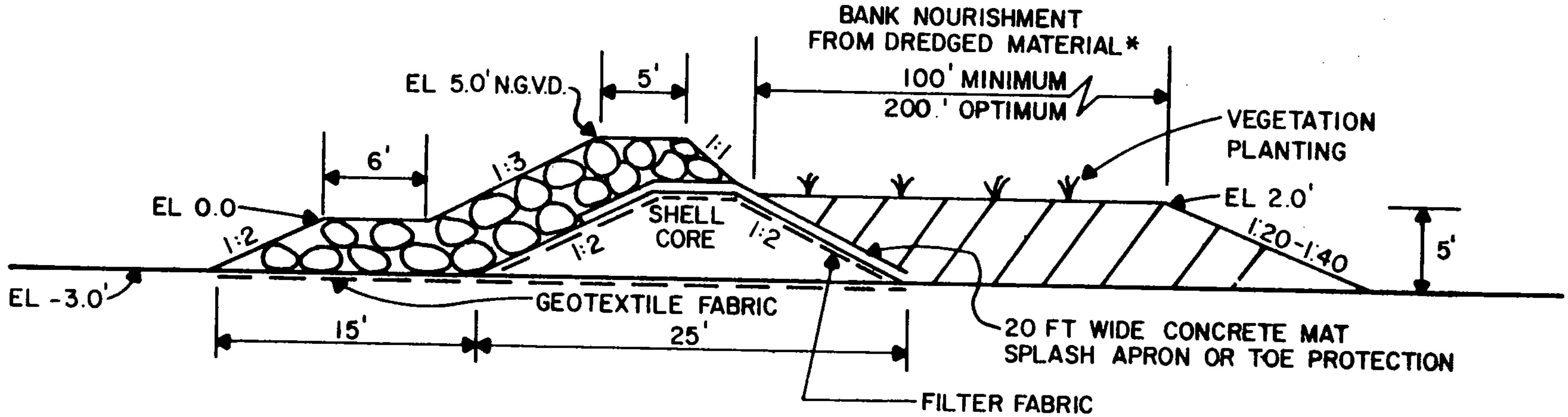
15. Appendix C. The acreages for Options 1 and 2, Appendix C, do not coincide with area definitions. The limits are probably only to ordinary high water or tide lines, not 2,000 feet.

16. Plate 10. A stage duration curve for the gage at Intracoastal Waterway near Paris Road Bridge was developed for the 1963-1987 period. This data indicates that the still water elevations of 2.0 and 3.0 feet NGVD will be equalled or exceeded 33.4 and 7.6 percent of the time, respectively. With a ship produced wave of 4.0 feet (identical to that recommended in the Mississippi River Baton Rouge to Gulf GDM Supplement 2), the stone dike crest elevation of 3.0 feet NGVD will be greatly exceeded with the passage of every vessel. The piles (on 5.0 foot centers) placed in the dike will not reduce the wave overtopping. For the piles to be effective in reducing overtopping the ratio of closed area (diameter of pile) to total available for overtopping should be approximately 9 to 10. In other words, approximately 90 percent of the available overtopping area must be closed for wave reduction to be realized. Therefore, this plan, as presented, will not produce the desired results and should not have been recommended.

17. Plate 11. The foreshore dikes presented in Supplement No. 3 to the GDM entitled Mississippi River Baton Rouge to the Gulf of Mexico, Louisiana (southwest pass and bar channel) will serve the same purpose as the subject line of protection (Design No. 4). It is noted that the forwarded speed of vessels using these waterways are essentially identical (15 knots versus 14 knots); thus, the resulting bank erosion caused by the ship waves should be similar. Furthermore, it is noted that the crown elevation of the GDM foreshore dikes is 8.0 feet NGVD, whereas, the subject report recommends 5.0 feet NGVD. Clarification is needed as to why a smaller structure will function on this waterway, whereas, a larger structure is required on another waterway (especially since the design conditions are similar).

18. Should the GDM Supplement studies be initiated, the assumptions, data, analysis, and recommendations must be consistent with the ongoing MRGO-IHNC Shiplock study.

BANK PROTECTION STRUCTURE



DESIGN I

MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

DESIGN I.
CONCRETE BLOCK / ROCK ARMOR-HIGH PROFILE

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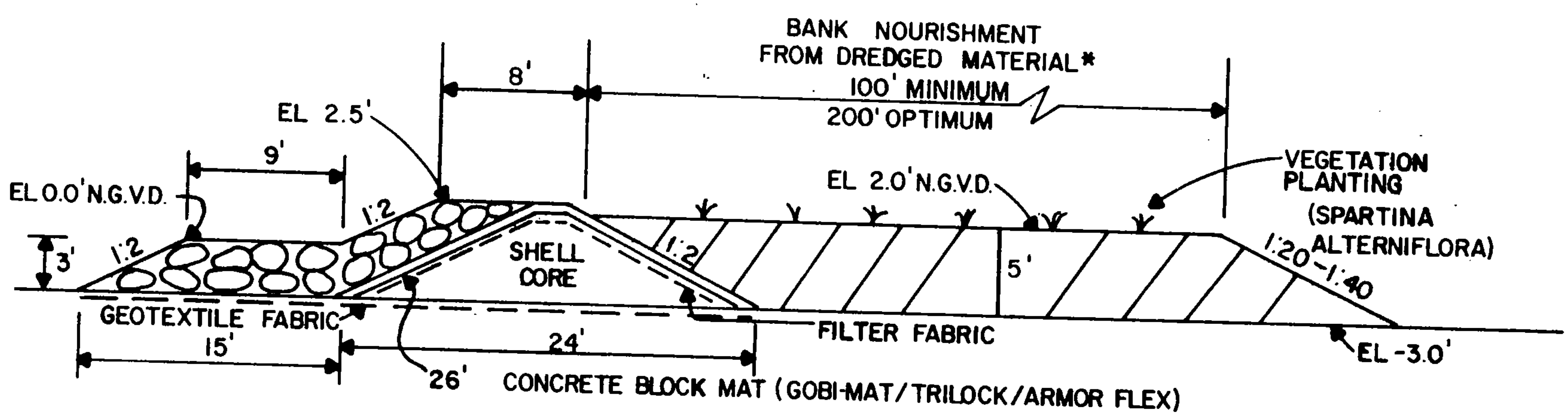
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1988

PLATE 8

BANK PROTECTION STRUCTURE



DESIGN 2

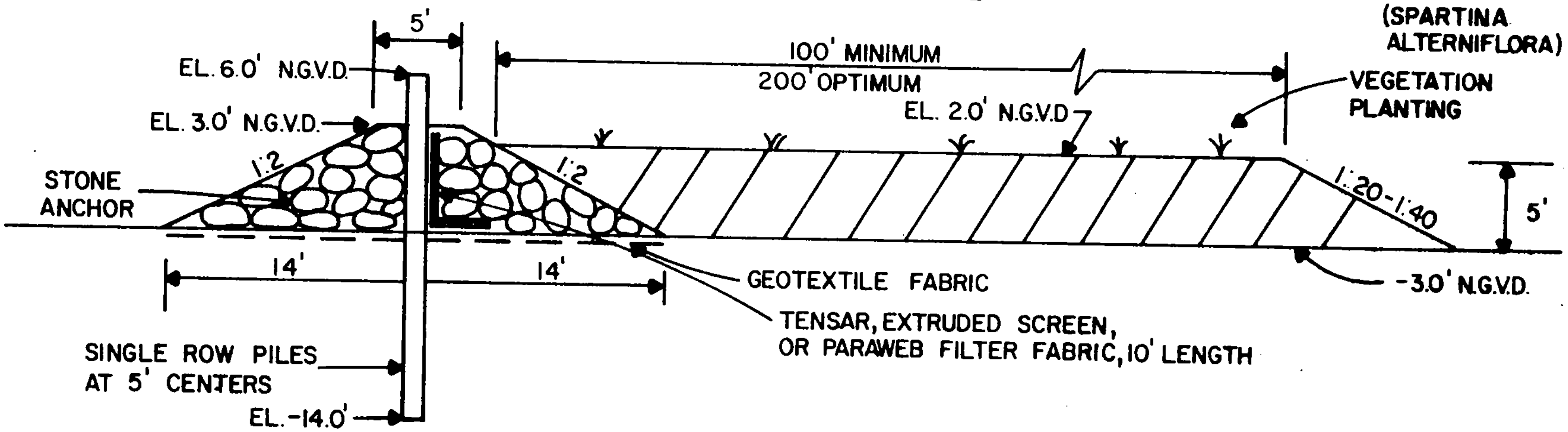
MISSISSIPPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 2
CONCRETE BLOCK ROCK ARMOR–
LOW PROFILE

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1988

PLATE 9

BANK PROTECTION STRUCTURE



DESIGN 3

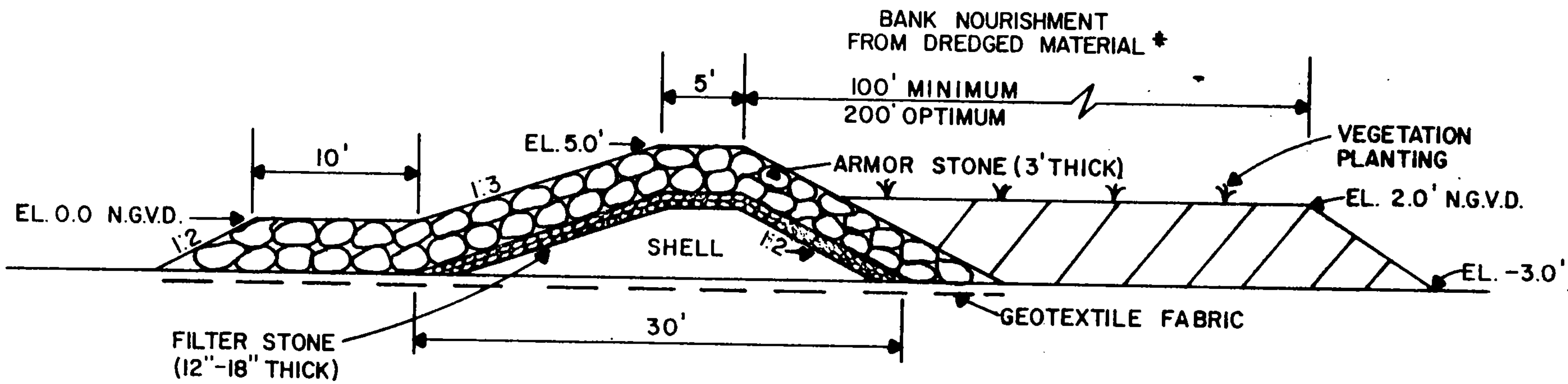
MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 3
SINGLE ROW TIMBER PILES/
GEOTEXTILE WALL WITH ROCK APRON

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1986

PLATE 10

BANK PROTECTION STRUCTURE



DESIGN 4

MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 4

STONE ARMORED SHELL CORE DIKE

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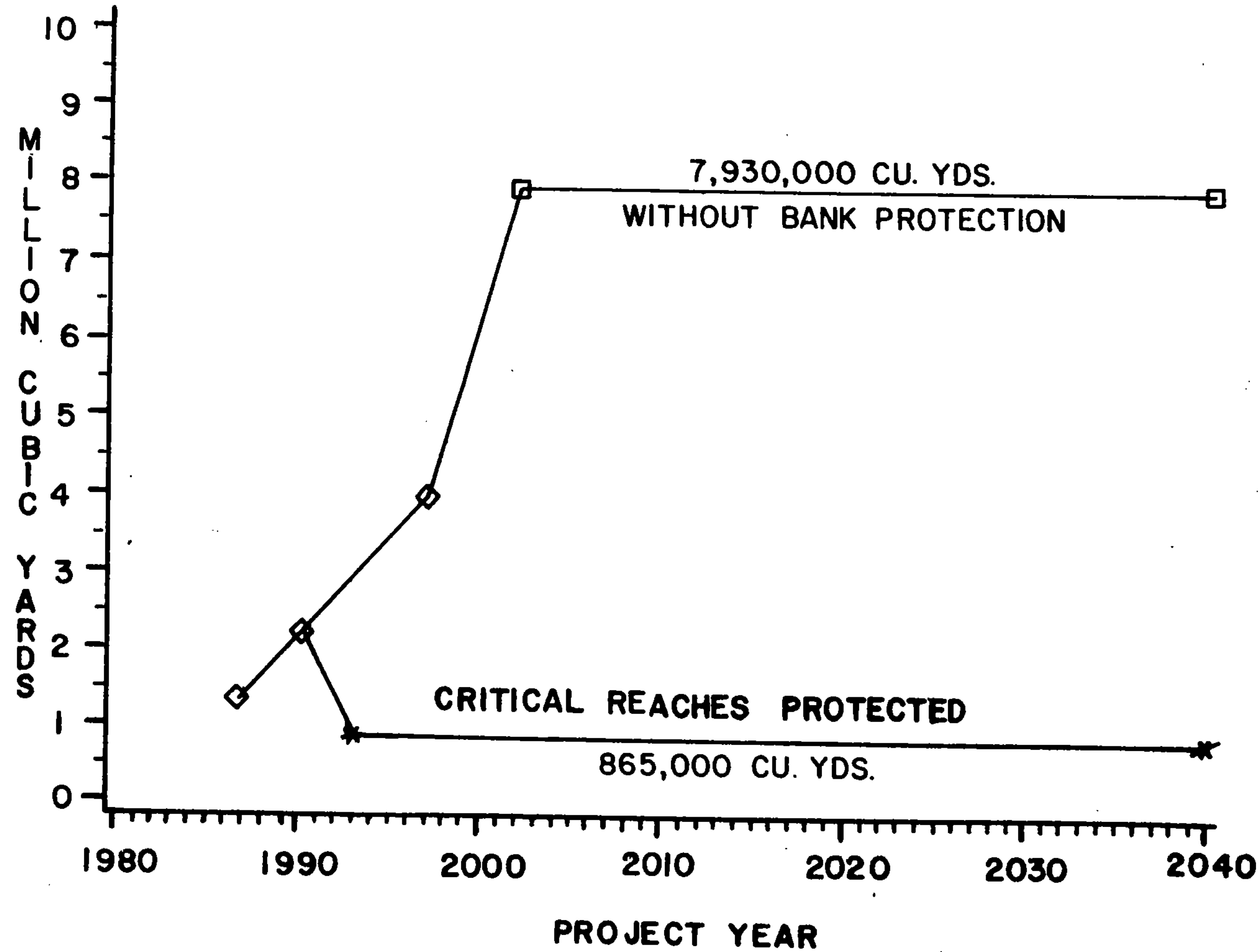
FEB. 1988

PLATE 11



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

IDEALIZED WITH AND WITHOUT PROJECT AVERAGE ANNUAL MAINTENANCE DREDGING REQUIREMENTS STRUCTURAL OPTION I

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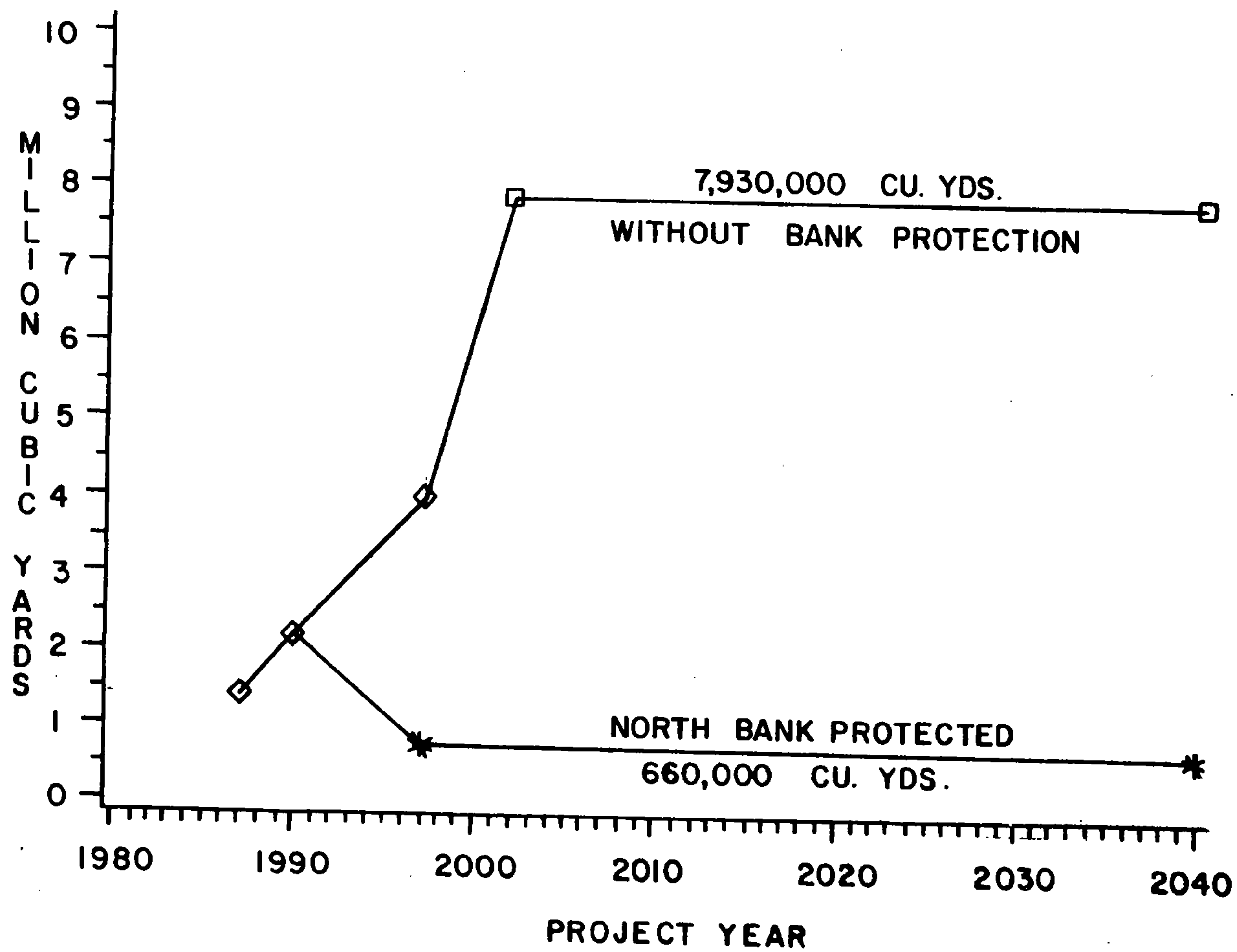
FEB. 1988

PLATE 12



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

IDEALIZED WITH AND WITHOUT PROJECT AVERAGE ANNUAL MAINTENANCE DREDGING REQUIREMENTS STRUCTURAL OPTION 2

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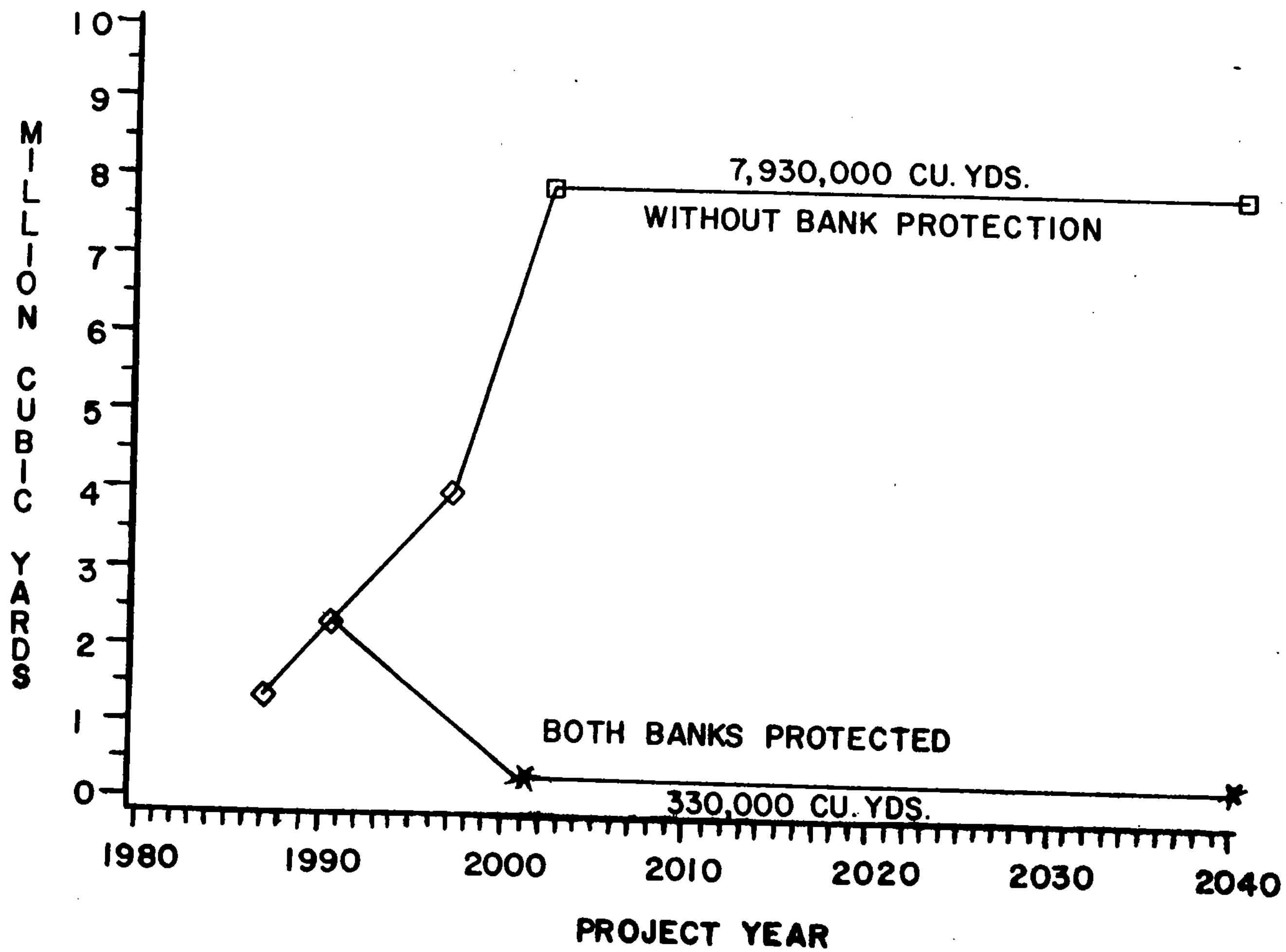
FEB. 1988

PLATE 1



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

IDEALIZED WITH AND WITHOUT PROJECT AVERAGE ANNUAL MAINTENANCE DREDGING REQUIREMENTS STRUCTURAL OPTION 3

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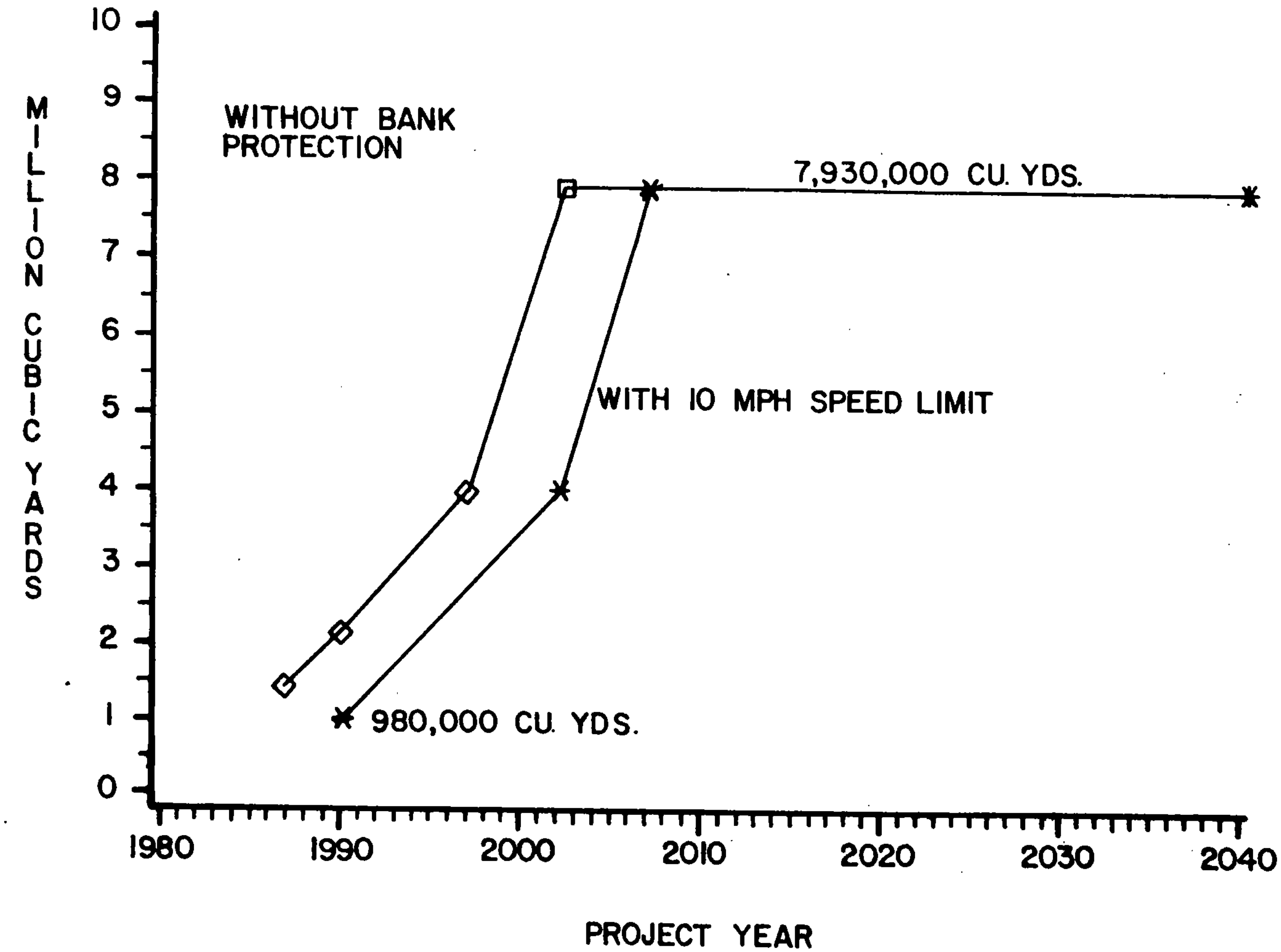
FEB. 1988

PLATE 14



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

IDEALIZED WITH AND WITHOUT PROJECT AVERAGE ANNUAL MAINTENANCE DREDGING REQUIREMENTS SPEED LIMIT OPTION

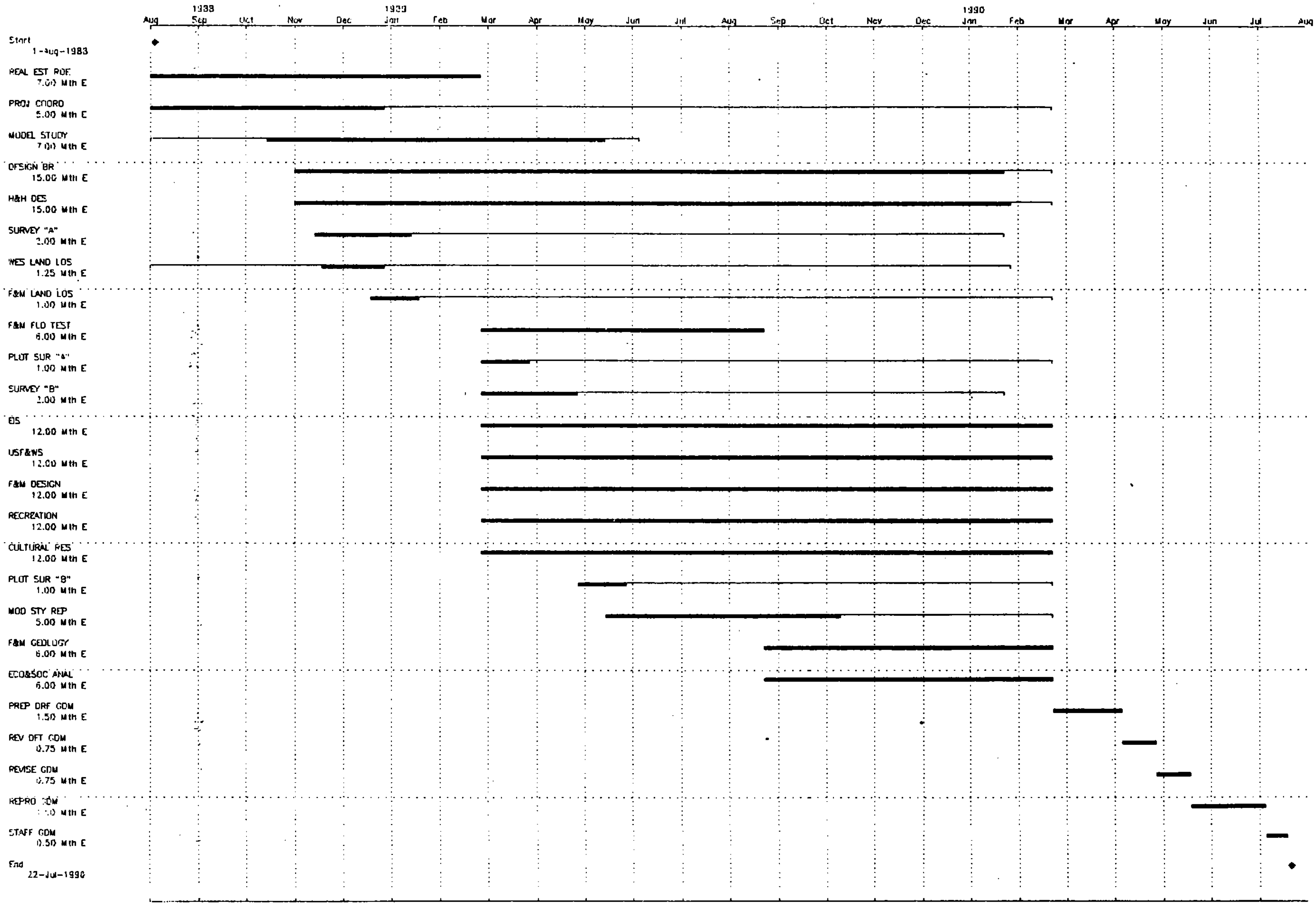
CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1989

PLATE 15

Gantt Chart

MRGO BANK EROSION STUDY
Project: MRGOBKE

17-Nov-1988



17 NOV 88

Encl 3

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
CELMN-ED-PN	Mississippi River - Gulf Outlet, St. Bernard Parish, Louisiana (Bank Erosion)

TO	FROM	DATE	CMT 1
C/Des Svcs Br	C/Proj Mgmt Br	2 Jun 88 Mr. Naomi/jmb/2377	

1. Reference CELMN-PD-FC DF dated 20 May 88 (Encl 1).

2. It has been decided that the enclosed LMVD comments will be addressed in the proposed GDM supplement and no endorsement will be prepared by NOD.

3. Please initiate work on the GDM supplement. In-house charges may be made to account number BBH83304J10BE00.

4. The enclosed cost estimate for the GDM supplement was included in the reconnaissance report. Please review the estimate and provide a schedule of expenditures by fiscal year by 30 Jun 88.

2 Encls

Calvin W. Shelton
CALVIN W. SHELTON
Chief, Projects Management Branch

DA FORM AUG 80 2496 PREVIOUS EDITIONS WILL BE USED GPO : 1987 0 191-043

DISPOSITION FORM

REFERENCE OR OFFICE SYMBOL	SUBJECT	Mississippi River-Gulf Outlet, St.Bernard Parish, Louisiana (Bank Erosion)
CELMN-PD-FC (10-1-7a)		

TO: C/Engr Div **FROM:** C/Plng Div 20 May 88 **CMT 1**
Warren/2543

1. LMVD comments on the reconnaissance report for the subject study are enclosed for your consideration and reponse.

2. LMVD Planning Division has indicated that they do not require a formal response since most of the enclosed comments are related to engineering and design. Consequently, I request that you prepare and transmit the formal response to these comments directly to LMVD Engineering Division. Planning Div will assist in preparing responses to comments as required.

Encl

CLETIS R. WAGAHOFF
Chief, Planning Division

We will address these comments in preparing the GDM.

Encl 1

CELMV-PD-F (CELMN-PD-FC/10 Mar 88) (1105-2-10c) 1st End Mr. Johnson/bab/5835
SUBJECT: Mississippi River-Gulf Outlet, St. Bernard Parish, Louisiana (Bank Erosion) - 10241

DA, Lower Mississippi Valley Division, CE, Vicksburg, MS 39180-0080 6 May 88

FOR: Commander, New Orleans District, ATTN: CELMN-PD-FC

1. The Reconnaissance Report is approved as meeting the requirements of the first phase of the two-phase planning process. Therefore, no additional funds should be expended on the reconnaissance effort.

2. The recommendation to proceed to the preparation of a supplement to the General Design Memorandum for the Mississippi River-Gulf Outlet (MRGO) Navigation Project is not concurred in until all LMVD comments on the report have been satisfactorily resolved. Comments are furnished as enclosure 2 and should be responded to by separate correspondence.

FOR THE COMMANDER:

D. E. LAWHUN, P.E.
Chief, Planning Division

2 Encls
1. nc
Added 1 encl
2. as

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT. CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS. LOUISIANA 70160-0267

REPLY TO
ATTENTION OF:

CELMN-PD-FC (10-1-7a) 10 March 1988

MEMORANDUM FOR: Commander, Lower Mississippi Valley Division
ATTN: CELMV-PD-G

SUBJECT: Mississippi River-Gulf Outlet, St. Bernard Parish, Louisiana (Bank Erosion) -10241

1. Fifteen copies of the reconnaissance report for the subject study are enclosed.

2. Options for structural bank erosion abatement were formulated for three lengths of application along the Mississippi River-Gulf Outlet (MR-GO): (1) reaches of "critical" erosion on the north bank of the channel, (2) the entire north bank of the waterway between miles 60 and 23, and, (3) all non-leveed reaches of the waterway, both north and south banks, between miles 60 and 23.

3. The three optional lengths of project, considered with four erosion abatement structure design possibilities, constituted the 12 structural alternatives evaluated to provide bank protection and to minimize channel shoaling. Benefit-cost ratios greater than unity were determined for providing bank protection at the north bank reaches of "critical" erosion using either of two structure design possibilities.

4. Study findings indicate that greater than 90 percent of the potential benefits of implementing structural bank protection measures would accrue due to reduced Federal maintenance of the navigation channel. Consequently, the State of Louisiana, which had expressed an interest in becoming the local sponsor and cost-sharer for feasibility studies, now feels that additional studies should be conducted at 100 percent Federal expense. Therefore, a draft Feasibility Cost Sharing Agreement is not included with the report.

5. The report contains a recommendation that instead of conducting feasibility studies, we proceed directly with

preparation of a supplement to the General Design Memorandum for the MR-GO navigation project.

Encl

LLOYD K. BROWN
Colonel, CE
Commanding

LMVD COMMENTS RELATIVE TO THE MISSISSIPPI RIVER-GULF OUTLET BANK EROSION RECONNAISSANCE REPORT

1. In view of the sensitivity of project justification to project maintenance dredging requirements, the District should furnish the rationale used for projecting annual maintenance dredging quantities. The discussion on page 24, Future MRGO Channel Maintenance, is inadequate to verify data on Plates 2 and 3. Additional discussion is needed to address the following:

Plate 2

a. The methodology used to project the location of the MRGO north bank by the year 2040. When the waterway was constructed in 1968, it had a top width of 650 feet which increased to approximately 1,500 feet by 1987. If New Orleans District used a straight-line protection using this past observed enlargement trend, then the future enlargement is vastly overstated. Waves from ships will decay in height over distance traveled (from the vessel) and also when they encounter a much shallower top bank than that which was originally constructed.

b. The erosion rate of Lake Borgne shoreline and the impact this erosion will have on the "buffering marshes."

c. The loss of the "buffering marshes" will reduce the erodible material that contributes to the maintenance dredging. However, maintenance dredging requirements are projected to increase significantly with the loss of these marshes. The rational for this increase is inadequate.

d. The projected increase in dredging for critical reaches 1 and 2 (see Table 4) is approximately three times as many cubic yards per mile as that of adjacent reaches. The increase in maintenance dredging quantities for non-critical areas is a substantial increase over present dredging requirements. The logic for determining the various rates of increase dredging quantities should be given.

Chatry sd "no" to this alternative

2. Page 30, Alternative Plans. The alternative to completely close the MRGO waterway should be evaluated and a discussion of the evaluation should be included in the report. The closure should be located in the vicinity of mile 23 and could be constructed of dredged material from the existing waterway. This alternative will control all future channel maintenance problems by controlling bank erosion, preventing the associated biological resources problems, preventing saltwater intrusion, and lessening the recreational losses. In addition to solving the aforementioned problems, it will also reduce the possibility of catastrophic damage to urban areas by a hurricane surge coming up this waterway and also greatly reduce the need to operate (and could possibly eliminate) the control structures at Bayous Dupre and Bienvenue. Furthermore, the salinity level in Lake Pontchartrain will be reduced which, according to some parties, will be a great benefit. Plus, by making this closure the problems/concerns addressed by April 1984 Feasibility Study entitled, Mississippi and Louisiana Estuarine Areas, will be substantially reduced.

3. Page 30, Alternative Plans. Recommend the economic justification of continued maintenance of the existing project be demonstrated.

4. Page 35 (Table 3) and Plates 8-11. The District should furnish the rationale used in the development of the four design options. Additional discussion is required on the following:

a. The design parameters for the four erosion abatement structures (briefly described in Table 3) should be presented. As shown on Plates 8 through 11, these four alternatives differ greatly in their structural configuration. For example, three have riverside berms, whereas one does not, the ones with berms have berm lengths of 6, 9 or 10 feet. The crest elevations are 2.5, 3.0 or 5.0 feet NGVD, and the riverside slope varies 1 on 2 to 1 on 3. Therefore, these structures cannot be expected to produce similar results (bank scour prevention) if the same design parameters are applied uniformly.

b. In the last sentence of the second paragraph on page 36, a statement is made that ". . . bank nourishment would be accomplished as opportunities to do so occur." Plates 8 through 11 show that bank nourishment from MRGO dredged material will have a minimum length of 100 feet. If dredging is not required in a certain reach of the waterway, it will be impossible to provide the "minimum length" unless it is specifically dredged for bank nourishment. These conflicting points should be explained.

c. The foreshore dike along critical reaches 1 and 2 could be subjected to wave erosion from the lakeside. This erosion threat and structural design to counter the threat should be addressed.

d. In Table 6, designs 3 and 4 are shown as producing identical benefits. These two designs represent riprap structures whose crest elevations are 3.0 and 5.0 feet NGVD. The lower crest structure (design 3) will permit more ship wave overtopping, thus it should produce less benefits, when compared to design 4 for maintenance dredging and marsh loss reduction. This needs to be explained.

5. Page 35, Table 3 and Page 47, Table 11. The presentation of construction costs is unacceptable. A cost estimate is not presented to reflect the project first costs. Table 3 should be accompanied by unit prices and quantities used to develop the costs presented. Table 11 should be accompanied by the breakdown of components which make up the first costs shown.

6. Page 36, First Paragraph. In the last sentence, it is stated that the increased cost of using this material to provide bank nourishment is accounted for as a reduction in the savings in future maintenance dredging. The preceding statements indicate that bank nourishment will be a by-product of the maintenance dredging operation and, therefore, not part of the cost of the structure. This discrepancy should be resolved.

7. Page 40. The non-structural alternative of imposition of speed limitation may be implemented by the Coast Guard based on the petition filed in October 1987 (Appendix B). Should GDM Supplement studies be initiated, the status of the petition will impact future alternatives.

8. Page 42, Speed Limitation Alternative.

a. The speed limitation benefits should include (if not included in the estimate) cultural resource preservation dollars. This would be similar to the structural work bank protection benefits.

b. By reducing the vessel speed from 14 to 10 mph, the waves are reduced, thus a smaller structure should meet the design criteria. This design criteria should be presented and also the smaller structural alternative analyzed.

c. An explanation is needed of the methodology used to calculate the maintenance dredging requirements (presented on Plate 15) for the speed limitation alternative.

9. Page 44, Table 7. The average annual maintenance dredging costs for the without project condition should be $2,591,000, not $2,724,000 as presented in the report on Table 7. This changes the savings in average annual maintenance dredging costs for each of the 4 scenarios presented on Table 7. The total average annual benefits for scenario 1 on Table 12 becomes $2,095,000, not $2,228,000, with a benefit-cost ratio of 1.04 to 1 for design 3. Design 4 drops below unity.

10. Page 45, Table 8. There is no explanation for the derivation of the marsh values of $3,500 per acre. Derivation of marsh values require documentation and substantiation.

11. Pages 47 and 48, Table 11. Present values cannot be verified from the data as it is presented in the table.

12. Page 55. A discussion of the model study and what is to be gained from this task should be provided this office. A statement is made on page 15 that little sediment enters MRGO from sources other than bank erosion. Presently, little sediment movement in the relatively shallow confined bay of Lake Borgne should be occurring. Therefore, on the surface, it is not clear as to the need of this study and supporting documentation should be provided.

13. Page 55. Since it has been concluded that water quality will not be significantly affected by bank stabilization measures, why are extensive analyses of historical water quality data and studies of water quality impacts caused by marsh loss and bank erosion required? It appears that water quality studies should be limited to those required for complying with Section 404(b).

14. Page 61, Table 13. Do costs for the EIS line item include funds for preparation of the Section 404(b) evaluation, endangered species assessments, CZM consistency determination, and other environmental analyses?

15. Appendix C. The acreages for Options 1 and 2, Appendix C, do not coincide with area definitions. The limits are probably only to ordinary high water or tide lines, not 2,000 feet.

Result in loss in navigation benefits. How much?

How do they know?

(based on what data?

Model Study

16. Plate 10. A stage duration curve for the gage at Intracoastal Waterway near Paris Road Bridge was developed for the 1963-1987 period. This data indicates that the still water elevations of 2.0 and 3.0 feet NGVD will be equalled or exceeded 33.4 and 7.6 percent of the time, respectively. With a ship produced wave of 4.0 feet (identical to that recommended in the Mississippi River Baton Rouge to Gulf GDM Supplement 2), the stone dike crest elevation of 3.0 feet NGVD will be greatly exceeded with the passage of every vessel. The piles (on 5.0 foot centers) placed in the dike will not reduce the wave overtopping. For the piles to be effective in reducing overtopping the ratio of closed area (diameter of pile) to total available for overtopping should be approximately 9 to 10. In other words, approximately 90 percent of the available overtopping area must be closed for wave reduction to be realized. Therefore, this plan, as presented, will not produce the desired results and should not have been recommended.

17. Plate 11. The foreshore dikes presented in Supplement No. 3 to the GDM entitled Mississippi River Baton Rouge to the Gulf of Mexico, Louisiana (southwest pass and bar channel) will serve the same purpose as the subject line of protection (Design No. 4). It is noted that the forwarded speed of vessels using these waterways are essentially identical (15 knots versus 14 knots); thus, the resulting bank erosion caused by the ship waves should be similar. Furthermore, it is noted that the crown elevation of the GDM foreshore dikes is 8.0 feet NGVD, whereas, the subject report recommends 5.0 feet NGVD. Clarification is needed as to why a smaller structure will function on this waterway, whereas, a larger structure is required on another waterway (especially since the design conditions are similar).

18. Should the GDM Supplement studies be initiated, the assumptions, data, analysis, and recommendations must be consistent with the ongoing MRGO-IHNC Shiplock study.

TABLE 13

GDM SUPPLEMENT COST ESTIMATE

General Design Memorandum Task	First Fiscal Year	Second Fiscal Year	Total GDM Cost
Engineering Investigations:			
Surveys	$137,000	-------	$137,000
Field Investigations & Testing	95,000	-------	95,000
Hydraulic Model Studies and Data Collection	235,000 ~~135,000~~	-------	~~135,000~~ 235,000
Hydraulic Design	40,000	23,000	63,000
Geology	38,000	24,000	62,000
Foundation Design	22,000	21,000	43,000
Design Studies & Cost Estimates	13,000	23,000	36,000
Study Management & Coordination	15,000	14,000	29,000
Total Engineering Investigations	495,000	105,000	600,000
Environmental Studies:			
EIS	45,000	23,000	68,000
USFWS	14,000	2,000	16,000
Cultural Resources	76,000	9,000	85,000
Recreation	16,000	4,000	20,000
Total Environmental Studies	151,000	38,000	189,000
Economic & Social Analyses:	30,000	7,000	37,000
Real Estate Investigations:	10,000	5,000	15,000
Contingencies:	19,000 ~~119,000~~	31,000	~~150,000~~ 50,000
Totals	$805,000	$186,000	$991,000

Encl 2

Mr. Harrington ~~- your copy~~

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

CF: Barton
Roman

REFERENCE OR OFFICE SYMBOL	SUBJECT
CELMN-ED-HC	Inspection of Mississippi River Baton Rouge to the Gulf of Mexico, LA Project - Bank Nourishment

TO	FROM	DATE	CMT 1
C/Proj Mgt Br	C/H & H Br	24 May 88 Combe/2480	

Ernest: Please get a copy of the latest P&S ind. This finishes our involvement. Tom H

1. Reference is made to:

a. CELMV-ED-TL 1st endorsement to 31 Mar 88 CELMN-ED-DW Memorandum on the subject Mississippi River, Baton Rouge to the Gulf Of Mexico, Baptiste Collette Bayou to Cubits Gap, MILE 11.2 L AHP to Mile 4.2 L AHP, Bank Nourishment, Plaquemines Parish, LA and

b. 4th and 6th endorsements to LMNED-SP letter dtd 4 May 84 on the subject Mississippi River, Baton rouge to the Gulf of Mexico, LA - Supplement no. 2.

2. In ref 1a, we were reminded that ref 1b prescribed a series of annual inspections that were to be performed on the first bank nourishment reach that was completed. The first reach completed, including foreshore dikes and the placement of material behind the dikes using project (Construction General) funds.

3. The foreshore dike from mile 3.0 R to 0.5 Right Bank (R) Above Head of Passes (AHP) was completed in June 1986 and from mile 4.0 R to 3.0 R AHP in February 1987. Bank nourishment behind the foreshore dikes Mile 4.0R to 0.5R AHP was completed in April 1987. About 5 months later profiles of the dike and cross-section of the dike and nourishment were surveyed in September 1987. Preliminary review of the dike profile and cross-section data and visual inspection indicate that the dikes and bank nourishment are performing well. On 6 April 1988, Messrs Jim Tuttle and Joe McCormick of LMVD accompanied Messrs Cecil Soileau, Robert Guizerix, and Joe Dicharry on an inspection of all stone dike work in SWP and the Mississippi River below Venice, LA.

4. We propose to continue monitoring the reach Mile 4.0 to 0.5 R AHP by surveys and visual inspections. We plan an annual inspection during the first week in April 1989. A summary of our findings to date and a trip report on the 5 April inspection by Soileau, et al is attached. During future inspections, transportation provided will allow the inspection team to actually walk on the structures or bank nourishment if deemed necessary by the team at the time. Because of our failure to properly coordinate the first inspection trip with all offices at LMVD, we propose that an interim inspection may be planned for the late fall when the bank nourishment for mile 11.2 to 4.2 L AHP has been completed.

5. We (LMNED) need to annually repeat the survey of the bank nourishment for the reach mile 4.0 R to 0.5 R similar to the survey job 87-153 ordered by Design Branch. In a similar manner we will also need to survey the reach mile 11.2 L to 4.2 L which will be completed this fall. Please program O & M funds in the amount of $3000.00 for each year's inspection trip and $100,000.00 for each year's surveys of total dike and nourishment system from Venice to the jetty reach.

☆U.S. Government Printing Office: 1983—406-862

6. Please find enclosed a draft letter to be sent to LMVD to satisfy their request for an annual report in reference 1a and 1b.

Encl
as

CECIL W. SOILEAU
Chief, Hydraulics and Hydrologic Branch

cf:
c/CELMN-ED-D, M-Marsalone
c/CELMN-ED-S, McHawington ✓ — C.F. Barton
Roman

CELMN-ED-HC

DATE 25 May 88
COMBE/2480

MEMORANDUM FOR: Commander, Lower Mississippi Valley Division
ATTN: CELMV-ED-TL

SUBJECT Inspection of Mississippi River Baton Rouge to the Gulf of Mexico, LA Project - Bank Nourishment

1. Reference is made to:

a. CELMV-ED-TL 1st endorsement to 31 Mar 88 CELMN-ED-DW Memorandum on the subject Mississippi River, Baton Rouge to the Gulf Of Mexico, Baptiste Collette Bayou to Cubits Gap, Mile 11.2 L AHP to Mile 4.2 L AHP, Bank Nourishment, Plaquemines Parish, LA and

b. 4th and 6th endorsements to LMNED-SP letter dtd 4 May 84 on the subject Mississippi River, Baton rouge to the Gulf of Mexico, LA - Supplement no. 2.

2. In ref 1a, we are reminded that ref 1b prescribed a series of annual inspections that were to be performed on the first bank nourishment reach that was completed. The first reach completed, including foreshore dikes and the placement of material behind the dikes using project (Construction General) funds is the reach from Mile 4.0 R to 0.5 R AHP.

3. The foreshore dike from mile 3.0 R to 0.5 Right Bank (R) Above Head of Passes (AHP) was completed in June 1986 and from mile 4.0 R to 3.0 R AHP in February 1987. Bank nourishment behind the foreshore dikes Mile 4.0R to 0.5R AHP was completed in April 1987. About 5 months later profiles of the dike and cross-section of the dike and nourishment were surveyed in September 1987. On 6 April 1988, Messrs Jim Tuttle and Joe McCormick of LMVD accompanied Messrs Cecil Soileau, Robert Guizerix, and Joe Dicharry on an inspection of all stone dike work in SWP and the Mississippi River below Venice, LA. Preliminary review of the dike profile and cross-section data indicate that the dikes and bank nourishment are performing well.

4. We propose to schedule an annual inspection of the reach Mile 4.0 to 0.5 R AHP the first week in April 1989. A summary of our findings to date and a trip report on the 5 April inspection by Soileau, et al is attached at enclosure 4. During future inspections, transportation provided will allow the inspection team to actually walk on the structures or bank nourishment if deemed necessary by the team at the time. Because of our failure to properly coordinate the first inspection trip with all offices at LMVD, we propose that an interim inspection may be planned for the late fall when the bank nourishment for mile 11.2 to 4.2 L AHP has been completed.

5. Details of the inspection trip and analysis of the behavior of the

Enclosure to DF

bank nourishment can be discussed with Mr. Soileau at (504) 862-2420 or Mr. Combe at (504) 862-2480.

FOR THE COMMANDER:

Encl
as

FREDERIC M. CHATRY
Chief, Engineering Division

Soileau

[illegible]

Harrington

Shelton

[illegible]

[illegible]

CELMN-ED-HC

MEMORANDUM FOR THE RECORD

ANALYSIS OF BANK NOURISHMENT
MILE 4.0 R TO 0.5 R ABOVE HEAD OF PASSES

1. The foreshore dike from mile 3.0 R to 0.5 Right Bank (R) Above Head of Passes (AHP) was completed in June 1986 and from mile 4.0 R to 3.0 R AHP in February 1987. The fill was pumped in by 11 April 1987. The area was visually inspected and photographed by Mr. Combe from a helicopter on 12 January 1988 and inspected by boat by Messrs Soileau, Dicharry, Guizerix, McCormick and Tuttle from a boat on 6 April 1988. The bank nourishment appears to be functioning as designed.

2. Mr. Combe's inspection by air indicated that the bank nourishment was complete, appeared to be in good condition and functioning well. Two photographs showing the appearance of the area on 12 January are attached as encl 1. Mr. DeMent visually inspected the dikes from a light aircraft in July 1986. At that time the dikes were completed but without bank nourishment. Because of the hazy climatic conditions on 2 July the water streaming through the dikes is visible on the photographs attached as encl 2, although not as obvious as when seen in person . An earlier aerial inspection by Combe and DeMent shows the critically eroded condition of the bank near mile 3 R AHP as depicted in the photograph at encl 3.

3. Settlement plates and profiles of the stone dikes were surveyed by the contractor, on completion. One monitoring survey, which consists of settlement plate elevations, profiles, and cross-sections has been completed and it is dated September 1987.

4. On the profile survey of the foreshore dike, one point at station 43+65 is below the design grade. The elevation at this point is +5.5 feet NGVD, 2 feet below grade. During the next inspection, we will locate this point to see if visual inspection will reveal whether settlement or movement of armor stone caused the low spot. Twenty-five feet upstream and downstream of the point, the elevation is above +7.5 feet NGVD.

5. On the cross-section plots, with only one monitoring survey, no comparisons can be drawn. The contractor's as built surveys of the foreshore dikes were either inaccurately located or surveyed from a different baseline. For the purpose of developing repetitive surveys, the location of the settlement plates was selected for cross-sections of the dikes and fill areas. Having once surveyed in the locations of the settlement plates, repeat monitoring surveys should be able be referenced to the settlement plates, thus keeping costs down. Examination of the

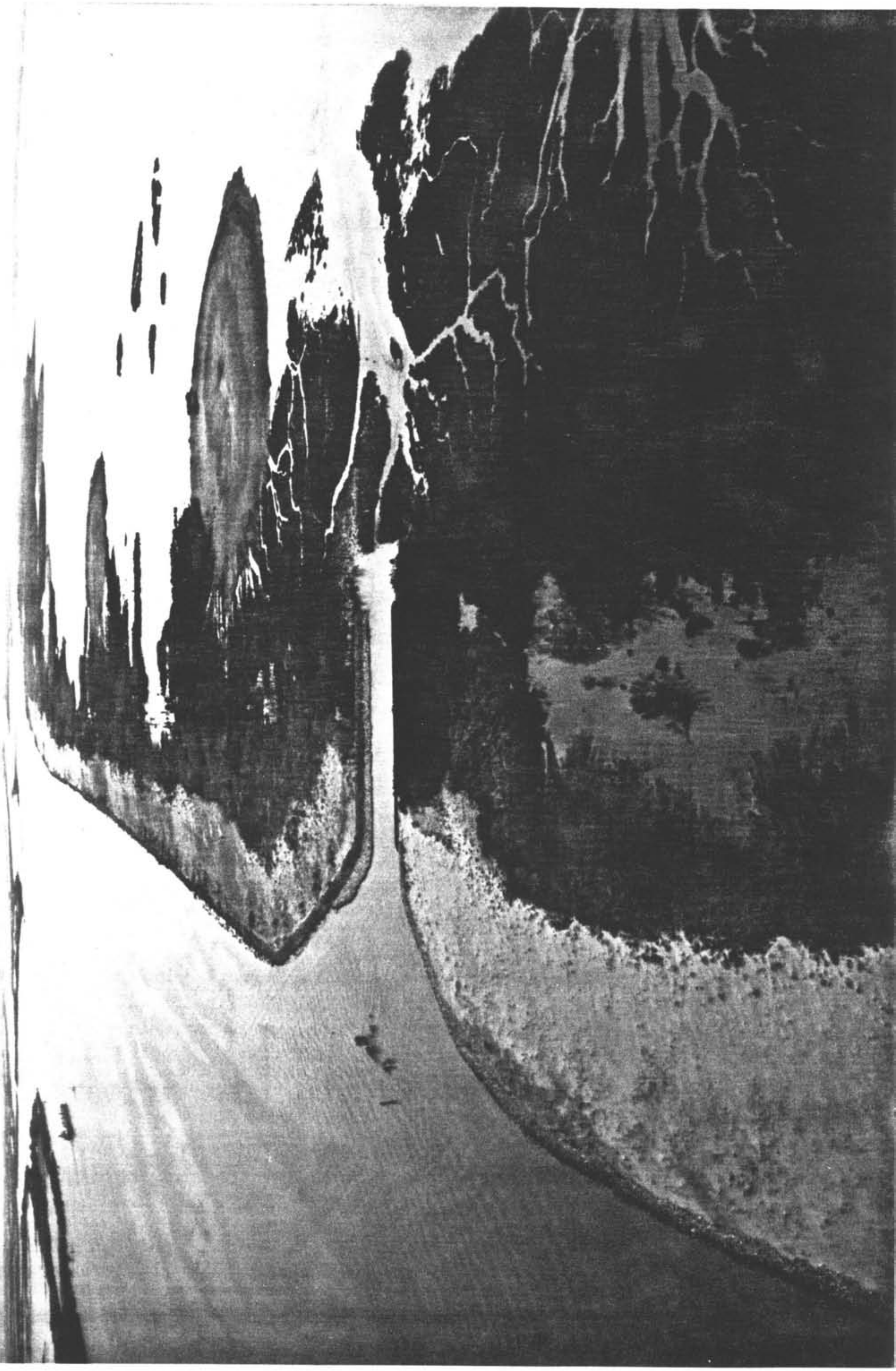
encl to Memorandum
FOR LMVD

cross-section data indicates that a minimum of 200 feet is at or above elevation +7 NGVD at each cross-section.

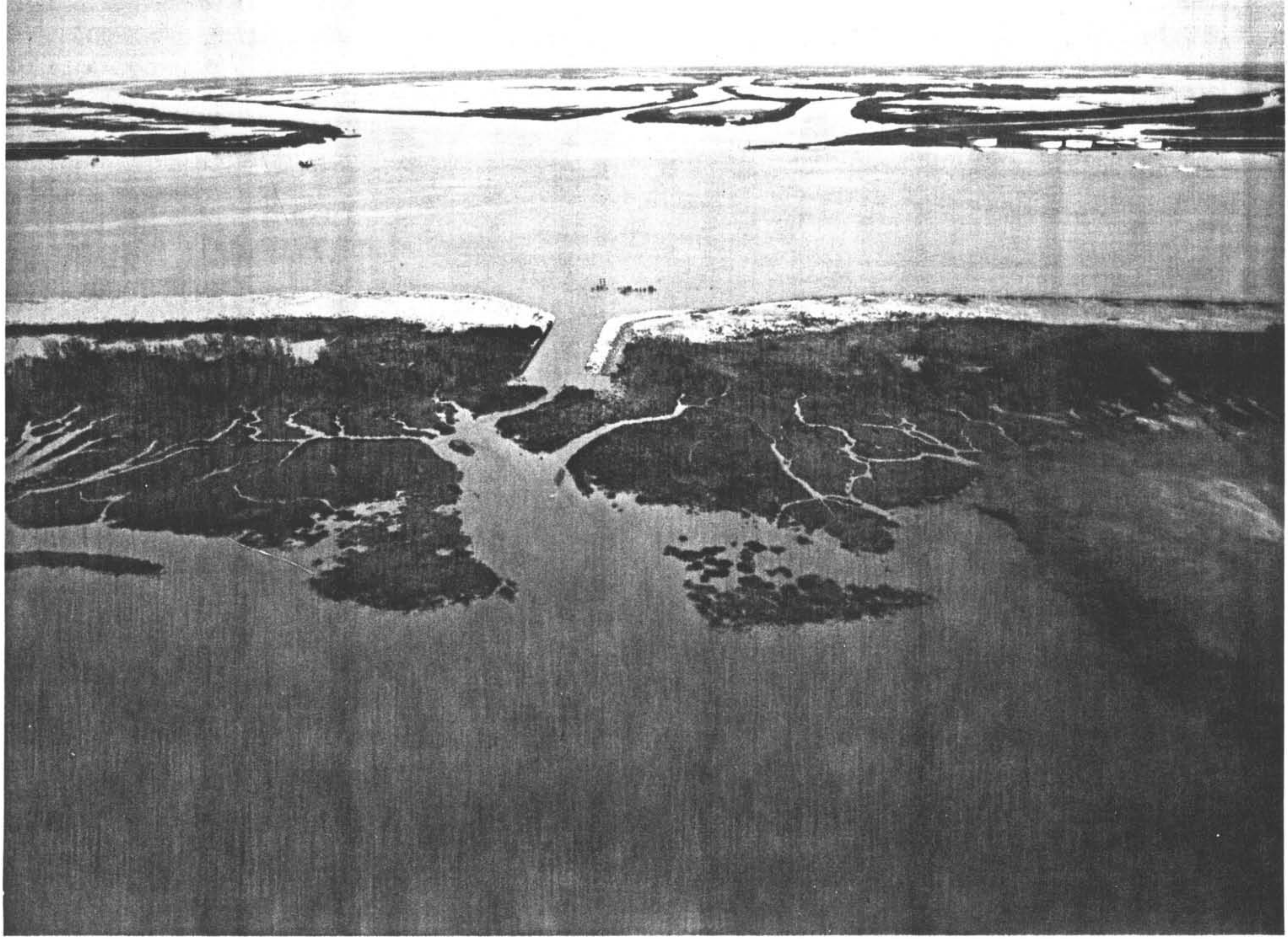
6. Mr. Soileau and party inspected the reach from mile 4.0 to 0.5 R AHP as well as several other reaches where maintenance dredging had been used in lieu of project funds to place the bank nourishment material. Both the bank nourishment work and the stone dike work completed to date appeared to be well constructed and to be functioning as designed. A copy of a trip report by Messrs Soileau, Dicharry and Guizerix is at encl 4.

7. In conclusion, although a formal inspection was not scheduled in April, an inspection was made by representatives from LMN and LMVD. Although a formal inspection could be scheduled now, the data available indicates that the bank nourishment project is performing well, and thus the inspection would be unlikely to produce significant additional information at this time.

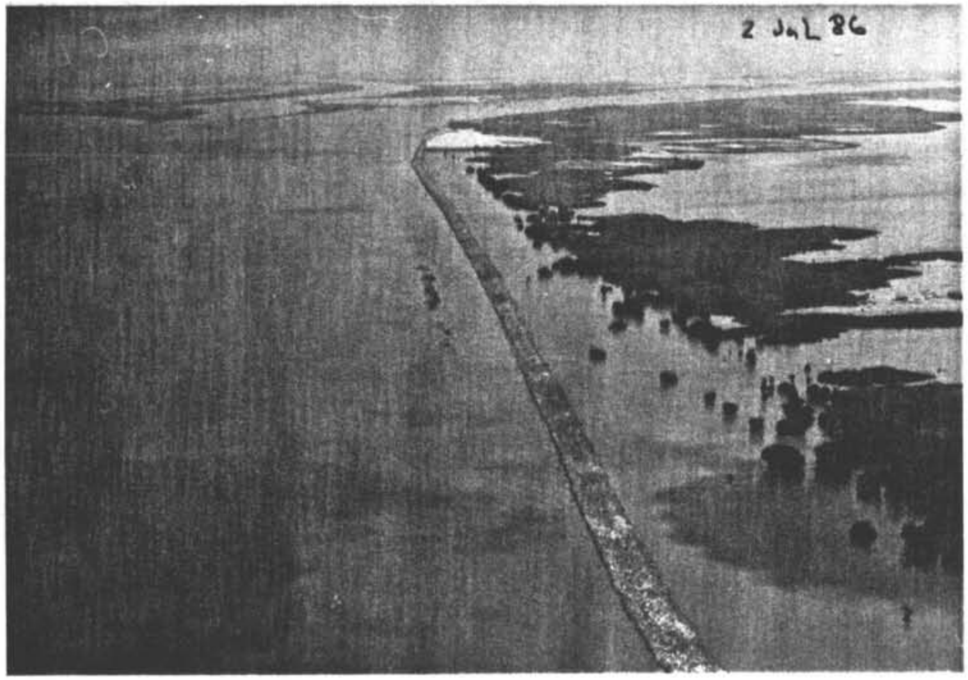
ADRIAN J. COMBE, III
Chief, Coastal Engineering Section



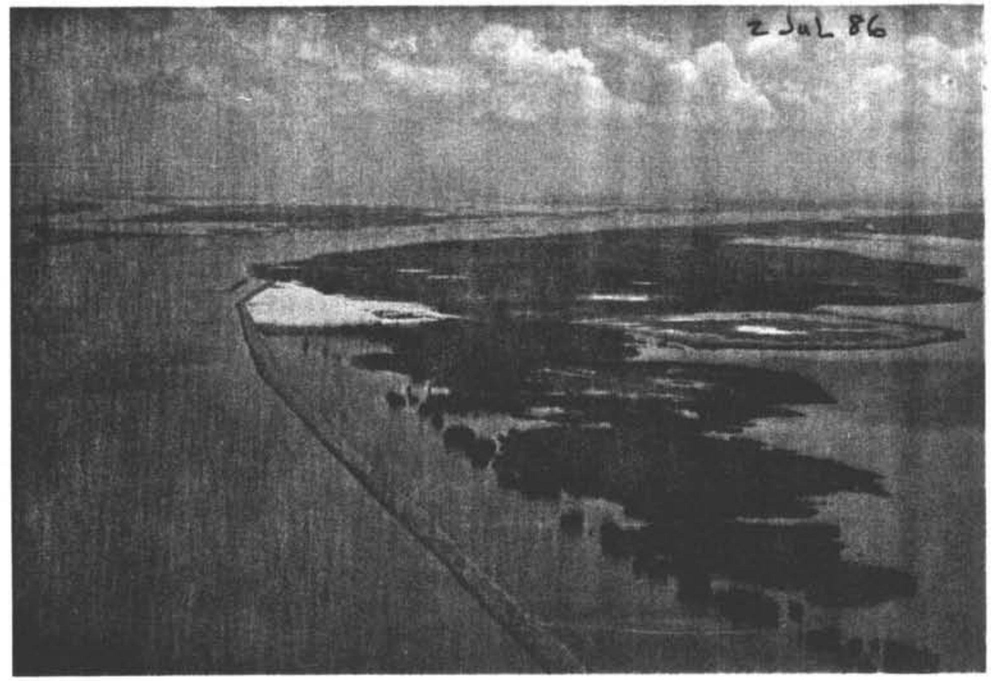
enclosure 1



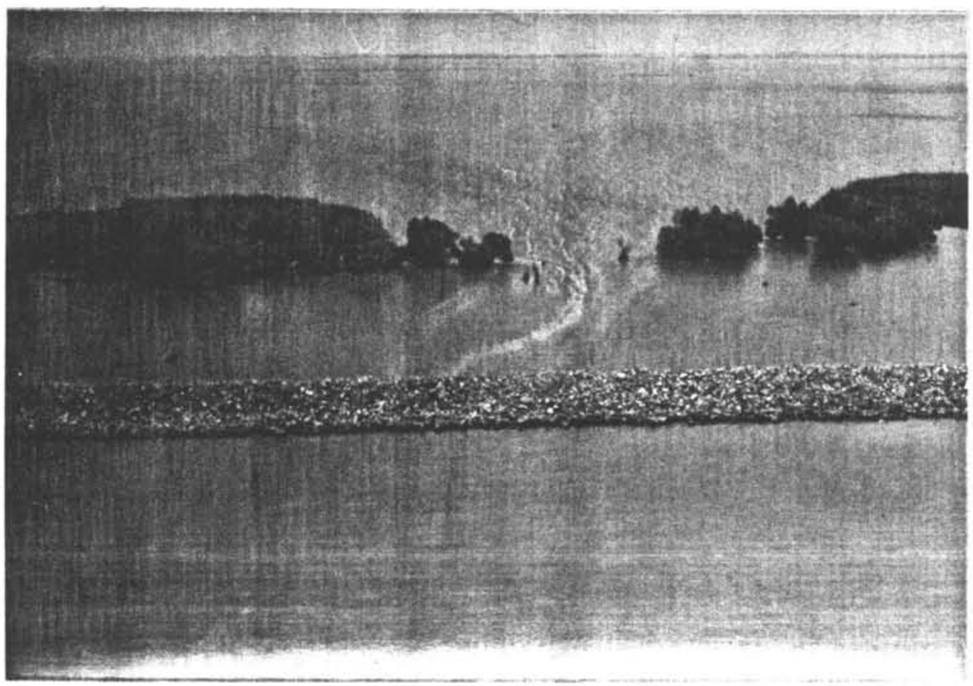
Mile 3 outlet from west, looking across the river to Cubit's Gap



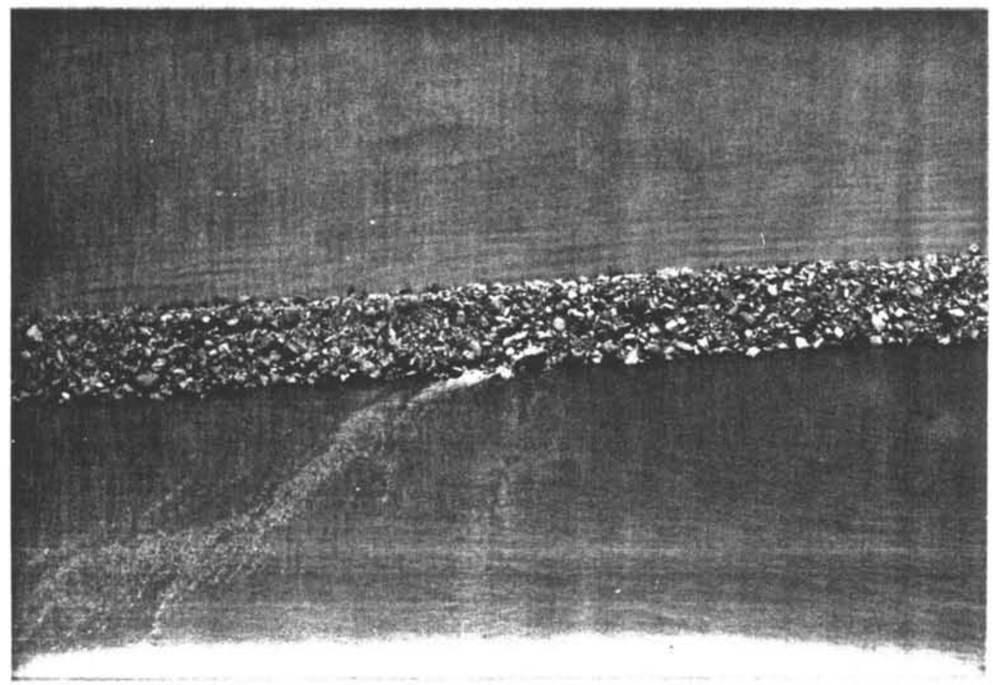
Looking Downstream from just below mile 3 R AHP



Looking Downstream from about mile 2½R AHP, note flow



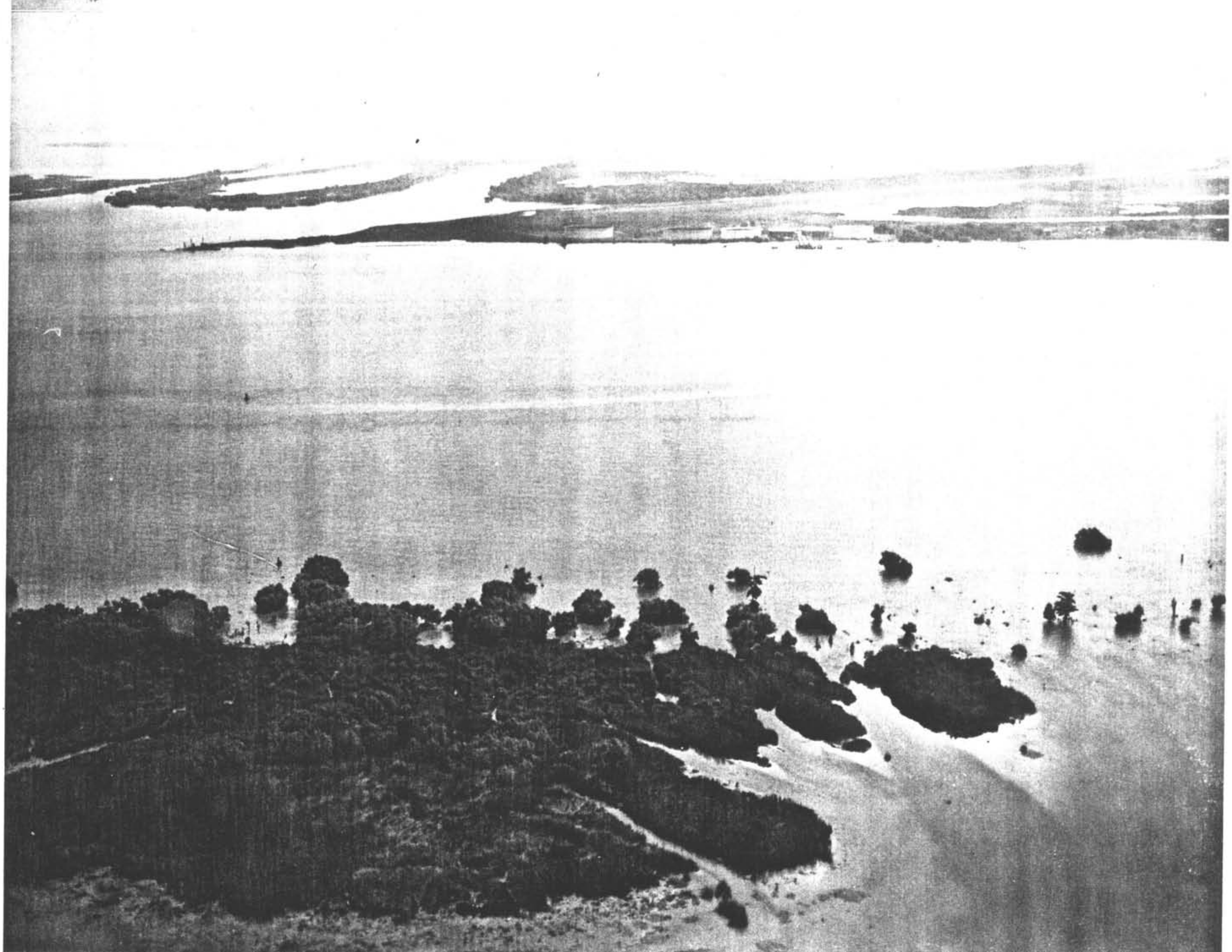
Closeup of flow through dike



Closer view

JUL 2 1986

enclosure 2



About mile 2¼, note deteriorated bank in foreground and Cubit's Gap across the river.

AUG 9 1985

enclosure 3

CELMN-ED-H 6 May 1988

MEMORANDUM FOR RECORD

SUBJECT: Inspection of Mississippi River Baton Rouge to Gulf of Mexico, LA Project

1. On 6 Apr 88, Messrs. Jim Tuttle, Joe McCormick, and Larry Cook accompanied Messrs. Cecil Soileau, [redacted] Joe Dicharry, and Robert Guizerix on a boat inspection of all rock dike work in the reach from Venice, Mississippi River, Mile 10 AHP, to the end of East Jetty, Southwest Pass, Mile 20 BHP. The purposes of the inspection trip were to introduce CELMV Water Control staff to project work already accomplished and to inspect the condition of the East Jetty in connection with hydraulic modeling needs and scheduling of final design effort for East Jetty repair and/or rehabilitation.

2. The boat provided for the inspection, W-46, had too much draft to allow walk-on inspection of dikes. Consequently, only those features which were adjacent to depths of 5 feet or more could be closely inspected. Other features had to be viewed from 20 to 30 yards away in order not to endanger the boat.

3. Only one nourishment feature, in two contracts, has been completed to date, between Mile 0.5 and 4 AHP on the right descending bank. However, there are extensive reaches of new rock dike that have been completed on either bank and some older dikes which are not of the same design that were completed with maintenance funds prior to supplement no. 2 work. Both the bank nourishment work and the rock dike work done to date are well done and appear to be functioning as designed.

4. In addition to completed work, the inspection team also viewed rock dike construction in progress on the left descending bank at Mile 3.5 to 10 AHP and Miles 9 and 17 BHP, and east headland dike repair work at South Pass entrance.

5. Because the river was at a stage near 3.5 at Venice, no breaking waves were being generated in the shallows in front of the dikes and it was not possible to observe wave attack directly on the dike. Instead only standing waves were observed on this day.

6. The inspection team concluded that the project has been constructed in accordance with the design plans and specifications, and that it was functioning as expected. The quality

enclosure 4

CELMN-ED-H
SUBJECT: Inspection of Mississippi River Baton Rouge to Gulf of Mexico, LA Project

of rock work is good and uniform placement is being achieved. The East Jetty head and trunk have some minor deficiencies in height and section, but overall condition is adequate.

CECIL W. SOILEAU
Chief, Hydraulics & Hydrologic Branch
CELMN-ED-H

JOE DICHARRY
Navigation Section
CELMN-ED-PN

ROBERT GUIZERIX
General Engineering Section
CELMN-ED-DG

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

REPLY TO
ATTENTION OF:

CELMN-PD-FC

February 1988

MISSISSIPPI RIVER-GULF OUTLET,

ST. BERNARD PARISH, LOUISIANA

RECONNAISSANCE REPORT

ON

CHANNEL BANK EROSION

SYLLABUS

This report presents the results of the reconnaissance phase investigation of bank erosion and erosion-related problems in the vicinity of the Mississippi River-Gulf Outlet (MR-GO) channel.

The affected study area is located in southeast Louisiana, and encompasses Orleans (City of New Orleans), St. Bernard, Jefferson, and Plaquemines Parishes. This report specifically addresses a 37 mile segment of the MR-GO navigation channel and adjacent wetlands in Orleans and St. Bernard Parishes, Louisiana.

Severe bank erosion is occurring on the MR-GO navigation channel. Approximately 41 miles of the 66 mile long channel consists of a land cut through unstable marsh and shallow water areas. Since its completion in 1968, the top width of the channel increased from 650 feet to an average of 1,500 feet, in 1987, principally due to erosion. The channel banks have eroded beyond the existing channel right-of-way in several locations. Much of the bank erosion is caused by wave-wash and drawdown from large displacement vessel traffic on the restrictive waterway. Passage of these vessels causes very large quantities of water to be displaced from the channel into the adjacent marsh, followed by rapid return flow into the channel. The tremendous forces exerted by these rapid and extreme water level fluctuations cause the relatively soft marsh adjacent to the channel to break up and be swept into the waterway. Between 1968 and 1987, bank erosion resulted in the loss of approximately 4,200 acres of highly productive marsh adjacent to the MR-GO channel.

Continued erosion threatens to produce large breaches in the rapidly dwindling marsh buffer between the navigation channel and the open waters of Lake Borgne and Breton Sound. Once the buffering marshes are lost, dredging frequency and quantity in the vicinity of the breached bank area will increase significantly. The navigation channel will be exposed to storms, currents, and less attenuated tidal action from the north and northeast. Attendant sedimentation and shoaling problems are expected to occur. Thus, without corrective action, the bank erosion problem will become a major channel maintenance problem in the future.

Both structural and non-structural measures were evaluated to address the bank erosion/channel maintenance problem. Options for structural bank erosion abatement were developed for three lengths of application along the MR-GO. Four erosion abatement structure design possibilities were developed to provide bank protection and thus, minimize channel shoaling. For each of the three optional lengths of project, any one of the four structure designs could be used. Consequently, a total of 12 structural alternatives were developed for initial evaluation. Additionally, plans that would use maintenance dredged material to reduce marsh losses adjacent to the navigation channel were evaluated. Imposition of a speed limit for large displacement vessels on the inland portion of the MR-GO was evaluated as a non-structural erosion and channel shoaling reduction option.

From preliminary analysis of potential structure design effectiveness, reliability, and survivability; costs; benefits; and impacts; one structural option and four conceptual structure designs are recommended for detailed investigation. Greater than 85 percent of the quantifiable potential benefits of implementing structural bank erosion reduction measures would accrue to navigation in the form of savings in maintenance of the MR-GO. Consequently, additional studies should be conducted via preparation of a supplement to the General Design Memorandum (GDM) for the Mississippi River-Gulf Outlet navigation project.

The total cost of the reconnaissance study is $171,000. The estimated cost to complete the supplement to the Mississippi River-Gulf Outlet GDM is $991,000. The GDM supplement will require 24 months to complete.

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MISSISSIPPI RIVER-GULF OUTLET,

ST. BERNARD PARISH, LOUISIANA

RECONNAISSANCE REPORT

ON

CHANNEL BANK EROSION

This report presents the findings of a reconnaissance study of bank erosion and erosion-related problems in the vicinity of the Mississippi River-Gulf Outlet channel. The reconnaissance study involved using available data and field reconnaissance to establish existing conditions in the study area. Study efforts were directed to determining the magnitude and extent of bank erosion and erosion-related problems, and to developing alternative solutions. Economically justifiable and environmentally acceptable plans have been identified that warrant proceeding to more detailed studies.

STUDY AUTHORITY

The study was authorized by a resolution adopted 23 September 1982 by the Committee on Public Works and Transportation of the United States House of Representatives at the request of Representative Robert L. Livingston, Jr., Louisiana 1st Congressional District. The resolution is as follows:

> "Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Mississippi River Gulf Outlet, Louisiana, published as House Document No. 245, 82nd Congress, 1st Session, and other pertinent reports, with a view to determining whether, in light of extensive erosion which has been occurring in St. Bernard Parish along the unleveed banks of the Gulf Outlet Channel, any modifications to the recommendations contained therein are advisable at this time with reference to the feasibility of bank protection measures."

STUDY PURPOSE AND SCOPE

This report contains the results of reconnaissance phase studies. The purpose of the reconnaissance study is to accomplish the following objectives:

- define the extent of erosion and erosion-related problems occurring in the study area,

- identify opportunities to implement potential solutions to the defined problems,

- appraise the Federal interest in potential solutions to defined problems by evaluating the costs, benefits, and environmental impacts of the potential solutions,

- determine, based on the appraisal of Federal interest, whether planning should proceed beyond the reconnaissance phase into more detailed feasibility phase investigations,

- estimate the time and cost required to complete feasibility phase studies, if Federal interest is indicated, and

- assess the level of interest and support of non-Federal interests in the identified potential solutions to defined problems.

Study efforts in the reconnaissance phase involve the use of available information and data, ground reconnaissance of the study area, field surveys, and office studies. Existing conditions and projected conditions with and without Federal improvements are assessed. Problems, needs, and opportunities are identified. The feasibility and performance of potential improvements are determined. Social, cultural, economic, and environmental impacts are evaluated.

The affected study area is located in southeast Louisiana, and encompasses Orleans (City of New Orleans), St. Bernard, Jefferson, and Plaquemines Parishes. The study specifically addresses a segment of the MR-GO navigation channel located in Orleans and St. Bernard Parishes. The study area is shown on Plate 1.

PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

Relevant studies and reports by the U.S. Army Corps of Engineers, and other Federal, state, and local agencies on water resources development in the study area are described in the following paragraphs.

[] The U.S. Army Corps of Engineers report , Mississippi River-Gulf Outlet, Louisiana, was published as House Document No. 245, 82nd Congress, 1st Session. This report recommends an additional outlet channel from New Orleans to the Gulf of Mexico with dimensions of 36 feet deep by 500 feet wide (bottom width). Improvements were authorized by the Rivers and Harbors Act of 29 March 1956. Construction of the outlet channel was completed to project dimensions in January 1968.

[] A miscellaneous paper (3-259) which reported the results of a geological investigation of the MR-GO channel by the U.S. Army Corps of Engineers, Waterways Experiment Station was published in 1958. This report documents soils and foundation conditions along the route of the MR-GO channel and adjacent wetlands.

[] An interim evaluation report on test sections of selected foreshore protection structure designs was prepared by the New Orleans District in 1983. In this report the performance of six erosion control structure designs was assessed. The foreshore protection structures were designed specifically for the leveed portion of the MR-GO south shore. Two of the test section showed satisfactory results.

[] Coastal Environments, Incorporated (CEI) published results of a study of bank stabilization for the MR-GO in December 1984. The study was conducted for the St. Bernard Police Jury and funded, principally, by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration and the State of Louisiana, Department of Natural Resources, Coastal Management Section. The St. Bernard Parish Police Jury provided a 25% match to the Federal funding.

This report specifically addresses a 22.5 mile reach of the MR-GO northeast shore between Bayou Bienvenue and Bayou LaLoutre. The report is comprehensive in that many factors that influence, or are influenced by, bank erosion are addressed. Factors discussed in the report include geology, soils, hydrology, vegetation, dredging, vessel traffic, and ship waves. Two bank protection structure designs, imposition of a speed limitation for vessel traffic, and enlargement of the MR-GO channel were discussed as potential erosion abatement measures.

[] St. Bernard Parish has conducted studies of its wetlands and established guidelines and goals for a parish wetlands management program. A report defining the wetlands management program was published in August 1978. Freshwater diversion to combat saltwater intrusion and enhance fish and wildlife productivity is included as one plan feature.

[] St. Bernard Parish completed a Draft Coastal Management Program Document in May 1982. The document will be the basis for parish planners to manage the coastal resources of the parish.

[] The Louisiana Coastal Area Study was authorized by resolutions of the Committees on Public Works of the United States Senate and the House of Representatives, adopted 19 April 1967 and 19 October 1967, respectively. Under this study the New Orleans District is investigating the need and feasibility of improvements in hurricane protection, erosion abatement, prevention of saltwater intrusion, water supply, preservation of fish and wildlife, and other related water resource problems in coastal Louisiana.

The New Orleans District prepared a report on fresh water diversion to Barataria and Breton Sound Basins in April 1983. Initial Evaluation Reports that addressed Water Supply, Shore and Barrier Island Erosion, and Land Loss and Marsh Creation were published in July, September, and November, of 1984, respectively.

PROBLEM IDENTIFICATION

Defining existing conditions and analyzing historical trends provide the base for forecasting future conditions. These analyses provide the focus required to define the magnitude and extent of problems. Problems, once well defined, lead to the identification of water and related land resources needs, and allow opportunities to be exploited that address those needs and produce solutions to water resources problems.

EXISTING CONDITIONS

Climate

The climate of the area is subtropical marine, with long humid summers and short moderate winters. Southerly winds prevail throughout the warmer months and produce intense thunderstorms during the summer. In the colder months the area is subjected to frontal movements which produce squalls and sudden temperature drops.

Temperature readings have been taken at New Orleans since 1870. Since 1870, the extremes recorded were a high of 102°F occurring on four different days and a low of 7°F in February 1899. The annual normal temperature based on the period 1951-1980 is 69.5°F, with monthly normal temperature varying from 83°F in July to 54°F in January. Extremes for the normal period were a maximum temperature of 102°F in August 1980 and a minimum of 14°F in January 1963. The average winter and summer temperatures are 55.3°F and 82.4°F, respectively.

Precipitation data from four climatological stations are used to represent the study area. The average annual rainfall of New Orleans at Algiers, St. Bernard, LSU Citrus Research Center, and Boothville based on the period 1967-1986 is 61.2 inches.

Wind data taken at New Orleans Moisant Airport shows an annual average of 7.8 mph based on the period 1966 to 1986. Predominant wind directions are north-northeast from September through February and south-southeast from March through June. Winds at Boothville averaged 8.8 mph over the period July 1971 through December 1978. Predominant wind directions are northeast from September through February and southeast from March through June. Boothville data are representative of the Gulfward portion of the study area.

Weather patterns which simultaneously affect large portions of the Gulf of Mexico cause three kinds of wind-generated tidal conditions in the study area. The Frontal Gulf Return and Gulf Return weather types have moderate to strong southeast to south-southwest winds associated with storms which cause moderate to severe wave set-up in Breton Sound and the MR-GO. These weather patterns occur when the returning air flow is affected by lifting and convergence along an approaching cold front. Cold fronts are generally associated with a Pacific High, Continental High or a Frontal Overrunning weather type generating winds from the northwest or northeast. These weather patterns are most active from late fall through spring.

The Gulf Tropical Disturbance weather type sometimes affects southern Louisiana during the summer and fall months. These disturbed tropical systems normally drift from east to west across the northern gulf and range from relatively weak easterly waves to strong severe hurricanes.

The Gulf Extra-Tropical disturbance weather type has behavior similar to tropical storms except that it occurs in winter-spring. It consists of a strong northeast to east wind component which causes wave set-up and flooding.

Analyses of hurricanes and tropical storms along the Louisiana coast have been made for storms from 1893 to present. During that time, a total of 47 storms have either struck or affected the coastal area of Grand Isle to the Louisiana-Mississippi state line. The highest maximum observed winds at landfall came from Hurricane Camille (14-22 August 1969) and measured 160 miles per hour near the center, with gusts to 190 miles per hour. This storm produced the maximum stage of 11.1 feet at Shell Beach.

Hurricanes Elena and Juan (1985) were the last two storms to affect the study area. Hurricane Juan broke records along the MR-GO. During this storm an interior stage of 3.53 ft. was recorded at the Bayou Dupre Floodgate (west) and a 7.61 ft. exterior stage was recorded on the east of the floodgate. At the Bayou Bienvenue Floodgate (east) a 7.98 ft. stage was recorded. A 6.86 ft. stage was recorded on Bayou Terre Aux

Boeufs at Delacroix. A high water mark of 7.5 ft. was recorded at Shell Beach.

In January 1983, a coastal storm hit the study area with very strong winds. The storm produced tides of 3 to 6 feet above normal along the MR-GO. At Shell Beach a high of 6.8 ft. was recorded and 7.61 ft. was recorded at the Paris Road Bridge.

Water Resources

Groundwater

A limited supply of groundwater suitable for municipal and industrial uses is available in the study area. For this reason, development of grounwater in the study area has been limited to industrial use. There are five major aquifers in the vicinity of the study area. The near surface aquifer consist of discontinuous layers of sand, point bar, and distributrary channel deposits. The deeper 200-foot aquifer consist of a series of sand lenses and channel deposits with poor areal continuity. The 400, 700, and 1,200-foot aquifers are sand layers that are deltaic and marine in origin.

Surface Water

Major surface waters in the study area include the MR-GO, Gulf Intracoastal Waterway (GIWW), Inner Harbor Navigation Canal (IHNC), Mississippi River, Lakes Pontchartrain and Borgne, and Chandeleur and Breton Sounds. All of these water bodies are connected hydraulically. Bayous Bienvenue, Dupre, Ycloskey, and La Loutre are relatively small natural waterways that intersect the MR-GO in the study area. Numerous smaller bayous and pipeline canals crisscross the marshlands adjacent to the MR-GO channel.

Tides in the Breton and Chandeleur Sound areas are of the daily or diurnal type, i.e., they exhibit only one high water and one low water per day. The most prominent feature of the daily tide is the variation in the daily range produced by changes in the moon's declination.

In a shallow body of water such as Breton Sound, tidal effects other than the daily range are masked by meteorological conditions which cause prominent water level fluctuations.

The tides in Breton Sound have a range of 1.4 feet. In Lake Borgne the tides have a range of 1.2 feet. Tidal ranges at several stations include 0.70 feet at Seabrook (Lake Pontchartrain), 1.2 feet at Shell Beach, 1.1 feet at Paris Road Bridge, 1.45 feet at Gardner Island, and 1.0 feet at Biloxi, Mississippi.

Water Quality

Wastewater and polluted stormwater runoff from developed areas enter the MR-GO from many sources. The Forty Arpent Canal, the Florida Walk Canal, and Bayou Bienvenue transport significant amounts of treated municipal and industrial wastewater to the MR-GO. Bayou Bienvenue also carries pumped stormwater from New Orleans to the MR-GO, and stormwater from upper St. Bernard Parish is transported by the Forty Arpent and Florida Walk Canals. Each of these waterways enter the MR-GO between miles 50 and 60 from the developed areas to the west near the Mississippi River.

The water quality gaging station at Bayou Dupre near its confluence with the MR-GO is most representative of this reach. Measured dissolved oxygen (DO) levels have consistently exceeded the minimum state standard and Environmental Protection Agency (EPA) criteria. With rare exceptions, the pH measurements have also been within the desirable range of 6.5 to 9.0. Both total and fecal coliform, which are indicators of bacterial pollution, have consistently exceeded the applicable criteria of 70 and 14 counts/100 milliliters, respectively. The proximity of this station to oyster beds in Lake Borgne and adjacent areas is cause for concern, since contaminated shellfish may not be harvested and sold for human consumption. Coliform levels observed at other locations along the

MR-GO have usually exceeded the criteria, indicating a widespread area of water and wetlands that are subject to bacterial pollution.

Toxic substances, including heavy metals and synthetic organics have occasionally been measured above EPA criteria levels but no patterns of consistently exceeding the criteria for particular substances have been observed. Tidal currents promote mixing and dispersion in the upper water column of the MR-GO, but density stratification as a result of the migrating saltwater wedge in the deep channel produces oxygen deficits and other associated water quality problems at deeper levels. These waters ordinarily remain confined to the MR-GO channel, and only directly influence the adjacent relatively shallow areas during periods of intense mixing.

Bayou Bienvenue crosses the MR-GO at mile 60 near the GIWW. It carries pumped stormwater from New Orleans, and contributes to intermittent periods of lowered DO levels in the MR-GO and adjacent water bodies, including Lake Borgne. Bacterial contamination risks generally increase in the northernmost reaches of the MR-GO following storm periods, but normal tidal circulation helps to restore more desirable conditions within reasonable time periods.

Land Resources

Most of the Mississippi River-Gulf Outlet is experiencing severe erosion along its unleveed banks. The erosion is a result of both man-induced and natural forces, including combinations of channelization, ship and wind generated waves, storm activity, and subsidence. Associated with subsidence is eustatic sea level rise that has been estimated at 0.5 feet per century (Nummendal, 1983). Subsidence and sea level rise intensify saltwater intrusion and erosion.

The marshes along the north bank of the Mississippi River-Gulf Outlet have been especially hard hit by these forces and are disappearing at an alarming rate. Because erosion is steadily widening the MR-GO, the east bank along Lake Borgne is dangerously close to being breached. Once the bank is breached, the following will happen: sediment from Lake Borgne will flow into the channel resulting in large increases in dredging costs to maintain the channel; development to the southwest would be exposed to direct hurricane attacks from Lake Borgne; the rich habitat around the area would be converted to open water; and more marsh would be exposed to higher salinity water.

Economy and Human Resources

Because of its unique location near the mouth of the Mississippi River, New Orleans is the natural gateway to the entire Mississippi Valley. Waterborne commerce is of major importance to the Greater New Orleans area and the state. New Orleans is the nation's second largest port in terms of tonnage handled in 1985 and ranks first in handling tonnage dedicated to foreign trade. Twenty-four percent of all grain exported from the United States in 1985 was loaded in New Orleans. Nearly 70,000 ships call at its docks each year. The Port of New Orleans, as well as the industrial developments along the Mississippi River between Head of Passes and Baton Rouge, serve as transshipment terminals for shallow-draft commerce utilizing the vast network of inland waterways formed by the river, its tributaries, and connecting streams.

Within the Port of New Orleans, facilities are spread over three waterways: the Mississippi River, the IHNC, and the MR-GO.

In recent years, 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 industries. Nevertheless, National Marine Fisheries Service reports indicate that in 1986 Louisiana ranked first among the nation's 50 states in total quantity of fish and shellfish landings with 1.7 billion pounds. The state ranked second in value of landings with $321.5 million, behind Alaska. Menhaden, a species of fish used for industrial purposes, accounted for the largest volume landed in Louisiana, followed by shrimp, crabs, oysters, and catfish.

The primary parishes directly or indirectly impacted by this project, and their populations, are shown in Table 1.

TABLE 1

POPULATIONS OF AFFECTED PARISHES
1950-1986

Parish	Land Area (Sq. Mi.)	Populations 1950	1960	1970	1980	1986
Jefferson	331	103,873	208,769	337,568	454,592	476,658
Orleans	205	570,445	627,525	593,471	557,482	563,811
St. Bernard	514	11,087	32,186	51,185	64,079	68,296
Plaquemines	1,030	14,239	22,545	25,225	26,049	26,662
TOTALS	2,080	699,644	891,025	1,007,449	1,102,202	1,135,427

The 1980 census estimated that about 12 percent of the employed people living in the study area were engaged in transportation, communication, and utility activities. The Louisiana Department of Labor has reported that study area employment in similar categories accounted for about 10 percent in the first quarter of 1987. A more 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 August of 1987.

Transportation

The MR-GO, along with the Mississippi River, provide deep-draft navigation access to the Ports of New Orleans and Baton Rouge. The Port of New Orleans handled 146.6 million tons of commerce in 1985. This commerce consisted of 53.5 million tons of foreign trade, 16.2 million tons of coastwide traffic, and 72.9 million tons of internal traffic. Although the Port of Baton Rouge is not in the study area, deep-draft traffic moves through the MR-GO to reach this port. Foreign traffic at Baton Rouge in 1986 amounted to 20.2 million tons.

Description Of The MR-GO Navigation Project

The Mississippi River-Gulf Outlet (MR-GO) navigation project is located in southeast Louisiana, in Orleans, St. Bernard, and Plaquemines Parishes. The navigation project was authorized in March 1956 by Public Law 455, 84th Congress, 2nd Session, as amended, to provide a safer and shorter outlet from the Mississippi River to the Gulf of Mexico.

The navigation project, as authorized, provides for construction of a ship channel 36 feet deep and 500 feet wide (bottom width). The navigation channel was to extend from the Inner Harbor Navigation Canal (IHNC) in eastern New Orleans approximately six miles eastward coincident with the Gulf Intracoastal Waterway (GIWW). This channel was to then veer to the southeast as a new land and water cut approximately 60 miles to Chandeleur Island. From Chandeleur Island the project channel was to gradually increase to a bottom width of 600 feet and a depth of 38 feet in the Gulf of Mexico. Protective jetties were to be provided at the channel entrance. The project also provides for a permanent retention dike through Chandeleur Sound and a wing dike along Breton Island as necessary. A turning basin, 36 feet deep, 1,000 feet wide, and 2,000 feet long was to be provided at the landward end of the seaway canal. A highway bridge with approaches was to be provided to carry Louisiana Highway No. 47 over the channel.

The project also provides for replacement of the existing IHNC lock or an additional lock with suitable connections when economically justified by obsolescence of the existing IHNC lock or by increased traffic.

The project was modified in August 1969 under the discretionary authority of the Chief of Engineers. The project modification provided for, as a mitigation measure, protecting a portion of the foreshore lying between the Lake Pontchartrain and Vicinity Hurricane Protection project levees and the MR-GO. This included six miles along the north bank of the MR-GO in the reach which is part of the GIWW and 18 miles along the south shore of the MR-GO.

Construction of the deep-draft channel was initiated in March 1958. An interim channel 36 by 250 feet (bottom width) was opened to traffic in July 1963. Enlargement to project dimensions was completed in January 1968. The turning basin at the intersection of the MR-GO with the IHNC and a high level bridge at Paris Road have been completed. Jetties extending from the seaward end of the land cut to the six-foot contour in Chandeleur Sound and a south jetty extension to mile 20.2 in Chandeleur Sound have been completed also.

A study is in progress to determine the feasibility of replacing the existing IHNC lock.

Foreshore protection along the north bank of the MR-GO and for 13 miles along the south bank from Bayou Bienvenue to the end of the leveed reach, as authorized by the August 1969 project modification, has been completed. Foreshore protection on the south bank from Bayou Bienvenue to the IHNC is indefinitely deferred until the need arises.

Of the 66 miles of waterway between Chandeleur Island and the IHNC approximately 25 miles are through the shallow bay of Chandeleur Sound. About 41 miles are through land and water area. Along the south/southwest shore of the MR-GO the 18 miles of leveed area have been provided foreshore protection. A dredged material disposal area approximately 0.5 miles wide extends along the remaining 23 miles of the MR-GO south bank.

Current MR-GO Channel Maintenance Requirements

Although some project features were still under construction until 1968, maintenance of the MR-GO channel was initiated in 1965. On average, at least one reach of the inland portion of the waterway, selected on the basis of annual reconnaissance surveys, is dredged for maintenance purposes every two years. The most frequently dredged reaches of the inland portion of the waterway since inception of channel maintenance are as follows:

- [] mile 24 to mile 27, dredged four times, 6.0 million cubic yards total,

- [] mile 38 to mile 42, dredged four times, 4.2 million cubic yards total, and

- [] mile 33 to mile 38, dredged three times, 3.6 million cubic yards total.

Most of the the other reaches of the inland portion of the MR-GO have been dredged once for maintenance since 1970. Reaches of the waterway corresponding to mile 30 to 32, mile 43 to mile 50, and mile 53 to mile 60 have never been dredged for maintenance purposes.

Where the MR-GO traverses marsh areas in the land cut reaches (mile 23 to mile 60), the average shoaling rate is approximately 40,000 cubic yards per mile per year (cu yd/mi/yr) based on maintenance dredging records. Required maintenance dredging in these reaches results almost exclusively from erosion of the channel banks. Little sediment enters the system from other sources.

Erosion along both the north and south banks of the land cut portion of the channel is significant. The average rate of bank retreat is about 15 feet per year for each bank. The south bank of the MR-GO along the Chalmette loop of the Lake Pontchartrain and Vicinity Hurricane Protection levee (mile 47 to mile 59) is protected with a rock foreshore dike. However, no erosion protection measures exist along the MR-GO north bank or on the south bank between mile 23 and mile 47.

Based on maintenance dredging records, shoaling rates in the land cut reaches are significantly less than in the open water area of Breton Sound. Records indicate that maintenance dredging can vary between 350,000 cu yd/mi/yr and 1 million cu yd/mi/yr in the portion of the channel in Breton Sound. Records from the first and second maintenance dredging periods after the channel was completed, indicate that shoaling varied between 700,000 and one million cu yd/mi/yr in Breton Sound. However, a large percentage of the shoaling was attributed to recirculation of dredged material from disposal areas that were located too close to the channel.

Substantially more dredging in the inland reaches of the MR-GO has been performed for other purposes than for channel maintenance. A significant amount of dredging has been performed to obtain construction material for the Lake Pontchartrain and Vicinity Hurricane Protection levees. Between 1968 and 1983 an estimated 100 million cubic yards of dredged material (33 million cubic yards of in-place levee fill) was removed from the MR-GO for use in levee construction. The extraction of this quanity of fill material has significantly reduced maintenance dredging requirements between mile 47 and mile 60. Thus, channel maintenance requirements have been masked by fill extraction for levee construction.

Significant Environmental Resources

Environmental resources considered to be significant in the MR-GO study area include coastal marshes, cultural resources, and recreational resources. Table 2 presents the basis for significance.

TABLE 2

ENVIRONMENTAL RESOURCE SIGNIFICANCE

INDICATOR	RESOURCES		
	Coastal Marshes	Cultural Resources	Recreation Resources
Ecological Attributes	Provide habitat for different life stages of numerous species. Decomposing portion provides substrate for living portion.	---	---
Cultural Attributes	Supports traditional extractive economy of coastal Louisiana.	Contains record of man's adaptation and use in the area.	Hunting and fishing skills are traditional among families and are taught by parents to children.
Esthetic Attributes	Typical coastal Louisiana landscape.	Some resources have high esthetic values.	Some activities include observations of high esthetic values.
Institutional Recognition	E.O. 11990 (Wetland Protection), CZMA, FWCA, Clean Water Act, NEPA.	Arch. Res. Prot. Act., Historic Sites Act of 1935, Nat. Hist. Preserv. Act, E.O. 11593, NEPA.	Fed. Water Project Recreation Act, Land and Water Conser. Fund Act of 1965.

TABLE 2 (Cont'd)

ENVIRONMENTAL RESOURCE SIGNIFICANCE

INDICATOR	RESOURCES		
	Coastal Marshes	Cultural Resources	Recreation Resources
Technical Recognition	Marsh is important for production of estuarine dependent finfish and shellfish of sport and commercial importance. Marshes act as a sediment trap, dissipate wave energy, and dissipate tidal energy.	---	---
Public Recognition	Large segments of the public recognize value of production of coastal marshes to the economy of the region.	Public supports preservation of historical artifacts and, thus, record of our culture.	Public commonly competes for access to recreation sites.

Biological Resources

The study area is characterized by the outlet channel, the adjacent marshes including open water ponds, and dredged material disposal areas. Marshes of the majority of the area are generally saline. Brackish marshes are generally some distance from the MR-GO. Dominant species of more saline marshes include oystergrass (Spartina anterniflora) and wiregrass (S. patens) with blackrush (Juncus roemerianus), saltgrass (Distichlis spicata), and saltwort (Batis maritima) as subdominants. The single dominant species of the brackish marshes is wiregrass. Common species of this marsh also include saltgrass, oystergrass, blackrush, and three-cornered grass (Scirpus olneyi). Vegetation of the extensive confined dredged material disposal areas generally consists of brackish marsh species. However, once these areas have been initially drained, rainwater elutriation and accumulation tend to result in lowered salinities and the establishment of plants associated with reduced salinities.

Wildlife species of these marshes reflect the change of vegetation attributable to the changed salinity levels. Historically, area fur animal populations reached very high levels and the adjacent Delecroix Island area of St. Bernard and Plaquemines Parishes was one of the leading fur producing areas of the world. The muskrat was the primary reason for this position. Muskrats reach highest populations in brackish marshes where three-cornered grass often produces extensive stands. Presently, muskrat populations in the marshes adjacent to the MR-GO are low. Nutria populations tend to be much higher in fresh marshes and are low in the brackish and saline marshes of the MR-GO area. Mink populations are greater in areas where brush piles or other forms of cover are abundant. The dredged material disposal areas along the MR-GO provide this habitat, along with numerous potential den sites.

Gadwalls, blue-winged teal, green-winged teal, and lesser scaup are the most important ducks in the area from a harvest standpoint. The mottled duck is the only duck commonly nesting in the area. No wading bird nesting colonies are known to exist in the MR-GO area; however, birds such as ibises, herons, egrets, shorebirds, rails, bitterns, and skimmers are common inhabitants of these marshes.

Several endangered species may occasionally visit the study area but none use the area as primary habitat. The brown pelican, hawksbill turtle, Kemp's (Atlantic) ridley turtle, and the leatherback turtle are endangered species that may occasionally frequent the study area. The Arctic peregrine falcon, the green turtle, and the loggerhead turtle are threatened species that may occasionally occur in the study area. The American alligator, listed as a threatened species under the Similarity of Appearance clause of the Endangered Species Act, is commonly found in the less saline habitats of the study area.

Commercially important finfish and shellfish in the waters of the area include brown shrimp, white shrimp, blue crab, oysters, menhaden, red drum (redfish), spotted seatrout (speckled trout) and croaker. The marshes provided by the coastal area are essential to the juvenile stages of several of these species. Rapid growth is experienced by juveniles during warm spring and summer months. The marshes are critical to the successful completion of the life cycle of these species. Additionally, the detritus provided by these marshes form the basis of the food chain for each of the species.

Cultural Resources

In the past, various marsh types and cypress swamps were present in the vicinity of the project. The subtropical climate of the study area is believed to have been in the past, for the most part , as it is today.

At present there are 30 known cultural resource locations along and near the MR-GO. These range in age from at least Poverty Point (1000 B.C.) to Historic 19th Century. Sites range in type from shell middens to Historic fortifications. One of these sites, Ft. Proctor, is listed on the National Register of Historic Places.

A boat and pedestrian survey of the MR-GO channel, dredged material disposal access canal and disposal area retaining dikes was conducted in September and October 1978 (Wiseman, et. al., 1979). Five new sites and five isolated finds were located by the survey. Three of the located sites were considered eligible for the National Register of Historic Places. In addition to the field survey, an extensive background literature search and review of previous archeological work in the study area was conducted. Visits were made to many of the sixteen known sites located within one mile of the MR-GO.

Due to the efforts of previous researchers in the coastal region over the last 40 years, there was little expectation that new intact midden sites would be located. This assumption was largely born out by the survey findings. Sites tended to cluster around major bayous and relict channels.

Analysis of eastern Delta (St. Bernard) paleogeography suggests that most of the record of settlement in the area has probably been lost due to subsidence and alluviation. Sites along the MR-GO cannot be considered in a vacuum, but rather must be seen in the light of the natural environmental and settlement systems of the times. The early establishment and continued importance of Shell Beach Bayou, Bayou Dupre, Shell Beach, and Doullut's Canal appear to have been due to their positions on main routes of travel between Lake Borgne and points west. This area remained favorably located with respect to several biotic zones for many centuries. The southeastern end of what is now the MR-GO became an important area for settlement from Coles Creek time onward.

The area is especially rich in archaeological resources. William McIntire, who cored throughout the eastern delta as part of his research relating sites to delta development, discovered evidence of scores of sites having no surface expression. It should be recognized that any dredging activity beyond the current limits of the MR-GO channel has a high probability of uncovering buried cultural resources.

The known distributions of sites in the vicinity of the MR-GO suggests that certain sections are high probability areas for site occurrence. These are the Bayou La Loutre natural levees, Bayou Yscloskey, a probable distributary between Violet and Proctor Point, the junction of the Gulf Intracoastal Waterway (GIWW) and the MR-GO, and Bayou Pointe-en-Pointe to Grace point.

Recreation Resources

The value of the MR-GO area for recreational resources is as high as the majority of coastal marshes. Numerous commercial boat launching areas are located in the Yscloskey and Shell Beach vicinity that allow sportsmen access into the MR-GO and adjacent marsh areas. Consumptive recreational activities taking place in the study area include fishing, small game hunting, large game hunting, and waterfowl hunting, sport shrimping and sport crabbing. Non-consumptive activities include boating, observation of nature and wildlife, and a minimal amount of water skiing.

The nearby state-operated Biloxi Wildlife Management Area (WMA) is located north of the study area between Lake Borgne and Chandeleur Sound. Numerous bayous, sloughs and potholes make this WMA an excellent producer of fish, shrimp, and crabs, and good habitat for waterfowl. Besides hunting and fishing, other forms of recreation available include boating, crabbing, shrimping, skiing, and camping.

FUTURE CONDITIONS

The most probable future conditions if no Federal action is taken are estimated by projecting conditions that will prevail in the study area over the planning horizon, 1990 through 2040. The composite of these scenarios serves as the base condition to which all action plans were compared to assess the effects of each plan.

Water Resources

Water Quality

Future improvements in the treatment of wastewater before discharge to receiving waters are expected to more than compensate for anticipated increases in wastewater discharge rates. Consequently, future improvements to general water quality in the MR-GO are expected.

Land Resources

Based on recent trends, the study area will continue to experience drastic losses due to erosion. The MR-GO east bank along Lake Borgne is dangerously close to being breached. Once the bank is breached, sediment from Lake Borgne will flow into the channel resulting in large increases in dredging costs to maintain the channel. These increases will amount to about six times what they are today.

As the marsh within the project area diminishes, significant losses to marsh dependent fish and wildlife species will also occur. Increases in water levels, resulting from the general rise in sea level and subsidence of the land will enlarge land/water interface, and accelerate saltwater intrusion.

Economy And Human Resources

The Port of New Orleans has been a dominant factor in the economy of the New Orleans area and that of the state as a whole. The Port has added millions of dollars annually to the state's treasury and provided thousands of jobs through the many services needed to carry on domestic and foreign trade. Economic growth and employment within the study area is expected to continue in domestic and foreign trade activities. Fish and wildlife harvests and recreational activities are expected to decline as a result of habitat losses. Without the buffering effect of the marsh, developed areas adjacent to the study area would be more susceptible to flooding. The increased flood hazards would restrict growth in the affected area.

Future MR-GO Channel Maintenance

Maintenance dredging quantities are not expected to increase substantially until a major portion of the buffering marsh between the MR-GO and Lake Borgne is lost. However, no erosion protection measures exist along the MR-GO north bank; consequently, erosion there is significant. Conversion of the majority of the marsh on the north bank of the MR-GO to open water is anticipated during the 1990 to 2040 period. The projected location of the MR-GO north bank by the year 2040 is shown on Plate 2.

Three reaches (mile 51 to mile 56, mile 38 to mile 45, and mile 23 to mile 30) of the north bank have been identified as having critical erosion trends. If erosion continues in these reaches without corrective action, loss of the buffering marsh will allow the open water areas of Lake Borgne and Breton Sound and the MR-GO to merge. Once the buffering marshes are lost, dredging frequency and quantities in the vicinity of the breached bank area will increase significantly. The navigation channel will be exposed to storms, currents, and less attenuated tidal action from the north and northeast. Attendant sedimentation and shoaling problems would be expected to occur. The bank erosion problem will become a major channel maintenance problem.

A similar situation currently exists in the Breton Sound reach between mile 15 and mile 20. This reach of the channel is exposed on the north and northeast and has an existing jetty on the south side only. Maintenance dredging records for this reach show a current average shoaling rate of 350,000 cu yd/mi/yr. Reaches where no jetties exist have shoaling rates that are considerably higher and average approximately 500,000 cu yd/mi/yr.

Analyses of past shoaling rates suggest that future maintenance dredging quantities between mile 23 and mile 60 could be almost six times the current annual average quantity reflected in maintenance dredging records. Projected maintenance dredging requirements are shown on Plate 3. As is indicated on Plate 3, the current average annual maintenance dredging requirement is about 1.4 million cubic yards per year (point A on the graph of Plate 3). However, with the loss of the marsh buffer between the MR-GO and the open waters of Lake Borgne and Breton Sound the average annual maintenance requirement is expected it increase dramatically. Maintenance requirements are expected to reach about 4.0 million cubic yards per year by 1997 (point B on the graph). By the year 2002 an ultimate average annual rate of about 7.9 million cubic yards per year is expected (point C on the graph).

Biological Resources

MR-GO bank erosion, if left unchecked, will result in the loss of approximately 5,600 acres of coastal marsh between 1990 and the year 2040. This will represent a significant loss of habitat to those species utilizing these marshes. Marsh creatures will move to adjacent areas as banks erode, but carrying capacities and territoriality will most likely result in population reductions for most species affected. The reduction of marsh acreage will also cause a reduction, through habitat loss and reduced detrital input, in productivity of the overall area for both finfish and shellfish. The breaches through the marsh between Lake Borgne and the MR-GO and the greater amplitude of Breton Sound influences in the Lake Borgne area will result in more rapid change of the adjacent marshes from a brackish to a saline vegetation type. Correspondingly, creatures utilizing the predominant vegetation of these brackish marshes will be deprived of their natural food sources as these changes occur. Therefore, the change in marsh fauna will be accelerated also.

Cultural Resources

Cultural resources will continue to subside, degrade, and probably be further altered by wave wash produced by vessel movements.

Recreation Resources

Conversion of wetlands to open water will continue. The loss of ecologically important wetland habitat translates into a less productive habitat area for those species sought after by sportsmen. Losses due to increased salinities would result in a loss in the preferred habitat of the area and, in turn, a loss in the man-day usage by sportsmen hunting and fishing the area.

PROBLEMS, NEEDS, AND OPPORTUNITIES

Since its completion in 1968, the top width of the 41 mile long land cut has increased from 650 feet to an average of 1,500 feet, in 1987, due to erosion. Much of the bank erosion is caused by wave-wash and drawdown from large displacement vessel traffic. The MR-GO channel was designed for a relatively small general cargo vessel (freighter). However, ship sizes have increased and larger container vessels move over the MR-GO to and from several container facilities located in New Orleans. The wave-wash and drawdown caused by these large vessels moving over the restrictive channel have eroded its banks beyond the limits of the channel rights-of-way in some areas. Passage of these vessels causes very large quantities of water to be displaced from the channel into the adjacent marsh, followed by rapid return flow into the channel. The tremendous forces exerted by these rapid and extreme water level fluctuations cause the relatively soft marsh adjacent to the channel to break up and be swept into the waterway.

The MR-GO was constructed in recognition of the need for a shorter and safer outlet from the Mississippi River to the Gulf of Mexico and for the potential benefit of national defense. Maintenance of the outlet channel is required to assure that these needs of the shipping industry and the national defense continue to be satisfied. Unabated bank erosion will substantially increase channel maintenance requirements. Controlling bank erosion will provide an opportunity to minimize channel maintenance requirements and allow the channel's purpose and function to remain unimpaired.

The most easily quantified biological resource problem resulting from bank erosion is the continuing loss of highly productive habitat. The diminution of fish and wildlife resources is a less easily quantifiable, but equally important, consequence of unabated bank erosion. Such losses, in an area where many depend on these resources for their livelihood, suggest a problem requiring urgent attention. Erosion of the channel banks has caused an average loss of 211 acres of marsh per year during the 20 year period between 1968 and 1987. Most of the lost acreage is in the marsh/estuarine area along the northeast bank. Undeniably, overall fish and wildlife productivity and recreational hunting in the study area have been diminished by the loss of this approximate 4,220 acres of marsh.

Saltwater intrusion also contributes significantly to marsh loss in the study area. Subsidence and lack of sediment deposition affect marsh loss to a lesser degree. Erosion and disintegration of the banks of the MR-GO has created many additional routes for saltwater to intrude into formerly less saline interior marshes. Consequently, salinity in the marshes has increased significantly in the last 20 years. High salinity levels of recent years have reduced the amount of three-cornered grass and, thus, muskrat populations in the marshes adjacent to the MR-GO. Other wildlife species that prefer less saline conditions have declined as well. Winter waterfowl populations within the marshes have also declined because of increased salinities. The less saline vegetation which is most attractive to waterfowl has been greatly reduced by saltwater intrusion. Thus, the recreational value of the overall area for waterfowl hunting has diminished.

Minimizing bank erosion and marsh loss affords an opportunity to avoid the potential disturbance and loss of known and yet unidentified sites of historic significance. Much of the immediate study area is considered to have high probability for cultural resource site occurrence. The exposure of significant sites by bank erosion allows wave battering and the elements to exact a potentially heavy toll in terms of irretrievable cultural resource losses. The desirability of preventing such losses is apparent.

The loss of recreation opportunities is not easily quantified, but is nonetheless an important and apparent consequence of unabated bank erosion. Minimizing bank erosion and marsh loss affords an opportunity to limit the loss of recreational opportunities. Controlling bank erosion and marsh loss will benefit recreationalists utilizing the marshes adjacent to the MR-GO and those that derive their livelihood from servicing recreation activities in the study area.

It is apparent that the identified current and potential future channel maintenance, biological, cultural, and recreation resources problems all follow from the ongoing bank erosion occurring along the MR-GO. Opportunities available for solution of the bank erosion problem will, to varying degrees, provide redress of other erosion-related problems experienced in the study area.

PLAN FORMULATION

Plan formulation is the process of conceiving and developing specific plan features to satisfy specific objectives. Combinations of measures are then integrated to form comprehensive alternative plans. Alternative plans consist of systems of structural and/or non-structural measures, strategies, or programs. These strategies are selected to alleviate specific problems or take advantage of specific opportunities associated with water and related land resources in the study area.

Alternative plans that address bank erosion abatement and other erosion-related problems were developed, in recognition of the planning objectives, using appropriate analytical techniques.

PLANNING CONSTRAINTS

Legislative and executive authorities specify the range of impacts to be assessed and planning constraints and criteria that must be applied when evaluating alternative plans. Tangible and intangible benefits and costs, as well as effects on the ecological, social, and economic well-being of the region, are considered in developing plans. Federal participation in a solution to an identified water resources problem requires that a plan be economically feasible in terms of current prices. Additionally, plans must be complete, efficient, safe, environmentally acceptable, and consistent with local, regional, and state plans.

PLANNING OBJECTIVES

Planning objectives are the national, state, and local water and related land resource management goals to redress needs specific to a study area. These specific needs may be addressed under a given study authority. The following objectives have been developed based on the identified problems, needs, and opportunities, and the expressed concerns of public, state, and local interests:

[] Control bank erosion to minimize channel maintenance requirements, and

[] Reduce the rate of loss of valuable coastal wetlands adjacent to the MR-GO channel.

MANAGEMENT MEASURES

Both structural and non-structural measures are available to arrest bank erosion on the MR-GO.

Structural measures include enlarging the MR-GO channel to minimize effects of wave activity, constructing temporary earthen retention dikes and depositing maintenance dredged material on the unprotected channel banks, and constructing a bank protection structure along selected reaches or the entire inland length of the waterway. Although widening and deepening the MR-GO would make it a less restrictive channel and thus reduce bank erosion, this measure was not evaluated in this study. Additionally, the concept of disposal of maintenance dredged material on the unprotected channel banks is only qualitatively assessed in the present study.

Non-structural measures include restricting vessel size and/or transit speed in the MR-GO. The authority to implement and enforce such restrictions is vested with the U.S. Coast Guard.[1]

PRESENTATION AND ECONOMIC EVALUATION OF ALTERNATIVE PLANS

No Action

The unleveed banks of the MR-GO will continue to erode in the absence of remedial action. Currently, banks of the unleveed reaches are retreating at rates varying from five to over 40 feet per year. The average rate of retreat of the north bank in the 41-mile land cut portion of the waterway is about 15 feet per year.

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[1] A group of land owners, and others, filed a petition with the U.S. Coast Guard in October 1987 requesting that some restrictions be imposed on the waterway. The petition requested that safety zone regulations be imposed on that portion of the MR-GO in St. Bernard Parish. Action on the petition was pending at the date of this report. A copy of the petition is shown in Appendix B.

Failure to reduce bank erosion will result in a significant increase in the required maintenance dredging of the waterway in the future. Annual average maintenance dredging requirements are projected to increase sixfold within the next 15 years (by the year 2002). The dredged material disposal area located on the MR-GO south bank between mile 23 and mile 27 could be exhausted by the year 2017. An estimated 970 additional acres of disposal area would be required on the MR-GO north bank. The preliminary assessment of this additional maintenance dredged material disposal area requirement is shown on Plate 4.

Structural Bank Protection

North Bank Disposal Area Options

These options would involve purchasing a suitable quantity of marsh area adjacent to the north bank of the MR-GO for disposal of material from channel maintenance. The options are structural only in the sense that construction of temporary earthen dikes would be required to contain dredged material deposited in the dedicated disposal areas. Possible plans include purchasing and dedicating marsh acreage at specific locations or along the entire inland portion of the waterway.

Local experience has shown that, ideally, dredged material disposal areas should be a minimum of 2,000 feet wide perpendicular to the channel. This minimum width has proven to be near optimal for the existing south bank disposal area. Smaller, more restrictive disposal areas increase disposal costs, impair liquid-solids separation, and make control of the quality of effluent returned to adjacent waterways more difficult.

New Disposal Areas Option 1--MR-GO Critical Reaches--Three reaches of the inland portion of the waterway have been identified as having critical erosion trends. Two of these three reaches correspond to portions of the waterway that have been dredged most frequently for maintenance purposes. The third critical reach is in a portion of the waterway where extensive dredging has been performed to obtain construction fill for the

Lake Pontchartrain and Vicinity Hurricane Protection levees. Marsh acreage would be purchased and dedicated as dredged material disposal areas at these three locations: mile 51 to mile 56, mile 38 to mile 45, and mile 23 to mile 30. Two of the dredged material disposal areas would be roughly 7 miles long by 2,000 feet wide perpendicular to the channel, and the other about 5 miles long by 2,000 feet wide. These critical reaches correspond to those proposed for structural bank protection in Structural Option 1 discussed in a subsequent section.

New Disposal Areas Option 2--MR-GO North Bank mile 60 to mile 23--For this option marsh acreage would be purchased for a dedicated dredged material disposal area approximately 37 miles long by 2,000 feet wide. The area would extend along the entire north bank of the inland portion of the waterway similar to the disposal area presently located on the south bank. The portion of the waterway that would be affected by this option is the same as that proposed for structural bank protection in Structural Option 2 discussed in a subsequent section.

Costs associated with these options would include the following:

[] disposal easement acquisitions

[] constructing temporary earthen retention dikes, and

[] possibly, mitigation costs for oyster lease damage.

Benefits associated with these options are difficult to assess but could include the following:

[] avoiding substantially increased future maintenance dredging quantities, and

[] reducing, to some extent, marsh loss with attendant recreation, fish and wildlife, and cultural resources preservation benefits.

The major difficulty with the potential effectiveness of these options, in terms of reducing marsh loss, is the lack of an annual maintenance dredging requirement in the inland reaches of the MR-GO. On average, only one reach of the waterway is dredged for maintenance purposes every two years. No single or any combination of reaches require maintenance dredging annually. Actual intervals between maintenance dredging of the same reach are highly variable. Even the most frequently maintenance dredged reaches of the waterway have only been dredged four times between 1970 and the present, or on average, about once every four or more years.

The situation is paradoxical in that in order to have enough material from channel maintenance to create a relatively stable disposal area on the north bank of the MR-GO, the north bank would have to be allowed to erode away. The south bank disposal area owes most of its stability to the vast quantities of material deposited there from the initial excavation of the navigation channel. If the restrictive waterway were made deeper and wider, large quantities of material would be available for use in stabilizing the channel north bank.

Even though disposal areas could be purchased and dedicated on the north bank, the unprotected banks of these areas would continue to retreat at the present or an accelerated rate until material from channel maintenance was available for disposal. After the disposal operations were completed the unconsolidated disposal material would erode at some rate substantially higher than the present average (about 15 feet per year) until the next dredging cycle. Required dredging frequency would increase. At best, the scenario envisaged would consist of a continuing cycle of dredging-disposal-redredging and redisposal of essentially the same material. Even if the obvious inefficiency of this scenario were ignored, it is unlikely that dredged material deposition could outpace, or keep pace with, retreat of channel banks that have not yet been subject to erosion.

An alternative to reliance on material from channel maintenance would be to dredge as much material as deemed necessary to produce relatively stable continuous disposal areas at the critical locations or along the entire waterway. This concept was evaluated and determined to be prohibitively expensive.

Bank Protection Structure Options

Plans for structural bank erosion abatement were developed for three lengths of application along the MR-GO: the "critical reaches" of the north bank, the entire north bank from mile 60 (its intersection with the GIWW) to mile 23 (the jetties at Breton Sound), and the unleveed north bank from mile 60 to mile 23 and south bank from mile 47 to mile 23.

Structural Option 1--MR-GO North Bank Critical Reaches--Three reaches along the north bank have been designated "critical" based on the potential for eminent loss of the buffering marsh between the MR-GO and Lake Borgne. These reaches total about 19 miles and extend from mile 51 to mile 56 (5 miles), mile 38 to mile 45 (7 miles), and mile 23 to mile 30 (7 miles). Mile 38 to mile 45, and mile 23 to mile 30 are the reaches of the inland portion of the waterway that have been most frequently dredged for channel maintenance. The "critical reaches" are indicated on Plate 5.

Structural Option 2--MR-GO North Bank mile 60 to mile 23--The entire north bank (including the reaches in Option 1 above) was considered for application of structural bank protection measures. Structural bank protection would be provided for a distance of roughly 37 miles as indicated on Plate 6. The bank protection structure would parallel the current bank as much as possible. Major streams and bayous would remain open; however, many small waterways which enter the marsh areas on the north bank of the MR-GO would be closed.

Structural Option 3--All Unleveed Reaches of the MR-GO--All unleveed reaches of the MR-GO: the north bank from mile 60 to mile 23 (Option 2 above) and the south bank from mile 47 to mile 23, were evaluated for application of structural bank protection (Plate 7). The unleveed MR-GO south bank, from mile 47 to mile 23 fronts a dredged material disposal area which parallels the channel and is approximately 2000 feet deep (roughly 6,000 total acres). Bank erosion in this reach appears to be less severe than that occurring on the north bank of the channel. However, the apparent smaller rate of bank retreat compared to the north bank results from the periodic placement of dredged material in the south bank disposal area.

Four erosion abatement structure designs were developed as described in Table 3 and shown on Plates 8 through 11. For each of the three options described above, any one of the four conceptual structure designs could be applied. Consequently, a total of 12 structural alternatives were developed for initial evaluation.

TABLE 3

Design Designation	Description and Preliminary Cost Estimate*
1	Concrete block/rock armor-high profile ($226/lf; $1.20 million/mile)
2	Concrete block/rock armor-low profile ($213/lf; $1.12 million/mile)
3	Single row timber piles/geotextile wall with rock aprons ($146/lf; $0.77 million/mile)
4	Stone-armored shell-core dike ($164/lf; $0.86 million/mile)

*Cost of structural components only.
lf=linear foot

Bank nourishment, i.e., placing earth fill behind the erosion control structure, was initially included as a component of the bank protection structure designs. The structure designs were subsequently modified to exclude bank nourishment as a component of initial construction. However, provision for bank nourishment using dredged material from periodic channel maintenance was retained. Cost estimates include provision to increase the current right-of-way by an additional 500 feet for construction of a bank protection structure and for placement of bank nourishment (real estate cost estimates are shown in Appendix C). Including 200 feet of bank nourishment as a component of the initial structure construction would increase the various structure costs by from about 34 to 52 percent. The same objective will be accomplished at less cost by the productive use of material from periodic channel maintenance. The increased cost of using this material to provide bank nourishment is accounted for as a reduction in the savings in future maintenance dredging costs over the life of the project.

The eventual strip deposition of material from maintenance dredging to an elevation approximating 2.0-feet NGVD is an integral part of each structure design. The typical marsh elevation at Shell Beach (near mile 40) is about 1.5-feet NGVD. Placement of dredged material to about 0.5-feet above this typical marsh elevation would allow for settlement. It should be emphasized that currently there is no annual dredging requirement for the entire waterway. On average, only one or two reaches of the waterway are dredged each year. Consequently, bank nourishment would be accomplished as opportunities to do so occur.

Costs associated with the structural bank protection plans include the following:

[] the cost of the structure components and construction

[] structure maintenance and replacement

[] real estate costs associated with additional rights-of-way, and

[] the incremental cost to deposit material from maintenance dredging behind the bank protection structure in lieu of in the existing disposal area.

Benefits of the structural bank protection plans include the following:

[] avoiding significantly increased maintenance dredging over the 50 year planning horizon

[] reducing marsh loss with attendant recreation, fish and wildlife, and cultural resource preservation benefits, and

[] avoiding additional future disposal area purchases

Potential average annual maintenance dredging quantities are shown on Table 4 for each of the plans evaluated. These data provide a measure of the average annual quantities of material expected to be available for use as bank nourishment. It should be noted that a cubic yard of dredged material is not equivalent to a cubic yard of bank nourishment. Typically, pumping three to five cubic yards of dredged material might be required to obtain one cubic yard of relatively well drained material for bank nourishment. The data of Table 4 are shown graphically on Plates 12 through 15. These plates show idealized representations of potential maintenance dredging savings over the 50-year planning horizon. Estimated marsh acreage savings are indicate on Table 5.

How does this compare with 40'

Costs include the following: structural components, flotation access, mobilization/demobilization, 25 percent contingency, 6 percent engineering and design (E&D), 8 percent supervision and administration (S&A), and real estate. Average annual structure maintenance costs are estimated as 2.8 percent of initial construction costs.

TABLE 4

ESTIMATED AVERAGE ANNUAL MAINTENANCE DREDGING QUANTITIES

					(--------	Future With 2/	----------)	
Reach mile no.	Distance miles	Remarks	Present Without Bank Protection (cu yd/yr)	Future 1/ Without Bank Protection (cu yd/yr)	Critical Reaches Protected (cu yd/yr)	North Bank Protected (cu yd/yr)	North and South Bank Protected (cu yd/yr)	10 MPH 3/ Speed Limit Imposed (cu yd/yr)
56 to 60	4		0	520,000	100,000	0	0	0
51 to 56	5	critical reach no. 1	45,000	1,750,000	50,000	50,000	50,000	100,000
45 to 51	6		24,000	780,000	150,000	60,000	60,000	120,000
38 to 45	7	critical reach no. 2	357,000	2,450,000	70,000	175,000	70,000	140,000
30 to 38	8		416,000	1,040,000	320,000	200,000	80,000	160,000
27 to 30	3	critical reach no. 3	93,000	390,000	75,000	75,000	30,000	60,000
23 to 27	4	critical reach no. 3	484,000	1,000,000	100,000	100,000	40,000	400,000
Totals	37		1,419,000	7,930,000	865,000	660,000	330,000	980,000

1/ Maintenance dredging quantities will approach 50 percent of the estimates shown in 10 years (1997) and 100 percent in 15 years (2002) if no speed limitation is imposed for large vessel traffic.

Maintenance dredging quantities will approach 50 percent of the estimates shown in 15 years (2002) and 100 percent in 20 years (2007) if a 10 mph speed limit is imposed and enforced.

2/ These rates are assumed to be achieved at the end of the construction period and maintained through the year 2040.

3/ These are initial rates that are assumed to increase to "future-without-bank-protection" rates as indicated in the first note above.

TABLE 5

POTENTIAL MARSH ACREAGE SAVINGS FOR ALTERNATIVE PLANS

Period	Extent of Structural Bank Protection						SPEED LIMIT OPTION	
	OPTION 1 Critical Reaches Only		OPTION 2 North Bank Only		OPTION 3 North Bank and South Bank			
	Per Period	Cumulative	Per Period	Cumulative	Per Period	Cumulative	Per Period	Cumulative
1990								
	345	345	673	673	1,109	1,109	277	277
2000								
	345	690	673	1,346	1,109	2,218	277	555
2010								
	345	1,035	673	2,019	1,109	3,327	277	832
2020								
	345	1,380	673	2,692	1,109	4,436	277	1,109
2030								
	345	1,725	673	3,365	1,109	5,545	277	1,386
2040								

The value of savings in channel maintenance dredging is estimated as $0.50 per cubic yard. This component accounts for 85 to 94 percent of the total estimated monetary benefits for the various alternatives. Marsh savings are valued at $3,500 per acre. This number represents the estimated composite of the real estate, commerical fish and wildlife, and storm surge reduction values of a typical acre of marsh. Marsh acres potentially saved by project implementation range from 27.7 acres per year to 110.9 acres per year for the various scenarios evaluated. The monetary benefit attributable to avoiding future dredged material disposal area purchases is taken as the real estate value of the acreage required.

Estimates of average annual costs and benefits are based on an 8-5/8 percent interest rate amortized over the 50-year life of the project. The base year for comparing all plans is 1990. Costs were compounded or discounted, as appropriate, and all benefits were discounted to this base year for comparison.

Benefit-to-cost (B/C) ratios greater than unity were produced for Structural Option 1, i.e., protecting the MR-GO north bank critical reaches. For this structural option, B/C ratios greater than unity were obtained for two conceptual designs for erosion abatement structures: design designations 3 and 4. Estimated costs, benefits, and B/C ratios for Structural Option 1 using these two coneptual designs are shown on Table 6.

Benefit-to-cost ratios greater than 0.6 were obtained for Structural Option 2, i.e., protecting the entire MR-GO north bank (mile 60 to mile 23), using these same two conceptual structure designs.

<u>Imposition of Speed Limitation</u>

One non-structural alternative was evaluated to determine its erosion abatement potential. This alternative involves imposing a 10 mile per

TABLE 6

SUMMARY OF AVERAGE ANNUAL COSTS, BENEFITS, AND B/C RATIOS
($1,000s)

Structural Option 1	Design Designation 3	4
Costs		
Interest on Initial Cost	$1,911	$2,122
Amortization	31	34
Average Annual Maintenance Costs	57	63
Total Average Annual Costs	$1,999	$2,219
Benefits		
Maintenance Dredging Savings	$2,105	$2,105
Marsh Loss Reduction Savings	121	121
Avoiding Future Disposal Area Purchases	2	2
Total Average Annual Benefits	$2,228	$2,228
Benefit-Cost Ratio	1.11	1.00

hour speed limit for large displacement vessel traffic within the 37 miles between mile 60 and mile 23. Currently, vessel transit speeds average about 14 miles per hour in this reach of the channel. A 10 mile per hour speed limit would diminish the wave-wash and drawdown effects produced by large displacement vessels that cause erosion of the unprotected channel banks.

Costs associated with this plan include: increased vessel operating cost due to a reduction in average transit speed, and speed limit enforcement costs. However, only vessel operating cost were considered in the evaluation of this plan.

Benefits of the speed limitation include the following:

[] increased safety for small commercial and recreational craft

[] reduced wave activity, and thus, a reduction in the rate of bank erosion and rate of marsh loss

[] savings in average annual maintenance dredging for at least a portion of the planning horizon-1990 to 2040, and

[] avoiding additional future disposal area purchases.

Shippers would face higher operating costs if forced to observe a speed limit of 10 statute miles per hour along the 37 mile portion of the waterway under study. For the without-project (i.e., no speed limit) condition, transit time for vessels averaging 14 statute miles per hour is 2.642 hours. Under with-project conditions (i.e., with a 10 mph speed limit), the transit time would be increased to 3.70 hours, a difference of 1.058 hours. Since hourly operating costs for vessels vary according to size, type, and flag of registration, the speed limit would impose unequal costs to individual vessels of the fleet. Estimated incremental costs are based on the array of operating costs for 1985 and the number of deep draft vessel trips through the MR-GO in the same year. Based on these data, the total incremental annual costs to shippers, should a 10 mile per hour speed limit be imposed, would be $1,973,000. Assuming no change in either the number of vessel trips or the fleet distribution during the project life, the $1,973,000 figure serves as the average annual cost attributable to a compulsory reduction in speed along the channel.

Estimated average annual saving from consequent reduced maintenance dredging requirements is $651,000. Marsh losses would be reduced by an estimated 25 percent during the 50-year period 1990 to 2040 with this plan. Estimated benefits from reduced marsh losses would amount to approximately $97,000 annually and avoiding the purchase of an additional small disposal area in the year 2017, about $2,000 annually.

The estimated B/C ratio for this plan (with enforcement cost not quantified) is <0.38.

Comparative Summary of Economic Data

Maintenance dredging requirements and costs for critical years, annual average dredging costs, and savings in annual average maintenance dredging costs for the three structural and one non-structural options are summarized in Table 7. These four options are designated as scenarios 1 through 4.

Average annual marsh acres saved and corresponding monetary values are summarized in Table 8. Savings associated with avoiding future dredged material disposal area purchases are summarized in Table 9. A summary of average annual benefits is shown in Table 10. First costs, present values, and average annual costs for the four scenarios and for the four conceptual structure designs are displayed Table 11. Average annual benefits and costs, and benefit-costs ratios for the four scenarios and the four conceptual structure designs are summarized in Table 12.

TABLE 7

AVERAGE ANNUAL MAINTENANCE DREDGING QUANTITIES, COSTS AND SAVINGS
(CUBIC YARDS AND DOLLARS) *
(OCTOBER 1987 PRICE LEVELS, 8-5/8% INTEREST RATE, BASE YEAR-1990)

YEAR	WITHOUT PROJECT	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
ANNUAL MAINTENANCE DREDGING QUANTITIES AND COSTS					
1990					
(CY)	2,182,800	2,182,800	2,182,800	2,182,800	980,000
($)	1,091,400	1,266,000	1,266,000	1,266,000	490,000
1993					
(CY)	2,946,600	865,000	1,530,000	1,677,000	1,726,000
($)	1,473,300	501,700	887,400	972,660	863,000
1997					
(CY)	3,965,000	865,000	660,000	1,004,000	2,721,000
($)	1,982,500	501,700	382,800	582,320	1,360,500
2001					
(CY)	7,137,000	865,000	660,000	330,000	3,716,000
($)	3,568,500	501,700	382,800	191,400	1,858,000
2002					
(CY)	7,930,000	865,000	660,000	330,000	3,965,000
($)	3,965,000	501,700	382,800	191,400	1,982,500
2007					
(CY)	7,930,000	865,000	660,000	330,000	7,930,000
($)	3,965,000	501,700	382,800	191,400	3,965,000
2040					
(CY)	7,930,000	865,000	660,000	330,000	7,930,000
($)	3,965,000	501,700	382,800	191,400	3,965,000
AVERAGE ANNUAL MAINTENANCE DREDGING COSTS					
($)	2,724,000	619,000	627,000	596,000	2,073,000
SAVINGS IN AVERAGE ANNUAL MAINTENANCE DREDGING COSTS					
($)		2,105,000	2,097,000	2,128,000	651,000

* \$0.50 per cubic yard for "Without Project" scenario and Scenario 4, and \$0.58 per cubic yard for Scenarios 1, 2, and 3.

TABLE 8

AVERAGE ANNUAL QUANTITY AND VALUE OF MARSH SAVINGS
(OCTOBER 1987 PRICE LEVELS, 8-5/8% INTEREST RATE, BASE YEAR-1990)

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
ACRES SAVED PER YEAR				
	34.5	67.3	110.9	27.7
VALUE PER ACRE				
($)	3,500	3,500	3,500	3,500
AVERAGE ANNUAL VALUE				
($)	121,000	236,000	388,000	97,000

TABLE 9

AVERAGE ANNUAL SAVINGS FROM AVOIDING
FUTURE DISPOSAL AREA PURCHASES
(OCTOBER 1987 PRICE LEVELS, 8-5/8% INTEREST RATE, BASE YEAR-1990)

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
AMOUNT				
($)	257,000	257,000	257,000	257,000
PRESENT VALUE IN YEAR 2017				
($)	27,000	27,000	27,000	27,000
AVERAGE ANNUAL VALUE				
($)	2,000	2,000	2,000	2,000

TABLE 10

SUMMARY OF AVERAGE ANNUAL BENEFITS BY CATEGORY
(OCTOBER 1987 PRICE LEVELS, 8-5/8% INTEREST RATE, BASE YEAR-1990)

SAVINGS IN AVERAGE ANNUAL MAINTENANCE DREDGING COSTS

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
($)	2,105,000	2,097,000	2,128,000	651,000

VALUE OF AVERAGE ANNUAL MARSH ACRES SAVED

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
($)	121,000	236,000	388,000	97,000

AVERAGE ANNUAL SAVINGS RESULTING FROM AVOIDANCE OF ADDITIONAL FUTURE DISPOSAL AREA PURCHASES

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
($)	2,000	2,000	2,000	2,000

TOTAL AVERAGE ANNUAL BENEFITS

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
($)	2,228,000	2,335,000	2,518,000	750,000

TABLE 11

SUMMARY OF FIRST COSTS, PRESENT VALUE OF FIRST COSTS,
AND AVERAGE ANNUAL COSTS
(OCTOBER 1987 PRICE LEVELS, 8-5/8% INTEREST RATE, BASE YEAR-1990)

STRUCTURAL DESIGN 1	SCENARIO 1	SCENARIO 2	SCENARIO 3
FIRSTS COSTS	$34,523,000	$67,226,000	$110,426,000
PRESENT VALUE	$33,200,000	$55,417,000	$ 78,731,000
AVERAGE ANNUAL COSTS			
INTEREST	$ 2,863,000	$ 4,780,000	$ 6,791,000
AMORTIZATION	$ 46,000	$ 78,000	$ 110,000
OPERATION AND MAINTENANCE	$ 85,000	$ 165,000	$ 271,000
TOTAL	$ 2,994,000	$ 5,023,000	$ 7,172,000

STRUCTURAL DESIGN 2	SCENARIO 1	SCENARIO 2	SCENARIO 3
FIRST COSTS	$32,550,000	$63,384,000	$104,092,000
PRESENT VALUE	$31,302,000	$52,250,000	$ 74,215,000
AVERAGE ANNUAL COSTS			
INTEREST	$ 2,700,000	$ 4,507,000	$ 6,401,000
AMORTIZATION	$ 44,000	$ 73,000	$ 104,000
OPERATION AND MAINTENANCE	$ 80,000	$ 156,000	$ 255,000
TOTAL	$ 2,824,000	$ 4,736,000	$ 6,760,000

TABLE 11 (Cont'd)

SUMMARY OF FIRST COSTS, PRESENT VALUE OF FIRST COSTS,
AND AVERAGE ANNUAL COSTS
(OCTOBER 1987 PRICE LEVELS, 8-5/8% INTEREST RATE, BASE YEAR-1990)

STRUCTURAL DESIGN 3	SCENARIO 1	SCENARIO 2	SCENARIO 3
FIRSTS COSTS	$23,036,000	$44,857,000	$73,548,000
PRESENT VALUE	$22,153,000	$36,977,000	$52,438,000
AVERAGE ANNUAL COSTS			
INTEREST	$ 1,911,000	$ 3,189,000	$ 4,523,000
AMORTIZATION	$ 31,000	$ 52,000	$ 73,000
OPERATION AND MAINTENANCE	$ 57,000	$ 110,000	$ 181,000
TOTAL	$ 1,999,000	$ 3,351,000	$ 4,777,000

STRUCTURAL DESIGN 4	SCENARIO 1	SCENARIO 2	SCENARIO 3
FIRST COSTS	$25,581,000	$49,813,000	$81,718,000
PRESENT VALUE	$24,600,000	$41,063,000	$58,263,000
AVERAGE ANNUAL COSTS			
INTEREST	$ 2,122,000	$ 3,542,000	$ 5,025,000
AMORTIZATION	$ 34,000	$ 57,000	$ 82,000
OPERATION AND MAINTENANCE	$ 63,000	$ 122,000	$ 201,000
TOTAL	$ 2,219,000	$ 3,721,000	$ 5,308,000

TABLE 11 (Cont'd)

SUMMARY OF FIRST COSTS, PRESENT VALUE OF FIRST COSTS,
AND AVERAGE ANNUAL COSTS
(OCTOBER 1987 PRICE LEVELS, 8-5/8% INTEREST RATE, BASE YEAR-1990)

NON-STRUCTURAL ALTERNATIVE (10 MILE PER HOUR SPEED LIMIT)	
INCREASED VESSEL OPERATING COSTS	SCENARIO 4
	$ 1,973,000
TOTAL	$ 1,973,000

TABLE 12

SUMMARY OF AVERAGE ANNUAL BENEFITS AND COSTS, AND BENEFIT COST RATIOS
(OCTOBER 1987 PRICE LEVELS, 8-5/8% INTEREST RATE, BASE YEAR-1990)

	SCENARIO 1	SCENARIO 2	SCENARIO 3
TOTAL AVERAGE ANNUAL BENEFITS			
($)	$2,228,000	$2,335,000	$2,518,000
TOTAL AVERAGE ANNUAL COSTS			
DESIGN 1	$2,994,000	$5,023,000	$7,172,000
BENEFIT-COST RATIO	0.74	0.46	0.35
DESIGN 2	$2,824,000	$4,736,000	$6,760,000
BENEFIT-COST RATIO	0.79	0.49	0.37
DESIGN 3	$1,999,000	$3,351,000	$4,777,000
BENEFIT-COST RATIO	1.11	0.70	0.53
DESIGN 4	$2,219,000	$3,721,000	$5,308,000
BENEFIT-COST RATIO	1.00	0.63	0.47

SPEED LIMIT OPTION	SCENARIO 4
TOTAL AVERAGE ANNUAL BENEFITS	$ 750,000
TOTAL AVERAGE ANNUAL COSTS	$1,973,000
BENEFIT-COST RATIO	<0.38

EVALUATION OF ENVIRONMENTAL EFFECTS OF ALTERNATIVE PLANS

No Action

At the current average rate of bank retreat, approximately 210 acres of intermediate/brackish marsh, mostly adjacent to the north bank of the MR-GO, are being converted to open water annually. The eventual loss of the buffering marsh adjacent to the MR-GO north bank will increase occurrences and the duration of periods of saltwater intrusion into the marsh surrounding Lake Borgne and that of the Biloxi State Wildlife Management Area

Structural And Non-structural Alternatives

Effects On Water Quality

The implementation of bank erosion reduction measures along the MR-GO is unlikely to significantly alter general water quality conditions. Temporary increases in turbidity and suspended solids concentrations will occur during construction. Temporary pH changes and dissolved oxygen deficits may also occur during construction. The future condition of the stabilized banks will significantly reduce rates of erosion, and result in lowered amounts of nonpoint pollution from that source, thereby improving water quality.

Effects On Bank Erosion and Marsh Loss

The overall effect of implementation of bank erosion abatement measures will be to substantially reduce erosion and marsh loss. However, where structural bank protection measures are discontinuous, erosion could be intensified due to wave diffraction from the structures. The ends of the bank protection structures must be engineered to counter this effect.

Navigation gaps would be provided in the bank protection structure at the locations of major waterways, such as Bayous Dupre, Bienvenue, and Ycloskey. Wave action and surges from passing vessels will be transmitted to the backshore areas at these locations, and could be intensified by the navigation openings. Erosion of these bayous could increase, and material may be drawn into the MR-GO through the openings.

Effects On Biological Resources

The deposition of dredged material would be beneficial in that it would provide materials from which the marsh was originally created. Although the existing marsh would be covered by dredged material and the existing inhabitants forced to evacuate the area, any replenishing of the rapidly diminishing resource in this subsiding area would provide more diversity and thus increased habitat for a variety of organisms. The area would be utilized after vegetation is established as feeding, refuge, and nesting area for both birds and mammals.

Construction of a protective dike or pile supported structure would result in adverse impacts through coverage of existing habitat. However, placement of rip-rap or similar materials would create numerous micro-environments similar to jetties that, particularly below the typical marsh level, are utilized by various marine organisms. Organisms using jetties commonly include the sea anemone, barnacle, and sea roach. Molluscs, such as periwincles, slipper shells, dove shells, oyster drills, mussels, and oysters are present. Decapods, such as fiddler, hermit, stone, and blue crabs are common inhabitants of jetties. These organisms, which are all at an intermediate position in the marine food web, would be beneficially impacted by an alternative that involved rock placement as a construction feature. Those alternatives that involve the deposition of dredged material over a large area would also cause adverse impacts through coverage of existing habitat, but would also insure the existence of a quantity of the diminishing marsh resource and thus would be more positive than negative.

The alternative of vessel speed reduction would result in no adverse environmental impacts in the traditional sense. However, neither would it provide the beneficial impact of marsh nourishment from the eventual placement of a 200-foot or more strip of dredged material.

Effects On Cultural Resources

Implementation of a structural alternative would affect existing and as yet unidentified cultural resources. Definition of project effects (both direct and indirect) must await selection of feature placement and impact zone definition. Project effects on Ft. Proctor must be considered. The determination of whether project effects are adverse to cultural resources would be ascertained from feature placement, impact zones, and cultural resource assessments of significance. From a point near Shell Beach and southeast, cultural resource work would be in consonance with the Southeast Louisiana Cultural Resource Management Plan. Project areas northwest of Shell Beach would be addressed in consonance with existing cultural resource regulation and law.

Effects On Recreation Resources

Alternatives that will reduce bank erosion or restore eroded marsh should benefit fish and wildlife and in turn sport hunting and fishing activities that are dependent on marsh habitats. With the eventual placement of dredged material behind linear bank retaining dikes, marsh would be created. It is possible that areas would exist that would trap rainwater and form marsh impoundments of value to waterfowl and marsh-oriented wildlife. Development of these retaining dikes would reduce bank erosion and saltwater intrusion which are adversely affecting the recreational environment. Additional bank erosion and possible large breaches of the buffering marsh between the MR-GO and Lake Borgne would be prevented.

Recreational hunting and fishing activities would benefit from the rebuilding of these productive marsh habitat types.

CONCLUSION

Findings of this study indicate that severe erosion is occurring along the banks of the MR-GO. The current bank erosion problem will become a major channel maintenance problem in the future. An estimated six-fold increase in required average annual maintenance dredging of the MR-GO could be realized by the year 2002. Wave-wash and drawdown effects produced by large vessel traffic are causing highly productive marsh to be converted to open water. Saltwater intrusion into marsh that remains has significantly modified the former fresh/intermediate marsh character of much of the study area. Recreational hunting and fishing resources have been diminished and cultural resources are threatened by the currently unabated bank erosion.

From preliminary analysis of potential structure design effectiveness, reliability, and survivability; costs; benefits; and impacts; one structural option and four conceptual structure designs are recommended for detailed investigation.

Greater than 85 percent of the quantifiable potential benefits of implementing structural bank erosion reduction measures would accrue to navigation in the form of savings in channel maintenance. Consequently, additional studies should be conducted via preparation of a supplement to the General Design Memorandum for the Mississippi River-Gulf Outlet navigation project.

REQUIREMENTS FOR FURTHER STUDY

ENGINEERING STUDIES

Detailed hydraulic and hydrologic engineering investigations, design and cost engineering investigations, and geotechnical investigations will be required. The tasks to be completed for the engineering studies requirements are summarized below.

Surveys

Detailed surveys will be performed to help determine the optimal location and design of the proposed erosion abatement structures.

Hydraulic And Hydrologic Engineering

Hydraulic model studies will be conducted to determine sediment transport quantities from Lake Borgne to the MR-GO.

A narrative description of coastal engineering studies conducted will be prepared for the GDM Supplement. These studies will include analyses of erosion trends; local wave, current, and littoral drift patterns; water level fluctuations; and relationships between ship traffic, erosion, and navigation channel design. Additional work will include determining optimal bank protection structure alignments, and maintenance dredging, bank nourishment, and right-of-way requirements.

A narrative description of existing water quality will be prepared to include the latest data from the Environmental Protection Agency water quality data base, "STORET". Literature searches will be conducted to define the impact of erosion and marsh loss on water quality. Tables and plates will be prepared for inclusion in the text.

Water quality sampling and analyses will be performed for each reach of the study. Samples will be analyzed for priority pollutants in water, sediment, and elutriate phases. These data will be evaluated and a report will be prepared.

A narrative description of hydrology and climatology will be prepared including the latest meteorological data from government sources. Literature searches will be conducted to link hydrometeorological events to erosion and marsh loss. Tables and plates will be prepared for inclusion in the text.

Design And Cost Engineering

The reconnaissance investigations indicate that several erosion abatement structure design alternatives are worthy of further consideration. These structure designs will be further evaluated based on design integrity and estimated performance. Modifications and improvements to these preliminary designs will also be investigated.

Cost estimates will be refined for the structure design alternatives. The cost analysis will include any modifications or improvements made to the designs as well as updated unit prices.

Additional work may be required to assess present and to estimate future maintenance dredging quantities. Also, research to identify future disposal areas for maintenance dredged material from the MR-GO navigation project may be required.

Geotechnical Investigations

The GDM Supplement tasks include geologic and land-loss mapping, subsurface investigations along the MR-GO channel, soil testing/ foundations investigations and design for the structure alternatives, and producing a narrative description of the geotechnical investigations performed.

SOCIO-ECONOMIC STUDIES

Socio-economic studies will be required to accurately document existing conditions and to evaluate alternative plans. Economic evaluations will require projecting economic activity in the study area over the 50-year planning horizon. Land use, recreation, and commercial activities will be analyzed, alternatives will be evaluated, and benefit-cost ratios will be developed.

ENVIRONMENTAL STUDIES

The tasks to be completed for the environmental studies requirements are summarized below.

Biological Resources Studies

The following studies and analyses will be required to assure compliance with both environmental and administrative procedures.

1) Endangered Species Assessment
2) Section 404 (b) (1) Evaluation
3) Coastal Zone Management (CZM) Consistency Determination
4) Environmental Impact Statement

Cultural Resources Studies

None of the existing and known cultural resources, with the exception of Ft. Proctor have had their significance evaluated. A study will be required to relocate known sites, assess their significance, and assess project impacts. The results of this study must be coordinated with the State Historic Preservation Officer (SHPO)-Louisiana Department of Culture, Recreation, and Tourism. If any sites are found to be significant and are to be adversely affected by the project then a mitigation plan must be developed and coordinated with the SHPO and Advisory Council on Historic Preservation (ACHP). The approved mitigation plan must then be implemented and a report written. This report must also be coordinated with the SHPO and ACHP.

Excavation for flotation access channel and feature placement should also be monitored and a report written on the results.

Recreation Resources Studies

In the event a portion of the acreage lost to bank erosion is replenished, the potential exists for additional hunting success and increased use by sportsmen. This additional hunting benefit must be quantified. Therefore, a recreational hunting and fishing man-day analysis must be conducted.

REAL ESTATE INVESTIGATIONS

Detailed real estate investigations will be required. Reconnaissance phase real estate cost estimated will be updated or revised as necessary. Real estate cost estimates include estimates for lands and damages, contingencies, acquisition costs and Public Law 91-646 costs. Field work will consist mainly of comparable sales research and research concerning the number of ownerships affected by the proposed project.

Additionally, field inspections will be required to determine whether there are improvements located within the proposed project rights-of-way.

STUDY PARTICIPATION AND COORDINATION

Public involvement is an important part of this study. Through public notices, meetings, and local and interagency coordination, people are encouraged to participate in and contribute information to the study effort.

A Notice of Study Initiation, which included a map indicating the extent of the study area, was published in April 1987. This notice announced the initiation of the reconnaissance study. The two-phase study process was briefly described and Federal funding for the reconnaissance study and local cost-sharing requirements for potential feasibility phase studies were indicated. Further, the notice requested that information, questions, concerns and views that could pertain to the study scope be forwarded to the District Engineer. The notice was sent to approximately 300 correspondents: individuals; the print and electronic news media; libraries; local, state, and Federal government officials and agencies; and various interest groups. The study mailing list is shown in Appendix D.

Several interagency meetings were held between the NOD and the Louisiana Department of Natural Resources (LDNR) to explore the level of interest and support of non-Federal interests in finding potential solutions to the bank erosion problems. Representatives of the LDNR were requested to review a preliminary draft of the reconnaissance report and comment on plan formulation, environmental and economic analyses, and the study findings. Comments of the LDNR were considered in preparing the reconnaissance report.

Study efforts have been closely coordinated with the U.S. Fish and Wildlife Service (USFWS). The USFWS has indicated support of the study efforts. The USFWS Planning Aid Letter is shown as Appendix E.

Subsequent to distribution of the Notice of Study Initiation, a reporter from WDSU TV Channel 6, New Orleans, requested and was granted an interview with the study manager. The interview covered the definition of the nature and extent of the erosion and erosion-related problems in the study area, the probable consequences of not arresting the erosion on the MR-GO, and some of the potential solutions that were being evaluated. The interview was aired in June 1987.

Two field trips were conducted in May 1987 to meet with a representative of a land owner that would be affected by implementation of structural erosion abatement measures. These meetings in the field allowed the land owner's representative to express the unique concerns of the land owners to environmental resources specialists, the study manger, and other members of the NOD interdisciplinary study team.

In August 1987 an additional field reconnaissance was conducted by three members of the Lower Mississippi Valley Division (LMVD) interdisciplinary planning team assigned to the study and the NOD study manager. The LMVD planning team's study manager, economist, and biologist toured the areas of critical bank erosion, and were briefed on the status and direction of the NOD study efforts.

GDM SUPPLEMENT COST ESTIMATE

Additional studies should be conducted via preparation of a supplement to the General Design Memorandum (GDM) for the Mississippi River-Gulf Outlet navigation project. The estimated cost to complete the supplement to the MR-GO GDM is $991,000 as is shown in Table 13. The GDM supplement will require 18 months of work effort for submission to LMVD and a total of 24 months to complete.

TABLE 13

GDM SUPPLEMENT COST ESTIMATE

General Design Memorandum Task	First Fiscal Year	Second Fiscal Year	Total GDM Cost
Engineering Investigations:			
Surveys	$137,000	-------	$137,000
Field Investigations & Testing	95,000	-------	95,000
Hydraulic Model Studies and Data Collection	135,000	-------	135,000
Hydraulic Design	40,000	23,000	63,000
Geology	38,000	24,000	62,000
Foundation Design	22,000	21,000	43,000
Design Studies & Cost Estimates	13,000	23,000	36,000
Study Management & Coordination	15,000	14,000	29,000
Total Engineering Investigations	495,000	105,000	600,000
Environmental Studies:			
EIS	45,000	23,000	68,000
USFWS	14,000	2,000	16,000
Cultural Resources	76,000	9,000	85,000
Recreation	16,000	4,000	20,000
Total Environmental Studies	151,000	38,000	189,000
Economic & Social Analyses:	30,000	7,000	37,000
Real Estate Investigations:	10,000	5,000	15,000
Contingencies:	119,000	31,000	150,000
Totals	$805,000	$186,000	$991,000

RECOMMENDATION

I recommend that this Reconnaissance Study Report on Mississippi River-Gulf Outlet Bank Erosion be approved. The report should be used as a basis to proceed with more detailed studies.

Lloyd K. Brown
Colonel, Corps of Engineers
District Engineer

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APPENDIX A

CLIMATOLOGIC AND HYDROLOGIC DATA

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APPENDIX A

APPENDIX A

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APPENDIX A

LIST OF TABLES (Continued)

General Climate

The climate of the area is subtropical marine, with long humid summers and short moderate winters. Southerly winds prevail throughout the warmer months the area produce intense thunderstorms during the summer. In the colder months the area is subjected to frontal movements which produce squalls and sudden temperature drops. Climatological data for this area are contained in monthly and annual publications of the U.S. Department of Commerce, National Climatic Center, titled "Climatological Data for Louisiana," and "Local Climatological Data, New Orleans, LA."

Temperature

Temperature readings have been taken at New Orleans since 1870. Over this period, the extremes recorded were a high of 102°F occurring on four different days and a low of 7°F in February 1899. The annual normal temperature based on the period 1951-1980 is 69.5°F, with monthly normal temperatures varying from 83°F in July to 54°F in January. Extremes for the normal period were a maximum temperature of 102°F in August 1980 and a minimum of 14°F in January 1963. The average winter and summer temperatures are 55.3°F and 82.4°F, respectively. The maximum, minimum, and mean monthly and annual normal temperatures (1951-1980) for New Orleans at Audubon Park are shown in Table A-1.

Precipitation

Precipitation data from four climatological stations are used to represent the study area. The average annual rainfall of New Orleans at Algiers, St. Bernard, LSU Citrus Research Center, and Boothville based on the period 1967-1986 is 61.2 inches. This average and the monthly averages are shown in Table A-2. The monthly and annual precipitation for these stations are shown in Table A-3 through A-6. Table A-7 gives the extremes of each station.

Wind And Synoptic Weather Types

Onshore wind records are available from 1949 based at New Orleans Moisant Airport. The average wind velocity over the period 1966-1986 is 7.8 miles per hour (mph). The predominant wind directions are north-northeast from September through February and south-southeast from March through June.

Wind data at Boothville can be used to represent shoreline wind conditions for the lower part of the study area. These winds average about 8.8 mph annually based on the period July 1971 through December 1978. Predominant wind directions are northeast from September through February and southeast from March through June.

Offshore winds have a mean annual speed of 13.6 mph. This average is based on the Summary of Synoptic Meteorological Observations (SSMO) taken by the U.S. Naval Weather Service Command over the period 1953 through 1971. Southeast and east winds are the predominant directions over the year. Detailed data on wind speed and direction are contained in Tables A-8 through A-11.

Weather patterns which simultaneously affect large portions of the Gulf of Mexico cause three kinds of wind generated tidal conditions in the study area. The Frontal Gulf Return and Gulf Return weather types have moderate to strong southeast to south-southwest winds associated with storms which cause moderate to severe wave set-up in Breton Sound and the MR-GO. These weather patterns occur when the returning air flow is affected by lifting and convergence along an approaching cold front. Cold fronts are generally associated with a Pacific High, Continental high or a Frontal Overrunning weather type generating winds from the northwest or northeast. These weather patterns are most active from late fall through spring.

The Gulf Tropical Disturbance weather type sometimes affects southern Louisiana during the summer and fall months. These disturbed tropical systems normally drift from east to west across the northern gulf and range from relatively weak easterly waves to strong severe hurricanes.

The Gulf Extra-Tropical disturbance weather type has behavior similar to tropical storms except that it occurs in winter-spring. It consists of a strong northeast to east wind component which causes wave set-up and flooding. Table A-12 shows the mean monthly frequencies of the seasonal weather types based on the twenty year period 1961 through 1990 at New Orleans Moisant Airport.

Hurricanes And Storms Of Record

Analyses of hurricanes and tropical storms along the Louisiana coast have been made for storms from 1893 to present. During that time, a total of 47 storms have either struck or affected the coastal area of Grand Isle to the Louisiana-Mississippi state line. The highest maximum observed winds at landfall came from Hurricane Camille (14-22 August 1969) and measured 160 miles per hour near the center with gusts to 190 miles per hour. This storm produced the maximum stage of 11.1 feet at Shell Beach.

Hurricane Elena and Juan (1985) were the last two storms to affect the study area. Hurricane Juan broke records along the MR-GO. During this storm an interior stage of 3.53 ft. was recorded at the Bayou Dupre Floodgate (west) and a 7.61 ft. exterior stage was recorded on the east side of the floodgate. At the Bayou Bienvenue Floodgate (east) a 7.98 ft. stage was recorded. A 6.86 ft. stage was recorded on Bayou Terre Aux Boeufs at Delacroix. A high water mark of 7.5 ft. was recorded at Shell Beach. A list of hurricane occurrences since 1893 is contained in Table A-13.

In January 1983, a coastal storm hit the study area with very strong winds. The storm produced tides of 3 to 6 feet above normal along the MR-GO. At Shell Beach a high of 6.8 ft. was recorded and 7.61 ft. was recorded at the Paris Road Bridge.

Tides

Tides in the Breton and Chandeleur Sound areas are of the daily or diurnal type, i.e., they exhibit only one high water and one low water per day. The most prominent feature of the daily tide is the variation in the daily range produced by changes in the moon's declination. The greatest change in the daily tide occurs when the moon is at its maximum semimonthly declination. The range then decreases for a period of approximately 8 days, at which time the moon has moved over or closer to the equator. Periods during which the daily ranges of the tide are at a maximum are called "spring" tides while those with minimum ranges are referred to as "neap."

In a shallow body of water such as Breton Sound, tidal effects other than the daily range are masked by meteorological conditions which cause predominent water level fluctuations. One such masked feature is the variation in the range of the tide in response to the annual variations in the declination of the sun. During the year, the daily ranges of the tide are at a minimum in March and September, corresponding with the sun's equinox, and at a maximum in June and December, corresponding to the sun's solstice.

The tides in Breton Sound have a range of 1.4 feet. In Lake Borgne the tides have a range of 1.2 feet. Tidal ranges at several stations include 0.70 feet at Seabrook (Lake Pontchartrain), 1.2 feet at Shell Beach, 1.1 feet at Paris Road Bridge, 1.45 feet at Gardner Island, and 1.0 feet at Biloxi, Mississippi.

Mean stages together with maximum and minimum gage readings are provided in Table A-14 of Appendix A for several stations along the MR-GO and at

Biloxi, Mississippi. Table A-15 give the mean summations of the mean, maximum, and minimum 8:00 am stages at each of these stations.

TABLE A-1
Temperature Normals (°F)
New Orleans at Audubon Park

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MAX	61.8	64.6	71.0	78.3	84.2	89.4	90.6	90.3	87.0	79.5	70.1	64.5	77.6
MIN	45.3	47.6	54.1	61.2	67.7	73.2	75.3	75.3	72.6	62.1	53.1	47.8	61.3
MEAN	53.6	56.1	62.6	69.8	76.0	81.3	83.0	82.8	79.8	70.8	61.6	56.2	69.5

TABLE A-2
Precipitation Averages (1967-1986)
(Inches)

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
ALGIERS	4.00	5.07	4.97	4.77	5.50	4.95	6.86	6.64	5.17	3.70	3.88	5.55	61.05
ST. BERNARD	4.46	5.47	5.42	4.75	5.27	4.32	7.10	6.55	5.81	3.52	4.31	5.05	62.02
LSU	5.01	5.47	5.62	4.85	6.56	4.45	6.59	7.98	5.95	4.32	4.22	5.11	65.90
BOOTHVILLE	4.60	3.84	4.66	3.01	3.91	3.57	6.19	6.67	6.03	3.54	4.27	5.26	55.73
AVERAGE	4.52	4.96	5.17	4.35	5.31	4.32	6.69	6.96	5.74	3.77	4.17	5.24	61.18

TABLE A-3
Monthly and Annual Precipitation
New Orleans Algiers Gage
(Inches)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1967	2.78	7.03	1.56	2.92	3.57	4.94	5.92	10.15	5.28	7.62	0.47	9.99	62.23
1968	1.15	3.12	2.40	3.29	6.89	7.47	7.69	7.97	2.27	4.42	4.44	7.76	58.87
1969	2.94	4.66	6.62	4.33	5.93	1.41	6.45	6.98	2.38	0.71	1.76	6.35	50.52
1970	4.04	2.33	8.64	0.85	6.31	4.72	7.10	8.17	6.32	5.40	1.13	4.08	59.09
1971	1.75	4.11	3.85	1.16	1.51	4.73	9.00	7.38	14.30	1.91	3.61	6.51	59.82
1972	5.85	5.05	5.33	1.04	6.69	0.42	6.79	0.62	1.65	1.93	8.64	6.28	50.29
1973	2.28	4.46	10.29	12.07	3.98	4.25	7.82	3.60	12.07	4.28	3.91	7.56	76.57
1974	8.66	3.51	5.34	4.74	12.88	1.27	7.72	10.14	4.69	0.38	7.63	6.06	73.02
1975	4.19	4.89	5.40	5.69	8.82	13.06	8.35	7.81	6.39	3.21	3.66	3.30	74.77
1976	2.24	3.58	3.08	0.73	7.34	6.28	5.54	4.65	1.54	5.76	6.07	8.18	54.99
1977	5.86	2.73	7.22	2.38	2.65	0.75	6.12	15.65	7.87	3.31	7.12	3.52	65.18
1978	11.51	2.50	3.60	3.23	12.86	10.54	6.25	7.21	4.81	0.0	4.88	6.07	73.46
1979	5.22	12.27	5.43	3.37	4.41	1.40	12.33	3.82	3.43	1.68	4.16	2.66	60.18
1980	5.49	3.82	9.67	22.44	9.25	1.04	5.88	3.26	5.57	5.37	3.37	1.57	76.73
1981	0.56	8.37	1.48	1.36	2.74	9.10	4.29	5.15	2.95	0.82	0.65	5.61	43.08
1982	1.62	5.60	3.24	6.33	5.53	4.05	4.87	6.98	3.87	1.88	2.75	10.53	57.25
1983	4.30	7.69	3.42	16.16	4.69	8.11	4.22	5.39	6.88	7.21	4.09	5.75	77.91
1984	2.32	5.54	3.53	1.63	1.99	4.18	5.78	5.81	2.19	1.63	3.26	1.35	39.21
1985	4.12	6.15	6.78	0.36	0.89	4.44	8.97	7.92	4.39	14.30	1.20	3.90	63.42
1986	3.03	3.94	2.58	1.38	1.08	6.81	6.09	4.23	4.61	2.11	4.75	3.89	44.50
AVERAGE	4.00	5.07	4.97	4.77	5.50	4.95	6.86	6.64	5.17	3.70	3.88	5.55	61.05

TABLE A-4
Monthly and Annual Precipitation
St. Bernard Gage
(Inches)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1967	3.51	6.52	1.86	2.34	2.47	5.09	6.18	5.70	4.63	10.75	0.24	9.97	59.26
1968	1.18	4.11	1.51	2.75	6.43	3.47	1.88	4.98	2.79	1.57	4.67	6.70	42.04
1969	5.54	3.73	8.25	4.99	6.15	0.63	8.46	8.78	0.48	0.84	2.05	6.36	56.26
1970	4.43	3.27	8.03	1.12	3.67	4.23	7.97E	7.61	6.64	4.82	0.91	3.22E	55.92E
1971	2.87	6.08	4.80	1.03	0.69	8.89	12.20	5.14	14.46	0.37	0.91	5.30	62.74
1972	7.66	7.58	6.87	1.34	6.06	2.64E	8.09E	4.08	2.83	1.77	8.19	6.82	63.93E
1973	4.77	4.95	10.40	8.94	2.77	1.64	3.37	5.33	10.54	3.73	4.95	4.44	65.83
1974	6.61	1.29	4.84	5.81	8.59E	1.37E	3.41	7.73E	5.13E	.05	7.72	3.48	56.03E
1975	3.07	1.35	5.00	5.61E	8.60	11.65	8.64	10.19	8.61	3.83	6.92	2.70	76.17E
1976	2.15	4.03	5.86	1.75	9.44	3.67	5.75	4.14	2.64	4.19	6.88	8.91	59.41
1977	5.75	2.73	5.35	1.82	2.88	1.24	6.19	15.52	9.99	4.84	9.17	3.70	69.18
1978	9.97	2.70	4.48	3.20	10.04	10.83	5.66	8.61	3.11	0.00	2.61	5.25	66.46
1979	4.32	12.88	7.11	6.20	6.40	1.98	10.50	7.51	5.86	0.52	3.87	2.52	69.67
1980	7.05	2.18	9.19	24.06	9.19	1.72	6.88	0.88	6.72	8.75	2.76	1.99	81.37
1981	0.77	12.91	1.69	0.94	2.70	2.69	3.77	4.11	4.28	0.54	1.38	5.60	41.38
1982	2.78	6.95	2.59	4.18	4.7	2.34	6.80	4.94	6.37	4.86	6.57	8.17	61.25
1983	5.59	9.83	5.28	16.01	3.81	13.38	8.57	4.79	7.48	2.13	5.03	6.50	88.40
1984	4.31	4.71	7.24	1.88	4.96	2.69	11.68	10.79	2.14	1.98	3.35	2.06	57.79
1985	4.08	5.03	4.23	.71	1.78	4.63	10.19	7.80	8.58	12.81	1.76	2.46	64.09
1986	2.81	6.41	3.69	0.22	4.18	1.54	5.80	2.46	3.05	1.92	6.14	4.92	43.14
AVERAGE	4.46	5.47	5.42	4.75	5.27	4.32	7.10	6.55	5.81	3.52	4.31	5.05	62.02

E-ESTIMATED

TABLE A-5
Monthly and Annual Precipitation
LSU Citrus Research Center
(Inches)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1967	5.70	3.08	2.56	2.55	4.92	5.10	5.83	9.73	7.46	9.62	0.00	8.38	64.93
1968	2.58	3.40	2.20	3.31	6.65	4.25	4.13	6.23	3.72	2.41	3.52	7.34	49.74
1969	4.19	3.84	7.04	5.37	11.34	0.68	7.02	11.01	3.53	1.32	1.60	4.48	61.42
1970	4.23	1.75	10.33	1.37	6.47	2.65	6.68	9.82	6.97	6.09	1.09	2.26	59.71
1971	4.84	10.10	7.67	1.43	1.14	6.68	9.46	12.92	11.21	1.36	1.58	5.21	73.60
1972	7.45	8.63	6.18	3.20	10.71	1.47	6.11	4.52	3.71	4.47	7.34	5.73	69.52
1973	4.70	3.85	12.49	15.56	0.78	0.77	4.42	3.72	5.65	6.78	2.20	7.31	68.23
1974	7.55	0.89	5.09	10.21	9.33	1.85	5.70	9.94	6.58	0.76	5.36	2.24	65.50
1975	3.59	0.83	4.19	4.52	14.19	6.53	8.08	10.21	4.71	5.42	8.76	4.14	75.17
1976	1.87	3.09	4.18	.98	10.09	4.98	5.53	4.81	5.82	5.20	9.83	9.23	65.61
1977	6.36	2.74	3.03	1.64	5.28	1.00	6.43	9.34	9.95	5.36	7.87	6.46	65.46
1978	12.55	2.96	6.66	4.47	3.91	5.32	8.46	9.27	8.32	0.00	6.32	6.41	74.65
1979	5.28	10.81	6.20	7.98	9.26	1.53	13.86	3.79	3.53	1.68	5.27	3.49	72.68
1980	6.14	1.43E	9.15	15.62	12.26	1.36	5.59	3.91	7.46	6.87	2.33	1.37	73.49E
1981	1.37	15.94	1.22	.20	3.75	3.74	3.16	6.99	5.27	.99	1.11	3.73	47.47
1982	4.15	8.97	3.31	4.68	2.74	3.25	5.38	10.20	5.98	4.51	7.76	8.77	69.70
1983	5.20	12.76	4.49	4.35	4.24	12.26	3.46	5.27	7.40	4.23	2.63	5.81	72.10
1984	4.89	4.71	8.76	M	3.7	10.57	8.34	15.97	1.32	2.79	3.31	2.14	--
1985	4.66	2.88	4.57	3.62	4.62	8.10	9.56	8.44	7.66	11.11	1.88	2.00	69.10
1986	3.77	6.70	3.09	1.13	5.86	6.88	4.58	3.45	2.80	5.43	4.61	5.71	54.01
AVERAGE	5.01	5.47	5.62	4.85	6.56	4.45	6.59	7.98	5.95	4.32	4.22	5.11	65.90

M-MISSING
E-ESTIMATED

TABLE A-6
Monthly and Annual Precipitation
Boothville, LA Gage
(Inches)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1967	4.98	3.51	3.22	1.35	2.98	3.55	5.38	10.99	4.94	6.72	.09	11.69	59.40
1968	0.91	1.91	3.43	1.79	3.88	5.04	4.56	4.65	3.17	1.91	3.01	5.54	39.80
1969	4.06	3.63	5.28	5.89	6.78	0.91	7.3	-	-	-	-	-	-
1970	-	-	-	-	-	-	--	-	-	-	-	-	-
1971	-	-	-	-	1.16	3.63	6.78	4.63	9.50	0.29	1.30	5.28	-
1972	5.32	3.83	7.02	2.32	8.11	0.82	2.0	2.65	2.97	3.32	9.89	3.04	51.29
1973	3.48	2.35	13.72	5.48	1.00	0.48	1.67	3.80	5.06	3.12	3.11	5.60	48.87
1974	1.22	1.04	3.88	3.66	6.96	1.85	9.47	8.66	4.76	1.03	3.16	1.01	46.70
1975	3.99	2.05	3.09	3.32	5.65	2.22	10.62	9.80	12.15	4.53	5.15	3.77	66.34
1976	1.49	2.21	1.84	0.69	7.93	4.61	2.36	3.97	7.10	4.30	5.86	13.06	55.42
1977	6.15	1.65	1.56	2.93	4.00	1.24	2.78	14.28	8.79	5.09	10.53	3.18	62.18
1978	11.43	2.27	4.74	3.23	1.77	4.47	10.53	7.17	2.94	T	6.34	2.70	57.59
1979	9.16	7.98	2.98	5.23	6.44	2.17	9.35	5.13	7.34	3.68	5.07	2.86	67.39
1980	9.30	1.02	7.64	9.65	7.02	3.59	9.32	2.99	5.45	6.75	4.02	1.82	68.57
1981	1.77	6.77	1.68	0.60	1.81	5.55	1.58	6.64	1.39	4.38	1.86	4.00	38.03
1982	2.78	7.93	2.67	2.74	1.95	6.22	11.44	5.29	5.65	1.88	4.96	11.63	65.14
1983	5.40	8.24	6.97	3.72	1.44	5.28	3.48	4.09	11.26	0.76	5.26	5.61	61.51
1984	3.39	2.95	5.07	1.11	1.44	2.75	5.28	6.4	6.98	2.92	1.69	2.98	42.96
1985	4.18	3.66	6.87	0.03	1.60	9.13	8.35	6.25	3.26	9.45	1.40	3.68	57.87
1986	3.74	6.17	2.27	0.37	2.44	4.31	5.40	12.67	5.90	3.59	4.13	7.28	58.27
AVERAGE	4.60	3.84	4.66	3.01	3.91	3.57	6.19	6.67	6.03	3.54	4.27	5.26	55.73

(-)-GAGE OUT
T -TRACE

TABLE A-7
Precipitation Extremes

STATION	PERIOD OF RECORD	GREATEST MONTHLY (in.)	DATE	LEAST MONTHLY (in.)	DATE	GREATEST DAY (in.)	DATE
ALGIERS	1951-1986	22.44	APR 80	0.00	OCT 78@	9.78	5/3/78
ST. BERNARD	1966-1986	24.06	APR 80	0.00	OCT 78@	8.73	4/13/80
LSU	1958-1986	15.94	FEB 81	0.00	OCT 78@	9.42	2/10/81
BOOTHVILLE	1965-1986	14.28	AUG 77	T	OCT 78	6.65	7/21/74

@-AND OTHER DATES
T-TRACE

TABLE A-8

Wind Summaries, New Orleans at Moisant Airport (1966-1986)

Average Wind Speed (mph)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1966	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
1967	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
1968	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
1969	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
1970	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
1971	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
1972	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
1973	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
1974	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
1975	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
1976	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
1977	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
1978	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
1979	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
1980	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
1981	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
1982	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
1983	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
1984	8.0	8.7	7.8	9.4	8.2	4.7	4.1	5.8	9.2	7.6	9.6	8.8	7.7
1985	9.4	10.1	9.7	9.2	8.3	7.8	6.1	7.3	8.6	9.6	8.1	8.2	8.5
1986	9.1	10.8	9.2	9.0	9.1	6.7	6.7	6.6	6.8	7.5	9.8	8.6	8.3
AVERAGE	9.1	9.3	9.5	9.2	8.0	6.7	5.7	5.6	6.8	7.3	8.2	8.8	7.8

TABLE A-9

Wind Summaries, New Orleans at Moisant Airport (1966-1986)

Resultant Direction*

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1966	02	04	07	16	07	07	23	15	02	03	03	05	05
1967	03	02	13	15	16	11	21	02	05	06	05	08	09
1968	03	35	12	16	15	19	12	05	06	04	04	06	07
1969	07	02	02	13	09	18	24	09	04	05	36	01	05
1970	03	03	08	17	19	21	29	12	08	03	32	06	09
1971	02	12	13	15	13	23	20	01	07	04	04	12	09
1972	07	07	12	15	04	20	14	34	12	06	02	06	08
1973	02	36	16	16	20	18	24	04	10	07	13	20	12
1974	12	24	16	13	16	16	25	13	05	06	06	16	12
1975	09	21	14	11	15	18	25	17	03	05	08	04	10
1976	04	19	15	15	15	13	25	01	04	02	02	02	07
1977	01	09	13	14	13	21	20	12	15	03	10	13	11
1978	01	01	28	15	16	12	19	11	08	03	08	07	07
1979	01	04	15	14	14	15	17	13	04	11	03	03	08
1980	06	06	09	20	15	22	27	13	09	04	02	02	08
1981	02	02	21	15	13	16	22	11	05	06	10	04	09
1982	11	01	12	10	13	22	21	21	06	06	06	10	09
1983	04	05	29	18	15	12	10	11	07	05	10	03	08
1984	03	08	16	18	14	17	13	18	06	13	04	12	12
1985	34	04	14	13	20	19	23	11	08	08	09	02	09
1986	01	23	10	15	15	18	24	33	13	08	05	03	10

*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.

TABLE A-10
Percent Frequency of Occurrence
Wind Direction vs. Wind Speed (MPH)
(1971-1978)
Boothville, LA

Direction	January % Freq	January Mean Speed	February % Freq	February Mean Speed	March % Freq	March Mean Speed	April % Freq	April Mean Speed	May % Freq	May Mean Speed	June % Freq	June Mean Speed	July % Freq	July Mean Speed	August % Freq	August Mean Speed	September % Freq	September Mean Speed	October % Freq	October Mean Speed	November % Freq	November Mean Speed	December % Freq	December Mean Speed	Annual % Freq	Annual Mean Speed
North	13.4	12.3	10.6	12.8	7.9	12.8	6.2	10.5	5.2	9.4	3.8	8.5	3.7	6.9	4.4	7.2	4.1	8.5	13.6	10.3	12.2	11.9	12.1	11.2	8.1	10.2
North-Northeast	9.9	12.8	7.6	11.0	5.4	12.3	3.6	11.4	4.0	10.5	3.2	9.6	2.1	6.9	4.7	8.3	5.8	9.6	12.0	11.0	10.3	11.6	8.9	10.5	6.5	10.5
Northeast	9.1	11.2	8.3	10.5	5.1	13.0	4.6	9.2	4.8	9.6	5.3	8.7	4.1	8.3	4.8	8.3	9.3	10.3	13.8	11.0	11.1	10.5	9.8	10.5	7.5	10.1
East-Northeast	6.7	8.9	5.1	9.2	6.1	10.7	6.5	9.4	5.9	9.2	4.5	9.6	4.9	8.9	6.3	8.3	9.4	10.0	9.6	10.3	8.7	9.8	5.5	9.4	6.6	9.5
East	6.1	6.3	4.9	8.1	8.2	8.3	10.6	8.7	8.8	8.9	7.4	8.9	5.3	7.8	8.2	8.3	12.4	8.9	11.1	8.7	7.7	6.7	5.9	7.2	8.0	8.1
East-Southeast	6.1	8.7	5.0	7.8	10.0	9.6	12.2	10.5	8.3	8.9	5.4	7.8	5.0	7.2	6.2	8.3	9.5	8.5	5.4	8.9	8.4	7.8	6.7	8.3	7.3	8.4
Southeast	7.0	7.8	6.1	8.3	9.8	10.7	12.2	10.1	10.9	9.4	6.5	6.9	5.8	6.7	7.2	7.2	7.3	8.1	1.8	8.7	6.9	8.5	7.1	8.9	7.4	8.5
South-Southeast	4.8	9.6	4.6	12.1	7.1	12.1	8.0	12.8	6.6	11.2	6.2	9.4	4.8	7.6	6.2	7.8	4.1	8.7	1.5	8.9	5.8	11.2	6.8	10.5	5.5	10.2
South	11.4	10.3	11.2	11.0	14.2	13.0	13.2	12.8	13.1	11.4	13.2	9.6	10.9	8.1	8.3	7.8	8.1	9.4	2.2	8.7	6.7	10.3	10.6	11.4	10.3	10.3
South-Southwest	2.2	9.8	2.8	11.6	3.4	12.8	3.0	12.5	5.8	10.3	7.0	9.6	6.1	8.7	3.2	7.2	2.8	9.8	0.7	10.5	1.2	9.4	2.2	8.9	3.4	10.0
Southwest	2.1	10.7	3.1	11.9	3.1	11.2	1.8	12.3	4.3	10.3	8.6	9.4	7.1	8.7	3.5	8.7	2.2	9.6	1.1	9.2	.8	7.2	1.2	12.1	3.2	10.1
West-Southwest	1.7	10.1	2.9	11.9	3.4	2.2	2.3	9.6	3.6	10.7	5.3	10.1	6.5	8.5	3.1	7.6	2.8	9.8	1.5	6.7	.8	7.6	1.6	8.5	3.0	9.5
West	2.0	9.8	4.1	10.7	13.0	11.4	1.9	9.4	3.6	9.8	3.9	8.3	7.1	7.6	3.4	7.4	2.0	6.9	2.0	7.8	2.0	8.7	2.6	10.3	4.0	9.0
West-Northwest	2.4	10.7	3.8	9.4	3.4	10.3	2.0	9.6	3.1	8.3	2.4	7.2	5.1	6.9	3.4	6.5	1.6	5.4	2.4	6.5	2.4	8.5	2.8	10.3	2.9	8.2
Northwest	3.7	11.0	5.1	11.2	2.8	10.1	4.1	11.6	2.3	10.3	3.1	7.2	4.5	6.7	2.8	6.7	2.2	7.4	2.8	6.9	4.1	10.3	5.0	10.3	3.5	9.1
North-Northwest	5.2	13.9	6.4	12.1	3.2	12.3	2.5	10.1	2.6	8.3	1.8	7.8	2.5	6.3	1.8	7.8	1.8	7.2	3.8	9.2	4.9	11.4	5.2	11.9	3.5	9.9
Calm	6.3	0	8.4	0	4.7	0	5.4	0	7.1	0	12.4	0	14.5	0	22.4	0	14.7	0	11.8	0	5.0	0	6.1	0	9.9	0
Mean Speed	-	9.8	-	9.8	-	11.0	-	10.1	-	9.2	-	7.8	-	6.7	-	6.0	-	7.6	-	8.5	-	9.4	-	9.6	-	8.8

TABLE A-11
Percentage Frequency of
Wind Direction and Mean Speed (MPH)
(1953-1971)
New Orleans Area*

Direction	January % Freq	January Mean Speed	February % Freq	February Mean Speed	March % Freq	March Mean Speed	April % Freq	April Mean Speed	May % Freq	May Mean Speed	June % Freq	June Mean Speed	July % Freq	July Mean Speed	August % Freq	August Mean Speed	September % Freq	September Mean Speed	October % Freq	October Mean Speed	November % Freq	November Mean Speed	December % Freq	December Mean Speed	Annual % Freq	Annual Mean Speed
North	17.4	18.3	14.0	17.5	13.8	17.8	8.8	16.5	7.5	12.6	4.5	8.3	3.9	8.9	6.0	9.4	8.2	13.1	17.0	15.8	18.9	18.4	17.2	18.0	11.4	14.5
Northeast	16.3	16.8	15.1	17.4	15.1	16.2	11.1	14.9	10.8	12.3	7.3	10.6	5.0	9.4	9.0	10.7	20.0	14.7	26.6	15.5	18.8	16.2	17.0	16.6	14.3	14.3
East	16.8	15.0	16.6	15.5	16.5	15.1	21.4	13.9	23.0	13.6	18.8	11.5	16.0	10.6	19.6	11.2	30.8	14.4	26.3	13.9	20.4	14.6	18.0	14.5	20.3	13.7
Southeast	15.1	13.8	17.5	15.0	22.3	14.6	29.4	14.6	29.5	13.2	27.6	12.1	20.3	10.6	19.7	10.7	18.1	14.0	12.5	13.9	15.2	15.1	16.3	15.2	20.3	13.6
South	12.4	14.2	14.2	14.9	14.9	15.2	14.9	14.7	13.8	12.4	19.1	11.2	19.3	10.0	15.8	10.7	9.0	13.7	5.4	12.3	9.8	14.7	13.1	15.2	13.5	13.2
Southwest	5.1	13.7	5.6	13.9	3.6	12.8	3.5	12.2	3.9	10.7	6.7	10.5	10.9	10.1	9.1	10.6	3.8	11.4	2.5	12.7	3.9	13.1	4.2	13.2	5.2	12.1
West	5.3	18.4	5.4	16.4	3.6	16.7	3.5	14.5	3.7	10.6	5.4	10.2	10.0	9.9	8.3	10.1	3.5	11.5	2.4	13.1	3.4	13.8	3.9	14.9	4.9	13.4
Northwest	10.1	20.5	10.2	19.0	8.5	19.2	5.2	17.8	4.0	11.4	4.5	9.1	6.2	10.0	6.1	9.7	3.5	11.2	5.4	15.7	7.7	17.6	8.8	19.6	6.7	15.1
Calm	1.6	.0	1.3	.0	1.7	.0	2.1	.0	3.7	.0	6.1	.0	8.4	.0	6.6	.0	3.2	.0	1.8	.0	2.0	.0	1.4	.0	3.3	.0
Mean Speed	-	16.0	-	16.0	-	15.7	-	14.4	-	12.3	-	10.5	-	9.3	-	9.8	-	13.5	-	14.6	-	15.5	-	15.9	-	13.6

*SSMO Area Boundaries: 27°N to 30°N latitude and 88°W to 93°W longitude

TABLE A-12
Synoptic Weather Types
Percent Frequency of Occurrence
At Moisant Airport
(1961-1980)

TYPE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Pacific High	3	7	6	4	5	0	0	0	1	4	3	4	3
Continental High	22	25	20	19	19	19	6	16	28	46	32	26	23
Frontal Overrunning	38	27	23	13	13	7	3	6	14	15	25	31	18
Coastal Return	7	8	8	9	13	12	12	21	17	14	13	8	12
Gulf Return	11	11	21	34	26	25	20	16	13	9	12	10	17
Frontal Gulf Return	14	17	19	16	15	10	7	8	8	7	13	17	13
Gulf High	4	6	2	5	9	23	40	26	6	4	2	4	11
Gulf Tropical Disturbance	0	0	0	0	1	4	11	7	13	1	1	0	3
Gulf Extra- * Tropical Dist.	(1 EVENT/YEAR			)	0	0	0	0	0	0	0	)	1

Source: Muller, Robert A., Louisiana State Climatologist, New Orleans Weather 1961-1980: A Climatology by Means of Synoptic Weather Types, 1983.

* One event per year during months of December through April.

TABLE A-13
Hurricane Occurrences

DATE	NAME	CLASSIFICATION[1]	CENTRAL PRESSURE (In. Hg)	EST. MAX. WINDS (mph)	FORWARD SPEED(knots)
27 Sep-5 Oct 1893	-	H	28.22	100	7
6-8 Aug 1894	-	T	NA	NA	NA
1-12 Oct 1894	-	H	29.42	NA	NA
16 Aug 1895	-	T	NA	NA	NA
10-13 Sep 1897	-	T	29.58	72	NA
10-16 Sep 1900	-	H	27.64	120	10
4-17 Aug 1901	-	H	28.72	80*	14
7-15 Oct 1902	-	H	29.72	NA	NA
29 Oct-10 Nov 1904	-	T	NA	NA	NA
24-30 Sep 1905	-	T	29.75	30	NA
19-30 Sep 1906	-	H	28.50	94	NA
17-23 Sep 1907	-	T	NA	NA	NA
10-24 Sep 1909	-	H	28.94	80	11
14-18 Sep 1914	-	T	NA	NA	NA
22 Sep-2 Oct 1915	-	H	27.53	94	10
29 Jun-10 Jul 1916	-	H	28.33	81	NA
21-29 Sep 1917	-	H	28.48	81	13
2-14 Sep 1919	-	H	27.36	95	NA
19-23 Sep 1920	-	H	28.93	90	28
13-17 Oct 1923	-	H	29.20	NA	NA
21-27 Aug 1926	-	H	28.31	100	10
11-22 Spe 1926	-	H	28.20	91	NA
4-21 Jun 1934	-	H	28.52	79*	16
21--25 Jul 1934	-	H	NA	NA	NA
26-27 Jul 1936	-	H	29.62	50	NA
20-22 Aug 1936	-	T	NA	NA	NA
2-10 Aug 1940	-	H	28.70	85	8
11-16 Sep 1941	-	T	29.61	75	NA
25-28 Jul 1943	-	H	28.78	85	8
8-10 Sep 1944	-	T	29.63	54	NA
3-6 Sep 1945	-	T	NA	NA	NA
13-16 Jun 1946	-	T	NA	36	NA
4-21 Sep 1947	-	H	28.57	110	16
28 Aug-6 Sep 1948	-	H	29.1	78	NA
3-5 Sep 1949	-	T	29.50	42	NA
31 Jul-2 Aug 1955	Brenda	T	29.50	60	NA
23-29 Aug 1955	-	T	29.54	45	NA
21-30 Sep 1956	Flossy	H	28.76	90	20
16-19 Sep 1957	Esther	T	29.62	52	NA
4-14 Sep 1961	Carla	H	27.50	145	9
28 Sep-5 Oct 1964	Hilda	H	28.40	135	7
27 Aug-10 Sep 1965	Betsy	H	27.99	150	17
14-22 Aug 1969	Camille	H	26.61	160**	13
29 Aug-10 Sep 1974	Carmen	H	27.64	116	9
9-16 Jul 1979	Bob	H	29.12	75	17
28 Aug-4 Sep 1985	Elena	H	29.55	127	13
26-31 Oct 1985	Juan	H	29.13	86	13

H-Hurricane T-Tropical Storm NA-Not Available
* Maximum Gradient Winds
** Estimates

SOURCES: NOAA Technical Report NWS 23 Meteorological criterian for Standard Project Hurricane & Probable Maximum Hurricane Windfields, Gulf & East Coasts of United States, September 1979

History of hurricane occurrances along coastal Louisiana, New Orleans District Corps of Engineers, August 1972

Storm Data Publications, National Climate Data Center, 1973 to Date.

TABLE A-14
Mean and Extreme Stages (FT. NGVD)
at Key Stations

STATION	PERIOD OF RECORD	MEAN	MAXIMUM	DATE	MINIMUM	DATE
Seabrook	1962-1987	1.46	6.47(a)	Aug 1969	-1.53	Mar 1965
Paris Road Bridge	1959-1986	1.53	10.04(a)	Sep 1965	-2.19	Mar 1965
Bayou Bienvenue						
@ Paris Road	1974-1986	1.16	4.82	May 1978	-1.78	Jan 1977
@ Floodgate(East)	1974-1986	1.04	7.98	Oct 1985	-1.89	Jan 1979
@Floodgate(West)	1975-1986	1.10	3.91	Apr 1980	-2.03(b)	May 1978
Bayou Dupre						
@ Floodgate(East)	1975-1986	0.96	7.61	Oct 1985	-1.89(b)	Feb 1978
@ Floodgate(West)	1975-1986	0.98	3.53	Oct 1985	-1.94	Jan 1979
Shell Beach	1961-1986	1.30	11.06(a)	Aug 1969	-2.7	Mar 1965
Breton Sound@ Gardner Island	1960-1983	1.34	5.74(a,c)	Sep 1960	-3.04	Feb 1961
Gulf of Mexico @Biloxi, Miss.	1959-1983	0.42	15.52(a)	Aug 1969	-4.18(d)	Sep 1926

(a) caused by Hurricane
(b) from incomplete record
(c) probably higher during hurricane of Aug. 1969
(d) overall record low

TABLE A-15
Mean, Maximum and Minimum Stages
(8:00 a.m. Observations)

Station 76060
Inner Harbor Navigation Canal near Seabrook Bridge, New Orleans, LA.
Gage Zero is at NGVD
Mean Summation for the Period of Record: 1962-1987

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	1.14	1.04	1.10	1.30	1.43	1.32	1.24	1.59	2.15	2.01	1.72	1.44	1.46
MAX.	4.10	4.15	3.52	4.71	4.25	3.54	3.42	4.35	5.45	4.09	3.51	3.94	5.45
MIN.	-1.28	-0.96	-0.90	-1.21	-0.19	-0.23	-0.75	-0.35	0.51	0.42	-0.18	-0.54	-1.28

Station 76040
Intracoastal Waterway near Paris Road Bridge, New Orleans, LA.
Gage Zero is at NGVD
Mean Summation for the Period of Record: 1959-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	1.08	0.98	1.04	1.26	1.42	1.44	1.48	1.92	2.42	2.23	1.77	1.43	1.53
MAX.	7.14	4.43	3.93	4.82	4.10	4.43	4.08	4.89	7.16	5.00	4.09	3.93	7.16
MIN.	-1.00	-1.75	-1.42	-0.74	-0.38	-0.50	-0.88	-0.03	0.12	0.01	-0.55	-0.78	-1.75

Station 76020
Bayou Bienvenue at Paris Road (LA.)
Gage Zero is at NGVD
Mean Summation for the Period of Record: 1974-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	0.93	0.88	0.90	1.11	1.15	0.95	0.78	1.16	1.69	1.56	1.48	1.19	1.16
MAX.	2.96	3.05	2.63	4.05	4.24	2.55	3.09	3.23	3.24	2.90	2.83	3.37	4.24
MIN.	-1.04	-1.65	-1.82	-0.95	-0.34	-0.34	-0.55	-0.10	0.76	0.38	-0.09	-0.70	-1.82

Station 76025
Bayou Bienvenue at Floodgate (East) (LA.)
Gage Zero is at NGVD
Mean Summation for the Period of Record: 1974-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	0.54	0.50	0.57	0.85	1.01	0.95	0.99	1.31	1.74	1.61	1.35	1.00	1.04
MAX.	5.99	4.05	2.64	4.02	2.89	2.70	3.20	3.54	4.11	5.40	3.23	3.25	5.99
MIN.	-1.13	-2.37	-1.26	-0.94	-0.45	-0.77	-0.27	0.29	0.34	0.17	-0.09	-0.60	-2.37

TABLE A-15 (Cont'd)
Mean, Maximum and Minimum Stages
(8:00 a.m. Observations)

Station 76024
Bayou Bienvenue at Floodgate (West)(LA.)
Gage Zero is at NGVD
Mean Summation for the Period of Record: 1975-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	0.70	0.67	0.70	0.99	1.08	1.03	0.85	1.25	1.65	1.57	1.38	1.14	1.10
MAX.	2.93	2.83	2.35	3.73	2.56	2.27	2.32	3.24	3.20	3.68	2.59	3.19	3.73
MIN.	-1.01	-1.33	-1.11	-0.87	-0.89	-0.32	-0.22	0.12	0.03	0.36	0.03	-0.25	-1.33

Station 76010
Bayou Dupre at Floodgate (East)(LA.)
Gage Zero is at NGVD
Mean Summation for the Period of Record: 1975-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	0.36	0.36	0.43	0.67	0.81	0.85	0.78	1.18	1.68	1.55	1.20	0.80	0.96
MAX.	1.93	2.47	2.62	3.27	2.65	2.59	3.05	3.36	4.08	5.32	2.97	5.08	5.32
MIN.	-1.14	-1.85	-1.22	-0.88	-0.67	-0.74	-0.73	0.10	0.01	0.05	-0.39	-0.64	-1.85

Station 76005
Bayou Dupre at Floodgate (West) (LA.)
Gage Zero is at NGVD
Mean Summation for the Period of Record: 1975-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	0.47	0.41	0.57	0.80	0.95	0.87	0.80	1.18	1.62	1.49	1.23	0.88	0.98
MAX.	2.20	2.49	2.26	3.29	2.53	2.08	2.63	2.85	2.87	3.28	2.44	2.49	3.29
MIN.	-1.30	-1.88	-1.23	-0.92	-0.51	-0.66	-0.33	0.07	0.80	0.12	-0.19	-0.53	-1.88

Station 85800
Mississippi River-Gulf Outlet at Shell Beach, LA.
Gage Zero is at NGVD
Mean Summation for the Period of Record: 1961-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	0.65	0.61	0.81	1.14	1.35	1.37	1.37	1.71	2.16	1.90	1.32	0.91	1.30
MAX.	6.80	4.05	3.25	3.97	4.09	3.57	3.46	4.52	9.17	4.62	3.74	2.83	9.17
MIN.	-1.28	-1.93	-1.09	-0.75	-0.47	-0.25	-0.51	0.25	0.57	0.03	-0.88	-0.88	-1.93

TABLE A-15 (Cont'd)
Mean, Maximum and Minimum Stages
(8:00 a.m. Observations)

Station 85850
Breton Sound near Gardner Island, LA.
Mean Summation for the Period of Record: 1960-1984

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	0.43	0.58	0.87	1.31	1.58	1.64	1.51	1.75	2.01	1.57	1.09	0.69	1.34
MAX.	2.19	2.80	2.99	3.40	3.53	3.54	3.48	3.55	5.10	4.43	3.13	2.64	5.10
MIN.	-2.30	-2.80	-1.26	-1.25	-0.10	0.03	-0.21	0.14	0.30	-0.59	-1.88	-0.81	-2.80

Station 88200
Gulf of Mexico at Biloxi, MS.
Mean Summation for the Period of Record: 1959-1983

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	PERIOD TOTAL
MEAN	-0.58	-0.48	0.01	0.60	0.91	1.07	0.98	1.06	1.16	0.60	-0.01	-0.40	0.42
MAX.	3.50	2.13	4.22	4.47	2.94	2.75	3.40	15.52	6.07	4.52	2.14	2.62	15.52
MIN.	-2.92	-3.17	-2.89	-1.28	-0.58	-0.34	-0.68	-0.33	-0.44	-1.39	-2.87	-2.53	-3.17

APPENDIX B

PETITION TO ESTABLISH SAFETY ZONE REGULATIONS ON THE MISSISSIPPI RIVER-GULF OUTLET

Tulane Law Clinic

7031 Freret Street
New Orleans, Louisiana 70118
(504) 865-5153

Col Brown
w/ the draft
this petition would
be of interest
Oh

October 1[illegible], 198[illegible]

Captain J.W. Klotz, Commanding Officer
United States Coast Guard
Marine Safety Office
600 South Maestri Place
New Orleans, LA 70130

RE: Mississippi River Gulf Outlet

Dear Captain Klotz:

Enclosed please find a Petition to Establish Safety Zone Regulations along the Mississippi River Gulf Outlet. This petition is filed pursuant to the Ports and Waterways Safety Act of 1972, 33 U.S.C. 1211 et seq.

I have enclosed an additional copy of the petition. Please mark on it the date and time of receipt for my records and return this copy to me. The necessary information is contained in the attached petition; however, should you desire additional information, please feel free to contact me.

Sincerely,

Kera Kostun
Student Attorney

KK/hc

10/13

Professor Houck,
This petition was mailed today.
Kera

IN THE UNITED STATES COAST GUARD

EIGHTH COAST GUARD DISTRICT

PETITION #

FILED:

PETITION TO ESTABLISH SAFETY ZONE REGULATIONS PURSUANT TO 33 U.S.C. SECTION 1221 ET SEQ.

A. STANDING OF THE PETITIONERS

1. Petitioners, William J. Guarino, Jr., Kenneth R. Campo, Sr., Bill Russell and Henry J. Rodriguez, Jr. each own property including fishing vessels and piers along canals which are connected to the Mississippi River Gulf Outlet (MRGO). Each of the above petitioners has suffered damage as a result of the movement of vessels on the MRGO and is therefore entitled to petition for the relief requested below.

2. Additionally, members of the Delta Chapter of the Sierra Club are users of the area surrounding the MRGO and the current and continuing enviromental harm to this area which is the result of wave action on the MRGO has impaired and limited the Sierra Club's use and enjoyment of the area. The establishment of the safety zone and other relief requested below would serve to protect the interest of this group and its individual members.

B. STATEMENT OF THE PROBLEM

3. The MRGO is a 76 mile waterway, 36 feet deep and 500 feet wide, authorized by the United States Congress in 1956 and constructed by the United States Army Corps. of Engineers commencing in 1958. See Howard, et al., the Mississippi River Gulf Outlet: A Study of Bank Stabilization (1984) [hereinafter 'Study'], at 1-1, 3-1.

4. Forty-three miles of the MRGO fall within a "landcut" through low-lying marshland, most of which traverses the ecologically sensitive wetlands of St. Bernard Parish. Id. and see 46 Fed. Reg. 29933, 29934.

5. An estimated 800 twenty to twenty-nine foot draft vessels and 600 thirty-plus foot draft vessels travelled the MRGO in 1984. Study at 3-8.

6. The MRGO has caused and is causing irrevocable environmental damage to land situated within the Parish of St. Bernard, including but not limited to the following: habitat change, marsh loss, and severe shoreline erosion. These problems evolved immediately following construction and continue largely unabated to this day. See, e.g., id., at 1-1; 2-12 et seq.

7. The United States Army Corps of Engineers has characterized the MRGO as one of eight areas in south Louisiana where "erosion stabilization measures are urgently needed." See id., at 1-1, and sources cited.

8. The northeast shore of the MRGO in particular is susceptible to erosion induced by saltwater intrusion and the force of waves from passing vessels, and has not yet received any protective stabilization measures. Id. at 1-1.

9. Erosion on the northeast shore of the MRGO between 1965 and 1981 ranged from 100 feet to 600 feet of direct shoreline recession, with rates of erosion measured at from 6 to 26 feet per year; and volume of erosion is calculated at 9,333,000 cubic yards during this period, or 583,000 cubic yards per year. Id. at 4-22; 4-32.

10. Erosion on the northeast shore of the MRGO threatens to break through the shoreline and join the MRGO with Lake Borgne, a consequence with potentially dramatic and adverse environmental and economic consequences.

11. The dominant cause of erosion on the MRGO shore is ship waves produced by large displacement, oceangoing vessels. Id. at 4-19 et seq.

12. Waves increase geometrically in proportion to vessel speed; accordingly, one factor contributing significantly to shoreline erosion in St. Bernard Parish is the rate of speed of vessels traveling through the MRGO. Id. at 5-27.

13. Present speeds of oceangoing vessels on the MRGO range from 12 to 17 miles per hour, with an average speed of 14 miles per hour. Id.

14. A speed limit of 10 miles per hour on the MRGO would substantially reduce erosion on the banks of the canal, such reduction in erosion estimated to be one half of the present rate. Id.

15. There currently exists no speed limit on the MRGO.

16. Hazardous substances, including but not limited to vinyl chloride, sytrene, benzene, chlorine, toluene, sulfuric acid, and analine, are commonly carried by tank ship and tank barge along the MRGO. "Major vessel casualties along the waterway could result in a catastrophic release of hazardous substances into the environment. The resulting damage to aquatic species and habitat could take years to mend." EA No. 08-71-84, U.S. Coast Guard, at 9.

17. The July 1980 collision of the M/V Sea Daniel and the M/V Testbank, at Mile 41 of the MRGO, caused a container holding "about twelve tons" of pentachlorophenol (PCP) to be lost overboard. "This was the largest PCP spill in United States history." The MRGO was closed to navigation; all fishing, shrimping and associated activities on and within 400 square miles of the canal was suspended for one month. Losses caused by the collision, by pollution, and by bans to navigation and fishing were extensive. See, e.g., State of Louisiana ex rel. Williams J. Guste, Jr., v. M/V Testbank, et al., 752 F.2d 1019 (5th Cir. 1985) (en banc) (Wisdom, J., dissenting).

18. Collisions, ramming, and groundings on delta waterways are expected to increase overall during the next 15 years. See EA No. 08-71-84, at 8 and sources cited.

19. There currently exists no mechanism by which the Parish of St. Bernard is informed of the nature and extent of hazardous cargo transport along the MRGO.

20. There currently exists no coordinated emergency or cleanup plan in anticipation of future catastrophies similar to the Testbank Collision.

C. STATEMENT OF COAST GUARD AUTHORITY AND DUTY TO REGULATE VESSEL SPEED

21. The United States Coast Guard is vested with authority under the Ports and Waterways Safety Act of 1972, 33 U.S.C. section 1221 et seq., to establish vessel speed limitations to protect the navigable waters and any land structure or shore area immediately adjacent to those waters.

22. The United States Coast Guard has undertaken to declare a Safety Zone for the MRGO. See 33 C.F.R. sec. 165.801 (1984).

23. The United States Coast Guard has authority to impose speed limitations on the MRGO for the specific purpose of preventing shoreline erosion and wake damage.

24. The United States Coast Guard has undertaken to regulate vessel speed in other waterways for the specific purpose of preventing shoreline erosion and wake damage. E.g., 33 C.F.R. sec. 161.157 (Puget Sound Vessel Traffic Service); 33

C.F.R. sec. 161.880-161.886 (St. Marys River Vessel Traffic Service); and see 46 Fed. Reg. 946, 948 January 5, 1981.

D. STATEMENT OF COAST GUARD AUTHORITY AND DUTY TO REGULATE TRANSPORT OF HAZARDOUS MATERIALS

25. The United States Coast Guard is vested with authority under the Ports and Waterways Safety Act of 1972, 33 U.S.C. sec. 1221 et seq. to regulate transport of hazardous substances on navigable waterways in order to protect against environmental harm resulting from collisions, rammings, and groundings.

26. The United States Coast Guard has undertaken to regulate transport of hazardous substances in other waterways for the specific purpose of protecting against environmental harm resulting from collisions, rammings, and groundings. E.g. 33 C.F.R. sec. 161.301 et seq. (Prince William Sound Vessel Traffic Service); 33 C.F.R. sec. 161.701 et seq. (Berwick Bay Vessel Traffic Service); and see VTS San Francisco User's Manual (VTSPUB P16630.3); COTP SFB Public Notice 3-82 (Vessel Movement Controls in Humboldt Bay); COTP SFB Public Notice 2-82 (Vessel Movement Controls in San Francisco Bay); Boston Marine Safety Circular 3-84 (Port of Boston LNG - LPB Vessel Management Plan and Emergency Plan); COTP Portland LPG Vessel Management Plan and LPG Emergency Contingency Plan).

27. The United States Coast Guard is vested with authority under the Ports and Waterways Safety Act of 1972, 33 U.S.C. sec. 1221 et seq. to develop, coordinate and implement Emergency

Contingency Plans to minimize harm caused by collisions, rammings, and groundings of vessels transporting hazardous substances.

28. The United States Coast Guard has undertaken to develop, coordinate and implement Emergency Contingency Plans to minimize harm caused by collisions, rammings, and groundings of vessels transporting hazardous substances in other waters. E.g., Boston Marine Safety Circular 3-84 (Port of Boston LNG - LPG Vessel Management Plan and Emergency Plan); COTP Portland LPG Vessel Management Plan and LPG Emergency Contingency Plan).

E. ENTITLEMENT OF PETITIONER TO SEEK RELIEF

29. Petitioner is entitled to request that vessel speed limitations be adopted to protect the navigable waters of the MRGO and any land structure or shore area immedaitely adjacent to those waters, as provided by 33 C.F.R. sec. 165.5(b), alternatively as provided by 33 C.F.R. sec. 160.7.

30. Petitioner is entitled to request that the transport of hazardous substances on the MRGO be regulated to protect against environmental harm resulting from collisions, rammings, and groundings, as provided by 33 C.F.R. sec. 165.5(b) alternatively as provided by 33 C.F.R. sec. 160.7.

31. Petitioner is entitled to request that the United States Coast Guard, Eighth Coast Guard District develop, coordinate and implement an Emergency Contingency Plan to

minimize harm caused by collisions, rammings, and groundings of vessels transporting hazardous substances on the MRGO, as provided by 33 C.F.R. sec. 165.5(b) alternatively as provided by 33 C.F.R. sec. 160.7.

F. RELIEF SOUGHT

32. Petitioner desires and respectfully requests that such speed limitations be imposed on the MRGO, and that a speed limit of 10 miles per hour be set by the United States Coast Guard on that portion of the MRGO which traverses St. Bernard Parish.

33. Petitioner desires and respectfully requests that such speed limitations be of indefinite or permanent duration.

34. Petitioner desires and respectfully requests that such speed limitations be imposed immediately upon conclusion of such proceedings as are required by law.

35. Petitioner desires and respectfully requests that the United States Coast Guard exercise its regulatory authority under the Ports and Waterways Safety Act of 1972, 33 U.S.C. sec. 1221 et seq. to protect the navigable waters of the MRGO and any land structure or shore area immediately adjacent to those waters from environmental harm resulting from collisions, rammings, and groundings of vessels transporting hazardous substances.

36. Petitioner desires and respectfully requests that such regulation, at a minimum, afford protection comparable to that

afforded under the Berwick Bay Vessel Traffic Service, 33 C.F.R. sec. 161.701 et seq.

37. Petitioner desires and respectfully requests that such regulatory measures incorporate a means of alerting petitioner to the names and positions of vessels carrying hazardous substances before such vessels enter or begin to navigate on the MRGO through St. Bernard Parish, and that such regulatory measures include a means of apprising petitioner of the nature and amount of hazardous substances transported by such vessels on the MRGO through St. Bernard Parish.

38. Petitioner desires and respectfully requests that such regulation be of indefinite or permanent duration.

39. Petitioner desires and respectfully requests that such regulation be undertaken immediately upon conclusion of such proceedings as are required by law.

40. Petitioner desires and respectfully requests that the United States Coast Guard, Eighth Coast Guard District develop, coordinate and implement an Emergency Contingency Plan to minimize harm caused by collisions, rammings, and groundings of vessels transporting hazardous substances on the MRGO.

41. Petitioner desires and respectfully requests that such Emergency Contingency Plan be substantially similiar to the Port of Boston LNG - LPG Vessel Management Plan and Emergency Plan, and the COTP Portland LPG Vessel Management Plan and LPG Emergency Contingency Plan, except that such plan not be limited

to incidents involving LNG/LPG vessels, but shall operate as to incidents involving vessels carrying any hazardous material listed under 33 C.F.R. sec. 162.10.

42. Petitioner desires and respectfully requests that such an Emergency Contingency Plan be developed, coordinated, and implemented on an indefinite or permanent basis.

43. Petitioner desires and respectfully requests that such an Emergency Contingency Plan be developed, coordinated, and implemented immediately upon conclusion of such proceedings as are required by law.

Respectfully submitted,

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Student Attorney

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APPENDIX C

REAL ESTATE COST ESTIMATES

TABLE OF CONTENTS

APPENDIX C

STRUCTURAL OPTION 1

IDENTIFICATION
NUMBER 70909

REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER-GULF OUTLET, ST. BERNARD PARISH,
LOUISIANA (BANK EROSION)
RECONNAISSANCE STUDY

North Bank Critical Reaches (Mile 51 to 56; Mile 38 to 45; Mile 23 to 30)

ESTIMATE OF COSTS (Date of Value - July 1987)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Bank Stabilization Easement Marshland	576	$250	$144,000
	Disposal Easement Marshland	576	$250 x .80	$115,200
	Improvements			0
	Severance Damage			0
	Total (R)			$259,000
(b)	Contingencies 25% (R)			$65,000
(c)	Acquisition Costs (Estimated 75 tracts)			
	Non-Federal	75 @ $1,000 per tract		$75,000
	Federal			$13,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Cost			$412,000

STRUCTURAL OPTION 2

IDENTIFICATION
NUMBER 70909

REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER-GULF OUTLET, ST. BERNARD PARISH,
LOUISIANA (BANK EROSION)

North Bank- Mile 60 to Mile 23

ESTIMATE OF COSTS (Date of Value - July 1987)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Bank Stabilization Easement Marshland	1,125	$250	$281,250
	Disposal Easement Marshland	1,125	$250 x .80	$225,000
	Improvements			0
	Severance Damage			0
	Total (R)			$506,000
(b)	Contingencies 25% (R)			$127,000
(c)	Acquisition Costs (Estimated 100 tracts)			
	Non-Federal	100 @ $1,000 per tract		$100,000
	Federal			$17,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Cost			$750,000

STRUCTURAL OPTION 3

IDENTIFICATION
NUMBER 70909

REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER-GULF OUTLET, ST. BERNARD PARISH,
LOUISIANA (BANK EROSION)

North Bank (Mile 60 to 23) and South Bank (Existing Disposal Area)

ESTIMATE OF COSTS (Date of Value - July 1987)

		Acres	Unit Value	Total Value
(a)	Lands and Damages			
	Bank Stabilization Easement Marshland (North Bank, Mile 60 to Mile 23)	1,125	$250	$281,250
	Disposal Easement Marshland (North Bank)	1,125	$250 x .80	$225,000
	Bank Stabilization Easement Marshland (South Bank within existing disposal area)	730	$250 x .20	$36,500
	Improvements			0
	Severance Damage			0
	Total (R)			$543,000
(b)	Contingencies 25% (R)			$136,000
(c)	Acquisition Costs (Estimated 150 tracts)			
	Non-Federal 150 @ $1,000 per tract			$150,000
	Federal			$25,000
(d)	PL 91-646			0
(e)	Total Estimated Real Estate Cost			$854,000

IDENTIFICATION
NUMBER 70909

REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER-GULF OUTLET, ST. BERNARD PARISH,
LOUISIANA (BANK EROSION)

This estimate is based on mapping and acreage calculations as provided by Planning Division. The north bank of the Mississippi River - Gulf Outlet consists of unencumbered marshland. The project area on the south bank is located within the present perpetual disposal area for the Mississippi River-Gulf Outlet. A bank stabilization easement will be required on the south bank.

JOSEPH G. KOPEC
Appraiser
9 September 1987

Approved:

WARREN E. deSAMBOURG
Reviewing Appraiser
9 September 1987

IDENTIFICATION
NUMBER 71030

REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER-GULF OUTLET, ST. BERNARD PARISH, LOUISIANA (BANK EROSION)

NORTH BANK DISPOSAL AREA - MILE 23 TO MILE 27

ESTIMATE OF COSTS (Date of Value - July 1987)

		Acres	Unit Value	Total Value
(a)	Lands & Damages			
	Disposal Easement Marshland	970	$250 x .80	$194,000
	Improvements			$0
	Severance Damage			$0
	Total			$194,000
(b)	Contingencies 25% (R)			$49,000
(c)	Acquisition Costs (Estimated 10 tracts)			
	Non-Federal 10 @ $1,000 per tract			$10,000
	Federal			$4,000
(d)	PL-91-646			$0
(e)	Total Estimated Real Estate Cost			$257,000

IDENTIFICATION
NUMBER 71030

REAL ESTATE COST ESTIMATE
MISSISSIPPI RIVER-GULF OUTLET, ST. BERNARD PARISH,
LOUISIANA (BANK EROSION)

NORTH BANK DISPOSAL AREA - MILE 23 TO MILE 27

This estimate is based on mapping and acreage calculations as provided by Planning Division.

JOSEPH G. KOPEC
Appraiser
30 October 1987

Approved:

WARREN E. deSAMBOURG
Reviewing Appraiser
30 October 1987

APPENDIX D

STUDY MAILING LIST

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APPENDIX E

USFWS PLANNING AID LETTER

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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August 21, 1987

Colonel Lloyd K. Brown
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160

Dear Colonel Brown:

Reference is made to the reconnaissance study "Mississippi River-Gulf Outlet, St. Bernard Parish, Louisiana, (Bank Erosion)" being conducted under a resolution adopted by the Committee on Public Works and Transportation of the United States House of Representatives on September 23, 1982. The purpose of the study is to assess the erosion problems on the Mississippi River-Gulf Outlet and determine the advisability of improving or modifying the existing unleveed banks of that waterway in St. Bernard Parish, Louisiana, to reduce the extensive erosion occurring there. The attached report is provided on a planning-aid basis to assist your staff in the preparation of a reconnaissance report for the above-referenced study; it does not constitute the report of the Secretary of the Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act.

We appreciate the cooperation exhibited by your staff during this study. Should questions arise regarding this report, please have your staff contact me.

Sincerely yours,

David W. Frugé
David W. Frugé
Field Supervisor

Attachment

PLANNING-AID REPORT

ON

MISSISSIPPI RIVER-GULF OUTLET

ST. BERNARD PARISH, LOUISIANA (BANK EROSION)

RECONNAISSANCE STUDY

PREPARED BY

WILFRED B. KUCERA

FISH AND WILDLIFE BIOLOGIST

FISH AND WILDLIFE ENHANCEMENT

LAFAYETTE, LOUISIANA

U.S. FISH AND WILDLIFE SERVICE

SOUTHEAST REGION

ATLANTA, GEORGIA

AUGUST 1987

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INTRODUCTION

The New Orleans District, Corps of Engineers, is conducting a reconnaissance study to assess the erosion problems on the Mississippi River-Gulf Outlet and to determine the advisability of improving or modifying the existing unleveed banks of that waterway in St. Bernard Parish, Louisiana, to reduce erosion. The study is being conducted in response to a resolution adopted on September 23, 1982, by the Committee on Public Works and Transportation of the United States House of Representatives. This planning-aid report has been prepared in an effort to assist the Corps of Engineers in its preparation of a reconnaissance report for this study. The report describes existing and anticipated future fish and wildlife resources in the study area, discusses fish- and wildlife-related problems, opportunities, and planning objectives, briefly assesses the impacts of various project alternatives being considered, discusses Fish and Wildlife Coordination Act activities anticipated in the feasibility phase, and provides tentative fish and wildlife conservation recommendations. This report 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 (Figure 1) lies in St. Bernard Parish in southeastern Louisiana and encompasses much of the portion of that Mississippi River-Gulf Outlet (Gulf Outlet) that was excavated through marsh habitats. On the northeast bank, the study area extends from mile 23 to mile 60. On the southwest bank the study area extends from mile 23 to mile 47, thus excluding a segment bordered by a hurricane protection levee. The Gulf Outlet is a 76-mile-long man-made waterway that extends from the Inner Harbor Navigation Canal at New Orleans to the Gulf of Mexico. This ship canal was originally dug to 36 feet deep (below mean sea level) and 500 feet wide (bottom width); it was completed in 1961. The primary purpose of the Gulf Outlet project was to provide a shorter, alternate route for ocean-going vessels between the Gulf of Mexico and the Port of New Orleans.

DESCRIPTION OF FISH AND WILDLIFE RESOURCE CONDITIONS

Existing Conditions

In 1978, an area largely coinciding with the present study area was characterized as consisting of about 61 percent marsh, 26 percent open water, 12 percent Gulf Outlet, and 1 percent shrub and forest land (Wicker et al. 1982). Since the Gulf Outlet was completed, it has continued to widen at a rate of about 15 feet per year. This erosion is believed to be mostly caused by the huge wakes of fast-moving ships. By 1978, about 3,015 acres that had been mostly marsh prior to

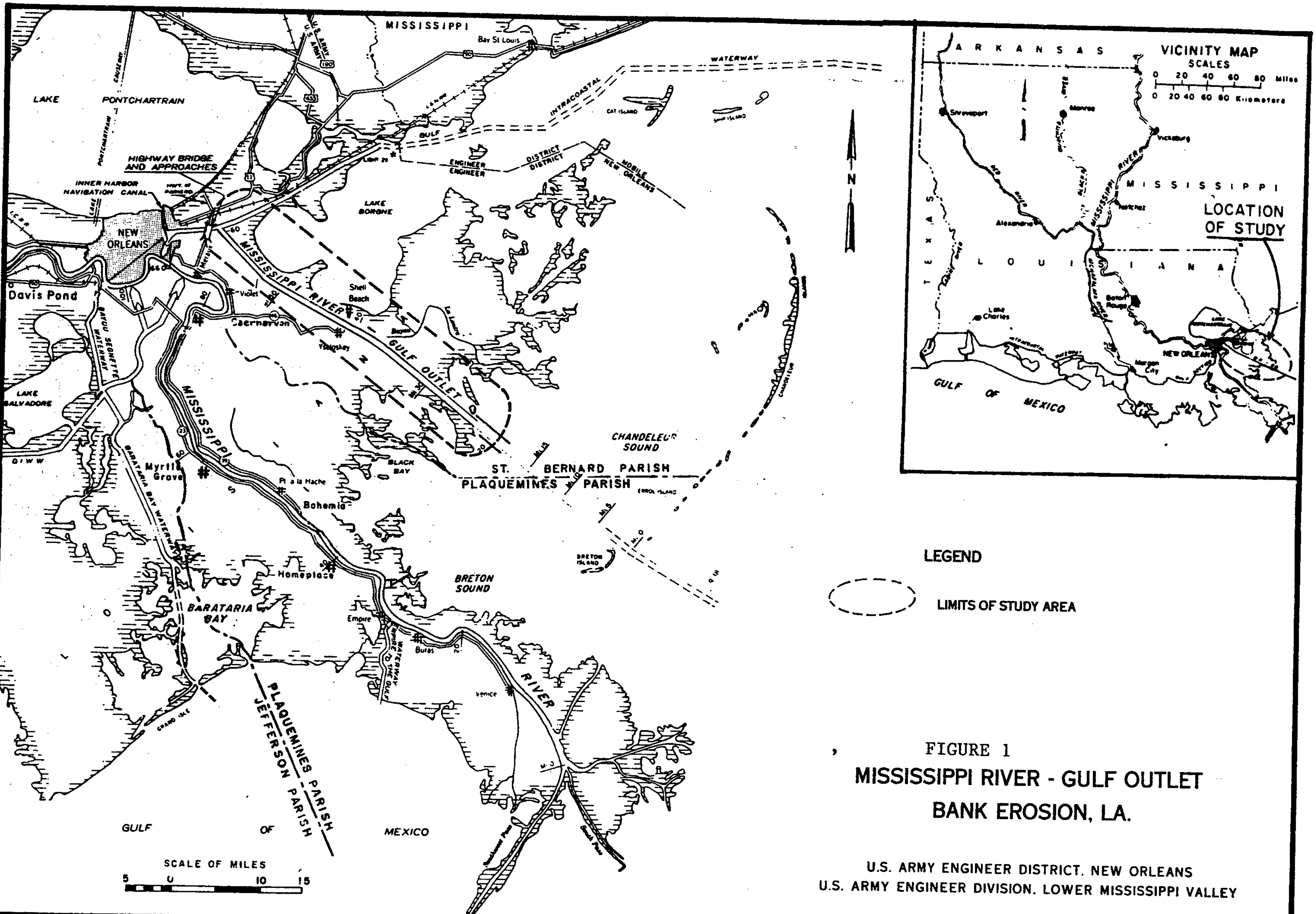

FIGURE 1

MISSISSIPPI RIVER - GULF OUTLET
BANK EROSION, LA.

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
U.S. ARMY ENGINEER DIVISION, LOWER MISSISSIPPI VALLEY

excavation of the Gulf Outlet were occupied by the Gulf Outlet and adjacent eroded areas. Before construction of the waterway the study area was a relatively fresh to brackish marsh. Salinity samples taken along the proposed route by Rounsefell (1964) in May and October 1960 showed that average salinities were only 2.4 parts per thousand and 3.85 parts per thousand, respectively. When the Bayou La Loutre Ridge was breached during construction, saline waters from Breton Sound traveled the length of the waterway. In 1981, a Corps of Engineers study recorded salinity levels of 35 parts per thousand at the channel entrance to the Gulf of Mexico and 10 parts per thousand at the Inner Harbor Navigation Canal (U.S. Army Corps of Engineers 1981). That study further suggested that no saltwater wedge exists in the Gulf Outlet and that salinities are uniform from the water surface to the bottom of the waterway.

The increase in salinity caused by the Gulf Outlet has had a significant effect on the kind of marsh that vegetates the area and the fish and wildlife species that inhabitat it. Before construction, the study area was largely vegetated with saltmeadow cordgrass and three-cornered grass with widgeon grass growing in many of the nearly isolated open waters. Following project construction, saltwater intrusion caused the freshwater vegetation and a large amount of brackish marsh vegetation in the study area to die. Without vegetation to hold it, a large amount of organic marsh soil eroded and large areas of marsh became open water before salt tolerant vegetation could become established. Sandy ridge soils and swamp soils protected by undecayed logs were somewhat more resistant to erosion. Anaerobic decomposition of organic soils also contributed to land loss after salt water intruded into the area, because salt water neutralizes the acids that tend to preserve organic matter.

Saline marsh is found along the edge of the Gulf Outlet throughout the study area. This marsh type is vegetated with almost pure stands of saltmarsh cordgrass, especially near the bodies of open water. Further inland from shoreline areas there are also sizable expanses of black rush, while saltgrass vegetates the higher elevations. Vegetation in the brackish marshes consists of saltmeadow cordgrass with occasional stands of three-cornered grass in the less-saline portions. The brackish marshes with the lowest salinity levels, as well as isolated pockets of intermediate marsh, are found within areas where water control is exercised by private land managers (via levees, weirs, and other water control structures), and within the existing spoil areas along the Gulf Outlet. The spoil containment dikes serve to trap rainwater, thus fostering the growth of more desirable plants sought by waterfowl and furbearers.

The marshes of the study area dissipate tidal and wave energy and thereby help control erosion. These marshes serve as a sediment trap, wildlife habitat, and an estuarine nursery. The marshes are an important part of the estuarine ecosystem because of their high rates of production of vegetation which ultimately is the source of food (as plant detritus) for the area's fishes and shellfishes. The extremely high primary productivity of the Louisiana marshes is thought to be largely responsible for this portion of the Gulf of Mexico being called the "fertile fisheries crescent" (Gunter 1967). Due to this high production, the saline and brackish marshes and associated shallow waters of the project area have been designated as Resource Category 2 habitats, as defined in the Fish and Wildlife Service Mitigation Policy (Federal Register, Vol. 46, No. 15, January 23, 1981). These wetlands are becoming relatively scarce on a national basis and throughout coastal Louisiana. The Service's mitigation goal for Resource Category 2 habitats is no net loss of "in-kind" habitat value.

The study area's limited populations of freshwater fish disappeared soon after construction of the Gulf Outlet. A post-construction inventory of the fishes of the study area revealed that spotted seatrout, Atlantic croaker, black drum, red drum, sheepshead, striped mullet, and menhaden were the most common sport and commercial fishes of the area (Fontenot and Rogillio 1970). Many other estuarine fishes are abundant in the area; while not recreationally or commercially important, those species play an important ecological role by serving as food for predatory species. Important prey species include bay anchovy, silversides, gobies, and various killifishes.

White shrimp and brown shrimp, which are the most valuable fishery products of the Gulf of Mexico, use the marshes and shallow open waters of the project area as nursery and feeding habitat. Although the adults spawn offshore, postlarval shrimp migrate into the marshes and estuaries where they feed and find shelter from predators until nearly grown. Other crustaceans utilizing the marshes include grass shrimp, mantis shrimp, and amphipods, which serve as food organisms for many of the species important to man. The blue crab is another estuarine-dependent crustacean that supports an extensive commercial fishery. Adults spawn in offshore areas and the larvae utilize the project area marshes for nursery purposes. Other crabs in the study area that are of ecological importance include the stone crab, the fiddler crab, and hermit crabs.

The study area also provides excellent habitat for the American oyster; some of the less saline canals and other open waters are regularly planted with seed oysters. These planted oysters, as well as naturally seeded oysters, support an important commercial fishery. Oyster reefs are also important ecologically because they provide food source for such species as black drum and stone crab and they also provide cover for numerous species of fishes and shellfishes.

The diamondback terrapin and the Gulf saltmarsh snake are the only two reptile species that are commonly found in the salt marshes of coastal Louisiana. The American alligator is primarily an inhabitant of fresh and slightly brackish marshes, but occasionally wanders into more saline waters; its numbers in the project area are low due to saline nature of the marshes. Five species of sea turtles occur off Louisiana in the Gulf of Mexico and may occasionally utilize the project area; these are listed in the subsequent section on endangered species.

The most common species of waterfowl in the project area include gadwall, American wigeon, green-winged teal, blue-winged teal, mallard, pintail, shoveler, mottled duck, lesser scaup, and ring-necked duck. Of the above ducks, the mottled duck is the only species that nests in the study area. The overall value of the study area as habitat for migratory waterfowl has been greatly reduced by saltwater intrusion and associated habitat degradation caused by the Gulf Outlet.

Clapper rails are year-round residents of the saline marshes, while coots utilize the less-saline habitats in the winter. Virginia and sora rails may be occasionally found in the area in the winter. King rails and gallinules are year round residents of coastal Louisiana that may be found in limited numbers in the study area's less-saline marshes.

Non-game birds using the project area include various seabirds, wading birds, shorebirds, raptors, and perching birds. Some of the seabirds expected to occur in the project area include herring gull, laughing gull, ring-billed gull, black skimmer, Forster's tern, royal tern, Caspian tern, and least tern. Wading birds frequenting the study area include great egret, snowy egret, Louisiana heron, green heron, black-crowned night heron, great blue heron, white ibis, white-faced ibis, American bittern, and least bittern. Raptors reported as seen in the study area include the osprey, marsh hawk, and American kestrel. The Arctic peregrine falcon often winters along Gulf Coast beaches and could thus occasionally be found in the area. Shorebirds found in the study area include various plovers and sandpipers, sanderlings, willet, black-necked stilt, American oystercatcher, and killdeer. Some common passerine birds are present in the project area the year round while others are abundant only during migration.

Swamp rabbit, white-tailed deer, and wild hogs are game mammals found in the study area. Commercially important furbearers present include muskrat, raccoon, nutria, mink, and river otter. Non-game mammals frequenting the area include the nine-banded armadillo and the marsh rice rat.

The study area may occasionally be visited by several endangered species but it is not primary habitat for any of them. The brown pelican, hawksbill turtle, Kemp's (Atlantic) ridley turtle, and the leatherback turtle are endangered species that may occasionally be present in the study area. The Arctic peregrine falcon, the green turtle, and the loggerhead turtle are threatened species that may occasionally occur in the study area. The American alligator, listed as a threatened species under the Similarity of Appearance clause of the Endangered Species Act, is commonly found in the less-saline habitats of the study area.

The nearby State-operated Biloxi Wildlife Management Area is located north of the study area between Lake Borgne and Chandeleur Sound. This area provides public hunting opportunities primarily for waterfowl, coots, rails, snipe, and rabbits.

Future Without-Project Conditions

Since the Gulf Outlet was completed in 1961, the waterway has continued to widen about 15 feet per year in the study area; about 2,000 acres of marsh has been lost to this erosion process. The Corps of Engineers has estimated that in the next 50 years, 3,350 acres of saline marsh will be converted to open water on the north side of that waterway and 2,327 acres of saline marsh on the south side will become open water. Thus about 5,677 acres of ecologically important wetland habitat will be lost in the study area due to shoreline erosion along the waterway. Additional wetlands in other areas will no doubt be lost due to project-related increased water velocities in adjacent tidal waters, and continued saltwater intrusion. Loss of marshes will allow a greater and faster tidal exchange and higher storm surges, which will further accelerate erosion of remaining marshes in and adjacent to the study area.

Loss of such vast acreages of saline and brackish marshes will result in a loss of the primary productivity of those areas and also a loss of these marshes as nursery areas. Even though the amount of open water is expected to increase, the kinds of fish and shellfish using the study area are expected to remain about the same. The total production of estuarine-dependent fishes and shellfishes is believed to be dependent on the total marsh acreage in a given estuarine drainage basin. Although shrimp, crabs, fish, and other estuarine species will continue to be caught in the present and newly created open waters, the production of those organisms in the study area is expected to decrease as the marshes of the study area decrease. As higher salinities intrude farther inland, oyster production will continue to move to the remaining brackish waters farther inland. Those more-inland waters will be more troubled with pollution problems because of their proximity to urban runoff and associated high levels of fecal coliform bacteria.

Loss of marshes and increased salinity is expected to result in continued declines in habitat for waterfowl, coots, certain rails, and many of the wading bird species found in the study area. Loss of marsh will also result in reduction of habitat for the white-tailed deer, wild hogs, rabbits, various furbearers, alligators, and other reptiles.

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

The principal fish- and wildlife-related problem of the study area is the continuing loss of marsh due to shoreline erosion, saltwater intrusion, and subsidence. Almost any action that would reduce or eliminate shoreline erosion or restore eroded marsh would benefit fish and wildlife that are dependent on marsh habitats. There is very little intermediate and fresher brackish marsh habitat in the study area, but most of the waterfowl, wading birds, furbearers, and alligators are concentrated in such areas. These less-saline marsh types occur in leveed water management areas and in isolated wetland pockets within diked spoil disposal areas. The fresher water areas are important to many species of wildlife that also utilize the salt marshes, because many species are dependent on or attracted to fresher water for drinking.

An opportunity exists to create marsh within designated spoil disposal areas through careful planning and design of retaining dikes and associated outflow structures. Such structures could be operated by landowners to trap rainwater to form marsh impoundments of significant value to migratory waterfowl and other marsh-associated wildlife. As indicated previously, some such pockets of fresher marsh have been created incidentally as a result of spoil disposal activities along the Gulf Outlet. Presently it takes several years for spoil areas to recover to fresher habitats after being used. In order to prolong the life of these areas of higher-quality wildlife habitat, spoil areas could be subdivided so that when maintenance dredging is done, only a part of each spoil area would be used each time. Thus, the time between spoil deposition on any particular area of marsh would be extended and the area would have more time to recover to a fresher habitat.

In view of the foregoing discussion it is recommended that the following planning objectives be established for this study:

1. Prevent or substantially reduce the erosion of marsh along the banks of the Gulf Outlet.

2. Restore as much of the marsh that has eroded since project construction as is feasible.

3. Utilize maintenance dredging spoil to build marsh.

4. Stop or reduce the saltwater intrusion into as many parts of the study area as possible.

5. Reduce the ever increasing velocity of tidal surges through the study area.

6. Preserve and increase the few small acreages of relatively fresh marsh habitats in the study area through careful planning of maintenance dredging spoil disposal activities and associated spoil retention measures (retaining dikes, outflow weirs, etc.).

ALTERNATIVES UNDER CONSIDERATION

Based on discussions with your staff, we understand that the following alternatives for erosion control are under consideration:

1. No Federal action.

2. Articulated concrete mats with geo-textile underlayment.

3. Gobi-mats with geo-textile underlayment.

4. Metal mesh and plastic mesh gabions or reno mattresses with geo-textile underlayment.

5. Single-row timber pile protection with geo-textile material.

6. Double-row timber pile protection with geo-textile material between the rows, backfilled with suitable material.

7. Set-back (and pile-supported, if necessary) geo-textile material "sausages", filled with dredged material.

8. Geo-web confinement of dredged material with geo-textile underlayment.

9. An analysis of the cost-effectiveness of simply disposing dredged material on erosion prone reaches of Gulf Outlet shoreline.

10. An analysis of the effectiveness of speed reduction along the waterway to reduce erosion.

Structures in alternatives 2 through 8 would be backfilled with 100 to 200 feet of dredged material.

POTENTIAL SIGNIFICANT IMPACTS AND COMPARISON OF ALTERNATIVES

The "no action" alternative would not restore the 2,000 acres of marsh along the Gulf Outlet banks already lost and would allow another 5,677 acres of marsh along the banks to erode. An undetermined amount of additional marsh would also be lost due to saltwater intrusion, subsidence, and erosion due to increased velocities of tidal and vessel-generated surges.

Reduction in the speed of ships using the Gulf Outlet would merely cause an undetermined reduction in the rate at which the banks erode, but they would continue to erode. Rebuilding the eroded banks with dredged spoil material is, according to the Corps of Engineers, the costliest alternative proposed. Restoration would have to be repeated every five years and would probably result in almost continuously elevated turbidity and suspended sediment levels. The elevated turbidity and suspended sediment would reduce productivity of the area for many estuarine dependent species, and would be especially harmful to oysters.

All of the alternatives except "no action" and "reducing speed of ships" entail structural protection and restoration of some or all of the marsh along the banks of the Gulf Outlet that has eroded since completion of the waterway. Viewed in this way, all of the structural alternatives would have similar effects and would restore most or all of the approximately 270-foot-wide strip of banks that has eroded since completion of the Gulf Outlet. The bank protection work associated with those alternatives would restore about 2,000 acres of eroded banks and prevent erosion loss of another 5,677 acres over the next 50 years. Priority would be assigned to segments along the Gulf Outlet that have a potential to break through to Lake Borgne, because such a break would increase tidal surges, erosion, and sedimentation. The proposed bank restoration alternatives would tend to reduce saltwater intrusion and the speed of tidal surges. The project would also reduce the rate of marsh erosion attributable to tidal scour in that portion of the study area that is not subject to wave action by passing ships.

Several of the alternatives entail protection of restored bank with stone rip-rap or wire gabions. These forms of bank protection would have greater benefit to the fisheries of the area than would mere pilings or fabric sausages filled with sand; this is because the porous rock structures would provide much more surface area for attachment by invertebrates and a greater amount of hiding places for fish-food organisms, juvenile blue crabs, and small fishes. Stone crabs, blue crabs, shrimps, and myriads of other reef-loving species of crustaceans, fish, and other animals would utilize the new habitat created by rip-rap or other rocky substrate (e.g., gabions, concrete or gobi-mats, etc.).

FISH AND WILDLIFE COORDINATION ACT ACTIVITIES FOR THE FEASIBILITY PHASE

Data Needs

Should a feasibility study be conducted for this project, the following data will be needed by the Service for its analysis of project impacts on fish and wildlife resources and the formulation of measures to conserve those resources.

1. Up-to-date detailed maps of the study area.

2. A detailed description of alternatives being considered during the feasibility phase.

3. An estimate of saline marsh, brackish marsh, and open water acreages in the study area under future without-project and future with-project conditions (for each alternative considered), provided for existing conditions and 10-year intervals over the period of analysis.

Tasks and Associated Cost Estimates

Should the study advance to the feasibility phase, the Service will require substantial funding to carry out review and reporting responsibilities under the Fish and Wildlife Coordination Act. It is estimated that $8,100 will be required to produce a planning-aid report evaluating the impacts of alternatives considered during the plan formulation stage. An additional $16,200 will be required to prepare a draft and final Fish and Wildlife Coordination Act report. A detailed Scope of Work defining specific tasks and associated funding requirements for Service participation in the feasibility study should be prepared jointly by our respective staffs, should your study conclude that further Federal participation is warranted.

RECOMMENDATIONS

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

1. Further (i.e., feasibility stage) project planning should incorporate those planning objectives listed above.

2. Any action recommended for further consideration should include plans for restoration of marsh lost due to erosion of the Gulf Outlet, and preservation and enhancement of the remaining marsh habitats to the greatest extent possible.

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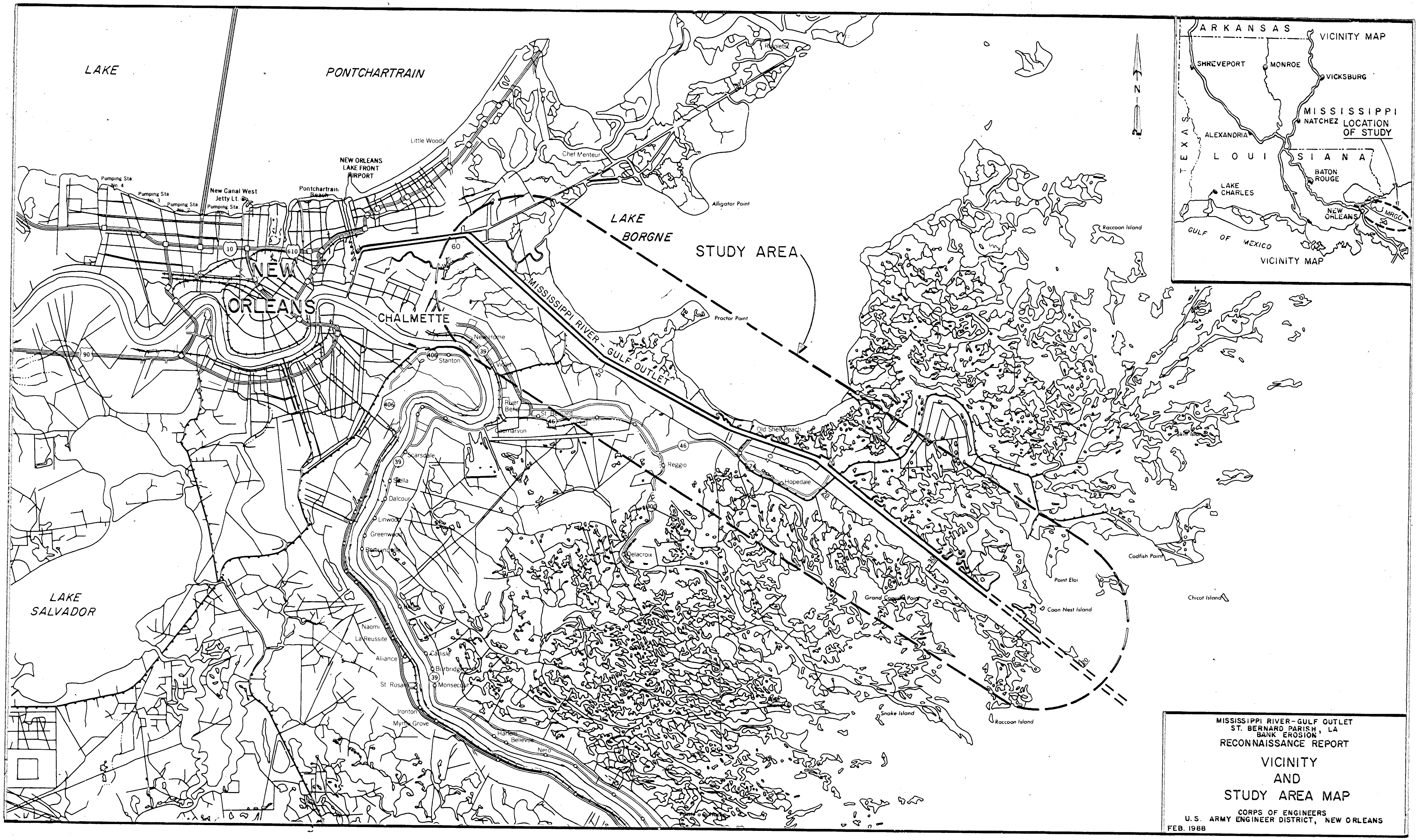

MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

VICINITY
AND
STUDY AREA MAP

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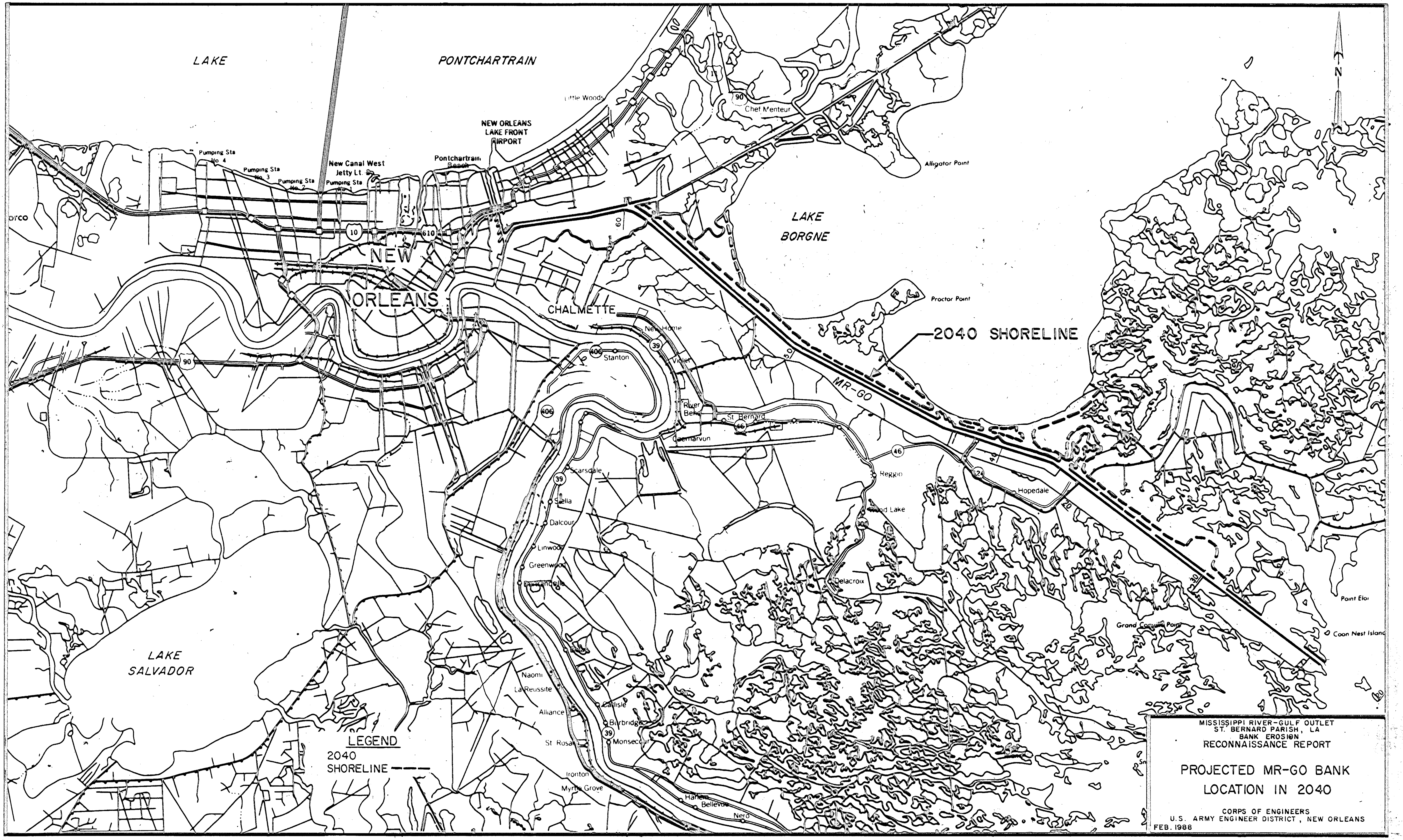

MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

PROJECTED MR-GO BANK
LOCATION IN 2040

CORPS OF ENGINEERS
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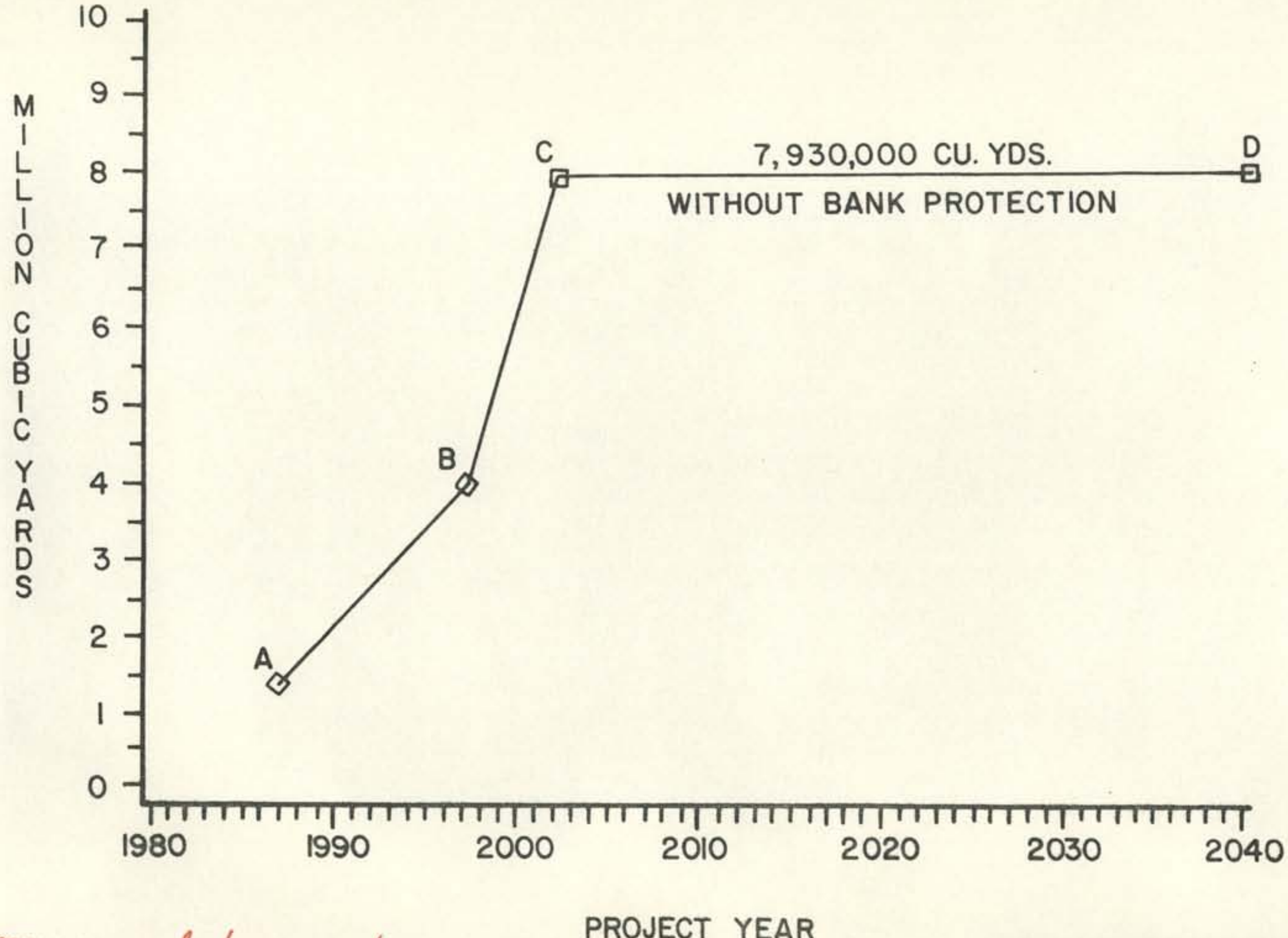
FEB. 1988



A - current average annual dredging (1.4 million cubic yds)
B - 1997 average " " (4.0 " " ")
C - 2002 ultimate average annual rate (7.9 million yds3)

MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

PROJECTED MAINTENANCE DREDGING REQUIREMENTS

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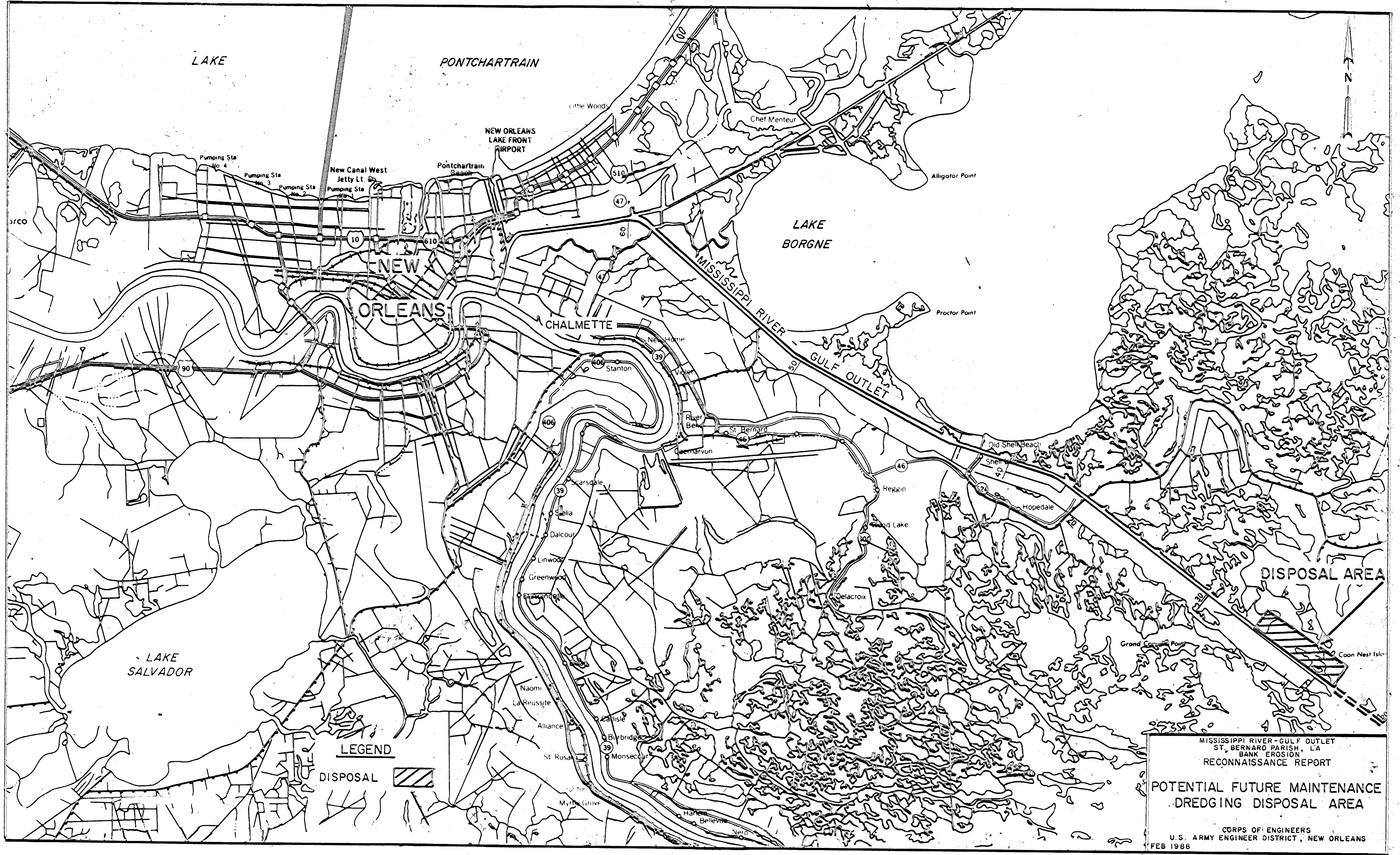
PLATE 3



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

POTENTIAL FUTURE MAINTENANCE DREDGING DISPOSAL AREA

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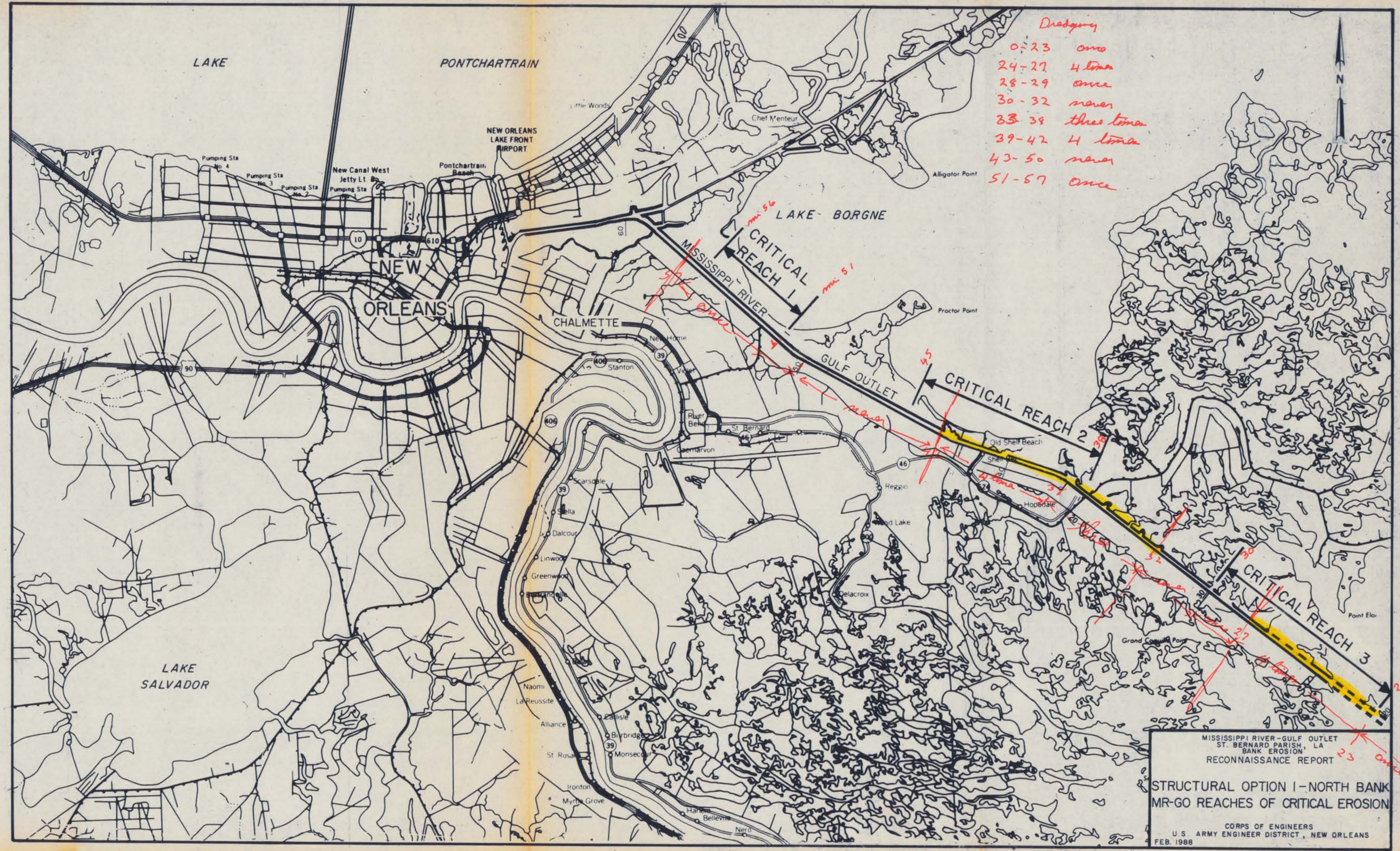
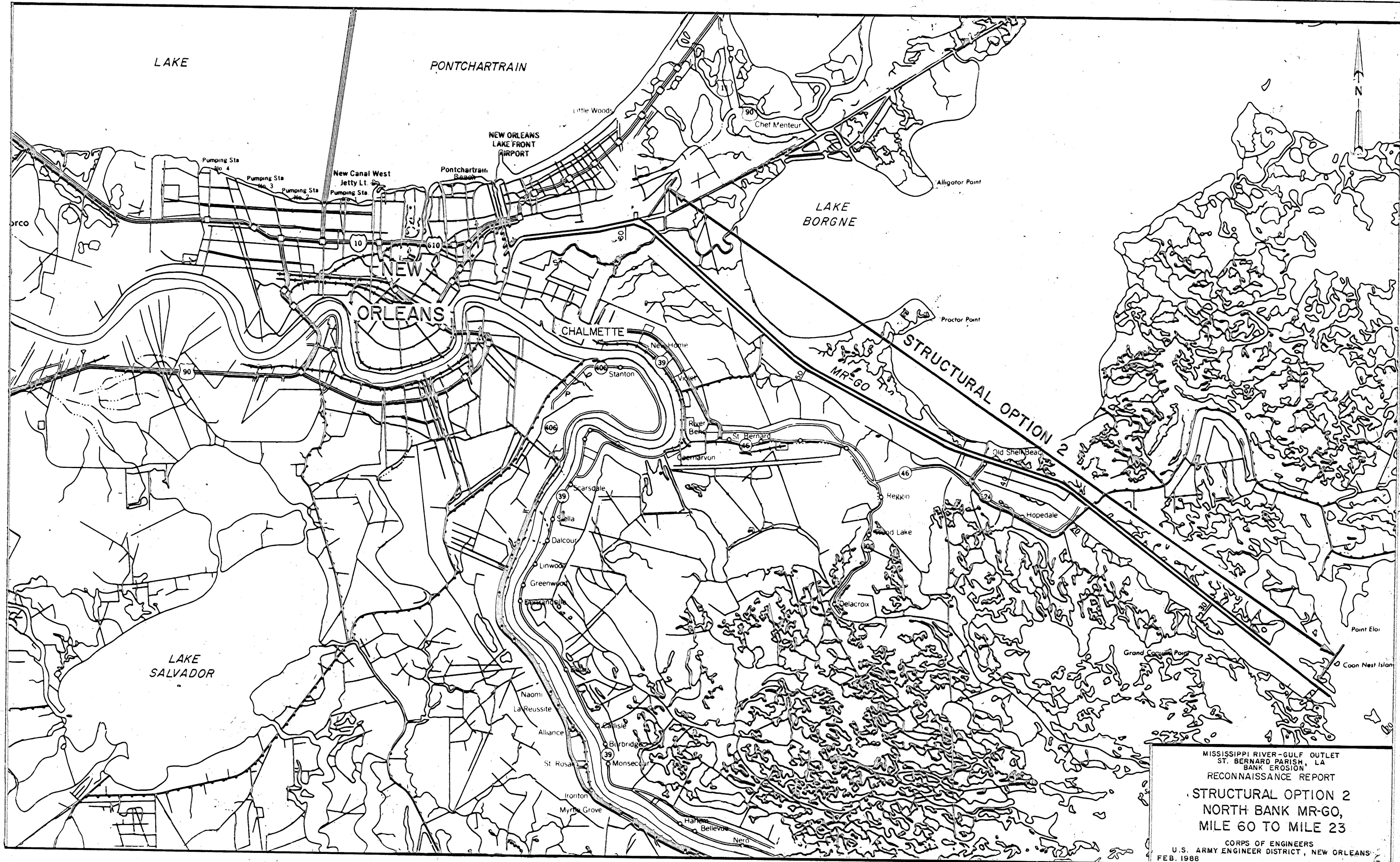

LAKE
PONTCHARTRAIN
LAKE BORGNE
LAKE SALVADOR
NEW ORLEANS
CHALMETTE
NEW ORLEANS LAKE FRONT AIRPORT
Pontchartrain Beach
New Canal West Jetty Lt.
Pumping Sta No. 4
Pumping Sta No. 3
Pumping Sta No. 2
Pumping Sta No. 1
Little Woods
Chef Menteur
Alligator Point
Proctor Point
Old Shell Beach
Shell Beach
Hopedale
Reggio
Delacroix
Grand Coquille Point
Point Eloi
New Home
Violet
Stanton
River Bend
St Bernard
Caernarvon
Scarsdale
Stella
Dalcour
Linwood
Greenwood
Naomi
La Reussite
Alliance
Carlisle
Burbridge
St Rosalie
Monsecour
Ironton
Myrtle Grove
Hamlet
Belleville
Nero
MISSISSIPPI RIVER
GULF OUTLET
CRITICAL REACH 1
CRITICAL REACH 2
CRITICAL REACH 3
N
Dredging
0-23 once
24-27 4 times
28-29 once
30-32 never
33-38 three times
39-42 4 times
43-50 never
51-57 once
mi 56
mi 51
MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT
STRUCTURAL OPTION I - NORTH BANK
MR-GO REACHES OF CRITICAL EROSION
CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1988

PLATE 5



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

STRUCTURAL OPTION 2
NORTH BANK MR-GO,
MILE 60 TO MILE 23

CORPS OF ENGINEERS
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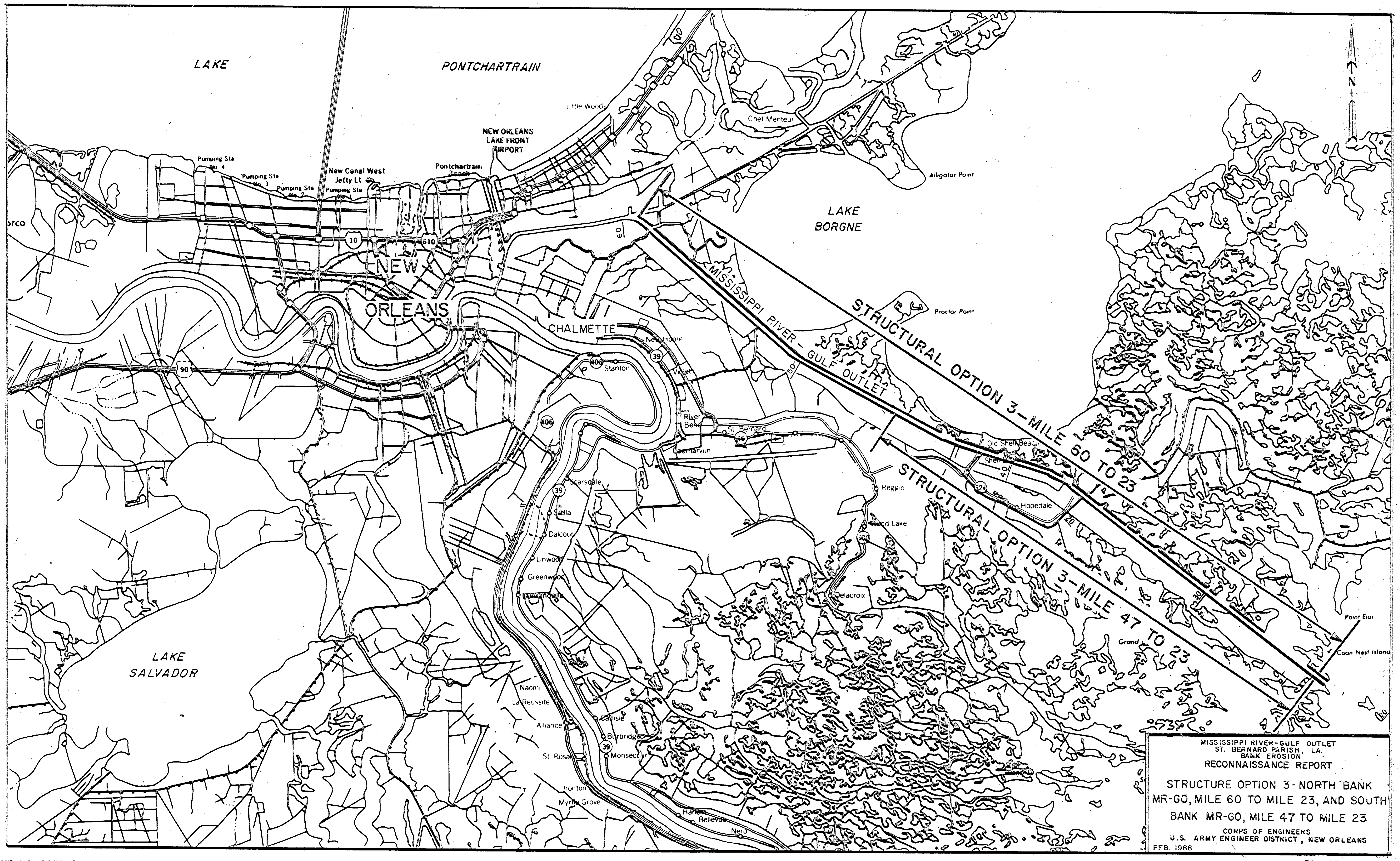
FEB. 1988



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

STRUCTURE OPTION 3-NORTH BANK MR-GO, MILE 60 TO MILE 23, AND SOUTH BANK MR-GO, MILE 47 TO MILE 23

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U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
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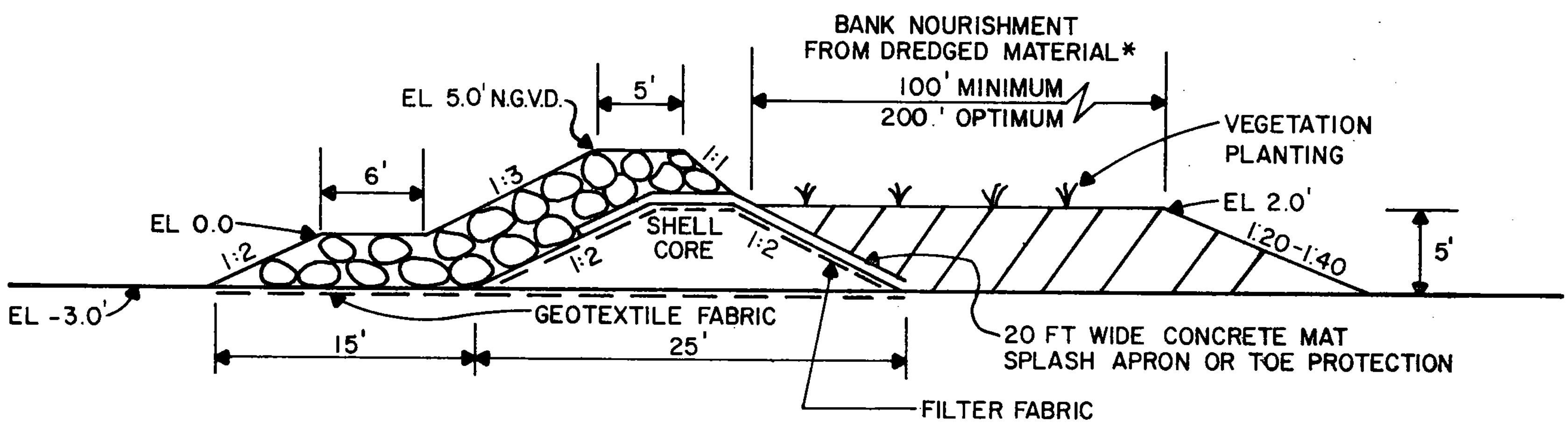
PLATE 7

BANK PROTECTION STRUCTURE



DESIGN I

MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

DESIGN I
CONCRETE BLOCK / ROCK ARMOR-
HIGH PROFILE

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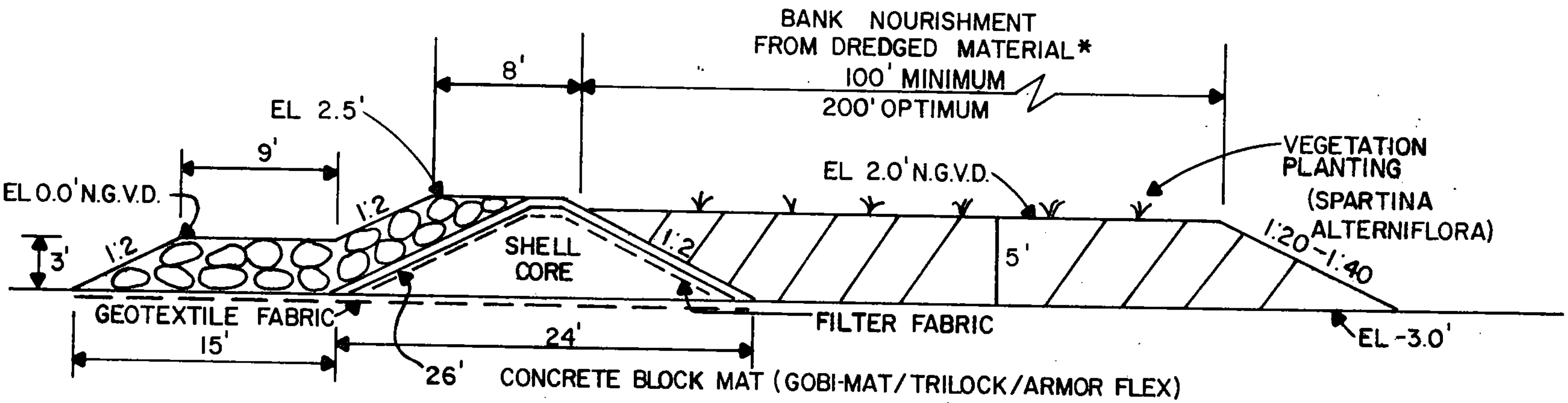
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1988

PLATE 8

BANK PROTECTION STRUCTURE



DESIGN 2

MISSISSIPPI RIVER - GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 2.
CONCRETE BLOCK ROCK ARMOR–
LOW PROFILE

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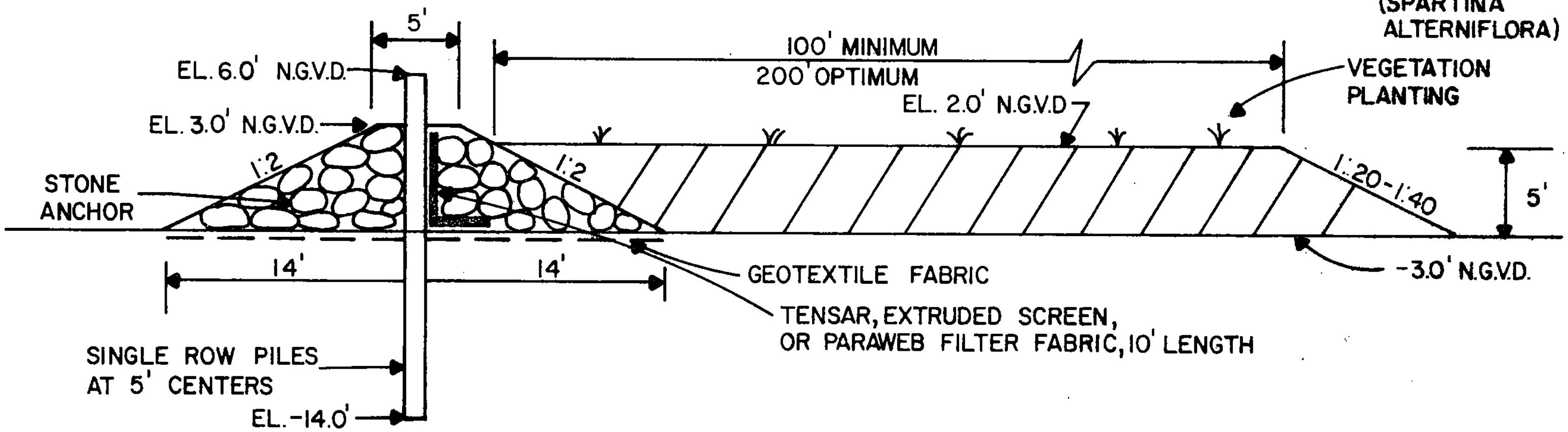
FEB. 1988

PLATE 9

BANK PROTECTION STRUCTURE



DESIGN 3

MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 3
SINGLE ROW TIMBER PILES/
GEOTEXTILE WALL WITH ROCK APRON

CORPS OF ENGINEERS
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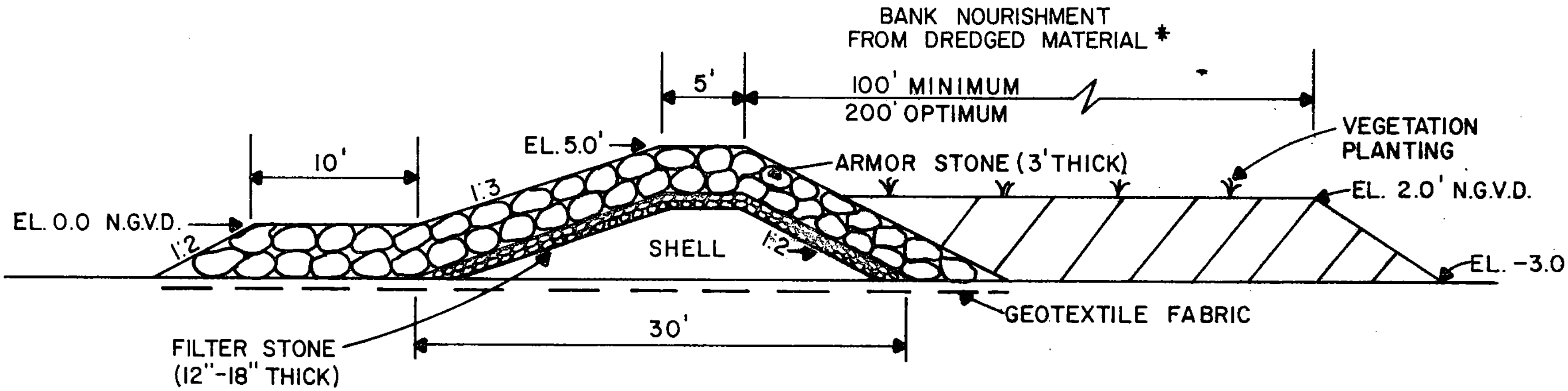
PLATE 10

BANK PROTECTION STRUCTURE



DESIGN 4

MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

DESIGN 4

STONE ARMORED SHELL CORE DIKE

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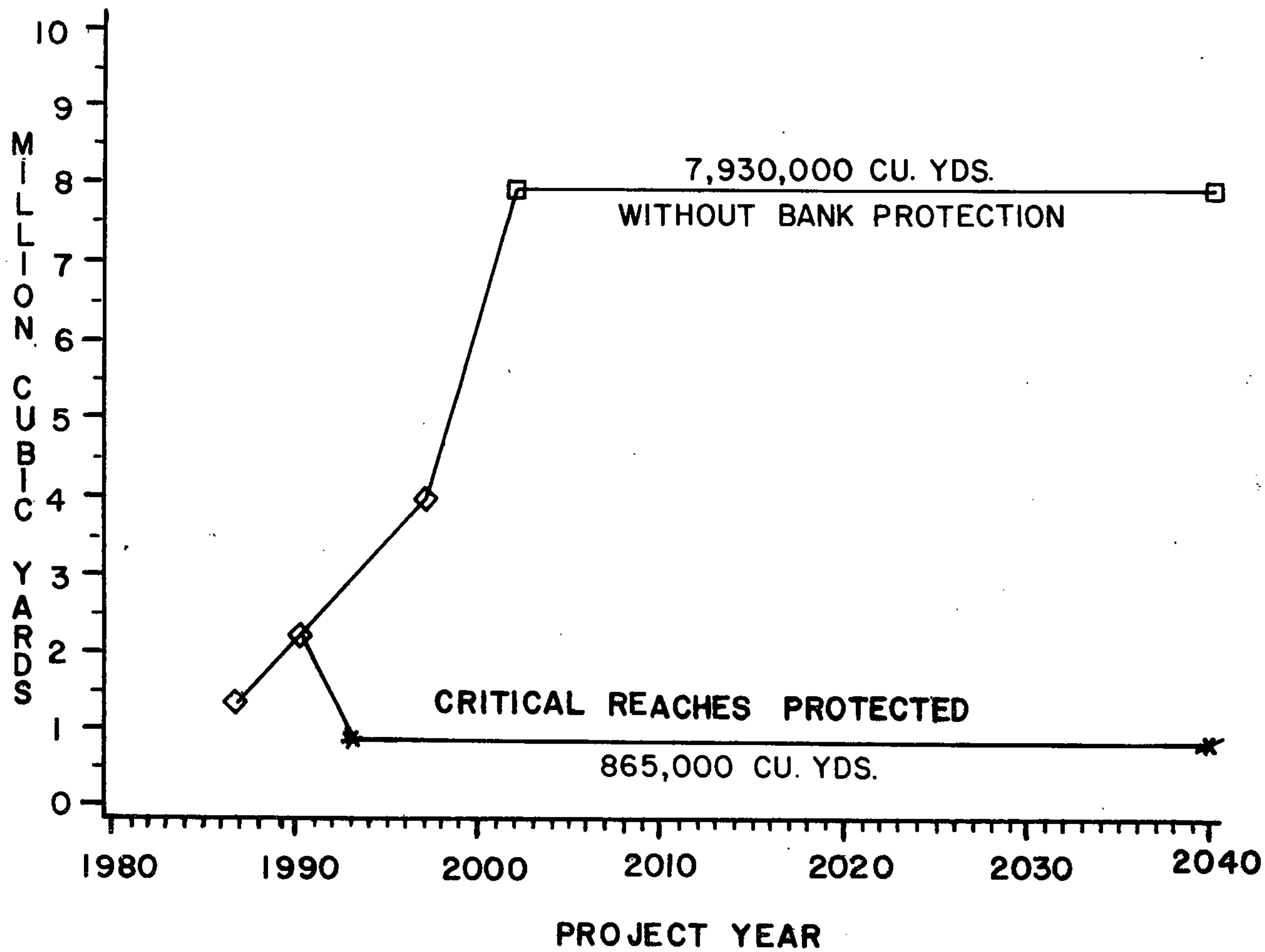
FEB. 1988

PLATE 11

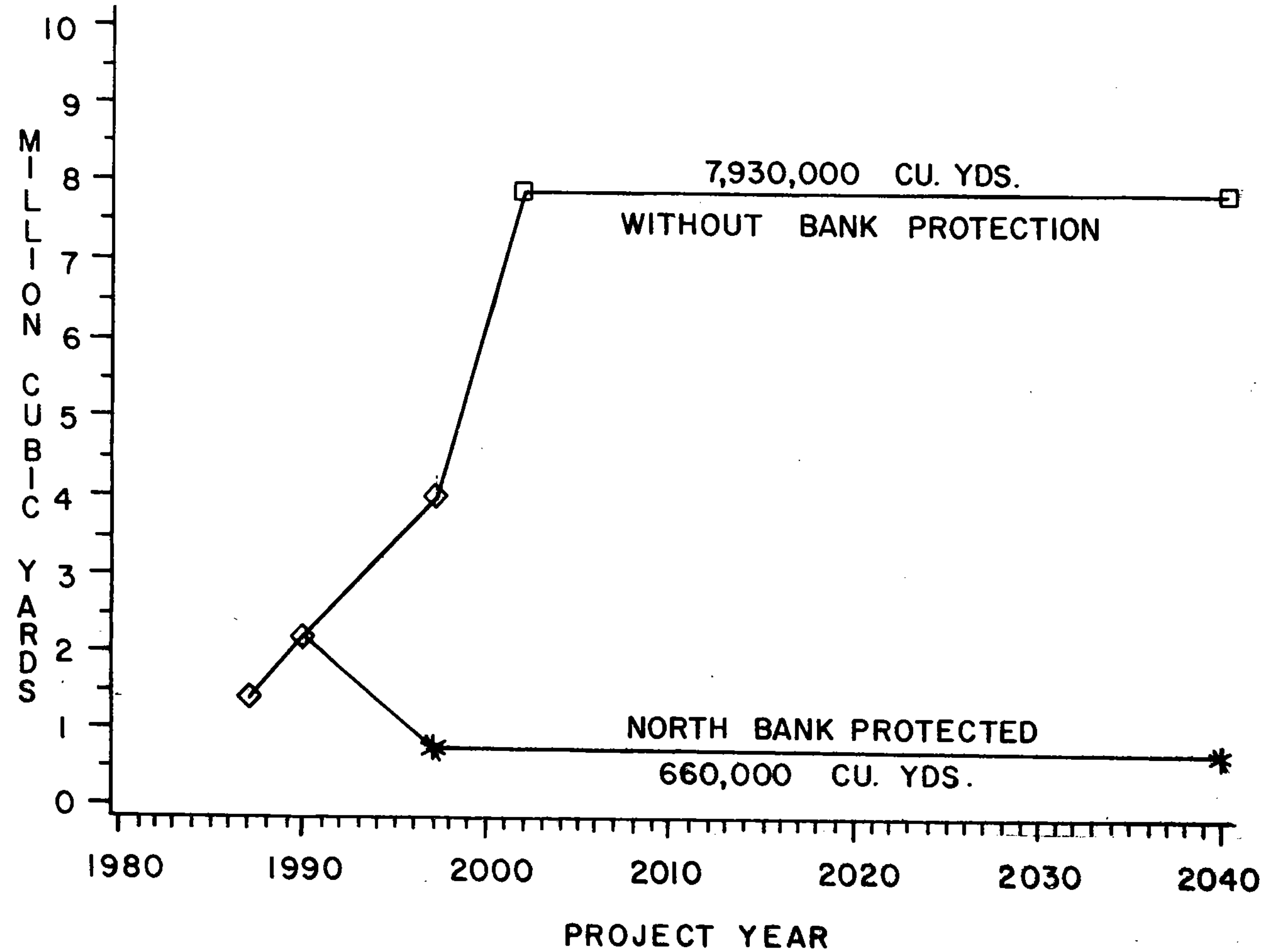


MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

IDEALIZED WITH AND WITHOUT PROJECT AVERAGE ANNUAL MAINTENANCE DREDGING REQUIREMENTS STRUCTURAL OPTION I

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1988

PLATE 12

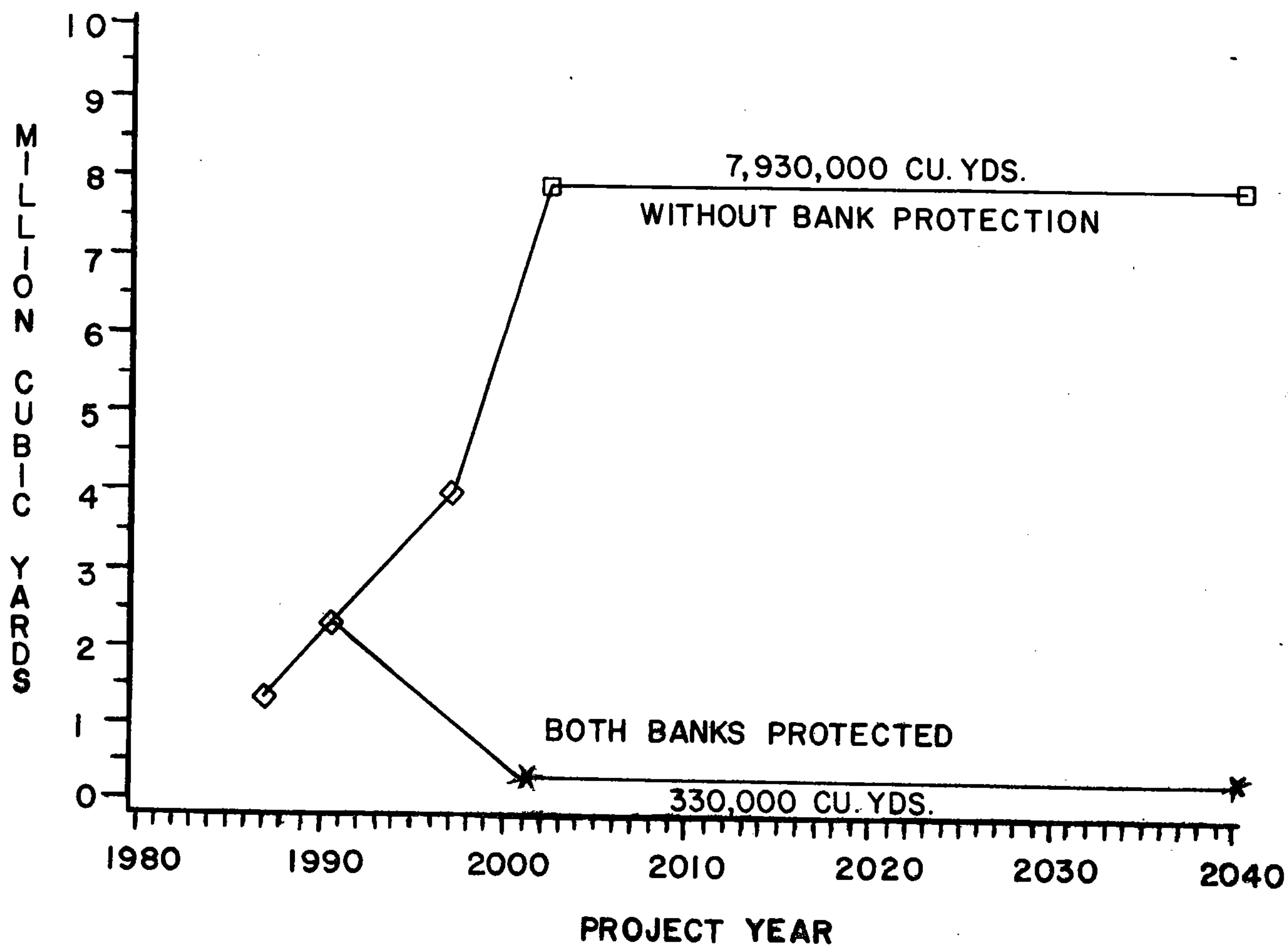


MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA.
BANK EROSION
RECONNAISSANCE REPORT

IDEALIZED WITH AND WITHOUT PROJECT AVERAGE ANNUAL MAINTENANCE DREDGING REQUIREMENTS STRUCTURAL OPTION 2

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1988

PLATE 13



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

IDEALIZED WITH AND WITHOUT PROJECT AVERAGE ANNUAL MAINTENANCE DREDGING REQUIREMENTS STRUCTURAL OPTION 3

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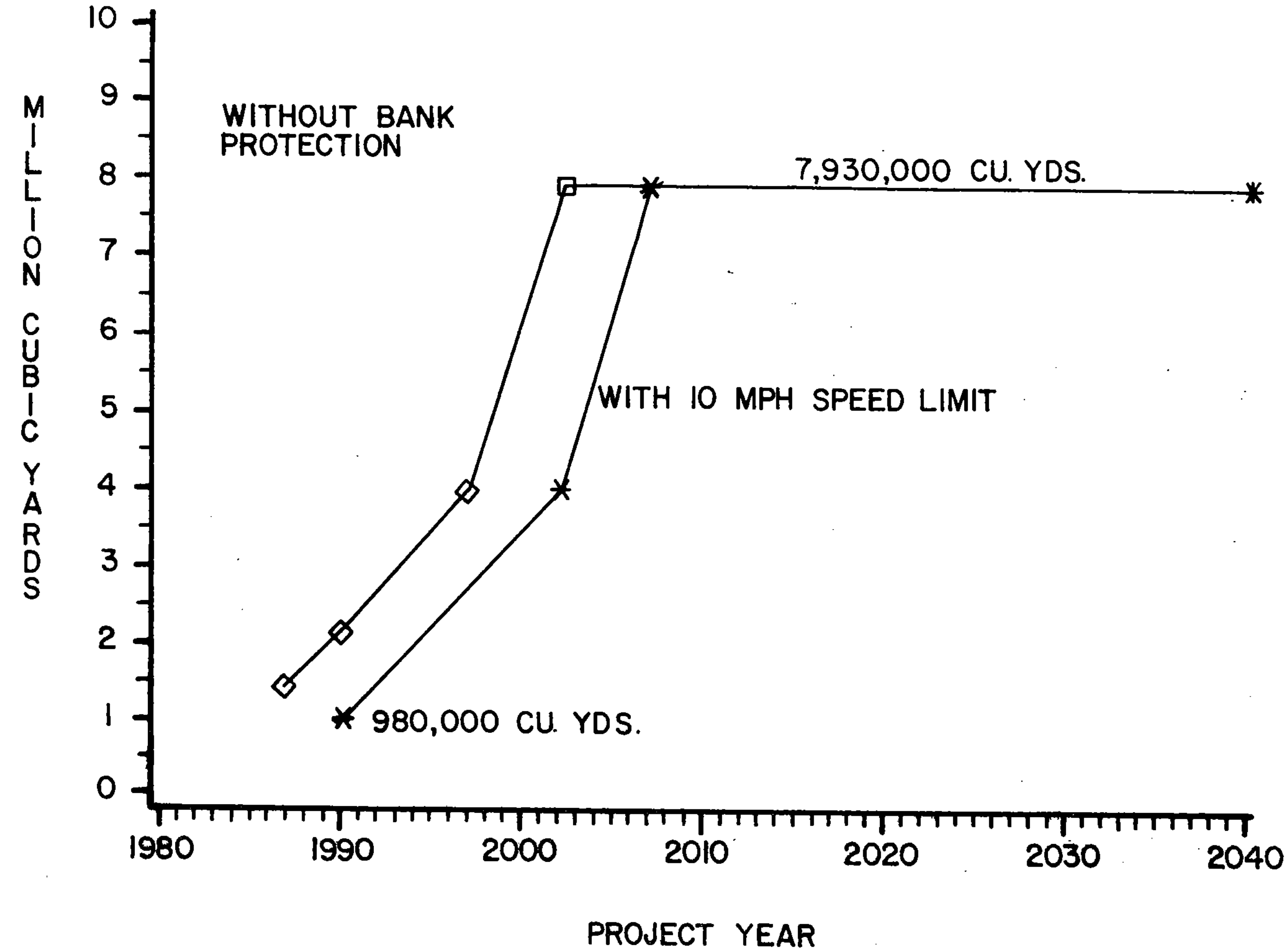
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1988

PLATE 14



MISSISSIPPI RIVER-GULF OUTLET
ST. BERNARD PARISH, LA
BANK EROSION
RECONNAISSANCE REPORT

IDEALIZED WITH AND WITHOUT PROJECT AVERAGE ANNUAL MAINTENANCE DREDGING REQUIREMENTS SPEED LIMIT OPTION

CORPS OF ENGINEERS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
FEB. 1988

PLATE 15