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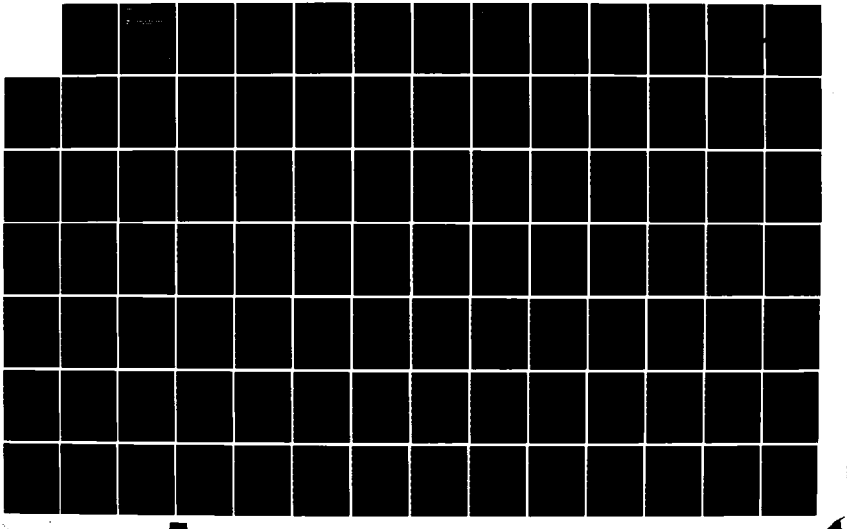

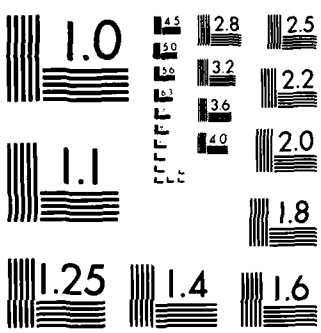

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US Army Corps
of Engineers
New Orleans District

Mississippi and Louisiana Estuarine Areas

Freshwater Diversion to Lake Pontchartrain Basin and Mississippi Sound

Feasibility Study

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Volume 1
Main Report
Environmental Impact Statement
April 1984

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If you have any questions or require additional information, please contact Mr. Falcolm Hull, Study Manager, U.S. Army Corps of Engineers, New Orleans District, P.O. Box 60267, New Orleans, LA 70160, telephone number (504) 838-2939.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
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9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. ARMY CORPS OF ENGINEERS NEW ORLEANS DISTRICT P.O. BOX 60267 NEW ORLEANS, LA 70160-0267	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS LMNPD-RE
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The study area has experienced land loss and saltwater intrusion due to natural processes such as subsidence and erosion, as well as man's developmental activities including leveeing, channelization, and petroleum exploration. The various natural processes and man's activities have altered overbank flooding and natural distributary flow which historically provided fresh water, sediments, and nutrients to the estuarine areas. This has resulted in conversion of fresh, intermediate, and brackish marshes to more saline marsh types and has

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20. ABSTRACT (CONTINUED)

also caused the loss of substantial areas of wooded swamp. Saltwater intrusion and loss of wetlands have adversely affected the productivity of wildlife and fishery resources. Influx of saline waters is particularly harmful to the American oyster, due to increased predation and disease. Thousands of acres of formerly productive oyster reefs in the area lie largely unproductive due to excessive salinities. One way to ameliorate loss of wetland habitat and rate of saltwater intrusion is timely introduction of fresh water and associated sediments and nutrients into the study area. A total of 13 potential sites were evaluated for diversion of fresh water. Based on the results of this study, it has been recommended that fresh water from the Mississippi River be diverted into Lake Pontchartrain at a site adjacent to the Bonnet Carre' Spillway. This site is located at river mile 128.5. Implementation of this plan would save approximately 4,186 acres of marsh and 6,355 acres of wooded swamp. Additionally, average annual oyster production in the study area would increase by about 7.5 million pounds.

*Proposed Report

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:
DAEN-CWP-A

SUBJECT: Mississippi and Louisiana Estuarine Areas

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on the Mississippi and Louisiana Estuarine Areas. It is accompanied by the reports of the Mississippi River Commission and the District Engineer. These reports are in final response to a resolution adopted 23 September 1976 by the U.S. House of Representatives Committee on Public Works and Transportation which requested the Corps of Engineers to review the report on the Mississippi River and Tributaries (MR&T), published as House Document 308, 88th Congress, and other pertinent reports with a view to determining the advisability of modifying the recommendations contained therein. Further, the Resolution requested particular attention to providing freshwater into Lakes Maurepas, Pontchartrain, Borgne, and Mississippi Sound areas in the interest of improving the wildlife and fisheries of this area.

2. The District Engineer recommends modification of the MR&T project to include provisions for diversion of freshwater from the Mississippi River to Lake Pontchartrain at the Bonnet Carre Spillway. The District Engineer's plan includes: a gated box culvert control structure; inflow and outflow channels; a sediment trap downstream of the diversion structure in the outflow channel; an access bridge across the outflow channel; five, two-acre recreation facilities; levee realinements; and a comprehensive monitoring system to guide structure operation and assess the effects of the diverted freshwater on fish and wildlife populations.

3. The Mississippi River Commission concurs with the District Engineer's plan with two exceptions. The Commission recommends deletion of the recreation areas and the access bridge across the outflow channel.

* This report contains the proposed recommendations of the Chief of Engineers. The recommendations are subject to change to reflect substantive comments received during the review period.

4. The estimated costs of the recommended plan, based on October 1984 price levels, are $56,690,000 for construction first costs and $813,000 for annual operation, maintenance, and replacement costs. Annual charges are estimated at $6,012,000 and average annual benefits are $6,530,000 based on a 50-year period for economic analysis and an interest rate of 8-3/8 percent. The benefit-cost ratio is 1.09 to 1.

5. The Administration's policy on water project financing and cost sharing is that all Federal water development agencies will continue to seek out new partnership arrangements with the States and other non-Federal interests in the financing and cost sharing of the proposed projects. Each such agency will negotiate reasonable financing arrangements for every project within its respective area of responsibility. In addition, prior commitment to individual States with regard to water development within their borders will be considered and shall be a factor in negotiations leading up to project construction; and, consistency in cost sharing for individual project purposes, with attendant equity, will be sought. Project beneficiaries, not necesarily governmental entities, should ultimately bear a substantial part of the cost of all project development.

6. The report is generally in compliance with all applicable rules and guidelines. Accordingly, I generally concur in the recommendation of the Mississippi River Commission and recommend implementation of the freshwater diversion measures generally in accordance with the plan of the Mississippi River Commission with such modifications as in the discretion of the Chief of Engineers may be advisable and in accordance with cost-sharing and financing arrangements which are satisfactory to the President and the Congress.

7. The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

E.R. HEIBERG III
Lieutenant General USA
Chief of Engineers

DEPARTMENT OF THE ARMY
MISSISSIPPI RIVER COMMISSION, CORPS OF ENGINEERS
P. O. BOX 80
VICKSBURG, MISSISSIPPI 39180

REPLY TO
ATTENTION OF:

MRCPD-C

10 January 1985

SUBJECT: Mississippi and Louisiana Estuarine Areas

Chief of Engineers
Department of the Army
Washington, D.C. 20314

Summary of Commission Action

The Mississippi River Commission concurs generally in the recommended plan of the reporting officer which includes a diversion structure through the mainline Mississippi River levee adjacent to the Bonnet Carre Spillway; inflow and outflow channels; a sediment trap; and levee modifications necessary to accommodate the diversion structure. The Commission recommends deletion of the recreation areas and the pile bridge for sand haulers contained in the reporting officer's plan. Elimination of these project features reduces the project cost by $1,557,000. Based on October 1984 price levels, the project first cost is estimated at $56,689,000, of which $14,172,000 would be non-Federal. The non-Federal share is based on traditional cost sharing policies and would be divided between the states of Mississippi and Louisiana with Mississippi's share $2,834,000 and Louisiana's share $11,338,000. The benefit to cost ratio is 1.09. The Commission concurs in the recommendation of the reporting officer with the exception of the recreation features and the bridge.

Summary of Report Under Review

1. Authority. The study was conducted in response to a resolution adopted 23 September 1976 by the United States House of Representatives Committee on Public Works and Transportation. The resolution, sponsored by Congressman Trent Lott of the Fifth Congressional District of Mississippi, reads:

> "Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Chief of Engineers of the U.S. Army is hereby requested to review the report on the Mississippi River and Tributaries, published as House Document 308, 88th Congress, and other pertinent reports with a view to determining the advisability of modifying the recommendations contained therein with particular reference to providing freshwater into Lakes Maurepas, Pontchartrain, Borgne, and Mississippi Sound areas in the interest of improving the wildlife and fisheries of this area."

2. Description of the Study Area. The study area encompasses 2,960,000 acres. In Louisiana, the area includes the lower Mississippi River from Bayou Manchac to Bayou Terre Aux Boeufs, Lakes Maurepas, Pontchartrain, Catherine and Borgne, Chandeleur Sound, and the swamps and marshes bordering the lakes. The study area in Mississippi embraces the Mississippi Sound and surrounding wetlands. The upper limits of the study area are defined by the area that would be inundated by a tidal surge generated by the Standard Project Hurricane with all authorized works in place.

3. Economic Development. The economy of the study area is founded on a base of natural resources that include commercially important minerals and a variety of fish and wildlife resources. Significant mineral deposits including crude petroleum, natural gas, clay, salt, sulphur, sand, gravel, and lime are found in the study area. Other extremely important commercial activities of the area center around fish and wildlife resources. During the 1963-1978 period, the average yearly harvest of estuarine-dependent fisheries was 96 million pounds with an average annual value of $52 million. Major commercial fishery species include oysters, shrimp, and menhaden. In Louisiana, the oyster fishery has evolved from a natural fishery to one dominated by privately leased and seeded bottoms in the more productive waters closer inshore. The study area average annual production of oyster meat during the period 1970-1976 was 8 million pounds valued at $12.5 million. The shrimp harvest in the study area averages 27.9 million pounds annually with a value of $31.0 million. As a result of an intricate navigation system, shipping has evolved into the major industry in the area. The Port of New Orleans is the world's largest grain port, the largest seaport in the United States, and the second largest in the world in terms of dollar value and waterborne tonnage handled. Major commodities handled at the port include grain, crude petroleum, fabricated steel, metallic minerals, chemicals, and refined petroleum products. Other ports in the study area include the Ports of Pascagoula and Gulfport. Both ports are considerably smaller than the Port of New Orleans, but make a sizeable contribution to their local economies. The ports provide dock and harboring facilities for ocean shipping, barge traffic, commercial fishing vessels, and recreation craft. In some rural parts of the study area, the economy depends on commercial fishing and agriculture. Major crops are sugarcane, soybeans, cotton, citrus, pecans, and truck crops.

4. Existing Improvements. The Mississippi River is confined through the study area by levees. These levees prevent the river from meandering as it has done historically and therefore prevents the distribution of sediment and freshwater into marsh areas. The levees also act to protect much of Louisiana from flooding and help provide the deep water channel that allows for navigation to the ports of New Orleans and Baton Rouge. The Bonnet Carre Spillway, north of New Orleans is used to divert floodwater from the Mississippi River into Lake Pontchartrain reducing the threat to the New Orleans area. The Inner Harbor Navigation Canal Lock is located in the east mainline Mississippi River levee in the city of New

Orleans and permits navigation access between the Mississippi River and the Gulf Intracoastal Waterway and Mississippi River Gulf Outlet systems. The Mississippi Delta Region Project authorized by Public Law 89-298, 27 October 1965, consists of four freshwater diversion structures on the Mississippi River south of New Orleans. There would be two structures on the east side of the river and two structures on the west side. The Caernarvon structure located on the east side of the river just below New Orleans is in final design stages with construction scheduled to begin in November 1986. The State of Louisiana and local interests have constructed five small freshwater diversion structures on the east bank of the Mississippi River south of New Orleans. The success of these facilities give credence to the recommended plan for diversion at Bonnet Carre Spillway.

5. Problems and Needs. The problems in the study area began when the Mississippi River was leveed and not allowed to migrate back and forth across what is now southeast Louisiana. As the river migrated, it deposited sediment in the form of deltaic marshes. The river overflowed its bank every spring, flooding and supplying the area with nutrients and sediments to sustain the deltas and maintain the marshes and their vegetative characteristics. Since the Mississippi River has been leveed, the only fresh water flowing into the estuaries in the study area has been from the seven Bonnet Carre Spillway openings, from the Mississippi River through the IHNC, and from rainfall runoff from the uplands adjoining the project area. Deprived of the annual fresh water and sediment from the river, the natural processes of subsidence, compaction, erosion, and saltwater intrusion along with man's channel dredging and levee building activities have resulted in the loss of 2.5-4.1 square miles per year of study area coastal marshes.

6. Improvements Desired. Methods to distribute fresh water and sediment in a manner that will reduce saltwater intrusion into historically freshwater area are desired.

7. Alternatives Considered. Initially, sixteen structural and nonstructural plans were formulated to confront the problems in the study area. The sixteen conceptual plans were narrowed down to eight on the basis of cost, unacceptable environmental damage, interference with navigation, and adverse effects on urbanizing areas. Of the structural plans, preliminary studies showed that freshwater diversion on an areawide scale would best alleviate saltwater intrusion problems. Diverting freshwater from the Mississippi River into the Lake Pontchartrain Basin and Mississippi Sound would establish favorable salinity conditions, enhance vegetation growth, reduce land loss, and increase commercial and sport fish and wildlife productivity. Detailed studies, therefore, focused on freshwater diversion. Thirteen diversion sites representative of all sites that could be considered above and below New Orleans were identified.

Any site farther upstream from New Orleans than Bayou Manchac would have to use the Amite River or its tributaries for the diverted water and would be prohibitively expensive. Using the Amite River to divert Mississippi River water was also ruled out for another reason. The largest flow of diverted freshwater would be necessary in the spring. Diverting water into the upper Amite River Basin at that time would increase the possibility of flood problems in East Baton Rouge, Livingston, and Ascension Parishes. Extensive urban development prohibited locating any sites along the Mississippi River between the City of Kenner and the Inner Harbor Navigation Canal. Of the ten sites above New Orleans, the best sites are those that divert water into Lake Pontchartrain. Among those, the site with the canal inside the Bonnet Carre Spillway was ranked Number One for several important reasons: conveyance channels would be shorter, fewer relocations would be required, scenic streams would not be altered, and archeological sites would not be disturbed. Below New Orleans, the best sites are the Inner Harbor Navigation Canal and Riverbend.

8. Plan of Improvement. The control structure would be located just west of the existing Bonnet Carre Spillway. The plan includes these features:

a. A 455-foot long multi-cell box culvert control structure with four 20- by 20-foot gated cells in a Mississippi River levee setback.

b. An inflow channel 950 feet long with a bottom width of 400 feet, side slopes of 1 vertical and 3 horizontal, and water depth of 25 feet.

c. An outflow channel 33,800 feet long with a bottom width of 400 feet and side slopes of 1 vertical and 3 horizontal.

d. Depth in most of the outflow channel would be 25 feet. For the last 1,360 feet of the channel near Lake Pontchartrain, the channel bottom width would be increased to 590 feet and then to 760 feet. Over that same distance, the channel depth would be decreased to 10 feet and then to 2 feet.

e. A sediment trap located about 3,500 feet downstream of the diversion structure in the outflow channel. The trap would have a bottom width of 780 feet, side slopes of 1 vertical on 3 horizontal, and would be 1,450 feet long. The trap would be 15 feet deeper than the outflow channel.

f. A 600-foot access bridge across the outflow channel on the lake side of the Illinois Central Gulf railroad tracks to give sand haulers access in and out of the floodway.

g. Two-acre recreation facilities at the lake end of the borrow channel within the floodway, at Frenier Beach, Point Aux Herbes, and the Rigolets in Louisiana, and at Cedar Point and Wolf River in Mississippi. Facilities would consist of two-lane boat ramps, courtesy piers, parking for 30 vehicles, five picnic tables, and five trash cans.

h. Realinement of the upper spillway guide levee adjacent to the control structure for 3,035 feet.

i. Mississippi River levee realined over the control structure for 1,250 feet.

j. A comprehensive monitoring system would guide structure operation and assess the effects of the diverted freshwater on fish and wildlife populations. The system will require certain hydrological, water quality, and biological data. A network of sampling stations will collect the data necessary for structure operation. The programs in the system will be conducted in three phases: preconstruction, postconstruction, and long term. The 3-year preconstruction phase will supplement existing information and establish baseline conditions for measuring future changes. The 4-year postconstruction phase will assess the effect of the diverted waters on important hydrological and water quality parameters and the fish and wildlife populations. This information will be used to devise and modify the operational scheme and the scope of the long-term monitoring phase. The cost of the pre- and postconstruction monitoring phases, $5,056,000 is included in the first cost of the plan. The cost of the long-term monitoring phase is included in the operation and maintenance costs. The New Orleans District and non-Federal assuring agencies will establish a two-state interagency advisory group to design and conduct the monitoring programs. The interagency group will include Federal, state, and local agencies that have responsibilities in the areas of water quality, fish and wildlife, water supply, navigation, and flood control.

9. Economic Evaluation. The first cost of the recommended plan is estimated to be $58,246,000. Based on traditional cost sharing policies (i.e. 75 percent Federal, 25 percent non-Federal for fish and wildlife enhancement and 50/50 cost sharing for recreation) the Federal first cost would be $43,497,000 and the non-Federal cost would be $11,751,000 for the State of Louisiana and $2,998,000 for the State of Mississippi. The division of responsibility between the States is based on each State's proportionate share of the benefits. The estimated average annual operation, maintenance, and replacement cost of $827,000 would be shared by the States of Louisiana and Mississippi in the same proportion as the first costs.

10. Project Effects. The proposed plan would create salinity conditions favorable to fish and wildlife productivity. Annual oyster production is expected to increase by 5.6 million pounds in Louisiana and by 1.9 million pounds in Mississippi. The productivity of white shrimp, blue crab, croaker, and menhaden should greatly increase. Commercial catfishing in Lakes Maurepas and Ponchartrain would be significantly improved. The diversion of fresh water would reduce the saltwater intrusion that kills marsh vegetation and creates open water. Sediments and nutrients in the diverted water would enhance growth of vegetation and revitalize some areas of marsh and reduce land loss. About 10,500 acres of marsh and

wooded swamp would be saved over the 50-year project life. Estuarine species less tolerant of low salinity waters such as brown shrimp, spotted sea trout, and red drum may be displaced eastward by the diversion. In the vicinity of the diversion outfall, there would be increased turbidity, nitrate and phosphorous levels, coliform counts, and other types of chemical concentrations, and temperatures would be slightly lowered.

11. Recommendation of the Reporting Officer. The District Commander recommends authorization of the selected plan subject to certain requirements of local cooperation.

Review by the Mississippi River Commission

12. General. The scope of the Commission's review encompassed the overall technical, economic, social, environmental, and policy aspects involved in the improvements proposed by the reporting officer. The Commission considered whether the report and its technical supporting documentation conformed to the Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complied with other applicable administrative and legislative policies and guidelines. The Commission assured that the general public has been afforded adequate opportunity for input and comment.

13. Response to the District Engineer's Public Notice. Two letters were received in response to the District Engineer's Notice commenting on the proposed plan. The National Wildlife Federation, in a letter dated 5 July 1984, stated support of the District's plan but suggested that the plan was mitigation for previous MR&T work and therefore should be constructed with 100 percent Federal funds. They also requested that responsibility for monitoring the effects of the proposed project be assigned before the report is sent to Congress. The Regional Planning Commission (Jefferson, Orleans, St. Bernard, and St. Tammany Parishes) by letter of 29 June 1984 objects to the proposed plan. They also included a letter from the St. Tammany Police Jury to the New Orleans District Commander objecting to the plan. Primarily these parties object to the plan because they feel that impacts to Lake Pontchartrain have not been adequately identified. They suggest also that the plan, if implemented, should be considered mitigation and therefore constructed with 100 percent Federal funds.

14. Findings and Conclusions. The Commission concurs in the findings and conclusions of the reporting officer. The recommended plan is economically justified and furthermore it is the plan which maximizes net benefits. The Commission notes the concerns of the Regional Planning Commission and the St. Tammany Police Jury regarding impacts to Lake Pontchartrain. However, the Commission recognizes that the comprehensive monitoring program will provide a data base of information that can be used to adjust the flows through the structure to maximize the beneficial effects for salinity control, while minimizing any adverse impacts to Lake Pontchartrain. The Commission notes that the monitoring program will be

water quality, cultural resources, and the preservation of environmentally unique and sensitive areas.

The study area, shown on plate 1, encompasses 2,960,000 acres. In Louisiana, the area includes the lower Mississippi River from Bayou Manchac to Bayou Terre Aux Boeufs, Lakes Maurepas, Pontchartrain, Catherine, and Borgne, Chandeleur Sound, and the swamps and marshes bordering the lakes. The study area in Mississippi embraces the Mississippi Sound and surrounding wetlands. The upper limits of the study area are defined by the area that would be inundated by a tidal surge generated by the Standard Project Hurricane with all authorized works in place.

Ten parishes and three counties are partially included in the study area: Ascension, Jefferson, Livingston, Orleans, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Tammany, and Tangipahoa Parishes, and Hancock, Harrison, and Jackson Counties. No parish or county is located wholly in the study area. In compiling statistical data for population, employment, income, and recreation use, all of the 10 parishes and three counties were included because they are economically significant to the study area. It would be virtually impossible to accurately disaggregate the statistical data according to study area boundaries.

Study efforts for this report involved use of available data and information, ground reconnaissance of the area as needed, and office studies. Existing conditions and projected conditions with and without Federal improvements related to fish and wildlife resources were assessed. Problems, needs, and opportunities associated with the fish and wildlife resources were identified. The feasibility and performance of engineering improvements were determined and social, cultural, economic, and environmental impacts were evaluated.

STUDY AUTHORITY

The study was conducted in response to a resolution adopted 23 September 1976 by the United States House of Representatives Committee on Public Works and Transportation. The resolution, sponsored by Congressman Trent Lott of the Fifth Congressional District of Mississippi, reads:

> "Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Chief of Engineers of the US Army is hereby requested to review the report on the Mississippi River and Tributaries, published as House Document 308, 88th Congress, and other pertinent reports with a view to determining the advisability of modifying the recommendations contained therein with particular reference to providing freshwater into Lakes Maurepas, Pontchartrain, Borgne, and Mississippi Sound areas in the interest of improving the wildlife and fisheries of this area."

STUDY PURPOSE AND SCOPE

The purpose of this study is to investigate the feasibility of introducing fresh water into the Lake Pontchartrain Basin and western Mississippi Sound in the interest of improving the habitat and the productivity of fish and wildlife resources. Preserving and restoring wetlands, enhancing vegetative growth, and establishing favorable salinity gradients were also considered. The study report and supporting documents are a final response to the authorizing resolution. Although the resolution specifically states that freshwater diversion should be investigated as the measure for improving fish and wildlife productivity, other measures were identified and evaluated to determine their effectiveness. In addition, related water resources problems, needs, and opportunities were analyzed including sport fishing, hunting, commercial fishing and trapping, outdoor recreation,

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

REPLY TO
ATTENTION OF

April 1984

MISSISSIPPI AND LOUISIANA ESTUARINE AREAS

MAIN REPORT

AND

ENVIRONMENTAL IMPACT STATEMENT

ON FRESHWATER DIVERSION

TO

LAKE PONTCHARTRAIN BASIN AND MISSISSIPPI SOUND

This report presents the findings of studies on the feasibility of diverting fresh water to the Lake Pontchartrain Basin and the Mississippi Sound in the interest of improving fish and wildlife resources. Volume 1 contains the Main Report and Environmental Impact Statement (EIS) and provides a concise, nontechnical summary of study results. An overview of the plan formulation process, an environmental impact assessment, and a description of the recommended plan are included in the Main Report. A description of existing resources and the impacts of the recommended plan on each of those is included in the EIS. Volumes 2 and 3 are technical appendixes that document and support the study findings. These appendixes contain the technical data, information, and pertinent references necessary for an informed technical review. Volume 4 contains pertinent correspondence and the responses to comments in the correspondence.

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The recommended plan would divert fresh water into the Lake Pontchartrain Basin and western Mississippi Sound just upriver of the Bonnet Carre' Spillway. The first cost of the plan is estimated at $57,814,000 with annual charges of $5,963,000 including interest of 8 1/8 percent, amortization over 50 years, and operation and maintenance. The plan includes the development of recreation facilities at six locations in the study area. The average annual benefits attributable to the plan are estimated at $7,178,000. The benefit-cost ratio is 1.20 to 1.

The plan would create favorable salinity conditions, save 10,541 acres of marsh and wooded swamp, increase oyster production by 7,500,000 pounds, and provide additional access to recreation resources. The plan would increase Louisiana's and Mississippi's average annual oyster harvest by 33 percent and 98 percent, respectively. The national oyster harvest would increase by 13 percent. The plan also provides many intangible benefits. Habitat conditions for noncommercial and nongame species and productivity of wooded swamps and associated fish and wildlife would be improved. Business opportunities in commercial and sport fisheries and wildlife industries and related support industries would increase.

SYLLABUS

The purpose of this study is to investigate the feasibility of introducing fresh water into the Lake Pontchartrain Basin and western Mississippi Sound in the interest of improving the habitat and fish and wildlife productivity. Louisiana estuaries and wetlands are among the most productive in the nation in terms of fish and wildlife. Wetlands in Mississippi and Louisiana provide about 30 percent of the nation's commercial fish harvest and about 40 percent of the nation's fur harvest. Numerous migratory waterfowl and nongame birds that use the Mississippi Valley Flyway spend all or a portion of their migration time in the coastal wetlands. The productivity of fish and wildlife has been adversely affected in recent years. The problem began when the Mississippi was leveed and not allowed to migrate back and forth across what is now southeast Louisiana, supplying nutrients and sediments and moderating salinities. Deprived of the annual fresh water, nutrients, and sediments, the natural processes of subsidence, compaction, erosion and saltwater intrusion along with channel dredging and levee building activities have resulted in a loss of 39 square miles of land per year in coastal Louisiana. The land loss rate in the study area varies from 4.1 square miles per year in the St. Bernard marshes to 2.5 square miles per year adjacent to Lake Pontchartrain. Historically, Louisiana's portion of the study area accounted for about 75 percent of Louisiana oyster harvest. Now only about 25 percent of the Louisiana oyster harvest is from the study area. The overall fish and wildlife harvest has also declined. To find a solution to these problems, a number of measures were considered. The measure that provides the best solution is to create favorable salinity conditions through freshwater diversion. This measure would enhance vegetative growth, reduce land loss, and increase production of commercial and sport fish and wildlife. A total of six plans to divert fresh water into the area were considered.

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

REPLY TO
ATTENTION OF:

MISSISSIPPI AND LOUISIANA ESTUARINE AREAS

FEASIBILITY REPORT ON FRESHWATER DIVERSION TO LAKE PONTCHARTRAIN AND MISSISSIPPI SOUND

VOLUME 1

MAIN REPORT AND ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2

APPENDIX A - BACKGROUND INFORMATION AND PROBLEM IDENTIFICATION

APPENDIX B - FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS

APPENDIX C - ENGINEERING INVESTIGATIONS

APPENDIX D - NATURAL RESOURCES

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APPENDIX E - CULTURAL RESOURCES

APPENDIX F - ECONOMICS AND SOCIAL ANALYSIS

APPENDIX G - RECREATION

APPENDIX H - WATER QUALITY

APPENDIX I - SECTION 404 (B) (1) EVALUATION

APPENDIX J - CONSISTENCY DETERMINATION
LOUISIANA COASTAL ZONE MANAGEMENT PROGRAM

APPENDIX K - FRESHWATER DIVERSION STRUCTURE OPERATION CRITERIA

VOLUME 4

APPENDIX L - PUBLIC VIEWS AND RESPONSES

MRCPD-C 10 January 1985

SUBJECT: Mississippi and Louisiana Estuarine Areas

The Commission recommends construction authorization of the plan of improvement to divert Mississippi River water to Lake Pontchartrain Basin and Mississippi Sound adjacent to the existing Bonnet Carre Spillway, subject to cost-sharing and financing arrangements with the non-Federal sponsors that are satisfactory to the President and Congress.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

THOMAS A. SANDS
Brigadier General, USA
President Designee,
Mississippi River Commission

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non-Federal costs and the State of Mississippi responsible for 20% of the non-Federal share. Average annual charges, reflecting a 50-year period for economic analysis and an interest rate of 8-3/8 percent, are estimated at $6,012,000. Annual operation and maintenance cost would be $813,000. Annual operation and maintenance costs would be shared between the states in the same proportion as the non-Federal first costs. Average annual benefits are estimated at $6,530,000, and the benefit-cost ratio is 1.09.

17. The Administration's policy on water project financing and cost sharing is that all Federal water development agencies will continue to seek out new partnership arrangements with the states and other non-Federal interests in the financing and cost sharing of the proposed projects. Each such agency will negotiate reasonable financing arrangements for every project within its respective area of responsibility. In addition, prior commitments to individual states with regard to water development within their borders will be considered and shall be a factor in negotiations leading up to project construction; and, consistency in cost sharing for individual project purposes, with attendant equity, will be sought. Project beneficiaries, not necessarily governmental entities, should ultimately bear a substantial part of the cost of all project development.

18. Recommendation. The Mississippi River Commission recommends that the existing Mississippi River and Tributaries project authorized by the Flood Control Act of 1928, as amended, be further modified to provide for freshwater diversion generally in accordance with the plans of the reporting officer, but excluding the recreation feature and the pile bent bridge for sand haulers, with such further modifications thereto as in the discretion of the Chief of Engineers may be advisable. Using traditional cost sharing policies, the first cost to the United States is presently estimated at $42,517,000. Under traditional cost sharing policies, non-Federal interests would agree to the following items of local cooperation prior to implementation:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for construction and operation of the works;

b. Hold and save the United States free from damages due to the construction works except where such damages are due to the fault or negligence of the United States or its contractor;

c. Operate and maintain the works after completion with the State of Louisiana paying approximately 80 percent and the State of Mississippi paying approximately 20 percent;

d. Contribute 25 percent of the project costs associated with fish and wildlife enhancement with the States of Louisiana and Mississippi shares being approximately 80 percent and 20 percent, respectively;

e. Assure adequate public access to the project.

designed and conducted by a two state interagency advisory group consisting of Federal, State, and local agencies so all views should be considered before and during operation of the structure.

15. The Commission has considered the issue of cost sharing for the proposed project. The Commission finds that the saltwater intrusion and associated impacts being experienced in the study area are a result of natural phenomena, and oil and gas exploration, other commercial, public, and/or private activities, and navigation and flood control works. The Commission finds that the recommended project is primarily for the enhancement of fish and wildlife resources and is therefore subject to the existing policy of cost sharing, 75 percent Federal and 25 percent non-Federal. The Commission notes that the states of Mississippi and Louisiana support this concept and that the level of cost sharing is commensurate with the Administration's policies.

The Commission has reviewed the recreational plan recommended by the reporting officer. The plan contains five recreation sites that are not located on basic project lands. Current administration policy states that the Federal Government will not participate in the development of recreation facilities unless they are on lands that would be acquired by local interests for the project without recreation. In accordance with this policy the Commission recommends deletion of these recreation sites. The sixth site is located on the proposed outflow channel near Lake Pontchartrain and is on basic project lands. However, the Commission notes that not only is this site subject to damage when the Bonnet Carre Spillway is operated, it is located in a remote area not readily accessible to the general public. Also, local interests have constructed a boat ramp on the Lake Pontchartrain end of the South Bonnet Carre Spillway levee. Therefore the Commission finds that site should also be deleted. Removal of the recreation sites decreases the project first cost by approximately $632,000 and reduces the annual operation and maintenance by $14,000.

The Commission notes that the reporting officer has included a pile bent bridge over the outlet channel to permit facilitated access by sand haulers. Sand is presently removed from the spillway at no cost to the Federal Government. The Commission recognizes that this operation is in the best interest of the Government and supports the continuation of sand hauling. However, since the diversion structure will include a roadway and since access to the floodway from the east side is possible, the Commission recommends deletion of the pile bent bridge and associated road construction at a savings of approximately $925,000.

16. Based on October 1984 price levels, the first cost of the proposed project, as modified by the Commission, is estimated to be $56,689,000, of which non-Federal costs would be $14,172,000, based on traditional cost sharing. Non-Federal costs will be shared between the States of Mississippi and Louisiana based on the expected benefits to each state. The State of Louisiana would be responsible for approximately 80% of the

PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

A number of studies and reports on water resources development in the study area have been prepared by the US Army Corps of Engineers, other Federal, state, and local agencies, research institutes, and individuals. Several Federal and non-Federal projects that influence water resources have been constructed in the area. Previous studies provided an extensive data base for this study. Historical trends and existing conditions were identified to provide insight into future conditions and to assist in isolating problems. The more relevant studies, reports, and projects are summarized in the following paragraphs. A more detailed list is in Appendix A, Problem Identification.

The Louisiana Coastal Area study was authorized by resolution of the Committee on Public Works of the United States Senate and the House of Representatives and adopted on 19 April 1967 and 19 October 1967, respectively. Under the study, the New Orleans District is investigating improvements for hurricane protection, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and related water resource problems in coastal Louisiana. A number of broad studies concerning the entire coastal area have been conducted. The purpose of the studies is to provide basic information on vital forces affecting the use of water, marsh, and land areas, and to identify problems and determine their seriousness, urgency, and possible solutions. The studies are:

- The Louisiana Wildlife and Fisheries Commission and the Cooperative Wildlife Research Unit, Louisiana State University, with support from the Corps of Engineers, investigated vegetation, water, and soil characteristics and conducted an inventory of wildlife in the coastal area. As a result of this effort, a vegetation type map of the Louisiana marshes and five reports were prepared. This information was

published in part in the fish and wildlife study of the Louisiana coastal area and Atchafalaya Basin Floodway described below.

- The Corps of Engineers, in participation with an interagency group, conducted a fish and wildlife study of the Louisiana coastal area and Atchafalaya Basin Floodway in support of several ongoing studies including the Louisiana Coastal Area study. The fish and wildlife study incorporated information from the previous studies and included a preliminary determination of the cyclic quantities of supplemental fresh water needed to optimize productivity of fish and wildlife resources, and the possible options for supplying this water to each estuarine area. The study was completed in September 1974.

- The National Marine Fisheries Service (NMFS), under contract to the Corps, analyzed the relationship between commercial fish production and characteristics of the estuarine environment, and established resources and resource development needs as related to estuarine ecology. The studies were completed in May 1972.

- The US Fish and Wildlife Service (USFWS) conducted a statewide survey in 1970 to determine participation in fishing, hunting, and wildlife-oriented activities in the coastal area in the 1968-1969 season. The survey was conducted under contract to the Corps.

- The Center for Wetland Resources, Louisiana State University, performed studies of the hydrologic and geologic characteristics of coastal Louisiana under a contract with the Corps. The studies examined and identified trends in the coastal area resulting from natural processes and human activities, identified significant environmental parameters, determined the fresh water required to implement changes for fish and wildlife enhancement, and developed management and structural approaches to solving problems in the estuarine environment. The

findings and recommendations of the studies are contained in a series of 18 published reports.

o As part of the Louisiana Coastal Area study, a revised draft interim report on freshwater diversion to the Barataria and Breton Sound Basins will be completed in the fall of 1984. The report tentatively recommends constructing structures to divert fresh water into Breton Sound Basin near Caernarvon and into Barataria Basin near Davis Pond. The final report on the overall study is scheduled for completion in 1987.

o The Mississippi Sound and Adjacent Areas (MSAA) study was authorized by a resolution of the Committee on Environment and Public Works of the United States Senate, adopted 1 February 1977, and the Committee on Public Works and Transportation of the United States House of Representatives, adopted 10 May 1977. The MSAA study is being conducted by the US Army Engineers, Mobile District. This study will assess dredging and dredged material disposal practices in existing and proposed navigation improvements in Mississippi Sound and Mobile Bay, and determine possible changes in these practices to enhance environmental quality and create a regional dredging program. Salinity, sediment, and tide data are being collected as part of the study and, with the aid of a mathematical model, the water circulation and salinity patterns in the area will be determined. Available data were used in this study where appropriate. A reconnaissance report was published in March 1979 and the final feasibility report is scheduled for completion in July 1984.

o The USFWS produced a report entitled, "Mississippi Deltaic Plain Region Ecological Characterization." Published in 1980, the report supplies information about the biological, physical, and social parameters in the Mississippi Deltaic Plain Region of Louisiana and

Mississippi. Portions of the USFWS report were used in the present study.

- The Department of Natural Resources contracted with Coastal Environments, Inc., to provide recommendations for freshwater diversion to Louisiana estuaries east of the Mississippi River. The final report was completed in June 1982. The report recommended that fresh water be diverted into the Lake Pontchartrain Basin at a diversion site just north of the Bonnet Carre' Spillway and that fresh water be diverted into the Breton Sound Basin just south of Caernarvon via Big Mar. The report was also intended to supplement parallel studies by the Corps of Engineers as part of the Louisiana Coastal Area, Louisiana, and the Mississippi and Louisiana Estuarine Areas studies.

- A report on the Mississippi River and Tributaries project published as House Document No. 308, 88th Congress, 1st Session, recommended construction of the Mississippi Delta Region project. The project provided for four salinity control structures to introduce fresh water into the delta region. These improvements were authorized by the Flood Control Act of 1965 but have not yet been constructed. The diversion structure near Caernarvon is in the advanced engineering and design phase and is scheduled for construction in 1987.

- The Lake Pontchartrain and Vicinity, Louisiana, project was authorized by the Flood Control Act of 1965. The project provides for hurricane protection for the Metropolitan New Orleans area by constructing hurricane protection levees and barriers at the entrances to Lake Pontchartrain. Construction was initiated in 1967, but construction of the barriers was halted in 1978 by court injunction until a new environmental impact statement could be prepared. Construction is continuing on other portions of the project.

• The Mississippi River-Gulf Outlet project was authorized by the River and Harbor Act of 1956 and provided for the construction of a 36- by 500-foot ship channel between the Inner Harbor Navigation Canal (IHNC) in New Orleans and the Gulf of Mexico, Louisiana. The project also provided for a 1,000- by 2,000- by 36-foot turning basin at the junction with the IHNC, and a new high level bridge over the channel at Louisiana Highway 47. Construction was initiated in 1958 and dredging of the channel was essentially completed in 1965. The authorization provides for a lock and connecting channel between the Mississippi River and the new ship channel when economically justified by obsolescence of the existing IHNC lock or by increased traffic. All work has been completed except the lock, connecting channel, jetty construction at Breton Sound, and foreshore protection work. Studies are underway to determine the best location for the new lock.

• The report, "Deep-Draft Access for the Ports of New Orleans and Baton Rouge, Louisiana," published in July 1981, recommended deepening the Mississippi River between Baton Rouge and the Gulf of Mexico to a 55-foot navigable depth. The Board of Engineers for Rivers and Harbors approved the report in March 1982.

• Construction of the Bonnet Carre' Spillway was authorized by the Flood Control Act of 15 May 1928 and amendments. The purpose of the project was to provide protection for the City of New Orleans. Mississippi River water is diverted through the spillway to prevent the river stage at the Carrollton gage in New Orleans from exceeding 20 feet National Geodetic Vertical Datum (NGVD). Although the spillway was constructed for flood control purposes, spillway openings have proven beneficial overall and have resulted in increased fish and wildlife productivity in the study area in subsequent years. The spillway was opened in 1937, 1945, 1950, 1973, 1975, 1979, and 1983.

- Local interests have constructed salinity control structures in the Breton Sound Basin, adjacent to the study area, at Bayou Lamoque, Little Coquille, Bohemia, and White's Ditch. (See figure A-2, Volume 2, Appendix A, Problem Identification.)

PLAN FORMULATION

The plan formulation process was conducted in an organized and systematic manner to ensure that all reasonable alternative plans were considered. The alternative plans addressed study planning objectives and included a plan to maximize net national economic development benefits consistent with protecting the nation's environment according to national environmental statutes, executive orders and other Federal planning requirements. The plan formulation process was conducted in accord with US Water Resources Council "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" published March 10, 1983. A wide variety of management measures were identified to alleviate water resource problems and take advantage of opportunities that contribute to the national economic development (NED) objective. Contributions to the NED objective increase the net value of the national output of goods and services. These contributions are direct net benefits that accrue in the study area and the rest of the nation. Benefits are maximized in full consideration of enhancing environmental quality, regional development, and social concerns.

Historical trends and existing conditions were used as a base for forecasting future conditions. In an assessment of the nature and extent of changing conditions, problems and needs were identified and specific planning objectives defined. Opportunities in the form of management measures that address the objectives were evaluated. The most feasible measures were incorporated into an array of plans. The

plans were then assessed and evaluated in terms of their engineering feasibility and performance and their adverse and beneficial effects on the NED objective. The effects on environmental quality were also evaluated. Finally, the plans were compared and a trade-off analysis performed to select the plan that best addresses the NED objective and to provide the rationale for the recommended plan.

EXISTING CONDITIONS

CLIMATE

The climate of the area is humid, subtropical, and strongly influenced by the Gulf of Mexico. Temperatures range from an average high of 81°F in summer to an average low of 51°F in winter with an annual normal temperature of about 68°F.

Major rainstorms are associated with tropical disturbances and hurricanes in summer and early fall, and with frontal activity of extratropical cyclones in late fall, winter, and spring. Convective thundershowers produce intense but localized rain in late spring and summer. Rainfall averages about 61.2 inches a year. The greatest rainfall occurs from June through September. The driest month is October. In a normal rainfall cycle, rainfall activity is at a minimum in the fall with 12.2 inches, increases in the winter to 15.5 inches, declines in the spring to 14.4 inches, and increases to a maximum of 19.0 inches in the summer.

Although the rainfall is high according to the national average, there are periods when the amount is below normal and is exceeded by water losses due to evaporation and transpiration. When rainfall is 10 percent below normal for several continuous months, a drought is said to exist. This condition occurs about 25 percent of the time. Rainfall

shortages from 2 to 5 inches are estimated to occur more than 50 percent of the time.

In Louisiana, winds from the northeast prevail from September through February. Southeasterly winds prevail from March through August. The prevailing winds in southern Mississippi are southerly from March through July, easterly in August and September, and northerly in the remaining months.

WATER RESOURCES

Water bodies comprise 65 percent of the study area or about 1,942,000 acres. The major water bodies according to size are Mississippi and Chandeleur Sounds and Lakes Pontchartrain, Borgne, and Maurepas. Historically, the Mississippi River exerted considerable control over salinities in the study area. The river overflowed its banks in the spring, nourishing the marshes with sediments and nutrients and moderating salinities in the estuarine water bodies. Since the river was leveed, most of the water bodies only receive freshwater inflows from rainfall, urban stormwater runoff, and several bayous, rivers, and canals. During years of extreme flooding on the Mississippi River, such as in 1937, 1945, 1950, 1973, 1975, 1979, and 1983, fresh water is diverted through the Bonnet Carre' Spillway into Lake Pontchartrain. Additional water from the Mississippi River enters Lake Pontchartrain through the IHNC. Major rivers that discharge into Lake Maurepas and Lake Pontchartrain include the Amite, Tickfaw, Tangipahoa, and Tchefuncta Rivers. The Pearl River discharges into Lake Borgne and the Mississippi Sound. Most of the freshwater inflows into the Mississippi Sound are from the Wolf, Jordan, Biloxi, Tchoutocabouffa, and Pascagoula Rivers. The combined average annual discharge to the estuarine bodies in the study area is estimated at 37,900 cfs.

The area generally has one high tide and one low tide a day that ranges from 0.9 to 1.9 feet. The normal tide range is about 0.3 feet in Lake Maurepas, 0.5 feet in Lake Pontchartrain, 1.2 feet in Lake Borgne, 1.4 feet in Chandeleur Sound, and 0.9 feet in Mississippi Sound. Water circulation in the study area is influenced by winds, tides, freshwater discharges, and current in the gulf. The general circulation pattern in Lake Pontchartrain is a littoral drift to the west along the south and north shores and a return current in a broad band of water running approximately from northwest to the southeast. The littoral drift is generally to the north in Chandeleur Sound and toward the west in the Mississippi Sound.

Salinities in the major lakes and sounds reflect the freshwater inflow from the major rivers and streams. The lowest salinities generally occur in late spring and the highest in the summer and late fall. Salinities in Lake Maurepas vary from less than 0.2 parts per thousand (ppt) to 4.8 ppt. Lake Pontchartrain salinities range seasonally from a low of about 0.45 ppt to about 10 ppt. Salinities in Lake Borgne generally range from 2 to 15 ppt. Mississippi Sound salinities vary from 2 to 30 ppt. The area has experienced a long-term increase in salinity as a result of erosion, subsidence, a general rise in sea level, canal dredging, and the construction of the Mississippi River-Gulf Outlet (MR-GO). Available salinity data indicates that the most notable increase in salinities occurred after the construction of the MR-GO. Average annual salinities have increased by about 0.4 ppt in Pass Manchac, by 1.0-2.0 ppt on the eastern end of Lake Pontchartrain, by about 2.0 ppt at Chef Menteur Pass near Lake Borgne, and about 4.0 ppt in Bayou LaLoutre near Alluvial City. Seasonal salinities may range as high as 8 to 15 ppt. Increased salinity levels are readily detected by shifts in vegetative types. As salinities increase, plants with high salinity tolerance replace plants with low salinity tolerance. Comparing marsh vegetation maps that depict 1945 and 1968 conditions indicates

that the saline marshes moved inland an average of 2.1 miles and the brackish marshes 3.8 miles as a result of increased salinity levels.

Water quality in the Mississippi River is affected by the inflow of municipal and industrial effluents. The river is characterized by high nutrient and dissolved oxygen (DO) concentrations, moderately high bacterial densities and trace metal concentrations, and low pesticide levels. Water quality in Lake Pontchartrain and Lake Maurepas is influenced, to a large extent, by land use activities in the basin. The lakes receive municipal and industrial effluents, urban storm water, and agricultural runoff. The water quality in Lake Pontchartrain is generally good. Occasionally, fecal coliform counts along the southern shore of the lake and at the mouth of major rivers and streams entering the lake exceed applicable water quality standards. On rare occasions, pesticides, cadmium, copper, lead, mercury, and zinc exceed appplicable US Environmental Protection Agency water quality criteria. These exceedances occur at the mouth of feeder rivers and streams and in canals that enter the lake. The quality of water in the lake improves toward the middle. Water quality in Lake Maurepas is generally good but occasionally chlorides, pH, and coliform counts exceed applicable water quality criteria. In Lake Borgne, DO, pH, and total coliform counts occasionally exceed water quality criteria. The water quality in the Mississippi Sound is generally good with localized high coliform counts, low DO, and high nutrient concentrations in the lower reaches of rivers and streams entering the sound.

LAND RESOURCES

The land forms in the Louisiana section of the study area were created as the Mississippi River migrated back and forth depositing sediments across what is now coastal southeast Louisiana. Continued sediment deposition created delta lobes that slowly extended gulfward. During

the delta-building process, an intricate network of distributaries, channels, natural levees, and interdistributaries were formed. Some distributaries were favored by the river while others were abandoned. In recent years, sediment deposition has only occurred at the Plaquemines or modern "birdfoot" delta. Where sediment deposition ceased, the natural forces of subsidence, compaction, and erosion allowed the gulf to advance over the delta and form lakes, bays, and sounds.

In Mississippi, the land was formed by the subsidence of the late Pleistocene deposits. Some of these materials were reworked and redeposited in a series of barrier beach/dune ridges along the shoreline in areas where shoaling existed and aggradation occurred during the Holocene period. After this formation, the ridges subsided and the intervening swales were covered with marshes. At the same time, the gulf encroached over most of the area.

The nature of the land formation has, to a large extent, determined the size and use of the land. The study covers 2,960,000 acres of which 1,036,000, about 35 percent, is land. Marshes and wooded swamps make up about 50 percent of the land. The remaining land is distributed between developed land[1/] (25 percent), upland forest (15 percent), bottomland hardwood forest (8 percent), and upland shrub scrub (2 percent). In Louisiana, the land is characterized by low relief with the most prominent topographic features, the Mississippi River levees, standing significantly above the wetlands. Elevations vary from approximately 30

1/ Developed land includes urban, agricultural, and barren lands.

feet above NGVD on the crest of the levees to at or -10 feet below NGVD in pumped drainage areas. Along the Mississippi Gulf Coast, elevations increase at a rate of about 8 feet per mile from the shoreline inland. Elevations range from 0 to 5 feet NGVD in the wetlands and swamps and to 30 feet NGVD on some select beach/dune ridges inland from the Mississippi coastline. The shoreline is rather smooth and occasionally indented by bays. Most of the wooded areas and wetlands are adjacent to the Pearl River and St. Louis, Biloxi, and Pascagoula Bays. The shoreline in Mississippi from Waveland to Biloxi Bay is fairly well developed.

Recent studies indicate that the average land loss rate for the deltaic plain of coastal Louisiana is about 39 square miles per year (Wicker, 1980). Between 1956 and 1978, marsh loss rates ranged from a low of 0.34 square miles in the marshes adjacent to the Mississippi Sound to 2.5 square miles per year in the upper Lake Pontchartrain Basin. Land loss rates in the St. Bernard marshes were higher and averaged 4.1 square miles per year (plate 2). About 93,500 acres of marshes were converted to open water between 1956 and 1978. The conversion was the result of compaction, subsidence, erosion, and seasonal high salinities. These seasonal increases in salinities were great enough to cause habitat changes and related land loss. Increased salinities are detected by the shifts in vegetative types in the study area.

The Chandeleur Island chain is being eroded and driven landward at an estimated rate of 32.8 feet per year. Erosion is also occurring along the shoreline of Lake Maurepas at the rate of 1.6 feet per mile per year, along Lake Pontchartrain at the rate of 4.7 feet per mile per year, and along Lake Borgne at the rate of 4.1 feet per mile per year. Land loss has been accelerated by construction of canals for navigation, drainage, and mineral exploration. By 1970, a total of 16.6 square miles of canals and channels had been dredged. These canals have

lengthened the tidal shoreline by 351 miles.

BIOLOGICAL RESOURCES

Coastal marshes cover approximately 319,500 acres or about 31 percent of the land area. Twenty-six percent of the marsh is saline, 49 percent is brackish, and 25 percent fresh/intermediate. Wooded swamps of cypress and tupelogum border the marshlands and represent 19 percent of the land area. Hardwood forests cover about 8 percent of the land area, mostly along the Mississippi River and its abandoned distributary ridges. Portions of these forests are seasonally flooded. Common trees associated with bottomland hardwoods are various types of oak, ash, pecan, and maple.

In the study area, the marshes play a vital role in the productivity of biological resources and are some of the most productive habitats known in terms of primary production. They produce large amounts of the organic detritus that is an important component of the estuarine food web. Marshes provide valuable nursery area habitat for numerous fish and wildlife species. The root systems of marshes protect banks and beaches from erosion. When hurricane and storm waves travel through and over the marshes, the waves are greatly reduced or completely dissipated by the friction of the vegetated surface. Extensive beds of submerged vegetation called seagrass beds occur in the Mississippi Sound, especially on the leeward side of Ship, Horn, and Petit Bois islands. Seagrass beds occur in Louisiana on the leeward side of the Chandeleur islands and along the northeastern shore of Lake Pontchartrain. These beds are prime habitat for a variety of estuarine finfish and shellfish.

Fishery resources consist of freshwater and marine species. The Mississippi River supports various species of freshwater fish but is relatively unproductive because of high turbidities and strong

currents. Freshwater sport species in the study area include largemouth bass, spotted bass, yellow bass, black and white crappie, bluegill, spotted sunfish, redear sunfish, warmouth, and channel, flathead, and blue catfish. Important commercial fishes include catfishes, bowfin, carp, gars, and buffaloes. Sport marine or estuarine-dependent species that use the area include spotted and sand seatrout, Atlantic croaker, king and Spanish mackerel, cobia, bluefish, greater amberjack, spadefish, red snapper, black drum, and sheepshead. Commercially important fishery resources support an extensive fisheries industry. In order of value of average annual harvest, they are shrimp, menhaden, oyster, blue crab, catfish, Atlantic croaker, seatrout, spot, and red drum.

The diversity and areal extent of productive habitat types support a wide variety of wildlife including game species, commercially important furbearers and alligators, endangered species, and numerous nongame species that are ecologically important. Birdwatchers and sportsmen enjoy the great variety of birds in the area. Numerous migratory waterfowl such as mallards, gadwalls, wigeons, teals, ring-neck ducks, canvasbacks, and mergansers find the study area wetlands an excellent location to spend the winter. Wetlands in Louisiana provide wintering habitat for over two-thirds of the waterfowl using the Mississippi Flyway. Some waterfowl nest in the area. The decline in fresh and intermediate habitat has resulted in a reduction in the number of wintering waterfowl. Bottomland hardwoods and wooded swamps provide habitat for the white-tailed deer, squirrels, raccoon, and other popular game animals. Commercially important furbearers include nutria, muskrat, mink, river otter, raccoon, striped skunk, bobcat, beaver, and opossum. The unique wildlife diversity in the area has been recognized by both Federal and state agencies. Six wildlife management areas approximating 104,823 acres or about 10.5 percent of the land in the study area have been established.

Saltwater intrusion was a key factor in habitat loss, erosion, and vegetative changes. As saltwater intrudes into fresher areas, vegetation gradually dies or is converted to a more saline marsh type. Often, before more saline-tolerant plant species can revegetate the areas, open water is created because there is no plant root system to hold the marsh together. As the marsh and water interface increases, these areas are more easily eroded away. Saltwater intrusion contributes indirectly to reduced wildlife productivity by converting the more desirable fresh and intermediate marsh habitat to less desirable brackish and saline marsh, and directly by causing marsh loss.

Saltwater intrusion into Lakes Maurepas and Pontchartrain has contributed substantially to major habitat changes in the last 25 years. Approximately 25,000 acres of formerly fresh habitats including fresh marsh and baldcypress swamp have been converted to nonfresh habitats. The changes occurred in the lower Pearl River drainage basin near the Rigolets, the area south of Pass Manchac, and in St. Charles Parish south of Interstate 10. Close to 21,000 acres of baldcypress swamp have been changed to marsh. These changes mostly occurred between Lakes Pontchartrain and Maurepas north of Pass Manchac. About 36,000 acres of baldcypress swamp is under stress because of continued excessive salinities. Most of the stressed swamp is located on the northern and southern shores of Lake Maurepas. Additional stressed swamp occurs in St. Charles Parish in a band along Airline highway from southeast of the Bonnet Carre' Floodway to the St. Charles-Jefferson Parish line. In St. Bernard Parish, increased salinity has caused 9,700 acres of fresh habitat to change to nonfresh habitat. About 900 acres of baldcypress swamp is under stress.

The loss and alteration of habitat types have adversely affected the productivity of fish and wildlife. The American oyster clearly reflects the adverse changes because it is a relatively immobile organism. As previously stated, St. Bernard Parish historically had the most productive oyster harvesting areas in Louisiana, accounting for 70-75

PROBLEMS, NEEDS, AND OPPORTUNITIES

Over the years, natural and manmade changes produced cumulative effects that have had adverse impacts on estuarine-dependent fish and wildlife resources. The changes resulted in saltwater intrusion, vegetative change, loss of habitat, reduction in nutrients, erosion, and deteriorating water quality. The interrelationship of these parameters is significant. Each factor causes or intensifies the other. The collective impact on fish and wildlife resources affects productivity, commercial harvest, and sporting opportunities in the study area. Therefore, any attempt to address one factor influences all others.

PROBLEMS

The problems in the study area began when the Mississippi River was leveed and not allowed to migrate back and forth across what is now southeast Louisiana. As the river migrated, it deposited sediment in the form of deltaic marshes. The river overflowed its bank every spring, flooding and supplying the area with nutrients and sediments to sustain the deltas and maintain the fresh, intermediate, brackish, and saline marshes and their vegetative characteristics. Since the Mississippi River has been leveed, the only fresh water flowing into the estuaries in the study area has been from the seven Bonnet Carre' Spillway openings, from the Mississippi River through the IHNC, and from rainfall runoff from the uplands adjoining the project area. Deprived of the annual fresh water and sediment from the river, the natural processes of subsidence, compaction, erosion, and saltwater intrusion along with man's channel dredging and levee building activities have resulted in the loss of 2.5 square miles per year of study area coastal marshes.

Employment is expected to increase by about 40 percent, exceeding 1 million jobs by 2040. Employment projections are shown in table 3 for the SMSAs in the study area. In Louisiana, increases in jobs are envisioned in the service, trade, and manufacturing sectors with a slight decline in mineral production and construction. A similar pattern is projected for Mississippi with about half of the jobs devoted to the manufacturing of durable goods. In the commercial fisheries sector, the number of full-time commercial fishermen is expected to decline in view of the projected decline in marsh and marsh productivity. The number of part-time commercial fishermen is expected to increase due to the expected reclassification of former full-time commercial fishermen. Per capita income is expected to almost triple during the study period. By 2040, the New Orleans SMSA is estimated to have the highest per capita income, exceeding $21,000 (1972 dollars), followed by Jackson County with an expected per capita income exceeding $18,000 (1972 dollars).

TABLE 3

EMPLOYMENT PROJECTIONS FOR SMSAs IN STUDY AREA

State SMSA	Year 1978	1980	1990	2000	2030	2040
Mississippi						
Biloxi-Gulfport	81,494	92,100	99,299	111,507	129,484	132,000
Pascagoula/ Moss Point	54,759	71,189	81,266	96,609	117,435	121,000
Louisiana						
New Orleans	546,209	631,403	682,171	760,796	879,435	922,100

Source: US Department of Commerce, Bureau of Economic Analysis, 1980 OBERS BEA Region Projections, Vol. 8.

and the quality of the experience will also decline. Sport hunting opportunities would decrease by 33 percent or 160,919 man-days valued at $12 million.

HUMAN RESOURCES

By the year 2040, the study area's population is expected to reach 2,676,300, a 51 percent increase from 1980. The population projections are shown in table 2. The New Orleans SMSA will maintain a significant share of the future population, about 65 percent. In Mississippi, the Biloxi-Gulfport SMSA is expected to account for about 10 percent of the study area's future population. The substantial population growth is due to the trend of population to concentrate in and around urban areas for jobs and business opportunities, the attractiveness of the sunbelt region to industry and people, and the general favorable economic growth.

TABLE 2

STUDY AREA POPULATION PROJECTIONS

Year							
1980	1985	1990	2000	2010	2020	2030	2040
(Thousands of People)							
1,767	1,830	1,939	2,109	2,239	2,376	2,522	2,676

Source: US Dept. of Commerce Bureau of Economic Analysis, 1980 OBERS BEA Regional Projections, July 1981; and Bureau of the Census, Census of Population, Number of Inhabitants, 1982.

RECREATION

Recreation demands are expected to significantly increase in the future. Hunting recreation needs are estimated to increase from 4,128,769 man-days in 1980 to 6,729,854 man-days by 2040. During that same period, the need for boat launching lanes is expected to increase by 702 lanes. Population growth and associated industrial development will increase the competition between commercial and recreation interests for the same resource. Continued loss of productive coastal marsh fish and wildlife habitat will adversely affect future recreation opportunities.

ECONOMY

The economy of the area is expected to continue to prosper as a result of the petroleum-based activities, tourism, port activities, and the extensive navigable waterways. However, the industries associated with wildlife and fisheries resources, which are of primary importance to this study, are expected to decline in productivity as a result of habitat losses.

The continued loss of fish and wildlife habitat will cause the future fish and wildlife harvest to decline significantly in value from the 1963-1978 average of $52 million. Commercial wildlife productivity would decline due to both direct loss of habitat and conversion of habitat to more saline types. Fresh/intermediate marsh areas provide more favorable habitat for furbearers, waterfowl, and the American alligator. By 2040, the potential annual value of commercial wildlife harvest would be reduced by over $378,000 or about 47 percent.

Habitat deterioration will reduce productivity of sport fish and wildlife. As sport fish populations decline, the fishermen's success

Venetian Isles in eastern New Orleans have been proposed along the northern shores of Lake Pontchartrain. Such development would contribute to wetland losses. A portion of the wetlands in Orleans Parish will probably be drained for urban development. Future urban pressure may cause the development of wetlands along the south shore of Lake Pontchartrain in St. Charles Parish. In St. Bernard Parish, wetlands adjacent to the Mississippi natural levees and Highway 46 may be drained for future development. Population increases along the Mississippi Gulf Coast will put an additional burden on the lands.

BIOLOGICAL RESOURCES

Changes in land and water resources over the next 50 years will have a direct adverse effect on the biological resources. Deteriorated and reduced habitat quality and quantity will cause a parallel decline in fish and wildlife resources. Marshlands, the primary habitat that will be lost, will be reduced by approximately 23 percent of the total acreage. Fifteen percent of bottomland hardwoods and 38 percent of wooded swamp would be lost or converted to less desirable habitats. The species that use these habitats will be the most greatly affected.

CULTURAL RESOURCES

Future research and more extensive field investigations will probably identify additional cultural resources in the area. Known archeological sites in the wetlands will continue to be subjected to the destructive forces of erosion, wavewash, saltwater intrusion, and subsidence and some will be lost. Sites near urban areas are likely to be adversely affected by urban and industrial development.

TABLE 1

PROJECTED HABITAT CHANGES IN THE STUDY AREA

1978-2040

Habitat Type	1978	1990	2000	2010	2020	2030	2040
				(acres)			
Bottomland Hardwoods	90,732	87,153	84,308	81,580	78,965	76,457	74,052
Wooded Swamp	188,669	166,233	150,030	135,800	123,302	112,326	102,687
Fresh/Intermediate Marsh	78,231	72,857	68,744	64,928	61,376	58,065	54,972
Brackish Marsh	157,604	149,141	142,455	136,086	130,017	124,234	119,723
Saline Marsh	83,711	76,803	71,579	66,795	62,411	58,386	54,695
Total Marsh	319,546	298,801	282,778	267,809	253,804	240,685	229,390

Source: US Army Corps of Engineers, New Orleans District

in habitat changes and related land loss in the St. Bernard marshes between the Mississippi River and the MR-GO. No significant increase in average annual salinity was projected for the Mississippi Sound. The sound would be subjected to salinity variations in response to freshwater inflows. Substantial improvements in the overall water quality of study area waters are not anticipated in the foreseeable future.

LAND RESOURCES

Land resources are projected to change in areal extent and diversity by the year 2040. About 146,058 acres of land are expected to be converted to water or other land uses between 1990 and 2040. Land would be lost at an estimated rate of 2.5 square miles a year. The Chandeleur Island chain will continue to be eroded and driven landward. These barrier islands act as a buffer against erosion for the St. Bernard marshes and keep out gulf water. Erosion is expected to continue along the shoreline of Lakes Maurepas, Pontchartrain, and Borgne as a result of wind and wave action. Based on historic subsidence and sea level trends, the relative elevation of land and water surfaces is projected to change by approximately 0.5 foot by 2040.

Substantial changes in land diversity will occur as a result of projected changes in environmental parameters such as subsidence and land use. Among the projected changes are reductions in fresh, intermediate, brackish, and saline marsh, wooded swamp, and bottomland hardwoods. Between 1990 and 2040, approximately 63,546 acres of wooded swamp (38 percent), 13,101 acres of bottomland hardwoods (15 percent), and 69,411 acres of marsh (23 percent) are expected to be lost or converted to other land uses such as agricultural, industrial, and urban if historical trends continue. Table 1 presents the anticipated changes in habitat types in the study area. The classification of the habitat types is discussed in EIS paragraph 5.2.

In addition to the natural losses, the activities of urbanization and industrialization are expected to affect the wetlands. Several developments similar to Eden Isles on Lake Pontchartrain north shore and

exceeded 650,000. Of the persons employed, 73 percent lived in the New Orleans SMSA. An analysis of employment distribution among the major sectors indicated that the largest source of jobs in Louisiana was in the retail and wholesale trade sector. This sector accounts for about 24 percent of the jobs. The primary occupations in order of the number employed are government, services, manufacturing, utilities, construction, finance, mining, agriculture, forestry, and fisheries. In Mississippi, about half of the jobs are in the manufacturing and government sectors. About 37 percent of the jobs are in the retail and wholesale trade and services sectors.

FUTURE CONDITIONS

The most probable future conditions if no Federal action is taken are determined by projecting conditions that would prevail in the study area over the planning period 1990 to 2040. All authorized projects are considered to be in place except the 16- by 150-foot channel authorized for the Gulf Intracoastal Waterway between Apalachee Bay, Florida, and the Mexican border, a replacement lock of the existing IHNC lock, and the barriers at the entrances to Lake Pontchartrain.

WATER RESOURCES

By 2040, projections are that about 135,700 acres of land would be converted to open water. Over the next 50 years, no significant increase in average annual salinity is projected for Lakes Maurepas and Pontchartrain. Salinities are expected to slightly increase in the Lake Borgne area and surrounding marshes due to future land loss. Seasonal salinity variations in Lake Pontchartrain from 8 to 15 ppt are expected to continue into the future in response to the freshwater inflows from major rivers and streams. These large seasonal variations would usually occur during summer and late fall. The wide variations in salinities are large enough to cause future habitat changes and related land loss in the wooded swamps and marsh vegetation adjacent to Lakes Maurepas and Pontchartrain. Wide variations in seasonal salinities would also result

As a result of an intricate navigation system, shipping has evolved into the major industry in the area. The Port of New Orleans is the world's largest grain port, the largest seaport in the United States, and the second largest in the world in terms of dollar value and waterborne tonnage handled. Major commodities handled at the port include grain, crude petroleum, fabricated steel, metallic minerals, chemicals, and refined petroleum products. Other ports in the study area include the Ports of Pascagoula and Gulfport. Both ports are considerably smaller than the Port of New Orleans, but make a sizeable contribution to their local economies. The ports provide dock and harboring facilities for ocean shipping, barge traffic, commercial fishing vessels, and recreation craft.

In some rural areas of the study area, the economy depends on commercial fishing and agriculture. Major crops are sugarcane, soybeans, cotton, citrus, pecans, and truck crops.

HUMAN RESOURCES

The economic study area population is 84 percent urban and 16 percent rural. Population in 1980 was 1,800,000, an increase of 300,000 over the 1970 level of 1,500,000. The majority of the residents are concentrated in the New Orleans and Biloxi-Gulfport Standard Metropolitan Statistical Areas (SMSAs). About 1,200,000 people, 67 percent, live in the New Orleans SMSA. The Biloxi-Gulfport SMSA accounts for 11 percent of the population. Other areas of population concentration are along the east bank of the Mississippi River west of New Orleans, along the Mississippi Gulf Coast, and in the southern portion of Tangipahoa Parish. Per capita income averages $8,940. Of the 10 parishes and three counties, five parishes and two counties had per capita incomes above the Louisiana and Mississippi state averages of $8,458 and $6,580, respectively. Employment in the study area in 1980

general decline in the Chesapeake Bay area. The decline in the domestic oyster harvest has been offset by oysters imported from Japan and Korea. Imports have increased by 200 percent since 1972 and have tripled since 1975. Imported canned oyster products average 70 million pounds and have generally replaced domestic oyster canning.

The shrimp harvest in the study area averages 27.9 million pounds annually with a value of $31.0 million. Menhaden harvest averages 51.8 million pounds annually with a value of $3.0 million. Menhaden is the principal industrial fish taken in Louisiana. The oily flesh of this species is not suitable for human consumption, but when menhaden is processed, it is a valuable source of oil and animal feed. The oyster, shrimp, and other fishery resources support a host of seafood-related industries. They range from the obvious ones of canning, shipping, wholesaling, retailing, and restaurant operation to building, selling, and servicing boat and fishing gear, ice making, and operating commercial marinas.

Commercial wildlife activities are associated mainly with alligators and furbearers. Based on 1978 habitat acreages and 1976-1981 average prices, potential annual net value of furbearers is about $643,000. Potential net annual harvest of alligators is 1,023 alligators valued at about $157,000.

The recreational resources support about 2.1 million annual man-days of recreation valued at $10 million. The most popular activities are freshwater and saltwater fishing and hunting. The breakdown of annual man-days and value between fishing and hunting is shown below:

Activity	Man-days	Dollar Value
Fishing	1,822,800	$7,656,000
Hunting	202,538	2,421,635
Total	2,125,338	$10,077,635

natural gas deposits, mineral production value in Mississippi was $0.5 billion in 1977, of which less than 1 percent was from the three counties in the study area.

Other extremely important commercial activities of the area center around fish and wildlife resources. During the 1963-1978 period, the average yearly harvest of estuarine-dependent fisheries was 96 million pounds with an average annual value of $52 million. Major commercial fishery species include oysters, shrimp, and menhaden. In Louisiana, the oyster fishery has evolved from a natural fishery to one predominated by privately leased and seeded bottoms in the more productive waters closer inshore. Historically, 70-75 percent of the oysters harvested in Louisiana were from the St. Bernard marshes. In recent years, saltwater intrusion has reduced the area and extent of productive water bottoms and shifted the production primarily to the Lake Borgne area. The shift in oyster beds can be readily seen on plates A-9 and A-10 in Volume 2, Appendix A, Problem Identification. This area is closer to sources of pollution and is periodically closed by health officials. Although there are 250,000 acres of public oyster seed grounds and 51,000 acres of leased water bottoms in the St. Bernard area, the area now contributes only 20 percent of the oysters harvested in Louisiana. Mississippi oyster harvest is primarily from natural reefs. The study area average annual production between 1970-1976 was 8.0 million pounds of meat with a value of $12.5 million. Of this production, 1.9 million pounds or 24 percent is from Mississippi. This production is about 13 percent of the nation's total oyster harvest. In the US, the oyster harvest has declined in the last 50 years. About 90 million pounds of oyster meat were harvested in 1929 compared to an average 54 million pounds in the 1970s. The harvest has declined because of overfishing, natural disasters, oyster predation and disease, and the closure of areas subject to pollution. In recent years, the gulf states have captured a larger percentage of the US market due to a

fishing and boating and a winter base for waterfowl hunting and trapping. In Louisiana's offshore waters, there are more than 2,000 oil platforms that serve as artifical attractors for fish communities. To take advantage of the fish that cluster around these platforms, 45 to 50 charter boats ferry saltwater anglers to the sites. In Mississippi, saltwater fishing activities dominate other recreation activities. Five manmade fishing reefs are available to take advantage of the excellent sport fishing. A fleet of more than 36 charter boats are in the sportfishing business in Biloxi, Ocean Springs, and Gautier. Gigging southern flounder at night in the shallow water along the Mississippi Gulf beaches is also a favorite sport. Big game, small game, waterfowl, and migratory birds are hunted in the area.

ECONOMY

The economy of the study area is founded on a base of natural resources that include commercially important minerals and a variety of fish and wildlife resources. With extensive navigable waterways and a strategic location, the area is a hub for foreign and domestic trade and harbors a cultural and historical heritage that ranks among the most significant in the nation.

Significant mineral deposits include crude petroleum, natural gas, and natural gas liquid. Other resources include cement, clay, salt, sulphur, sand, gravel, lime, and magnesium compounds. These deposits make a considerable contribution to the study area's economy. The total value of Louisiana production for 1975, 1976, and 1977 was $8.5, $8.7, and $10.5 billion, respectively.

The three Mississippi counties are not as well endowed with minerals as Louisiana. Harrison County has few resources while Jackson County has deposits of natural gas and crude petroleum. With few petroleum and

CULTURAL RESOURCES

The study area has a rich cultural heritage, a result of the diversity and abundance of natural resources that provided early settlers with food, work, recreation, and travel routes. Many features of great cultural value have survived the years including plantations, churches, forts, historic shipwrecks, village sites, and shell middens. Over 620 known archeological sites are in the area and, of these, 36 are on the National Register of Historic Places. Of the 36 historic places, 25 are in Mississippi. The 11 sites in Louisiana include 3 forts built in the 1800s to protect the City of New Orleans, 3 lakefront structures in the historic town of Mandeville, 2 historic lighthouses, 1 shell midden, 1 mound site, and 1 deeply buried cultural deposit dating back between 1500 and 500 B.C.

RECREATION RESOURCES

The study area is blessed with numerous lakes, bays, swamps, and marshes that provide an excellent environment for year-round recreation opportunities. In fall and winter, hunters, trappers, and fishermen harvest ducks, muskrat, nutria, alligator, and numerous fresh and saltwater fish. Spring and fall are the primary seasons to shrimp, crab, and fish for spotted seatrout, largemouth bass, and other finfish species. Recreation areas that fishermen use extensively include Chef Menteur Pass, Little Woods, North Shore, and Spanish Fort. There are about 30 marinas in the study area with over 3,000 berths. These facilities house the larger pleasure boats used for fishing, sailboating, and family cruising. The marinas are located on the northern and southern shores of Lake Pontchartrain and in the lower reaches of feeder streams entering the lake. In Mississippi, the marinas are located along the gulf coast. Thousands of camps have been constructed in the marsh to provide sportsmen with a summer site for

percent of all oysters harvested. The areas were located in the numerous bays and sounds in St. Bernard Parish along the eastern fringes of the marsh. In recent years, intruding salt water has caused the productive oyster producing areas to shift inland into Lake Borgne. The inland shift has moved the oyster beds closer to human activities, making the beds more susceptible to pollution and subject to contamination and closure. The historically productive oyster areas are experiencing considerable predation, parasitism, and disease. The St. Bernard area now only contributes about 20 percent of the oysters harvested in Louisiana. There has also been a general decline in fish and wildlife productivity. The St. Bernard marshes were some of the most productive in the state for muskrat, nutria, mink, otter, and raccoon. Because of increased salinity, fur production has decreased significantly. These animals generally prefer the fresh/intermediate marshes and swamps and a large portion of this habitat has been lost to open water or converted to brackish-to-saline marshes. Waterfowl that prefer the fresher habitats have also declined.

The decline in fish and wildlife resources will result in even greater loss of jobs in the commercial and recreational fish and wildlife harvesting and processing industries. In the last 40 years, the number of oyster canners in Louisiana and Mississippi decreased from 25 to 4. Job loss followed this decrease and diminished the canneries' ability to meet the canned oyster demand. As a result, imported canned oyster products have generally replaced canning of oysters in the United States. Between 64 and 79 million pounds of canned oyster meat are imported yearly. The cannery closings have been linked to the processors' inability to obtain a steady supply of oysters. Oyster harvest varies widely from year to year. Between 1970 and 1976, oyster harvests ranged from a low of 4.0 million pounds to 7.3 million in the study area. As the fish and wildlife resources decline, the quality of the sport fishing experience will also suffer. In addition, the fishery industry's capacity to meet the demand for seafood will be diminished.

NEEDS AND OPPORTUNITIES

The problems in the study area point clearly to several urgent needs that must be addressed to prevent further deterioration of the coastal marshes and to slow the decline in the fish and wildlife resource productivity.

- Salinity levels need to be reduced so commercial fisheries and wildlife production can be increased.

- The amounts of nutrients and sediments in the estuarine-marsh areas need to be increased to enhance aquatic and marsh vegetation.

- Recreation opportunities need to be increased.

- Habitat changes and related land loss need to be reduced.

Restoring low salinities in the St. Bernard marshes and western Mississippi Sound on the average of every other year and preventing higher salinity waters from intruding into Lakes Maurepas and Pontchartrain would benefit juvenile white shrimp, menhaden, Atlantic croaker, catfish, and several other species of finfish. The major benefits, however, would be to improve and restore the historical oyster harvesting areas. Lower salinities would expand the area in which the southern oyster drill and other oyster predators cannot survive.

Preventing saltwater intrusion into Lakes Maurepas and Pontchartrain during periods of low fresh water flows from major streams would reduce habitat changes and related land loss in marshes and wooded swamps near the lakes. These habitats would be restored to a healthier condition and some nonfresh habitat would be converted to fresh habitat. Increasing nutrients and sediments in estuarine areas would enhance the growth of marsh vegetation and slow the rate of land loss. Increased

plant growth would result in greater production of organic detritus that is essential for a high rate of fisheries production. Production of phytoplankton and zooplankton would increase and, as a result, the harvest of sport and commercial fish and shellfish that depend on these microorganisms may increase.

Sport fishing and hunting is related to the availability of fish and wildlife resources and access to these resources. By the year 2040, the need for boat launching ramps is expected to increase from the existing 1,160 to 1,862 lanes. Estimated total hunting needs are expected to increase from 4.1 million man-days to 6.7 million man-days. By the year 2040, the projected loss in habitat will cause estimated hunting losses of 160,919 man-days valued at $1.0 million annually. Enhancing habitat conditions would increase sport hunting opportunities by 10,000 man-days in 2040 valued at $77,000. The loss of habitat does not reduce the resource base for fishing, but continued habitat deterioration would reduce the potential fish harvest. As a result, the "expected catch" would be reduced and the quality of the fishing experience would be lowered.

A range of opportunities are available to address the most urgent problems in the estuarine-marsh study area. These opportunities can be realized by improving management of fish and wildlife resources, establishing sanctuaries, filling open water areas with dredged material to create new marsh, regulating the alteration of marsh areas, placing barriers in the marsh to reduce saltwater intrusion, providing more access to the area, and introducing fresh water to reduce salinities in the marsh and estuaries.

STUDY PLANNING OBJECTIVES

The following planning objectives have been developed based on the identified problems, needs, and opportunities, and the concerns of

public, state, and local interests.

- Restore and maintain favorable salinity regimes in wetlands and estuaries to increase fish and wildlife productivity.

- Increase commercial fisheries production to meet the demands for fish products, increase the number of jobs available, and stabilize the wide fluctuations in the fisheries industry.

- Increase commercial wildlife production to meet the demands for pelts and hides, increase the number of jobs available, and stabilize the wide fluctuations in the wildlife industry.

- Improve fishing opportunities to satisfy a portion of the sport fishing demands and to increase the quality of the fishing experience by minimizing the reduction in the "expected catch."

- Improve hunting opportunities to satisfy a portion of the hunting needs.

- Enhance marsh and aquatic vegetation growth to reduce habitat changes and related land loss and increase the nutrient and organic detritus supply for fish and wildlife productivity.

- Preserve, restore, and create natural habitats to offset potential declines in fish and wildlife populations and reduce erosion, subsidence, and avenues for saltwater intrusion.

- Provide additional access to fish and wildlife resources to increase recreation opportunities.

PLANNING CONSTRAINTS

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

In the estuarine-marsh complex, there is an intricate relationship between subsidence, the rise in sea level, saltwater intrusion, erosion, fresh water, sediment, nutrients, and resource productivity. Subsidence accompanied by a rise in sea level, saltwater intrusion, and erosion have already affected the area and the fish and wildlife resources that use it. Restoring desirable habitat conditions and associating changes in the salinity gradients to increases in primary productivity of habitat types and fish and wildlife populations is a complex problem. Actual experience with altering salinity for the purpose of conserving and enhancing fish and wildlife resources is limited in scope and duration. Current knowledge of relationships between changes in physical and chemical parameters and biological communities is partly derived from large-scale diversions for flood control, but is largely based on inductive reasoning and expert judgment. There is no one accepted method for relating primary productivity to the harvest of fish and wildlife and the benefits derived from freshwater inputs. Studies to refine presently known information would require several years of basic research, extensive data collection, and development. The effort could take four years or more to accomplish. In view of these constraints, the most reasonable approach was to limit the study effort to review and evaluation of existing information and available data.

ALTERNATIVE PLANS

MANAGEMENT MEASURES

Measures were identified that could address one or more of the planning objectives. The measures are:

- Divert fresh water.
- Construct saltwater barriers.
- Fill open water areas with dredged material.
- Regulate alteration of wetlands.
- Establish sanctuaries.
- Manage fish and wildlife.

Suggestions made in public meetings and at coordination meetings with interested Federal, state, and local agencies are included among the measures. Each measure could be accomplished in numerous ways and combinations of measures could produce innumerable alternative plans.

DEVELOPMENT OF ALTERNATIVE PLANS

These measures were used to formulate 16 conceptual plans. The 16 plans include eight freshwater diversion plans, three barrier plans, one plan to regulate alteration of wetlands, one plan to fill subsiding areas, one plan to establish sanctuaries, one plan to manage fish and wildlife, and one plan with features of a number of measures. The no-action alternative plan was also considered. The conceptual plans are shown in table 4. As a result of preliminary assessment and evaluation of the

TABLE 4

CONCEPTUAL ALTERNATIVE PLANS

Alternative Plan	Plan Description
1	Divert fresh water from Mississippi River at one location above New Orleans.
2	Divert fresh water from Mississippi River at one location below New Orleans.
3	Divert fresh water from Mississippi River at one location above New Orleans and at one location below New Orleans.
4	Divert fresh water from Mississippi River at most effective combination of sites above New Orleans.
5	Divert fresh water from Mississippi River at most effective combination of sites below New Orleans.
6	Divert fresh water from Mississippi River at most effective combination of sites above and below New Orleans.
7	Divert fresh water from Mississippi River at Bayous Manchac, Braud, and Conway, Blind River, drainage canals at Garyville, Reserve Relief Canal, canals north of boundary of Bonnet Carre' Spillway, canals inside Bonnet Carre' Spillway, Walker Canal, St. Charles Parish Canal, Inner Harbor Navigation Canal, Lake Borgne Canal, and Bayous Terre Aux Boeufs and La Loutre.
8	Divert fresh water from Mississippi River using siphons at above locations.
9	Construct a navigable saltwater barrier in the MR-GO.

TABLE 4 (CONTINUED)

CONCEPTUAL ALTERNATIVE PLANS

Alternative Plan	Plan Description
10	Construct a system of saltwater barriers and weirs in marshes.
11	Construct artificial barrier islands and reefs connecting existing islands.
12	Regulate alteration and destruction of wetlands.
13	Fill subsiding areas.
14	Establish sanctuaries in areas important as breeding, nursery, and feeding grounds.
15	Manage fish and wildlife by regulating harvest, stocking, planting cultch and vegetation, and controlled marsh burning.
16	Various combinations of the above.
17	No action.

performance of the conceptual plans, eight plans were eliminated. The plans were eliminated because some interfered with navigation and some would cause severe impacts on development in urbanizing areas. The conceptual plans subjected to further analysis are shown in table 5.

Plans 1, 2, and 3 - Divert freshwater above and below New Orleans. Conceptual plans 1, 2, and 3 are freshwater diversion plans. In these plans, fresh water would be diverted at various locations above and/or below New Orleans. The freshwater diversion plans would make major contributions to enhancing vegetative growth, establishing favorable salinity gradients, and increasing sport and commercial fish and wildlife production. The plans would make moderate contributions to preserving and restoring wetlands. Since freshwater diversion contributes the most to the study planning objectives, specific freshwater diversion sites were identified and evaluated. In Conceptual Plan 1, fresh water is diverted from the Mississippi River at one location above New Orleans. Ten possible freshwater diversion sites above New Orleans were identified as representative of all the sites that could be considered. The sites are shown on plate 3. The sites are located where connections to the river previously existed or where development is sparse. The most upstream site selected is at Bayou Manchac. Any site farther upstream would have to use the Amite River as a conveyance channel. Excavating such a channel to the Amite River or its tributaries would be prohibitively expensive. In addition, large quantities of water diverted into the upper Amite River Basin in the spring when the largest diversions are necessary could increase the possibility of flood problems in East Baton Rouge, Livingston, and Ascension parishes. No sites were located along the Mississippi River between the City of Kenner and the IHNC because of extensive urban development. Pertinent engineering, environmental, and socio-economic

TABLE 5

CONCEPTUAL PLANS RETAINED FOR FURTHER ANALYSIS

Conceptual Alternative Plan	Plan Description
1	Divert fresh water from Mississippi River at one location above New Orleans.
2	Divert fresh water from Mississippi River at one location below New Orleans.
3	Divert fresh water from Mississippi River at one location above New Orleans and at one location below New Orleans.
12	Regulate alteration and destruction of wetlands.
13	Fill subsiding areas.
14	Establish sanctuaries in areas important as breeding, nursery, and fishing grounds.
15	Manage fish and wildlife by regulating harvest, stocking, planting cultch, and vegetation and controlled marsh burning.
16	Various combinations of plans.
17	No action.

information on the sites is shown in table 6. The performance of the diversion sites was compared using a numerical system to rate and rank the sites. The numerical ranking system is described in Appendix B, Plan Formulation. According to the potential site ranking (plate 4), the borrow channel inside the Bonnet Carre' Floodway site is the most feasible of the above New Orleans sites. A plan with this site was retained for further analysis.

Three potential freshwater diversion sites at or below New Orleans that divert water primarily to Lake Borgne were identified. (Conceptual Plan 2). The three sites are shown on plate 3. The IHNC site was identified because conveyance channels exist to Lakes Pontchartrain and Borgne. No sites were considered between the IHNC and Violet, Louisiana, because of extensive New Orleans metropolitan area urban development along the river. Potential sites were located betwen the communities of Violet and Riverbend and at Bayou Terre Aux Boeufs.

No sites were located below Bayou Terre Aux Boeufs because water diverted below that point would flow into Breton Sound Basin outside the study area. Pertinent engineering, environmental, and socio-economic information on these three sites is shown in table 7. According to the potential site ranking, the IHNC site ranks better then either the Riverbend or Bayou Aux Boeufs site (plate 4). Both the IHNC site and the Riverbend site were retained for further study because preliminary analysis indicated that it might not be possible to divert sufficient flow through the IHNC site without adversely affecting navigation.

In Conceptual Plan 3, fresh water is diverted at two locations, one above and one below New Orleans. This plan is an attempt to balance the advantages and disadvantages of using one site. Several combinations of

TABLE 6

EVALUATION DATA ON POTENTIAL
FRESHWATER DIVERSION SITES ABOVE NEW ORLEANS

Site Name	Mile AHP	Primary Receiving Body	Parish Affected	Number of Relocations		Foundation Considerations			Length of Diversion Channel (Miles)	Habitat Altered				Relocation	Aggravate Flood Problems
										Bottomland Hardwoods	Wooded Swamps	Marshes	Other		
Bayou Manchac	214.8	Lake Maurepas	East Baton Rouge, Ascension, Livingston, St. John the Baptist	6 roads 6 pipelines	3 powerlines 3 bridges	SP EC		FP	40	970	-	-	-	5 residents 1 com. bldg.	Possible
Bayou Braud	196.0	Lake Maurepas	Iberville, Livingston, Ascension, St. John the Baptist Parish	3 roads 5 pipelines	2 powerlines 7 bridges	SCP	SP	EC	45	394	364	-	-	1 com bldg.	Possible
Bayou Conway	176.0	Lake Maurepas	Ascension, St. John the Baptist	2 roads 8 pipelines	7 bridges	SP SEP	EP	EC	30	390	758	-	-	15 residents disrupt community	Possible
Drainage Canal into Blind River	155.0	Lake Maurepas	St. John the Baptist, St. James, Ascension	3 roads 6 pipelines	3 bridges	EP	SEP	EC	25	121	730	-	575*	5 residents	Possible
Canal at Garyville	142.0	Lake Maurepas	St. John the Baptist	1 road 5 pipelines	4 bridges	EP EC	SEP		15	-	667	-	120*	disrupt community	Possible
Reserve Relief Canal	137.4	Lake Maurepas	St. John the Baptist	1 road 5 pipelines	4 bridges	SP CC	SEP		8.5	364	-	-	-	40 residents, 1 com. bldg.	Possible
Canal West of Bonnet Carre' Spillway	129.0	Lake Pontchartrain	St. Charles	1 road 5 pipelines	1 powerline 5 bridges	EP	SP SEP	EC	6.4	182	182	-	-	25 residents disrupt community	No
Borrow Channel inside Bonnet Carre' Spillway	118.5	Lake Pontchartrain	St. Charles	4 pipelines	3 bridges		EP		6.6	-	-	-	364**	25 residents disrupt community	No
Walker and St. Charles Parish Canals	116.0 115.0	Lake Pontchartrain	St. Charles, Jefferson	3 roads 2 pipelines	3 bridges	SP	EP		5.0 5.5	-	182 91	182 242	-	1 sand mining co.	No

FP - Failure Problems
SP - Settlement Problems
EC - Earthfill Cofferdam required
CC - Cellular Cofferdam required
SCP - Scour Protection required
SEP - Seepage Problem
EP - Erosion Problem

*Agricultural lands
**Bottomland hardwoods, Wooded Swamp, and Marshes

TABLE [illegible] (Continued)

EVALUATION DATA ON POTENTIAL FRESHWATER DIVERSION SITES ABOVE NEW ORLEANS

Site Name	Hydraulic Head[1/] (feet)	Hydraulic Slope[2/] (feet/foot)	Water Quality Dredged	Cultural Resources
[illegible] Canal	1.2	0.0000	Increased turbidity, decreased water temperature in vicinity of outfall to Lake Maurepas. Copper, zinc, chromium, cadmium, mercury, fecal coliform bacteria may exceed EPA water quality criteria.	High probability of uncovering cultural resources. Bayou Manchac served as a major commercial artery during the 18th centuries and numerous historic sites are along its bank. Galvestown is located along Bayou Manchac.
Bayou Braud	9.0	0.00004	Same as Bayou Manchac.	High probability of uncovering cultural resources. Hard Times Plantation and other structures are located at the site area.
Bayou Conway	8.6	0.00005	Same as Bayou Manchac.	High probability of uncovering cultural resources. Several historical structures are located at the site area.
Drainage Canal to Blind River	9.4	0.00005	Same as Bayou Manchac	Same as Bayou Conway.
Canal to Garyville	7.1	0.00008	Same as Bayou Manchac.	Medium probability of uncovering cultural resources. Site close to Pope Plantation and San Francisco Plantation, a National Register property.
Reserve Related Canal	5.8	0.0001	Same as Bayou Manchac.	Same as Bayou Conway.
Canal West of Bonnet Carre' Spillway	5.4	0.0002	Increased turbidity decreased water temperature in vicinity of outfall to Lake Pontchartrain. Copper, zinc, chromium, cadmium, mercury, and fecal coliform bacteria may exceed EPA water quality criteria.	Same as Bayou Conway.
[illegible] Canal Inside Bonnet Carre' Spillway	4.7	0.0002	Same as Canal West of Bonnet Carre' Spillway.	Low probability of uncovering cultural resources.
[illegible] Canal Outside Bonnet Carre' Spillway	4.5	0.0002	Same as Canal West of Bonnet Carre' Spillway.	High probability of uncovering cultural resources. Fairview and Bellevue Plantations located near site.

1/ [illegible] increase between stages in river and tailwater area.

2/ [illegible] ratio of hydraulic head to [illegible] length.

TABLE 7

EVALUATION DATA ON POTENTIAL FRESHWATER DIVERSION SITES BELOW NEW ORLEANS

Site Name	Hydraulic Head[1] (feet)	Hydraulic Slope[2] (feet/foot)	Water Quality Dredged	Cultural Resources
IHNC	3.4	0.00010	Increased turbidity decreased water temperature in vicinity of outfall to Lake Pontchartrain. Copper, zinc, chromium, cadmium, mercury, and fecal coliform bacteria may exceed EPA water quality criteria. Lead and arsenic may occasionally exceed EPA water quality criteria.	Low probability of uncovering cultural resources.
Riverbend	3.1	0.00010	Same as IHNC.	High probability of uncovering cultural resources. Hard Times Plantation and other structures are located at the site area.
Bayou Terre Aux, Boeuf and La Loutre	3.0	0.00003	Same as IHNC.	Same as Riverbend.

[1] Hydraulic Head represents difference between stages in river and tailwater area.

[2] Hydraulic Slope represents ratio of hydraulic head to channel length.

disposal area. Oyster beds in Lake Borgne may be temporarily or permanently closed because of high fecal coliform counts. The Riverbend diversion site is located too close to oyster beds in Lake Borgne to allow fecal coliform organisms in the Mississippi River to dieoff. River sediments that would settle out in Lake Borgne would cover oyster beds and adversely affect oyster growth. Plans B and C do not meet the criterion of acceptability. As previously indicated, officials of St. Bernard Parish have expressed opposition to a diversion site in their parish. Consequently, Plans B and C were eliminated from consideration.

Three diversion schemes were considered at the IHNC site (Plan D) due to the uncertainty of recommendations that might be forthcoming from the Corps of Engineers study , "Mississippi River-Gulf Outlet, New Lock and Connecting Channels", which is currently underway. Detailed lock site selection studies are being made but a study completion date has not been determined. The existing lock dimensions are 31.5 feet by 75 feet by 640 feet. In the first diversion scheme, 18 combinations of types and sizes of locks were considered with various operational modes at the existing lock location. The 18 combinations are shown in Table C-1-30, Appendix C, Engineering Investigations. The second scheme assumes that the existing lock, without modification, would be used to divert fresh water through the existing lock culvert system. The third developmental scheme investigated the possibility of constructing a freshwater diversion structure adjacent to the existing lock within the existing rights-of-way. The maximum design capacity of the structure would be about 9,500 cfs. None of the diversion schemes were able to provide sufficient supplemental flows to attain the desirable salinity regime at Location #2. Plan D does not meet any of the performance criteria. Therefore, alternative Plan D was eliminated from consideration.

- Diversion channel required to convey a peak flow would be of sufficient size to support deep-draft navigation. The diversion structure could be modified to include a navigation lock. Deep-draft navigation would then be possible between the Mississippi and MR-GO. This type of channel may encourage industrial development in the parish which is undesirable at this time.

- The plan to install culverts and dikes in the marsh would not be necessary. The public investment in the construction of portions of the plan would be lost.

Plan A was eliminated because it could not achieve the desired salinity regime and the plan does not meet any of the performance criteria.

In Plan B, 25 percent of the required supplemental flows would be diverted at the Riverbend site. The remaining required flows would be diverted at the Bonnet Carre' site. The estimated cost of Plan B is $85 million. Plan C requires that 50 percent of the flows would be diverted at Riverbend and 50 percent at Bonnet Carre'. The estimated cost of this plan is $109 million.

Plan B and C were eliminated because the plans would not be economically feasible and the plans would not meet the performance criteria of efficiency and acceptability. Plans B and C do not meet the criterion of efficiency because they would require that more supplemental fresh water be diverted to achieve the desired salinity regime. Fifty percent of the water diverted at the Riverbend site would be lost in the MR-GO at ebb tide. These plans contain two diversion sites that would require more land acquisition. More overall adverse impacts to the environment are anticipated, although the impacts would be less at the Bonnet Carre' site since only a portion of the flow is being diverted. At the Riverbend site, marsh would be converted to conveyance channel and

construct new dikes in the marshes between the back hurricane protection levee and the hurricane protection levee adjacent to the MR-GO. Some of the improvements have been put in place. These improvements are envisioned to reduce saltwater intrusion in the area by conserving rainfall runoff and water diverted through the Violet siphon. The parish does support the IHNC and Bonnet Carre' freshwater diversion sites. The main reasons for opposition to the Riverbend site are listed below.

- o The Violet siphon would not be needed if the Riverbend diversion is constructed. The public investment in the siphon would be lost.

- o The diversion channel would bisect a large portion of St. Bernard Parish.

- o The increased flow as a result of the diverted freshwater through the Bayou Dupre structure outlet would cause additional navigation problems for fishermen in the area.

- o The water would be diverted too close to the oyster beds in Lake Borgne. The beds would be overfreshened and subjected to fecal coliform contamination.

- o The increase in water levels in the marshes as a result of the diverted water would aggravate drainage problems in the area bounded by the Violet Canal, back hurricane protection levee, diversion channel, and Mississippi River levee.

- o Several scenic streams would be impacted by the proposed diversion. They are: Bayou Dupre, Bashman Bayou, Terre Beau Bayou, Pirogue Bayou, and Lake Borgne Canal.

structure and channel sizes would depend on the required maximum design flows for alternative Plans A, B, and C. Plan A would result in the conversion of about 1,240 acres of marsh to conveyance channel and disposal area. Plan A has a high probability of uncovering cultural resources and five streams within the Louisiana Natural and Scenic Streams System would be altered. They are Bayou Dupre, Bashman Bayou, Terre Beau Bayou, Pirogue Bayou, and Lake Borgne Canal.

Floodgates would be required as part of the project at the intersection of the diversion channel and the hurricane protection levee adjacent to the MR-GO. A maximum of 45,000 cfs would be required at the Riverbend site compared to 30,000 cfs at sites above the IHNC. The 50 percent increase in supplemental flows is required because a large portion of the water would be lost in the MR-GO at ebb tide. Hydraulic analysis at the Riverbend site indicated that the hydraulic head available would only permit water to be diverted from January to July. To attain the desired salinity levels, supplemental flows are required March through November. Creating an impoundment area in the marshes between the back protection levee and the hurricane protection levee was investigated and proved to be impractical because water levels would be too high. The elevated water levels would require considerable modification of the existing drainage systems in St. Bernard Parish and about 24,000 acres of marsh would be inundated. The estimated cost of Plan A is $137 million.

Officials from St. Bernard Parish have indicated that they will oppose a freshwater diversion project in their parish. They do support the concept of freshwater diversion and realize the need for additional freshwater in St. Bernard Parish. They have constructed a 250 cfs siphon at Violet, LA to provide supplemental water to adjacent wetlands. The Parish has been issued permits by the Corps of Engineers and the state to install flap gate culverts, upgrade spoil dikes, and

plans. In addition, the plans were evaluated to determine their performance relative to the criteria established in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation studies dated March 10, 1983. The performance criteria are completeness, effectiveness, efficiency, and acceptability. They are defined below.

1. Completeness - the extent to which an alternative provides and accounts for all necessary investments.

2. Effectiveness - the extent to which an alternative plan is technically feasible and alleviates the identified problems.

3. Efficiency - the extent to which an alternative plan is the most cost effective means of alleviating the problems identified and is consistent with protecting the nation's environment.

4. Acceptability - the workability of the alternative plan with respect to acceptance by state and local entities and the public.

When a plan did not achieve the desired salinity regime or meet the performance criteria, it was eliminated from further consideration. All plans were designed to achieve the desired salinity regime; therefore, all plans would also produce similar benefits. The estimated present worth value of benefits that accrue to any plan that achieves the desired salinity regime is $79 million.

Plan A uses the Riverbend site located between the communities of Violet and Riverbend at river mile 83 AHP. The outflow diversion channel would be excavated from the control structure to the MR-GO. The control

Mississippi. The pounds of oysters produced were calculated by multiplying the productivity per square meter by the total acres of reefs. Adjustments were made to insure that the estimates of oyster harvest were conservative.

The estimates of increased oyster production were used to evaluate three future economic scenarios. In Scenario I, per capita oyster consumption was assumed to remain about the same. Applying the per capita consumption to projected population results in a small increase in oyster consumption. Scenarios II and III were based on projecting per capita consumption back to historical high rates. This gives a much higher level of oyster consumption. The difference between Scenario II and III would be in the timing of when the oysters are taken from the market. Operating costs were calculated to determine what they would translate into in terms of NED benefits. In Scenario I, no increase in sales of oysters was projected but operating costs would be reduced by 60 percent, which comprised the NED benefits. Scenarios II and III are based on increased sales handled in different ways. The most probable future was determined by assuming a normal distribution between Scenario I and Scenario III. More information on oyster benefit calculations is contained in Appendix D, Volume 2, and Appendix F, Volume 3.

Benefits for the recreation development sites were calculated by applying selected unit-day values to projected annual use figures for the recreation activity type provided by the facility developments to arrive at an annual total dollar figure. Additional information on the calculation of recreation benefits can be found in Appendix G, Volume 3.

PRESENTATION AND EVALUATION OF PLANS

The ability of the six plans to achieve the desired salinity regime at Location #2 was used as an evaluation criterion to eliminate or retain

TABLE 10

ALTERNATIVE PLAN COMBINATIONS OF SITES AND MAXIMUM DESIGN FLOWS

Alternative Plan No.	Diversion Sites			Total Design Flow
	Riverbend	IHNC	Bonnet Carre'	
	(cubic feet per second)			
A	45,000	-	-	45,000
B	11,350		22,500	33,800
C	22,500		15,000	37,500
D	-	45,000	-	45,000
E		9,500	25,000	34,500
F	-	-	30,000	30,000

defined the monthly optimum salinity conditions for oysters. The optimum conditions would produce 20 or more seed oysters per square meter of suitable bottoms. Zones of lesser production were determined based on an average of 10 seed oysters per square meter. The acres of suitable public and private reefs were determined in Louisiana and

TABLE 9

REQUIRED SUPPLEMENTAL FLOWS AT LOCATION #2 FOR A 50% DROUGHT

Months	Sites that divert water to Lakes Maurepas and Pontchartrain	Sites at or below IHNC
Jan	-	-
Feb	-	-
Mar	10,800	16,200
Apr	30,000	45,000
May	10,700	25,000
Jun	14,600	21,900
Jul	3,200	4,800
Aug	2,600	3,900
Sep	2,000	3,000
Oct	5,500	8,200
Nov	3,200	4,800
Dec	-	-

NED BENEFIT CALCULATIONS

The methodology employed to calculate oyster benefits was based on a study completed by the Louisiana Department of Wildlife and Fisheries in 1982. The study is based on data collected from 1971-1981. The study

Using this methodology, it was possible to quantify the major portion of the monetary benefits associated with freshwater diversion in accord with the Principles and Guidelines. Consequently, the control structure that would be used to divert fresh water was designed to pass sufficient water to establish an optimum salinity regime for oyster production. This salinity regime is also favorable for most of the fish and wildlife species in the study area. The optimum salinity regime is based on 10 years of study by the Louisiana Department of Wildlife and Fisheries and was recommended by a two-state interagency ad hoc group in June 1982 (see exhibit 1 of Appendix B, Plan Formulation). Of the three locations shown on plate 6, Location #2, the marsh area east of Lake Borgne, midway between the eastern edge of Lake Borgne and Chandeleur Sound, was determined to be the best location to establish the optimum salinity regime. The choice was based on an analysis of the location of most of the public reefs and private leased water bottoms and the supplemental flows required to achieve the optimum salinity regime. Hydraulic analyses determined that a maximum diversion of 30,000 cfs would be required at sites that divert water to Lakes Maurepas and Pontchartrain and a maximum diversion of 45,000 cfs would be required at sites that divert water at or below the IHNC site. The 50-percent increase in supplemental flows is required at the sites at or below the IHNC site because a large portion of the water would be lost in the MR-GO at ebb tide. The diversion period is March through November at all sites. The required supplemental flows are shown in table 9. Table 10 shows the six alternative plans with site combinations and maximum design flows.

salinity gradients.

Plan 16 - Various Combinations of Plans. The analyses conducted for the individual conceptual plans revealed that various combinations of plans need not be considered because most of the plans are being implemented to the maximum practicable extent. Federal and state permit and coastal zone management programs are adequately regulating wetlands alteration. As part of the Corps of Engineers navigation maintenance program, certain subsiding areas are being filled. Corps marsh creation studies initiated in October 1983 will investigate other ways to use dredged material. Certain aspects of the sanctuary concept are already being implemented in Louisiana inshore waters and in Mississippi Sound. Additional programs to manage fish and wildlife resources are not presently warranted.

Plan 17 - No Action Plan. The no-action plan will serve as the base condition for comparing the merits of other alternative plans. If no action is taken, coastal wetlands will continue to be lost due to natural processes and human activities. Seasonal high salinities will continue to encroach upon the area causing habitat changes and related land loss and reduction in fish and wildlife resources.

SUPPLEMENTAL FLOW REQUIREMENTS

Diverting fresh water to the Lake Pontchartrain Basin and Mississippi Sound is considered beneficial overall to the fish and wildlife resources in the study area. Despite this beneficial effect, benefits attributable to most of the fish and wildlife species except oysters could not be satisfactorily quantified in accord with the Water Resources Council Principles and Guidelines for Water and Related Land Resources Studies. Throughout the report, these benefits are described qualitatively. The benefits to oysters were calculated based on a theoretical maximum sustained yield given optimum salinity conditions.

Plan 13 - Fill Subsiding Areas. The Corps of Engineers is currently using dredged material from the MR-GO to a limited extent to build marsh at the lower end of the waterway. A comprehensive plan for the use of dredged material to build marsh will be developed as part of the Louisiana Coastal Area study. The marsh creation study was initiated in October 1983.

Plan 14 - Establish Sanctuaries. No areas are designated in the study area as sanctuaries; however, this plan is implemented to a limited extent. Louisiana inshore waters and the Mississippi Sound north of the barrier islands are managed a portion of the year as "quasi-sanctuaries" to allow certain commercially important estuarine species the opportunity to mature. (See Table B-1-13, Appendix B, Volume 2). However, this management plan does not address the major problems associated with habitat losses. The plan would also reduce the commercial and sport harvest of fish and wildlife resources. Because other plans would accomplish the planning objective more extensively without reducing harvest, this plan was not considered further.

Plan 15- Manage Fish and Wildlife. Managing the fish and wildlife resources would make moderate contributions to enhancing vegetative growth and increasing fish and wildlife production. Oyster fishermen and the states of Louisiana and Mississippi have planted cultch material extensively in the study area to create suitable water bottom for oyster culture. Indications are that if favorable salinity levels occurred more often at the public oyster grounds, the cultch planting program would be expanded. Planting and propagation of vegetation is used to a limited extent primarily on the barrier islands in Chandeleur Sound. Controlled marsh burning is a management measure used in St. Bernard Parish to promote growth of the vegetation preferred by muskrat. The fish and wildlife management alternative plan would have only a minor effect on preserving and restoring wetlands or creating favorable

TABLE 8

ALTERNATIVE PLANS RETAINED FOR INTERMEDATE STAGE ANALYSIS

Alternative Plan Number	Strategy	Diversion Site
A	Divert at one location below New Orleans	Riverbend
B	Divert one location above New Orleans and one location below New Orleans	Bonnet Carre' - 75% of supplemental flow
C	Divert at one location above New Orleans and one location below New Orleans	Bonnet Carre' - 50% of supplemental flow Riverbend-- 50% of supplemental flow.
D	Divert at one location in New Orleans	IHNC
E	Divert at one location above New Orleans and one location in New Orleans	Bonnet Carre' IHNC
F	Divert at one location above New Orleans	Bonnet Carre'

flows were considered for diverting water at the three sites retained for further analysis: diverting 75 percent of the required flow at Bonnet Carre' and 25 percent at Riverbend, diverting 50 percent at Bonnet Carre' and 50 percent at Riverbend, and diverting the maximum required flow possible at IHNC site without affecting navigation and the remainder of the required flow at the Bonnet Carre' site. The freshwater diversion alternative plans and the alphabetical designation assigned to them for further analysis are shown on table 8 and on plate 5.

Plan 12 - Regulate Alteration of Wetlands. Federal, state, and local agencies have implemented numerous programs to regulate human activities in the wetlands. The US Army Corps of Engineers administers major regulatory programs under authorities in Sections 9, 10, and 13 of the River and Harbor Act of 1899, Section 404 of the Clean Water Act of 1977, Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended.

In addition, the State of Louisiana has an approved coastal resources program that regulates development in the coastal area. The program is administered by state and parish government. In Mississippi, county coastal zone management programs are currently being implemented. Louisiana parish coastal zone management programs are in various stages of development. These regulatory programs are comprehensive and capable of effectively regulating alteration that contributes to saltwater intrusion. An evalution of these programs could not identify any additional regulatory requirements that would significantly improve them. Stringent enforcement of the existing programs will provide moderate contributions to most of the planning objectives.

TABLE 7 (Continued)

EVALUATION DATA OF POTENTIAL
FRESHWATER DIVERSION SITES BELOW NEW ORLEANS

Site Name	Mile AHP	Primary Receiving Body	Parish Affected	Number of Relocations	Foundation Considerations	Length of Diversion Channel (Miles)	Habitat Altered				Relocation	Aggravate Flood Problems
							Bottomland Hardwoods	Wooded Swamps	Marshes	Other		
Inner Harbor Navigation Canal	92.6	Lake Borgne/ Lake Pontchartrain	Orleans		-	5.0	-	-	-	-	-	No
Riverbend	83.0	Lake Borgne	St. Bernard	2 roads 5 pipelines	SF	SEP SF 6	61	-	273	-	Disrupt community	No
Bayou Terre Aux Boeuf and La Loutre	82.0	Chandeleur Sound	St. Bernard	2 roads 3 pipelines	EF	SEP SF FC 20	-	-	796	-	49 residents, 7 comm. bldg. Disrupt 3 communities	No

EF - Failure Problems
SF - Settlement Problems
EC - Earthfill Cofferdam required
CC - Cellular Cofferdam required
SCP- Scour Protection required
SEP- Seepage Problem
EE - Erosion Problem

*Agricultural lands
**Bottomland Hardwoods, Wooded Swamp, and Marshes

Alternative Plan E consists of a 9,500 cfs freshwater diversion structure adjacent to the IHNC lock and a 25,000 cfs structure at the Bonnet Carre' site. The estimated first cost of the plan is $81.0 million. Plan E does not meet the efficiency and acceptability criteria. The design capacity of the diversion structure at the Bonnet Carre' site is only 17 percent less than the capacity of a diversion structure required to divert 100 percent of the flow at the Bonnet Carre' site. However, the cost of Plan E is 40 percent greater than diverting 100 percent of the flow at the Bonnet Carre' site. In addition, half of the Mississippi River flow diverted at the IHNC would be lost in the MR-GO and GIWW ebb tide and would only benefit the marshes immediately adjacent to these waterbodies. Oyster beds in Lake Borgne may be temporarily or permanently closed because of high fecal coliform counts. The IHNC site is located too close to the oyster beds in Lake Borgne to allow fecal coliform organisms in the Mississippi River water to dieoff. Several industries adjacent to the IHNC discharge waste waters into the IHNC along with waste from vessels that utilize the waterway. The City of New Orleans discharges stormwater runoff into the IHNC. The water quality of the IHNC is adversely affected by these wastewater discharges and has been classified as water quality limited by the state. Fecal coliform counts exceed water quality criteria frequently.

A diversion site adjacent to the existing IHNC would be opposed by the City of New Orleans and the shipping industry. The City of New Orleans would not receive any direct benefits from the project and the shipping industry would be concerned by adverse impact on navigation in terms of greater velocities through the IHNC than normal when water is being diverted. Therefore, Plan E was eliminated from consideration.

Plan F would divert water only at the Bonnet Carre' site. The control structure would be placed just upriver of the existing Bonnet Spillway

structure. The estimated cost of Plan F is $57.8 million. Plan F was the only plan retained for further study.

Plan F meets all the performance criteria and the desired salinity regime can be achieved. Plan F provides and accounts for all necessary investments and actions to ensure that the contributions to the planning objectives are realized. However, it is assumed that other Federal, state, and local agencies would continue to implement their programs to regulate alteration of wetlands, fill open water areas, and manage the fish and wildlife resources of the study area.

The Bonnet Carre' Plan is the most effective and efficient plan in providing the required supplemental flow and in maximizing benefits. Plans A and D could not divert enough water to provide the required supplemtnal flows. Plans B, C, and E would require 13, 25, and 75 percent more water, respectively, to attain the desired optimum salinity regime. The plans would be more expensive because the total length of channels would be longer, more habitat would be altered, and more relocations would be required.

Plan F has one of the shortest conveyance channels. The 6.6 mile conveyance channel would use 2.0 miles of the existing borrow channel. Therefore, only 4.6 miles of channel excavation is required. Most of the excavation is through upland developed areas which have low values for fish and wildlife. Plan F is accepted by Federal, Louisiana, and Mississippi state agencies concerned with fish and wildlife resources. The plan has a low probability of uncovering cultural resources.

Adverse water quality impacts associated with Plan F would be limited to the southwestern portion of the lake in the vicinity of the outfall canal. These impacts include increased turbidity, nutrients, coliform bacteria, and slightly lower temperatures. Beneficial effects on

western Lake Pontchartrain from the diversion include higher dissolved oxygen levels and lower coliform concentrations along the southern shore in Jefferson and Orleans Parishes, particularly in the vicinity of stormwater outfall canals. During periods of diversion, the lower salinity waters in Lake Pontchartrain may displace brown shrimp, spotted seatrout, red drum, and other estuarine species to eastern Lake Pontchartrain and to Lake Borgne. During years of lesser diversions, or no diversion at all, there will be little or no adverse impacts on these species. They will be benefitted due to the increased nutrients in the system. Even in years of maximum design diversion, salinities would return to near normal conditions during the fall and winter months.

Modifying the spillway structure to incorporate a freshwater diversion structure, as in Plans B, C, E, and F would be much more expensive. Such modification would cost an addtitional $5,200,000. The increase in cost is because 17 of 350 bays in the spillway structure would have to be removed and reconstructed for freshwater diversion, cofferdams would be needed to protect the work site from Mississippi River overflow, the structure above the culverts would have to be reinforced concrete instead of embankment, and an additional bridge over the conveyance channel would have to be built to provide continued access to the road on the landside of the structure. Therefore, it was decided that the freshwater diversion structure would be just upriver of the spillway structure. Site analysis indicated that there are no constraints that could not be reasonably overcome in the engineering design of the freshwater diversion structure channel and associated works at the site just upriver of the spillway structure. Since the hydraulic head is available, a freshwater diversion structure could be designed to pass the required maximum flow of 30,000 cfs. At the proposed site, land acquisition would be small because a large portion of the outflow would be within the Federally-owned Bonnet Carre' Floodway. Detailed plan formulation and selection information is in Volume 2, Appendix B, Plan Formulation.

RECREATION DEVELOPMENT PLAN

Concurrently with the analysis of the six plans, a recreation development plan was designed. Potential recreation sites in the study area were visited and evaluated on the basis of proximity of location to the project affected areas, reasonableness of land acquisition costs, lack of or overuse of available access areas, desire for additional boating that the public has expressed or that is reflected in opinion surveys, and in the recreation demand-need analyses. Six recreation sites are proposed for development: Frenier Beach, the lake end of the borrow channel within the floodway, the Rigolets, and Pointe Aux Herbes in Louisiana, and Cedar Point and Wolf River in Mississippi.

The recreation site development plan will be part of the recommended plan. Comments received from the Federal, state, and local agency review of the proposed recreation development plan were very favorable. Requests from St. Tammany, St. Bernard, and St. Charles Parishes for additional facilities would be considered in the advanced engineering and design phase of the study. Detailed information on the recreation analysis is in Volume 3, Appendix G, Recreation Resources.

RATIONALE FOR NATIONAL ECONOMIC DEVELOPMENT AND RECOMMENDED PLAN

Plan F maximizes contributions to the NED account for commercial fisheries and wildlife and recreation. The Bonnet Carre' plan is the least costly, has the greatest benefit-to-cost ratio, and provides the maximum benefits over cost. The plan would have fewer adverse environmental impacts and would maximize tangible and intangible benefits to environmental quality. Plan F is generally supported by most Federal, state, and local agencies concerned with fish and wildlife resources in the study area. Therefore, Plan F was designated the recommended plan.

As previously indicated plan F is design to attain the desired salinity regime at location #2. To insure that net benefits are maximized Plan F was modified to divert less or more than 30,000 cfs to move the position of the desired salinity regime inland or seaward of location #2. No supplemental flow is required to achieve the desired salinity regime at location #1. A maximum flow at 20,000 cfs is required to achieve the desired salinity regime between location #1 and #2. Increased oyster production attributable to this proposed diversion is 58 percent of the production at location #2 and just 20 percent greater than existing oyster production. The cost of a diversion structure capable of diverting 20,000 cfs is estimated at $46 million. The average annual cost and benefits of this diversion plan would be $4,300,000 and $2,588,000. The benefit-cost ratio is 0.6 to 1.

At location #2 the desired salinity regime is located directly over the area that was historically productive in the past. About 70 percent of the known reefs and leased water bottoms would be within the zone of optimal oyster production. Oyster production would increase by 7,500,000 lbs. value at $6,540,000 annually.

Establishing the desired salinity regime between location #2 and #3 would significantly reduce project benefit areas. None of the reefs in Mississippi would be inland of the optimal salinity zones. Most of Lake Borgne and adjacent marshes would be eliminated from oyster production. A structure capable of diverting 100,000 cfs would be required.

Establishing the desired salinity regime at location #3 would require a diversion of 180,000 cfs. Most of the public oyster reefs and privately leased water bottoms in the study area would be inland of the optimal desired salinity regime. The large quantity of freshwater would overfreshen Lakes Pontchartrain and Borgne. Oyster production would be

reduced below existing levels. The estimated first cost of a structure capable of diverting 180,000 cfs is in excess of $200 million. Such a plan would lack adequate benefits to make it economically feasible.

The Bonnet Carre' site is located in St. Charles Parish. The parish has requested that the Corps of Engineers purchase the entire community of Montz bounded by the Bonnet Carre' Spillway, River Road, the Louisiana Power and Light Little Gypsy power plant, and the Illinois Central Gulf Railroad (Plate B-9). The plan as originally designed would require relocation of 26 homes and 6 trailers. The modification of the plan as requested by St. Charles Parish would require relocation of 52 single-family dwellings, 16 trailers, and 1 church. The acreages that must be acquired would increase from 61.2 to 77.2.

The community of Montz is a predominantly low-income community and most of the residents are closely related. The community has a strong sense of cohesiveness. Several residents have indicated that three and four generations of their families live in Montz and they have no desire to live apart. At the Corps public meeting in Destrehan, Louisiana, on December 6, 1983, the councilman representing the community presented a petition signed by 24 residents requesting that the community be relocated as a unit. Relocating the community as a unit would increase the cost of the project by $1.6 million. The New Orleans District of the Corps of Engineers concurs with the request and the recommended plan has been revised accordingly.

DESCRIPTION OF RECOMMENDED PLAN

The Bonnet Carre' site is located about 33 miles upstream of New Orleans on the left descending bank of the Mississippi River in St. Charles Parish. The control structure would be located just west of the existing Bonnet Carre' Spillway (plates 7 and 8). The plan includes these features:

o A 455-foot long multi-cell box culvert control structure with four 20- by 20-foot gated cells in a Mississippi River levee setback.

o An inflow channel 950 feet long with a bottom width of 400 feet, side slopes of 1 vertical and 3 horizontal, and water depth of 25 feet.

o An outflow channel 33,800 feet long with a bottom width of 400 feet and side slopes of 1 vertical and 3 horizontal.

o Depth in most of the outflow channel would be 25 feet. For the last 1,360 feet of the channel near Lake Pontchartrain, the channel bottom width would be increased to 590 feet and then to 760 feet. Over that same distance, the channel depth would be decreased to 10 feet and then to 2 feet.

o A sediment trap located about 3,500 feet downstream of the diversion structure in the outflow channel. The trap would have a bottom width of 780 feet, side slopes of 1 vertical on 3 horizontal, and would be 1,450 feet long. The trap would be 15 feet deep.

o A 600-foot access bridge across the outflow channel on the lake side of the Illinois Central Gulf railroad tracks to give sand haulers access in and out of the floodway.

o Two-acre recreation facilities at the lake end of the borrow channel within the floodway, at Frenier Beach, Point Aux Herbes, and the Rigolets in Louisiana, and at Cedar Point and Wolf River in Mississippi. Facilities would consist of two-lane boat ramps, courtesy piers, parking for 30 vehicles, five picnic tables, and five trash cans.

o Realinement of the upper spillway guide levee adjacent to the control structure for 3,035 feet. The realined levee would be 12 to 16

feet high with side slopes 1 vertical on 5.5 horizontal on the protected side and 1 vertical on 3.5 horizontal on the side within the floodway.

o Mississippi River levee realined over the control structure for ,250 feet. The realined levee would be about 26 feet high with side slopes 1 vertical on 5.5 horizontal on the protected side and 1 vertical on 4 horizontal on the land side.

DESIGN AND STRUCTURE CONSIDERATIONS

The facilities are designed to divert the maximum supplemental flows shown below during a 50-percent drought condition or drought conditions with a frequency of occurrence of once every 2 years.

Maximum Design Supplement Flow Requirements (cfs)

Jan -	0
Feb -	0
Mar -	10,800
Apr -	30,000
May -	16,700
Jun -	14,600
Jul -	3,200
Aug -	2,600
Sep -	2,000
Oct -	5,500
Nov -	3,200
Dec -	0

The diversion period is from March through November. The structure and channel require approximately 41.6 acres, the Mississippi River levee setback and realined guide levee require 29.9 acres, and realined

Highway 628 requires 5.7 acres. All real estate requirements are outside the Bonnet Carre' Floodway. Within the floodway, the channel and sediment trap would convert about 180 acres to water. The temporary disposal area for the excess excavated material is about 1,460 acres within the floodway. The structure and channel were designed to minimize annual maintenance dredging. However, some maintenance dredging would be required in years the structure is operated.

STRUCTURE OPERATION CONSIDERATIONS

A comprehensive monitoring system would guide structure operation and assess the effects of the diverted fresh water on fish and wildlife populations. The system will require certain hydrological, water quality, and biological data. A network of sampling stations will collect the data necessary for structure operation. The programs in the system will be conducted in three phases: preconstruction, postconstruction, and long term. The 3-year preconstruction phase will supplement existing information and establish baseline conditions for measuring future changes. The 4-year postconstruction phase will assess the effect of the diverted waters on important hydrological and water quality paramaters and the fish and wildlife populations. This information will be used to devise and modify the operational scheme and the scope of the long-term monitoring phase.

Structure operation will depend on whether fresh water is needed to supplement rainfall in order to establish the optimum salinity regime. In a normal 10-year period, the maximum design supplemental flow requirement would be diverted in five of those years. In other years, lesser amounts of flow may be diverted to prevent higher salinity water from entering the marshes and wooded swamps adjacent to Lakes Pontchartrain and Maurepas. Particular attention would be paid to months when heavy rainfall occurs in the Lake Pontchartrain and Pearl

River Basins. If water is being diverted during these months, supplemental flows would be adjusted so that the area is not overfreshened by the supplemental flow. If rainfall heavy enough to overfreshen the area occurs during diversion, the structure would be closed. When salinities are predicted to be greater than desired, supplemental flows would be diverted based on computations and refinements to a linear regression model developed in the course of this feasibility study. The model is described in detail in Appendix C, Engineering Investigations. If salinities are predicted to be less than desired, supplemental flows would be decreased or halted. Refining the operation to determine the proper quantities of fresh water to be released and the appropriate timing of the release, and correctly interpreting the field and discharge data of the monitoring programs would come through actual operations, data collection, and analysis.

The cost of the pre- and postconstruction monitoring phases, $5,016,000, is included in the first cost of the plan. The cost of the long-term monitoring phase is included in the operation and maintenance costs. The New Orleans District and non-Federal assuring agency will establish a two-state interagency advisory group to design and conduct the monitoring programs. The interagency group will include Federal, state, and local agencies that have responsibilities in the areas of water quality, fish and wildlife, water supply, navigation, and flood control. The monitoring programs are discussed in Appendix K, Freshwater Diversion Structure Operation Criteria and Comprehensive Monitoring System.

OPERATION AND MAINTENANCE

The operation, maintenance, and replacement cost of the diversion facilities is estimated at $822,000 annually. This cost includes major structure maintenance repair once every 15 years, an annual cost for

maintaining a monitoring system, average annual dredging of an estimated 167,000 cubic yards of sediment from the channels and sediment trap, and maintenance of the recreation sites. In the long-term monitoring system, hydrological, water quality, and biological data necessary for structure operation will be collected at a network of sampling stations. The hydrological data will include information on tides, salinity, precipitation, discharge, temperature, and wind that will form the basis for the operating scheme. Important water quality parameters will be measured and the biological information necessary to assess effects of the diversions on fish and wildlife populations will be collected. Operating and maintaining the monitoring system will cost an estimated $243,000 annually. The Corps of Engineers will take a leadership role in implementing the comprehensive monitoring system. Design and conduct of the system will be determined by the New Orleans District and the non-Federal assuring agency with the cooperation of a two-state interagency advisory group after the postconstruction monitoring phase is completed. The sponsor will provide timely reports containing collected data and analysis of structure operation and results to the New Orleans District. The district will review the reports to determine whether the structure operation manual should be modified to obtain maximum benefits.

SUMMARY OF ECONOMIC, ENVIRONMENTAL, AND OTHER SOCIAL EFFECTS

The first cost of the recommended plan is $57,814,000. The average annual cost is $5,963,000, which includes interest, amortization (50 years at 8 1/8 percent), and operation and maintenance. The average annual benefits are estimated at $7,178,000 and result in a benefit-cost ratio of 1.20 to 1. Benefits for enhancement of commercial fish and wildlife are estimated at $6,540,000; benefits for recreation enhancement are estimated at $638,000. The plan would increase potential oyster production by 105 percent in the study area. This additional

production would increase Louisiana's and Mississippi's annual average potential harvest by 33 percent and 98 percent, respectively, and the national harvest potential by 13 percent.

In addition to the monetary benefits previously addressed, other benefits would result from project implementation. They include improved habitat for nongame and noncommercial species, improved productivity of wooded swamps, increased recreation potential, increased plant species diversity, and beneficial effects on businesses that support commercial fish and wildlife and recreational opportunities. Projected marsh losses would be reduced by 10,541 acres. Intangible benefits are also derived from the function of the marsh as an interface between urban areas and open water areas, as a buffer zone for hurricane tides that reduces damages caused by the tidal action, and as a medium to treat waste products.

Some adverse impacts would result with project implementation. Various habitat types would be converted to open water or levee and dredged material disposal areas. Excavation for the channels and structures would require 618 acres of wooded swamp, 1,074 acres of developed upland, and 56 acres of scrub shrub. An average annual loss of 637 man-days of hunting is estimated to occur as a result of lands altered by project implementation. This loss is considered relatively minor. Short-term impacts associated with turbidity and water quality would occur during construction.

No recorded archeological sites or National Register-eligible properties are located in the proposed construction rights-of-way. However, available information on the history of the area indicates that there is a probability of affecting subsurface cultural remains. After project construction, business opportunities and employment would increase in the commercial and recreation wildlife and fisheries industries and

support service industries. Increased real income and income distribution would accompany the increased employment and provide additional tax revenues. The plan would aid in preserving the unique cultural heritage and lifestyles of coastal fishing and trapping communities.

PLAN IMPLEMENTATION

APPORTIONMENT OF COSTS AMONG INTERESTS

Traditional cost-sharing policies for enhancement of fish and wildlife, the primary function of the plan, provide for first costs to be shared on a 75-percent Federal and 25-percent non-Federal basis. Cost-sharing policies for recreation facilities provide for first costs to be shared on a 50 percent Federal and 50 percent non-Federal basis. Non-Federal interests must also assume all costs for operation, maintenance, and replacement. Under these policies, the currently estimated first cost of $57,814,000 is apportioned $43,175,000 Federal and $14,639,000 non-Federal. All of the estimated average annual operation, maintenance, and replacement costs of $822,000 would be borne by non-Federal interests.

Benefits attributable to the Recommended Plan would accrue to the states of Louisiana and Mississippi. About 80 percent of the benefits of the project would occur in Louisiana and about 20 percent in Mississippi and the non-Federal share of the cost was distributed on that basis. Louisiana's share of the project would be $11,700,000 and Mississippi's share would be $2,939,000. The distribution of cost between Federal and non-Federal sponsors is shown below:

	Federal	Non-Federal		Total
		Louisiana	Mississippi	
Structures, channel, and associated works	$32,803,700	$11,450,400	$2,817,200	$57,071,300
Recreation	371,300	249,600	121,800	742,700
Total	$43,175,000	$11,700,000	$2,939,000	$57,814,000

DIVISION OF PLAN RESPONSIBILITIES

The States of Louisiana and Mississippi would be the non-Federal sponsors for the project. The states furnished letters dated January 26, 1984, and February 29, 1984, respectively, that indicate their intentions to provide the necessary funding and the local cooperation at the appropriate time. The letters of intent are in Exhibit 1. The states must agree to comply with the requirements for construction of the freshwater diversion control structures, channels, and associated works. Cost-sharing requirements on these features of the project would be 75-percent Federal and 25-percent non-Federal.

The State of Louisiana must agree to comply with the requirements for construction of recreation facilities planned at the lake end of the borrow channel, Frenier Beach, the Rigolets, and Point Aux Herbes in Louisiana. The cost-sharing requirements on the recreation facilities are 50-percent Federal and 50-percent non-Federal.

In Mississippi, development of recreation facilities is planned at two locations. Therefore, the State of Mississippi must agree to comply with the requirements for construction of these recreation facilities. The cost-sharing requirement is the same as described for recreation facilities in Louisiana.

AD-A152 723 MISSISSIPPI AND LOUISIANA ESTUARINE AREAS FRESHWATER DIVERSION TO LAKE PO..(U) ARMY ENGINEER DISTRICT NEW ORLEANS LA D L CHEW APR 84 2/3

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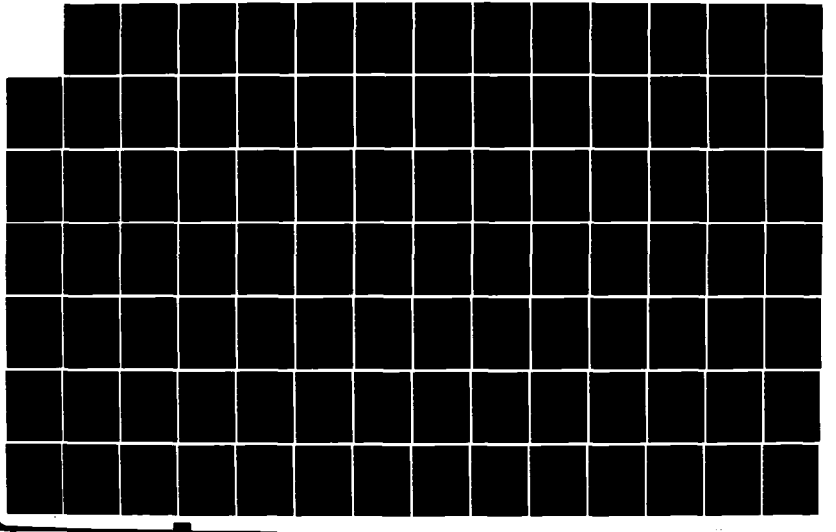

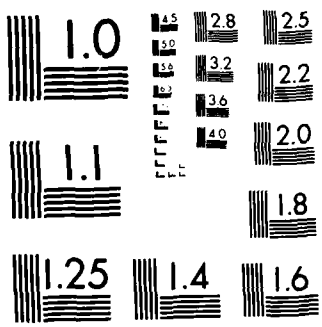

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

Before features of the Bonnet Carre' plan adjacent to and within the floodway can be constructed, the states must agree to comply with the following requirements:

o Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for construction and operation of the works,

o Hold and save the United States free from damages due to the construction works except where such damages are due to the fault or negligence of the United States or its contractors,

o Operate and maintain the works after completion,

o Contribute 25 percent of the project construction costs;

o Assure adequate public access to the project area.

In addition, the non-Federal interests must agree to comply with the following:

o Section 221, Public Law 91-611, approved 31 December 1970, as amended,

o Section 601 of Title VI of the Civil Rights Act of 1964 (PL 88-352) that no person shall be excluded from participation in, denied the benefits of, or subjected to discrimination in connection with the project on the grounds of race, creed, or national origin, and

o the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646.

The Federal government will credit the costs and expenses incurred in the acquisition of the required real estate interests toward the non-Federal share of the project construction costs.

The Federal government will require the right to enter at reasonable times and in a reasonable manner upon land which the sponsor owns or controls for access to the project.

The Corps of Engineers will take a leadership role in implementing the comprehensive monitoring system. As part of the operation and maintenance of the project, the Corps and the States of Louisiana and Mississippi will establish a two-state interagency advisory group to participate in decisions governing structure operation. This group should include people from local, state, and Federal sectors knowledgeable in the multiple needs of fish and wildlife resources, navigation, water supply, and flood control. The states must also maintain a network for collecting hydrological, water quality, and biological data essential for determining the best use of diverted water.

The states must agree to comply with the following requirements before construction of recreation facilities along the shore of Lake Pontchartrain and in Mississippi.

o Acquire in its name and dedicate to public outdoor recreation use an adequate interest in all lands on which cost-shared recreation facilities and improvements for access, parking, potable water, sanitary facilities and related developments for health and safety are provided, with credit as specified below.

o Make an additional contribution sufficient to raise the non-Federal share to at least 50 percent of the total first cost of adding

recreation to the project, where the appraised value of separable lands that are eligible for credit is less than that percentage. Such additional contribution may consist of the actual cost of carrying out an agreed-upon portion of the development within a specified time frame, a cash contribution during the construction period, or a combination of the above.

o Operate, maintain, and replace without cost to the Federal government, for the economic life of the project, the recreation areas and all facililties installed pursuant to the agreement.

o Hold and save the United States free from damages due to the construction works except where such damages are due to the fault or negligence of the United States or its contractors.

In addition, the non-Federal entity must agree to comply with the following:

o Section 221, Public Law 91-611, approved 31 December 1970, as amended,

o Section 601 of Title VI of the Civil Rights Act of 1964 (PL 88-352) that no person shall be excluded from participation in, denied the benefits of, or subjected to discrimination in connection with the project on the grounds of race, creed, or national origin, and

o the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646.

SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

The initial public meetings on the Mississippi and Louisiana Estuarine Areas study were held on 1 and 9 February 1978 in Gulfport, Mississippi, and New Orleans, Louisiana, respectively. At those meetings, local interests expressed a need to reduce saltwater intrusion and to improve fish and wildlife productivity.

Between March 1978 and July 1983, a series of informal meetings were held with representatives of Federal, state, and local agencies. The meetings provided forums to discuss the status and direction of the study. A briefing on the Mississippi and Louisiana Estuarine Areas study and the Louisiana Coastal Area study was given at joint meetings on 25 August 1981 and 21 January 1982. The New Orleans District maintained coordination with the Administrator, Coastal Management Section, Louisiana Department of Natural Resources. The district discussed the freshwater diversion studies at the Louisiana Universities Marine Consortium symposium on coastal erosion and wetlands modification on 5 and 6 October 1981.

Several Federal and local agencies actively cooperated in the study by providing advice or assistance. The NMFS provided commercial fisheries catch statistics. The USFWS, under an interagency agreement, cooperated with the New Orleans District in determining future habitat changes with and without the project. These two agencies were assisted by the Louisiana Department of Wildlife and Fisheries (LDWF) in conducting the impact as essment and habitat evaluation procedures, and in developing methodologies for estimating benefits to commercial fish and wildlife. The USFWS and LDWF provided advice and data used in conducting the recreation studies and evaluating benefits to sport fish and hunting.

A two-state interagency ad hoc group was convened in May and June 1982 to consider salinity goals in the study area. The ad hoc group made recommendations on salinity conditions desired in the study area. The signed memorandum for record is Exhibit 1 of Appendix B, Plan Formulation. Participants in the ad hoc group meetings were USFWS, LDWF, NMFS, Mississippi Department of Wildlife Conservation, Bureau of Marine Resources, Department of Natural Resources, US Food and Drug Administration, and Louisiana Department of Health and Human Resources. The study status and direction was discussed with the St. Bernard Coastal Zone advisory committee on 29 July 1982.

The recommended plan was presented to numerous state and local agencies and groups from May 1983 to April 1984. The meetings are listed below:

State/Local Agency/Interested Groups	Date
Governor's Coastal Protection Task Force	May 26, 1983
Department of Natural Resources	
Department of Wildlife and Fisheries	
Department of Transportation and Development	
St. Charles Parish Council President	June 7, 1983
St. Charles Parish Coastal Zone Advisory Committee	July 28, 1983
Lake Pontchartrain Basin Area Committee	June 28, 1983
Orleans Parish	
St. Tammany Parish	
St. Charles Parish	
St. John the Baptist Parish	
Livingston Parish	
Tangipahoa Parish	

Harrison County, Board of Supervisors	September 27, 1983
Hancock County, Board of Supervisors	September 29, 1983
Louisiana Oyster Dealers and Growers Association	October 8, 1983
St. John the Baptist Parish Planning Department	October 14, 1983
City of New Orleans Planning Commission/Regional Planning Commission for Jefferson, Orleans, St. Bernard, and St. Tammany Parishes Technical Staff	October 18, 1983
Jefferson Parish Rod and Gun Club	November 18, 1983
East Bank Fishermen's Association	November 23, 1983
Public Meeting - Destrehan, Louisiana	December 6, 1983
Public Meeting - New Orleans, Louisiana	December 13, 1983
Public Meeting - Gulfport, Louisiana	December 15, 1983
St. Bernard Parish Coastal Zone Advisory Committee	June 30, 1983
Regional Planning Commission for Jefferson, Orleans, St. Bernard, and St. Tammany Parishes	January 11, 1984
Health and Human Resource Committee of the St. Tammany Police Jury	February 8, 1984

Members of Mississippi State Legislature and Governor's Aide	February 8, 1984
Slidell Sportsmen's League	February 23, 1984
Lake Pontchartrain Basin Area Committee Technical Staff	April 13, 1984

The draft report and EIS was coordinated with other Federal, state, and local interests. Three public meetings were held: Destrehan and New Orleans, Louisiana, and Gulfport, Mississippi. Comments received from Federal, state, and local agencies and interested groups and individuals on the draft report and EIS are contained in Appendix L, Public Views and Responses. Public views and comments received at and following the public meetings are summarized in Appendix L.

FINAL
ENVIRONMENTAL IMPACT STATEMENT

MISSISSIPPI AND LOUISIANA ESTUARINE AREAS STUDY
REPORT ON FRESHWATER DIVERSION
TO THE LAKE PONTCHARTRAIN BASIN AND MISSISSIPPI SOUND

LEAD AGENCY: U. S. ARMY CORPS OF ENGINEERS DISTRICT
NEW ORLEANS, LOUISIANA
SEPTEMBER 1984

LOUISIANA PARISHES: Ascension, Jefferson, Livingston, Orleans
St. Bernard, St. Charles, St. James,
St. John the Baptist, St. Tammany, Tangipahoa

MISSISSIPPI COUNTIES: Hancock, Harrison, Jackson

ABSTRACT: The study area has experienced land loss and saltwater intrusion due to natural processes such as subsidence and erosion, as well as man's developmental activities including leveeing, channelization, and petroleum exploration. The various natural processes and man's activities have altered overbank flooding and natural distributary flow which historically provided fresh water, sediments, and nutrients to the estuarine areas. This has resulted in conversion of fresh, intermediate, and brackish marshes to more saline marsh types and has also caused the loss of substantial areas of wooded swamp. Saltwater intrusion and loss of wetlands have adversely affected productivity of wildlife and fishery resources. Influx of saline waters is particularly harmful to the American oyster, due to increased predation and disease. Thousands of acres of formerly productive oyster reefs in the area lie largely unproductive due to excessive salinities. One way to ameliorate loss of wetland habitat and rate of saltwater intrusion is timely introduction of fresh water and associated sediments and nutrients into the study area. A total of 13 potential sites were evaluated for diversion of fresh water. Three of these sites were recommended using a screening process involving engineering, socioeconomic, and environmental considerations. The Bonnet Carre' Site (Plan F) has been designated as the National Economic Development (NED) Plan and the Recommended Plan (RP). This plan would provide maximum benefits to the study area and maximum contribution toward satisfaction of the planning objectives. Implementation of the RP would save approximately 4,186 acres of marsh and 6,355 acres of wooded swamp. Average annual oyster production would increase by about 7.5 million pounds. Potential adverse impacts could occur due to the relatively poor water quality of the Mississippi River and the relocation of 26 permanent single dwellings and 6 mobile homes located in the construction rights-of-way. An additional 26 permanent single dwellings, 10 mobile homes, and 1 church would be relocated to maintain community cohesion for the residents of Montz, Louisiana.

Date: MAY 28 1985

Send your comments by the date stamped above. Comments should be sent to the Office of the Chief of Engineers, Attn: DAEN-CWP, Washington, D.C. 20314-1000. If you would like further information on this statement, please contact Mr. Dennis L. Chew, U.S. Army Engineer District, New Orleans, LA 70160-0267. Commercial telephone: (504) 838-2523.

NOTE: Information, displays, maps, etc. discussed in the Main Report and Appendixes are incorporated by reference in the EIS.

1. SUMMARY

1.1. MAJOR CONCLUSIONS AND FINDINGS

1.1.1. The purpose of this study was to determine the feasibility of diverting fresh water into the Lake Pontchartrain Basin and Mississippi Sound to restore historical salinities, reduce the rate of land loss, and enhance wildlife and fishery production, particularly for the American oyster.

1.1.2. Plan F, which provides diversion of Mississippi River water to Lake Pontchartrain in the vicinity of the Bonnet Carre' Spillway, has been designated as the National Economic Development (NED) Plan. This designation is based on the fact that it is the least costly and would provide the maximum benefits to the study area. This plan would provide the maximum annual excess benefits over cost.

1.1.3. Plan F has also been designated as the Recommended Plan (RP). This plan is the least costly and provides the maximum contribution toward satisfaction of the planning objectives.

1.1.4. It has been determined, based on the information contained in Appendix D, Section 2, that the RP would not jeopardize the existence of any endangered and/or threatened species or critical habitat.

1.1.5. Based on findings of the Section 404(b)(1) Evaluation, the construction methods to be used for the RP would have the least amount of adverse impact upon the aquatic ecosystems compared to other available practical construction methods. The Section 404(b)(1) Evaluation is found in Appendix I. It has been determined that the proposed construction would not result in significant adverse effects on human health and welfare, including municipal and private water

supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic organisms and other wildlife would not be adversely affected. Significant adverse effects upon aquatic ecosystem diversity; productivity and stability; and recreational, esthetic, and economic values would not occur. Adverse effects that could occur as a result of the proposed dredged-material discharge would not be significant. No developed recreational facilities are located in the impact zone.

1.1.6. The proposed action would divert fresh water into the Lake Pontchartrain and Mississippi Sound area. This area constitutes a flood plain. Other than the no action plan, no nonflood plain alternatives exist. The planning objectives involve improvement of the habitat conditions in these flood plains. The diversion of water would not cause flooding in the study area. The maximum increase in water level in Lake Pontchartrain attributable to the project would be less than one inch. The RP is consistent with the requirements of Executive Order 11988.

1.1.7. The project planning objectives include reduction in the rate of wetland loss and improvement in the quality of wetland habitat. Implementation of the RP would result in savings of 10,541 acres of wetlands over project life. The proposed action is consistent with the requirements of Executive Order 11990.

1.1.8. Based on the Consistency Determination (Appendix J), New Orleans District has determined that implementation of the RP is consistent, to the maximum extent practicable, with the State of Louisiana's approved Coastal Zone Management Program. The State of Louisiana has stated that the proposed project is consistent with the goals of the Louisiana Coastal Resources Program.

1.2. AREAS OF CONTROVERSY AND UNRESOLVED ISSUES

1.2.1. It is the general concensus among Federal, state, and local agencies, as well as the public, that benefits resulting from freshwater diversion would far outweigh the negative impacts. However, certain major controversial issues were raised at the public meetings held in December 1983. These include relocation of individuals affected by project construction, potential impacts to brown shrimp in Lake Pontchartrain, possible compensation for oyster leases in Lake Borgne lost due to decreased salinities, and specific identification of entities responsible for operation of the diversion structure.

1.2.2. Regarding the relocation of individuals affected by project construction, the recommended plan has been changed to include relocation of all the individuals in the community of Montz.

1.2.3. Although the report has made every effort to assess the potential impacts to brown shrimp in Lake Pontchartrain, the actual impacts will only be assessed through implementation of a thorough pre- and post- construction biological monitoring program. A monitoring program is included in the recommended plan.

1.2.4. Regarding possible compensation to fisherman for oyster leases lost in Lake Borgne due to decreased salinities, the Louisiana Department of Wildlife and Fisheries believes that with a lifting of the existing moratorium on new lease applications, lease holders who might be adversely affected would be provided opportunities to establish productive leases in other areas.

1.2.5. Identification of specific entities responsible for operation of the project is normally accomplished at a later stage in the planning process. However, structure operation will be a non-Federal responsibility and it has been recommended that the non-Federal sponsor establish and interagency advisory group to govern structure operation. The group would include local, state, and Federal people who have expert knowledge of the multiple needs of fish and wildlife resources, water quality and supply, navigation, and flood control.

TABLE 1.3 - RELATIONSHIP OF PLAN TO ENVIRONMENTAL REQUIREMENTS

FEDERAL POLICIES	PLAN F
Archeological and Historical Preservation Act	Plan in FULL Compliance
Clean Air Act	Plan in FULL Compliance
Clean Water Act	Plan in PARTIAL Compliance
Coastal Zone Management Act	Plan in FULL Compliance
Endangered Species Act	Plan in FULL Compliance
Estuary Protection Act	Plan in FULL Compliance
Federal Water Project Recreation Act	Plan in FULL Compliance
Fish and Wildlife Coordination Act	Plan in FULL Compliance
Flood Plain Management (E.O. 11988)	Plan in FULL Compliance
Land and Water Conservation Fund Act	Plan in FULL Compliance
Marine Protection Research and Sanctuaries Act	Not Applicable
National Environmental Policy Act	Plan in PARTIAL Compliance
National Historic Preservation Act	Plan in FULL Compliance
Prime and Unique Farmlands, CEQ, Memorandum	Plan in FULL Compliance
Protection and Enhancement of Cultural Environment (E.O. 11593)	Plan in FULL Compliance
Protection of Wetlands (E.O. 11990)	Plan in FULL Compliance
River, Harbor, and Flood Control Act of 1970, Section 122	Plan in FULL Compliance
Water Resources Planning Act	Plan in FULL Compliance
Watershed Protection and Flood Prevention Act	Not Applicable
Wild and Scenic Rivers Act	Subject Resource Not in Study Area
STATE POLICIES	
Air Control Act	Plan in FULL Compliance
Archeological Treasure Act	Not Applicable
Historic Preservation Districts Act	Not Applicable
Louisiana Natural and Scenic Rivers Act	Plan in FULL Compliance
Protection of Cypress Trees (Act 795)	Plan in FULL Compliance
Water Control Act	Plan in FULL Compliance
LAND USE PLANS	
Louisiana Coastal Zone Management Program	Plan in FULL Compliance
The Land Use Element of the Area-Wide Comprehensive Plan	Plan in FULL Compliance

shared on a 75-percent Federal and 25-percent non-Federal basis. st-sharing policies for recreational facilities provide for first sts to be shared on a 50-percent Federal and 50-percent non-Federal sis. Details of cost sharing requirements may be found in the Main port, Appendix F, Economic and Social Analysis, and Appendix G, creation.

3.7. Plan F has been selected as the NED and RP. The rationale for ese designations is on page EIS-1.

3.8. Table 4-4, "Comparative Impacts of Alternatives," describes in a mparative form the base and without condition, the impacts of the tailed plan on significant resources, and plan economic haracteristics. More detailed information on the impacts described in is table can be found in Section 6, "Environmental Effects."

TABLE 4-3-1

COST-SHARING REQUIREMENTS

Implementation Responsibilities	Bonnet Carre' Plan
a. First Cost	
(1) Federal	$43,175,000
(2) Non-Federal	14,639,000
(3) Total	$57,814,000
b. Annual Cost	
(1) Federal	$ 4,456,000
(2) Non-Federal	1,507,000
(3) Total	$ 5,963,000

4.3.3. The first 3.8 miles of the outflow channel would require excavation of a new channel from the diversion structure to the borrow channel above Airline Highway. A new channel would also be required from the borrow channel to Lake Pontchartrain. The channel would be excavated by bucket dragline in the floodway and bucket dragline on barges in open-water areas in Lake Pontchartrain. Excavated material in the floodway would be placed 3 to 4 feet high adjacent to the diversion channel to be removed by sand haulers. The excavated material would be used as fill for construction activities in the surrounding urban areas. Sand haulers are currently allowed to remove sand material from the floodway. It is envisioned that the clayey material would be used in levee construction and in a sanitary landfill located near the spillway. The excavated material would be removed from the floodway in order to maintain the capacity for flood control. The diversion channel through the floodway would sever access roads used by sand haulers. A timber bridge would be provided across the diversion channel just above the Illinois Central Gulf Railroad to provide sand haulers continued access in and out of the floodway.

4.3.4. The spillway guide levee would be relocated to provide flood protection to surrounding residents from overflow of floodwaters diverted through the Bonnet Carre' floodway. The diversion channel is designed to contain all flows within banks.

4.3.5. At the lake end of the diversion channel, recreational facilities are proposed in the plan. These facilities would include two boat ramps, courtesy piers, parking areas, and picnic tables. Similar facilities are proposed for development at Frenier Beach, the Rigolets, and Point Aux Herbes in Louisiana, and Cedar Point and Wolf River in Mississippi.

4.3.6. The cost-sharing requirements for Plan F are summarized in table 4-3-1. Traditional cost-sharing policies for enhancement of fish and wildlife, the primary function of the plan, provide for first costs to

existing structure has two sill elevations: + 16.1 and 18.1 feet NGVD[1/]. The structure is operated to prevent the Mississippi River flows downstream of the spillway from exceeding 1,250,000 cfs. On the contrary, freshwater diversions would be made during periods of average to low flow on the river. The invert elevation of the freshwater diversion structure would be -21.0 feet NGVD. Overall, modifying the existing spillway structure to allow diversion would be expensive. Engineering analysis of modifying part of the existing spillway structure for freshwater diversion or placing the diversion structure adjacent to the existing structure revealed that it would cost $5,200,000 more to modify the spillway structure. An investigation of possible locations adjacent to the existing structure determined that the most feasible location for a freshwater diversion structure was just northwest of the existing structure. This location would cause the least disruption to existing developments.

4.3.2. Plan F, which uses the Bonnet Carre' Spillway, is shown on plate 7 of the Main Report. Developments would consist of a salinity control structure, inflow and outflow channels, sedimentation trap, access bridge, and recreational facilities at six locations throughout the study area. The salinity control structure would consist of a multigated box culvert. The structure would be constructed about 600 feet north of the spillway. The invert elevation of the structure would be -21.0 feet NGVD. The Mississippi River levee would be set back to tie into the diversion structure. The inflow channel would be about 950 feet long. The total outflow channel length would be 6.4 miles. The channel would extend 0.7 miles into Lake Pontchartrain. The diversion channel would be designed to handle all diverted flows within banks.

1/ National Geodetic Vertical Datum

finfish species. These declines in production would adversely affect employment and earnings in the commercial fish and wildlife industries.

4.2.3. The decreases in fish and wildlife productivity throughout the study area would cause a reduction of outdoor recreational opportunities. The supply of fish and wildlife is anticipated to decrease to a level which would support 1,997,921 man-days of recreation by 2040. This is a reduction of 127,417 annual man-days from its present use level. This loss is valued at $904,310 per year. Market area demands are projected to reach 56,732,809 man-days by 2040. Increasing future demands with a diminishing resource base would result in higher levels of need than currently exist.

4.2.4. The population of the economic area is projected to reach 2,676,300 by the year 2040. Economic activities are expected to continue their historic trends to keep pace with a growing population.

4.2.5. Cultural resources of the study area are presently being impacted by the natural processes of erosion, wave wash, subsidence, and by the urbanization of the area. These impacts are significant and are destroying archeological and historic resources located in the marshes, along the coastlines and waterways, and in areas of planned urban development. In the future, the destructive forces of nature and urban expansion will continue to adversely impact cultural resources in the study area.

4.3. PLANS CONSIDERED IN DETAIL

4.3.1. As described in Appendix B and Section 4.1 of this discussion, Plan F utilizing the Bonnet Carre' site was the most favorable plan. At the Bonnet Carre' site, consideration was given to modification of part of the existing spillway structure for freshwater diversion. The

4.1.7. The IHNC proved to have a number of insurmountable problems, the most notable being the uncertainty regarding the Corps' "Mississippi River - Gulf Outlet, New Lock and Connecting Channels" study to determine the feasibility of rehabilitating or replacing the existing IHNC lock. Detailed studies are underway and a study completion date has not been determined. Due to the uncertainty of the shiplock study, three developmental schemes were considered in analyzing the potential of the existing IHNC site. In all cases, the magnitude of flow which could be passed was significantly less than that required to achieve the desired salinity regime which is the primary objective of the proposed project. Thus, alternative plan D shown in table 4-1-2 was eliminated. Combination of the IHNC site and the Bonnet Carre' site was also analyzed and represents alternative plan E in table 4-1-2. This plan was economically infeasible and was eliminated.

4.2. WITHOUT CONDITIONS

4.2.1. If no action is taken to ameliorate the rate of habitat deterioration in the study area, approximately 91,000 acres of marsh and 86,000 acres of wooded swamp would be lost by the year 2040 due to the natural processes of subsidence, compaction, and erosion as well as man's developmental activites including leveeing, channelization, and petroleum exploration. Salinities in the study area would continue to severely stress areas of wooded swamp and remain unfavorable for oyster production. Approximately 51,000 acres of suitable, historically productive oyster bottoms would remain largely unproductive due to excessive salinities.

4.2.2. Habitat deterioration in the study area would adversely affect productivity of fish and wildlife resources and lead to declines in populations of alligators, furbearers, and important shellfish and

River overflowed its banks in the spring. The freshening apparently controls many of the organisms which prey on and compete with oysters. The diversion plan recommended has been designed to maintain the optimum monthly salinities identified in the LDWF study over the historically productive bottoms in the study area. This plan was reviewed and recommended by the interagency ad hoc group in June 1982. The optimum salinity regime is shown on Plate B-4 of Appendix B as well as in Section 5 of Appendix D. The location of the historically productive oyster bottoms over which the optimal monthly salinities would be achieved is shown on Plate D-1 of Appendix D.

4.1.6. The Bonnet Carre' site (Plan F) was chosen for detailed analysis in this report. The analysis used in the selection of Plan F is thoroughly covered in Appendix B as well as Section 4.3 of this discussion. The Riverbend site in Plans A, B, and C was shown to be undesirable for a number of reasons. The hydraulic head available at this site is not sufficient to maintain the desired salinity regime even with a flow of 45,000 cfs. The rights-of-way necessary for the diversion route would exceed 2,000 feet over a major portion of the route. A total of 1,940 acres would be impacted. Of these, about 1,250 acres are marsh. The required rights-of-way would cut a significant swath through St. Bernard Parish. In addition, five streams within the Louisiana Natural and Scenic Streams System would be impacted, including Bayou Dupre, Lake Borgne Canal, Bashman Bayou, Terre Beau Bayou, and Pirogue Bayou. Consideration was given to using this site in combination with one of the other sites; however, these alternatives presented many of the same problems and were economically infeasible. Elimination of the Riverbend site excludes alternative plans A, B, and C shown in table 4-1-2.

TABLE 4-1-2

ALTERNATIVE PLANS RECOMMENDED FOR INTERMEDIATE STAGE STUDY

Alternative Plan	Strategy	Diversion Site
A	Divert at one location below New Orleans	Riverbend
B	Divert one location above New Orleans and one location below New Orleans	Bonnet Carre' - 75% of supplemental flow Riverbend - 25% of supplemental flow
C	Divert at one location above New Orleans and one location below New Orleans	Bonnet Carre' - 50% of supplemental flow Riverbend - 50% of supplemental flow
D	Divert at one location in New Orleans	IHNC
E	Divert at one location above New Orleans and one location in New Orleans	Bonnet Carre' IHNC
F	Divert at one location above New Orleans	Bonnet Carre'

were the sites at the Bonnet Carre' Spillway (mile 128.5), the Inner Harbor Navigation Canal (IHNC, mile 92.6), and Riverbend (mile 83.0).

4.1.4. In the July 1981 Final Reconnaissance Report on this study, the strategy of alternative plans recommended for further study was to divert water at one site above and/or one site below New Orleans. The Bonnet Carre' site is above New Orleans and the IHNC and Riverbend sites are at or below New Orleans. These three sites were used to formulate 6 intermediate stage alternative plans. These plans are presented in table 4-1-2.

4.1.5. The plans were further analyzed to determine which plan would most efficiently achieve the desired salinity regime which is the primary purpose of the study. The salinity regime was established through a series of meetings and workshops by an ad hoc group consisting of representatives from the US Fish and Wildlife Service, National Marine Fisheries Service, Louisiana Department of Wildlife and Fisheries, Louisiana Department of Natural Resources, Louisiana Department of Health and Human Resources, Mississippi Department of Wildlife Conservation, and US Army Corps of Engineers. Memoranda for the Record summarizing the results of these three meetings are contained in Exhibit 1 of Appendix B. The rationale for establishment of the desired salinity regime is discussed in the Memorandum for the Record for the meeting held on June 22-23, 1982. The salinity regime was identified based on studies conducted by the Louisiana Department of Wildlife and Fisheries (LDWF) on Louisiana's prime oyster seed grounds using data collected over the the 10-year period 1971-1981. The results of the LDWF study are presented in a paper entitled "Optimum Salinity Regime for Oyster Production on Louisiana's State Seed Grounds." A copy of this paper is presented in Exhibit A of Appendix D. The critical factor relative to salinity and oyster production appears to be a spring freshening effect similar to that which occurred when the Mississippi

TABLE 4-1-1

POTENTIAL FRESHWATER DIVERSION SITES

Diversion Site	River Mile (AHP)[1/]	Channel Improvements (Miles)	Primary Receiving Area(s)
Bayou Manchac	214.8	40	Lake Maurepas
Bayou Braud	196.0	45	Lake Maurepas
Bayou Conway	176.0	30	Lake Maurepas
Blind River	155.0	25	Lake Maurepas
Garyville Canal	142.0	15	Lake Maurepas
Reserve Relief Canal	137.4	8.5	Lake Maurepas
Canal North of Bonnet Carre'	129.0	6.5	Lake Pontchartrain
Borrow Pits Inside Bonnet Carre'	128.5	6.0	Lake Pontchartrain
Walker Canal	116.0	5.5	Lake Pontchartrain
St. Charles Parish Canal	115.7	5.0	Lake Pontchartrain
Inner Harbor Navigation Canal	92.6	5.0	Lake Pontchartrain Mississippi River-Gulf Outlet
Riverbend	83.0	6.0	Mississippi River-Gulf Outlet, Lake Borgne
Bayous Terre Aux Boeufs and LaLoutre	82.0	20	Mississippi River-Gulf Outlet

1/ Above Head of Passes

4. ALTERNATIVES

4.1. PLANS ELIMINATED FROM FURTHER STUDY

4.1.1. A total of 13 potential sites were evaluated for diversion of fresh water into the study area. These sites were identified by using topographical maps, high altitude infrared photos, field reconnaissance, and a general knowledge of the study area. The sites were chosen by an Interdisciplinary Planning Team (IPT) utilizing engineering, socioeconomic, and environmental information. The potential diversion sites are described in detail and shown on plate B-1 in Appendix B, Plan Formulation. A list of these sites with river mile location, approximate length of channel improvements, and primary receiving areas is provided in table 4-1-1.

4.1.2. The 13 sites were subjected to a screening process using an order-of-magnitude type assessment of engineering, socioeconomic, and environmental factors. The engineering assessment consisted of a preliminary hydraulic design, structure and channel design, relocations, hydraulic efficiency, and foundation considerations. The environmental and socioeconomic analyses were based on available reports, file data, maps, infrared photography, and field reconnaissance to identify impacts on habitat, water quality, cultural resources, businesses, residences, and existing facilities.

4.1.3. The IPT encountered some problems in rating the comparative performance of the various sites because it is difficult to evaluate the relative importance of engineering, socioeconomic, and environmental criteria. Therefore, a numerical system was designed and employed to establish consistency and reduce bias in the evaluation. This procedure is discussed in detail in Section 1 of Appendix B. Based on the analysis, three sites were recommended for further investigation. These

progress on January 26, 1981. Ad hoc interagency meetings were held on May 28 and June 22-24, 1982 to develop objectives for enhancing fish and wildlife resources through freshwater diversion. Various informal meetings have been held and more will be held with representatives of Federal and state fish and wildlife management agencies, local interests, environmental groups, and other special interest groups. Studies have been coordinated with the US Fish and Wildlife Service, National Marine Fisheries Service, US Food and Drug Administration, Louisiana Department of Wildlife and Fisheries, Louisiana Department of Natural Resources, Louisiana Department of Health and Human Resources, and Mississippi Department of Wildlife Conservation, Bureau of Marine Resources. Five coordination meetings have been held with the Mobile District Corps of Engineers. Three public meetings were held in December 1983. A list of major meetings held with interested agencies and groups is in the Main Report, page 75.

3.2.2. During the conduct of the study, a number of public concerns have been identified and are addressed in the EIS. These include coastal wetland deterioration; adverse and beneficial effects of freshwater diversion on the estuarine ecosystem; impacts on water quality; impacts on sport and commercial fishing; project costs; real estate requirements; impacts of diversions on local drainage and flooding; and impacts on human, cultural, and historical resources.

3.3. PLANNING OBJECTIVES

Based on the problems, needs, and opportunities identified by both public and private interests, the following planning objectives were developed: restore optimum salinity regimes in wetlands and estuaries; preserve, restore, and create natural habitats; enhance growth of marsh and aquatic vegetation; increase commercial fisheries production; increase commercial wildlife production; improve sport fishing opportunities; and improve sport hunting opportunities.

3. NEED FOR AND OBJECTIVES OF ACTION

3.1. STUDY AUTHORITY

The purpose of this study is to investigate problems, needs, and opportunities for improving fish and wildlife resources in and adjacent to Lakes Maurepas, Pontchartrain, and Borgne, and Chandeleur and Mississippi Sounds. The study is being conducted in response to a resolution of the Committee on Public Works and Transportation of the United States House of Representatives. The resolution, sponsored by Congressman Trent Lott of the Fifth Congressional District of Mississippi, was adopted on September 23, 1976 and reads as follows:

> "Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Chief of Engineers of the US Army is hereby requested to review the report on the Mississippi River and Tributaries, published as House Document 308, 88th Congress, and other pertinent reports with a view to determining the advisability of modifying the recommendations contained therein with particular reference to providing fresh water into Lakes Maurepas, Pontchartrain, Borgne, and Mississippi Sound areas in the interest of improving the wildlife and fisheries of this area."

3.2. PUBLIC CONCERNS

3.2.1. Two public notices were issued and initial public meetings were held on February 1 and 9, 1978 at Gulfport, Mississippi and New Orleans, Louisiana, respectively. A meeting was held with representatives of interested Federal and non-Federal agencies to discuss the status and future direction of the study on April 21, 1980 and to discuss study

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MISSISSIPPI AND LOUISIANA ESTUARINE AREAS STUDY: REPORT ON FRESHWATER DIVERSION TO THE LAKE PONTCHARTRAIN BASIN AND MISSISSIPPI SOUND

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES

ALTERNATIVE	SIGNIFICANT RESOURCES
	MARSHES
Base Condition	Marshes dominate the vegetated habitats in the study area, covering about 319,546 acres. About 78,231 acres of fresh/intermediate marsh, 157,604 acres of brackish marsh, and 83,711 acres of saline marsh occur. These marshes sustain populations of important fish and wildlife species.
Without Project (No Action)	By 2040, fresh/intermediate marsh would decrease to about 54,972 acres, brackish marsh to about 118,723 acres, and saline marsh to about 54,695 acres. Corresponding decreases in fish and wildlife productivity would occur.
Bonnet Carre' Plan (Plan F)	The proposed plan would reduce marsh loss rates in the study area. About 4,186 more acres of marsh would occur in 2040 than without project. These savings would be mostly in fresh/intermediate marsh. Brackish and saline marshes would be subjected to reduced average salinities and would be healthier and more productive for wildlife.
	WOODED SWAMP
Base Condition	About 188,669 acres of wooded swamp occur in the study area. Most of this acreage is found in the western portion of the Lake Pontchartrain Basin.
Without Project (No Action)	Wooded swamp in the Louisiana portion of the area would decrease to about 69,525 acres by 2040, primarily due to drainage for alternative uses and saltwater stress. Wooded swamps in Mississippi would experience only a negligible loss rate.
Bonnet Carre' Plan (Plan F)	Construction of the proposed plan would eliminate about 618 acres of wooded swamp within the spillway. However, the plan would save about 6,355 acres of wooded swamp over the project life, primarily due to a reduction in existing salinities.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	BOTTOMLAND HARDWOOD FOREST
Base Condition	About 90,732 acres occur within the study area, primarily along the natural levees of the Mississippi River and other major streams. These forests provide valuable wildlife habitat.
Without Project (No Action)	Acreage of this habitat type would be reduced to about 74,052 acres by 2040 due to agricultural, industrial, and urban development.
Bonnet Carre' Plan (Plan F)	The proposed plan would not adversely impact any bottomland hardwood forests due to construction. The proposed project claims no quantified benefits to this habitat type.
	AGRICULTURAL LANDS
Base Condition	Primary crops grown in the study area include sugarcane, soybeans, cotton, citrus, pecans, and truck crops. Pastureland is also present. Both prime and unique farmlands occur.
Without Project (No Action)	Agricultural lands in the study area would decrease by 2040 due to urban and industrial expansion, particularly those lands adjacent to heavily developed urban centers.
Bonnet Carre' Plan (Plan F)	The proposed plan would not impact any agricultural lands during construction. No benefits to agricultural lands would accrue due to project implementation.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	WATER BODIES
Base Condition	Approximately 1,924,000 acres of fresh to estuarine water bodies occur in the area. The water bodies provide habitat for a variety of commercially and recreationally important species.
Without Project (No Action)	Acreage of open water in the study area is projected to increase about 135,700 acres by 2040. This increase would be due to the natural processes of subsidence, compaction, and erosion, as well as man's developmental activities.
Bonnet Carre' Plan (Plan F)	The proposed plan would significantly alter salinity regimes in the water bodies of the study area. Open-water acreage would decrease slightly because of the marsh saved by the project. About 63 acres of existing water bodies would be impacted due to construction.
	BARRIER ISLANDS
Base Condition	A chain of barrier islands forms the seaward boundary of the study area. From east to west, the islands forming this chain are Dauphin, Petit Bois, Horn, Ship, and Cat Islands, and the Chandeleurs.
Without Project (No Action)	Erosion, subsidence, and other factors would cause these islands to shift and be reduced in areal extent by the year 2040.
Bonnet Carre' Plan (Plan F)	The proposed plan would have no significant impacts on barrier islands.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES SEAGRASS BEDS
Base Condition	Seagrass beds occur in Mississippi and Chandeleur Sounds, especially on the leeward side of the barrier islands. Concentrations of brackish submerged vegetation assemblages are found in Lake Pontchartrain.
Without Project (No Action)	Seagrass beds would continue to exist in Lake Pontchartrain and adjacent to the barrier islands. Their areal extent would be largely governed by hurricanes and prolonged exposure to low salinities which occur in years of large spillway openings and heavy flooding on the Pearl and Pascagoula Rivers.
Bonnet Carre' Plan (Plan F)	It is not expected that this plan would adversely affect seagrass beds. The release of water through the spillway in 1973 did not have observable effects on the beds in Lake Pontchartrain. Due to the large volume of high salinity waters adjacent to the barrier islands, the proposed plan would not significantly lower salinities in these areas.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	FISHERIES
Base Condition	The study area supports valuable commercial and sport fishery resources. Average annual landings from 1963-1978 were approximately 96 million pounds, valued at $52 million. Average annual oyster harvest is about 8 million pounds, valued at $12 million.
Without Project (No Action)	Fishery productivity would decline significantly due to a 29-percent reduction in wetland acreage. If no action is taken to ameliorate salinity conditions in the area, thousands of acres of historically productive oyster bottoms would remain largely unproductive.
Bonnet Carre' Plan (Plan F)	The proposed plan would restore favorable salinities and provide additional nutrients to the study area, resulting in increased fishery production. Average annual oyster harvest would be about 15 million pounds, valued at $23 million.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	WILDLIFE
Base Condition	The diverse habitat in the study area supports abundant wildlife resources including commercially and recreationally important species. In the Louisiana portion, potential annual net value of furbearers and alligators is about $800 thousand.
Without Project (No Action)	Wildlife populations would decline due to reduced quality and quantity of wetland habitat. Potential annual value of commercial wildlife would be reduced by over $378 thousand by 2040.
Bonnet Carre' Plan (Plan F)	The proposed plan would benefit wildlife populations by reducing the rate of habitat loss and deterioration. Potential total net value of commercial wildlife would be $40 thousand greater in 2040. Potential adverse impacts to certain species could occur due to environmental changes resulting from the diversion.
	ENDANGERED SPECIES
Base Condition	Three threatened and 19 endangered species are known to occur or could possibly occur in the study area. These include reptiles, birds, and mammals.
Without Project (No Action)	The continuing trend of habitat deterioration, as well as increased urbanization and population growth, would adversely impact threatened and endangered species.
Bonnet Carre' Plan (Plan F)	Improvements in habitat quality would benefit most species.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	BLUE LIST SPECIES
Base Condition	The range of 23 species of birds listed on the 1982 Audubon Society "Blue List" includes the study area.
Without Project (No Action)	The continuing trend of habitat deterioration, as well as increased urbanization and population growth, would adversely impact most Blue List species.
Bonnet Carre' Plan (Plan F)	Improvements in habitat quantity and quality would benefit most Blue List Species. Increased pollutant levels could cause subtle, long-term adverse impacts to some species.
	NESTING COLONIES
Base Condition	A total of 51 sea and wading bird nesting concentrations occur in the forests, swamps, marshes, and on the barrier islands.
Without Project (No Action)	The continuing trend of habitat deterioration, as well as urbanization and population growth, would adversely impact nesting colonies.
Bonnet Carre' Plan (Plan F)	Improvements in quantity and quality of habitat would benefit nesting colonies overall. Increased pollutant levels could cause subtle, long-term adverse impacts to some colonies.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	RECREATIONAL RESOURCES
Base Condition	The study area provides opportunities for a variety of consumptive and nonconsumptive recreational activities. The area supports 1,822,800 annual man-days of sport fishing and 302,538 man-days of hunting.
Without Project (No Action)	Recreational opportunities are related to habitat quantity and quality, as well as access to the area. As habitats deteriorate, recreational opportunities would be lost. By 2040, project area use would be reduced by 127,417 man-days compared to base condition.
Bonnet Carre' Plan (Plan F)	Recreational benefits in 2040 would be valued at about $690 thousand, $77 thousand from hunting, $455 thousand from fishing, and $158 thousand from picnicking. Fishing and picnicking benefits accrue primarily from the six proposed recreational developments which are included in the plan.
	WILDLIFE MANAGEMENT AREAS/REFUGES
Base Condition	Four state wildlife management areas (WMA's), two national refuges, and one state refuge occur in the study area. The WMA's and refuges cover a total of about 110,000 acres and provide excellent recreational opportunities.
Without Project (No Action)	As habitat deterioration continues over the life of the project, the WMA's and refuges would be adversely impacted and associated recreational opportunities reduced.
Bonnet Carre' Plan (Plan F)	Habitat degradation would be reduced, particularly in the Manchac and Joyce WMA's and the St. Tammany Wildlife Refuge. The Biloxi WMA would also experience some improvements in habitat conditions.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	MINERALS
Base Condition	Mineral resources consist mainly of oil, natural gas, aggregate deposits, salt, and sulphur.
Without Project (No Action)	Petroleum exploration and production will occur in the future. Activities will include canal dredging, drilling, and other activities related to the petroleum industry.
Bonnet Carre' Plan (Plan F)	Construction of the diversion routes would require relocation of six oil and gas pipelines.
	MISSISSIPPI RIVER
Base Condition	Study area was created by the delta building processes of the Mississippi River. The river is an important navigational route and source of municipal and industrial water supply. Water quality of the river is relatively poor.
Without Project (No Action)	River will continue to be used for navigation and water supply. Water quality will continue to degrade unless laws governing introduction of pollutants are enforced.
Bonnet Carre' Plan (Plan F)	Minimal impacts on the Mississippi River. Maximum design flow into receiving area would represent only about 6 percent of average river flow.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	WATER QUALITY
Base Condition	Mississippi River sometimes contains high levels of fecal coliforms, plant nutrients, heavy metals, phenols, pesticides, polychlorinated biphenyls, and other compounds. Receiving areas generally contain lower levels of pollutants than the proposed source water, although water quality in some of the receiving areas is also poor. Temperature of river water is cooler than receiving areas during certain times of the year.
Without Project (No Action)	Wastewater loading in the Mississippi River and the rest of the study area will continue to increase with expanding urbanization and industrialization, although implementation of improved treatment methods would offset long-term impacts. Water quality in the receiving areas would continue to degrade.
Bonnet Carre' Plan (Plan F)	Diversions would result in increased mean concentrations of heavy metals, nutrients, hydrocarbons, and fecal coliform bacteria in the receiving areas. Water temperature in the immediate receiving area would be lowered during certain times of the year. Diversions would increase dissolved oxygen levels in the receiving area.
	LOUISIANA NATURAL AND SCENIC STREAMS SYSTEM
Base Condition	Within the study area, twelve streams, or portions thereof, are included in the Louisiana Natural and Scenic Streams System.
Without Project (No Action)	State law should prevent significant adverse alterations in these streams as as result of man's activities. Natural processes would continue to impact these streams.
Bonnet Carre' Plan (Plan F)	The proposed plan would result in some minor changes in salinity and water quality in certain scenic streams.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	NATIONAL REGISTER PROPERTIES
Base Condition	Eleven properties listed on the National Register occur within the Louisiana portion of the study area. These include three prehistoric archeological sites and eight historic sites.
Without Project (No Action)	National Register properties are being adversely affected by both natural processes and urbanization in the area. These destructive forces will continue, if not accelerate, in the future.
Bonnet Carre' Plan (Plan F)	No presently listed National Register or Register-eligible properties would be affected. However, future cultural resources surveys may locate resources eligible for the Register in the study area.
	ARCHEOLOGICAL RESOURCES
Base Condition	Over 620 archeological sites are recorded in the study area. These sites include prehistoric and historic cultural remains.
Without Project (No Action)	Archeological resources are being adversely affected by both natural processes and urbanization in the study area. These destructive processes will continue, if not accelerate, in the future.
Bonnet Carre' Plan (Plan F)	No presently recorded archeological sites would be affected. However, the diversion site and three of the six proposed recreational areas have a high probability of being in the vicinity of presently unrecorded archeological remains. Future cultural resource surveys will be conducted.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES BUSINESS AND INDUSTRY
Base Condition	Mineral production and the Port of New Orleans form the primary economic base. However, the seafood industry is very important due to the abundance of seafood which is heavily promoted by tourist industries. Popular seafood items include oysters, shrimp, and crabs. The oyster industry is experiencing serious problems in the study area, primarily due to saltwater intrusion in the recent past and pollution.
Without Project (No Action)	The seafood industries, particularly the oyster industry, would continue to experience problems. Habitat deterioration and saltwater intrusion which have occurred in the area have led to instability in the oyster harvest and related industry. If no action is taken, large areas of historically productive oyster bottoms would remain largely unproductive.
Bonnet Carre' Plan (Plan F)	The proposed plan would restore favorable habitat conditions and salinities to the area. Restoration of productive oyster bottoms would add stability to the industry. Some commercial fisheries such as brown shrimp, spotted seatrout, and red drum would be displaced during peak diversions; however, improvements in habitat conditions and addition of nutrients is expected to improve overall fisheries production.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES
	EMPLOYMENT/LABOR FORCE
Base Condition	The seafood industry is important to the study area. The oyster industry is experiencing problems because it is unpredictable due to extreme fluctuations in availability of oysters.
Without Project (No Action)	Employment difficulities in the oyster industry can be expected to continue. Excessive salinities which plague the area have rendered large areas of potentially productive oyster bottoms largely unproductive. Employment of oyster fishermen, processors, and those involved in marketing would decline.
Bonnet Carre' Plan (Plan F)	The proposed plan would provide favorable salinities to the area on a regular basis and would lead to more stable oyster production in the long term. Employment in the industry would stabilize. Fishery-related employment in some local areas may be temporarily adversely affected due to displacement of species preferring higher salinities.
	LAND USE
Base Condition	Wildlife and fishery resources are important to the economy of the area. The productivity of these resources is dependent on habitat, particularly wetlands. Therefore, land-use patterns are influenced by the value of these resources. Competition exists between land use for these resources and industrial and urban expansion.
Without Project (No Action)	Current land-use trends would probably continue as economic growth and the need for additional housing continues. Competition between fish and wildlife related industries and a variety of developmental activities would continue.
Bonnet Carre' Plan (Plan F)	Primary impacts on land use due to project implementation would occur in the community located just north of the spillway. About 33.6 acres of residential area and another 43.6 acres of land with potential for residential development would be affected by project construction.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ERNATIVE	SIGNIFICANT RESOURCES
	DISPLACEMENT OF PEOPLE
se Condition	Instability and decline of the oyster industry, as well as other fish and wildlife related pursuits, have caused certain individuals to seek alternative employment.
ithout Project o Action)	Continued declines and instability in the oyster industry and other fish and wildlife related industries dependent upon habitat quality would reduce employment, thereby displacing those working in these industries.
onnet Carre' Plan Plan F)	The proposed project would increase and stabilize fish and wildlife production, thereby benefiting employment in industries related to these resources. Construction of the project would affect 52 permanent residential structures, 16 mobile homes, and 1 church within the construction rights-of-way. A number of families would have to be relocated.
	COMMUNITY COHESION
ase Condition	Fishery resources such as oysters, shrimp, and crabs, as well as wildlife resources, form an integral part of the culture of the study area. Activities related to these resources, such as dining on fine seafoods, benefits community and social cohesion.
ithout Project No Action)	Declines in availability of products related to fish and wildlife resources would continue and would adversely impact related local and tourist industries. Prices of seafood would rise as a result of reduced and unstable supply.
onnet Carre' Plan Plan F)	The proposed plan would increase supply of oysters and other seafood items, as well as wildlife resources. Employment and income related to these products would increase and stabilize resulting in less displacement of people and increased social and community cohesion. The primary adverse impact would be due to relocation of 26 permanent single dwellings and 6 mobile homes in the construction rights-of-way and an additional 26 permanent single dwellings, 10 mobile homes, and 1 church to maintain community cohesion for the residents of Montz, Louisiana.

water-oriented recreational activities. Consumptive activities include hunting and fishing. Both fresh and saltwater sport fishing are popular in the area, as well as sport shrimping and sport crabbing. Nonconsumptive recreational activities in the area include boating, swimming, camping, picnicking, and various forms of wildlife-oriented recreation. The study area supports approximately 11,250,000 man-days of these major nonconsumptive recreational activities. The Wildlife Management Areas in the study area provide consumptive and nonconsumptive opportunities. The bottomland hardwoods, wooded swamps, marshes, and associated estuarine water bodies are heavily utilized by hunters and fishermen. The study area supports a total of 2,125,338 man-days per year of use, 302,538 man-days of hunting, and 1,822,800 man-days of sportfishing. These activities are valued at $10,076,635 per year-$2,421,635 for hunting, and $7,655,000 for fishing. Within the market area, the demand for sport hunting presently exceeds supply by 4,128,769 man-days. A total of 202 boat launch lanes exist in the area. Present fishing facility needs indicate that 1,160 additional lanes are required in order to satisfy current demand levels for the market area. More information concerning recreational resources is located in Appendix G, Recreation.

5.2.15. WILDLIFE MANAGEMENT AREAS/REFUGES

5.2.15.1. A number of wildlife management areas (WMA's) and refuges occur within the study area and recreational market area. These include the Biloxi, Manchac, Joyce, Pearl River, Red Creek, and Little Biloxi WMA's; the Breton National Wildlife Refuge; Mississippi Sandhill Crane National Wildlife Refuge; and the St. Tammany Wildlife Refuge.

5.2.15.2. The Biloxi, Manchac, Joyce, and Pearl River WMA's are located within the study area proper. The 39,583-acre Biloxi WMA is located in eastern St. Bernard Parish. Habitat consists primarily of brackish and

Upland Sandpiper	Dickcissel
Least Tern	Bachman's Sparrow
Black Tern	

5.2.13. NESTING COLONIES

A total of 51 sea and wading bird nesting colonies occur within the study area. Wading bird concentrations occur in the forests, swamps, marshes, and on the barrier islands. Seabird nesting colonies are generally associated with the brackish to saline marshes and barrier islands. Species comprising nesting colonies in the study area include the following:

Great Blue Heron	Green Heron
Great Egret	Least Tern
Cattle Egret	Black Skimmer
Little Blue Heron	Forster's Tern
Louisiana Heron	Black-crowned Night Heron
Snowy Egret	Brown Pelican
White Ibis	Laughing Gull
White-faced Ibis	Reddish Egret
Glossy Ibis	American Oystercatcher
Yellow-crowned Night Heron	Gull-billed Tern
Common Tern	Caspian Tern

The locations of active seabird and wading bird nesting concentrations in the study area are located in table 10 of the US Fish and Wildlife Service Planning Aid Report on this study published in June 1980.

5.2.14. RECREATIONAL RESOURCES

The study area provides opportunities for a variety of out-

visits the study area marshes, and the red-cockaded woodpecker inhabits mature pines in upland areas. Bachman's Warber, the Eskimo curlew, and the ivory-billed woodpecker could possibly exist in the study area, although their presence is doubtful.

5.2.11.3. The Florida panther may occur in the forests and wooded swamps. A West Indian manatee was captured in the small craft harbor at Gulfport, Mississippi, in January, 1979. Correspondence with the US Fish and Wildlife Service and National Marine Fisheries Service concerning threatened and endangered species is in Appendix D, Section 2.

5.2.12. BLUE LIST SPECIES

The "Blue List," published by the National Audubon Society, lists birds that are showing indications of noncyclical population decline or range contraction, either locally or throughout their range. This list, compiled by interested observers throughout the country, serves as an early warning system to indicate those species that might be in danger of extinction in the future. The 1982 "Blue List" cites 30 species. The range of 23 of these includes the study area. These species are listed below:

Least Bittern	Short-eared Owl
American Bittern	Ruby-throated Hummingbird
Sharp-shinned Hawk	Hairy Woodpecker
Red-shouldered Hawk	Bewick's Wren
Marsh Hawk	Eastern Bluebird
King Rail	Loggerhead Shrike
Piping Plover	Golden-winged Warbler
Snowy Plover	Yellow Warbler
Long-billed Curlew	Eastern Meadowlark

approximately $157 thousand.

5.2.10.2. Numerous terrestrial invertebrates occur throughout the study area. The most notable are insects, which often serve as vectors, transmitting disease organisms to higher animals, including man. Mosquitoes are the most important of the vectors in the area, although other groups, such as deerflies, horseflies, and biting midges are also considered as vectors. The area provides suitable breeding habitat for such species as Aedes sollicitans (salt-marsh mosquito), Culex salinarius, and other species of mosquitoes. Mosquitoes are important vectors for various strains of viral encephalitis within the study area. Additional information is contained in paragraph A.3.113. of Appendix A.

5.2.11. ENDANGERED SPECIES

5.2.11.1. The study area provides habitat for a number of endangered species, including reptiles, birds, and mammals. The American alligator remains on the endangered list in the Mississippi and Alabama portions of the study area. In Louisiana, the alligator is classified as "threatened" under the Similarity of Appearance clause of the Endangered Species Act of 1973. Under this classification, controlled harvest of this species is permitted. Endangered sea turtles present in the area include the Kemp's Ridley, hawksbill, and leatherback. Loggerhead and green sea turtles are also found in the study area and are considered threatened.

5.2.11.2. Endangered birds known to occur in the area include the bald eagle, brown pelican, arctic peregrine falcon, red-cockaded woodpecker, and Mississippi sandhill crane. The bald eagle is found in the marshes, lakes, and swamps from September through May. Brown pelicans can be found near the barrier islands. The arctic peregrine falcon sometimes

These organisms constitute vital components of the aquatic food chain.

5.2.10. WILDLIFE

5.2.10.1. The study area contains a great variety of mammals, birds, reptiles, and amphibians. Of special interest from a commercial standpoint are nutria, muskrat, mink, otter, and raccoon, which are trapped for their valuable pelts. Based on 1978 habitat acreages and 1976-1981 average prices, potential annual net value of furbearers is about $643 thousand. Other species inhabiting the area include white-tailed deer, skunks, rabbits, squirrels, armadillos, and various species of small mammals. Large populations of migratory waterfowl including snow geese, gadwalls, pintails, mallards, blue-winged teal, green-winged teal, wigeons, mottled ducks, and lesser scaup are present in the area. These waterfowl are highly sought by sportsmen. In addition, coots, gallinules, rails, mourning doves, and snipe are important game species. The study area supports about 489 thousand annual man-days of sport hunting. Nongame wading birds, shore birds, and sea birds include egrets, ibises, herons, sandpipers, willets, black-necked stilts, gulls, terns, skimmers, grebes, loons, cormorants, and white and brown pelicans. Various raptors such as barred owls, red-shouldered hawks, marsh hawks, ospreys, arctic peregrine falcons, and bald eagles are present. Passerine birds present include sparrows, vireos, warblers, mockingbirds, grackles, red-winged blackbirds, wrens, bluejays, cardinals, and crows. Many of these birds are present primarily during periods of spring and fall migrations. The area provides habitat for such herptiles as salamanders, toads, frogs, turtles, lizards, and several species of poisonous and nonpoisonous snakes. The American alligator is abundant in the swamps and fresh to intermediate marshes and is caught commercially for its hides and meat throughout the Louisiana portion of the study area. Potential net annual harvest of alligators in the study area is 1,023 alligators, valued at

based on 1982 exvessel prices, was approximately 96 million pounds, valued at about $52 million. A wealth of information on the biology and harvest of the commercially important estuarine fishes and shellfishes has been summarized in a report prepared by the National Marine Fisheries Service (Lindall et al., 1972). The primary freshwater species which are harvested commercially in the area include red swamp crawfish, gars, bowfin, carp, freshwater drum, buffaloes, blue catfish, channel catfish, flathead catfish, and yellow bullhead. Commercial harvest data for freshwater species are available only for catfish and bullheads. The average catch and value of catfish and bullheads for the years 1963-1976, based on 1976 exvessel prices, was about 97 thousand pounds valued at $27 thousand.

5.2.9.2. Sportfishing in the study area is diverse and substantial, including both fresh and saltwater fishing. The area supports a total of 1,822,800 annual man-days of sportfishing. Access is a limiting factor, and governs the level of participation. Saltwater sportfishing includes sport shrimp trawling, sport crabbing, and sport finfishing. Both brown shrimp and white shrimp are taken by sport trawlers, while blue crab is the only crab species taken in significant numbers by sportfishermen. Saltwater sport finfishes commonly harvested include spotted seatrout, sand seatrout, Atlantic croaker, spot, red drum, black drum, sheepshead, southern flounder, southern kingfish, and Spanish mackerel. Freshwater sportfishing occurs in the fresh to slightly brackish waters in the upper portion of the area. Species commonly taken include largemouth bass, black crappie, white crappie, warmouth, bluegill, redear sunfish, channel catfish, blue catfish, and flathead catfish. Red swamp crawfish are also taken in the wooded swamps and fresh marshes.

5.2.9.3. The study area supports rich populations of phytoplankton, zooplankton, benthos, macroinvertebrates, and numerous small fishes.

5.2.8. SEAGRASS BEDS

Significant assemblages of submerged vegetation (seagrass beds) occur in Mississippi Sound, especially on the leeward side of Ship Horn, and Petit Bois Islands. The primary plant species comprising these communities include shoalgrass, turtlegrass, manateegrass, and various species of red and brown algae. Widgeongrass is also abundant in the Mississippi Sound area (Eleuterius, 1973). Seagrass and seaweed beds in Mississippi Sound were reduced in size following Hurricane Camille in 1969 (Eleuterius and Miller, 1976). This decline was probably related to erosion and sedimentation followed by reduced salinities resulting from prolonged floodwater runoff. In the Louisiana portion of the study area, most of the seagrass beds are found on the leeward side of the Chandeleur Islands from North Point westward to Freemason and North Islands and south toward Curlew Island (Burk and Associates, Inc., 1977). Concentrations of brackish submerged vegetation assemblages are found within the Lake Pontchartrain Basin (Montz, 1975). The most abundant species are wildcelery, widgeongrass, and southern naiad. The greatest concentration of these submerged species is in the shallow waters near the northeastern shore of Lake Pontchartrain. This area is believed to be approximately 2,000 acres in extent. These grass beds are utilized as nursery areas by a variety of finfish and shellfish species.

5.2.9. FISHERIES

5.2.9.1. The commerical fishery resources in the study area are primarily estuarine/marine in nature. Menhaden dominate the total poundage harvested, while shrimp rank first in total value. Other commercially important species include the American oyster, blue crab, Atlantic croaker, spotted seatrout, sand seatrout, spot, and red drum. The average catch and value of these fisheries for the years 1963-1978,

quality, fresh fruits and vegetables to the New Orleans metropolitan area.

5.2.6. WATER BODIES

Many fresh to saline water bodies of various sizes and depths are interspersed throughout the study area. In 1978, approximately 1,924,000 acres of fresh and estuarine water bodies were present in the area. The water bodies include ponds, lakes, streams, bayous, canals, bays, sounds, tidal passes, and navigational channels. Lakes, bays, and sounds cover about 70 percent of the area. Major water bodies include Chandeleur Sound (578,000 acres), Mississippi Sound (526,000 acres), Lake Pontchartrain (394,130 acres), Lake Borgne (171,380 acres), and Lake Maurepas (58,190 acres). These water bodies are generally flat-bottomed with average natural depths of 1 to 12 feet. Greater depths occur in the tidal passes and navigational channels. The various water bodies are inhabited by a variety of finfish and shellfish and provide valuable nursery areas for many important estuarine-dependent species.

5.2.7. BARRIER ISLANDS

The study area is fringed by barrier islands along the seaward boundary. The Chandeleur Islands form the gulfward boundary of Chandeleur Sound. This island chain, which also fringes Breton Sound, is about 50 miles long, 1 mile wide, and lies approximately 20 miles offshore. The barrier islands delineating the seaward boundary of the study area off Mississippi and western Alabama form a chain approximately 66 miles long, 1/2 mile wide, and lie about 9 miles offshore. From east to west, the islands forming this chain are Dauphin, Petit Bois, Horn, Ship, and Cat. Barrier islands support sand and sand/shell beaches, low vegetated dunes, and tidal wetlands vegetated by black mangrove and oystergrass. Protected shallows associated with these islands sometimes support beds of seagrass.

lizard's tail. Wooded swamps are productive fish and wildlife habitats. They also serve an important hydrological function by storing and regulating the flow of fresh water to marshes and estuaries seaward of them. A total of 188,669 acres of wooded swamp occur in the study area, 155,507 acres in Louisiana and 33,162 acres in Mississippi. The largest acreage is found in the western portion of the Lake Pontchartrain Basin between the Mississippi River and western shore of the lake. The Pearl River swamps are also extensive and substantial wooded swamps are located in lower portions of the Pascagoula River system.

5.2.4. BOTTOMLAND HARDWOOD FOREST

This habitat type is found at slightly higher elevations than wooded swamp along natural levees of the Mississippi River and flood plains of other major rivers flowing into the study area. Portions of these areas are seasonally flooded. Common species in this habitat include American elm, black willow, water oak, overcup oak, Nuttall oak, swamp chestnut oak, eastern cottonwood, American sycamore, hackberry, red bay, red maple, green hawthorn, and bitter pecan. Bottomland hardwood forest is very productive fish and wildlife habitat. Because of its increasing scarcity and high productivity, it is an important natural and recreational resource. A total of 90,732 acres occur in the study area, 48,338 acres in Louisiana and 42,394 acres in Mississippi.

5.2.5. AGRICULTURAL LANDS

About 79,000 acres of agricultural croplands occur in the study area. Primary crops grown in the area include sugarcane, soybeans, cotton, citrus, pecans, and truck crops. Both prime and unique farmlands occur in the area. Pastureland is also present. Although the agricultural lands are of limited extent, they are of major importance to the inhabitants of the area because they provide high

5.2.2.3. Brackish marshes are the most extensive of all marsh types in the Louisiana portion of the area. Wiregrass is dominant in this marsh type. Saltgrass, oystergrass, hogcane, black rush, three-cornered grass, and leafy threesquare are also common. Brackish marshes in Mississippi are vegetated by black rush, wiregrass, hogcane, marsh boltonia, sea-lavender, three-cornered grass, common morning glory, saltmarsh lythrum, and bulltongue. A total of 157,604 acres of brackish marsh occur in the study area, 137,662 acres in Louisiana and 19,942 acres in Mississippi.

5.2.2.4. Saline marshes in the study area are dominated by oystergrass, with black rush and saltgrass also common. In Mississippi, stands of oystergrass are bordered by stands of black rush interspersed with species such as hogcane and three-cornered grass. A total of 83,711 acres of saline marsh occur in the study area, 56,386 acres in Louisiana and 27,325 acres in Mississippi.

5.2.2.5. Marshes provide habitats for fish and wildlife, act as storm buffers between the Gulf of Mexico and developed areas of the coastal zone, and have the capacity to absorb water pollutants. The fresher marsh types function as valuable habitat for waterfowl, furbearers, and the American alligator. The higher salinity marshes produce food and serve as nursery areas essential to the reproduction, survival, and growth of many estuarine-dependent species of fish and shellfish. Most of these species are extremely valuable commercial and recreational resources in the study area.

5.2.3. WOODED SWAMP

This habitat is typically located inland from fresh marsh areas. Common woody vegetation includes baldcypress, tupelogum, Drummond red maple, green ash, and buttonbush. Herbaceous vegetation includes duckweeds, alligator weed, water hyacinth, swamp lily, and

5.2.2. MARSHES

5.2.2.1. The following types of marshes occur in the study area: (1) fresh marsh, with a mean salinity of 1.5 parts per thousand (ppt); (2) intermediate marsh, with a mean salinity of 3.3 ppt; (3) brackish marsh, with a mean salinity of 8.1 ppt; and (4) saline marsh, with a mean salinity of 15.9 ppt. 1/

5.2.2.2. For the purposes of this study, fresh and intermediate marsh types are combined and referred to as fresh/intermediate marsh. This is because the habitat values of these marsh types are similar. Typical fresh marsh vegetation includes bulltongue 2/, sawgrass, water hyssop, royal fern, panic grass, cattail, and deerpea. In Mississippi's fresh marshes, gulf spikerush is the dominant species. Other species present include blunt spikerush, squarestem spikerush, softstem bulrush, swamp lily, lizard's tail, southern-blue flag, pickerelweed, wildrice, royal fern, and cutleaf mermaidweed. As indicated by the name, intermediate marsh occurs in the transition zone between fresh and brackish marsh. Common vegetation in Louisiana's intermediate marshes includes wiregrass, cyperus, bulltongue, three-cornered grass, deerpea, and sawgrass. In Mississippi, roseau occurs in homogenous stands in higher areas, with deeper marshes dominated by softstem bulrush. Other species include black rush, pickerelweed, swamp lily, Gulf spikerush, freshwater threesquare, bulltongue, and sawgrass. A total of 78,231 acres of fresh/intermediate marsh occurs in the area, 58,346 acres in Louisiana and 19,885 acres in Mississippi.

1/ Mean salinities for fresh, intermediate, brackish, and saline marshes are based on mean salinities for the four marsh types in coastal Louisiana based on Chabreck (1972).

2/ All common and scientific nomenclature of plants mentioned in this EIS follow Montz (1975a, 1975b), and are listed in Section 1, Appendix D, Natural Resources.

5.1.4. Numerous historical and archeological sites occur throughout the study area, including a number of sites listed in the National Register of Historic Places.

5.1.5. The petroleum, chemical, and related industries, the port of New Orleans, and commercial fisheries form the economic base of the area. Major commodities moving through the port include grain, petroleum products, salt, and sulphur.

5.2. SIGNIFICANT RESOURCES

5.2.1. GENERAL

A given resource is considered to be significant if it is identified in the laws, regulations, guidelines or other institutional standards of national, regional, and local public agencies; it is specifically identified as a concern by local public interests; or it is judged by the responsible Federal agency to be of sufficient importance to be designated as significant. This section discusses each significant resource listed previously in table 4-4 "Comparative Impacts of Alternatives." Appropriate significant resources identified in Section 122 of the 1970 River and Harbor Act (PL 91-611) are discussed in this section. These include business and industry, employment/labor force, land use, displacement of people, and community cohesion. Additional information concerning the various significant resources addressed in this section is in Appendix A, Problem Identification, and Appendix F, Economic and Social Analysis.

5. AFFECTED ENVIRONMENT

5.1. ENVIRONMENTAL CONDITIONS

5.1.1. The study area encompasses 2,960,000 acres and includes a portion of southeast Louisiana and all of the Mississippi gulf coast. In Louisiana, it includes the Lower Mississippi River, Lakes Maurepas, Pontchartrain, and Borgne, Chandeleur Sound, and the wetlands bordering these water bodies. In southern Mississippi, the study area embraces Mississippi Sound and adjacent wetlands. On the east side of the river, the boundary runs from Bayou Manchac to the natural ridge along Louisiana Highway 46, then east to the MR-GO. Due to its proximity to the Gulf of Mexico, the area has a subtropical marine climate. The study area is shown on plate 1 of the Main Report.

5.1.2. The dominant habitat types in the study area are bottomland hardwood forest (natural levee forest), wooded swamp, fresh, intermediate, brackish, and saline marshes and associated fresh to saline water bodies. Barrier islands border the gulf edge of the study area. Agricultural crops grown in the area include sugarcane, soybeans, cotton, corn, citrus fruits, and truck crops.

5.1.3. Important terrestrial animals in the area include nutria, muskrat, raccoon, mink, and otter which are harvested for their furs. White-tailed deer, rabbits, various small mammals, and a variety of birds, reptiles, and amphibians also occur in the study area. The American alligator is harvested throughout the area for its meat and hide. The marshes and shallow water bodies in the area function as nursery grounds for valuable stocks of shrimp, oysters, crabs, and finfishes. These resources provide excellent opportunities for sport and commercial fishing. Popular recreational activities in the area include fishing, hunting, boating, camping, and picnicking.

TABLE 4-4. COMPARATIVE IMPACTS OF ALTERNATIVES (CONTINUED)

ALTERNATIVE	SIGNIFICANT RESOURCES			
	PLAN ECONOMICS*			
	First Costs	Average Annual Costs	B/C Ratio	Net Benefits
Base Condition	N/A	N/A	N/A	N/A
Without Project (No Action)	0	0	0	0
Bonnet Carre' Plan (Plan F)	$57,814	$5,963	1.20	$1,215

*Based on 8 1/8% interest rate; in thousands of dollars.

saline marsh. Public hunting is allowed and access is by boat only. The 8,325-acre Manchac WMA is located in eastern St. John the Baptist Parish. The area consists primarily of intermediate marsh and cypress-tupelo swamp. Public hunting is allowed for deer, small game, and waterfowl. The 13,659-acre Joyce WMA is located in Tangipahoa Parish just above Pass Manchac. Habitat consists primarily of wooded swamp. Public hunting is allowed for a variety of game animals. The 26,716-acre Pearl River WMA is located in southeastern St. Tammany Parish. Habitat consists primarily of bottomland hardwood forest and wooded swamp. Public hunting is allowed for a variety of game animals including deer, squirrels, rabbits, wild hogs, wild turkey, woodcock, snipe, rails, gallinules, and waterfowl. The little Biloxi and Red Creek WMA's are not located within the study area proper, but are in the recreational market area.

5.2.15.3. The Breton Island National Refuge covers 7,512 acres and includes portions of the Chandeleur Islands. Habitat consists of sand beaches, dunes, black mangrove thickets, saline marsh, and seagrass beds. Although hunting is not allowed, sportfishing in the surf is popular.

5.2.15.4. The Mississippi Sandhill Crane Refuge in Jackson County, Mississippi, was established in 1974. This 12,728-acre area consists of coastal savannahs and pine forest and provides critical habitat for the entire population of Mississippi sandhill cranes, which numbers 40-50 individuals. No hunting is allowed.

5.2.15.5. The St. Tammany Wildlife Refuge in St. Tammany Parish is a small, 1,300-acre refuge consisting of brackish marsh. No hunting is allowed in the area.

5.2.16. MINERALS

The most significant mineral deposits in the study area include crude petroleum, natural gas, and natural gas liquid. Other mineral resources include salt, sulphur, sand, gravel, clay, cement, lime, and magnesium compounds. Mineral resources are an extremely valuable component of the study area economy. The value of Louisiana's mineral production in 1977 was about $10.5 billion. Natural gas and natural gas liquids were valued at $5.7 billion and crude petroleum was valued at $4.4 billion. Mississippi mineral production was valued at only $0.5 billion due to lack of significant deposits of petroleum and natural gas. In 1981, approximately 13 percent of U. S. crude petroleum production came from Louisiana. About 92 percent of this came from the coastal regions. The three Mississippi counties included in the study area are not as richly endowed with mineral deposits as the Louisiana parishes. Hancock County has small deposits of natural gas and crude petroleum, Harrison County has few mineral resources, and Jackson County has deposits of magnesium and lime. Numerous submarine and subsurface pipelines are located throughout the area. The vast majority of these pipelines transport oil and natural gas.

5.2.17. MISSISSIPPI RIVER

The Mississippi River is of obvious significance to the study area. The area owes its existence to the delta building activities of the lower Mississippi River over the past 5,000 years. In addition, the river is the only source of sufficient fresh water for the proposed project. The river is an important navigational route and essential source of municipal and industrial water supply. The Mississippi River is a critical link between 12,000 miles of inland navigable waterways and the rest of the world. New Orleans is the largest port in the United States, the second largest port in the world, and the world's largest grain port. In excess of 5,000 ships utilize the port each year.

5.2.18. WATER QUALITY

5.2.18.1. The quality of water bodies in the study area is, to a large extent, affected by land use in the drainage areas of the water bodies. Municipal, industrial, and vessel wastes, urban stormwater, agricultural and silvicultural runoff, and water-oriented recreation and camps can adversely affect water quality.

5.2.18.2. The Mississippi River within the study area is designated by the Louisiana Environmental Control Commission for secondary contact recreation, propagation of fish and wildlife, and domestic raw water supply. The river has been classified "water quality limited" due primarily to consistently high total and fecal coliform bacteria densities and recurrent taste and odor problems associated with phenolic compounds. Violations of DO, chloride, sulfate, TDS, pH, and temperature standards have been very infrequent. State standards do not limit ambient nitrogen and phosphorous concentrations. However, two forms of these macronutrients are of particular significance in the quality characterization of a water body: un-ionized ammonia because of its toxicity to aquatic life, and phosphate because of its role in the accelerated aging and enrichment of lakes and estuaries. The US Environmental Protection Agency (EPA) recommends in its Quality Criteria for Water that un-ionized ammonia concentrations not exceed 20 ug/l for protection of freshwater aquatic life. To prevent the development of nuisance biological growth and control accelerated or cultural eutrophication, the EPA also recommends that total phosphate as phosphorus not exceed 50 ug/l in any stream at the point where it enters any lake or reservoir. The EPA criteria recommends further that total phosphorus not exceed 100 ug/l in streams not discharging directly to lakes or impoundments. Un-ionized ammonia concentrations computed from total ammonia, temperature, and pH data for the Mississippi River at New Orleans exceeded the EPA criterion in 80 of 337 samples (24 percent).

Ninety-two percent (199 of 216) of the phosphate observations from samples collected in the river between miles 155 and 75 exceeded the 50 ug/l criterion and 94 percent (568 of 605) of the total phosphorus observations exceeded the 100 ug/l criterion. Although phosphorus concentrations in the river consistently exceed EPA recommendations, phosphorus is not a problem because the river's swift currents and the absence of quiet zones with poor circulation retard outbreaks of algal blooms. The trace metals copper, zinc, and iron have been detected in the Mississippi River near New Orleans at concentrations of 4.0, 7.2, and 15.1 mg/L, respectively. Detection of such high concentrations has been exceedingly rare; however, considering the enormous dilution capacity of the river, trace metal concentrations at these levels are cause for concern. Such high concentrations indicate the impact of industrial and urban stormwater discharges to the river. A review of water quality data indicates that the trace metals cadmium and copper consistently exceed the EPA freshwater aquatic life criteria. The data indicate further recurrent exceedances of the EPA criteria for mercury, zinc, and lead. The most frequently detected of the phenoxy herbicides and organochlorine and organophosphorus insecticides are 2, 4-D, dieldrin, and diazinon, respectively. Data indicate decreasing trends in criteria exceedances for the insecticides. Residue concentrations of several pesticides detected in fish tissue from samples collected at various locations in the Mississippi River are shown in table H-7-2 of Appendix H, Water Quality. The concentrations of pesticides shown are, in some cases, several orders of magnitude greater in the tissue samples than the maximum relative concentrations detected in the surface water. However, only one sample indicated a pesticide concentration above the corresponding Food and Drug Administration (FDA) action level. This sample, taken at river mile 227 AHP, had a chlordane residue concentration that exceeded the FDA action level of 300 parts per billion.

5.2.18.3. Lake Maurepas is reserved for primary and secondary contact recreation and for the propagation of fish and wildlife. All parameters analyzed were in compliance with the state criteria except for occasional chlorides, pH, and coliform criteria exceedances. Recorded values of cadmium, copper, toxaphene, DDT, PCB, and mercury occasionally exceeded the EPA criteria for aquatic life. All of these parameters exceeded the EPA water quality criteria less than 10 percent of the time except for copper. The low pH recorded is attributable to the tributaries and surrounding marshes that are, perhaps, naturally acidic. DO and fecal coliform criteria exceedances have been noted by the Environmental Control Commission in St. John the Baptist Parish drainage canals that flow into Lake Maurepas. These criteria exceedances are caused by municipal wastes.

5.2.18.4. Along the north and west shores of Lake Pontchartrain, concentrations of constitutents analyzed satisfy the state water quality standards except for occasional DO, pH, and fecal coliform violations. The EPA criteria were occasionally exceeded by concentrations of chlordane, DDT, dieldrin, PCB, mercury, and copper at or near the mouth of feeder streams to the lake. Water quality is slightly improved away from the shores toward the middle of the lake. The Environmental Control Commission has classified the south shore of the lake as "water quality limited" because of coliform and dissolved oxygen violations. The urban areas of Kenner, Metairie, and New Orleans adjacent to the lake pump their urban stormwater runoff into Lake Pontchartrain and studies have indicated that severe violations of coliform and dissolved oxygen standards correspond with heavy rainfall. In addition, urban areas in Jefferson Parish discharge municipal waste into stormwater drainage canals that eventually pump into Lake Pontchartrain. Jefferson Parish has proposed to construct, under the EPA facility construction grants program, a regional wastewater treatment facility that will have an outfall to the Mississippi instead of into the stormwater drainage

canals. The lack of Federal funds in the grant program has delayed construction of the regional facility.

5.2.18.5. Lake Borgne is classified for primary and secondary contact recreation and for the propagation of fish and wildlife. Water quality data indicate that State and EPA water quality criteria are occasionally exceeded for DO, pH, and fecal coliform bacteria.

5.2.18.6. The Inner Harbor Navigation Canal (IHNC) is currently classified as "water quality limited" due to frequent coliform violations. Urban stormwater runoff and vessel wastes are primary sources of pollution in addition to the interchange of flow with Lake Pontchartrain, the GIWW, and the Mississippi River.

5.2.18.7. The Mississippi River-Gulf Outlet (MR-GO) is classified for secondary contact recreation and for the propagation of fish and wildlife. Because the MR-GO is in close proximity to oyster leases in Lake Borgne and coliform counts frequently exceed the state water quality criteria, this water body is classified as "water quality limited." The EPA water quality criteria are occasionally exceeded for mercury, copper, DDT, zinc, PCB, and dieldrin concentrations.

5.2.18.8. The Mississippi Sound is classified for recreation. The general water quality is considered relatively good; however, localized water quality problems exist where the lower reaches of rivers enter the sounds and the bays. The Biloxi Bay estuary is considered polluted from a bacterial standpoint and is nutrient-enriched, reflecting the consequences of heavy municipal and industrial development on a relatively small body of water that is inadequately flushed by the tides. Biloxi Bay has been permanently closed to shellfish harvesting because of the high fecal coliform counts.

5.2.18.9. On the Pascagoula-Escatawpa River system, the lower reaches are classified for agricultural and industrial usage. The lower Escatawpa River is reported to be polluted due to inadequately treated waste from the Moss Point industrial complex. Fish inhabit the area only during part of the winter and spring and fish kills frequently occur as the seasons change. The Pascagoula River is considered moderately polluted, receiving the untreated wastes from seafood processing plants, a pet food processing plant, and two municipal sewage treatment plants. In addition, wastes associated with the harbor facilities and shipbuilding operations are discharged in this area. The West Pascagoula River is of relatively good quality with small localized problems resulting from residential development. Bayou Casotte, classified for agricultural and industrial usage, is polluted by a harbor, a refinery, a fertilizer plant, and a chemical operation. Waste discharged into the bayou has created temperature, bacteria, and pH problems.

5.2.19. LOUISIANA NATURAL AND SCENIC STREAMS SYSTEM

The Louisiana Natural and Scenic Streams System was established for the purposes of preserving, protecting, developing, reclaiming, and enhancing the wilderness qualities, scenic beauties, and ecological regimen of certain freeflowing rivers or segments thereof. Twelve streams, or portions thereof, which are part of this system, occur in the study area. These include the Blind River, West Pearl River, Bayou Trepagnier, Bayou La Branche, Bayou Dupre, Lake Borgne Canal, Bashman Bayou, Terre Beau Bayou, Pirogue Bayou, Bayou Bienvenue, Bayou Chaperon, and Holmes Bayou.

5.2.20. NATIONAL REGISTER PROPERTIES

5.2.20.1 The National Register of Historic Places, as published in the Federal Register dated 6 February 1979 and annual and weekly supplements through 17 May 1983, were consulted to identify National Register and Register-eligible properties in the study area.

5.2.20.2. Eleven National Register properties are located in the Louisiana portion of the study area. These include nine properties in the Lake Pontchartrain Basin. Forts Pike and McComb are massive brick fortifications built in the early 1800's to protect the two natural passes into Lake Pontchartrain, the Rigolets, and Chef Menteur Pass. The historic town of Mandeville, including three structures listed in the Register, is located on the north shore of the lake. The Tchefuncte and Pass Manchac lighthouses are in the process of being nominated to the National Register by the US Coast Guard. Also listed in the Register are two archeological sites located in the marshes and swamps which constitute Lake Pontchartrain's shoreline. The Tchefuncte type site (16STl) is composed of two Rangia shell middens in the marsh east of Mandeville. The Bayou Jasmine site (16SJB2), a deeply buried cultural deposit dating to the Poverty Point period, is located in St. John the Baptist Parish between Lakes Maurepas and Pontchartrain.

5.2.20.3. Two of the properties are located in the St. Bernard delta; Fort Proctor and Magnolia Mound (16SB49). Fort Proctor was begun in 1856 to protect a possible invasion from Proctor's Landing on Lake Borgne. Bayou Yscloskey and a parallel shell road provide access to the Mississippi River from this landing. Magnolia Mound (16SB49) is a large, well preserved, multicomponent, archeological site which possibly served as a major ceremonial center in the delta. In addition to the National Register Properties in Louisiana, 25 properties in the Mississippi portion of the area are listed on or determined eligible for

the National Register.

5.2.20.4. A cultural resources survey of the selected plan, which will be conducted in the next stage of project planning, may locate additional cultural resources eligible for inclusion into the National Register.

5.2.21. ARCHEOLOGICAL RESOURCES

Over 290 archeological sites are recorded in the Louisiana portion of the study area. Additionally, 330 sites are recorded in the Mississippi and Alabama portion of the study area. These sites include both prehistoric and historic cultural remains. The most common types of prehistoric sites in the study area are earth and shell middens, although mound sites are also represented. Middens are concentrations of various kinds of refuse built up over a period of years. Historical archeological resources in the area include early settlements, forts, historic shipwrecks, structures, and other remains of historic use. These resources date from the earliest exploration and settlement of the Lower Mississippi River and represent the successive stages of the area's history. Known site locations are largely a function of where cultural resource surveys have been undertaken and, therefore, the recorded resource base represents an incomplete sample of the resources expected to exist in the study area.

5.2.22. BUSINESS AND INDUSTRY

5.2.22.1. The Port of New Orleans and related transportation industries, ship and barge construction, and mineral production form the area's primary economic base. However, hotel and motel construction, tourism, and the seafood industry are also very important. The abundance and variety of seafoods are very important to the local

culture and have been heavily promoted by tourist industries. The restaurant business in New Orleans is very famous and much of the cuisine revolves around seafoods such as oysters, shrimp, crabs, and fish such as red drum and spotted seatrout. The abundance of these seafoods is due to the expansive coastal wetlands and waterbodies which provide food and habitat for fish and wildlife resources. Wildlife resources, including furbearers and alligators, are also important to the economy of the area. Louisiana leads the nation in fur and alligator harvest. In addition, recreational activities, including sport hunting and wildlife-oriented recreation, are important to the economy.

5.2.22.2. Natural and man-made alterations in the coastal environment have resulted in serious loss and deterioration of coastal wetlands upon which the productivity of valuable fish and wildlife resources depends. One of the most significant problems is saltwater intrusion. Saltwater intrusion is detrimental to the swamps and marshes and is particularly harmful to the American oyster. Thousands of acres of historically productive oyster reefs are largely unproductive due to excessive salinities. This has led to a significant decline in availability of oysters and a great deal of instability in the industry. The history of the oyster industry of the area is discussed in detail in Appendixes A and F.

5.2.23. EMPLOYMENT/LABOR FORCE

5.2.23.1. As discussed in the preceding paragraphs, business and industry related to fish and wildlife resources are important to the economy of the area. These resources are experiencing problems due habitat deterioration and saltwater intrusion in the recent past. Employment and labor related to these resources are affected accordingly. One of the most notable problem areas is the oyster

industry. Severe saltwater intrusion has dramatically reduced the areal extent of oyster producing areas. This has caused decline and instability in this industry. Employment in the area's oyster industry is unpredictable due to extreme fluctuations in the availability of oysters. The industry is labor intensive and dependent upon workers who can withstand the effects of these fluctuations. In 1973, about 3,300 people were employed in the harvest of oysters in the Gulf region. In 1975, about 1,980 were employed in oyster processing industries in the same area. In addition, an unknown number of jobs exist due to the demand for oysters on the half shell in restaurants and bars.

5.2.23.2. In addition to the problems facing the oyster industry, employment/labor force problems are being experienced in a variety of industries related to fish and wildlife resources. These problems are due to loss and deterioration of coastal habitats vital to the productivity of valuable commercially and recreationally important fish and wildlife species. Additional information concerning employment/labor force is found in Appendix F, Section 8.

5.2.24. LAND USE

Because of the importance of the aforementioned fish and wildlife resources to the economy and culture of the study area, land-use patterns are influenced by these resources. Development of harbors, recreational facilities, seafood industries, hotels, and restaurants are largely dependent upon the productivity and exploitation of these resources. Since productivity of fish and wildlife are dependent upon habitat quantity and quality, competition exists between land use for these resources and other economic influences such as industrial and urban expansion. Additional information concerning land use is found in Appendix F, Section 8.

5.2.25. DISPLACEMENT OF PEOPLE

The problems facing the various pursuits related to fish and wildlife resources in the study area has resulted in displacement of people from certain related occupations. These include a variety of individuals involved in harvesting and processing of commercial fish and wildlife resources as well as some recreational activities such as waterfowl hunting. Many people have been displaced from these activities and forced to seek alternative employment. Problems facing these in the oyster industry are very obvious. The decline in oyster production and unstable supply of oysters has forced a number of individuals out of this industry. These trends will continue and adversely impact the local economy and the tourist industries. Additional information concerning displacement of people is found in Appendix F, Section 8.

5.2.26. COMMUNITY COHESION

5.2.26.1. In addition to its importance to the local economy, the availability of abundant seafood items including oysters, shrimp, crabs, and fish such as red drum, flounder, and spotted seatrout, and the many ways in which they are prepared, is a topic of conversation which crosses all social and cultural lines. Recipes for various seafood dishes are published frequently in local newspapers and magazines and have even been circulated by a local utility company. Some of the world's finest seafood restuarants are located in New Orleans. It is not uncommon to see both white and blue collar workers eating lunch at the same oyster bar in the Central Business District of New Orleans. An abundance of oysters and other popular seafood items at reasonable prices has a positive impact on social and community cohesion.

5.2.26.2. Activities such as trapping of furbearers, alligator harvesting, and sport hunting for migratory birds and waterfowl are also important to social and community cohesion among certain coastal residents. These pursuits are also jeopardized by the environmental problems facing the coastal wetlands. Additional information concerning community cohesion is found in Appendix F, Section 8.

ENVIRONMENTAL EFFECTS

1. GENERAL

1.1. This section describes the effects of the Bonnet Carre' Plan on each significant resource described in Section 5. Additional information concerning the impacts of the plan can be found in Appendix B and the Main Report.

1.2. This section supplements Table 4-4 "Comparative Impacts of Alternatives" on page EIS-19, with a more detailed description of the impacts noted in that table.

2. MARSHES

2.1. Bonnet Carre' Plan

2.1.1. The proposed plan would not impact any marsh due to direct construction activities. However, implementation of the plan would reduce rates of marsh loss in portions of the study area and would also improve marsh conditions in certain areas. Methodologies for estimating with- and without-project marsh acreages in Louisiana and Mississippi are found in Section 4 of Appendix D, Natural Resources. Included are tables demonstrating the acreages of each marsh type over the life of the project.

2.1.2. The effects of freshwater diversion would be most pronounced in marshes nearest the diversion outfall, with effects being less noticeable in those marshes further removed. Approximately 4,576 acres of brackish marsh located adjacent to the Bonnet Carre' Spillway would be converted to fresh/intermediate marsh. This conversion to a fresher

would increase from 7,993,000 to 15,499,500 pounds. The annual enefits attributable to this increased harvest is $6,540,000.

.9.1.10. Without the project, fishery productivity would decline due wetland loss and habitat degradation. Thousands of acres of istorically productive oyster bottoms would remain largely unproductive e to excessive salinities. Commercial and recreational fishing ctivities would decline concomitantly.

.9.1.11. Although a variety of potential adverse impacts could occur, he general consensus of fishery experts is that fishery resource enefits would outweigh adverse impacts. Certain species could be dversely impacted by changes in salinity, temperature, levels of ollutants, and hydrologic factors. Quantification of many of the otential impacts is not possible based on available information. More nformation will become available with implementation of the pre- and ost-construction biological and water quality monitoring programs. The ollowing information identifies concerns and discusses potential dverse impacts in a qualitative manner.

.9.1.12. The primary project objective is to retard continued habitat eterioration in the area and to restore the salinity regime which xisted historically. The diversions would move existing isohalines eaward. This would result in overall positive benefits to species such s oysters, white shrimp, blue crab, menhaden, and Atlantic croaker, but ould exert adverse impacts on certain species, including brown shrimp, potted seatrout, and red drum. Salinities would be significantly educed within a few miles of the conveyance channel outfall. emperature differences between the Mississippi River and the rospective receiving area could also cause adverse impacts. ississippi River water is normally 6 to 10°C cooler than Lake ontchartrain during March and April. Most of the southwest portion of he lake would experience maximum reductions in temperature of about 0.4

seasonal flooding of the river lowered salinities over the oyster reefs and provided great quantities of nutrients. However, due to the levees which now exist, river water does not flow over the reefs, and the original oyster zones in Mississippi and Louisiana are significantly smaller. These historic reefs are quite impressive in size. Gunter and Demoran (1970) stated that these reefs lie on 20-foot deposits of shell about 7,000 years old at the bottom. Demoran (1966) stated that the Pass Christian reefs constitute one of the largest nearly continuous oyster reefs in the world. In the early part of this century, Biloxi, Mississippi, was second only to Baltimore, Maryland, as the largest oyster processing city in the United States (Churchill, 1920).

6.9.1.9. It is estimated that the proposed project would significantly increase average annual oyster harvest in the study area. This increased production would be due to the establishment of optimal salinity conditions over known acreages of historically productive oyster bottoms which now lie largely unproductive because of excessive salinities. The methodology and calculations used to derive with-project oyster harvest are quite involved and are explained in detail in Appendix D, Section 5. The methodology employed utilized the results of a study conducted by the Louisiana Department of Wildlife and Fisheries (LDWF) which identified optimal monthly salinities for oyster production. The diversion structure would be operated to achieve the desired salinities over quantified acreages of prime, historically productive oyster bottoms. The LDWF study also defined productivity in terms of number of oysters per unit area of suitable bottom. Using a conservative productivity factor, it was possible to estimate the pounds of oysters which could be produced in the study area. Estimates were then made of what portion of these oysters would be harvested. The with-project harvest has been compared to production under the without-project condition and analyzed with regard to the various economic factors related to the oyster industry in Appendix F. Based on these analyses, it has been estimated that annual oyster harvest in the study

sustained salinity level of less than 15 ppt." The southern oyster drill has plagued the Louisiana oyster industry for years. St. Amant (1938) stated that oyster drills caused estimated losses in oyster production as high as 50 percent statewide. May and Bland (1969) observed that during a nine-month period, over 85 percent of the oysters in a high salinity area were killed by drills. Dugas (1977) reported that oysters remaining in high salinity areas throughout the summer generally encounter high mortalities from oyster drill predation. Based on the above discussion, the importance of maintaining optimal salinities over oyster production areas becomes obvious. Increased salinities in the study area have had a dramatic effect on the oyster fishery. Historically, the St. Bernard marsh was the most productive oyster harvesting area in the state, accounting for 70-75 percent of the oysters harvested in Louisiana. In recent years, oyster grounds have experienced dramatic landward shifts, primarily due to saltwater intrusion via the MR-GO. The inland shift closer to man's activities has made the oyster beds more susceptible to pollution. Prior to 1960, oyster leases were located primarily in the numerous bays of the St. Bernard marsh. Only a few isolated beds existed in Lake Borgne. By 1970, the productive oyster zone shifted completely into Lake Borgne. The zone is closer to sources of domestic pollution, and the area is subject to periodic closures by health officials. Oyster beds are now appearing in Lake Pontchartrain. However, because of pollution, these beds are closed to harvesting. The St. Bernard area now only contributes about 20 percent of the oysters harvested in Louisiana. In Louisiana and Mississippi, the historically productive reefs which flourished before the construction of the Mississippi River levees will continue to lie dormant and the lessened production which now occurs more inland will be plagued by man's pollution problems. The effect of leveeing of the Mississippi River on oyster reefs in Mississippi and Louisiana has been reviewed by Gunter (1952, 1953, 1975). The Mississippi oyster industry was at its prime between 1880 and 1940 when the Mississippi River had low levees or none south of New Orleans. The

1975, shad harvests were positively affected by the spillway opening. Commercial fishermen presently take large quantities of gizzard shad from the tailwaters of the Bayou Lamoque Diversion Structure located on the Mississippi River. It is believed that a similar fishery would develop at the diversion structure proposed by this project (USFWS, 1980).

6.9.1.8. Saltwater intrusion has narrowed the broad brackish, low salinity zones that are vital for the juvenile stage of most important commercial and sport finfish and shellfish. The rising salinities have reduced the low-salinity nursery habitat important to white shrimp and blue crab. Saltwater intrusion is particularly harmful to the American oyster. The optimal salinity range for growth and survival of oysters is 5-15 ppt (Galtsoff, 1964; St. Amant, 1964; Loosanoff, 1965). Prolonged salinities lower than 5 ppt cause osmoregulatory difficulties in oysters and reduced reproductive capabilities. However, grave problems occur when salinities exceed 15 ppt. Above this level, oysters are subject to considerable predation, parasitism, and disease. The most important enemies of oysters in higher salinities include a carnivorous conch, the southern oyster drill (Thais haemostoma) and the fungus Labyrinthomyxa marina. The black drum, Pogonia cromis, is also a serious oyster predator at certain times. Other notable enemies include boring sponges, polychaete worms, boring clams, and stone crabs. Butler (1953) reported that the southern oyster drill was probably the most destructive single agent affecting the oyster industry in Louisiana and the other gulf states. It is generally assumed and reported (Chapman, 1959) that average salinities in excess of 15 ppt favor oyster drill populations. Perret et al. (1971) reported the majority of drills were caught at salinities above 15 ppt. Burkenroad (1931) reported that salinity seems to be the most important limiting factor for the southern oyster drill. Butler (1953) stated, "The only real barrier to snail [southern oyster drill] migration is a chemical one - lack of sufficient salt in the water. They are normally absent from those areas having a

6.9.1.6. Recreationally important fish and shellfish species would also benefit from reductions in rates of habitat degradation. This would lead to increased sport fishing opportunities. Increases in sport fishing benefits are discussed in Section 6.14. Additional information concerning recreational values due to sport fishing can be found in Appendix G, Recreation.

6.9.1.7. A number of other beneficial impacts would occur to fisheries which cannot be easily quantified in monetary terms, even though they are highly significant from a qualitative standpoint. The increased nutrient inflow should also increase the production of phytoplankton and zooplankton and lead to greater harvest of sport and commercial fishes and shellfishes directly or indirectly dependent of these microscopic organisms. Freshwater introduction is also expected to have unquantified beneficial effects on menhaden production. Menhaden are important industrial fish because of their high oil content, and the fish meal that remains after the oil is extracted is a valuable livestock feed supplement. The Gulf of Mexico and associated marshes and estuaries are the most important menhaden producing areas in the world. Over one-half of the menhaden landings in the United States come from the Gulf. During flood years when large volumes of nutrient-rich fresh water from the Mississippi River enter the Gulf and associated estuaries, the fertility of these water bodies is increased. Menhaden feed on plankton and other nutrients, and plankton abundance is dependent upon water fertility. Following the release of large volumes of fresh water through the Bonnet Carre' Spillway in 1973, menhaden catch in the Mississippi Sound area was higher than in previous years, but more importantly, the oil yield was up 54 percent over the average for the previous 15 years (Wallace, 1978). Water fertility resulting in increased plankton production is recognized as important to a healthy menhaden population. However, other physical and biological factors also contribute to menhaden production and the oil content of the fish. Shad populations should also benefit from the diversions. In

predators, warmer water temperatures, optimal salinity regimes, and the rich detrital food chain. Many important sport and commercial species depend on shallow marsh areas. They include the Atlantic croaker (Rogers, 1979), menhaden (Simoneaux, 1977), brown and white shrimp (White and Boudreaux, 1977), and blue crab (More, 1969). Conner and Truesdale (1973) demonstrated the value of shallow marsh habitat to juvenile brown and white shrimp, gulf menhaden, Atlantic croaker, sand seatrout, and southern flounder.

6.9.1.5. Wetland acreage would be greater with project implementation than under the without project conditions. Since production of commercially important estuarine-dependent species is directly correlated to wetland acreage, the project would benefit productivity of the resources. However, the relatively small acreage of wetlands which would be saved over the life of the project (6,355 acres of swamp and 4,186 acres of marsh) would not result in substantial quantified (monetary) benefits. The only currently acceptable method for applying monetary benefits to these fisheries is to correlate harvest from the area with marsh acreages and determine how many pounds of fish an acre of marsh produces. This figure can then be multipled by acres saved to derive monetary benefits. Using this methodology in this study would not justify the time it would take to conduct the economic analyses. Even in the Louisiana Coastal Area Study, Interim Report on Freshwater Diversion to Barataria and Breton Sound Basins, where savings of nearly 100,000 acres of marsh were claimed, these fisheries, combined with wildlife and recreational benefits, were responsible for only about 7 percent of the monetary benefits. Oysters contributed the remaining 93 percent. Nevertheless, the wetlands and related productivity which would be saved by the proposed project are important from a qualitative standpoint, probably far more important than the meager monetary benefits which could be attributed to them would indicate. The methodology used to estimate with- and without-project wetland acreages are described in Appendix D, Section 4.

years. In 1980, approximately 1.4 billion pounds, valued at $178 million, were landed. In addition, estimates are that recreational fishing in Louisiana contributes another $150 million annually to the state economy (Aquanotes, 1981). Historically, Louisiana's most valuable commercial fisheries have revolved around shrimp, menhaden, and oysters. These species, as well as the majority of other finfish and shellfish species of importance in Louisiana, depend heavily on estuarine ecosystems. The EPA (1971) stated that "it is currently assumed that none of the major commercial species would continue to exist in commercial quantities if estuaries were not available for development." Average annual harvests have not declined in recent years, primarily because of improved technology and increased fishing effort. These factors have compensated for declines in habitat, in terms of harvest. However, in the opinion of biologists, a continuation of current trends in habitat reduction will be accompanied by a diminishing harvest (Craig et al., 1979). Shrimp and menhaden yields have been directly correlated to the area of wetlands. Turner (1979) reported that the Louisiana commercial inshore shrimp catch is directly proportional to the area of intertidal wetlands, and that the area of estuarine open water does not seem to be associated with average shrimp yields. Cavit (1979), in work conducted for the US Fish and Wildlife Service, established that yields of menhaden increase as the ratio of marsh to open water increases. Harris (1973) has stated that total estuarine-dependent commercial fisheries production in coastal Louisiana has peaked and will decline in proportion to the acreage of marshland lost. Swamps and marshes produce large amounts of organic detritus that are transported into adjacent water bodies. Detritus is a very important component of the estuarine food web and is vital to maintaining the high level of fishery productivity in Louisiana. The role and importance of detritus in the estuarine food web is well documented by Darnell (1961) and Odum et al. (1973). Marshes and associated shallow water bodies are used by various life stages of many estuarine-dependent species that take advantage of the protection from

6.9. FISHERIES

6.9.1. Bonnet Carre' Plan

6.9.1.1. Benthic losses would be nearly total in the 38 acres of open water and the 130 acres of wooded swamp that would become channel. Most benthos in the 25 acres of open water and 488 acres of wooded swamp that become disposal areas would be destroyed. Benthic repopulation by adult migration and larval recruitment should occur, except in much of the wooded swamp disposal area.

6.9.1.2. Effects of turbidity in the construction areas would be localized and of short duration. Suspended particles may clog gills and feeding apparatuses in some instances. Phytoplankton production adjacent to construction areas would be temporarily affected due to decreased light penetration. Construction impacts are also discussed in Appendix I.

6.9.1.3. The proposed plan would provide benefits to fishery resources due to maintenance of favorable salinity regimes, reductions in rates of marsh loss, and increased nutrients.

6.9.1.4. It is the general consensus of fishery experts that fishery production is related to wetland acreage. Studies point to wetlands as being an ecological limiting factor, and a declining wetland area is occurring within the study area. Wetland loss has had an adverse impact on fishery resources production and seriously threatens the Louisiana fishery resource. In coastal Louisiana, the majority of commercially and recreationally important finfish and shellfish species are estuarine-dependent with juveniles using the estuaries and adjacent wetlands as nursery areas. Louisiana's commercial fishery harvest represents over 25 percent of the total United States harvest every

amur is a voracious aquatic plant grazer and could endanger the grass beds in Lake Pontchartrain. Both larval and adult white amur are known to occur in the Mississippi River in the vicinity of the diversion structure. However, if it is possible for this species to become established in Lake Pontchartrain to the extent that they pose a serious threat, it is likely that this would have already occurred due to recent openings of the Bonnet Carre' Spillway, particularly during 1979 and 1983. Tremendous volumes of Mississippi River water were introduced into Lake Pontchartrain during these events. In 1979, the spillway began opening on April 17 and was not fully closed until May 31. In 1983, the structure began opening on May 20 and was not fully closed until June 23. Considering the duration and timing of these releases, it is likely that both larval and adult white amur could have been introduced into the lake via the spillway. Given the prolificacy of the species, their ability to tolerate brackish water, and the availability of freshwater environments connected to the lake, it would appear that these fish would already be present in the area. However, to date there has been no documentation of the species presence in the lake.

6.8.1.3. Seagrasses and algae on the leeward side of barrier islands in Louisiana and Mississippi are quite sensitive to prolonged periods of low salinity (McMillan and Moseley, 1967; McMillan, 1974; McMahan, 1968; and Eleuterius and Miller, 1976). The areal extent of these seagrass beds is governed largely by hurricanes and prolonged low salinities which occur in years of massive diversion of fresh water through the Bonnet Carre' Spillway and heavy flooding on the Pearl and Pascagoula Rivers. It is not anticipated that the proposed plan would cause significant impacts to these seagrass beds. Due to the large volume of high salinity water adjacent to the barrier islands in Mississippi and Chandeleur Sounds, the proposed plan would not significantly lower salinity levels over these seagrass beds. The projected with-project isohalines for the study area are in Appendix C.

6.6.1.2. The primary impact of the proposed project on the receiving water bodies within the study area would be alteration of existing salinity regimes. Open-water acreage would decrease slightly, compared to without project conditions, due to the reduced rate of marsh loss which would occur over the life of the project. Water quality parameters would be altered in Lake Pontchartrain and other water bodies. Water quality changes are discussed in detail later in this section and in Appendix H, Water Quality. Acreage of open water in the study area would increase significantly over project life due to the natural processes of subsidence, compaction, and erosion, as well as man's developmental activities.

6.7. BARRIER ISLANDS

6.7.1. Bonnet Carre' Plan

The proposed plan would have no significant effect on barrier islands.

6.8. SEAGRASS BEDS

6.8.1. Bonnet Carre' Plan

6.8.1.1. No seagrass beds would be impacted by direct construction activities. The release of fresh water during the 1973 opening of the Bonnet Carre' Spillway did not have observable effects on the 2,000 acres of submerged vegetation in northeastern Lake Pontchartrain (Montz, 1978). It is not expected that adverse impacts would occur to these beds of submerged aquatic vegetation due to project implementation.

6.8.1.2. A potential area of concern involves introduction of the white amur (grass carp) into the lake via the diversion channel. The white

6.4. BOTTOMLAND HARDWOODS

6.4.1. Bonnet Carre' Plan

The proposed plan would not directly impact this habitat type due to project construction. No quantifiable benefits to bottomland hardwoods would result from project implementation. As discussed earlier, it is possible that some of the 488 acres of wooded swamp utilized as a disposal area could revegetate to bottomland hardwoods.

6.5. AGRICULTURAL LANDS

6.5.1. Bonnet Carre' Plan

The proposed plan would not impact any agricultural lands due to direct construction activities nor would any benefits to these lands accrue due to project implementation.

6.6. WATER BODIES

6.6.1. Bonnet Carre' Plan

6.6.1.1. Approximtely 63 acres of water bodies would be impacted due to direct construction activities. About 10 acres of water bottoms in Lake Pontchartrain would be converted to channel and 25 acres would be used for dredged-material disposal. The remaining 28 acres of water bodies consist of small ponds and borrow areas within the spillway that would be converted to channel. The impacts of the proposed project on aquatic organisms in these water bodies is discussed in the fisheries section and also in Appendix I.

salinity of 1.9 $\pm$ 0.7 ppt to be the tolerance limit for baldcypress. Based on the with-project isohalines projected for the proposed project (Appendix C, Engineering Investigations), large areas of wooded swamp which are currently stressed by high salinities would benefit due to maintenance of salinities below 2 ppt. According to van Beek et al. (1982), approximately 36,000 acres of wooded swamps on the north and south shores of Lake Maurepas and southeast of Bonnet Carre' Spillway are in a stressed condition. In order for salt water to stress cypress trees, it must first cause an increase in soil salinity. This increase is primarily a function of salt concentration and duration of exposure; however, soil composition, rate of evapotranspiration, and amount of flushing play a role. Wicker et al. (1981) examined the relationship between soil salinity and baldcypress abundance. They found that both the basal area and number of stems per acre were proportional to soil pore salinities (chlorides). The authors concluded that major impacts occurred when soil pore salinities reached about 1.0 ppt. From their data, it appears as though soil salinities of less than 0.5 ppt are preferable. Reduced salinities due to implementation of the proposed project would tend to ameliorate stress conditions.

6.3.1.3. In addition to the reduced rate of loss of this habitat type due to project implementation, the addition of fresh water and nutrients would rejuvenate large areas of wooded swamp.

6.3.1.4. Without the project, wooded swamp acreage would be reduced to about 102,687 acres by 2040. The losses would be primarily due to drainage for alternative uses and saltwater stress. Reductions in acreage of this habitat would occur primarily in Louisiana. The rate of loss of wooded swamp in Mississippi is negligible.

6.2.1.3. Without the project, total marsh acreage would decline to about 228,390 acres by 2040. The losses would be due to both natural processes and man's developmental activities. Fresh/intermediate, brackish, and saline marsh acreage would be reduced to 54,972, 118,723, and 54,695 acres, respectively.

6.3. WOODED SWAMP

6.3.1. Bonnet Carre' Plan

6.3.1.1. The proposed plan would impact approximately 618 acres of wooded swamp due to direct construction activities. About 130 acres would be converted to channel and 488 acres would be altered by dredged-material disposal. Dredged material would be placed about 3 to 4 feet thick in certain areas of this wetland habitat. The areas would revegetate through various successional stages from grass to scrub/shrub and probably eventually to bottomland hardwoods. It is possible that some of the dredged material would be used for fill material at some time during the project life. Therefore, some of these disposal areas would probably be periodically disturbed and remain scrub/shrub or early successional bottomland hardwoods.

6.3.1.2. Implementation of the proposed project would reduce the rate of loss of wooded swamp over the life of the project. Approximately 6,355 acres of this habitat would be saved in Louisiana, largely due to reduced salinities in the study area. Methodologies for estimating with- and without-project wooded swamp acreages in Louisiana and Mississippi can be found in Appendix D, Section 4. Included are tables demonstrating the acreages of wooded swamp over the life of the project. According to reports by Wicker et al. (1981) and van Beek et al. (1982), prolonged salinities in excess of 2 ppt eventually cause mortality to wooded swamps. Chabreck (1972) reported a mean water

marsh type would be due to the reduced annual salinity extremes projected to occur under with-project conditions.

6.2.1.3. Approximately 4,186 acres of fresh/intermediate to brackish marsh would be saved over the life of the project in the Louisiana portion of the study area. Due to their distance from the point of diversion and close proximity to highly saline waters, no reductions in rates of loss of saline marshes were quantified in this study. In addition, no reductions in rates of marsh loss in Mississippi were quantified.

6.2.1.4. Although it is difficult to quantify savings in marsh acreages, a number of qualitative benefits can be discussed and documented. The diversion of nutrient-laden water from the Mississippi River would benefit marshes. The far greater nutrient content of Mississippi River water compared to that of adjacent estuaries has been reported by Ho and Barrett (1975). Enrichment of emergent marsh vegetation with nutrient-rich waste water from a menhaden processing plant in coastal Louisiana increased the growth of bulltongue, softstem bulrush, and wiregrass by 30 to 51 percent (Payonk, 1975). It has also been reported that lowered salinities during the growing season results in increased seed germination and plant growth of fresh/intermediate and brackish marsh species important to wildlife (Palmisano, 1971). Increased plant growth and sedimentation would reduce the rate of marsh loss by enabling the marsh to better withstand effects of subsidence (Delaune et al., 1978). Riverine overbank flow on deteriorating marshes has been shown to reduce the deterioration process (Baumann and Adams, 1982). The proposed diversion is expected to result in increased plant growth and species diversity, especially in the fresh/intermediate and brackish marshes.

to 1.6°C. However, areas immediately adjacent to the diversion outfall could be reduced by as much as 4°C. These estimated temperature reductions are only about one-half the magnitude of changes observed during the 1979 Bonnet Carre' Spillway operation. Temperature differentials associated with the proposed diversion project could be reduced by gradual opening of the structure to allow maximum warming of the water between the structure and the lake. Additional information concerning salinity and temperature changes can be found in Appendix H, Water Quality. Table 6-9-1 presents pertinent information concerning key environmental parameters affecting important estuarine-dependent fish and shellfish in the study area. Optimal salinity ranges and critical salinity/temperature relationships are included in the table. Review of the information presented in the table, as well as other information available in the literature, indicates that the majority of estuarine-dependent species tolerate wide ranges of salinity and temperature. Each species has optimal ranges for these parameters. However, the ranges vary with the different life stages of each species. It is also important to note that salinity and temperature often function synergistically in their effects on organisms.

6.9.1.13. The overall benefits to oysters due to management of salinity regimes have been discussed previously. However, as the isohalines are moved seaward, some inland areas now productive for oysters would be adversely impacted. It is estimated that approximately 7,000 acres of leased oystering areas in the upper lobe of Lake Borgne between Proctor Point and Alligator Point would be eliminated or have reduced productivity due to overfreshening. However, it is unlikely that the entire area would become too fresh because some oysters survived in this area even during the recent 1983 spillway opening. It should be noted that this area is marginal for oyster harvest due to pollution problems. Lowered salinities have been directly correlated with increased oyster mortalities (Butler, 1949). Marine bivalves have reduced osmoregulatory powers when placed in dilute seawater, and must

TABLE [illegible]

KEY ENVIRONMENTAL PARAMETERS AFFECTING IMPORTANT ESTUARINE-DEPENDENT FISHES AND SHELLFISH*

Species	Spawning Locations	Peak Spawning Period	Period of Peak Juvenile Abundance	Optimum Salinity	Critical Salinity and/or Temperature Relationships
American Oyster	On oyster grounds (sessile)	May-September [1/] peaks when temperature is 27°C [5/]	May-September [1/]	5-15 ppt for seed oysters; 10-25 ppt on bedding grounds; above 10 ppt for reproduction [1/]	Exposure to salinity less than 5 ppt when temperature greater than 20°C causes mortality [5/]. Oysters subject to heavy predation by southern oyster drill at salinities above 15 ppt [4/] [15/]
Brown Shrimp	Open gulf [3/]	March-May [5/]	March-May [5/]	15-20 ppt best for rapid growth for juveniles [6/]	Salinities below 10 ppt and temperatures below 20°C occurring after first week of April lead to decreased growth and survival of post-larvae [6/] [7/] [8/]
White Shrimp	Open gulf [3/]	Late spring-early summer; late fall-early winter [5/]	Main influx of post-larvae in June-August; smaller influx of over-wintering sub-adults in spring [5/]	0.5-10 ppt [8/]	Growth of juveniles best at 20-25°C, growth negligible below 15°C [5/]
Blue Crab	Copulate in low salinity waters [3/] females migrate to waters greater than 21 ppt to spawn, usually in open gulf or bays [10/]	June-August [10/]	January-March; June-July [11/]	Peak juvenile catches below 5 ppt [3/]	Inconclusive.
Menhaden	Gulf [3/]	October-March [3/]	Summer months [3/]	Between 10 and 12 ppt [12/]	Optimum catch in 25-35°C waters [12/]
Atlantic Croaker	Offshore and deep Passes [3/]	Fall-winter [3/]	Spring-summer [3/]	Peak juvenile abundance less than 5 ppt [3/]	Inconclusive, greatest juvenile abundance 20-30° [3/]
Spotted Seatrout	Estuaries and lagoons [3/]	March-November; peaks when water temperature between 22-25°C and where salinities are 34-36 ppt [3/]	Data inconclusive species in estuary entire year	5-20 ppt [3/]	Abrupt decreases in salinity or temperature can cause mass movement to more saline areas [3/]
Red Drum	Open ponds and along sand beaches [3/]	September-January [13/]	Data inconclusive; species in estuary entire year	Data limited; most larvae and juveniles occur at 9-26 ppt; bigger fish prefer higher salinities [16/]	Extremes in temperature and salinity tolerated; sudden temperature drops (cold fronts) may cause mortality [14/] greatest catch of juveniles in 5-15°C range [3/]

Source: Modified from US Fish and Wildlife Service (1980).

* Numbers in table refer to citations listed below.

1/ Dugas, 1977.
2/ Dugas, 1979.
3/ Lindall, et al., 1972.
4/ Perret et al., 1971.
5/ White and Gaidry, 1973.
6/ Ford and St. Amant, 1971.
7/ Ford and St. Amant, 1971
8/ Gunter et al., 1964.
9/ St. Amant et.al., 1965.
10/ Fontenot, 1970.
11/ Adkins, 1972.
12/ Copeland and Bechtel, 1974.
13/ Yokel, 1966.
14/ Simmons and Breuer, 1962.
15/ Butler, 1953.
16/ Benson, 1981.

close their valves to reduce loss of salts. Prolonged exposure to low salinities results in death. Reproductive capability of oysters is reduced by low salinity. Butler (1949) showed that gametogenesis is inhibited in oysters maintained in salinities less than 6 ppt. The synergistic effects of salinity and temperature are also an important consideration. Exposure to salinities less than 5 ppt when temperature is greater than 20°C can lead to oyster mortalities (Dugas, 1977). Salinities below 5 ppt are not as harmful when temperatures are lower. Adverse impacts of lower salinities on brown shrimp have also been documented. Survival and growth of maturing brown shrimp appear to be enhanced if salinities are in excess of 10 ppt (St. Amant et al., 1965). Venkataramaiah et al. (1974) reported the best growth and survival of young brown shrimp in salinities of 8.5 to 17.0 ppt. Christmas and Langley (1973) in a study conducted in Mississippi Sound reported greatest catches of small brown shrimp in the salinity interval of 15.0 to 19.9 ppt. However, it should be pointed out that the optimum salinity range for white shrimp during periods of rapid growth on the nursery grounds is 0.5 to 10.0 ppt (Gunter et al., 1964). Zein-Eldin and Griffith (1969) reported that in waters as warm as 30°C in laboratory studies, twice as much tissue was produced by post-larval white shrimp at salinities of 5 and 15 ppt than at higher salinities of 25 and 35 ppt. Lower salinities appear to be preferable for postlarval and juvenile white shrimp on the nursery grounds. In Mississippi Sound, Christmas and Langley (1973) reported greatest catches of subadult white shrimp in a salinity range of 10.0 to 19.9 ppt. The proposed project would broaden the areal extent of these low to moderate salinity zones within the overall study area. Temperature is also an important factor affecting brown shrimp. Venkataramaiah (1974) reported growth, survival, and food conversion efficiency were best at normal temperatures of about 26°C. Growth was depressed below 21°C. Research conducted by the Louisiana Department of Wildlife and Fisheries has shown that the total number of hours of water temperature below 20° C

after the first week of April appears to be a critical factor influencing brown shrimp production, particularly at salinities below 10 ppt (Barrett and Gillespie, 1973). Although lower temperatures and salinities reduce growth rates of juvenile brown shrimp, the problem could be ameliorated by delaying the opening of brown shrimp season to compensate for the lag in juvenile shrimp growth. Spotted seatrout and red drum also prefer higher salinities. Tabb (1966) reported that salinities below 5 ppt were intolerable to larval spotted seatrout. Juveniles are usually collected in the 10 to 25 ppt salinity range and adults in the 15 to 30 ppt range. Red drum also prefer moderate to high salinities. In addition to some of the more prominent species discussed above, a variety of other estuarine-dependent organisms could be affected. Some species of polychaetes, crustaceans, fish, and other groups of organisms could be displaced from some of their range during certain times of the year.

6.9.1.14. Due to the hydrology and topography of the study area and the location of the diversion site, many of the impacts, both beneficial and adverse, would be experienced in Lake Pontchartrain. Impacts would be greatest adjacent to the diversion outfall, becoming less as distance from the point of freshwater input increases. The following is a discussion of potential impacts which could occur in the Lake Pontchartrain system as a result of project implementation. The discussion addresses impacts to fisheries important from an ecological, commercial, and recreational standpoint and includes background information to make the impact analysis more meaningful.

6.9.1.15. Lake Pontchartrain functions as a nursery and feeding area for many marine, estuarine, and freshwater species. The fish community is dominated by transient species that move into the lake for periods of several months and then emigrate back out to the gulf. Under the without project condition, there are distinct, seasonally grouped species that utilize the lake habitat depending upon various physical

(temperature, turbidity, tidal range, and bottom topography) and chemical (salinity and nutrients) conditions which exist in a particular season. These fish species can be further distinguished by the amount of time spent in the lake. As noted by Thompson and Verret (1980), species can be grouped as periodic, resident, or occasional components of the population, based on the time spent in the lake. The population is dominated by the semiresident estuarine species component comprised of the bay anchovy, menhaden, Atlantic croaker, and silversides. These species live in the lake all year, but have certain portions of their population entering or leaving the lake at all times of the year. These species comprise about 80 percent of the fish population (Thompson and Verret, 1980). Based on habitat preference, approximately 55 species utilize the open lake, 22 species utilize the marsh, and 8 species are resident to both areas. Fish species found only in the marsh are primarily fresh water and euryhaline.

6.9.1.16. The freshwater component is also mostly seasonal, with blue catfish becoming more abundant during cooler, less saline periods. The blue catfish move into Lake Maurepas and the tributary rivers with high salinity and increasing temperatures of late spring and summer (Thompson and Verret, 1980).

6.9.1.17. In general, the fish population in the lake increases in the spring, reaches maximum numbers in July, and gradually declines through late summer and fall. Nine of the 20 most abundant fish species utilize the lake area, while the remaining 11 use the marsh. The forage base species such as croakers and anchovies utilize the open water areas of the lake from spring through fall. However, anchovies utilize the marsh as well as the lake. Juvenile menhaden are predominant users of the beach and marsh; however, as they become larger they move to the more open waters of the lake. The effects of the proposed project on the fish populations on the lake are linked to the salinity and turbidity

tolerance of the species as well as their spatial and seasonal distribution.

6.9.1.18. As noted in the previous discussion, the fish population reaches its maximum in the lake in July. Therefore, diversion during this month would conceivably have the potential to affect the greatest number of fish species. However, the proposed flow for July is only 3,200 cfs. The greater flows from March through June would have already affected the distribution of fish species in the lake, and species sensitive to lower salinities would not be abundant near the diversion outfall. In addition, the twenty most abundant species (table 6-9-2) tolerate salinity ranges well within the range of the salinities which would exist under the with-project condition for July. The salinity tolerance for most of these fish ranges from 0.0 to 8.7 ppt, well within the salinity range expected for the period of July through December (Thompson and Verret, 1980).

6.9.1.19. The adverse fishery impacts associated with the project are expected to be minimal and highly localized. The area of greatest impact would be the area directly adjacent to the diversion site, with salinity and temperature effects being moderated as distance from the site increases. The range in temperature and salinity tolerances for the twenty most abundant fish species in the lake are well within the limits of the expected project-induced ranges. As noted in Thompson and Verret (1980), tolerances for the twenty most abundant species range on the average from 0.1 to 8.7 ppt, and 6.6 to 34.3°C for salinity and temperature, respectively. Turbidity and suspended solids would be slightly increased during the diversion period. These increases could affect sight feeders such as seatrout and largemouth bass. However, most of the species that overwinter in the lake are adapted to the naturally occurring wind-induced turbidities which normally occur in the lake during the winter months (Thompson and Verret, 1980). Although

TABLE 6-9-2

THE 20 MOST ABUNDANT FISH SPECIES IN LAKE PONTCHARTRAIN AND SURROUNDING MARSH BY OVERALL HABITAT PREFERENCE

(Based on 1978 Data)

Common Name	Scientific Name	Open Lake	Grassbeds	Beach	Marsh
Bay anchovy	Anchoa mitchilli	1		2	2
Atlantic croaker	Micropogonias undulatus	1			
Gulf menhaden	Brevoortia patronus	1		2j	2j
Tidewater silverside	Menidia beryllina			2j	2j
Sheepshead minnow	Cyprinodon variegatus			2	1
Rainwater killifish	Lucania parva		2		1
Sailfin molly	Poecilia latipinna		2		1
Gulf pipefish	Syngnathus scovelli		1		
Spot	Leiostomus xanthurus	1	2j[1/]		
Mosquito fish	Gambusia affinis				1
Gulf killifish	Fundulus grandis			1	2
Sea catfish	Arius felis	1		2j	
Striped mullet	Mugil cephalus	1		2j	
Spotted sunfish	Lepomis punctatus		2		1
Bluegill	Lepomis macrochirus		2		1
Sand seatrout	Cynoscion arenarius	1			
Blue catfish	Ictalurus furcatus	1			
Redear sunfish	Lepomis microlophus		2		1
Least killifish	Heterandria formosa				1
Naked goby	Gobiosoma bosci		1		

1/ Juveniles

diverted river water would be much higher in turbidity and suspended solids than the receiving area, initial concentration gradients would rapidly diminish. Slowed velocities and exposure to moderate salinities would promote settling of most suspended matter within a few miles of the outfall. In addition, it is estimated that up to 30 percent of the sediment would settle out before reaching the lake. During project design conditions, turbidity in the river would range from about 79 to 83 JTU's. Ambient levels in the lake would range from 6 to 18 JTU's at the four stations described in paragraph 6.9.1.35. Turbidity levels at these stations would increase to only 11 to 20 JTU's as a result of the diversion. For the twenty most abundant fish species in Lake Pontchartrain, the turbidities tolerated over a total year range from 5.0 to 56.1 Jackson Turbidity Units (JTU's).

6.9.1.20. While it is expected that most of the fish species would not be adversely impacted by the freshwater input, some temporary changes in species composition would be expected near the diversion site. This change in composition would probably result from the replacement of species less tolerant of lower temperature and salinity with species more tolerant to these conditions. Thus, the various species would exchange niches as dictated by the environmental conditions which exist at the time. As the ambient conditions are reestablished, the species composition should again be similar to that which existed before the diversion.

6.9.1.21. Due to the displacement of some of the forage base components of the fish community, certain predators linked to this food base would follow this food source, thus further altering the species composition. However, the predator species would be replaced by opportunistic feeders which would move into the area of the diversion to take advantage of the increased food supply introduced by the incoming water.

6.9.1.22. In general, the effect of the project on the food chain within the lake should be minimal to moderate. Two major food chains occur in the lake. The first is based upon six major groups of benthic species including polychaete worms, mollusks, chironomids, isopods, amphipods, and xanthid crabs. The dominant species of benthos in the lake are two small gastropods, Texadina sphinctostoma and Probythinella louisianae. These two species comprise 70 to 80 percent of the benthic community in th lake. Brackish water clams, Rangia cuneata, are also abundant and heavily utilized as food by some demersal species (Sikora and Sikora, 1982). The second chain consists of planktonic and nektonic food organisms associated with the water column including mysids, copepods, decapods, and fish (Darnell, 1961).

6.9.1.23. Sikora and Sikora (1982) noted a general decline in benthic biomass in the lake, probably related to lower carbon levels in the sediments. Introduction of nutrients by the project could benefit benthic populations and increase productivity of the benthic food base. Based on data from the 1979 spillway opening, changes in the benthic community which might be expected as a result of the diversion include increased nematode populations, due to their quick response to additional organic substrate, and moderate increases in abundance of the gastropod Texadina sphinctostoma. Although it has been reported that spillway openings have adversely affected populations of Rangia clams due to the deposition of large quantities of fine sediments on the lake bottom, it is not likely that the proposed project would cause any harm to this species because the quantity of fresh water and associated sediments diverted by this project is magnitudes smaller than those diverted through the spillway. On the contrary, it has been reported that freshwater introduction stimulates spawning of this clam and Tarver and Dugas (1973) suggested that controlled freshwater input be investigated as a management technique for increasing spawning of the

clam to increase supply of shells. Therefore, it appears as though the benthic food base in general would be improved, along with the various fish species which utilize this food base. Most of the commercially and recreationally important fish species either utilize this benthic forage, which would increase due to additional nutrient and detrital input, or are generalized "opportunistic" feeders. Therefore, economically important fish species should benefit from the project. Viosca (1938) reported that spillway openings were generally beneficial and "the plant growths were greatly stimulated, and associated animal life, such as scuds and grass shrimp was found in great concentrations. Plankton feeders, such as mullet, anchovies, menhaden, and shad were seen in great abundance everywhere."

6.9.1.24. Studies by Porrier and Mulino (1975) investigated effects of the 1973 spillway opening on the benthic community and found that only 5 out of 28 benthic species were eliminated. Similar results were noted after the 1975 opening. Their conclusions noted "that there was a lack of significant change in the epifaunal community after the opening" (Porrier and Mulino, 1977). Hawes and Perry (1979) concluded that effects on plankton in the lake had been dramatic, but short term, during the 1973 spillway opening. The naturally occurring assemblages of plankton were temporarily displaced by a freshwater assemblage. However, the original assemblage returned after the spillway was closed. It is expected that some of these same trends would occur during with-project diversion, but the magnitude and intensity would not be as great as observed in conjunction with spillway operations. It should be remembered that the maximum flow with the proposed structure is 30,000 cfs, and the average flow for the proposed 9-month diversion period is only 9,800 cfs, or about 4 percent of the capacity of the Bonnet Carre' Spillway. Some changes in plankton communities would be expected due to alterations in salinity patterns and increased nutrient concentrations and turbidity. However, impacts would not be expected to

be severe and recovery should be rapid. Studies by Stone et al. (1980) indicate that phytoplankton in Lake Pontchartrain consists of freshwater and euryhaline species which should be minimally affected by the project due to their tolerance to low salinity conditions. The zooplankton community is dominated by the copepod, Acartia tonsa. The juveniles are found in both fresh and brackish water while adults are generally found in slightly brackish water. Diversion should have no effects on juveniles and might slightly displace adults. Other common brackish water copepods and mud crab zoea might also be displaced. Potential impacts due to introduction of plant nutrients (phosphorus and nitrogen) are discussed in Appendix H as well as in paragraphs 6.9.1.32. through 6.9.1.38. and Section 6.18 of this EIS. It is acknowledged that introduction of nutrients via the diversions may be sufficient to cause nearshore eutrophication and possibly trigger occasional abundances of algae along the south shore. However, it is unlikely that widespread overloading of the lake would occur. It is anticipated that the thrust of late winter and spring flow rates in excess of 10,000 cfs would be sufficient to distribute nutrient loads widely throughout the southern reaches of the lake and that normal wind-driven circulation would further retard their rates of deposition. It is believed that the lake would assimilate the imported nutrients without significant adverse effects. Increases in turbidity due to project implementation are discussed in Appendix H and in paragraph 6.9.1.19 and Section 6.18 of this EIS. Although diverted water would be higher in turbidity and suspended solids than the lake, initial concentration gradients would rapidly diminish. Slowed velocities and exposure to moderate salinities would promote settling of most suspended matter within a few miles of the outfall. Up to 30 percent of the sediment would settle out before reaching the lake. It is acknowledged that both increased nutrients and turbidity could adversely impact plankton populations; however, it is felt that these impacts would be limited to the nearshore areas and the southwest quadrant of the lake. Although plankton productivity may be

reduced in some areas, introduction of nutrients would likely improve overall primary productivity in areas several miles beyond the shoreline. It should be pointed out that any nuisance algal production occasioned by diversion may be largely offset by increased turbidity and by improved reaeration rates and increased circulation. With regard to impacts on plankton feeders such as shad, menhaden, anchovies, and mullet, there is every reason to believe that these fish would benefit due to the diversion. These fish have historically been very abundant in the lake during and following spillway openings.

6.9.1.25. The preceding discussion addresses primarily those organisms important from an overall ecological and food base standpoint and included the twenty most abundant fish species and selected benthos and plankton. The importance of these organisms cannot be over emphasized, because the lake is important as a nursery area for many species. Of special concern to many people, however, are harvestable size commercial and recreational species and what impacts the proposed project would have upon these resources.

6.9.1.26. The following discussion addresses the major commercial fisheries resources and some of the impacts the proposed project would have upon these resources. Harvest data described in the following paragraphs are from the National Marine Fisheries Service. The figures do not include harvest by private commercial or recreational fishermen, as harvest by these sectors is largely unknown. Therefore, these statistics do not show the total fishing pressure on the lake. Most of the information concerning Lake Pontchartrain's commercial fisheries was extracted from Thompson and Stone (1980).

6.9.1.27. Crabs, shrimp, and catfish comprise the bulk of Lake Pontchartrain's commercial fishery. Lakes Pontchartrain and Maurepas account for about 9% of Louisiana's crab harvest and 0.13% and 0.10%,

respectively, of the state's shrimp and fish harvest. However, the nursery potential of Lakes Pontchartrain and Maurepas amounts to about 20×10^3 km^2 (1/2 million acres), or about 30% of Hydrologic Unit I and about 15% of the state's total. The blue crab dominates the catch. During the 13-year period of 1963-1975, blue crab accounted for, on the average, 67 percent of the value and 79 percent of the volume of Lake Pontchartrain's catch. During this period, the harvest of blue crabs far exceeded the other fishery resources. The catch ranged from 325,800 to 2,028,300 pounds and averaged about 807 thousand pounds. The total catch for the 13-year period was about 10.5 million pounds, valued at $1.7 million. The proposed project is expected to benefit blue crabs, as this species is very tolerant of low salinities. In fact, the juveniles and adults (particularly males) prefer them. Adkins (1972) indicated that blue crabs can exist in a wide range of salinities (0.0-31.4 ppt) during various phases of their cycle. Crabs of commercial size prefer lower salinities and thus migrate to the waters of Lake Pontchartrain. Rounsefell (1964), during a study on the MR-GO, also indicated that larger blue crabs were found in lower salinity waters. Peak catches of juvenile blue crabs are found in salinities less than 5.0 ppt. Blue crab catches were very high in 1973 and 1975. The spillway was open both of these years.

6.9.1.28. Shrimp and fishes account for on the average, 19 and 14 percent, respectively of the value and 10 percent each of the volume of the lake's catch. The shrimp fishery in Lake Pontchartrain includes both brown and white shrimp. Brown shrimp prefer higher salinities (para. 6.9.1.12.) and are found in the lake in greatest abundance in dry years. White shrimp prefer lower salinities and were historically found in greater abundance in Lake Pontchartrain. The proposed project would displace brown shrimp eastward toward Lake Borgne during periods of peak diversion. However, increased nutrients and improved habitat quality should improve brown shrimp production overall in years when small

diversions, or no diversions, occur. In addition, losses to brown shrimp harvest in Lake Pontchartrain should be compensated for by increased catches in Lake Borgne and other areas within the study area. It is believed that the proposed diversion would benefit catches of white shrimp overall. It should be emphasized that the impacts of the project on shrimp primarily involve their displacement and not an actual reduction in abundance within the study area. Even brown shrimp are tolerant of very low salinities and would not experience significant mortalities due to the diversions. They would simply avoid areas where salinities and temperatures are not favorable.

[illegible]. Commercial finfishing in the lake is dominated overall by [illegible] spotted seatrout. Between 1963 and 1975, catfish dominated [illegible] out of 13 years. Freshwater diversion would benefit [illegible] harvest. Tarver (1974) noted a very high freshwater catfish harvest following the 1973 spillway opening. Both channel catfish and blue catfish are harvested and are affected by fluctuations in salinity. These species are facultative invaders of brackish water, but have a limited ability to live in brackish waters (Thompson and Stone, 1980). The channel catfish is less tolerant of salinity and could disappear completely from Lake Pontchartrain if the normal salinity were raised above 2 to 3 ppt (Perry 1968). The blue catfish is much more tolerant of increases in salinity. This species has been shown to live at salinities equal to or greater than the normal upper maximum in Lake Pontchartrain. Overall, this species seems to occur in most abundance at salinities below 9 to 10 ppt; it seems, however, to prefer salinities below 5 ppt (Perry, 1968 and Kelly, 1965). As noted previously in this fisheries section, spotted seatrout prefer high salinities, athough they can tolerate low salinities. They can survive for a period of time in early fresh water; however, spotted seatrout would tend to be displaced eastward due to the diverted water. This movement was noted by Viosca (1937) and Gunter (1950). However, according to Thompson and Verret

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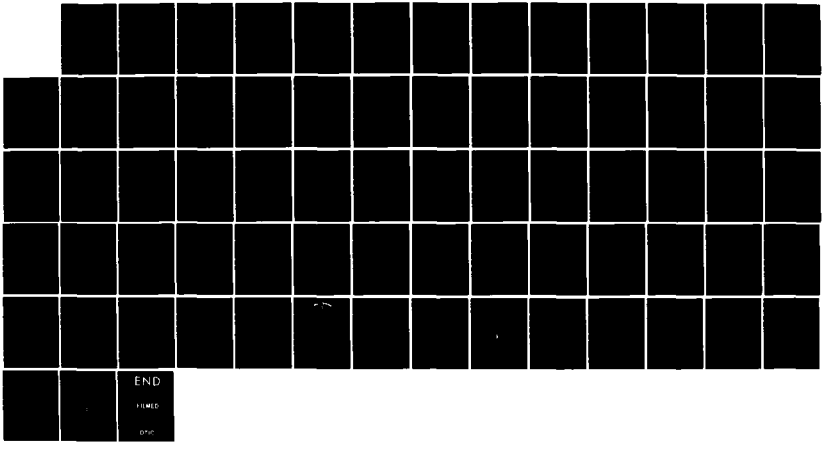

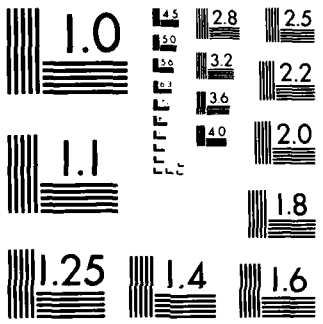

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(1980) spotted seatrout are most abundant in Lake Pontchartrain between December and early March. Since diversions associated with the proposed project would not begin until March and would end in October, it appears as though a trout fishery would still exist, even in years of design diversion.

6.9.1.30. As noted by Darnell (1962), the populations of commercial species have, through the geologic changes in the Lake Pontchartrain-Maurepas estuary, become adjusted to a natural range of changes in the lakes. The changes in this estuary as a result of the proposed project fall well within this natural range.

6.9.1.31. In general, it appears as though the adverse effects of the diversion primarily involve displacement, or relocation, of certain species, rather than outright elimination. In this case, the impacts become more social than biological, in that those people harvesting certain species such as brown shrimp and spotted seatrout either commercially or recreationally would have to go to eastern Lake Pontchartrain or Lake Borgne in order to do so. Additional information concerning these social impacts is found in Sections 6.22. through 6.26. and Appendix F, Section 8.

6.9.1.32. Perhaps the greatest potential adverse impacts of the proposed freshwater diversions are related to the high levels of pollutants in the Mississippi River. The river often contains high levels of plant nutrients, heavy metals, phenols, pesticides, polychlorinated biphenyls, and other compounds. Information concerning levels of these pollutants can be found in Appendix H, Water Quality. The following discussion identifies potential impacts of these substances on fish and other aquatic organisms and identifies areas of concern.

6.9.1.33. Although plant nutrients (phosphorus and nitrogen) are not generally considered to be contaminants, their excessive introduction into aquatic environments can create hypereutrophic conditions. During a typical year in which project design discharges were diverted from March through November, about 10,000 tons of nitrite plus nitrate and 2,000 tons of total phosphorus would be added to Lake Pontchartrain.

6.9.1.34. According to Witzig and Day (1980), the open waters of Lake Pontchartrain range in trophic state from lower mesotrophic to oligotrophic, which implies low productivity and low nutrient enrichment within the lake itself. However, phosphorus and nitrogen are significantly higher in areas fringing and surrounding the lake such as in Lake Maurepas, in the marshes, and along the southeast shoreline just off New Orleans. It is estimated that total phosphorus loading to Lake Pontchartrain has increased by about 70 percent since the 1950's (Stone et. al., 1980). In addition, it is known that in some of these areas, excessive nutrients are producing large amounts of plant material, such as Anabaena spp. and Oscillatoria spp.; forms that are known to indicate eutrophication and to cause changes in the species composition of the food web.

6.9.1.35. Observations of total nitrite plus nitrate concentrations in the lake range from zero to 2,500 ug/L and average about 316 ug/L-N overall. The distribution of sample means for the sum of nitrite plus nitrate concentrations also shows wide variation-ranging from about 80 ug/L-N for the Pass Rigolets sampling station to about 1,233 ug/L-N for a short-term sampling station near Kenner. Observations of total phosphorus concentrations in the lake average about 99 ug/L-P overall and range widely from 5 ug/L-P to 4,200 ug/L-P. The total phosphorus sample means also show significant variation, ranging from 39 ug/L-P for the temporary sampling station near Pointe Aux Herbes to about 137 ug/L-P for the sampling station near the Tangipahoa River.

6.9.1.36. Predictions were made of nutrient levels at four stations in Lake Pontchartrain during the first few months of diversion. The methodology and calculations used to derive these values are presented in Appendix H. One station is located at the mouth of Pass Manchac, one 10 miles north-northwest of Kenner, one at Mid-Causeway, and one at the entrance of the IHNC. A map showing these stations is located in Appendix H. Under project design conditions, total nitrite plus nitrate levels in the river would range from about 1,200 to 1,700 ug/L. Ambient levels at the four lake stations would range from 40 to 230 ug/L. The proposed diversion would elevate levels in the lake to 140 and 560 ug/L at the Mid-Causeway and Kenner stations, respectively. Under a more extreme condition- for example, when river nitrite plus nitrate is at a level which would be exceeded 10 percent of the time and lake nitrite plus nitrate is at a level which would be exceeded 90 percent of the time- the total nitrate plus nitrite level would be about 2,000 ug/L in the river. Ambient levels in the lake would range from 0 to 140 ug/L. The proposed diversion would elevate levels in the lake to 150 and 1,020 ug/L at the Mid-Causeway and Kenner stations, respectively.

6.9.1.37. Under project design conditions, phosphorus levels in the river would be about 270 ug/L. Ambient levels at the four lake stations would range from 40 to 80 ug/L. The proposed diversion would elevate levels in the lake to 60 and 150 ug/L at the Mid-Causeway and Kenner stations, respectively. Under the 10 percent exceedance condition in the river and 90 percent exceedance condition in the lake, the phosphorus level in the river would be about 390 ug/L. Ambient levels in the lake would range from 0.0 to 40 ug/L in the lake. The proposed diversion would elevate levels in the lake to 70 and 240 ug/L at the Mid-Causeway and Kenner stations, respectively.

6.9.1.38. Although it is acknowledged that the design condition discharge would occur on the average of only every other year, the ability of the lake to process the additional nutrient load is uncertain. It does not appear that the increased nutrient levels would have significant adverse impacts upon the lake overall. The increased nutrients could aggravate the eutrophication problems already being experienced in some areas on the fringes of the lake. However, as mentioned previously, the open waters of the lake are deficient in nutrients, and enrichment due to the diverted water would be beneficial, particularly in years where tributary runoff is below normal. High nutrient levels in lake areas adjacent to the diversion outfall would be reduced somewhat by flocculation and saline waters. Suspended sediments in diverted water would also tend to retard eutrophication processes. Although some over-fertilization may occur in certain areas, nutrients introduced into the marshes and swamps would help sustain and enhance productive wetlands and fisheries.

6.9.1.39. The bacteriological quality of the river and its impacts to fisheries in the prospective receiving areas is also a significant concern, particularly due to the relationship between bacterial levels and shellfish harvesting. Since oyster benefits attributable to the proposed diversion are substantial, potential adverse impacts due to high levels of fecal coliform bacteria in the river must be considered. The presence of coliform organisms in water has long been regarded as an indication of fecal contamination and has served for many years as a basis for water quality criteria. The use of fecal coliform bacteria as indicator organisms has proven to be of sanitary significance and the number of fecal coliforms indicates the degree of health risk associated with a variety of activities, including shellfish harvesting.

6.9.1.40. Shellfish, particularly bivalve mollusks such as oysters, clams, and mussels, have long been recognized as vectors of typhoid, hepatitis, and other diseases. These mollusks are filter feeders and tend to concentrate and accumulate viruses and bacteria, including pathogens from the overlying water. Due to the high densities of indicator organisms in Mississippi River water, during periods of diversion, significant quantities of fresh water with high bacterial densities would be introduced into Lake Pontchartrain. Natural die-off, dilution, bacterial sedimentation, predation, and the bacteriocidal effect of increased salinities in the receiving area would reduce fecal coliform populations. Predictions of fecal coliform die-off rates were made. Based on the predictions, it can be reasonably assumed that fecal coliforms diverted with the river water would die-off before reaching inland areas in Lake Borgne which currently produce oysters.

6.9.1.41. Under project design conditions, fecal coliform colony counts in the Mississppi River in the vicinity of the Bonnet Carre' site are about 550 MPN/100 mL. Although this level is very high when compared to typical fecal coliform levels in Lake Pontchartrain, it appears that the levels in the diverted water would diminish very rapidly during passage through the lake. Observations of fecal coliform counts at the stations in Lake Pontchartrain during the 1979 Bonnet Carre' operation indicate that, during the design diversion proposed by this project, only 2 to 3 percent of the original colonies would remain by the time the diverted water reached the Kenner station, which is about 10 miles from the diversion outfall, resulting in a maximum rise of about 13 MPN/100 mL. More importantly, however, is that observations at the Mid-Causeway station showed little evidence of bacterial influence from the diverted water. This station is about 20 miles from the diversion outfall. Considering the distance, travel times, dilution volumes, exposure to moderately saline conditions, and the relatively small volume of water as compared to that introduced during spillway openings, it appears

certain that the diversion proposed by this project would have no measureable effect on fecal coliform levels in oyster harvesting areas in Lake Borgne and beyond.

6.9.1.42. A variety of agricultural and industrial chemicals, such as pesticides and volatile and semivolatile organic compounds, occur in the Mississippi River. Costs of analyzing water for many of the compounds are prohibitive. Therefore, only limited data on the occurrence of many of these compounds are available.

6.9.1.43. Information on pesticide residues measured in fish tissue is given in table H-7-3. The indicated samples were collected from the Mississippi River at Luling, Louisiana from 1969 to 1979. As is shown in this table, fish tissue concentrations in excess of FDA action levels for total PCB's, dieldrin, and heptachlor epoxide have been observed. Table H-7-4 presents hydrocarbon concentrations measured in fish collected from the Mississipi River at Lutcher, Louisiana and table H-7-5 shows hydrocarbon and phenol concentrations in fish taken at river mile 109 AHP. None of these data indicate inordinately high tissue concentrations.

6.9.1.44. Examination of data for water samples collected from Lake Pontchartrain suggests that chlorinated hydrocarbons are infrequently detected. A criteria exceedance summary, based on analyses of 1,100 water samples collected from June 1974 through January 1983, at various locations in the lake, showed one percent or less of the samples indicated hydrocarbon concentrations greater than the EPA criteria. If the project is implemented, the occurrence and variety of pesticides and other organic compounds in some of the prospective receiving areas would probably increase. Thus, the potential for bioconcentration of such compounds in aquatic life would also increase, assuming these compounds are available to the respective organisms.

6.9.1.45. A variety of industrial compounds present in the river in the Baton Rouge to New Orleans industrial corridor are known or suspected carcinogens. Some organisms are noted for their ability to bioconcentrate such compounds to levels that may be dangerous to consumers of aquatic life. Consequently, the potential effect on consumers, including man, from ingesting organisms exposed to industrial chemicals, must be considered. Because methods have not been established to determine a threshold for carcinogenic effects, the Environmental Protection Agency (EPA) policy is that there is no scientific basis for estimating "safe" levels of carcinogens. Therefore, the recommended ambient water concentration for carcinogens for maximum protection of human health is zero. Table H-7-6 in the Water Quality Appendix lists the concentrations of 11 compounds, suspected or proven organic carcinogens and noncarcinogenic volatile and semivolatile organics, detected in the Mississippi River - Baton Rouge to New Orleans industrial corridor. Incremental lifetime cancer risks to an individual consuming 6.5 grams of fish and shellfish and two liters of water daily were estimated for the four carcinogenic compounds of the group having the highest concentrations detected in 1976 and 1977. These ranged from 1 in 2,100 for a 90 ug/l concentration of chloroform to 1 in 110,000 for a 7 ug/l level of tetrachloroetlylene. Estimated cancer risks from lifetime ingestion of fish and water containing lower measured concentrations of the same compounds (1 and 0 ug/l, respectively) were 1 in 190,000 to less than 1 in 1,600,000. Additional information concerning this matter is contained in Appendix H.

6.9.1.46. Trace metals and trace inorganics enter surface waters via several routes and from several sources. Fallout and washout of contaminants from the polluted atmosphere of urban and highly industrialized areas can be significant nonpoint sources. Metallic

salts leached from soils and natural ore deposits can also contribute significantly to the trace metal content of a surface water body. For the most part, heavy waste loading to neighboring surface waters is a consequence of continuing proliferation of industrial establishments adjacent to the Mississippi River and general industrialization of the New Orleans - Baton Rouge urban corridor. Several metals that are frequent components of many industrial wastewaters and urban stormwater runoff have been detected at high concentrations in the Mississippi River. These metals are rarely found in more than trace quantities in unpolluted waters. Trace metals and selected trace inorganics routinely detected in the Mississippi River include arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc. Data indicated that, except for mercury, the dissolved fractions of these constituents are generally lower and less frequently detected, and that the highest trace metal concentrations are normally associated with suspended particulates in the river. The trace metals copper, zinc, and iron have been detected at concentrations of 4.0, 2.2, and 15.1 mg/L, respectively. Mercury has been detected at a concentration of 5.5 ug/L. Such concentrations are generally rare; however, considering the enormous dilution capacity of the river, trace metals at the levels cited are cause for concern. Summary statistics for selected trace metals detected at the nine primary Mississippi River sampling stations considered in detail for this study are shown in table H-6-3 of the Water Quality Appendix.

6.9.1.47. Mean concentration of five selected trace metals, cadmium, copper, mercury, nickel, and zinc, were measured at twelve sampling locations in Lake Pontchartrain. These are shown in table H-6-10 of the Water Quality Appendix. Relatively high trace metal concentrations have been detected at some locations in the lake. However, the mean concentrations of all five of the trace metals listed are generally lower than those computed for the Mississippi River and freshwater

tributaries to the lake.

6.9.1.48. Of the trace metals, only copper was analyzed in detail with respect to concentration levels in the river and the lake and what concentrations would be expected to be with the proposed diversion. It was noted that during the 1979 flood, total copper in the spillway averaged only about 50 percent of the concentrations observed at Luling Ferry station about nine miles downstream on the river. It was presumed that similarly reduced copper levels would be effective at the diversion structure outfall during project operations. This would result in incoming levels of only slightly higher than lake background levels during normal conditions. Very slight increases of less than 1.0 ug/L would be expected. Comparisons of record period summaries of lake and river stations do not indicate large differences in water concentrations of cadmium, lead, or mercury. Since most trace metals tend to be attracted to sediment particles, the potential exists for significant deposition of waterborne metals prior to entry into Lake Pontchartrain. The degree to which this would occur for particular metals has not been analyzed for with-project conditions. At this time, no evidence of immediate or long-term toxic effects of introduction of metals in diverted water to Lake Pontchartrain is available.

6.9.1.49. The Council on Environmental Quality National Environmental Policy Act (40 CFR 1502.22 a and b) and ER 200-2-2 (section 26c) require that when an agency is evaluating significant adverse effects on the human environment in an EIS and there are gaps in relevant information or scientific uncertainty, the agency shall always make clear that such information is lacking or that uncertainty exists. It is further required that if information relative to adverse impacts is important to making a decision on the project and the means to obtain it are beyond the state of the art, the agency shall weigh the need for the action against the risk and severity of possible adverse impacts were

the action to proceed in the face of uncertainity. If the agency proceeds, it shall include a worst case analysis and an indication of the probability or improbability of its occurrence. The following discussion addresses these requirements.

6.9.1.50. In the case of the proposed project, or any project involving diversion of Mississippi River water, impacts of the relatively poor quality of the river water are an obvious source of concern. Although considerable data is available on the quality of Mississippi River water, it certainly cannot be considered exhaustive. Costs of analyzing water for many of the compounds known to occur in the river are prohibitive. Therefore, only limited data on the occurrence of these compounds are available. Water quality data on receiving areas, such as Lake Pontchartrain, are even more limited.

6.9.1.51. In addition to constraints and uncertainties related to water quality data, numerous gaps exist with regard to assessing the impacts of various water quality parameters on aquatic and terrestrial organisms. For many parameters, assessing impacts with any degree of certainty is beyond the state of the art. For some parameters, complex hydrological and water quality modeling would necessary to determine the distribution and concentration of these parameters throughout the receiving areas before better judgements could be made concerning their effects upon organisms. The studies culminating in this report are based primarily on existing information. Another consideration is that effects of many contaminants are subtle and long term and concrete information on effects of the thousands of chemical compounds in the Mississippi River may never be known.

6.9.1.52. Based on the available information used in this study, it does not appear that the proposed project would result in significant adverse effects. The Bonnet Carre' Spillway has been operated four

times in the past ten years to alleviate flood conditions on the Mississippi River. Diversions in 1973, 1975, 1979, and 1983 have allowed large volumes of river water into the study area. To date, no significant water-quality related problems have become manifest as a result of introduction of these massive volumes of water into the area. This should not be interpreted to mean that problems do not necessarily exist; it simply means that no problems have been detected. Effects of unfavorable water quality are often subtle and long term. Therefore, although it appears that no obvious problems are likely to result from implementation of the proposed project, the available information is not conclusive.

6.9.1.53. These data gaps and uncertainties are the primary reasons for the proposed water quality and biological monitoring programs. These programs are intended to determine and verify any beneficial or adverse impacts of the diverted water on water quality, estuarine habitats, and fish and wildlife resources. The programs include tissue analysis of selected organisms to assess potential bioaccumulation problems and insure the safety of humans.

6.9.1.54. It has been determined that a "worst case" impact analysis for the proposed project would involve what could occur in the event of a major discharge of a highly toxic contaminant from one of the industries along the river, or as a result of a ship or barge collision. The industries along the river manufacture or use a wide variety of toxic chemicals. In addition, ships and barges transport a wide variety of toxic chemicals. The proposed structure would be electronically operated and could be closed in a relatively short period of time (about 1 hour). Provisions for manual closure in the event of power failure would also be incorporated. However, if a major toxic contaminant spill were to occur upriver from the structure, the potential for catastrophic impacts exists in the event that the spill is

immediately reported, or in the case of human failure in operation of the structure. If this should occur, some of the toxic substance would be introduced into the Lake Pontchartrain Basin and serious environmental impacts could result. It should be emphasized, however, that the true "worst case" condition already exists without this project. If a major contaminant spill occurred upriver from the existing Bonnet Carre' Spillway while that structure was being used for flood control, the results could be truly catastrophic. The spillway structure cannot be closed in a reasonable length of time when it is passing floodwaters. Even if a major spill were reported, virtually nothing could be done to ameliorate the impacts.

5.10. WILDLIFE

5.10.1. Bonnet Carre' Plan

5.10.1.1. The proposed plan would impact 1,811 acres of habitat due to direct construction activities. Approximately 346 acres would become channel and 1,465 acres would be used for disposal of dredged material. Of the total 1,811 acres impacted, 1,074 acres are considered developed land of limited importance to wildlife. The remaining acreage consists of wooded swamp (618 acres), scrub/shrub (56 acres) and open water (63 acres). The most serious wildlife impacts would be associated with the 618 acres of wooded swamp which would be impacted. About 130 acres would be converted to channel and 488 acres would be altered by disposal of dredged material. A small number of the less mobile species would be lost through burial during disposal. A greater number of less mobile species would be displaced to adjacent habitats where some may suffer mortality due to competition with residents, and/or these habitats would be degraded due to overcrowding. Those disposal areas converted to shrub/scrub and early successional bottomland hardwoods would retain some wildlife value for upland species. Recreational

overall community cohesion. Additional information concerning community cohesion is found in Appendix F, Section 8.

6.25. DISPLACEMENT OF PEOPLE

6.25.1. Bonnet Carre' Plan

If the proposed project is successful in expanding the oyster industry without significantly impacting other elements of the commercial seafood industry or sport fishing activities, the resultant economic stimulus would add stability to population trends. Construction of the project would, nevertheless, require the permanent relocation of a number of people currently living within the proposed project rights-of-way. During certain phases of construction, another smaller number of people may need to move temporarily due to inconveniences experienced during construction activities. The original project would require the taking of 26 permanent residential structures and six mobile homes. The project was modified to take 52 single-family dwellings, 16 trailers, and 1 church. The people living in the community of Montz have a strong sense of cohesiveness. Three to four generations of families live there and they have no desire to live apart. Additional information concerning displacement of people is found in Appendix F, Section 8.

6.26. COMMUNITY COHESION

6.26.1. Bonnet Carre' Plan

Construction of the proposed project would require relocation of a number of families living in the vicinity of the construction site. However, increased production of fish and wildlife resources, particularly oysters, would increase employment potential and stability and would have a significant beneficial impact on the study area. To the extent that construction of the project increases the total production of seafood in the project area, employment and income would be benefited. These are two of the most significant factors influencing

industry. Employment of oyster fishermen, processors, and those involved in product marketing would become more stable. Although some fishery resources would be displaced during peak diversions, making it necessary for some shrimpers and other commercial fishermen to move toward eastern Lake Pontchartrain and Lake Borgne, the improved habitat conditions are expected to increase fisheries production and related employment/labor in the overall study area. Commercial and recreational activities related to wildlife resources would also improve. Additional information concerning employment/labor force is found in Appendix F, Section 8.

6.24. LAND USE

6.24.1. Bonnet Carre' Plan

The primary impacts to land use as a result of implementation of the proposed plan would occur in the community located just above the spillway structure. The total amount of land required for the project includes portions of the existing Bonnet Carre' Spillway rights-of-way as well as an adjacent 77.2 acres. Of this additional land, 33.6 acres are currently being used for residential purposes and the remaining 43.6 acres have significant potential for residential use. While land adjacent to the rights-of-way could be less desirable for development during project construction, the limited availability of land in St. Charles Parish would provide sufficient pressure for future development. Additional information concerning land use is found in Appendix F, Section 8.

6.21.1.2. The beneficial impact of this plan would result from the deceleration in rate of land loss in the study area. This, however, is a minor benefit, as the natural and cultural forces which are presently destroying the resource base will continue.

6.22. BUSINESS AND INDUSTRY

6.22.1. Bonnet Carre' Plan

The proposed plan would improve salinity levels and establish favorable salinity regimes in the study area. This would facilitate the development of oyster production. Better control of oyster production would add stability to the industry, from the fishermen, to wholesale and retail markets, restaurants, and bars. The additional fresh water into Lake Pontchartrain during periods of high salinity could encourage certain fish and shellfish species such as red drum, spotted seatrout, and brown shrimp to move eastward toward Lake Borgne and Chandeleur Sound. The net effect on these resources is expected to be their relocation rather than their decline. Other fishery resources, such as white shrimp, blue crab, Atlantic croaker, and menhaden are not expected to be adversely affected or significantly displaced by the additional fresh water. Additional information concerning impacts to business and industry is found in Appendix F, Section 8.

6.23. EMPLOYMENT/LABOR FORCE

6.23.1. Bonnet Carre' Plan

The proposed plan would ameliorate the problems associated with historical saltwater intrusion in the study area, thereby lessening the impact of one of the major difficulties facing the future of the oyster

6.20. NATIONAL REGISTER PROPERTIES

6.20.1. Bonnet Carre' Plan

6.20.1.1. The proposed plan would not adversely affect any property currently listed in or determined eligible for inclusion in the National Register of Historic Places. None of the National Register properties in the study area are located near the proposed diversion site or the six recreational development sites.

6.20.1.2. The beneficial impact of this plan would result from the deceleration of rate of land loss in the study area over the life of the project. However, this is a minor benefit, as destructive natural and man-made forces will continue.

6.20.1.3. The full impacts of this plan on resources eligible for inclusion in the National Register cannot be addressed without benefit of an intensive cultural resources survey of all impact areas. Such a survey will be conducted for the proposed plan during the next stage of project planning to identify any significant cultural resources in the potential impact area of the project eligible for inclusion in the Register.

6.21. ARCHEOLOGICAL RESOURCES

6.21.1. Bonnet Carre' Plan

6.21.1.1. The proposed plan would not adversely affect any presently recorded archeological resources. However, based upon available data, the diversion site and three of the six proposed recreational sites (Rigolets, Cedar Point, and Wolf River) have a relatively high probability of affecting presently unrecorded archeological remains.

changes in copper levels, as well as inferences concerning the effects of the proposed project on levels of other trace metals such as cadmium, lead, and mercury, have been discussed in Section 6.9.

6.18.1.7. The analysis of receiving water effects of Mississippi River diversions, presented in Appendix H, also considers more extreme condition parameter levels which would be exceeded only once in ten years on the average in the river, except for salinity, and winter and spring temperatures, which are represented as values to be exceeded nine years out of ten. In Lake Pontchartrain, the parameters are represented in the opposite extreme, i.e., 90 percent and 10 percent exceedance levels, respectively. The much wider gradients between the two water bodies thus represents a more critical condition. Except for nitrate plus nitrite loading in nearshore areas, the increased changes do not necessarily suggest significant adverse effects. The capability of the lake waters, in the presence of somewhat higher suspended matter and turbidity as a result of diversion, to effectively assimilate and dispose of any nutrient excesses, is largely indeterminate at present.

6.19. LOUISIANA NATURAL AND SCENIC STREAMS SYSTEM

6.19.1. Bonnet Carre' Plan

The proposed plan would not result in significant impacts to any of the study area water bodies included in this system. Minor changes in water quality and salinity could occur in some streams, particularly in Bayous Trepagnier and La Branche, which are located in the marshes just east of the spillway.

6.18.1.4. The Mississippi River in the vicinity of the Bonnet Carre' diversion site harbors high fecal coliform colony counts. Although frequent observations were made during the 1979 Bonnet Carre' operation at a number of lake stations, it was difficult to detect any consistent patterns of bacterial trends with respect to those measured within the spillway. Colony counts of fecal coliform at each station were much more erratic than in the spillway, suggesting that altered circulation patterns and other physical and chemical influences had combined to interfere with the orderly transport of these and other bacteria through open water areas. It was roughly estimated from those data that only a small percentage of the original colonies would persist from the diversion site to the 10-mile distant station location during a typical diversion season. It was observed that there was little direct evidence of Bonnet Carre' bacterial influence at the Mid-Causeway station in 1979. It would seem certain that the diversion structure operation would have no significant pathogenic effect on oyster harvesting areas in the study area.

6.18.1.5. Although diverted river water would normally be much higher in suspended matter and turbidity than the receiving areas, initial concentration gradients would be expected to rapidly diminish with distance from the outfall. Slowed velocities and exposure to moderate salinities would promote settlement of most of the suspended matter within a few miles of the shore. It is also estimated that up to 30 percent of the incoming sediment from the river would settle out before reaching the lake. Minor increases of about 30 percent or less above background levels of suspended matter and turbidity are predicted at each of the above-referenced Lake Pontchartrain stations under normal river and lake conditions.

6.18.1.6. Of the trace metals, only copper was analyzed in detail with respect to concentration levels in the river and the lake. Predicted

6.18. WATER QUALITY

6.18.1. Bonnet Carre' Plan

6.18.1.1. The introduction of Mississippi River water to Lake Pontchartrain at the Bonnet Carre' site would produce increases above background levels of most constituents, particularly on the western and southern portions of the lake. Salinity would be greatly reduced within a few miles of the conveyance channel outfall. The degree of change at a given location would be dependent on the background salinity level, rate of freshwater inflow, and the volume of lake water between the location and the diversion site. Water temperatures would likewise be reduced during peak diversions. Predicted temperature changes due to project implementation are discussed in Section 6.9. Appendix H contains predicted project-induced changes in salinity and seven other important water quality parameters that were developed from 1979 Bonnet Carre' Spillway operation period data collected both in the spillway and a number of locations in Lake Pontchartrain.

6.18.1.2. Induced changes in water quality parameter levels would be gradual, deviating maximally from background levels at times ranging from one to six weeks after the peak diversion period (late April to early June).

6.18.1.3. The Mississippi River is characteristically much higher in nitrites plus nitrates than is Lake Pontchartrain. The diversions would significantly increase levels of these parameters in the lake. Total phosphorus would increase by relatively small amounts. Predicted changes in nitrite plus nitrate levels due to project implementation are discussed in Section 6.9.

6.16. MINERALS

6.16.1. Bonnet Carre' Plan

The proposed plan would have minimal impacts on mineral resources. Impacts would be associated with relocation of five gas pipelines and one oil pipeline. Six-hundred linear feet of two 16-inch gas pipelines, one 18-inch gas pipeline, and one 20-inch oil pipeline would require relocation. In addition, 3,500 linear feet of one 2-inch gas pipeline and 700 linear feet of one 4-inch gas pipeline would have to be relocated.

6.17. MISSISSIPPI RIVER

6.17.1. Bonnet Carre' Plan

The proposed plan would have minimal impacts on the Mississippi River. During April, the month of maximum design diversion, 30,000 cfs would be passed through the structure. This represents about 6 percent of the average river flow. During the 9 month diversion period from March through November, the average monthly flow would be 9,844 cfs. This represents only about 2 percent of the average annual river flow. No problems associated with water supply are anticipated. The effect on shoaling in the river immediately downstream of the diversion site would be insignificant because of the naturally deep river channel. Any increase in dredging in Southwest Pass as a result of the diversion would be negligible.

satisfy a portion of the existing need for outdoor recreation in the project market area. Six strategically located sites were chosen for development in order to provide access to water bodies in the area. Four sites are proposed for Louisiana and two sites for Mississippi. Each site would consist of a 2-lane concrete boat launching ramp with courtesy pier, a paved parking area with capacity for 30 cars or trailers, and a small picnic area with 5 tables. The four sites in Louisiana include Frenier Beach, Bonnet Carre' Spillway, Point Aux Herbes, and the Rigolets. Proposed recreational sites in Mississippi include Cedar Point and Wolf River. Details concerning these sites and the recreational development plan are contained in Appendix G, Recreation. The benefit cost ratio of the proposed recreational development features is 8.1 to 1.0.

6.15. STATE WILDLIFE MANAGEMENT AREAS/REFUGES

6.15.1. Bonnet Carre' Plan

The proposed plan would not impact any state wildlife management areas or any refuges due to direct construction activities. Habitat degradation would be reduced and habitat quality would be improved in some of these areas. The Manchac and Joyce WMA's and the St. Tammany Wildlife Refuge should experience significant improvements. Wooded swamp conditions would improve in the Manchac and Joyce WMA's. The brackish marsh in the St. Tammany Wildlife Refuge would be periodically subjected to reduced salinities, resulting in a lower salinity brackish marsh vegetation assemblage which would be more productive for wildlife. The Biloxi WMA would also experience some improvements in habitat conditions due to reduced salinities.

6.13. NESTING COLONIES

6.13.1. Bonnet Carre' Plan

The proposed plan would not impact any nesting colonies as a result of direct construction activities. Most of the 51 nesting colonies in the study area are considerable distances from the diversion structure. Improvement of habitat conditions throughout the study area should benefit nesting colonies overall. Potential problems related to increased levels of certain pollutants in the area could occur. However, the monitoring program associated with the proposed diversion is expected to detect any significant problems.

6.14. RECREATIONAL RESOURCES

6.14.1. Bonnet Carre' Plan

6.14.1.1. The proposed plan would result in total annual losses of 637 man-days of sporthunting, valued at $4,124, due to direct construction activities. This loss would be due to impacts to 618 acres of wooded swamp within the spillway.

6.14.1.2. With the plan, benefits claimed in the year 2040 are 160,088 man-days of hunting, fishing, and picnicking, valued at approximately $690 thousand. Hunting benefits would be 10,088 man-days, valued at about $77 thousand. Fishing benefits would be 108,300 man-days, valued at about $455 thousand. Picnicking benefits would be 41,700 man-days, valued at about $158 thousand.

6.14.1.3. Because of the far-reaching effects of the proposed plan and the resultant improvement in habitat conditions in the study area, a plan was developed to increase public access to the area and also to

the mortality rate after exposure to duck hepatitis virus as did the normal birds (Snow, 1973).

6.10.1.7. Construction of the proposed project is not expected to contribute to vector-borne disease or nuisance problems. If future studies indicate that vector-related problems could arise, appropriate measures would be taken to minimize the impacts to the maximum extent practicable. Coordination will be maintained with local health authorities concerning this matter.

6.11. ENDANGERED SPECIES

6.11.1. Bonnet Carre' Plan

The proposed plan would not impact any endangered species due to direct construction activities. Improvements in habitat quality and quantity would benefit most species. However, some potential adverse impacts could occur due to increased levels of pollutants introduced by the diversion. A monitoring program including water quality and tissue analysis in selected fish and wildlife species is an integral part of the project and should detect any problems. Correspondence between the US Army Corps of Engineers and the US Fish and Wildlife Service and National Marine Fisheries Service concerning impacts to threatened and endangered species in the study area is located in Appendix D, Section 2.

6.12. BLUE LIST SPECIES

6.12 1. Bonnet Carre' Plan

The proposed plan would have minimal impacts on the 23 Blue List species due to direct construction activities. Improvements in habitat quality would benefit most Blue List species, particularly those species utilizing the wooded swamp and marsh habitats. Potential adverse impacts could occur to some species due to the increased pollutant levels. Additional information concerning impacts on birds and other wildlife species is in Section 6.10.

temperatures near the diversion channel outfall could impact specific wildlife, particularly reptiles and amphibians. Most populations would not be harmed, and many would be helped due to the reduction in wetland loss and increased productivity due to the project.

6.10.1.6. Potential negative impacts to wildlife could be related to the introduction of pollutants from the Mississippi River, including pathogens, toxins, nutrients, and sediments. Most problems would occur near the outfall of the diversion channel, with potential for impacts being reduced as distance from the outfall increases. Enriching the receiving body with inorganic nutrients, especially inorganic nitrogen and phosphorus, could in some situations create additional problems in already eutrophic areas. This could impact the prey base, especially fish, and could be more critical during the warm months. Siltation and turbidity could also impact the prey base adjacent to the outfall area. The presence of toxic substances is of greater concern and would impact a greater area than nutrients or suspended particles. The toxic materials include pesticides (DDT, dieldrin), industrial wastes (PCB's), and heavy metals (copper, cadmium, and mercury). This is because these materials are relatively persistant in the environment, travel long distances, and can be biologically magnified. Most of these toxic materials would be either deposited in the sediment or attached to particulate matter. However, some would be taken up by biological systems and enter the food chain. Once in the food web, the materials would be biomagnified and would continue to be so until they reach top carnivores or man. For example, PCB's can be concentrated at a level of 10 to 100 times per trophic level. The dramatic impact of this bioaccumulation can be observed in oceanic birds which never contact any large land area, yet carry a load of over 6 ppm. Although a pollutant may not reach a lethal level in healthy animals, it can result in decreased vigor or death during periods of stress or starvation. Ducklings exposed to a dosage of 25 ppm Aroclor (a PCB) had about twice

losses due to impacts to the 618 acres of wooded swamp have been computed to be 637 annual man-days, valued at about $4,124.

6.10.1.2. Commercially important wildlife, including furbearers and alligators, are dependent upon productive swamp and marsh habitat in the coastal area. Most of these species prefer the swamps and fresher marsh areas; therefore, annual future harvests are expected to be greater with the project than they would without freshwater diversion. With implementation of the proposed plan, it is projected that the study area would contain a total of 6,355 acres more wooded swamp and 4,186 more acres of fresh/intermediate marsh in year 2040 than under the without-project condition. The potential total net value of furbearers in the study area is projected to be $34 thousand greater in 2040 with than without the project. The potential total net value of alligators would be about $6 thousand greater in 2040.

6.10.1.3. Recreationally important wildlife, including big game, small game, migratory birds, and waterfowl would also benefit from reductions in rates of habitat degradation. This would, in turn, lead to increased hunting opportunities. Increases in man-days of hunting and their attendant values are presented in Section 6.14. Additional information concerning recreational values attributed to wildlife can be found in Appendix G, Recreation.

6.10.1.4. Without the project, wildlife populations would decline due to reduced quantity and quality of wetland habitat. The potential annual value of commercial wildlife would be reduced by over $378 thousand in 2040. The study area would support only 328,218 man-days of sport hunting.

6.10.1.5. Modifications of the existing isohalines would result in some redistribution of particular wildlife populations. Changes in water

TABLE 7. LIST OF PREPARERS

The following people were primarily responsible for preparing this Environmental Impact Statement.

NAME	DISCIPLINE/ EXPERTISE	EXPERIENCE	ROLE IN PREPARING EIS
Mr. Dennis L. Chew	Fisheries Biology/ Management	4 years, Marine Biologist, Gulf Coast Research Laboratory, Ocean Springs, MS: 2 years, Assistant to the Director, Mississippi Marine Conservation Commission, Biloxi, MS; 4 years Environmental Studies, Corps of Engineers, New Orleans District	EIS Coordinator, Effects on Fisheries and Wildlife
Mr. Falcolm E. Hull	Engineer/Civil Engineer	12 years, Planner, Corps of Engineers, New Orleans District	Study Manager, Engineering
Mr. Larry Hartzog	Fishery Biologist	2 years, Water Quality Analyst, Hercules Chemical; 4 years, Fisheries Research Florida Came and Freshwater Fish Commission; 4 years, Environmental Studies New Orleans District	Effects on Fishery Resources
Mr. Marvin Drake	Engineer/Environmental Engineer	13 years, Hydraulic and Environmental Engineer, Corps of Engineers, New Orleans District	Effects on Water Quality
Mr. Howard R. Bush	Recreation Planning/ Resource Development	5 years, State of Arkansas, 4 years, Corps of Engineers, New Orleans District	Effects on Recreational Resources

TABLE 7. LIST OF PREPARERS (Continued)

NAME	DISCIPLINE/ EXPERTISE	EXPERIENCE	ROLE IN PREPARING EIS
Mr. Theodore C. Hokkanen	Outdoor Recreation Planning/Recreation Resource Management	5 1/2 years, Pennsylvania Bureau of State Parks; 4 years, Chief Park Ranger, Vicksburg District; 4 years, Outdoor Recreation Planner, New Orleans District	Effects on Recreational Resources
Mr. Michael Stout	Archeology/Cultural Resource Management	6 years, Corps of Engineers, New Orleans District	Effects on Cultural Resources
Mr. Nicholas G. Constan	Regional Economist	14 years, Corps of Engineers, New Orleans District	Plan Economics, Social Impacts
Mr. Robert Lacy	Regional Economist	12 years, Corps of Engineers, New Orleans District	Plan Economics, Social Impacts
Mrs. Suzanne Hawes	Botany/Fisheries/ Marsh Ecology	1 year, Lab Associate, LSU Medical School; 11 years, Environmental Studies, New Orleans District	Review and Technical Assistance
Mr. Henry P. Claviano	English/Technical Writing and Editing	4 years, Technical Writer/Editor, The Boeing Company; 12 years, Technical Writer/Editor, Corps of Engineers, New Orleans District	Review and Editorial Assistance
Mr. James Warren	Sanitary/Environmental Engineer	1 year, Civil Engineer, Arkansas State Highway and Transportation Dept; 5 years, Environmental Engineer, Corps of Engineers, New Orleans District.	Existing Water Quality Conditions

8. PUBLIC INVOLVEMENT

8.1. PUBLIC INVOLVEMENT PROGRAM

8.1.1. Two public notices were issued and initial public meetings were held on February 1 and 9, 1978 at Gulfport, Mississippi, and New Orleans, Louisiana, respectively. A meeting was held with representatives of interested Federal and non-Federal agencies to discuss the status and future direction of the study on April 23, 1980, and to discuss study progress on January 26, 1981. Ad hoc interagency meetings were held on May 28 and June 22-24, 1982 to develop objectives for enhancing fish and wildlife resources through freshwater diversion. On July 29, 1982, a meeting was held to present preliminary information on the study to the St. Bernard Parish Police Jury, Planning Commission, and Citizen's Coastal Zone Management Advisory Committee. A meeting was held with the Governor's Coastal Protection Task Force Technical Subcommittee on May 26, 1983, to present the proposed plan to them. The proposed plan was presented to the President of St. Charles Parish on June 7, 1983, to provide him with information on the plan. On June 28, 1983, a presentation on the plan was made to the Lake Pontchartrain Basin Advisory Committee and on June 30, a meeting was held with the St. Bernard Parish Citizen's Coastal Zone Management Advisory Committee to update them on the study.

8.1.2. Numerous informal meetings have been held and more will be held with representatives of Federal and state fish and wildlife management agencies, local interests, environmental groups, and other special interest groups. Studies have been coordinated with the US Fish and Wildlife Service, National Marine Fisheries Service, US Food and Drug Administration, Louisiana Department of Wildlife and Fisheries, Louisiana Department of Natural Resources, Louisiana Department of Health and Human Resources, and Mississippi Department of Wildlife

Conservation. Five coordination meetings have been held with the Mobile District Corps of Engineers. Three public meetings were held in December 1983.

8.2 REQUIRED COORDINATION

The draft Environmental Impact Statement (EIS) was furnished to Federal agencies, state agencies, and other interested parties for their review in October 1983. Circulation of this final report will accomplish the remaining required coordination with the National Park Service (NPS) and State Historic Preservation Officer (SHPO) as provided under the National Historic Preservation Act; and the NPS as provided under the Federal Water Project Recreation Act.

8.3. STATEMENT RECIPIENTS

The US senators and congressmen, Federal, and state agencies listed below have received copies of the draft Main Report and accompanying EIS (Volume 1) and Report Appendixes (Volumes 2 and 3). All others listed below have received at least copies of Volume 1 or a Notice of Availability. For those interested in reviewing Volumes 1, 2, and 3, copies have been furnished to the libraries listed below. Distribution of the final volumes will be the same as that of the draft volumes except that the Public Views and Responses Appendix (Volume 4) has been added.

Honorable J. Bennett Johnston
Honorable Russell B. Long
Honorable John Stennis
Honorable Thad Cochran
Honorable Lindy (Mrs. Hale) Boggs
Honorable John B. Breaux

Honorable Jerry Huckaby
Honorable Robert L. Livingston
Honorable Gillis W. Long
Honorable W. Henson Moore
Honorable William "Billy" Tauzin
Honorable Buddy Roemer
Honorable Jamie Whitten
Honorable Webb Franklin
Honorable G. V. Montgomery
Honorable Trent Lott
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US Department of the Interior, Fish and Wildlife Service, Office of Biological Services, Bay St. Louis, MS
US Department of the Interior, Fish and Wildlife Service, Field Supervisor, Division of Ecological Services, Bay St. Louis, MS
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US Department of the Interior, US Geological Survey, District Chief, Jackson, MS
US Environmental Protection Agency, Regional EIS Coordinator, Region VI
US Environmental Protection Agency, the Administrator
US Department of Commerce, Joyce M. Wood, Director, Office of Ecology and Conservation
US Department of Commerce, National Oceanic & Atmospheric Administration, National Marine Fisheries Service, Southeast Region
US Department of Commerce, National Oceanic & Atmospheric Administration, Director, National Ocean Survey, Bay St. Louis, MS

US Department of Commerce, Executive Director, Gulf of Mexico Fishery Management Council

US Department of Commerce, Regional Economic Analysis Division, Bureau of Economic Analysis, Washington, DC

National Park Service, Gulf Islands National Seashore, Ocean Springs, MS

US Department of Health, Education, and Welfare, Food and Drug Administration, Regional Shellfish Consultant, Dallas, TX

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US Department of Energy, Division of NEPA Affairs, Washington, DC

Federal Emergency Management Administration, Washington, DC

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US Department of Transportation, Deputy Director for Environmental and Policy Review

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Louisiana Department of Transportation and Development, Office of Public Works, Assistant Secretary

Louisiana Department of Highways, Mr. Vincent Pizzolato, Public Hearings and Environmental Impact Engineer

Louisiana Department of Wildlife & Fisheries, Mr. Maurice B. Watson, Ecological Studies Section

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Louisiana Department of Wildlife & Fisheries, Chief, Oysters, Water Bottoms, and Seafood Division, New Orleans, LA

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Louisiana State University Library
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Tulane University Library
Ascension Parish Library
Jefferson Parish Library Department
Livingston Parish Library
St. Bernard Parish Library
St. Charles Parish Library
St. James Parish Library
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St. Tammany Parish Library
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US Department of Commerce, Gulf of Mexico Fishery Management Council, Tampa, FL
US Department of Commerce, National Marine Fisheries Service, St. Petersburg, FL

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productivity resulted in preparation of the draft and final reports on freshwater diversion under the authority of the Mississippi and Louisiana Estuarine Areas Study. The planning objectives established for this study were in response to concerns and views of the public. As discussed in Section 1.2 of this EIS, several controversial issues may require resolution prior to project implementation. These issues were brought forth at the public meetings. Public views and reponses are presented in Volume 4, Appendix L.

ORGANIZATIONS

A.J.S., Inc., Mary T. Slavich, New Orleans, LA
City of New Orleans, City Planning Commission, New Orleans, LA
Environmental Defense Fund, Washington, DC
Gulf Coast Research Laboratory, Ocean Springs, MS
Jesse S. Guillot, Law and Notarial Office, New Orleans, LA
League of Women Voters of Louisiana, Baton Rouge, LA
Louisiana Oyster Dealers & Growers Association, New Orleans, LA
National Wildlife Federation, Washington, DC
Regional Planning Commission, Jefferson, Orleans, St. Bernard,
and St. Tammany Parishes, New Orleans, LA
St. Bernard Parish Police Jury
St. Charles Parish Council, Hahnville, LA
St. Charles Parish, Department of Planning and Zoning, Hahnville, LA
St. Tammany Parish Police Jury, Covington, LA
Tulane Law School, Oliver A. Houck, New Orleans, LA
Wildlife Management Institute, Washington, DC

INDIVIDUALS

James C. Burns
Enoch J. Faltermen
Neuman F. Gaines
Bryon Lee Hinyub
Ronald J. Ricca
John Joseph Ross

8.5. PUBLIC VIEWS AND RESPONSES

Public views expressed to this agency concerning saltwater intrusion, land loss, and concomitant declines in fish and wildlife

US Department of Commerce, Office of the Administrator, Chief, Ecology and Conservation Division, Washington, DC

US Department of the Interior, National Park Service, Jean Lafitte National Historical Park

US Department of the Interior, Office of Environmental Project Review, Albuquerque, NM

US Department of Health and Human Services, Public Health Service, Atlanta, GA

US Department of Housing and Urban Development, Region VI, Fort Worth, TX

US Department of Transportation, Federal Highway Administration, Baton Rouge, LA

US Environmental Protection Agency, Region VI, Dallas, TX

STATE AGENCIES

Mississippi Department of Natural Resources, Bureau of Pollution Control, Jackson, MS

Mississippi Department of Wildlife Conservation, Bureau of Marine Resources, Long Beach, MS

Mississippi State Clearinghouse for Federal Programs, Office of the Governor, Jackson, MS

Louisiana Department of Culture, Recreation, and Tourism, Office of Cultural Development, State Historic Preservation Officer, Baton Rouge, LA

Louisiana Department of Culture, Recreation, and Tourism, Office of State Parks, Baton Rouge, LA

Louisiana Department of Natural Resources, Governor's Coastal Protection Task Force, Baton Rouge, LA

Louisiana Department of Natural Resources, Land, Water, and Research, CMS Administrator, Baton Rouge, LA

Louisiana Department of Transportation and Development, Office of Public Works, Baton Rouge, LA

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RECOMMENDATION

I find that a plan of improvement to divert Mississippi River water to Lake Pontchartrain Basin and Mississippi Sound adjacent to the existing Bonnet Carre' Spillway, as developed in this report, is based on a thorough analysis and evaluation of all practicable alternative courses of action. The plan produces net benefits in excess of cost and has a favorable benefit-to-cost ratio. It involves some disruption of existing facilities but causes the fewest adverse environmental impacts. Where the proposed action has an adverse effect, this effect is minimized or substantially outweighed by beneficial social, economic, and environmental effects. The plan has been endorsed by the States of Louisiana and Mississippi. On balance, the total public interest could best be served by implementing the plan.

I recommend that the existing project "Mississippi River and Tributaries," authorized by the Flood Control Act of 1928 as amended by the Water Resources Development Act of 1976, be modified to provide for the implementation of a Federal project to divert Mississippi River water into the Lake Pontchartrain Basin and Western Mississippi Sound in order to create favorable salinity conditions and enhance fish and wildlife, in accordance with the plan selected herein with such further modifications thereto as in the discretion of the Chief of Engineers may be advisable; at a first cost to the United States presently estimated at $57,814,000, provided that the exact amount of non-Federal contributions shall be determined by the Chief of Engineers prior to project implementation. Non-Federal interests must agree to the following prior to implementation:

a. Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for construction and operation of the works;

b. Hold and save the United States free from damages due to the construction works except where such damages are due to the fault or negligence of the United States or its contractor;

c. Operate and maintain the works after completion;

d. Contribute 25 percent of the project costs associated with fish and wildlife enhancement;

e. Contribute 50 percent of the project costs associated with recreation; and

f. Assure adequate public access to the project.

Further, I recommend construction authorization of the plan of improvement to divert Mississippi River water to Lake Pontchartrain Basin and Mississippi Sound adjacent to the existing Bonnet Carre' Spillway, subject to cost-sharing and financing arrangements with the non-Federal sponsors that are satisfactory to the President and Congress.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels

within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

Robert C. Lee
Colonel, CE
Commanding

LETTERS OF INTENT

Exhibit 1

DAVID C. TREEN
GOVERNOR

State of Louisiana

DEPARTMENT OF NATURAL RESOURCES

FRANK P. SIMONEAUX
SECRETARY

January 26, 1984

Colonel Robert C. Lee
Commander and District Engineer
U. S. Army Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160

RE: Bonnet Carre Site, St. Charles Parish
Freshwater Diversion Project

Dear Colonel Lee:

The State of Louisiana contains nearly twenty-five percent of the nation's coastal wetlands within its boundaries. These highly productive habitats are being lost through erosion and saltwater intrusion at an alarming rate. We must take steps necessary to maintain and preserve these areas. Freshwater diversion projects offer an economically and technically feasible approach to help accomplish this end.

One area of particular concern is the hydrologic unit east of the Mississippi River that includes Lakes Maurepas, Pontchartrain, Catherine and Borgne, and Mississippi and Chandeleur Sounds and adjacent wetlands. The Louisiana legislature has been actively pursuing and developing a coastal protection program to help resolve problems associated with coastal erosion, saltwater intrusion, land subsidence and land loss. Acts 41 of the First Extra Session of 1981 and 669 of 1983 (La. R.S. 30:311-316) provide a vehicle to fund this program.

One of the high priority areas for a freshwater diversion structure is at the Bonnet Carre site in St. Charles Parish as defined by your current Mississippi and Louisiana Estuarine Areas Study. This structure has the potential for reducing saltwater intrusion and landloss, and will provide valuable nutrients to this highly productive marshland area.

I am pleased to advise you that the State of Louisiana, as authorized by La. R.S. 30:311-316, will provide Louisiana's share of the necessary funding and at the appropriate time will provide the assurances normally required for this type project. This letter, therefore, states our intention to cooperate with the Federal Government to the extent required by law in the implementation of the project, as well as our intention to provide, or to arrange for an appropriate

P.O. BOX 44396 . BATON ROUGE, LA. 70804 . PHONE 342-4500

NATURAL RESOURCES BUILDING

public body of the State of Louisiana to provide, the local cooperation required by the law authorizing this project.

It is requested that you proceed with acquisition of funds necessary to develop plans to construct this facility at the earliest possible date. We will provide coordination for the project through the Department of Natural Resources in cooperation with the Office of Public Works and other appropriate entities in order to develop this site.

Sincerely,

Frank P. Simoneaux

FPS:DC/ct

cc: Honorable David C. Treen
Senator Samuel B. Nunez, Jr.
Senator Ron Landry
Representative Ralph Miller
Office of Public Works
Senate Committee on Natural Resources
House Committee on Natural Resources

STATE OF MISSISSIPPI
OFFICE OF THE GOVERNOR
JACKSON 39205

BILL ALLAIN
GOVERNOR

February 29, 1984

POST OFFICE BOX 139

Colonel Robert C. Lee, District Engineer
New Orleans District, Corps of Engineers
Department of the Army
Post Office Box 60267
New Orleans, Louisiana 70160

Attention of: Planning Division
Regional Planning Branch

Dear Colonel Lee:

The tentatively selected plan for freshwater diversion from the Mississippi River into Lake Pontchartrain Basin and Mississippi Sound has been made available to me.

This is to advise that it is our intention to cooperate with the Corps of Engineers to the extent required by law.

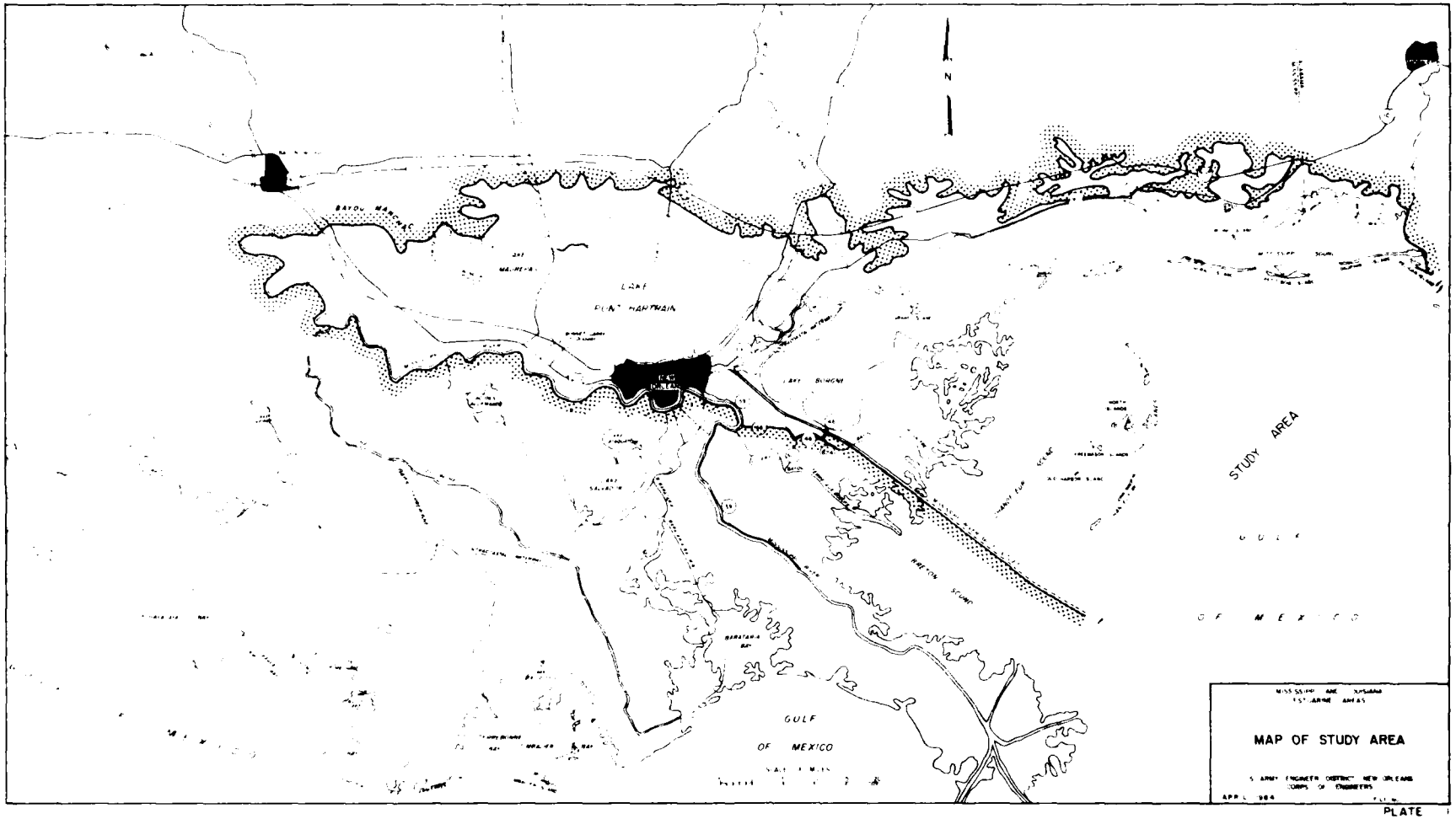
You are requested to proceed to submit your final report and EIS through channels to The Congress for project authorization.

Respectfully,

Bill Allain

BILL ALLAIN
GOVERNOR

BA:gjp


N
LAKE PONTCHARTRAIN
LAKE BORGNE
STUDY AREA
GULF OF MEXICO
MAP OF STUDY AREA

PLATE

legend

ac mi² yr

LOSS

very severe (>4)

severe (2-4)

moderate (1-2)

low (0-1

GAIN

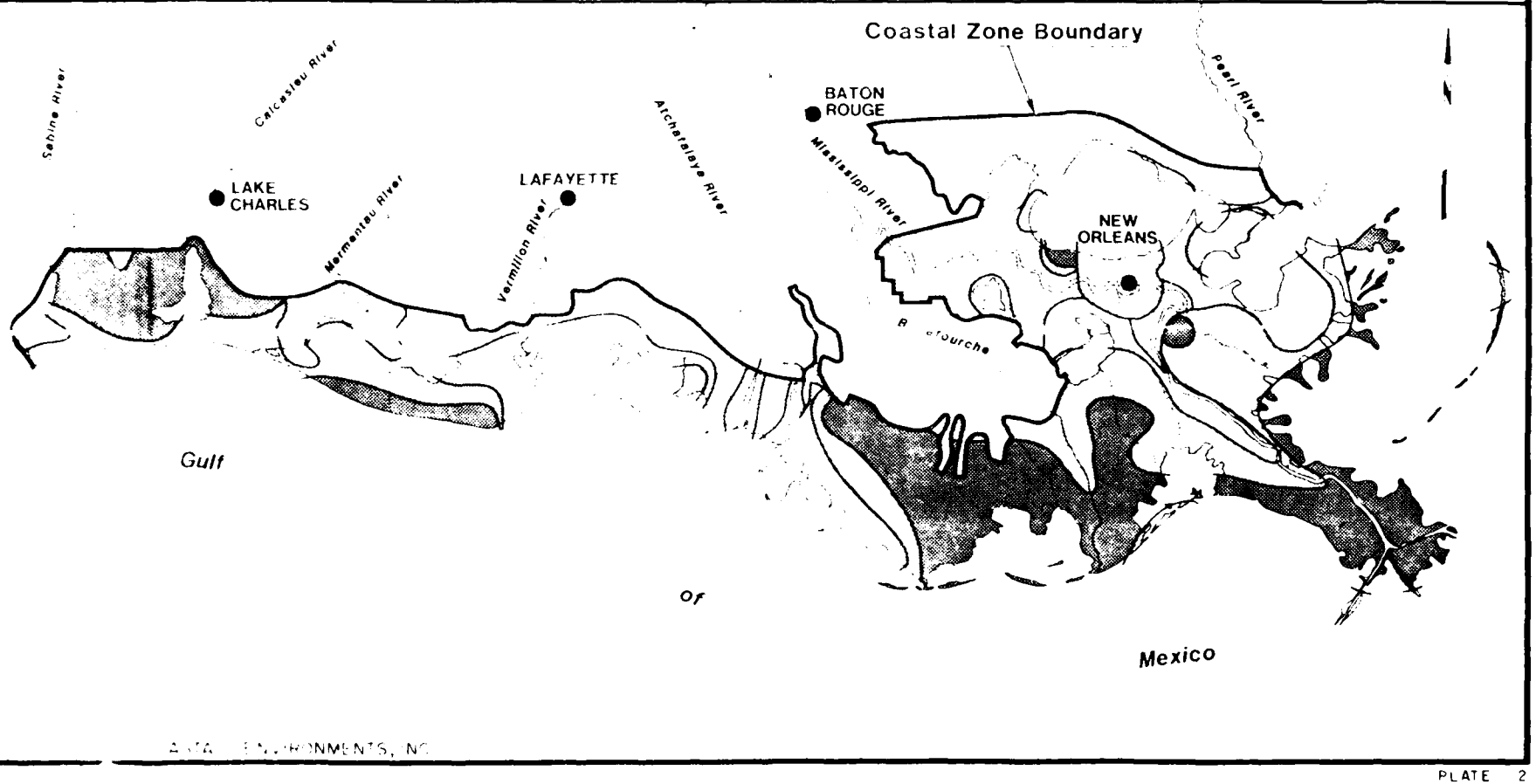
LOUISIANA COASTAL ZONE

LAND CHANGE RATES 1955-1978

ALL VALUES AVERAGED OVER THE GROSS LAND AREA WITHIN EACH 7.5 MIN. TOPOGRAPHIC QUADRANGLE

miles 0 25 50

kilometers 0 25 50



ATA ENVIRONMENTS, INC.

PLATE 2

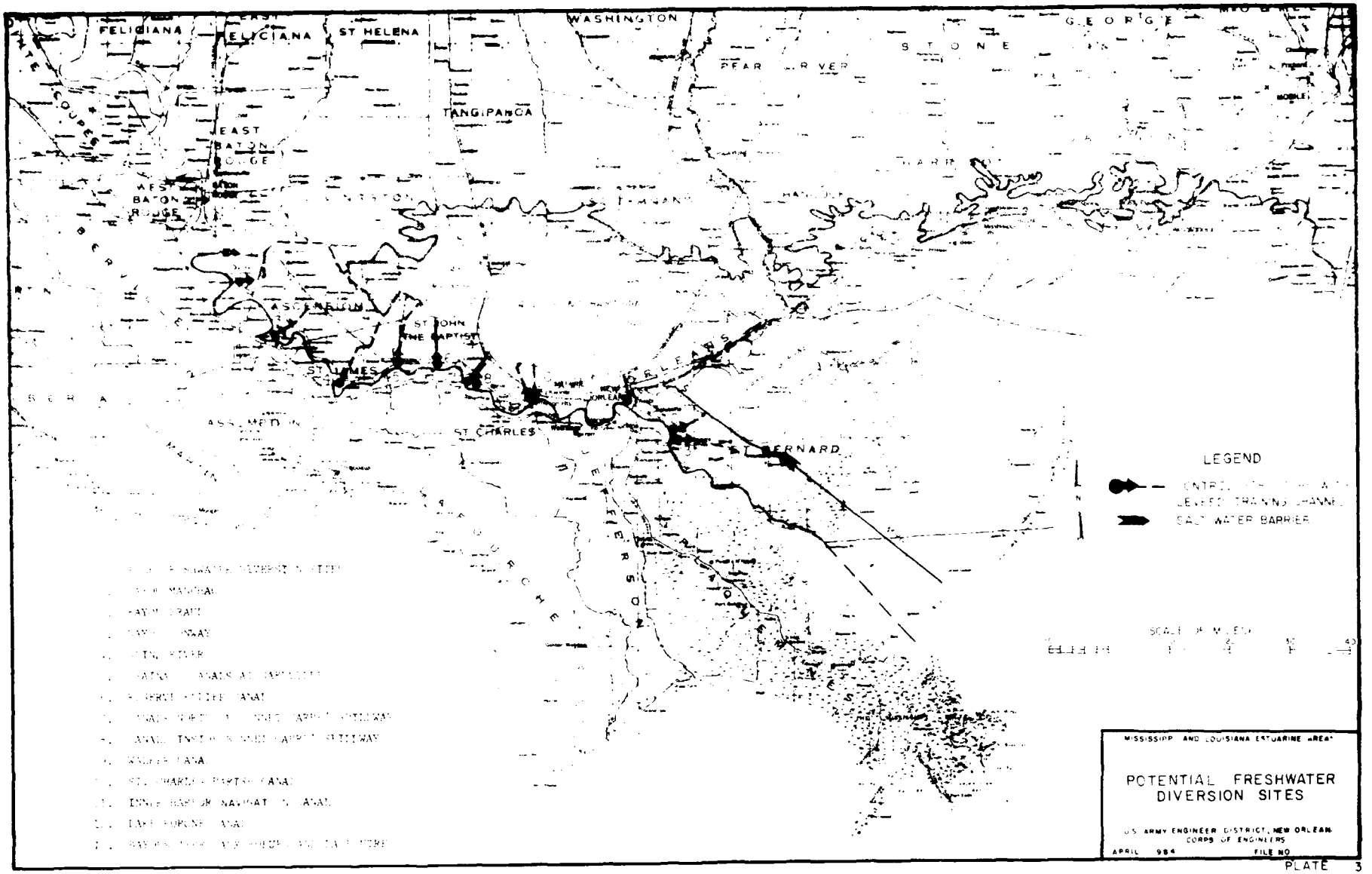
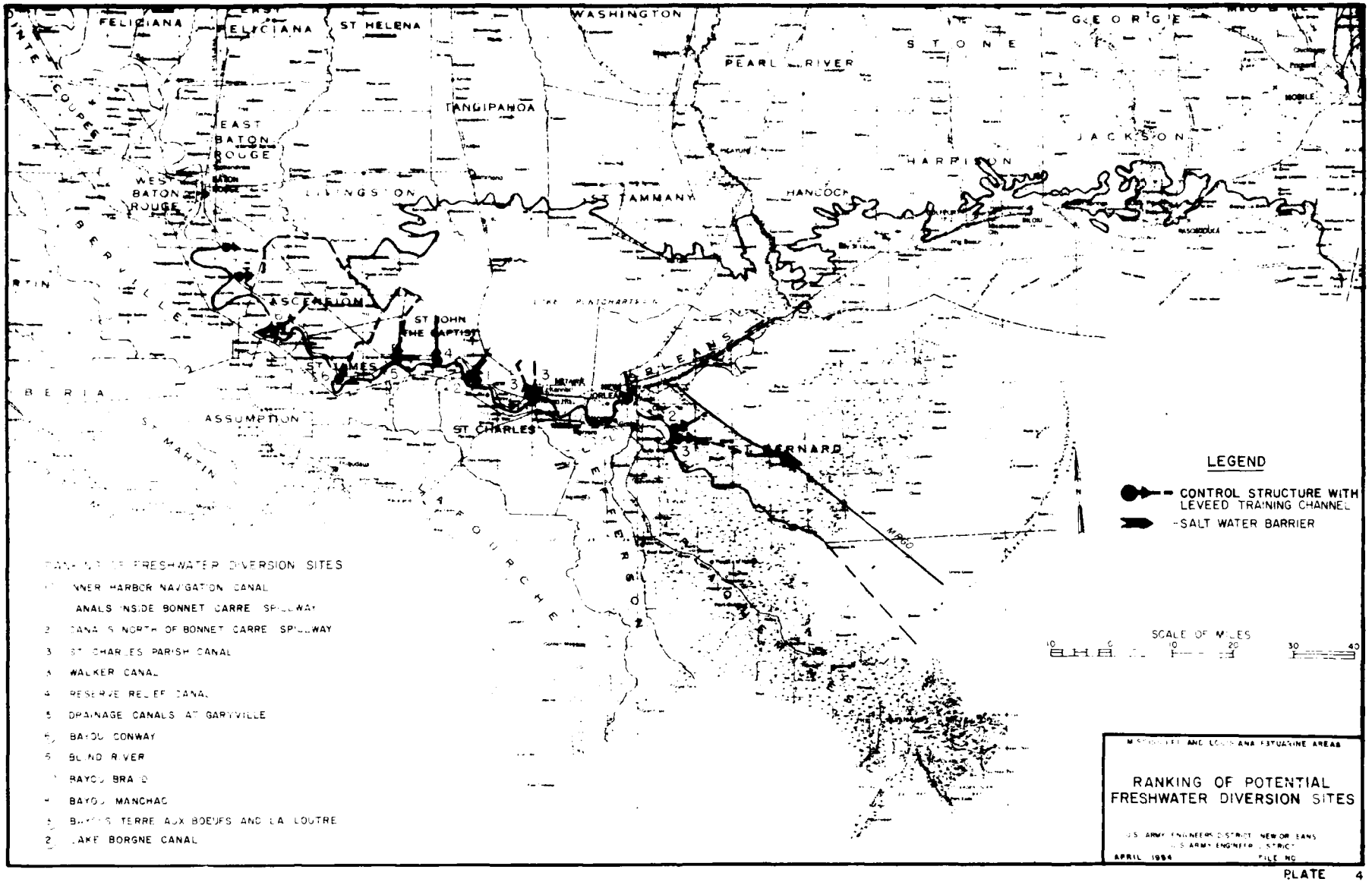

FELICIANA
FELICIANA
ST HELENA
WASHINGTON
GEORGE
STONE
PEARL RIVER
TANGIPAHOA
EAST BATON ROUGE
WEST BATON ROUGE
ASCENSION
ST JOHN THE BAPTIST
ST JAMES
NEW ORLEANS
ST CHARLES
ST BERNARD
LEGEND
LEVEE TRANS CHANNEL
SALT WATER BARRIER
MISSISSIPPI AND LOUISIANA ESTUARINE AREA
POTENTIAL FRESHWATER DIVERSION SITES
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
APRIL 984
FILE NO

PLATE 3



RANKING OF FRESHWATER DIVERSION SITES

1. INNER HARBOR NAVIGATION CANAL
   CANALS INSIDE BONNET CARRE SPILLWAY
2. CANAL S NORTH OF BONNET CARRE SPILLWAY
3. ST CHARLES PARISH CANAL
4. WALKER CANAL
4. RESERVE RELIEF CANAL
5. DRAINAGE CANALS AT GARYVILLE
5. BAYOU CONWAY
6. BLIND RIVER
7. BAYOU BRA D
8. BAYOU MANCHAC
9. BAYOUS TERRE AUX BOEUFS AND LA LOUTRE
2. LAKE BORGNE CANAL

MISSISSIPPI AND LOUISIANA ESTUARINE AREAS

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

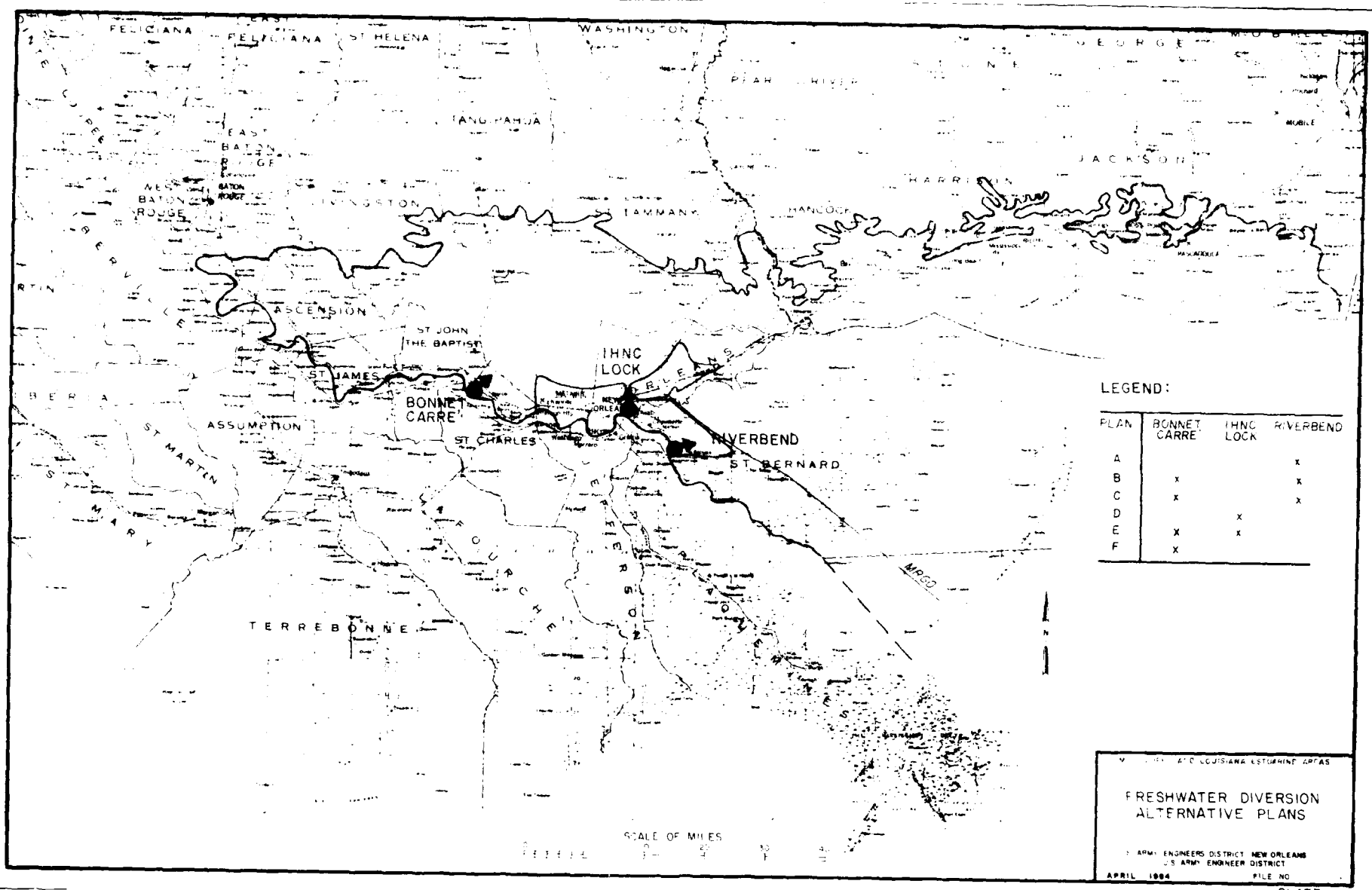
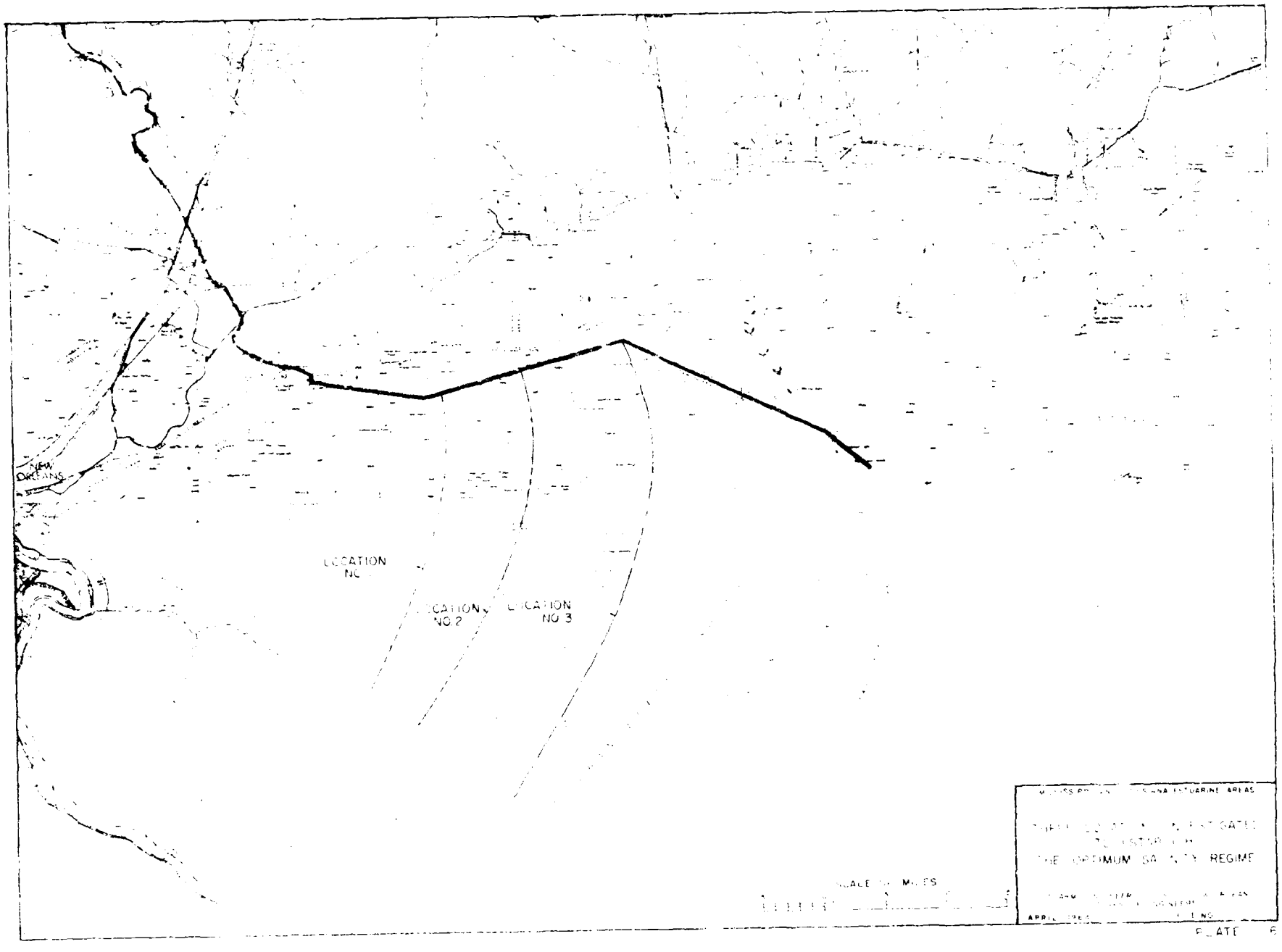

FELICIANA
EAST FELICIANA
ST HELENA
WASHINGTON
EAST BATON ROUGE
WEST BATON ROUGE
LIVINGSTON
ST TAMMANY
HANCOCK
HARRISON
JACKSON
ASCENSION
ST JOHN THE BAPTIST
ST JAMES
IHNC LOCK
BONNET CARRE
ASSUMPTION
ST CHARLES
RIVERBEND
ST BERNARD
ST MARTIN
ST MARY
TERREBONNE
MRGO
SCALE OF MILES
LEGEND:
PLAN | BONNET CARRE | IHNC LOCK | RIVERBEND
A | | | x
B | x | | x
C | x | | x
D | | x |
E | x | x |
F | x | |
FRESHWATER DIVERSION ALTERNATIVE PLANS
ARMY ENGINEERS DISTRICT NEW ORLEANS
US ARMY ENGINEER DISTRICT
APRIL 1984
FILE NO

PLATE 5


NEW ORLEANS
LOCATION NO.
LOCATION NO.2
LOCATION NO.3
SCALE IN MILES
PLATE

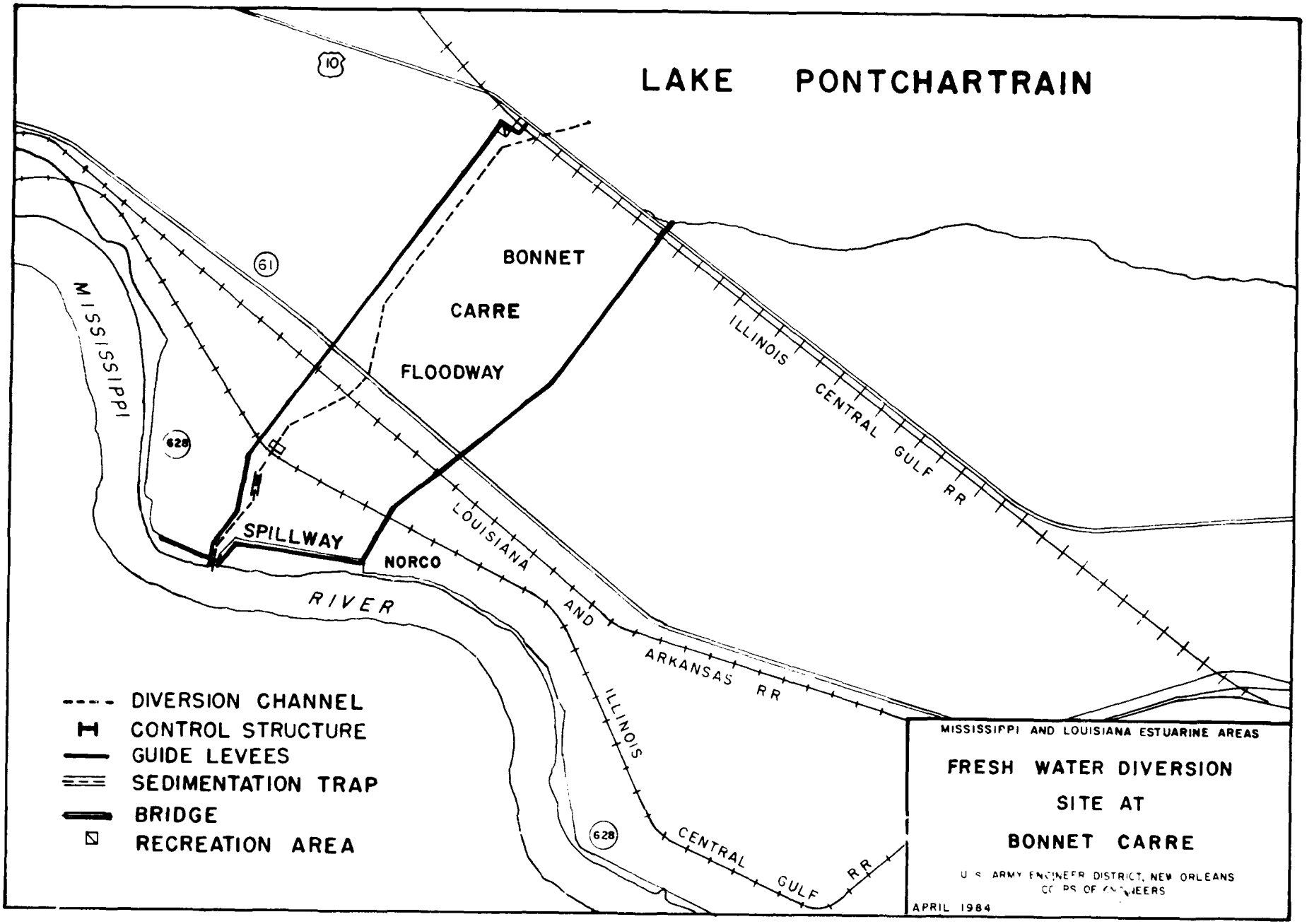
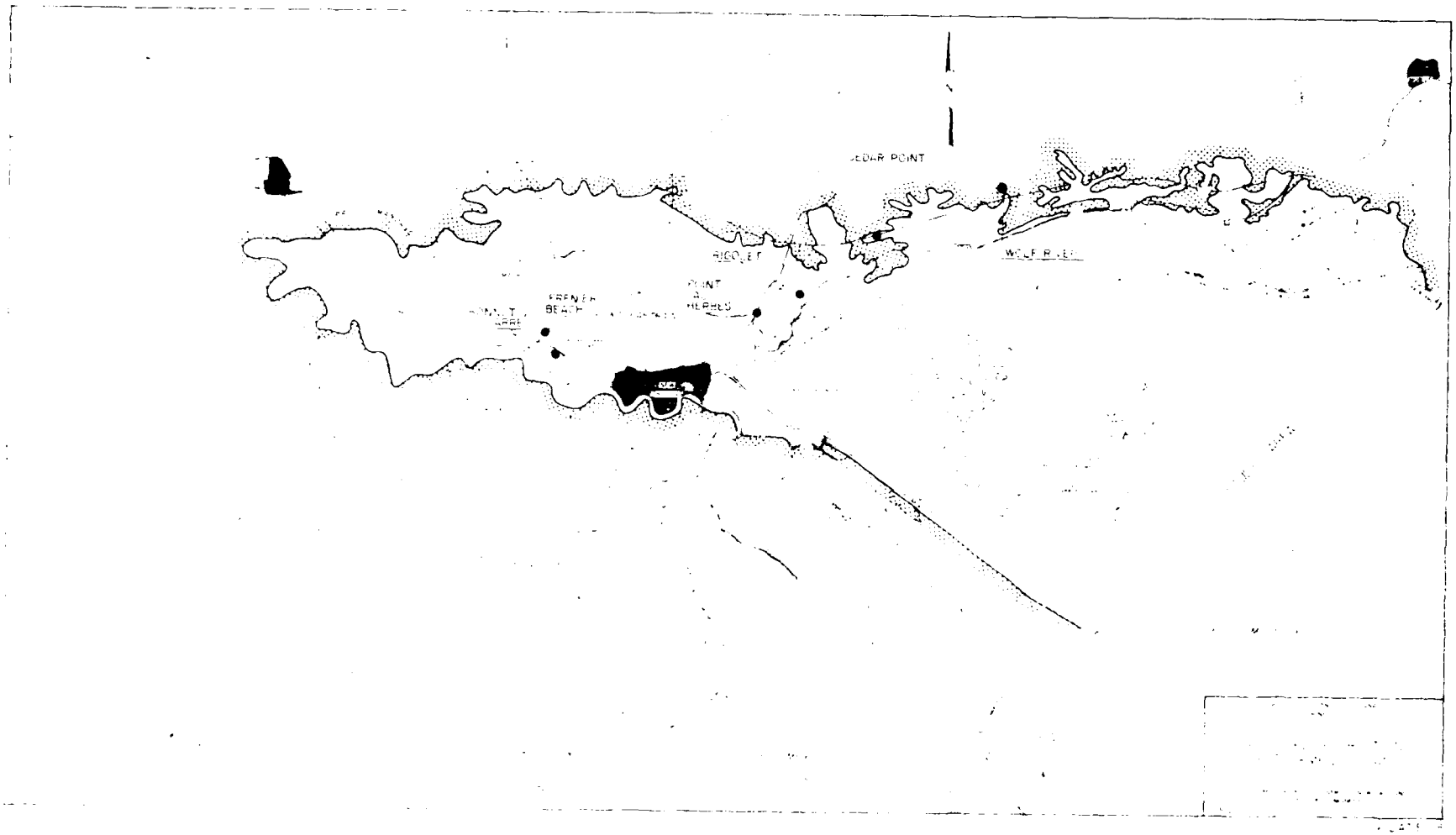

LAKE PONTCHARTRAIN
10
61
628
628
BONNET
CARRE
FLOODWAY
SPILLWAY
NORCO
MISSISSIPPI
RIVER
ILLINOIS CENTRAL GULF RR
LOUISIANA AND ARKANSAS RR
ILLINOIS CENTRAL GULF RR
DIVERSION CHANNEL
CONTROL STRUCTURE
GUIDE LEVEES
SEDIMENTATION TRAP
BRIDGE
RECREATION AREA
MISSISSIPPI AND LOUISIANA ESTUARINE AREAS
FRESH WATER DIVERSION
SITE AT
BONNET CARRE
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
APRIL 1984

PLATE 7


CEDAR POINT
FRENCH BEACH

END

FILMED

5-85

DTIC