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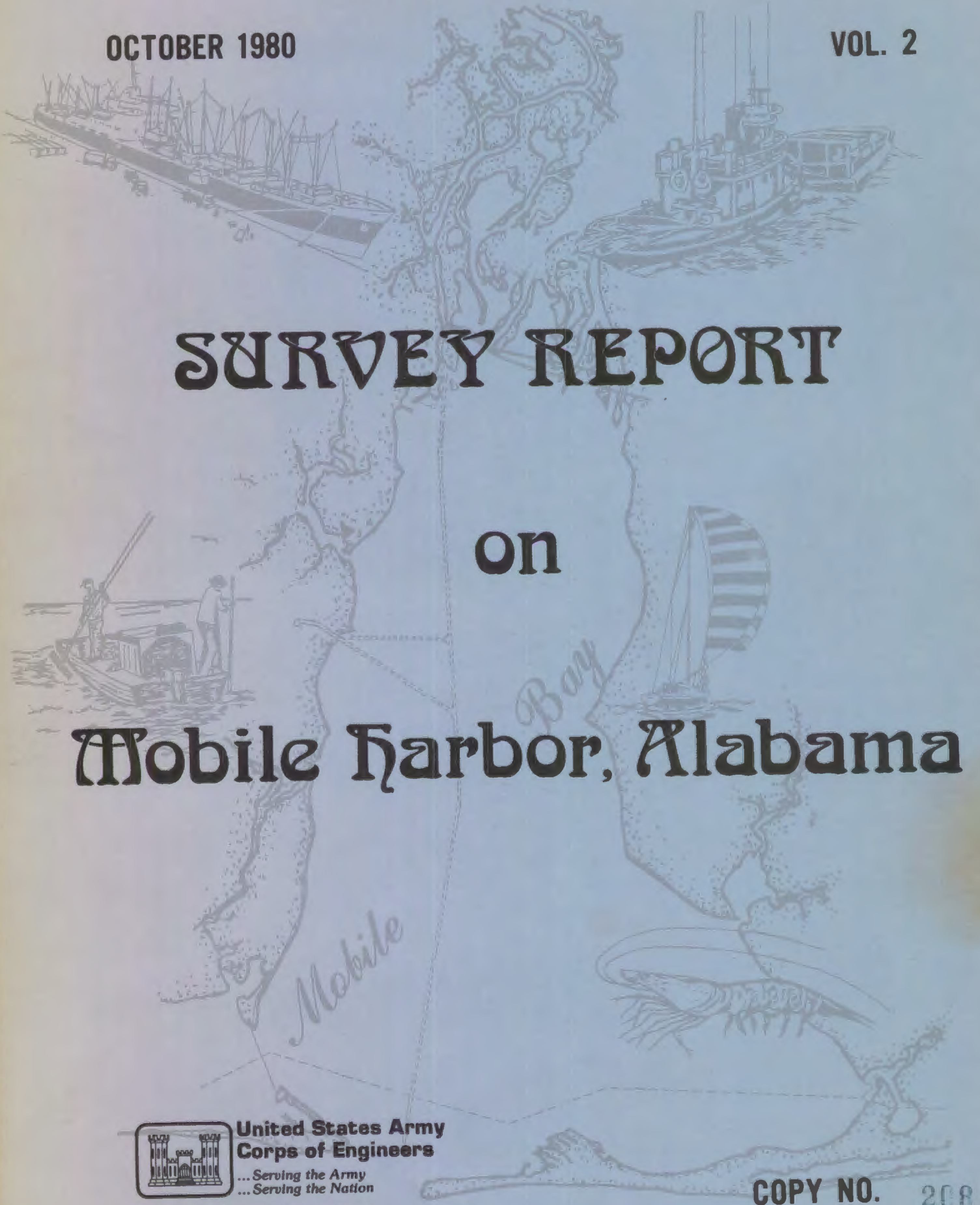

SURVEY REPORT

on

Mobile Harbor, Alabama

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation
Mobile District

COPY NO. 208

FOREWORD

This feasibility report presents a recommended plan and detailed alternatives for navigation improvements at Mobile Harbor, Alabama. All plans are compared based on October 1978 cost and benefit data. The cost and benefits of the recommended plan have been updated to August 1980 price levels and construction time shown as four and one-half years. This information is available in attachment 1 of the Summary Report.

MOBILE HARBOR, ALABAMA

FEASIBILITY REPORT

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MOBILE HARBOR, ALABAMA
FEASIBILITY REPORT
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PREPARED BY
MOBILE DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

SECTION A

THE STUDY AND REPORT

THE STUDY AND REPORT

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SECTION A

THE STUDY AND REPORT

1. This section of the report presents background and institutional information to introduce the study and to describe its presentation in the report.

PURPOSE AND AUTHORITY

2. The purpose of this study is to determine the need and justification for modification, in any way, of the existing Federal navigation project for deep-draft shipping at Mobile Harbor, Alabama. The total water and related land resources problems and needs and their relationship to the navigation system serving Mobile Harbor have been studied to ensure that all measures relating to these problems and needs will be properly considered in the formulation of water resource plans. Recommendations of the study are presented in the main report.

3. The study and the report are in compliance with the following resolution adopted 24 June 1965 by the Public Works Committee, United States House of Representatives:

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, That the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on Mobile Harbor, Alabama, published as House Document Numbered 74, Eighty-third Congress, first session, and other reports with a view to determining whether the existing project should be modified in any way at this time.

SCOPE OF THE STUDY

4. The geographical scope of the study is limited to Mobile Bay and Delta and the counties of Mobile and Baldwin which comprise the land mass which surrounds the bay and delta regions. The study is limited to the investigation of the water and related land resources problems of this region while the impacts and effects of plans will be investigated without regard to geographical boundaries.

5. This study is designed to assess the overall water and related land resources problems and needs of Mobile Harbor and to assess the capability of the navigation facilities of Mobile Harbor to accommodate existing and projected navigation traffic. Plans were formulated to meet the identified problems and needs, and costs and benefits were estimated for the various plans. An assessment was made of the economic, environmental, and social impacts of final plans and a plan of action was selected. The depth and detail of the study were commensurate with the objective of selecting the most suitable plan and establishing its feasibility and acceptability.

6. An earlier interim report established the feasibility of providing a ship channel into the Theodore Industrial Complex. A 40- x 400-foot channel was authorized in 1970. The need for this channel was reinvestigated and was reestablished in March 1976 and reauthorized by Congress in October 1976. The authorized Theodore Ship Channel is considered to be in place for the purpose of this study. Since the Mobile Ship Channel limited the consideration of ship channels in excess of 40 feet to Theodore, this overall study of Mobile Harbor addresses the need for enlarged channel dimensions to the Theodore Industrial complex in conjunction with the overall study of Mobile Harbor.

PLANNING OBJECTIVES

7. The "Principles and Standards for Planning Water and Related Land Resources" requires that Federal and federally assisted water and related land planning be directed to achieve National Economic Development and Environmental Quality as equal national objectives. Principles and Standards also requires that the impacts of proposed actions be measured and the results displayed or accounted for in terms of contributions to four accounts: National Economic Development, Environmental Quality, Regional Development, and Social Well-Being.

8. Specific planning objectives for this study derive from Mobile Harbor's need to more efficiently and safely accommodate the large vessels desiring to call at the port. To achieve these ends it it necessary to widen and deepen the ship channels, and to provide additional turning basins, anchorages, and auxiliary facilities. Also sought is a long-range solution to dredged material disposal from the Mobile River and Bay sections of Mobile Harbor, and the investigation of measures for shoreline erosion protection which could be implemented in conjunction with plans for improving navigation facilities at Mobile Harbor. In conjunction with these goals it is the local citizenry's desire to preserve and enhance the ecologic and recreational integrity of Mobile Bay.

STUDY PARTICIPANTS AND COORDINATION

9. The Corps of Engineers was responsible for the conduct and coordination of the study, the formulation of a plan, and the preparation of the feasibility report to present that plan. At the District level, a multi-disciplinary team was used to conduct the study and to prepare the report. Major team members consisted of a study manager, regional economist, transportation economics analyst, sociologist, ecologist, and

an environmental resources analyst. Additional assistance was rendered by soils engineers, structural engineers, hydraulics engineers, dredging engineers, cost estimators, and other District staff as required. The Waterways Experiment Station of the U.S. Army Corps of Engineers constructed and verified a physical hydraulic model of Mobile Bay. This model was used to evaluate the effects that alternative plans for dredged material disposal had on salinity regimens in Mobile Bay. These model tests and studies were conducted under the supervision of the Waterways Experiment Station with coordination and guidance from Mobile District personnel.

10. Reynolds, Smith and Hill, Architects-Engineers-Planners, Incorporated was selected as the consultant to conduct a preliminary engineering and economic study of various practical dredging and spoil disposal techniques for Mobile Harbor. The Gulf South Research Institute prepared a report which identified existing social, economic, and environmental conditions in the area of Mobile Harbor and projected possible future conditions without major improvements to existing harbor facilities. Water and Air Research, Incorporated conducted an investigation to determine the effects of maintenance dredging of the Mobile Bay Ship Channel upon the distribution of coliform bacteria and on the benthic invertebrates and plankton biota in the bay.

11. Study activities were also coordinated with several key governmental entities and agencies on a continuing and as needed basis. These included the Alabama State Docks Department, the city of Mobile, the county of Mobile, the Alabama Development Office, the Alabama Department of Conservation and the Natural Resources, and the South Alabama Regional Planning Commission. The Alabama State Docks Department and the South Alabama Regional Planning Commission also furnished substantial amounts of data and information used in the study. The Mobile Bar Pilots Association provided a continual source of information on the navigation and safety problems and needs for Mobile Harbor.

12. Sincere efforts were extended throughout the course of the study to provide opportunities for active participation and involvement by all segments of the public. The initial public meeting for the study was held on 15 April 1967 for the purpose of informing the public about the study and to obtain their views as to desired modifications to the existing project for Mobile Harbor. Study efforts were directed for the next several years to the authorization and advanced engineering and design studies for the Theodore Ship Channel and are not reported here. Early in 1975, a special committee which became known as the Mobile Harbor Advisory Committee was formed for the purpose of providing access to the planning process for a wide cross-section of the various publics in the Mobile region. Membership on the committee was comprised of individuals from the following interest groups:

- Individual citizens
- Business and commerce
- Local government
- Environmental interests
- State Government
- Port interests
- Organized labor
- Fish and wildlife interests

Several workshop meetings were held with this committee during the major stages in plan formulation. This committee served a vital role to assess the public response to alternative plans and to provide a public contact point through key stages in the plan formulation process.

13. On 22 November 1976, a plan formulation public meeting was held on the Mobile Harbor, Alabama, study. The purpose of this meeting was to present the identification of tentative plans to be carried into the final detail phase of the study.

14. (Paragraph on coordination of the draft report).

THE REPORT

15. This report has been arranged as a main report and two appendices. The main report is a presentation of the feasibility study for modification of the existing Federal navigation project for Mobile Harbor, Alabama. The main report includes a description of the study area and an assessment of the resource base for the study area; an assessment of the needs and problems of the region from both environmental and eocnomic viewpoints; a description of the process of formulation of a plan to meet these needs; a summary of the environmental, social, and economic effects of the detail plans to meet the needs; a description of the selected plan and the rationale for its selection; a summary of project economics indicating benefits, costs, and economic justification of the selected plan; the division of plan responsibilities between Federal and non-Federal interests; and the recommendations for implementing the selected plan.

16. Appendix 1 is the Environmental Impact Statement. Appendix 2 contains the pertinent correspondence on the report and gives the views and comments of those who reviewed the report in draft stage.

PRIOR STUDIES AND REPORTS

17. Dredging to provide a navigation channel in Mobile Bay and Mobile River began as a result of enactment of the River and Harbor Act of 20 May 1826 by the U.S. Congress. Subsequently, further modifications to the channel were authorized and the original Federal project was enlarged by the addition of the Arlington, Garrows Bend, and Hollingers Island Channels within the bay, a channel into Chickasaw Creek from the Mobile River, and maintenance snagging in Three Mile Creek.

18. The report published as House Document Number 74, 83rd Congress, 1st Session, recommended modification of the existing project to provide a 42- by 600-foot channel about 1.5 miles long across Mobile Bay; a 40- by 400-foot channel in Mobile Bay to the mouth of Mobile River; a 40-foot channel in Mobile River to the Cochrane Bridge, varying in width from 500 to 775 feet; and several branch channels, turning basins and anchorages. The improvement was authorized by the River and Harbor Act approved 3 September 1954. The existing project was completed in 1965.

19. Due to a request by local interests to expedite studies of the Theodore Ship Channel, the Chief of Engineers authorized an interim report limited to consideration of that project on 6 March 1968. The Senate Public Works Committee on 16 July 1970 and the House Public Works Committee on 15 December 1970, under provision of Section 201 of the 1965 Flood Control Act, authorized a 40- by 400-foot channel, branching from the main ship channel and extending through a land cut to the Theodore Industrial Park. A shoreline turning basin and anchorage area are also included in the authorization. Construction was authorized in October 1976.

20. The various authorizing legislations for Mobile Harbor are listed in Tables A-1 through A-8.

TABLE A-1 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR

ACTS DATED	LOCATION	WORK AUTHORIZED MOBILE RIVER	DOCUMENT AND REPORT
Riv. & Har. Act of 20 May 1826	Mobile River & Bay	A channel 10 feet deep dredged through the shoals in Mobile Bay up to the city of Mobile. Construction 1826-1857.	NA
Riv. & Har. Act of 11 July 1870	Mobile River & Bay	Channel depth increased to 13 feet. Construction 1870-1876.	NA
Riv. & Har. Act of 3 March 1879	Mobile River & Bay	Project adopted to provide a channel 17 feet deep and 200 feet wide.	NA
Riv. & Har. Act of 11 August 1888	Mobile River & Bay	Modified to provide a 23-foot depth.	NA
Riv. & Har. Act of 1890	Mobile River & Bay	Modified to provide a top width of 280 feet.	NA
Riv. & Har. Act of 1899	Mobile River	Provide a 23- by 100-foot channel from the entrance of the bay to the mouth of Chickasaw Creek.	NA

TABLE A-1 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR (Cont'd)

ACTS DATED	LOCATION	WORK AUTHORIZED MOBILE RIVER	DOCUMENT AND REPORT
Riv. & Har. Act of 13 June 1902	Mobile River	Removal of sunken obstructions as part of maintenance work.	NA
Riv. & Har. Act of 25 June 1910	Mobile River	Provide a channel width of 300 feet and depth of 27 feet.	
Riv. & Har. Act of 8 August 1917	Mobile River	Provide a channel of 30 feet x 300 feet.	H. D. 1763, 64th Cong., 2d Sess.
Riv. & Har. Act of 3 July 1930	Mobile River	Provide a channel 32 feet deep x 500 feet wide from the mouth to a point about 5,000 feet below the mouth of Threemile Creek, and 300 feet wide thence to the highway bridge; and easing the bends at the mouth and about 3,000 feet above, with the new head of the improvement to be at the highway bridge about 1,000 feet below the mouth of Chickasaw Creek.	H. D. 26, 71st Cong., 2d Sess.

TABLE A-1 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR (Cont'd)

ACTS DATED	LOCATION	WORK AUTHORIZED MOBILE RIVER	DOCUMENT AND REPORT
Riv. & Har. Act of 26 August 1937	Mobile River	Provide extension of the 500-foot-wide channel in Mobile River to the highway bridge at mile 4.6.	H. D. 44, 75th Cong.
Riv. & Har. Act of 2 March 1945	Mobile River	Provide a channel 700 feet wide in Mobile River from the mouth to the first bend, 775 feet wide through the first bend, and 600 feet wide thence to Alabama State Docks Pier A, south, and a turning basin opposite the Alabama State Docks about 2,500 feet long, 800 feet wide at the lower end, and 1,000 feet wide at the upper end, all to a depth of 32 feet.	H. D. 739, 79th Cong., 2d Sess.
Riv. & Har. Act of 3 Sep 1954		Provide a 40-foot channel in Mobile River to the highway bridge, the width varying from 500 to 775 feet.	H. D. 74, 83rd Cong., 1st Sess.

TABLE A-1 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR (Cont'd)

ACTS DATED	LOCATION	WORK AUTHORIZED MOBILE RIVER	DOCUMENT AND REPORT
Riv. & Har. Act of 3 Sep 1954	Mobile River	Provide a turning basin 40 feet deep, 2,500 feet long, and 800 to 1,000 feet wide, opposite the Alabama State Docks.	H. D. 74, 83rd Cong., 1st Sess.
Riv. & Har. Act of 3 Sep 1954	Mobile River	Provide a turning basin 40 feet deep, 800 feet wide, and 1,400 feet long opposite Magazine Point.	H. D. 74, 83rd 1st Sess. 2d Sess.

TABLE A-2 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR

ACTS DATED	LOCATION	WORK AUTHORIZED MOBILE BAY	DOCUMENT AND REPORT
Riv. & Har. Act of 20 May 1826	Mobile River & Bay	A channel 10 feet deep dredged through the shoals in Mobile Bay up to the city of Mobile. Construction 1826-1857.	NA
Riv. & Har. Act of 11 July 1970	Mobile River & Bay	Channel depth increased to 13 feet. Construction 1870-1876.	NA
Riv. & Har. Act of 3 March 1879	Mobile River & Bay	Project adopted to provide a channel 17 feet deep and 200 feet wide.	NA
Riv. & Har. Act of 11 August 1888	Mobile River & Bay	Modified to provide a 23-foot depth.	NA
Riv. & Har. Act of 1890	Mobile River & Bay	Modified to provide a top width of 280 feet.	NA
Riv. & Har. Act of 25 June 1910	Mobile Bay	Provide a channel width of 200 feet and depth of 27 feet.	NA

TABLE A-2 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR (Cont'd)

ACTS DATED	LOCATION	WORK AUTHORIZED MOBILE BAY	DOCUMENT AND REPORT
Riv. & Har. Act of 8 March 1917	Mobile Bay	Provide a channel of 30 feet x 300 feet.	H. D. 1763, 64th Cong., 2d Sess.
Riv. & Har. Act of 3 July 1930	Mobile Bay	Provide a channel of 32 feet x 300 feet through the bay to the Quarantine Station, and 350 feet wide thence to the mouth of the river; a basin 32 feet deep, 200 feet wide and 1,000 feet long, on the west side of the channel at the Quarantine Station.	H. D. 26, 71st Cong., 2d Sess.
Riv. & Har. Act of 2 March 1945	Mobile Bay	Provide an anchorage area 32 feet deep, 200 feet wide and about 2,000 feet long on the west side of Mobile Bay Channel at the Quarantine Station by extending the existing anchorage southward 500 feet and northward to an intersection with the Mobile River Channel.	H. D. 739, 79th Cong., 2d Sess.

TABLE A-2 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR (Cont'd)

ACTS DATED	LOCATION	WORK AUTHORIZED MOBILE BAY	DOCUMENT AND REPORT
Riv. & Har. Act of 3 Sep 1954	Mobile Bay	Provide a 40- by 400-foot channel in Mobile Bay to the mouth of Mobile River (widen along west side).	H. D. 74, 83rd Cong., 1st Sess.
Riv. & Har. Act of 3 Sep 1954		Provide for an anchorage area 32 feet deep, 100 feet wide, and 2,000 feet long opposite the site formerly occupied by the U.S. Quarantine Station at McDuffie (Sand) Island prior to widening the Mobile Bay Channel as authorized in 1954, the Quarantine Station anchorage was maintained to a project width of 200 feet.	H. D. 74, 83rd Cong., 1st Sess.

TABLE A-3 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR

ACTS DATED	LOCATION	WORK AUTHORIZED MOBILE BAR	DOCUMENT AND REPORT
Riv. & Har. Act of 13 June 1902	Mobile Bar Channel	Provide 30 feet x 300 feet across the bar.	
Riv. & Har. Act of 8 March 1917	Mobile Bar Channel	Provide 33 feet x 450 feet across the bar.	H. D. 1763, 64th Cong., 2d Sess.
Riv. & Har. Act of 3 July 1930	Mobile Bar Channel	Provide 36 feet x 450 feet across the bar.	H. D. 26, 71st Cong., 2d Sess.
Riv. & Har. Act of 3 Sep 1954	Mobile Bar Channel	Provide 42-foot x 600-foot channel about 1.5 miles long across Mobile Bar.	H. D. 74, 83rd Cong., 1st Sess.

TABLE A-4 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR

ACTS DATED	LOCATION	WORK AUTHORIZED ARLINGTON & GARROWS BEND	DOCUMENT AND REPORT
Riv. & Har. Act of 7 Oct 1940	Garrows Bend	Provide a channel 27 feet deep and 125 feet wide from the Mobile River Channel at its mouth through Garrows Bend to and including a turning basin of like depth 250 feet wide and 800 feet long opposite National Gypsum Company Plant.	H. D. 221, 76th Cong., 1st Sess.
Riv. & Har. Act of 7 Oct 1940	Garrows Bend	Provide channel extension 27 feet deep and 125 feet wide to and including a turning basin of like depth 600 feet wide and 800 feet long adjacent to Arlington River.	H. D. 282, 76th Cong., 1st Sess.
Riv. & Har. Act of 2 Mar 1945	Garrows Bend	Provide existing channel through Garrows Bend from Choctaw Point to Arlington Pier, 27 feet deep and 150 feet wide with two turning basins, one 250 feet by 800 feet and the other 600 feet by 800 feet, both 27 feet deep.	H. D. 739, 79th Cong., 2d Sess.
Riv. Har. Act of 2 Mar 1945	Arlington Channel	Adoption of the channel, dredged during the 2nd World War, as an emergency measure alongside Arlington Pier from Mobile Bay Channel to the turning basin at the inner end of the Garrows Bend Channel, 27 feet deep and 150 feet wide.	H. D. 739, 79th Cong., 2d Sess.

TABLE A-4 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR (Cont'd)

ACTS DATED	WORK AUTHORIZED ARLINGTON & GARROWS BEND	DOCUMENT AND REPORT
Riv. & Har. Act of 3 Sep 1954	Construction by local interest of a solid-fill causeway across the Garrows Bend Channel between McDuffie Island and the mainland is also provided under the existing project.	Sec. 104, Act of 3 Sep 1954
	Provide a 27- by 150-foot channel from Mobile Bay Channel along Arlington Pier to a turning basin 800 feet long and 600 feet wide opposite Brookley AFB Ocean Terminal, and continuing thence to a turning basin 250 wide and 800 feet long in Garrows Bend, thence a 27- by 150-foot channel to the causeway linking McDuffie Island to the mainland. (1965 Report)	

TABLE A-5 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR

ACTS DATED	LOCATION	WORK AUTHORIZED CHICKASAW CREEK	DOCUMENT AND REPORT
Congressional Act 27 July 1917		No existing project for improvement except for occasional removal of water hyacinths from the lower 4 miles.	
Riv. & Har. Act of 30 August 1935		Provide a channel 18 feet deep and 150 feet wide extending from the mouth about 2-1/8 miles to Chickasaw Slips.	H. D. 47, 73rd Cong., 1st Sess.
Riv. & Har. Act of 2 March 1945	Chickasaw Cr.	Provide a channel 25 feet deep and generally 500 feet wide in Mobile River from the highway bridge to the mouth of Chickasaw Creek to a point 400 feet below the mouth of Shell Bayou.	H. D. 739, 79th Cong., 2d Sess.

TABLE A-6 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR

ACTS DATED	WORK AUTHORIZED THREEMILE CREEK	DOCUMENT AND REPORT
26 August 1937	For improvement of Threemile Creek by snagging from Mobile River to the Industrial Canal.	Rivers and Harbor Committee Doc. 69, 74th Cong., 1st Sess.

TABLE A-7 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR

ACTS DATED	WORK AUTHORIZED HOLLINGERS ISLAND CHANNEL	DOCUMENT AND REPORT
1943 Military Authorization	Federal Government dredged the Hollingers Island (Theodore) Channel and turning basin connecting the Mobile Bay Channel with terminal facilities on the western shore of the bay about 9 miles below the mouth of Mobile River. The channel is about 4 miles long and was dredged to a depth of 32 feet and a width of 175 feet. Construction was as a military project with no provisions for regular maintenance.	NA
Riv. & Har. Act of 1945	In 1948 the channel was redredged with emergency funds provided under authority of Section 3 of the 1945 River and Harbor Act.	

TABLE A-8 AUTHORIZATION OF FEDERAL IMPROVEMENT AT MOBILE HARBOR

ACTS DATED	WORK AUTHORIZED THEODORE SHIP CHANNEL	DOCUMENT AND REPORT
Flood Control Act of 1965	Existing Project: Provides for a channel 40 feet wide, branching from the main ship channel in Mobile Bay at a point about 2.8 miles north of Mobile Bay Light and extending northwesterly about 5.3 miles to the shore of Mobile Bay, thence via land cut 40 feet deep, 300 feet wide, and about 1.9 miles long, to and including a trapezoidal turning basin 40 feet deep and approximately 42 acres in area within the Theodore Industrial Park, and an anchorage basin 40 feet deep, 300 feet wide, and 1,200 feet long located adjacent to the proposed channel near the bay shoreline. The existing project was authorized by the Senate Public Works Committee on 16 July 1970 and the House Public Works Committee on 15 December 1970 under provision of Section 201 of the 1965 Flood Control Act.	**H. D. 91-335 91st Cong., 2d Sess.**
Riv. & Har. Act of 1976	The project for navigation improvements on Mobile Harbor, Theodore Ship Channel, Alabama, authorized by the House Public Works Committee on 15 December 1970 was modified to provide an additional turning basin adjacent to shoreline and a barge channel extension. Progress: Construction **was** initiated in the spring of 1979.	**H. D. 95-376 95th Cong., 2d Sess.**

SECTION B

RESOURCES AND ECONOMY OF STUDY AREA

RESOURCES AND ECONOMY

OF

STUDY AREA

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SECTION B

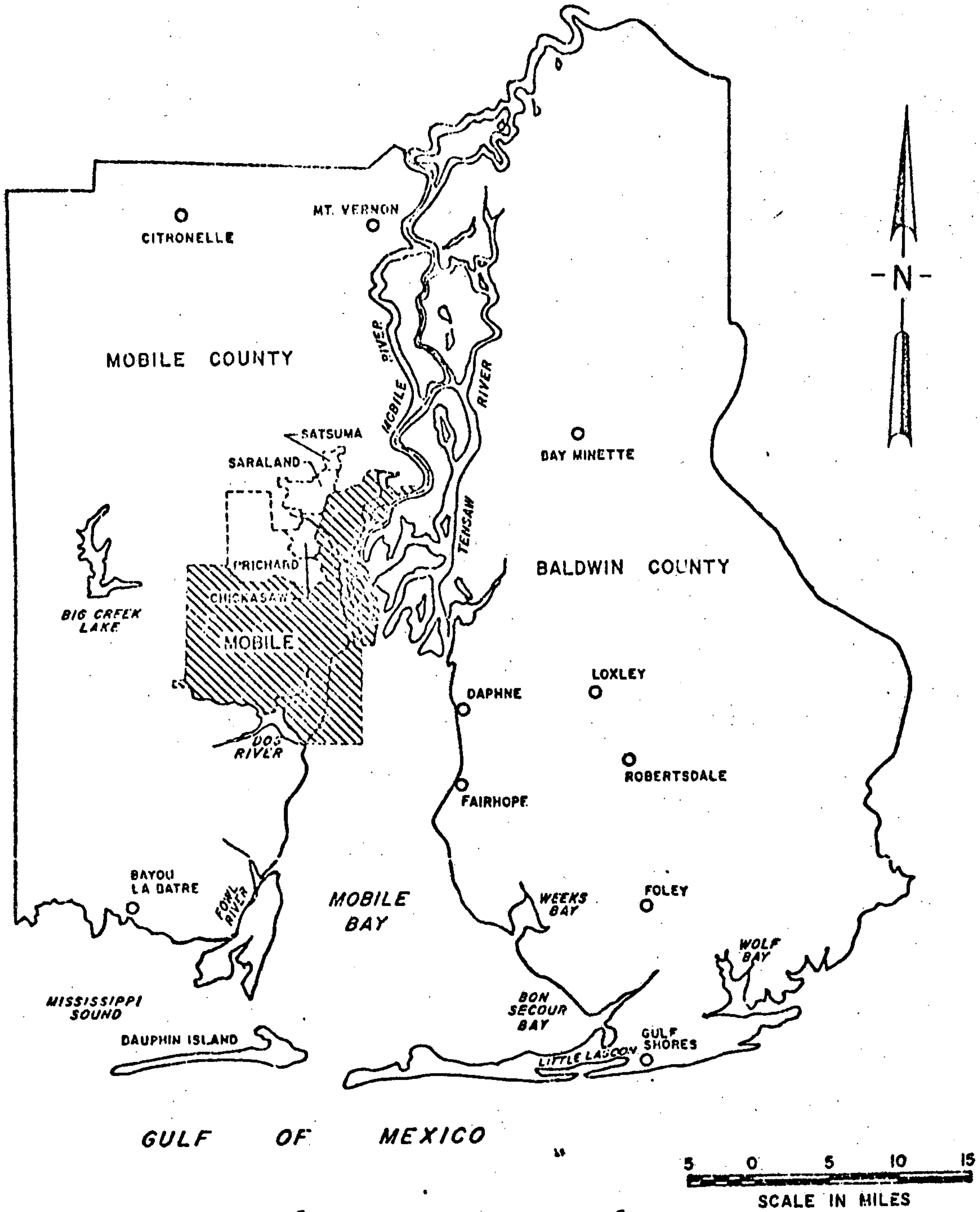
RESOURCES AND ECONOMY OF THE STUDY AREA

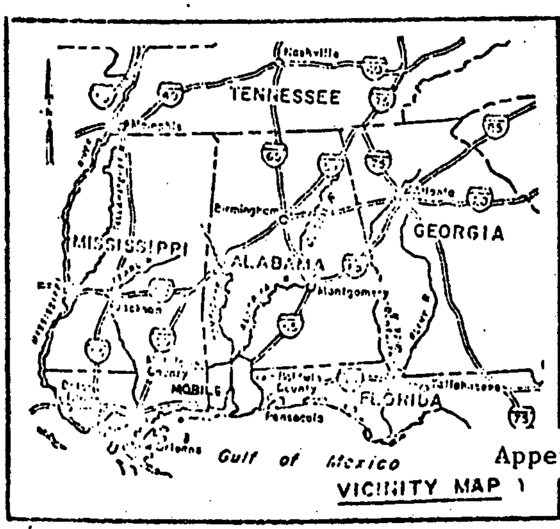
1. This section presents an economic, social, and environmental profile of the Mobile study area, outlining key factors which define the area's resource development, social patterns, economy, and environment. Industrial expansion, transportation, port development, and existing land uses are examined, as well as the region's human resources. Where applicable and within the limits of data availabilty, conditions are defined for the immediate counties of Mobile and Baldwin, and compared with similar statistics for the State of Alabama and the nation. The region's environmental setting and natural resources are also reviewed. These existing conditions are presented to provide a base line against which the effects of alternative actions will be evaluated.

DEVELOPMENT AND ECONOMY

GEOGRAPHICAL DESCRIPTION

2. The study area is located in the extreme southwest corner of Alabama, bordering Mississippi on the west and Florida on the southeast. It includes Mobile County, Baldwin County, and Mobile Bay. The southern borders of Mobile and Baldwin Counties lie on Mississippi Sound and the Gulf of Mexico and contain all of Alabama's coastal area. Mobile Bay and the northern delta divide Mobile and Baldwin Counties. These two counties form the Mobile Standard Metropolitan Statistical Area (SMSA). See Figure B-1 for a general map of the study area. Mobile Bay is situated at the mouth of an extensive river system which drains approximately 45,000 square miles within Alabama, Mississippi, Georgia, and Tennessee. Mobile Harbor is located at the mouth of the Mobile River, and the City of Mobile is on the west bank of the river near its mouth. The southern end of Mobile Bay opens into the Gulf of Mexico. The entrance to the bay is 46 miles west of Pensacola, Florida, and 104 miles northeast of the mouth of the Mississippi River.





Appendix 5
B-2

SURVEY REPORT
ON
MOBILE HARBOR, ALABAMA
STUDY AREA MAP

Figure B-1

PRINCIPAL ECONOMIC ACTIVITIES

3. The economy of the Mobile SMSA is based on its port and port-related activities, its natural resources and their use by industry, and the growing non-commodity producing, service-oriented industries. In 1977 the Port of Mobile ranked twelfth among U. S. port in "total all traffic," both foreign and domestic . Principal products handled through the port included iron and aluminum ores, coal and lignite, basic chemicals, crude petroleum, soybeans, and sand, gravel, and crushed rock. Since 1951 total commerce at the port has increased at a rate of about 6 percent annually.

4. An industry is considered basic if it exports products outside a region, making it a source of non-local income. Five of the major manufacturing industries in the study are are considered basic, including paper and allied products, shipbuilding and repair, chemicals and allied products, textiles and apparel, and lumber and wood products. In addition to bringing in non-local income, basic industries generate related secondary economic activites. Secondary industries account for 5 percent or more of the sales to, or purchases from, the basic industries. Broadly defined, the five major manufacturing industries embrace a complex of sub industries. The interrelationship among basic industries and related secondary industries in the study area is presented in table B-1.

5. OBERS projections (see table B-2), present earnings by industry for the United States, the State of Alabama, and the Mobile SMSA. The table refers to historical and estimated figures for the period 1962 to 1976. During these years the nation's total earnings by industry increased 85 percent, while the State of Alabama experienced a 78 percent growth rate, and the study area, a 55 percent growth rate. In contrast, the study area led the state and nation for the period 1970 to 1976 with a growth rate of 31 percent while the state and nation followed with 30 and 28 percent growth

Table B-1

Basic Industries and Related Secondary Industries

Basic Industries	Secondary Industries
Paper and Allied Products	Printing and Publishing Food and Kindred Products. Lumber and Wood Products. Wholesale and Retail Trade. Transportation and Warehousing. Chemicals and Selected Products.
Shipbuilding and Repair	Primary Iron and Steel Manufacturing. Transportation and Warehousing Wholesale and Retail Trade. Electrical Industrial Equipment and Apparatus. General Industrial Machines. Primary Nonferrous Metals. Heating, Plumbing and Structural Products. Engines and Turbines. Lumber and Wood Products.
Chemicals and Allied Products	Plastics and Synthetic Materials. Petroleum Refining. Other Agricultural Products. Drug, Cleaning, and Toilet Products.
Textile and Apparel Products	Plastics and Synthetic Materials.
Lumber and Wood Products	New Construction. Forestry and Fishery Products. Paper Products, excluding Boxes. Household Furniture. Electric, Gas, Water, and Sanitation Services.
Fisheries	

Source: The Economy and Population of the South Alabama Region, South Alabama Regional Planning Commission, June, 1975.

rates respectively. In 1976, estimated earnings by industry in the study area totaled $945.4 million. The manufacturing sector produced the highest earnings, $233 million, followed by wholesale and retail trade at $173.2 million, services at $168.6 million and government at $141.4 million.

INDUSTRIAL DEVELOPMENT

6. For the purpose of this study, industrial development will be evaluated by considering employment and capital expenditures. In 1974, an estimated 18,000, or 13 percent of the total work force of the Mobile SMSA, were employed by manufacturing industries closely allied with or dependent upon the port and related waterways. An additional 2,800 persons were employed in water transportation and transportation services which were directly related to port and waterway associated activities. A large percentage of the 3,000 employees involved in railroad, motor freight, and warehousing activities work at jobs connected with the port and waterways.

7. Total SMSA employment grew slightly during the decade from 1960 to 1970 from 121,400 to 123,100. These figures reflect the impact on the area of the phase out of Brookley Air Force Base in the mid-1960's. In 1970 the wholesale and retail trade sector employed the greatest numbers, 25,400, closely followed by the manufacturing industries with 24,700 workers. The government was the third most important employer with 17,200 employees. The remaining industries employed 32,700 persons. In 1974, with employment at 151,900, the unemployment rate in the study area reached 3.7 percent versus a State of Alabama rate of 4.0 percent, and a national unemployment rate of 5.6 percent.

TABLE B-2

EARNINGS BY INDUSTRY FOR SELECTED YEARS

MOBILE SMSA, STATE OF ALABAMA, AND UNITED STATES
(In Thousands of 1967 Dollars)

Industry Sector	1962 United States	1962 Alabama[1]	1962 Mobile SMSA	1970 United States	1970 Alabama	1970 Mobile SMSA	1976[2] United States	1976[2] Alabama	1976[2] Mobile SMSA
Total Earnings	389,993,433	5,187,847	609,155	562,311,127	7,101,139	721,448	721,032,198	9,233,892	945,354
Agriculture, Forestry and Fisheries	18,462,090	324,274	11,009	19,640,721	320,695	14,329	20,508,427	347,635	20,333
Mining	4,908,611	75,928	-	5,647,503	70,809	804	6,099,942	80,061	2,232
Contract Construction	22,990,095	282,517	30,235	34,457,902	380,676	55,674	44,824,600	528,615	75,177
Manufacturing	115,576,458	1,442,654	113,496	156,291,199	2,069,953	186,328	190,400,192	2,630,122	223,048
Transportation, Comm. and Public Utilities	28,694,815	341,044	61,550	39,925,053	443,134	75,750	51,124,624	579,156	92,308
Wholesale and Retail Trade	67,565,645	819,771	103,286	93,080,363	1,066,328	136,997	116,984,836	1,364,958	173,179
Finance, Insurance and Real Estate	19,805,660	207,371	25,396	28,880,241	277,231	32,511	40,664,052	404,406	48,472
Services	52,608,614	623,263	78,641	85,077,671	922,580	117,401	122,705,584	1,324,883	168,579
Government	59,386,445	1,071,022	179,795	99,310,475	1,549,753	101,653	127,719,936	1,973,861	141,446

[1] Straight line interpolation using 1959-1970 rate of growth

[2] Straight line interpolation using 1971-1980 rate of growth

Source: Projections of Economic Activity in Alabama, U. S. Department of Commerce, Bureau of Economic Analysis, December 1925
1972 Obers Projections Economic Activity in the U. S., U. S. Department of Commerce, Bureau of Economic Analysis, April 1974.

8. Capital investment for new plants and equipment reflects an industry's effort to avoid obsolescence, and is an important indicator of past and future growth. Published annual studies by the Bureau of Census on capital expenditures for the United States, the State of Alabama, and the Mobile SMSA have been prepared by the Bureau of the Census and are presented in table B-3. In 1972, capital expenditures in the study area amounted to $33.7 million compared with $45 million in 1971 and $48.6 million in 1970. The total investment in the 1963-1972 period amounted to $360.7 million. The Alabama Development Office has published data which announces investments by new and expanding industries in the Mobile SMSA. More than $714.3 million in estimated investment has been announced for the years 1973-1975, Mobile County receiving $693.6 million and Baldwin County $20.7 million. The announced investments indicate the relative importance of chemicals and allied products, which account for 82 percent of the study area's projected growth. Approximately 5,800 additional industrial jobs would be generated by the 1973-1975 growth.

TABLE B-3

CAPITAL EXPENDITURES BY MANUFACTURING FIRMS
IN THE UNITED STATES, STATE OF ALABAMA, AND MOBILE SMSA
($1,000,000)

	United States	State of Alabama	Mobile SMSA
1963	$11,370.0	$147.4	$18.2
1964	13,294.3	282.2	43.1
1965	16,615.0	371.9	40.2
1966	20,235.8	423.7	20.8
1967	21,503.0	378.9	27.5
1968	20,613.1	347.1	50.4
1969	22,291.4	382.8	32.9
1970	22,164.3	417.2	48.6
1971	20,940.7	355.5	45.0
1972	24,077.7	355.1	33.7

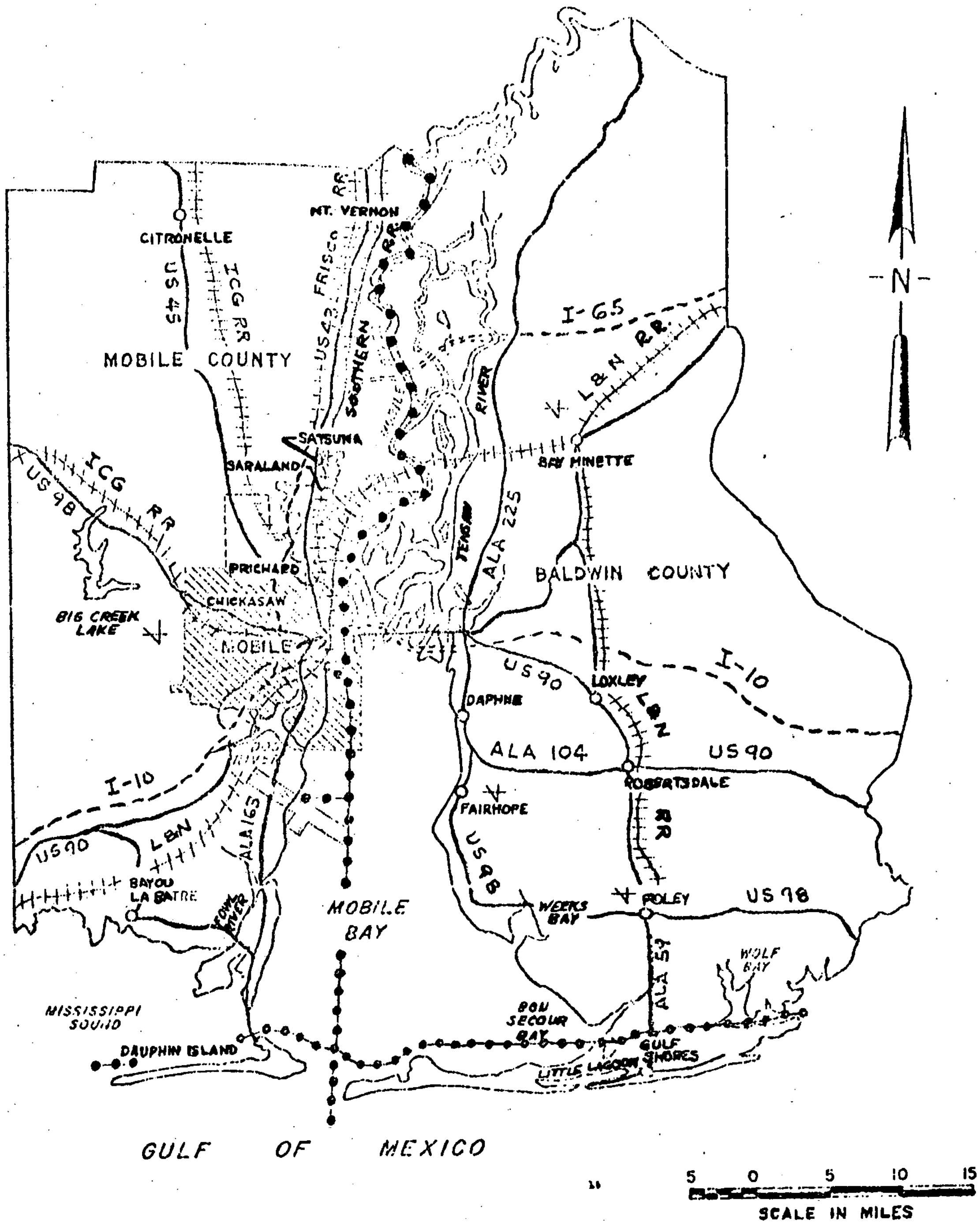
Annual Surveys of Manufactures and Census of Manufactures, U. S. Department of Commerce, Bureau of the Census - manufacturing employment and capital expenditures.

Although the announced investments are influenced to some extent by the inflated costs of capital goods, it is noteworthy that the 1973-1975 total of $714.3 million far exceeds the actual capital expenditures of $360.7 million invested by industry in the Mobile SMSA for the decade from 1963-1972.

TRANSPORTATION

9. A well developed system of transportation is essential to an area's economic well-being. The Mobile SMSA is served by an integrated network of highway, air, rail, and water transportation facilities. The study area's highway system consists of six U. S. highways, two interstate routes, and a secondary system composed of state and county roads. These highways provide access within the area and connect it to major cities outside the region. However, several of the roads are inadequate to handle the existing traffic volume. Interstate highways I-65 and I-10 are nearing completion. The I-10 bridge across Mobile Bay is under construction with completion expected in May 1978. The I-65 bridges across the delta are scheduled for completion in 1982.

10. Commercial and private air transportation are available at the municipally-owned Bates Field and Brookley Aerospace Center. Airlines serving the area include Eastern, National, and Southern. A total of thirty flights are made daily to or from Mobile carrying freight, mail and passengers. Charter flights, air ambulances service, aircraft repair, and hanger storages are provided by several independent flying services. Eight other municipal or private airfields also serve the study area. The railroads providing transportation service in the area are the Illinois



LEGEND

- EXISTING INTERSTATE
- PROPOSED INTERSTATE
- MAJOR HIGHWAYS
- RAILWAY SYSTEM
- MUNICIPAL AIRPORT
- WATERWAYS
- PROPOSED WATERWAY

SURVEY REPORT
ON
MOBILE HARBOR, ALABAMA

TRANSPORTATION
NETWORK

Figure B-2

Central Gulf (ICG), the St. Louis-San Francisco (Frisco), the Southern, and the Louisville and Nashville (L&N). The L&N is the only through line. It serves the Theodore Industrial Complex and has spur tracks which extend from Bay Minette to Foley in Baldwin County. The others terminate in Mobile. The Alabama State Docks Terminal Railway connects these railroads to portside tracks, other marine terminal facilities, and industries near the Alabama State Docks. The area is also linked to all major cities in the United States by 55 common freight carriers which serve the study region.

11. The study area is also served by a well developed system of waterways. Deep draft facilities are provided by a 36.5 mile channel extending from the entrance to the bay, northward into the Mobile River. It is 40 feet deep and varies in width from 400 feet in the bay to 500 to 1,000 feet in the river section. A plan for constructing the Theodore Ship Channel to a 40-feet depth and 400-foot width has been authorized by Congress. Barge traffic in the area is accommodated by the Mobile-Tombigbee-Black Warrior River system, the Mobile-Alabama-Coosa River system and the Gulf Intracoastal Waterway which extends east-west across the southern part of the bay. The Tennessee-Tombigbee River Project is now under construction and is expected to be completed in 1986. It will connect a 16,000 mile inland waterway system, located in 23 states, with the Gulf of Mexico at the port of Mobile. Figure B-2 outlines the area's transportation network.

PORT DEVELOPMENT

12. Existing Federal Project - The first Federal project for Mobile Harbor was authorized by Congress in 1826. Since that year numerous modifications and extensions to the harbor channels have been authorized and constructed. The existing Federal project includes both completed facilities and facilities that have been authorized and have not been constructed. The completed portion of the project, authorized by the 1954 River and Harbor Act, is comprised of the following features:

a. A 42- by 600-foot channel about 1.5 miles long across Mobile Bar;

b. A 40- by 400-foot channel in Mobile Bay to the mouth of Mobile River;

c. A 40-foot channel in Mobile River to the highway bridge, the width varying from 500 to 775 feet;

d. A 25-foot channel from the highway bridge to and up Chickasaw Creek to a point 400 feet south of the mouth of Shell Bayou, the widths being 500 feet in Mobile River and 250 feet in Chickasaw Creek;

e. A turning basin 40 feet deep, 2,500 feet long, and 800 to 1,000 feet wide, opposite the Alabama State Docks;

f. A turning basin 40 feet deep, 1,000 feet wide, and 1,600 feet long opposite Three Mile Creek;

g. A 27- by 150-foot channel from the mouth of Mobile River to and including a turning basin 250 feet wide and 800 feet long in Garrows Bend, and continuing thence to a turning basin 800 feet long and 600 feet wide opposite Brookley Field ocean terminal, thence a 27- by 150-foot channel along Arlington pier to the Mobile Bay Channel; and

h. Maintenance by snagging Threemile Creek from its intersection with the Industrial Canal to Mobile River.

13. The project also provides for an anchorage area 32 feet deep, 100 feet wide, and 2,000 feet long opposite the site formerly occupied by the U. S. Quarantine Station at McDuffie Island. Construction by local interests of a solid-fill causeway across the Garrows Bend Channel between McDuffie Island and the mainland is also provided for under the existing project.

14. The Theodore Ship Channel feature of the Mobile Harbor, Alabama project was authorized by the Water Resources Development Act of 22 October 1976. The authorization provides for a channel 40 feet deep and 400 feet wide branching from the main ship channel in Mobile Bay at a point 2.8 miles north of Mobile Bay Light and extending northwesterly about 5.3 miles to the western shore of Mobile Bay, thence via land cut 40 feet deep, 300 feet wide, and about 1.9 miles long generally along the route of the existing barge canal to a trapezoidal turning basin about 42 acres in an area within the Theodore Industrial Park. The plan also includes an anchorage area 40 feet deep, 300 feet wide, and 1,200 feet long adjacent to the south side of the channel near the bay shoreline; and a turning basin 40 feet deep, 1,200 feet wide, and 2,200 feet long to be located adjacent to the channel near the bay shoreline. The authorized plan includes a barge channel extension 12 feet deep, 100 feet wide, and approximately 6,000 feet long extending in a westerly direction to a turning basin approximately two acres in area. Construction of the Theodore Ship Channel is scheduled to start in the spring of 1979 with completion scheduled in 1982.

15. Project Maintenance - The Mobile River and Mobile Bay channels are maintained by hydraulic pipeline dredge and the channel across Mobile Bar is maintained by hopper dredge. The dredged material from Mobile River is currently being placed in approved upland disposal areas. This includes maintenance from Chickasaw Creek channel. The dredged material from Mobile Bay is currently being disposed of in the open waters of Mobile Bay in approved areas. The material from the Mobile Bar channel is being disposed of in the Gulf of Mexico in an approved area. The annual quantities of dredged maintenance material experienced over the 10-year period ending 30 June 1975 are as follows:

	Cubic Yards Per Annum
Mobile River (including Chickasaw Creek)	1,054,000

	Cubic Yards Per Annum
Mobile Bay	3,743,000
Mobile Bar Channel	264,000

16. Existing Commerce - A comparative statement of commerce for Mobile Harbor, Alabama for the 10-year period from 1966-1975 is shown in table B-4. As shown in the table, total commerce for the harbor has shown a steady increase. The increase in internal barge traffic has been the most significant source of the increase. Foreign and coastwise traffic (deep-draft) have shown a somewhat less significant increase in commerce. The major increase in deep-draft movements has been in the export of coal and coastwise shipments of crude petroleum.

17. Vessel Traffic. Waterborne commerce at Mobile Harbor is transported in liquid and dry bulk carriers and general cargo ships having drafts up to 40 feet, and in barge tows, commercial fishing boats, and other miscellaneous vessels having drafts up to about 18 feet. Some vessels which could have loaded drafts in excess of 40 feet call on Mobile Harbor with partial loads. Table B-5 contains trips and drafts of vessels using Mobile Harbor during the 10-year period from 1966-1975 as reported in the publication "Waterborne Commerce of the United States". As can be seen in the table, shallow draft commerce has increased substantially for the 10-year period. Trips of deep-draft vessels have actually exhibited an actual decline for the 10-year period while commerce for the 10-year period has shown an increase. This indicates the trend in using larger ships to transport deep-draft cargo.

18. Existing and Planned Port Facilities - There are 26 general cargo berths owned and operated by the Alabama State Docks Department. These facilities are located on the west bank of Mobile River between Cochrane Bridge and the area where Bankhead and 1-10 Highway Tunnels cross the Mobile River. These general cargo berths vary from relatively modern

Table B-4

Comparative Statement of Commerce
1966-1975
(Short Tons)

Year	Total	Foreign		Domestic				
				Coastwise		Internal		
		Imports	Exports	Receipts	Shipments	Receipts	Shipments	Local
1966	22,307,913	9,359,294	2,020,096	423,279	2,617,096	3,250,843	3,430,300	1,207,005
1967	21,283,786	8,873,419	1,873,620	236,509	1,877,269	3,510,211	3,584,823	1,327,935
1968	22,326,318	8,884,717	2,236,133	158,643	1,600,918	4,109,143	3,950,758	1,386,006
1969	23,162,341	8,206,210	2,503,868	69,154	2,173,344	4,774,682	4,113,566	1,332,617
1970	23,829,585	8,777,034	2,940,323	33,236	1,837,661	5,009,713	3,983,712	1,247,906
1971	24,919,228	8,527,252	2,325,097	15,469	1,773,663	6,086,307	4,963,965	1,227,505
1972	27,921,063	6,674,404	3,053,760	170,806	3,025,715	7,975,690	5,220,933	1,169,755
1973	30,518,422	7,909,649	3,856,377	554,381	4,670,406	6,351,757	6,001,289	1,174,563
1974	33,153,954	9,415,532	3,962,579	447,610	3,770,903	7,148,739	7,016,646	1,391,925
1975	32,452,912	7,895,820	5,404,733	363,652	3,013,583	7,559,129	6,832,326	1,383,669

Table B-5

Trips and Drafts of Vessels
1965-1974

Year	Total trips	Draft in feet	
		18 and less	19 and above
1966	20,706	18,218	2,488
1967	23,049	20,572	2,477
1968	25,609	23,208	2,401
1969	23,867	21,644	2,223
1970	23,314	21,077	2,237
1971	26,696	24,761	1,935
1972	27,429	25,393	2,036
1973	25,992	23,747	2,245
1974	29,059	27,069	1,990
1975	29,805	27,939	1,966

to 50 year old docks. The old facilities are still usable although they lack modern design features. General cargo berth utilization is low with an average utilization rate of 27 percent. The tonnage handled through these facilities was 1,400,000 tons in 1976, representing an average usage of 55,000 tons per berth. Both tonnage and berth utilization figures indicate there is not a need for additional general cargo berths. With timely renovation of the old berths and the anticipated construction of new, modern berths, these facilities will be adequate for anticipated future general cargo commerce. Figure B-3 gives a view of the general cargo berths at Mobile.

19. A public grain elevator, owned and operated by the Alabama State Docks Department, is located on the west bank of Mobile River above the I-10 tunnels. Prior to 1975, the elevator had a capacity of 1.1 million bushels giving a throughput capability of 2.5 million tons annually, Subsequent to 1975, the State Docks embarked on a series of modernization programs. The first program involved the construction of an annex to the present elevator, increasing the storage capacity to 2.5 million bushels. This expansion was completed in September of 1975. The expenditure for this expansion of the elevator was $6.0 million. Another expansion program currently underway involves the construction of a new dump truck and scales and a new shipping system complete with a 40,000 bushel per hour elevator leg and cleaning system. This will be a $5.8 million venture. All these improvements will be linked directly to the existing grain elevator. Upon completion of latest expansion of the elevator, it is estimated the annual throughput capacity will be over 3.5 million tons. Figure B-4 gives a pictoral view of the public grain elevator at Mobile.

FIGURE B-8 - AERIAL VIEW OF GENERAL CARGO TERMINALS OWNED AND OPERATED BY THE ALABAMA STATE DOCKS

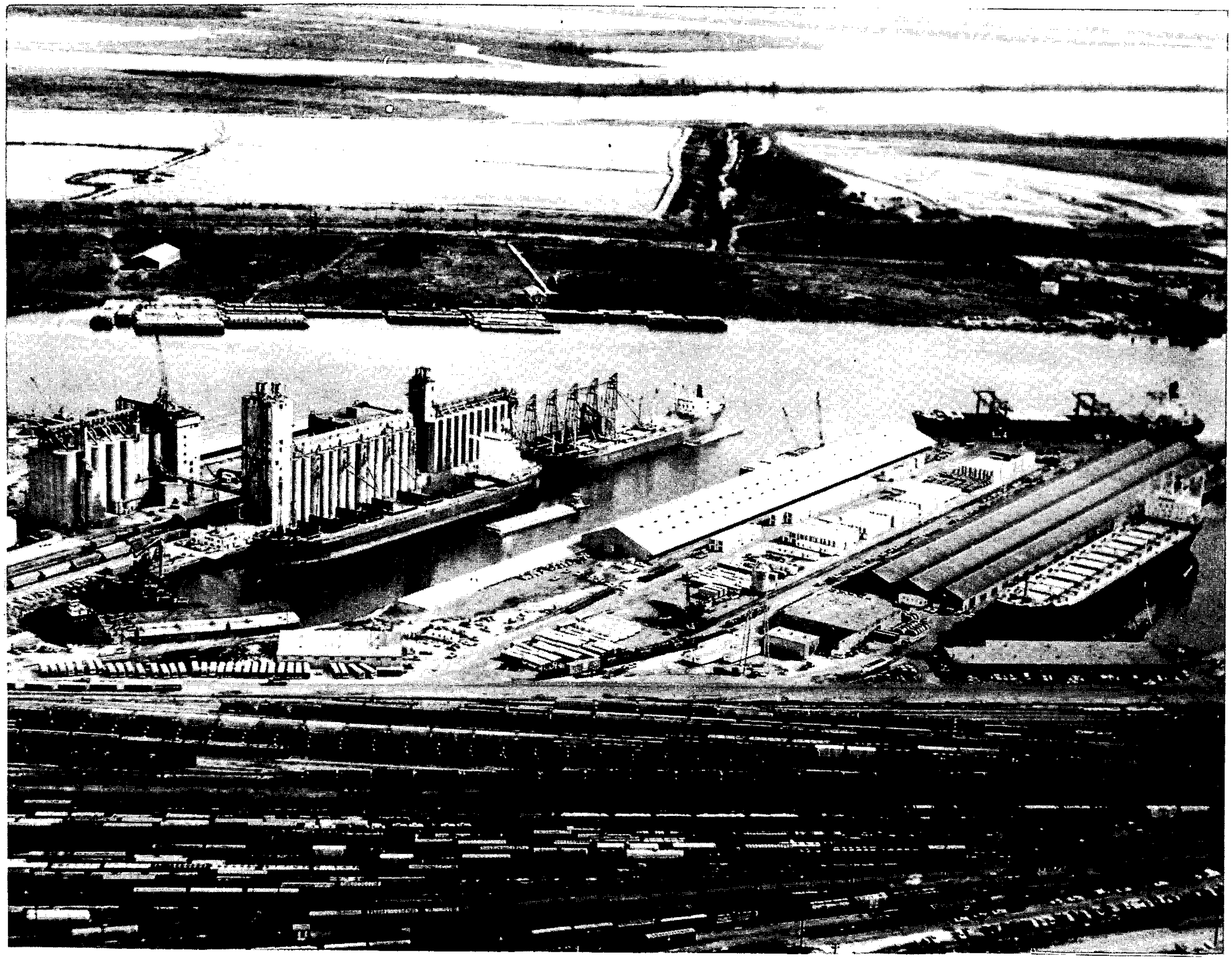


FIGURE B-4 - AERIAL VIEW OF THE PUBLIC GRAIN ELEVATOR OWNED AND OPERATED BY THE ALABAMA STATE DOCKS

20. A Dry-Bulk Handling Terminal, owned and operated by the Alabama State Docks, is located on Three Mile Creek. This plant was constructed in 1927. The facility has been renovated several times since initial construction to accommodate larger vessels and provide more storage space. About 13 acres of dry-bulk storage is presently available with berths able to accommodate two ships. The annual throughput capacity of this terminal is 5.0 to 6.0 million tons. It is being operated near capacity at the present time. The principal commodities being handled consist of bauxite, coal (imports), iron ore, and other miscellaneous ores. Coal exports previously moving through this facility are now being exported through McDuffie Terminal. A view of this facility is shown in figure B-5.

21. McDuffie Coal Terminal is located on McDuffie Island at the mouth of Mobile River below the I-10 Highway Tunnels. This terminal is designed to handle coal for export from barges and rail cars to large dry-bulk carriers. There is a 16.5 acre live storage area for approximately 175,000 tons. This facility is owned and operated as a public coal terminal by the Alabama State Docks. The terminal began operation in 1975. The present facility has a maximum rated throughput of 4.8 million tons per year. With completion of improvements now under construction by the Alabama State Docks, the throughput will be increased to 10.2 million tons annually. Long-range plans by the Alabama State Docks indicate additional facilities will be provided as needed. Figure B-6 shown an overall view of the McDuffie Island Coal Terminal. The stacker-reclaimer moves the coal to storage as it is being unloaded from barge or rail. It is also used to transfer coal from stockpile to ships at the rate of 4,000 tons per hour. A view of this equipment is shown in figure B-7. Coal is unloaded from barges by a ladder-type bucket unloader with a rated unloading capacity of 3,000 tons per hour. This facility is shown in figure B-8. A ship loader located along the dockside can load ships at the rate of 4,000 tons per hour. A view of the ship-loading equipment is shown in figure B-9. Figure B-10 shows an overall view of the port facilities at Mobile.

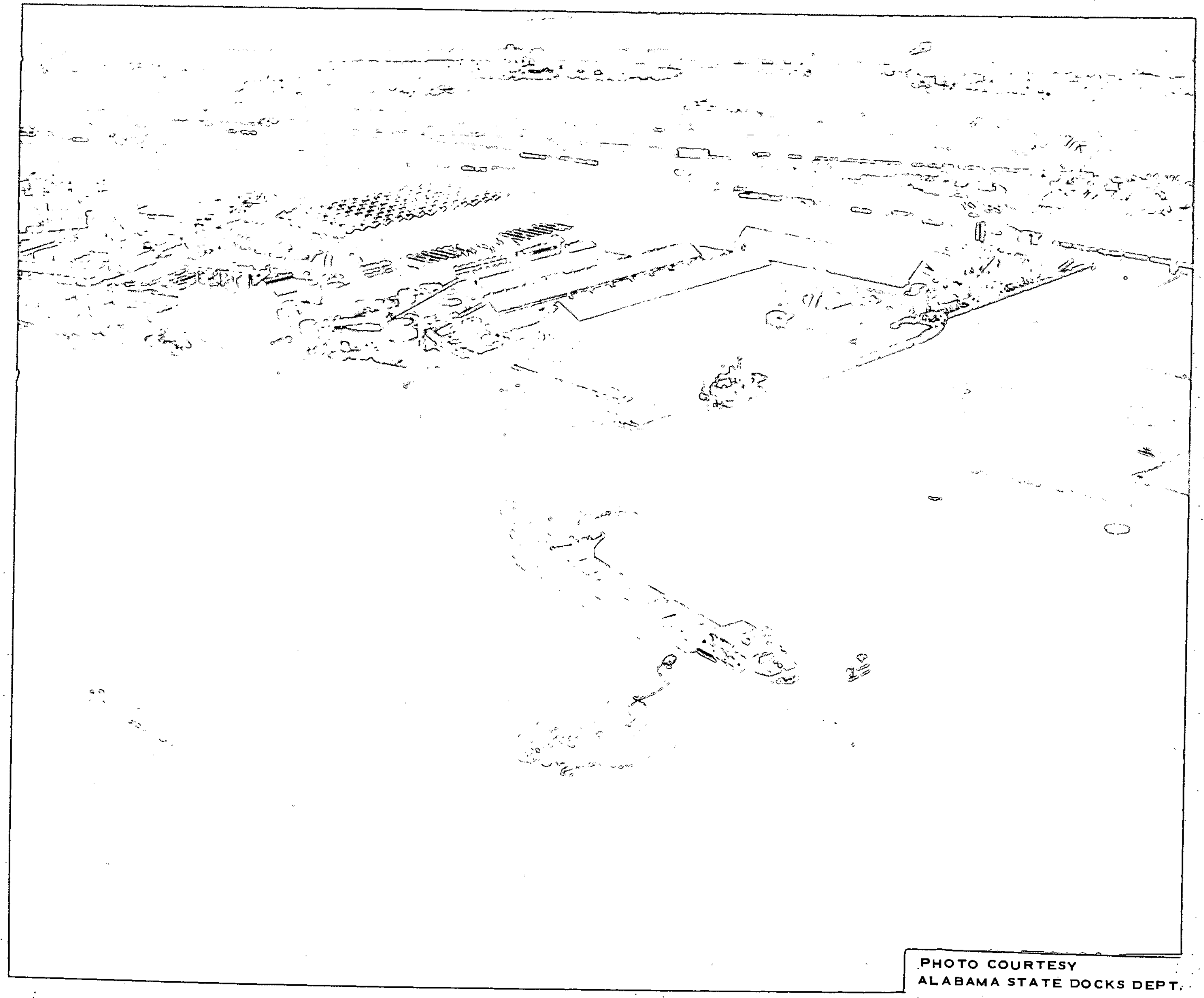


PHOTO COURTESY
ALABAMA STATE DOCKS DEPT.

FIGURE B-5 - AERIAL VIEW OF THE BULK HANDLING PLANT (TIPPLE) LOCATED AT THREE MILE CREEK OWNED AND OPERATED BY THE ALABAMA STATE DOCKS

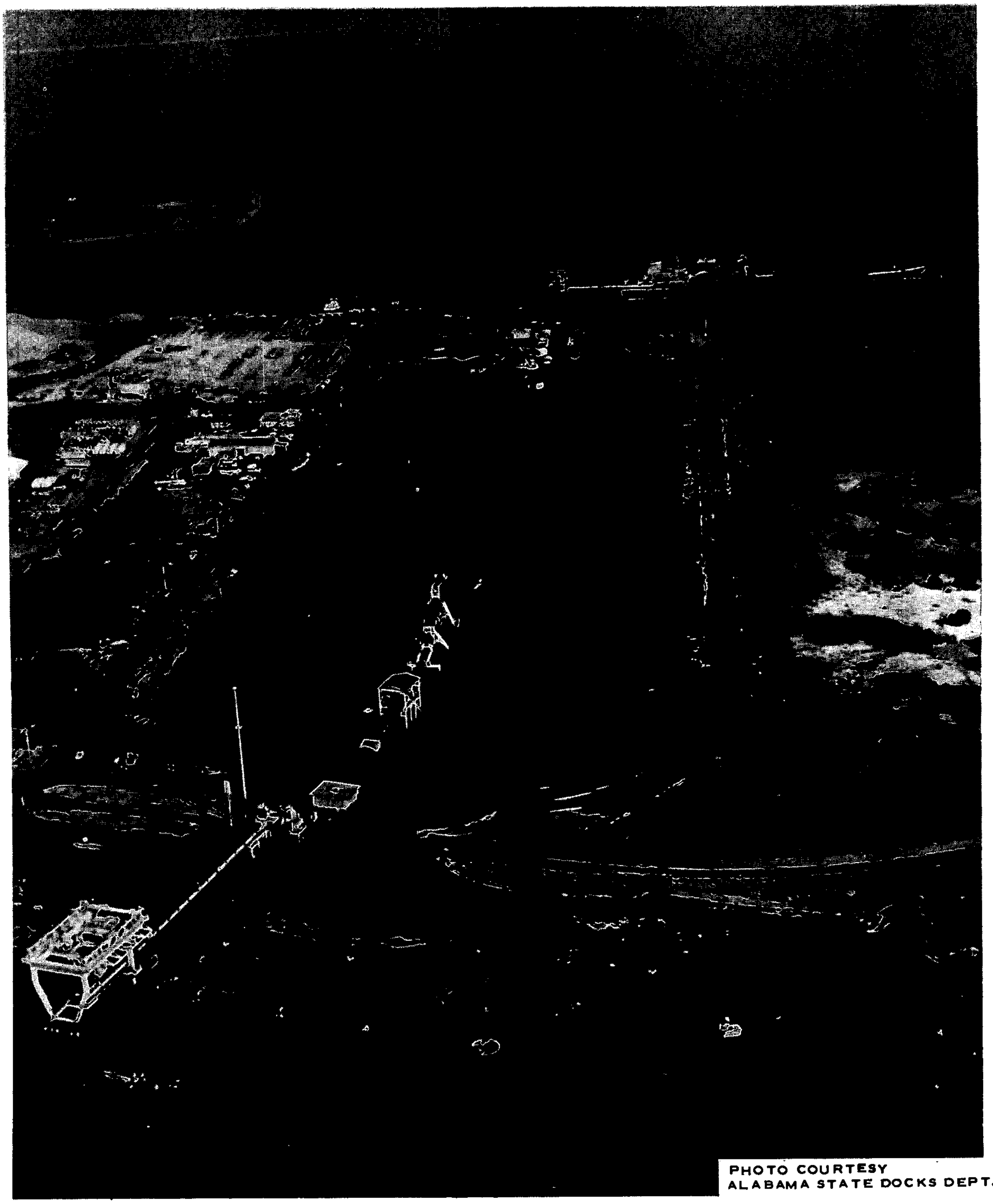


FIGURE B-6 - McDUFFIE ISLAND COAL TERMINAL LOCATED AT MOUTH OF MOBILE RIVER

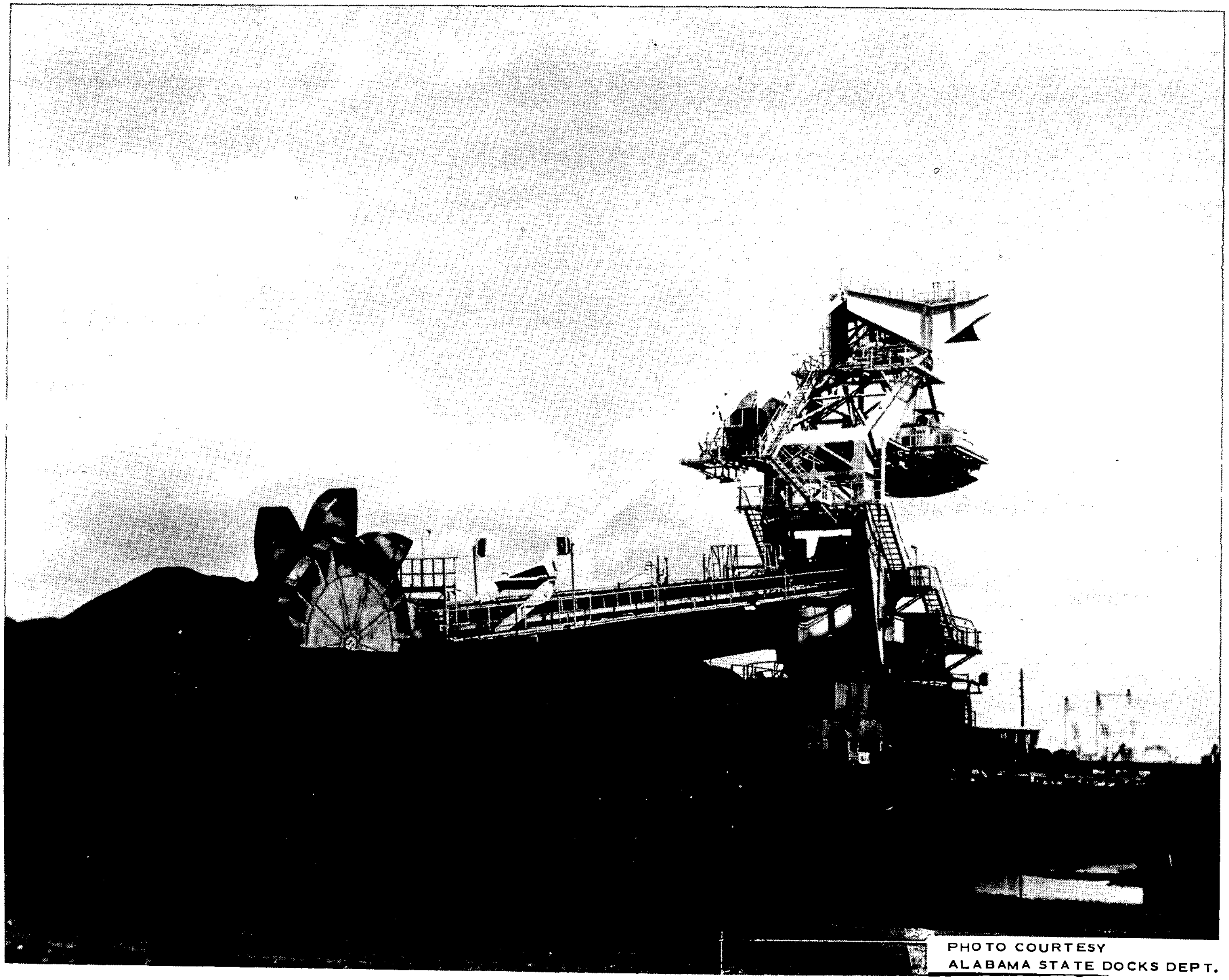


FIGURE B-7 - STACKER-RECLAIMER USED TO TRANSFER COAL FROM RAIL/BARGE TO SHIP AT McDUFFIE COAL TERMINAL

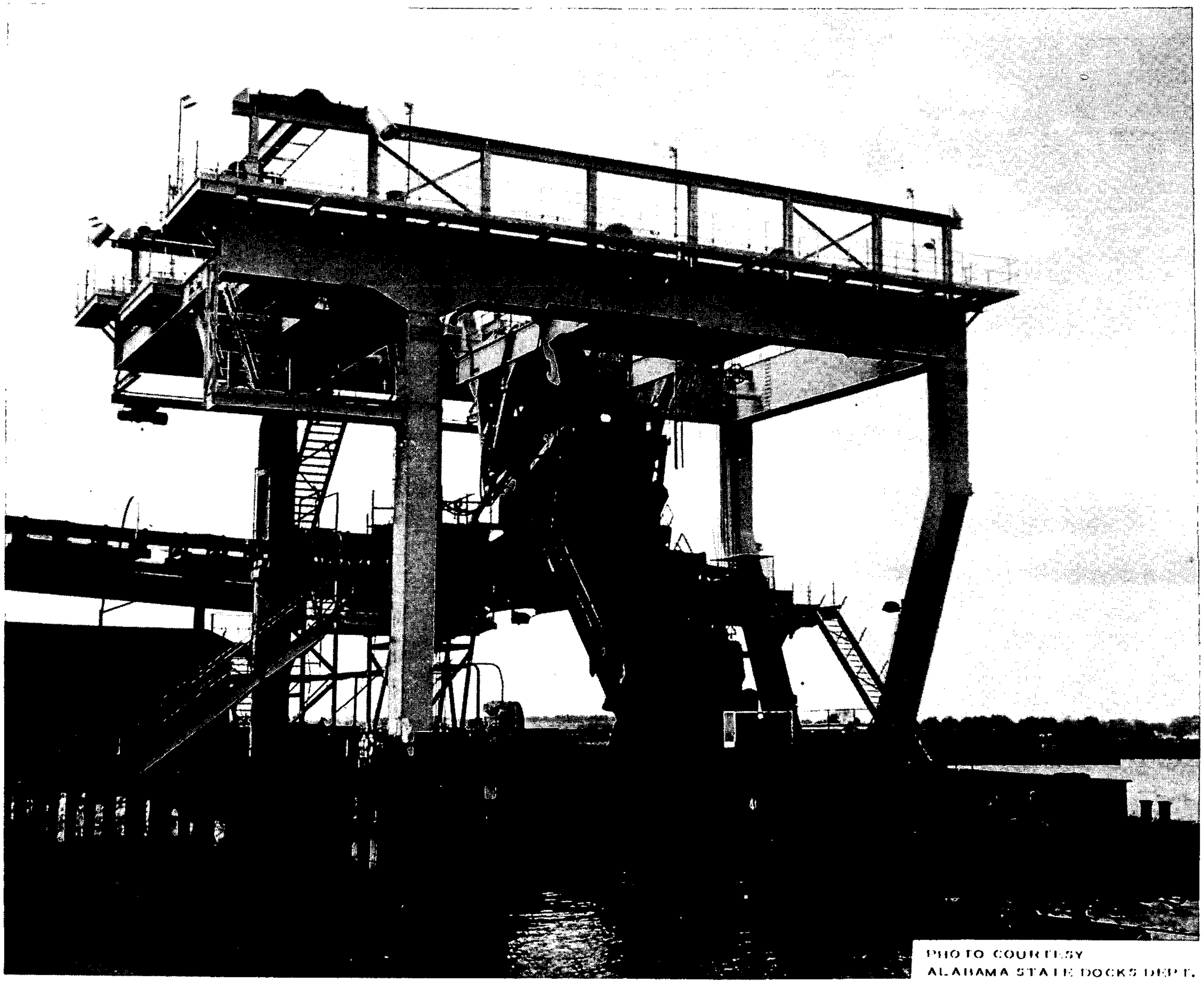


PHOTO COURTESY
ALABAMA STATE DOCKS DEPT.

FIGURE B-8 - BARGE UNLOADING FACILITY AT McDUFFIE COAL TERMINAL

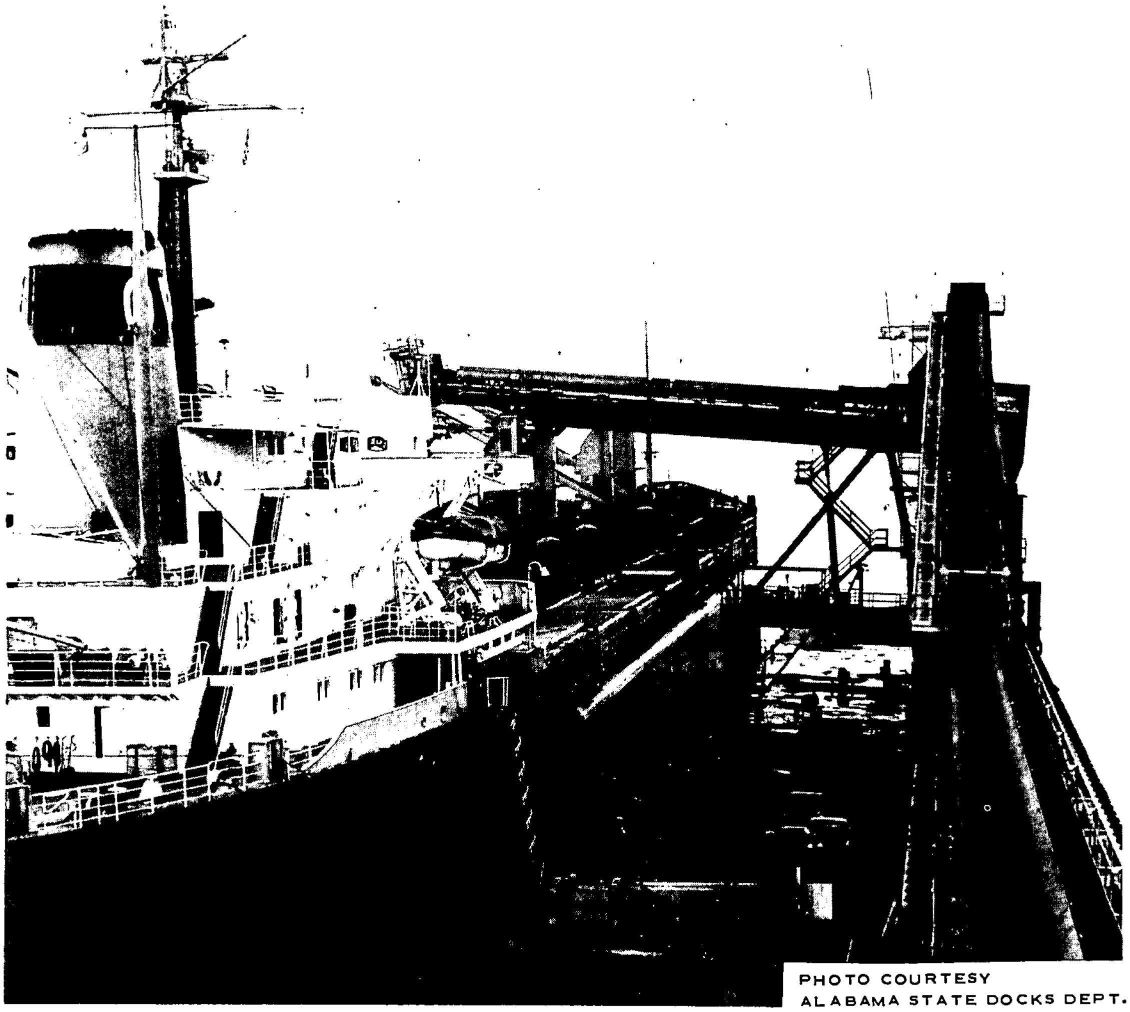


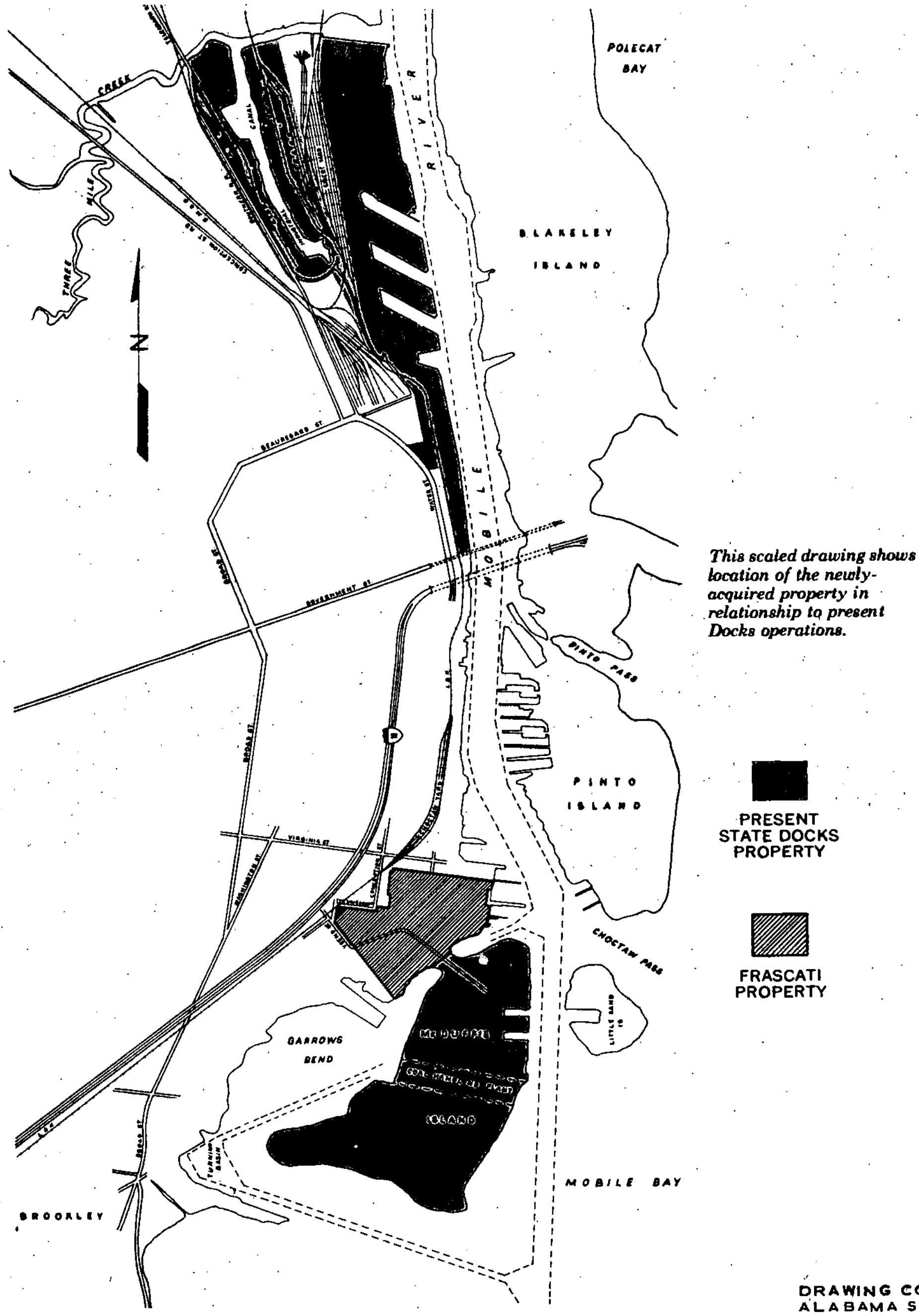
PHOTO COURTESY
ALABAMA STATE DOCKS DEPT.

FIGURE B-9 - VESSEL LOADING COAL AT McDUFFIE COAL TERMINAL

FIGURE B-10 - OVERALL VIEW OF TERMINAL FACILITIES AT THE PORT OF MOBILE

22. Other plans of improvement being considered by the Alabama State Docks include a long-range program to provide bulk terminal facilities and ship berths below the I-10 tunnels. The areas under consideration for development are located adjacent to the bay side of the old Brookley Field area currently known as the "Mobile Aerospace Industrial Complex" and an area adjacent to Mobile River and McDuffie Island recently pruchased by the Alabama State Docks from the Illinois Central Gulf Railroad. This newly purchased property is a 143-acre parcel is located adjacent to the 600 acres already owned by the A.S.D. on McDuffie Island. The acquisition as shown on figure B-11 includes a rail yard and gives the Docks all railroad rights of way and switching rights formerly held by the ICG in the Frascati and McDuffie area.

23. The private dock facilities for handling deep-draft vessels located at Mobile are: Amerada-Hess Terminal and Storage Facilities, Citmoco Services Dock, Chevron Asphalt Refinery, Texaco Terminal, Pinto Island Metals, Pro Rico Industries, Argon Terminal, and TCI Marine Bulk Handling Terminal. There are numerous other small docks, primarily used for loading and unloading barges. The Amerada-Hess and Citmoco Terminals and docks are located on west bank of the Mobile River between Cochrane Bridge and Three Mile Creek. These facilities are used to store crude oil gathered by pipelines from northwest Florida, central Mississippi, and north Mobile County oil fields. The crude oil is shipped from storage, by tankers, to the Atlantic Seaboard and Texas Gulf Coast areas. Chevron Asphalt Refinery Docks located on Blakeley Island on the east bank of Mobile River are used for receiving crude oil by tanker and barge and shipping asphalt by barge. Texaco Terminal and Dock, located on the west bank of Mobile River north of McDuffie Coal Terminal, is used for receiving refined petroleum products by small tankers. Pinto Island Metal Docks, located on the east bank of Mobile River below the Alabama Dry Docks and Shipbuilding Company, export small quantities of scrap iron. Pro Rico Industries is located on the west bank of Mobile River above the McDuffie



DRAWING COURTESY
ALABAMA STATE DOCKS DEPT.

FIGURE B-11 - LAND RECENTLY PURCHASED BY THE ALABAMA STATE DOCKS TO BE USED FOR PORT EXPANSION

Island Coal Terminal. It is used for importing blackstrap molasses in small tankers. Argon Terminal Dock is located on Blakeley Island and used for unloading petroleum products and chemicals primarily from barges.

24. The TCI Marine Bulk Handling Terminal and Dock is located on the west bank of Mobile River below the I-10 Highway Tunnels. This facility is used for unloading iron ore from large dry bulk carriers and reloading it into barges and rail cars. They have a limited storage capacity with most of the iron ore being transferred directly from ship to barge.

25. The Alabama State Docks is committed to provide a public deep-water liquid terminal and dock at Theodore in conjunction with completion of the 40-foot channel into the Theodore Industrial Complex. This facility will be used primarily for unloading crude oil from tankers.

26. Other private terminals at Theodore are the proposed docks of Ideal Basic Industries and the existing docks of New Autlan Manganese Corp. Kerr-McGee Chemical and Degussa Alabama, Inc. will have barge docks on the barge channel extension when it is completed. Ideal Basic Industries will handle cement by deep-draft bulk carriers and inbound products such as coal, limestone, and other raw material for cement production. Airco will handle manganese ore and ferro alloys over their docks. Kerr-McGee and Degussa will handle various chemical products over their barge docks.

27. Figure B-10 gives a view of all the port facilities at Mobile. The overall view of the port facilities at Mobile, looking south from the Cochrane Bridge to McDuffie Island in the upper portion of the picture, shows that most of the berths are located on the west bank of the river.

DEVELOPMENT TRENDS

28. A summary of existing land use in the Mobile SMSA and the state of Alabama is presented in table B-6. In both Mobile and Baldwin counties forest and agricultural lands comprise the predominant land use, occupying 72.8 percent of the total acreage. Water and wetlands follow with 11.3 percent of the area. The classification, other (8.4 percent), applies to undeveloped dry land (8.1 percent) and other resources (.3 percent). The category, urban and developed (7.5 percent) includes residential, industrial, roads, transportation, communications and utilities, commercial, public lands, and culture, recreation and entertainment. Urban and developed occupies 11.4 percent of the total land in Mobile County versus 0.4 percent in Baldwin County.

TABLE B-6

EXISTING LAND USE IN THE MOBILE SMSA AND THE STATE OF ALABAMA (1970)

	Mobile County	Baldwin County	Mobile SMSA	State of Alabama
Urban and Developed	91,193	35,974	127,167	519,668
Agriculture	136,077	218,153	354,230	9,051,256
Forest	406,259	480,671	886,930	22,491,065
Water	19,448	41,427	60,875	737,664
Wetlands	76,722	55,755	132,477	120,008
Other	72,886	70,531	143,417	110,099
Total	802,585	902,511	1,705,096	33,029,760

Source: South Alabama Regional Planning Commission, November 1976.
Alabama Development Office

HUMAN RESOURCES

ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

29. Mobile Bay's location and the area's mild climate have contributed greatly to the region's long and varied history. Throughout aboriginal times a variety of cultures converged in the region. Although only a limited amount of archeological investigation has been conducted in the study area, archeologists believe that people first entered the region about 8000 years ago, beginning the Archaic, or prepottery, period. This period is not well known in the area. Pottery appeared about 1500 B.C. at the beginning of the Woodland culture, and continued until the Mississipian culture, which began with the advent of shell tempered pottery about 1000 A. D. Pottery types taken from shell middens and shell mounds present some of the earliest records for the region. When the first Europeans arrived in the Mobile area the main aboriginal inhabitants were the Tohone and the Naniaba Indian tribes. The Mobile, also known as the Mabila or Mavila, were the largest and strongest of these groups and their language, closely related to the Choctaw, became the trade jargon for a wide area. When the French settlement was established it became a center for trade and attracted many Indian tribes.

30. In 1519 the Spanish explorer, Alonzo Alvarez de Pineda, sailed into Mobile Bay naming it Rio del Espiritu Santo. Other Spanish explorers, including DeSoto in 1540, followed de Pineda and in 1559 a sand and log fort was built at what is now know as Fort Morgan. Although the Spanish first explored the territories surrounding Mobile Bay, the first formal colony was established by the French. In 1702 Jean Baptiste Le Moyne Sieur de Bienville was commissioned by his brother, Iberville, to build Fort Louis de la Mobile, the French capital of Louisiana, at Twenty-Seven Mile Bluff, due north of the present Mobile urban area. In 1711, after yellow fever epidemics and a serious flood, the settlers were forced to move Fort Louis down the river to the present site of Mobile. In 1763 as a result of the French and Indian War, the French territories east of the Mississippi River including Mobile were ceded to the British. The British subsequently lost Mobile to the Spanish in 1780 and the area became a part of Spanish Florida. The Spanish continued to hold Mobile despite U. S. efforts to include it in the Louisiana Purchase. In the War of 1812 the United States was able to force the Spanish out and Mobile was added to the Mississippi territory. In 1819 Alabama was admitted to the Union and Mobile was granted a city charter. The city was an important agricultural trade center for the area and became an international port in the 1830's when a shipping channel was dredged in the bay. The city continued to grow and in the 1850's had a population of 30,000. Mobile was second only to New Orleans as a cotton shipping port.

31. In 1861 Alabama seceded from the Union and was known as the Republic of Alabama until it became a part of the Confederacy. Mobile was an important Confederate port and for three years the Union Navy blockaded the city in an attempt to stop trade. The Union victory at the Battle

of Mobile Bay on August 5, 1864 closed Mobile to the Gulf and led to the final surrender of the city to Union forces on April 12, 1865. After the Civil War the study area was part of the effort to overcome the post-war economic depression and to rebuild the economy of the South. By the turn of the century manufacturing activities had grown but agriculture was still dominant. In 1923 the Alabama State Docks opened at the port of Mobile, and increased the city's importance as a shipping center. During the 1940's and 1950's the population grew as manufacturing and service trades became dominant forces in the economy. Today the area is experiencing another surge of growth as the popularity of the South as the "sun belt" attracts residents and tourists alike.

DEMOGRAPHY

32. Changes in population in the Mobile SMSA, the state of Alabama, and the nation are presented in table B-7. It can be seen that the study area's population more than doubled between 1940 and 1960 while the state and nation experienced growth rates of 15 percent and 36 percent respectively. During the 1960 to 1970 period the growth rate in the study area fell dramatically to 3.7 percent, lower than the state (5.4 percent) and the nation (13.3 percent). This was primarily due to the phase out of Brookley Air Force Base during the late 1960's when southern Alabama had a significant out-imigration of 42,000 people. Provisional figures for 1974 indicate that between 1970 and 1974 the study area's population increased by 5.4 percent while the state and nation experienced a 4 percent growth rate. It is interesting to note that in 1970,52 percent of the study area's total population resided in the city of Mobile.

33. Data pertaining to the general characteristics of the population of the Mobile SMSA are presented in table B-8. On the basis of these data it can be seen that in 1970, 72.2 percent of the study area's population was white and 51.9 percent was female. Nearly half the population was

TABLE B-7

TOTAL POPULATION IN THE MOBILE SMSA
STATE OF ALABAMA, AND THE UNITED STATES 1940-1974

	1940	1950	1960	1970	1974*
Mobile SMSA	174,298	272,102	363,389	376,690	396,400
Mobile County	141,974	231,105	314,301	317,308	333,600
Baldwin County	32,324	40,997	49,088	59,382	65,800
State of Alabama	2,832,961	3,061,743	3,266,740	3,444,165	3,577,000
United States	132,164,569	151,325,798	179,323,175	203,211,926	211,390,000

* Provisional

Source: Economic Abstract of Alabama 1975 - December 1975

TABLE B-8

GENERAL CHARACTERISTICS OF THE POPULATION MOBILE SMSA MOBILE AND BALDWIN COUNTIES - 1970

		PERCENT						
		Racial Composition		Sex		Age		
	Total Population	Black and Other	White	M	F	Under 25 Years	25-64 Years	65 and Over
Mobile County	317,308	32.9	67.1	48.0	52.0	49.5	42.7	7.8
Baldwin County	59,382	12.8	82.2	48.9	51.1	46.9	42.4	10.7
Mobile SMSA	376,690	27.8	72.2	48.1	51.9	49.0	42.8	8.3
State of Alabama	3,444,165	26.4	73.6	48.3	51.7	47.5	42.9	9.4
United States	203,857,864	12.4	87.6	49.0	51.0	44.2	46.1	9.8

Source: The Economy and Population of the South Alabama Region, South Alabama Regional Planning Commission, June 1975.

under 25 years of age, 8.3 percent was age 65 and over 42.8 percent fell between these two age groups.

SKILLS AND OCCUPATIONS

34. The occupational profile of an area's labor force indicates its diversity of industries as well as the levels of skill available. In 1970, 41 percent of the employed persons residing in the study area were classified as white collar workers. Blue collar workers comprised 41.6 percent of the work force. The service workers category contains 14 percent of the employed. About 4 percent of the area's employed are farm workers. Comparing the study area's employment with the occupational profile for the state of Alabama and the nation in 1970 reveals that the Mobile SMSA had more blue collar jobs (41.6 percent) than the state (39 percent) or the nation 35.3 percent). The study area and the state each have fewer white collar jobs (41 percent) than the nation (48.3 percent). Farm and service workers were employed in the study area at near national and statewide percentage levels. However, the farm sector in Mobile County at 1.2 percent, in contrast to Baldwin County's 6.1 percent, reflects the importance of farming in Baldwin County.

PERSONAL INCOME

35. Data on historic and estimated per capita income for the United States, the state of Alabama, and the Mobile SMSA are contained in table B-9. In 1970 the study area's per capita income was $2,501. Although this represented a 30 percent increase over the 1962 figure of $1,918 it was approximately $1,000 less than the national per capita income in that year. Based on estimated figures for 1976, the state and the study area continued to lag behind the nation for the period 1970-1976 in per capita income, but had surpassed the nation in rate of growth of income.

TABLE B-9

PER CAPITA INCOME FOR THE UNITED STATES, THE STATE OF ALABAMA AND THE MOBILE SMSA FOR SELECTED YEARS
(in 1967 $)

	1962	1970	1976[1]
United States	2,585	3,476	4,186
State of Alabama	1,745	2,565	3,127
Mobile SMSA	1,918	2,501	3,087

[1] Straight line interpolation using 1971 - 1980 rate of growth

Source: 1972 OBERS Projections Economic Activity in the U. S., U. S. Department of Commerce, Bureau of Economic Analysis, April 1974.

EDUCATION

36. Education in the study area is provided by a system composed of public and private schools. In addition to elementary and high schools, there are two colleges, one university, two junior colleges, and a mix of vocational, technical and training schools.

37. Data on the educational achievement of the population 25 years old and over, in the study area, the state of Alabama, and the United States is shown in table B-10. State percentages closely parallel study area statistics except for 1960 figures for elementary and high school years completed. In 1960 the study area led the state in high school graduates by 5.6 percent and nearly equaled the nation in this category. By 1970 the State of Alabama approached the study area's percentage of high school graduates, however, both lagged behind the nation at this level of education. If those who attended one or more years of college are combined with high school graduates the gap between the study area, the state and the nation climbs to 12.9 to 14.0 percent.

TABLE B-10

POPULATION 25 YEARS OLD AND OVER

BY YEARS OF SCHOOL COMPLETED

UNITED STATES AND MOBILE SMSA BY COUNTY

	1960 Percent	1970 Percent
Mobile SMSA	100.0	100.0
Elementary	41.5	34.1
High School: 1 to 3 years	21.6	23.6
High School: 4 years	24.3	27.2
College: 1 to 3 years	7.0	7.8
College: 4 years or more	5.6	7.3
Mobile County	100.0	99.9
Elementary	40.4	33.7
High School: 1 to 3 years	21.7	23.6
High School: 4 years	25.1	27.2
College: 1 to 3 years	7.1	7.9
College: 4 years or more	5.7	7.5
Baldwin County	100.0	100.0
Elementary	48.9	36.2
High School: 1 to 3 years	20.9	23.2
High School: 4 years	18.8	26.7
College: 1 to 3 years	6.4	7.4
College: 4 years or more	5.0	6.5

	1960 Percent	1970 Percent
United States	99.9	100.1
Elementary	39.6	27.8
High School: 1 to 3 years	19.2	17.1
High School: 4 years	24.6	34.0
College: 1 to 3 years	8.8	10.2
College: 4 years or more	7.7	11.0
State of Alabama	100.0	99.9
Elementary	49.3	36.8
High School: 1 to 3 years	20.3	21.9
High School: 4 years	18.6	25.9
College: 1 to 3 years	6.1	7.5
College: 4 years	5.7	7.8

Source: General Social and Economic Characteristics, U. S. Department of Commerce, Bureau of the Census, 1960 and 1970.

HOUSING

38. Housing data for the study area is presented in Table B-11. In 1970 there were 121,244 housing units available in the SMSA. In Baldwin County 78 percent were owner occupied while in Mobile County the owner occupancy rate was 66 percent. The remainer were rented. The median number of rooms per unit in the study area was 5.1. More than one person per room, per unit is indicative of o·ercrowding. More than 1.51 persons per room is regarded as severe overcrowding. Twelve percent of the housing units in the study area experienced some degree of overcrowding, 4 percent were severely overcrowed. The median value of the owner occupied, one-family unit in Baldwin County was $11,100 versus $12,900 in Mobile County. In Baldwin County 35 percent of the houses were built after 1959, 26 percent from 1950-1959, and 39 percent before 1950. In Mobile County the corresponding figures are 26 percent (1960+), 31 percent (1950-1959), and 43 percent (before 1950).

COMMUNITY COHESION

39. Community cohesion refers to the relationships among people who have resided in an area for a sufficient period of time to have created a sense of identity as a group. The study area encompasses 2,855 square miles and a 1970 population figure of 376,690. Mobile County covers 1,242 square miles and had a 1970 population of 317,308. Eighty-one percent of the people live in urban areas, with 59 percent, 190,026, living in the city of Mobile. In contrast Baldwin County is characterized by an urban population comprising only 40 percent of the County's population of 59,382. Its largest town is Bay Minette with 6,727 people.

40. The study area is rich in history and a segment of the region's population traces its ancestry back to the early colonists. Economic development is a force at work in the study area. The area experienced an economic setback when Brookley Air Force Base closed in the mid-1960's.

TABLE B-11

CHARACTERISTICS OF HOUSING UNITS IN THE MOBILE SMSA
MOBILE AND BALDWIN COUNTIES - 1970

	Baldwin County	Mobile County	Mobile SMSA
Owner occupied	13,793	60,952	74,745
Renter occupied	3,928	30,817	34,745
Total housing units	21,803	99,441	121,244
Median number of rooms	4.9	5.1	5.1
Persons per room			
1.00 or less	15,545	80,310	95,855
1.01 to 1.50	1,423	7,598	9,021
1.51 or more	753	3,861	4,614
Median value, owner occupied, 1-family	$11,100	$12,900	$12,700
Median rent	$ 72	$ 73	$ 73
Built 1960 or later	7,299	26,108	33,407
Built 1950-1959	5,492	30,126	35,618
Built before 1950	8,091	42,575	50,666

The effects were not only felt by those who lost their jobs directly but also by the businesses and workers who lost profits and wages because of the decrease in purchasing power in the community. The Mobile area Chamber of Commerce, representing 3600 members and 1600 of the study area's 6.093 business establishments, is seeking to attract a mix of industry to the region to provide the area greater economic security.

41. Historically the bay has been a focal point for people living in the area. It has provided transportation, water for industrial development and recreational activities, and natural resources for commercial pursuits. The climate makes the area attractive to many, especially retirees. A question which draws interest and opinions from the region's citizens is how to best utilize and yet protect Mobile Bay. The business community is a force for economic development in the area and regards the bay as an economic asset to be developed. The environmental action groups warn that development without regard for the ecological ramifications could lead to the degradation of the bay for all interests.

CULTURAL RESOURCES

42. Mobile Bay has been the site of considerable navigational activity primarily since the French arrival in 1699, although the bay was discovered perhaps as early as 1519. The bay experienced several phases of navigation from this period to the present, each capable of producing significant cultural resources, such as sunken steamboats, ferrys, ships and obstructions placed to block the channel during the Civil War. Table B-12 lists known shipwrecks in the bay. Approximately 17 identified wrecks, ballist dumps or obstructions have been reported on Mobile Bay navigation charts from 1850 to 1976. Each of these are potential significant cultural resources. Table B-13 list properties in the area included on the the National Register.

TABLE B-12

KNOWN SHIPWRECKS IN THE BAY

Wreck	Date	Cause
Arkansas	1827	snagged
Emeline	March 8, 1827	burned
Elizabeth	May 30, 1827	burned
General Brown	February 24, 1830	burned
Helen McGregor	December 23, 1832	collided with Herald
Herald	December 23, 1832	collided with Helen McGregor
Ben Franklin	March 13, 1836	exploded, 20 lives lost
Wanderer	November 11, 1836	snagged
Bouge Homer	1837	snagged
Vincennes	February 10, 1838	snagged
Andrew Jackson	May 16, 1838	snagged
Plough Boy	January 14, 1839	snagged
Emblem	April 18, 1839	foundered, 5 lives lost
William Hulburt	July 26, 1839	burned, 2 lives lost
Mary Express	1840	burned
Dover	April 1, 1840	snagged

Wreck	Date	Cause
Fox	August 6, 1840	snagged
Ivanhoe	August 6, 1840	snagged
Sun	August 6, 1840	stranded
Chippewa	March 25, 1841	snagged
Choctaw	February 5, 1842	snagged
Neptune	February 10, 1842	burned
Juniata	October 11, 1842	snagged
Charles L. Bass	November 22, 1842	snagged
Despatch	December 30, 1842	stranded
Gainesville	March 31, 1843	collided
Rowena	March 20, 1844	burned
Norma	June 1, 1846	snagged
Lion	October 5, 1846	burned
Eagle	October 15, 1846	burned
Penelope	October 15, 1846	burned
Tuscaloosa	January 29, 1847	exploded, 12 lives lost
Robert Emmet	May 26, 1847	snagged
Native	April 4, 1848	foundered
Belle Poule	July 2, 1849	snagged
Norfolk	July 2, 1849	snagged
Little Harriet	August 2, 1849	snagged
E. D. King	April 1, 1850	stranded
Irene	April 1, 1850	sank
Motive	June 26, 1850	snagged
Ambassador	February 25, 1854	burned
Sam Dale	February 25, 1854	burned
Daniel Pratt	October 26, 1854	exploded, 3 lives lost
Helen	May 12, 1855	burned
Wade Allen	July 30, 1855	burned, 1 life lost
Sunny South	October 1, 1855	snagged
Correo	May 20, 1856	snagged
Alamo	June 1, 1856	sank
Arkansas No. 5	June 5, 1856	snagged
Emperor	July 1, 1856	stranded
Sallie Spann	October 1, 1856	burned
Ben Lee	December 13, 1856	snagged
Canonchet	October 16, 1857	burned
Southern Belle	October 16, 1857	burned
Emma Watts	September 22, 1858	snagged
Enterprise	September 22, 1858	snagged
South Carolina	January 15, 1859	wrecked on Mobile Bar
F. M. Streck	October 6, 1859	snagged
Osceola	December 8, 1859	snagged
Baltic	November 3, 1860	exploded, 20 lives lost
Lecompte	March 27, 1861	burned
Josephine	March 5, 1863	ran aground (blockade runner)

Wreck	Date	Cause
Isabel	May 18, 1863	burned (blockade runner)
Ivanhoe	June 30, 1864	burned (blockade runner)
U.S.S. Tecumseh	August 5, 1864	torpedo, 93 lives lost
C.S.S. Gaines	August 5, 1864	lost in battle
U.S.S. Phillipi	August 5, 1864	lost in battle
Kate Dale	May 25, 1865	burned
R. B. Taney	October 27, 1865	stranded
Thomas Sparks	January 12, 1866	stranded
Natchez	March 10, 1866	foundered
Sir William Wallace	March 27, 1866	burned
Flirt	July 18, 1867	burned
Jewess	December 28, 1868	snagged
May Flower	October 1870	burned
Seneca	November 23, 1870	burned, 13 lives lost
Salmon	1873	snagged
Mary Shaw	November 3, 1900	snagged
Gamma	September 26, 1906	foundered
Mary	September 27, 1906	foundered
Lady Grace	September 27, 1906	stranded in hurricane
Josephine	September 27, 1906	collided with Black Diamond
Black Diamond	September 27, 1906	collided with Josephine
Edgar Randall	December 14, 1906	collided with Delta
Laura L. Sprague	March 18, 1913	stranded on Mobile Bar
American	April 4, 1915	burned
Sunny South	April 20, 1916	foundered
Harry Morse	July 5, 1916	collided, 8 lives lost
Dean E. Brown	September 17, 1917	foundered, 9 lives lost
Stranger	April 22, 1923	burned
Bay Queen	March 27, 1929	burned
Elizabeth	June 7, 1930	burned

TABLE B-13

NATIONAL REGISTER PROPERTIES IN MOBILE AREA

Fort Morgan
U.S.S. Tecumseh
Sand Island Lighthouse
Mobile Point Light Station Keeper's Quarters
Middle Bay Light
Fort Gaines

43. To date, two small cultural resource surveys of submerged resources have been conducted in the Bay, one for the Theodore Channel and the other for the Pinto Pass disposal area. Unevaluated magnetic anomalies were located in both surveys.

NATURAL RESOURCES

PHYSIOGRAPHY

44. South Alabama lies within parts of two major physiographic provinces; The East Gulf Coast Section of the Coastal Plain Province, and the Mississippi-Alabama Shelf Section of the Continental Shelf Province. Coastal Alabama lies within the Southern Pine Hills and the Coastal Lowlands subdivisions of the East Gulf Coast Section.

45. The Southern Pine Hills are a moderately dissected, southward-sloping plain underlain by sediments of Miocene to Pleistocene age. Undifferentiated Miocene sediments are exposed in the northern part of the subdivision while sediments of the Citronelle Formation Characterize the southern part.

46. The Southern Pine Hills comprise the elevated divides between the Escatawpa, Mobile-Tensaw,, and Perdido Rivers. This section ranges in elevation from about 100 feet near the coast to about 300 feet in the northern parts of Baldwin and Mobile Counties. Relief is greatest in the northern part where stream valleys are incised as much as 200 feet; but to south the topography is more subdued. Numerous shallow saucerlike depressions, which hold water most of the year, are scattered over the nearly level divide.

47. The Coastal Lowlands is an essentially flat to gently undulating plain extending along the coast adjacent to Mississippi Sound, along the margins of Mobile and Perdido Bays, and lying behind the coastal beaches in southern Baldwin County (Cooke, 1939). The lowlands area merges inland with the alluvial-deltaic plains of the Mobile-Tensaw and Perdido fluvial systems and smaller streams of the area. The Lowlands area ranges in width from almost zero to approximately 10 miles and in elevation from sea level to about 30 feet and is indented by many tidewater creeks and rivers and fringed by tidal marshes. Alluvial, deltaic, estuarine, and coastal deposits of Holocene and Pleistocene age underlie the Coastal Lowlands.

48. The Mobile Bay estuarine system occupies 466 square miles, including the lower Mobile River delta, and, it is the northernmost estuary interfacing with the Gulf of Mexico (Crance 1971). The third largest runoff volume in the continental United States (73,077 cfs annual average) enters Mobile Bay from a drainage area covering 43,560 square miles (Ryan 1969; Chermock, 1974). The long-term average of monthly discharge is strongly seasonal with the period of greatest runoff occuring during the late winter and early spring. Discharge is least during late summer and early fall. The range of recorded discharge has been from a maximum of 590,000 cfs to a minium of about 5,100 cfs (U. S. Army Corps of Engineers, 1975).

49. Mobile Bay is 31 miles in length (not including 12.6 miles of delta) and has an average width of 10.8 miles (Tanner, 1970). Within the estuarine zone, including the lower Mobile delta, are 6,224 acres of tidal marsh, 12,000 acres of freshwater lakes, 15,127 acres in bayous, rivers, and connecting bays, and 249,343 acres in the bay itself. The total shoreline length of 162 miles is constantly changing as a result of: (1) deposition of sediments in the Mobile-Tensaw River delta; (2) the accumulation of tidally-introduced sand along the southern boundary of the bay; and (3) wind-caused erosion of the eastern and western bay margins.

50. The average depth of Mobile Bay is 9.7 feet and the maximum is about 60 feet off Fort Morgan near the Gulf entrance to the bay. Two dredged navigation channels cross the bay, the Mobile Ship Channel from north to south and the Gulf Intracoastal Waterway from east to west. Other dredged channels intersect either the eastward or westward shore line. These include: Sea Cliff Yacht Club Channel, Fly Creek, Fowl River and Arlington Channel. An underwater levee parallels the sides of approximately the upper-third of the 40-foot deep ship channel and a 3,500-foot wide scoured tidal pass exists between Mobile Point and Dauphin Island. A submerged tidal delta covers 16 square miles on the seaward side of the pass, while shoaling on the landward side of the pass has reduced depths to as little as two feet.

HYDROLOGY

51. More data exist on the hydrology of Mobile Bay than for any other set of parameters. Extensive studies of circulation, salinity, temperature, dissolved oxygen, and other estuarine water quality variables have been performed by Austin (1954), Ryan (1969), and McPhearson (1970), Bault (1972), May (1973), and Schroeder (1976). Additional testing on a hydraulic model has been conducted by the Corps of Engineers at Vicksburg, Mississippi. Mathematical modeling has been conducted by Hill and April (1972, 1974 ng and April (1976), Pitts and Farmer (1976), and Game, et.al. (1978). The general characteristics of the Mobile Bay system indicated that the hydrology (circulation, currents, salinity, density, layers, etc.) reflects a situation that fluctuates seasonally while being greatly influenced by a variable volume of stream discharge, wind, and tidal conditions. Intermittently, perhaps daily, each of these variables will have a dominant influence on the hydrologic characteristics of the estuary.

52. The L-shaped morphology of Mobile Bay is significant in regard to the movement of water and sediment by both tides and wind. The long axis of Mobile Bay, as a continuation of the Mobile River flood plain and delta, is significant in regard to movement of freshwater floods from the Mobile River. This 31-mile fetch is also important in the generation of waves from either the north or south. The restricted outlet into the Gulf of Mexico between Dauphin Island and Mobile Point (3 miles in width) exerts significant control on the movement of water and sediment by both wind- and tidal-generated currents.

53. Tidal movement into Mobile Bay is a continuation of the Gulf of Mexico tide. The estuary has a tidal cycle which is diurnal, with one high and one low in a 24-hour period. During the bi-weekly neap tides, however, two highs or two lows, occur within one day. The mean diurnal range in the bayous and inlets along the Alabama coast varies from 1.8 feet to approximately 0.6 foot. The mean range in Mobile Bay varies from 1.5 feet at the head of the bay to 1.2 feet at the entrance. Mean low water in the winter varies from 1.0 to 0.5 foot below that of the summer. The weighted mean tidal range

of the bay, 1.4 feet, and the surface area of the bay, produce a tidal prism volume of 330,575 acre feet. The flushing time, under a relatively low river inflow condition of 12,262 cfs, is between 45 and 54 days (Austin, 1954).

54. Although astronomical tides in the Mobile Bay region are relatively small, winds can induce larger variations. Strong northers can blow water out of the bay and result in current velocities of several knots at the bay's mouth. Water levels as much as 1.9 feet below mean low water have been recorded under these conditions (U. S. Army Corps of Engineers, 1975). An opposite condition occurs when the steadier and more prevailing southeast and southwest winds pile up water in the head of the bay. Data furnished by the Alabama State Highway Department indicate that portions of the east-bound lane (the most susceptible to tidal flooding at elevation +2.6 feet mlw) of Battleship Parkway have been closed on an annual average of 11 occasions since 1971. This indicates the frequency of abnormal wind-driven waves and water setup resulting from south and southeast winds. Hurricane tides have varied from -10.5 msl to 10.8 msl (McPhearson, 1970).

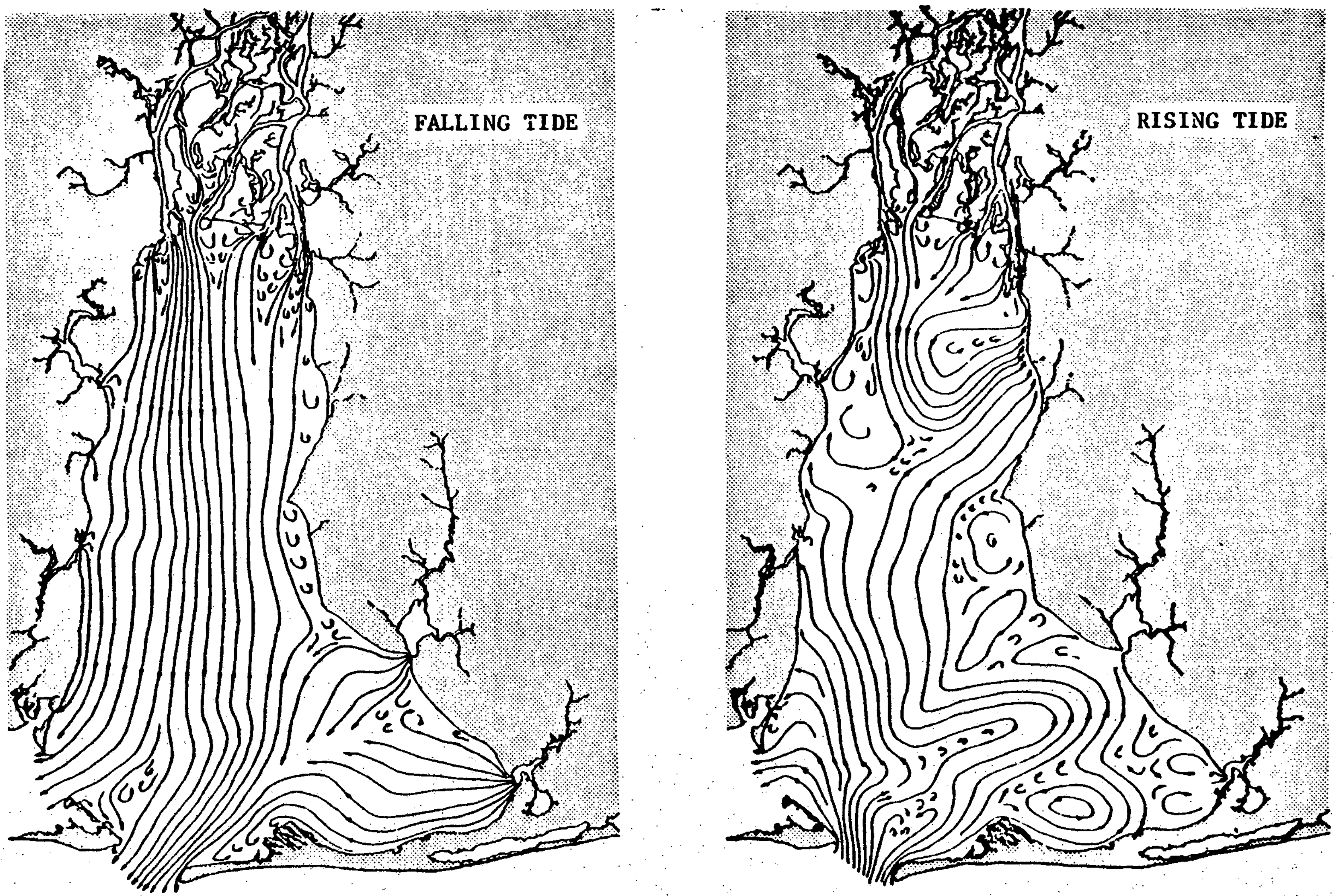
55. In addition to wind and astronomical tides, some bay tides are affected by floods in the drainage basin of the rivers emptying into Mobile Bay. This portion of Alabama is humid and receives an average annual (66 inches) rainfall which produces high river discharges into Mobile Bay. The principal drainage into Mobile Bay is from the Mobile, Tensaw, Alabama, and Tombigbee Rivers.

56. According to Crance (1971), highest river discharges occur in late winter to early spring, while the lowest occur in early summer and late fall. During low stream flow, salt water intrudes as much as 21 miles up the Mobile River (Corps of Engineers, 1949). The relationship between river discharge and salinity along the ship channel was defined by McPhearson (1970). Even in the southernmost parts of the bay, high river discharge can depress average surface salinity values from 20 $^{o}/oo$ to nearly zero, while the bottom strata are largely unaffected. These high flows result in a

high hydrostatic head which produces higher tides and currents than normal at the bay's mouth. Under extremely high flows, a southernly surface flow continues even during flood tides.

57. Salinities in Mobile Bay change rapidly and over a wide range, from zero to 35 ^{o}/oo. Major fluctuations in river discharge have an immediate effect upon salinity in all parts of Mobile Bay; although, if short-lived, the effects are usually expressed only in the surface portions of the water column. Although salinities in Mobile Bay are characteristically lower than adjacent open Gulf values, even the Gulf waters are generally lower than most coastal areas along the northern Gulf. This results from the transport of low salinity, turbid water from the Mississippi River passes on the east side of the delta which trends towards Mississippi Sound and the Alabama coast most of the year (Scruton and Moore, 1953). These flows of water from the Mississippi plus the periodic high discharge from Alabama's rivers create a permanently lowered salinity regimen, which eliminates many animals common to the higher (and more normal) salinity areas of the Gulf coast (Parker, et al, 1974).

58. The tidal circulation of Mobile Bay has been investigated by Austin (1954) during a period of unusually low river discharge (figure B-12). The following description of ebb and flood tide behavior was postualted from non-synoptic data. On a flood tide, the incoming current from the Gulf of Mexico enters through the pass between Dauphin Island and Mobile Point. Part of the water flows up the west side of the bay and part flows into Mississippi Sound. Within four hours this latter flow reverses and water enters Mobile Bay from Mississippi Sound (Chermock, 1974; U. S. Army Corps of Engineers, 1977). Another part of the water entering from the Gulf flows to the east into Bon Secour Bay before turning back to the west, where the flow joins the generally northward movement of water into the central part of the bay. Eddies develop in Bon Secour Bay and between Great Point Clear and Mullet Point.



Source: Austin, 1954 as given in Chermock, 1974

FIGURE B-12

TIDAL FLOW PATTERNS IN MOBILE BAY

59. In the northern part of the bay during the flood tide the flow from the Mobile River continues southward on the surface along the western side of the bay. The tidal flow from the south is pushed to the east side of the bay creating a counterclockwise circulation pattern.

60. On an ebb tide (figure B-12), the movement of water in the main part of Mobile Bay is uniformly to the south. Flows in Bon Secour Bay are toward the mouth of Mobile Bay with the pattern affected by discharges from Weeks Bay and the Bon Secour River. About 28 percent of the water passes into Mississippi Sound with the remainder leaving the bay through the main pass (Austin, 1954).

61. The short-term salinity structure of the Bay can vary considerably depending on the progression of tidal amplitude and short-term variations in discharge of the Mobile River. As a result, conditions in Mobile Bay represent a wide range of mixing or stratified salinity conditions. Mixing between the surface and bottom water layers of the Bay is not yet well studied. Factors that have altered natural circulation patterns include the construction of deep navigation channels with associated disposal areas and landfill causeways (Chermock, 1974; U.S. Army Corps of Engineers, 1977).

62. Typical surface isohalines show outflows of low salinity water along the west side of Mobile Bay, with higher salinity water entering from Mississippi Sound. During certain periods (November-December) high-salinity surface waters characterize Bon Secour Bay. Bottom water masses are sharply divided by the Mobile Ship Channel which contains higher salinity Gulf waters. This results in the division of the bay into two cells of fresher bottom water. Generally higher salinity values are found along the eastern shore of the bay.

63. According to Bault (1972), during January and February surface waters are nearly isothermal, while considerable differences in water temperatures exist between the head and mouth of the bay in November and December.

64. A more recent conception of Mobile Bay circulation has been prepared by Schroeder (1974). His concept of flood tide circulation, with inflow spreading evenly into the bay from both the Gulf and Mississippi Sound differs considerably from that of Austin (1954). Turbulent mixing occurs northeast of Dauphin Island and along the southwest shore of the bay, where tidal waters meet river water flowing out. Ebb tide circulation, as depicted by Schroeder (1974), is even more simple--showing rapid movement directly out of the bay, through the mouth and also into the Mississippi Sound. This study is in general agreement with that generated by the Mobile Bay physical model. In the model the only irregularity in flow is the pile-up of water at Dauphin Island, where it is deflected southeast and northwest along Little Dauphin Island.

GEOMORPHOLOGY AND SEDIMENTOLOGY

65. The geomorphic characteristics of the Mobile Bay estuarine system are due to the processes of sediment deposition and erosion that have altered the estuary during its 3,500-year history (Tanner, 1970). The estuarine system is the drowned mouth of a river valley, possibly a graben, that is filling with sediments introduced by the Mobile River system. The gently curving, steep-sided shorelines on the east and west sides of Mobile Bay have been modified by wave erosion and deposition of sediment. The irregular shoreline of the north end of the bay is the result of the deposition of sediment in the Mobile-Tensaw River delta as it has progressed southward into the bay. The southern shoreline and tidal inlet have been modified by the deposition and removal of sand by marine longshore currents moving from east to west. This deposition has progressively narrowed the seaward opening of the estuary, and created the interconnected Mobile Bay-Mississippi Sound systems.

66. An annual average of 4.7 million tons of suspended sediment and an unknown quantity of bed load are currently being transported into the estuary (Ryan 1969). As the sediments encounter the increased salinity and decreased water velocity of the bay, many of the suspended particles flocculate and settle, gravitating toward holes, channels, and basins within the bay, leveling and stabilizing the bay floor. As shown by figure B-13, the bay bottom is composed mostly of silty clays and clays; while coarser inorganic sands encircle the bay near its shores. About 1.4 million tons annually pass through the estuary and are deposited to the south and west of the tidal inlet.

67. May (1976) determined a range of deposition of 3 to 21 centimeters per century during the past 5,000 years from buried oyster shell within the bay. Ryan (1969) calculated a baywide sedimentation rate of 56 cm during the past century from bathymetery changes in the bay. This suggests that the rate of filling has increased.

68. Ryan (1969) reported a crescent-shaped tidal delta of clean sand immediately south of the tidal inlet between Fort Morgan and Alabama Point. Seaward of the tidal delta, in water depths usually greater than 12 to 18 feet, is a region of sand-silt-clay which reflects the mixing of shelf sands with silts and clays from the estuary. Most of the fine-grained sediment from the Mobile Bay system is deposited to the south and southwest of the tidal inlet in response to the predominant littoral drift. However, during the summer months, an eastward component of the littoral drift system causes some of the silts and clays to move eastward. Gorsline (1966) estimated a total net littoral transport at Gulf Shores, Florida, of 196,000 yd^3/yr. Garcia (1977) accepts this value and has further calculated total net littoral transport seaward of the breaker zone at Dauphin Island to be 27,737 yd^3/yr. Toward the east the shelf sands are progressively coarser and better sorted. Influence of the Mississippi River sediments is also reflected south and west of Mobile Bay.

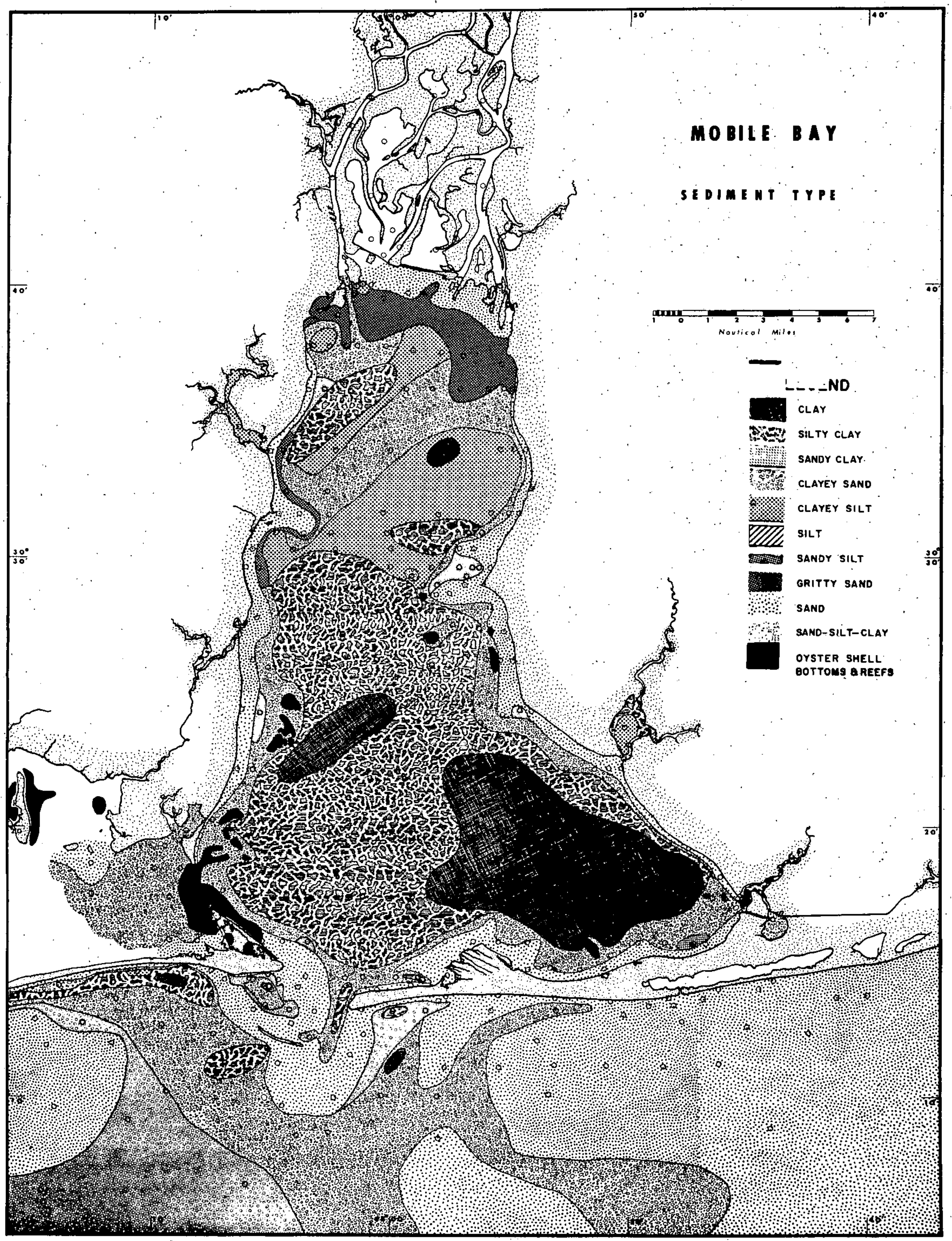


FIGURE B-13 SEDIMENT TYPES IN MOBILE BAY AND ADJACENT AREAS

69. The study of the bottom sediments of Mobile Bay and the harbor channels has been fairly well documented in recent years (Tech. Comm. Anal. Mobile Bay Dredging 1972 and Chermock, 1974). The Technical Committee for Analysis of Mobile Bay Dredging, 1972, collected sediment samples from 33 stations in the Mobile Bay area, including 17 stations located in the bay proper. The sediment samples were analyzed for volatile solids, COD, TKN, Phosphorous, Chromium, Zinc, Lead, Copper, and Mercury. Results of the study indicated that:

a. The concentrations for all parameters analyzed were generally higher in the clay, silty-clays, and clayey silts, rather than the sand and silty sand bottom;

b. Considering a simple circulation pattern from the Mobile-Tensaw river system southward along the western side of the ship channel through the mouth of Mobile Bay, thence re-entry through the mouth on the flood tide to the eastern shore in a northeasterly direction (Ryan, 1969), the concentrations of the materials generally appear to increase with distance from the causeway;

c. the relationship of concentration with depth varied from station to station with no discernible pattern. However, most often no change was exhibited with depth.

According to Chermock (1974), sediments in northern Mobile Bay are prodeltaic silts, clayey silts and delta front sands and silty sands. In the southern part of the bay, sediments are estuarine silty clay and clay. Toward the periphery of the bay are bay - margin sands and clayey-sands. Oyster shell accummulations occur locally forming oyster shell bottoms and reefs. Holocene sediments are from 15 to 20 feet in thickness in the western parts of the bay.

70. The Alabama Highway Department conducted extensive subsurface investigations in connection with the bridge crossing of Interstate Highway 10 at the delta front. As a result of the analyses, it was found that the trace metals in the sediments are stratified and increase with depth. Surface lead, zinc, and mercury west of the Tensaw River nearer the city of

Mobile were higher than to the east. Mercury values were within the natural range, but average lead and zinc concentrations were higher than in the open bay (May, 1973) or in the sediments with depth, which suggests that there may be an anthropogenic source for the higher level (May, 1976).

71. The Mobile District Corps of Engineers collected sediment samples from the harbor portion of the bay in 1971 and 1974. Locations of the sampling stations and the characteristics of the sediment are shown in Attachment B-1. The 1971 program consisted of analysis of the bulk content of surface layer samples collected from three locations in Mobile Harbor.

72. Although the bulk analysis method is not considered a good indicator of the potential for sediments to release chemical contaminants when disturbed, it does illustrate the nature of the sediments in respect to the exisiting project area. Physically, the surface layer sediments of the ship channels range from sand and silt to inorganic silts and clays, most having the latter classification. The deeper sediments are somewhat coarser-grained with the upper bay channel containing large amounts of sand. Generally, the Corps of Engineers findings for the ship channel sediments were similar to the conclusions reached by the Technical Committee regarding bay sediments. However, in respect to depth, the overall average concentrations of the deeper sediments of the Mobile Ship Channel were less than that of the surface layer sediments. This possibly indicates that minor cultural enrichment has occurred during the last century.

UPLAND ECOSYSTEMS

73. Several upland communities are found in the Mobile and Baldwin County area. The four donimant communities are the longleaf pine-oaks community, pine savannah community, bay forest community, and the large floodplain forest community of the Mobile River Delta (Gemborys and Hodgkins, 1970; J. B. Converse and Company, Inc., 1975). These natural communities have been removed or altered considerably by man's activities in the area,

74. The bay forest community occurs on the floodplains of most of the small and moderate size streams of Mobile and Baldwin Counties (Gemborys and Hodgkins, 1970). The dominant trees are mostly hardwoods and include slash pine (Pinus elliottii), yellow poplar (Liriodendron tulipifera), sweetgum (Liquidambar styraciflua), water oak (Quercus nigra) black tupelo (Nyssa sylvatica var. biflora), sweetbay magnolia (Magnolia virginiana), and red maple (Acerrubrum). Fire is rare in this community.

75. In a mature bay forest, the evergreen canopy is well developed so that the understory is poorly developed. However, more open portions can have dense growths of swamp Cyrilla (Cyrilla racemiflora), black titi (Cliftonia monophylla), cane (Arundinaria), black willow (Salix nigra), wax myrtle (Myrica cerifera), and hazel alder (Alnus serrulata).

WETLAND ECOSYSTEMS

76. A floodplain forest is found in the Mobile River delta. Important species in this forest community include black gum (Nyssa biflora), white bay (Magnolia glauca), cypress (Taxodium distichum), red maple (Acer rubrum), tupelo gum (Nyssa uniflora), ash (Fraxinus spp.), cottonwood (Populus heterophylla), red bay (Persea pubescens), and black willow (Salix nigra).

77. Three general types of wetland communities are found in Mobile and Baldwin Counties. These are freshwater marshes, low salinity brackish water marshes, and higher salinity saltmarshes. All these marshes receive some tidal influence.

78. Tidal marshes are most extensive in the Mobile Delta and the northern shore of Mississippi Sound. Chermock (1974), using photographs taken by the Earth Resources Technology Satellite on 28 December 1972, calculated 30,207 acres of marsh in coastal Alabama. Crance (1971) give 34,614 acres as shown in the following tabulation. The principal difference lies in estimates in Mobile Bay. Vittor and Stout (1975) have determined a value of 27,346 for Alabama's total coastal zone. Although this latest report contains site specific errors, it is probably the best available estimate of Alabama's coastal wetlands.

especially by farming in the southern portions of the counties, by management of lands for pulpwood production in the northern part of the area, and by logging activities and suppression of fires.

79. Within the longleaf Pine-Oaks Community the longleaf pine (Pinus palustris), is dominant. Species comprising the community are adapted to survive periodic ground fires, which eliminate competing hardwood species. Where these natural fires still occur or controlled burning is used to keep out the shrub layer, this community has a very open character with an extensive herbaceous ground layer of little bluestem (Andropogon scoparius), A. tener, broomsedge (A. virginicus), windmill grass (Gymnopogon spp.), dropseed grass (Sporobolus junceus) sensitive briar (Schrankia microphylla), Lupinus diffuses, Helianthus radula, Chrysopsis graminifolia, Coreopsis major, and blazing star (Liatris spp.). When fires are suppressed, a thick understory of oaks and shrubs develops. On moister soils these include the laurel oak (Quercus lemispherica), southern red oak (Quercus falcata), sparkleberry (Vaccinium arboreum), and winged sumac (Rhus capallina). On well drained sites the turkey oak (Quercus laevis), blue jack oak (Quercus incana), and sand post oak (Quercus margaretta) are found in greater numbers.

80. The pine savannah community is found on wet, poorly drained soils. Longleaf pine is the dominant tree. Associated is a fairly dense understory, that includes gallberry (Ilex glabra), wax myrtle (Myrica cerifera), and saw palmetto (Serenoa repens). The ground cover of herbs and grasses include Muhlenbergia expansa, Panicum spretum, Rhynchospora spp., Scleria, Lycopodium alopecuroides, Rhexia, Aletris spp., Eriocaulon spp., Pogonia ophioglossides, Calopogon Pulchellus, and Xyris spp. The wettest areas support pitcher plant bogs, which contain insectivorous plants such as sundews (Drosera spp.), butterwort (Pinguicula spp.), bladderwort (Ultricularia spp.), and pitcherplant (Sarracenia spp.).

Areas of Tidal Marsh
(After Crance, 1971)

Mississippi Sound	11,762 acres
Mobile Bay	6,224 acres
Mobile Delta	15,257 acres
Perdido Bay	1,072 acres
Little Lagoon	299 acres
Total	34,614 acres

81. These values, however, make no distinction between the various salinity regimens which bathe the marshes and, in turn, determine the wetland's overall value and contribution to the Mobile estuarine system. This aspect has been examined by Vittor and Stout (1975) with the following results:

Wetland Habitat Acreage in the Alabama Coastal Zone

Habitat	Total Acres	Percent Occuring in Mobile Bay and Mobile Delta
Saltmarsh	2,330	43.0
Brackish-mixed marsh	13,512	8.4
Saltbush	111	0
Saltflat	162	0
Fresh-mixed marsh	11,231	63.4
	27,346	

82. In Mississippi Sound, there are large areas of tidal marsh along the northern shore and including the marsh islands. These marshes are usually bordered along the water's edge by a strip of salt marsh grass, Spartina alteriflora, with scattered stands of S. cynosuroides, S. patens, Distichlis spicata, and Phragmites communis. The majority of the marsh within Alabama is composed mostly of Juncus roemerianus (Swingle, 1971). The small areas of marsh, primarily S. patens, still present along the northern shore of Dauphin Island are being increasingly threatened by development.

83. The bulk of Mobile Bays' saltmarsh is associated with Deer, Fowl, and Dog Rivers. In the southeastern part of the bay, marshes are found at Little Point Clear on the north shore of Fort Morgan Peninsula and around the edge of Oyster Bay. These are similar to those found in Mississippi Sound. The peripheral border of Spartina alterniflora grades into almost pure stands of Juncus roemerianus. On higher ground occur stands of Spartina patens, Fimbristylis sp., Spartina cynosuroides, Phragmites communis, and Borrichia frutescens.

84. Lueth (1963) delineated the marsh areas of the lower Mobile Delta. The tidal marshes were described as occurring in a zone varying from a few inches below mean low tide to about a foot above it. Plants growing in this fringe were classified as tidal emergents. Although some species, such as Juncus, found here are able to tolerate brackish waters, the majority are essentially freshwater forms.

DEVELOPED AREAS

85. Urban and/or industrial lands are located within the metropolitan and residential areas of towns and larger cities. These lands are concentrated along the eastern shore of Mobile Bay and areas immediately south of the Mobile metropolitan area. Smaller areas occur on Dauphin Island, Fort Morgan Peninsula, and the community of Bayou La Batre. Vegetation in these areas consists mainly of unconsolidated plantings used in landscaping. Included within this designation are numerous recreational areas, municipal parks, and small wildlife sanctuaries. The National Audubon Society maintains a 150-acre wildlife sanctuary on Dauphin Island. The area is used intensely by migrating birds during the spring and fall. Tracts such as these, although small, combine to offer valuable wildlife habitat and represent significant economic investment in terms of land use and other resources. There are approximately 5,280 acres of this designation in Mobile County and 5,760 acres in Baldwin County.

ESTUARINE ECOSYSTEMS

86. Phytoplankton are microscopic single-celled plants that float freely in the water. They often serve as an important food source to many estuarine animals. Thirteen species of blue-green algae and 24 species of green algae have been identified from Mobile Bay. No data are available on their abundance, distribution within the bay or seasonal pattern of occurrence.

87. Macroscopic attached algae are not particularly common in Mobile Bay because of the lack of suitable hard substrates for attachment and the somewhat turbid conditions (U.S. Army Corps of Engineers, 1977). Some are found on oyster reefs and man-made objects such as pilings and jetties. In the higher salinity waters of the Alabama coast, attached algae were most diverse and abundant during late winter and early spring (Morrill, 1959, as summarized in Chermock, 1974).

88. The types and occurrences of submerged macroscopic plants have been studied most in the Mobile delta and in Mississippi Sound. Few data are available from the estuarine waters of Mobile Bay (Chermock, 1974). In the low salinity waters of the upper bay near the causeway aquatic species may include tape grass (Vallisneria americana), redhead grass (Potamogeton perfoliatus), coontail (Ceratophyllum demersum), water stargrass (Heteranthera dubia), horned pondweed (Zannichellia palustris), bushy pondweed (Najas quadalupensis), Eurasian watermilfoil (Myriophyllum spicatum), elodea (Egeria sp.), and muskgrass (Nitella spp.). Vallisneria often occurs in beds southward to Fairhope according to Chermock (1974). However, more recent indications are that these Vallisneria beds have disappeared in recent years.

89. Benthic seagrasses occur in the higher salinity shallow waters of coastal Alabama. Turtle grass (Thalassia), manatee grass (Syringodium), and shoal grass (Halodule) are the most common (Chermock, 1974).

90. No data on the zooplankton of Mobile Bay are readily available. Some copepod species commonly found in Mississippi Sound include Acartia tonsa, Labidocera aestiva, Oithona brevicornis, Temora turbinata, and Centropages hamatus (Perry, 1975). The relatively high salinity of Mississippi Sound makes it similar only to the southern portions of Mobile Bay. The lower salinity areas of the upper bay are likely to have a different assemblage of species than found in the sound.

91. Few quantitative data are available on the abundance or seasonal variation in species dominance of the larger macroinvertebrate animals that live in or on the bottom sediments of Mobile Bay. Parker (1960) has briefly characterized the faunal assemblages of the bottom of Mobile Bay. His more recent work developed during review of the Mobile Bay environmental study prepared by the Alabama Geological Survey indicates that four molluscan faunal assemblages are traversed by the Mobile Ship Channel. Diversity increases markedly from the river mouth to bay entrance and offshore. Only four species of mollusks are commonly found in the upper bay area and near the delta (river-influenced, low-salinity assemblage), while 11 species are found in similar sediments, but with higher salinities of the open sound or open bay center habitat. The number of typical species increases to 26 along the higher-salinity bay margins. The inlet and inner-shelf habitats of the Mississippi-Alabama area are characterized by 20 and 18 species, respectively but only the common species are given. Another 20 or 30 uncommon species of mollusks might be taken from both habitats by dredging with a fine-mesh shell dredge. The surf zone is expected to have only four species, since it is a rigorous habitat for molluscan life.

92. Oysters are an important part of the commercial fishery of the Mobile Bay region. Presently, there are 3,064 acres of natural living oyster reefs in Mobile Bay (table B-14), most of which are found in the southern half of the bay (figure B-14). Other oyster areas that are used for growing oysters include about 1,050 acres of riparian bottoms and 924 acres of State-owned bottoms.

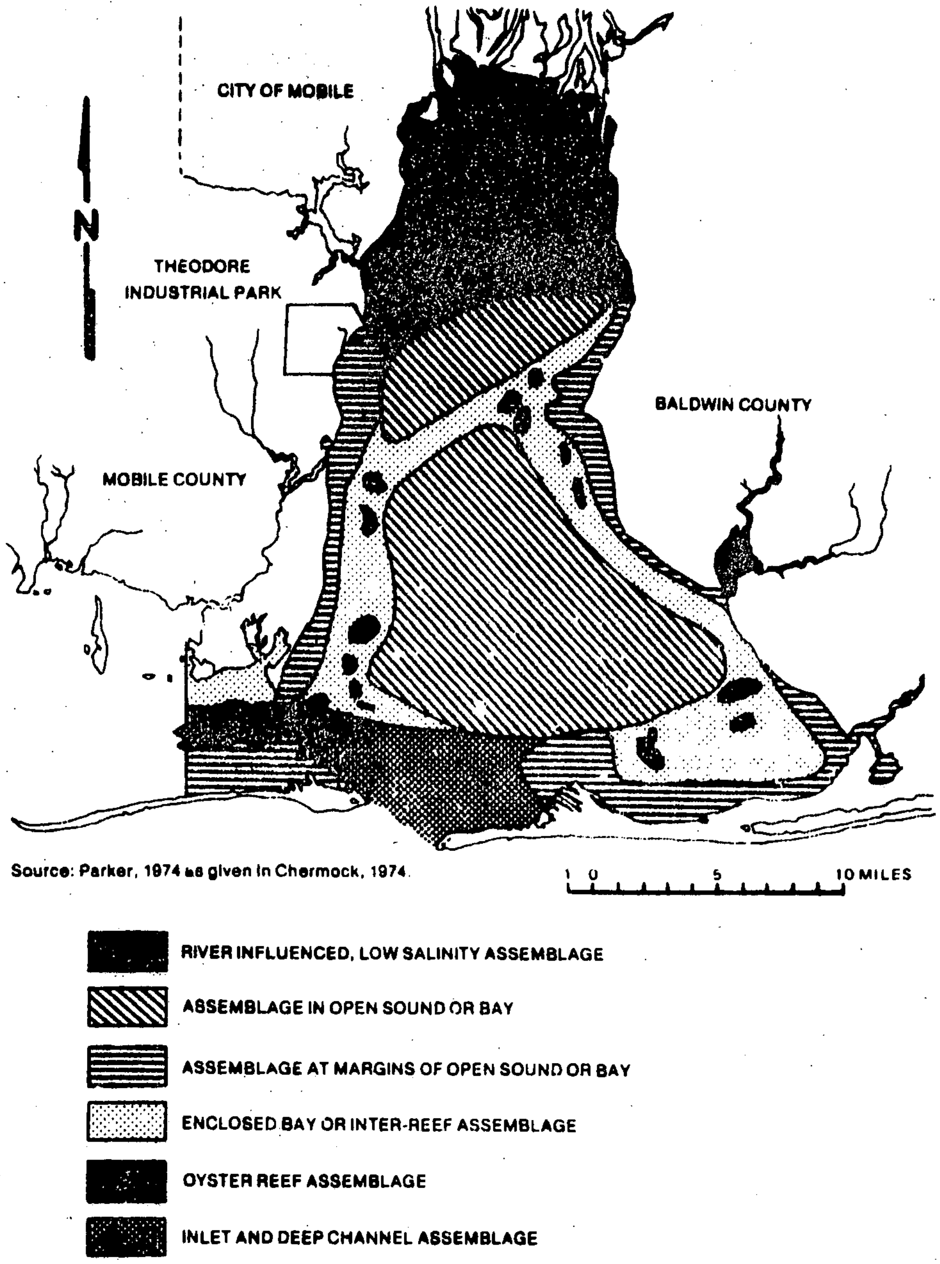


FIGURE B-14
BENTHIC MACROINVERTEBRATE COMMUNITIES IN MOBILE BAY, ALABAMA

TABLE B-14

LIVING NATURAL OYSTER REEFS IN THE MOBILE BAY AREA.

REEF	AREA (acres)
Dauphin Island Bay	8.7
Cedar Point	1411.7
Heron Bay	143.6
Sand	38.1
Buoy	207.8
Kings Bayon	68.6
White House	452.6
Hollingers Island[1/]	12.2
Point Clear	205.8
Klondike	160.7
Fish River	105.5
Bayou Cour	67.1
Bon Secour	31.7
Shellbank	149.0
Total Area	3063.1

Source: Chermock, 1974

[1/] This reef has been reportedly destroyed to present illegal harvest and sale of polluted oysters.

93. The density of oysters on most reefs is less than 4,000 3-inch oysters per acre. Only 882 acres of reef have over 7,000 3-inch oysters per acres, the minimum density necessary for profitable commercial harvesting with hand tongs (Chermock, 1974). These reefs are Kings Bayou Reef, Cedar Point A and F, and Hollinger Island Reef. The latter is permanently closed to commercial harvesting because of year-round coliform bacterial contamination of that part of Mobile Bay and has been reportedly destroyed. All other oyster reefs are usually closed during periods of high freshwater discharge.

94. Shrimp are an important part of the commercial fishery of the entire Gulf Coast (Gulf Coast Research Laboratory, 1974, 1976; Etzold and Christmas, 1977). Three species, brown shrimp (Penaeus aztecus), white shrimp (Penaeus setiferus), and pink shrimp (Penaeus duorarum) utilize coastal estuarine waters such as Mobile Bay as nursery areas for the growth and maturation of the younger life stages.

95. Spawning of adults occurs during the winter in the high salinity and more stable environment of the coastal Gulf of Mexico waters. The free-floating young larval stages are eventually carried into the lower salinity estuarine areas, brown shrimp beginning in February with peak movement in March and April, white and pink shrimp from June through September. Upon entering the estuary the post larvae become bottom dwellers with white shrimp generally seeking out lower salinity areas than brown or pink shrimp. Growth is rapid during the warm months, but actual survival and growth rate is strongly influenced by environmental conditions experienced during this time. As the juvenile shrimp get larger they move to deeper parts of the bay and eventually move offshore into the coastal gulf waters.

96. Blue crabs, another commercially important species, are also dependent on both the estuarine and gulf areas for their total life cycle (Chermock, 1974; Gulf Coast Research Laboratory, undated). Mating of adult crabs occurs in the low salinity waters of Mobile Bay from March through November,

after which the females migrate to the high salinity Gulf waters, where spawning occurs. The planktonic larvae are eventually carried back into the bay, where they mature.

97. A total of 233 species of fish representing 173 genera and 80 families has been documented as occurring in the Mobile Bay area (Swingle, 1971). Swingle utilized both seines and trawls in assessing the fish fauna of this region. The most abundant fish taken by seine, according to Swingle (1971), are herring-like, anchovies, croaker-like, Silversides, and mullet. The most abundant species representing these groups are as follows: Brevoortia patronus (Gulf Menhaden), Anchoa mitchilli (Bay anchovy), Leiostomus xanthurus (spot), Menidia beryllina (Tidewater Silverside), Membras martinica (rough silverside) and Mugil cephalus (striped mullet). The most numerous families and species taken by trawl are basically the same as those taken by seine. Recent studies conducted in the Mobile Bay area by researchers from the Dauphin Island Sealab and the University of South Alabama (1974-1978) indicate that large numbers of Menhaden, Croaker-like fish, Jacks, Sea robins, and flounder are frequently taken by trawl. The fisheres represented by the aforementioned groups are Longspine Porgy, Pinfish, Sand Perch, Rock Sea Bass, Rough Blackfin Searobin and Dusky Flounder. These fishes, while abundant in Mobile Bay and the surrounding Gulf waters, are numerically less abundant in the Mobile Bay ship channel; however, Swingle (1971) determined that the total number of species found in the ship channel is higher than that of the adjacent areas in the bay since, the high salinity water is conducive to the existence of many of of the inshore gulf fish species. He also reported that eight species were collected only in the Mobile ship channel, which suggests that these species may be moving into the bay on the incoming tide. Further information presented by Swingle (1971) on Alabama commercial fisheries landings between 1964 and 1968 indicate that (Striped Mullet), (Atlantic Croaker), (Kingfish), (Gulf and Southern Flounder) are the most valuable estuarine-dependent species along the Alabama coast.

98. Swingle (1976) stated that 106 species of fish and eleven species of invertebrates are classified as commercial species in Alabama. Most of the seafood is landed in Mobile County at Bayou la Batre which ranked as the tenth port in the nation in value of seafood landed during the past few years. Commercial landings have increased from about 8 million pounds in 1961 to 34 million pounds in 1974 while showing an eight-fold increase in dockside value to over 16 million dollars. Swingle (1976) also calculated the economic value of the seafood industry to the local economy of south Alabama to be in excess of $70 million and an economic value to the state and Nation in excess of $120 million annually.

99. Although almost all of this catch is estuarine dependent, much is caught in waters either offshore of Alabama of in adjacent areas in Mississippi orLouisiana. Although, catches made in Mobile Bay probably are much less, they are still highly valuable. The fisheries landings from Mobile Bay during the period 1963-1975 are summarized in table B-15. During this period fish and shellfish landings have fluctuated around an average of four million pounds with about $740,000 at the dock. Colberg and Windham (1965) have determined an economic multiplier of four for oysters in Apalachicola Bay. Utilization of this multiplier suggests an annual value from Mobile Bay in excess of $2.8 million.

Table B- 13

Fishery Landings from Mobile Bay
During the Period 1963 - 1975

Year	Fish (lbs)	Shellfish (lbs)	Total Value (Dollars)	Total (lbs)
1963	1,374,700	3,366,100	800,355	4,740,800
1964	1,042,400	2,188,500	599,946	3,230,900
1965	1,296,200	1,781,600	471,829	3,077,800
1966	1,116,500	1,993,800	627,920	3,110,300
1967	3,748,300	3,811,900	1,197,280	7,560,200
1968	3,351,700	2,696,700	854,219	6,048,400
1969	3,065,800	1,751,500	746,504	4,817,300
1970	2,939,200	1,302,800	571,897	4,242,000
1971	2,168,600	1,257,500	495,970	3,426,100
1972	1,317,700	1,557,600	694,028	2,875,300
1973	2,435,300	1,381,900	780,248	3,817,200
1974	1,672,300	1,323,800	847,640	2,996,100
1975	1,293,900	1,300,400	934,328	2,594,300

100. Table B-16 illustrates the historical shellfish harvest from Mobile Bay. Catches in all four catagories, shrimp, oysters, crabs, and squid are highly variable. No clear trend in the crab harvest is evident. However, the shrimp catch has declined significantly. The decline can be attributed to either of two causes, a decrease in fishing effort or an actual decline in abundance of the resource. Swingle (1976) has attributed the decreased catch from Mobile Bay to changes in the fishing effort. Between 1964 and 1971, the number of bay boats--those less than five tons in displacement--has decreased 27%, while the offshore fleet has nearly doubled. During the same period the catch data (expressed as pounds per trip) decline at an average value of 2 percent annually while the number of trips declined 5 percent annually. The average catch per trip during the same period has fluctuated moderately about an average of 367 pounds (See table B-17).

101. Table B-16 also presents oyster catches from the bay. With the exception of 1967 in which the harvesting of undersize oyster was permitted, catches are down in Mobile Bay. However, the bulk of the state's oyster harvest occurs just west of the Dauphin Island Bridge and is consequently credited in the fisheries statistics to Mississippi Sound. Inspection of these data indicated a highly fluctuating oyster harvest with no apparent trend. However, when the data are coupled with that from Mobile Bay, an overall shift in principal oyster harvest into the sound is strongly indicated.

ENDANGERED AND THREATENED SPECIES

102. As the result of a 1975 symposium at the University of Alabama, the State of Alabama has designated species of plants and animals(including crayfishes, shrimps, gastropods, naidd mollusks, fishes, amphibians, reptiles, birds and mammals) that are considered endangered, threatened or of special concern in the state. Three catagories are now recognized and are defined as follows:

Endangered Species - those species whose prospects for survival are in immediate jeopardy (in danger of extinction) throughout all or a significant protion of their range in Alabama.

Threatened species - those species which are likely to become endangered in the forseeable future throughout all or a signigicant protion of their range in Alabama.

Species of special concern - species which must be continually monitored because imminent degrading factors. The limited distribution of these species in Alabama or other physical and biological characters may cause them to become threatened or endangered in the forseeable future.

In addition, the United States Department of the Interior, Fish and Wildlife Service maintains a list of endangered and Threatened Wildlife and Plants within the United States as required under the Endangered Species Act of 1973 (16 U.S.C. 1531 - 1543; 87 Stat. 884).

103. The U.S. Department of the Interior, Fish and Wildlife Service, includes in their list of "Endangered and Threatened Wildlife and Plants" of 14 July 1977, six mammals, eight birds, and four reptiles that may occur in South Mobile County (see Attachment B-2). Of these mammals, birds and reptiles only four mammals (Felis concolor coryi Florida panther, Balaenoptera physalus finback whole and Physeter catodon sperm whole), five birds (Falco peregrinus tundrius artic peregrial flacon, Pelecanus occidentolis brown pelican, Vermivora bachamanii bachman's warbler, Campephilus principals ivory-billed woodpecker and Picoides borpolis redcockoded woodpecker) and four reptiles Alligator mississippaensis American alligator Lepidochelys kempir Atlantic ridley sea turtle, enotmochelys imbricata. Hawkshill turtle and Dermochelys cariocea leatherback turtle have been reported in the immediate project area.

104. Endangered and Threatened Plants and Animals of Alabama published by the Alabama Museum of Natural History, 15 October 1976, lists an additional 40 plants, 6 fishes, 14 amphibians and reptiles, and 15 birds from the Mobile Bay area as endangered, threatened, or of special concern in Alabama;

however, only a few of these occur in the project area and these are: Scaphirhynchus sp. Alabama shovelnose sturgeon, Acipernser Oxyrhynchus Atlantic sturgeon, Caretta caretta Atlantic luggerhead turtle, Chelonia mydas green sea turtle, Desmochelys coriacea leatherback sea turtle, Alligator mississippiensis American alligator, Pseudemys alabamensis Alabama red-bellied turtle, Rana heckscherii river frog, Siren lacertina greater siren, Pelecanus occidentalis brown pelican, Felis concolor coryi Florida panther, and Ursus americanus floridanus Florida black bear.

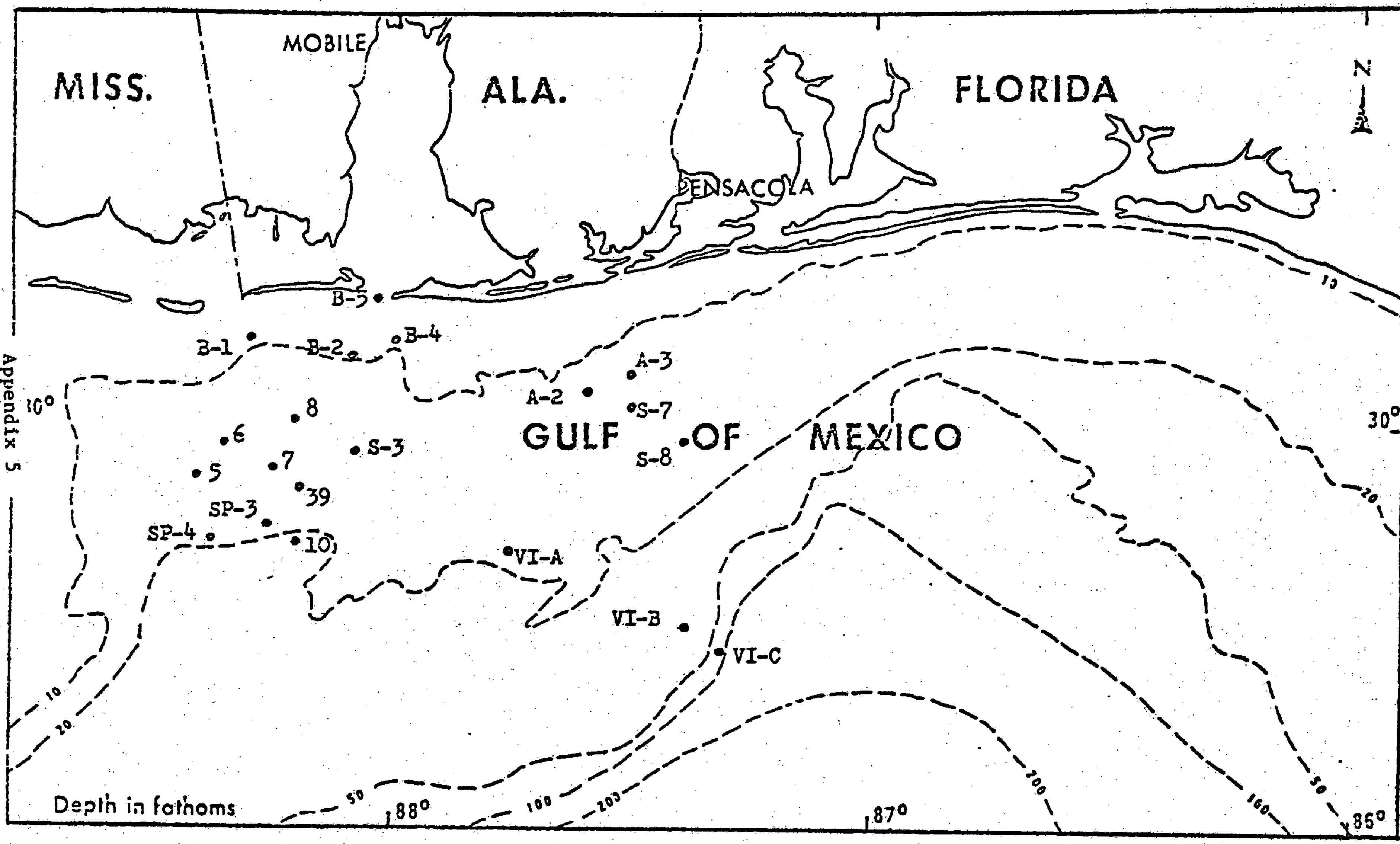


Figure B-15 Locations of sampling sites

TABLE B-16

SHELLFISH HARVEST FROM MOBILE BAY
FROM 1963 THROUGH 1974 (IN 1,000's LBS)[1/]

Year	Shrimp	Oysters	Crabs
1963	2,373	324	730
1964	1,223	349	613
1965	1,086	21	675
1966	1,028	237	728
1967	1,726	1,123[2/]	962
1968	1,395	279	1,062
1969	1,000	72	680
1970	725	42	535
1971	543	52	643
1972	722	239	596
1973	343	129	987

[1/] Data supplied by Mr. Orville Allen, National Marine Fisheries Service.

[2/] This value reflects the harvest of undersize oysters to supply cannery operation.

TABLE B-17

CHANGES IN ALABAMA'S SHRIMP FEET AND CATCH

Year	Shrimp Boats Under 5 Tons	Fishermen on Boats	Shrimp Vessels Over 5 Tons	Fishermen on Vessels	Average Catch per Trip from Mobile Bay lbs (heads off)
1964	231	380	230	582	362
1965	206	335	295	706	317
1966	203	311	366	882	368
1967	174	279	397	961	481
1968	139	227	467	1,164	420
1969	129	188	506	1,283	300
1970	149	174	448	1,143	294
1971	169	171	456	1,160	363

1/ Adapted from Swingle (1976).

OFFSHORE BENTHIC HABITATS

105. Data on the offshore benthic habitats are limited for Alabama waters. Four stations have been sampled in recent years within the 10-fathom curve, while 13 samples have been taken between the 10- and 20-fathom curve (Figure B-15). This effort represents roughly one sample per 100 square miles of water bottoms that are less than 20 fathoms in depth. Although much additional data are required prior to accurately describing the various benthic habitats characterizing Alabama's coastline, the following paragraphs represent the available data.

106. Within the area lying shoreward of the 10-fathom curve (Stations B-1, B-2, B-4, and B-5), the benthic community is not as numerous south of Dauphin Island as it is south of Perdido Bay. Sediment type influenced the abundance of macro-infauna. Smaller numbers of organisms were found in fine sand and clay substrates, but the individual size of each orgamism was larger. This relationship suggests that in the fine sand-clay substrates bivalves dominated, while polychaetes dominated the coaser substrates.

107. Much of the area between the 10- and 20- fathom curve is located in the Mississippi-Alabama-Florida sand sheet. The particle size generally increases with distance from the shore as increasing amounts of shell hash are revealed. Stations 6, 7, 8, and S-3 relate to this study. Substrate at stations S-3 and 8 is coarse sand, while median sand was encountered at stations 6 and 7. Medium and coarse sand supported a much higher standing crop of benthic infauna. Much of this difference can be attributed to the increased contribution of non-polychaetes, such as mollusks, arthropods, and echinoderms to the community.

WATER QUALITY

108. Mixing of the various water masses that enter Mobile Bay at regular intervals produces an infinitely varying combination of chemical and physical gradients. The range and mean of selected water quality parameters in Mobile Bay are given in table B-8. Generally, the bay's water temperatures range from about

10° in January to about 31° C in August, while the average annual temperature is about 22° C (Bault, 1972). Salinity varies markedly within the bay as a result of the large freshwater runoff from the Mobile River System and the tidal influx of gulf waters. Occasionally, these salinity variations are of sufficient magnitude to stress biological communities. Floods from the Mobile River occur at irregular intervals. McPhearson (1970) and Bault (1972) each contend that during these periods of high river discharge, a jet-like flow from the rivers in the eastern delta deflects the flow of the Mobile River to the southwest. This effectively concentrates the fresh water discharge over the state's principal oyster reefs and shortens the time of travel from Mobile greatly. Story, et al (1974) determined a 41-hour time of travel from Mobile River to a point near Cedar Point Reef at a flood discharge of 337,600 cfs.

109. Since the bay is so large individual pollution sources have little effect on the overall water quality of the bay except in highly localized areas. Nonetheless, Mobile Bay has been subject to a slow but steady degradation. In some areas, notably Garrow's Bend, there is evidence that this trend has been reversed in recent years.

110. The most wide ranging and serious pollution impact has been the closing of oyster reefs for harvesting (South Alabama Regional Planning Commission 1978). An area encompassing 72,370 acres in the northern section of the bay has been permanently closed to the harvest of oysters and other bivalves because of high coliform levels. The recent adoption of fecal coliform criteria could result in a reopening of some of this area to oyster harvest. However, Presnell (personal communication) in an annual study on indicator bacterial organisms and Salmonella found an average most probable number (mpn) of 680 fecal coliforms per 100 ml at a station off Dog River. During the entire year a total of 45 samples were taken and Salmonella, a pathogenic bacterium, was isolated on four occassions. Under these conditions it is highly doubtful that waters of the upper bay could be repoened since values in excess of 14 mpn/100ml result in harvest prohibitions.

Table B-18

Range and Mean of Water Quality Parameters
Mobile Bay, Alabama

Parameter	Range	Mean
Surface temperature	4.7 - 32.2° C	20.5° C
Bottom temperature	7.1 - 31.9° C	20.3° C
Surface salinity	0.2 - 27.6°/oo	11.3°/oo
Bottom salinity	0.1 - 34.0°/oo	17.1°/oo
Surface dissolved oxygen	2.2 - 12.7 ppm	7.7 ppm
Bottom dissolved oxygen	1.4 - 11.9 ppm	7.0 ppm
Surface turbidity	1 - 39 JTU	15.1 JTU
Bottom turbidity	2 - 250 JTU	29.5 JTU
Surface pH	5.89 - 8.44	7.06
Bottom pH	2.30 - 8.32	7.01
Surface nitrate	0.00 - 53.38 g-at/1	
Bottom nitrate	0.00 - 51.46 g-at/1	
Surface nitrite	0.00 - 0.69 g-at/1	0.5 g-at/1
Bottom nitrite	0.00 - 1.15 g-at/1	0.8 g-at/1
Surface orthophosphate	0.00 - 10.86 g-at/1	1.80 g-at/1
Bottom orthophosphate	0.00 - 25.68 g-at/1	1.98 g-at/1
Surface total phosphorus	0.00 - 12.01 g-at/1	
Bottom total phosphorus	0.00 - 91.4 g-at/1	91.4 g-at/1

Source: Bault (1972)

°C = Degrees centigrade
°/oo = Parts per thousand
ppm = Parts per million
g - at/1 = Microgram atoms per liter
JTU = Jackson turbidity units

111. A comprehensive planning document on the area's water quality has been recently completed by the South Alabama Regional Planning Commission (SARPC, 1978). The planning area included portions of Mobile and Baldwin Counties that comprise the Mobile Standard Metropolitian Statistical Area. Within this area are 21 municipally owned treatment facilities, 36 industrial facilities and 49 semi-public and private systems. Collectively these facilities discharge approximately 194 million gallons of wastewater per day. Additionally the Barry Steam Plant of the Alabama Power Company discharges 1,170 million gallons per day (MGD) of cooling water. Although this plan is still under review and has not been approved by the Environmental Protection Agency, specific recommendations have been made to achieve the greatest improvement of water quality at the least expenditure of funds. These recommendations are displayed in table B-19. A total of $582 million would be required for plan implementation through the year 2000.

112. Localized severe degradation of water quality has been documented in Chickasaw Creek, Three Mile Creek, and Dog River. Detailed discussion of these water bodies can be found in recent 208 reports for Mobile and Baldwin Counties (SARPC, 1978). Chickasaw and Three Mile Creek were identified as the most significent municipal wastewater treatment needs within the immediate Mobile area in these reports. The next most significant need was the elimination of the numerous package treatment plants which discharge directly into the water along the Mobile Causeway. The primary industrial wastewater treatment needs identified were associated with industries which discharge into Chickasaw and Three Mile Creeks. Outside the immediate area discharge from the seafood industries in Coden, Bayou la Batre, and Bon Secour were identified as significant needs.

113. As seen in figure B-16, Alabama coastal waters are classified for a variety of uses by the Alabama Water Improvement Commission according to water quality. In general, water quality improves with distance from the Mobile urban center. A large portion of the bay (including Bon Secour Bay) is classified for swimming and for fish and wildlife. About two-thirds of the bay is classified for shellfish harvesting in addition to swimming and fish and wildlife. The northwestern corner of the bay is classified for fish and wildlife. The portion of Chickasaw Creek included in the project

TABLE B-19

COST OF IMPLEMENTING WATER QUALITY MANAGEMENT PLAN
FOR MOBILE AND BALDWIN COUNTIES UNTIL THE YEAR 2000

Waste Source		Cost
Municipal Point Sources		$182,916,542
Industiral Point Sources		139,209,962
Residual Waste		80,580,700
Urban Stormwater		163,200,575
Nonpoint Source		16,037,000
	Total	$581,944,77

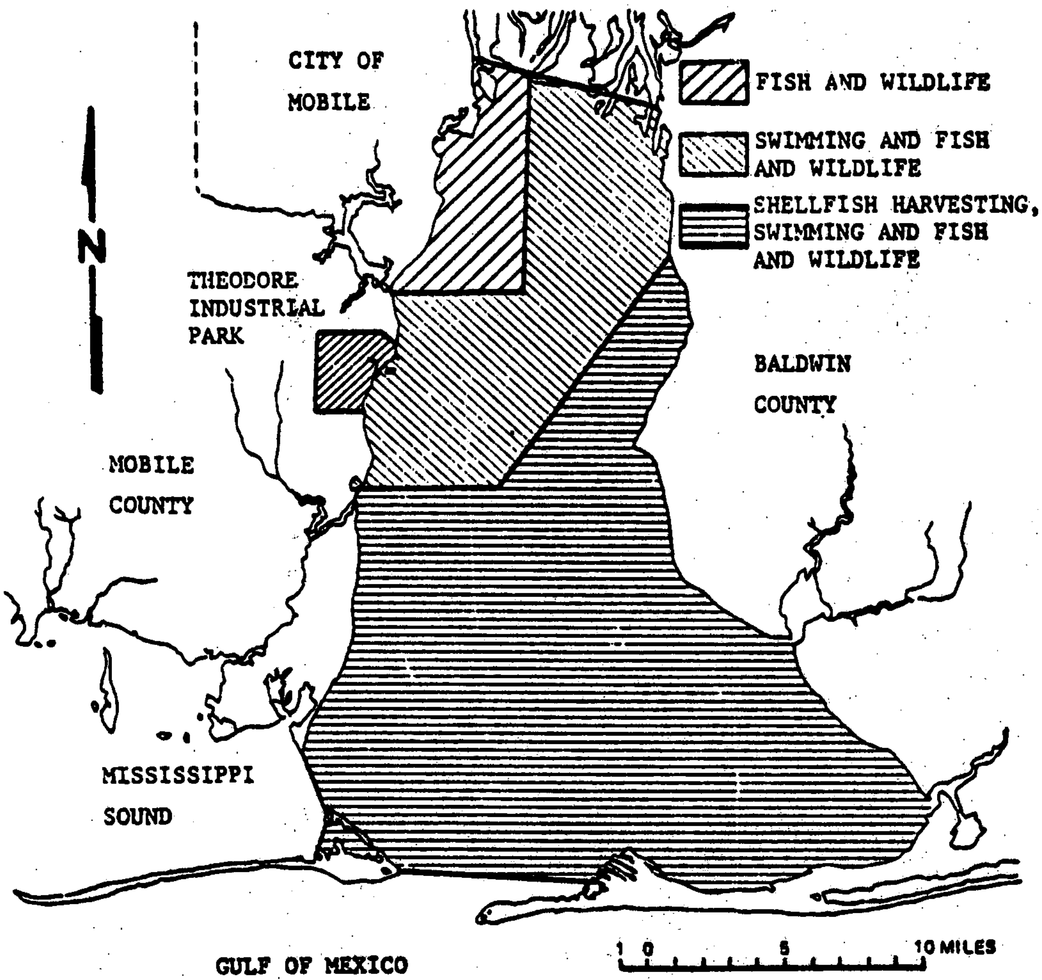


FIGURE B-16
WATER QUALITY CLASSIFICATION OF
MOBILE BAY, ALABAMA

is classified for fish and wildlife but carries a lower dissolved oxygen criteria than the standard fish and wildlife classifiation (AWIC).

AIR QUALITY

114. Current Ambient Air Quality Standards are presented in table B-20. The primary standard is intended for the protection of human health; the secondary standard is intended to protect public welfare.

115. An extensive air quality monitoring program has been conducted since 1972 by the Mobile County Health Department, Division of Air Pollution Control. A network of 9 ambient monitoring stations contributing data to the program, operates in Mobile County. Emphasis of the program has been placed primarily on suspended particulate matter, sulfur dioxide and photochemical oxidants values since these have been recognized as the primary concern for Mobile County in attainment and maintenance of Federal ambient air quality standards. Mobile County is an Air Quality Maintenance Area for particulates.

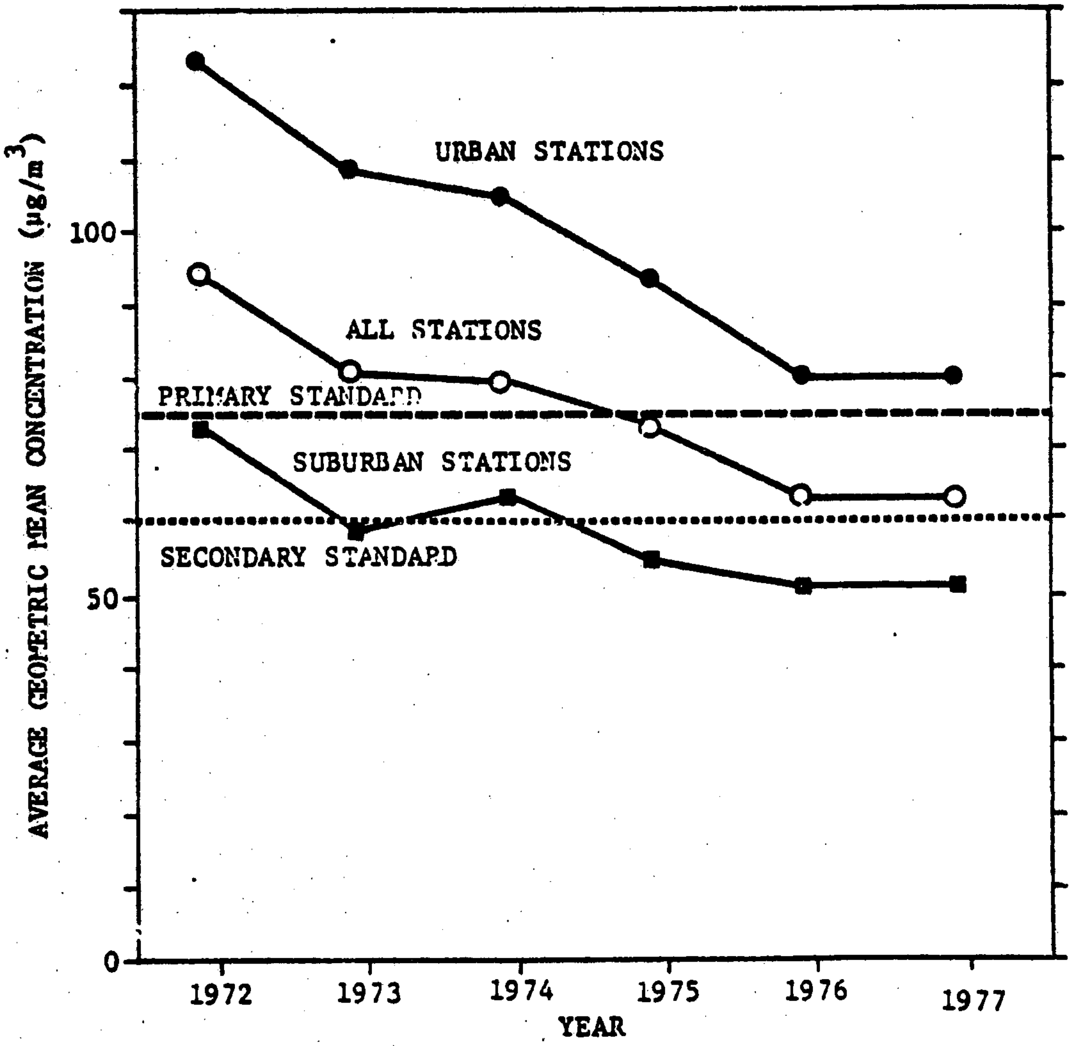
116. Annual trends for area-wide total suspended particulate levels in suburban, urban and composite categories are illustrated in Figure B-17 for the interval 1972 through 1977. Values for urban stations correspond to those in the immediate Mobile area; the remaining stations are designated suburban. These data show that particulate levels for Mobile County have declined significantly since 1972. Some urban stations exceeded the primary ambient air quality standard, therefore, a section of downtown Mobile is designated as not meeting the primary standard for total suspended particulates. Sulfur dioxide was monitored continuously through 1977 at an urban and suburban station. For both stations, levels were lower than the secondary national ambient air quality standard.

TABLE B-20

NATIONAL AMBIENT AIR QUALITY STANDARDS
($\mu g/m^3$ except as noted)

POLLUTANT	PRIMARY	SECONDARY
SULFUR OXIDES		
Annual Arithmetic Mean	80	
24-Hour Maximum[a]	365	
3-Hour Maximum[a]		1,300
SUSPENDED PARTICULATE MATTER		
Annual Geometric Mean	75	60
24-Hour Maximum[a]	260	150
CARBON MONOXIDE		
8-Hour Maximum[a], mg/m^3	10	
1-Hour Maximum[a], mg/m^3	40	
HYDROCARBONS		
3-Hour (6:00 to 9:00 a.m.) Maximum[a]	160	160
NITROGEN DIOXIDE		
Annual Arithmetic Mean	100	100
PHOTOCHEMICAL OXIDANTS		
1-Hour Maximum[a]	160	160

[a]Not to be exceeded more than once per year.



Source: U.S. Environmental Protection Agency, 1973

FIGURE B-17
AREAWIDE TOTAL SUSPENDED PARTICULATE MATTER, MOBILE COUNTY, 1972-1977

117. Data were obtained for photochemical oxidants at two suburban stations during 1978. It was found that the 1-hour oxidant standard of 160 ug/m^3 was exceeded 134 times. Mobile County is currently listed as not meeting the primary national ambient air quality standards for photochemical oxidants.

NOISE

118. The most commonly used unit of noise measurement is the decibel, a logarithmic term representing the amount of power behind a sound-producing wavefront. In terms of everyday noises, levels range from about 50 decibels for background sounds in a typical office, to about 70 decibels for freeway traffic at a distance of 50 feet, to 100 decibels for a jet takeoff at 2,000 feet. Contributions to hearing impairments begin around 70 decibels, or at the noise level associated with freeway traffic. In 1970, the Occupational Safety and Health Act (OSHA) included standards to define the permissible durations of exposure of employees to various noise levels. Exposure time decreases from 8 hours per day for sound levels of 90 decibels to 15 minutes per day for 115 decibels. The office of the Department of Labor-Occupational Safety and Health investigates industries which are suspected of violating these standards with regard to their employees. In the area surrounding the bay, truck and automobile traffic as well as the heavy machinery associated with loading and unloading at the docks are the major sources of noise. While this noise may be annoying to persons passing through the area it does not pose a health problem and does not approach the levels set as standards by the OSHA.

DESCRIPTIVE PUBLICATIONS

119. Published maps of the study area include the National Ocean Survey Chart No. 11376 at a scale of 1:80,000. This chart provides information needed by Navigational interests for Mobile Bay and its entrances and for coastal Alabama. The two-county study area is covered by U. S. Geological Survey 7.5 and 15 minute series quadrangle maps. These maps provide topographic information, The urban areas are covered by the 7.5 minute series at a scale of 1:24,000. The remainder of the study area is covered by the 15 minute series quadrangle maps at a scale of 1:62,500.

120. Following is a bibliography of significant publications that contain material descriptive of the study area some of which were used or consulted in the preparation of this section of the technical appendix.

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ATTACHMENT B-1

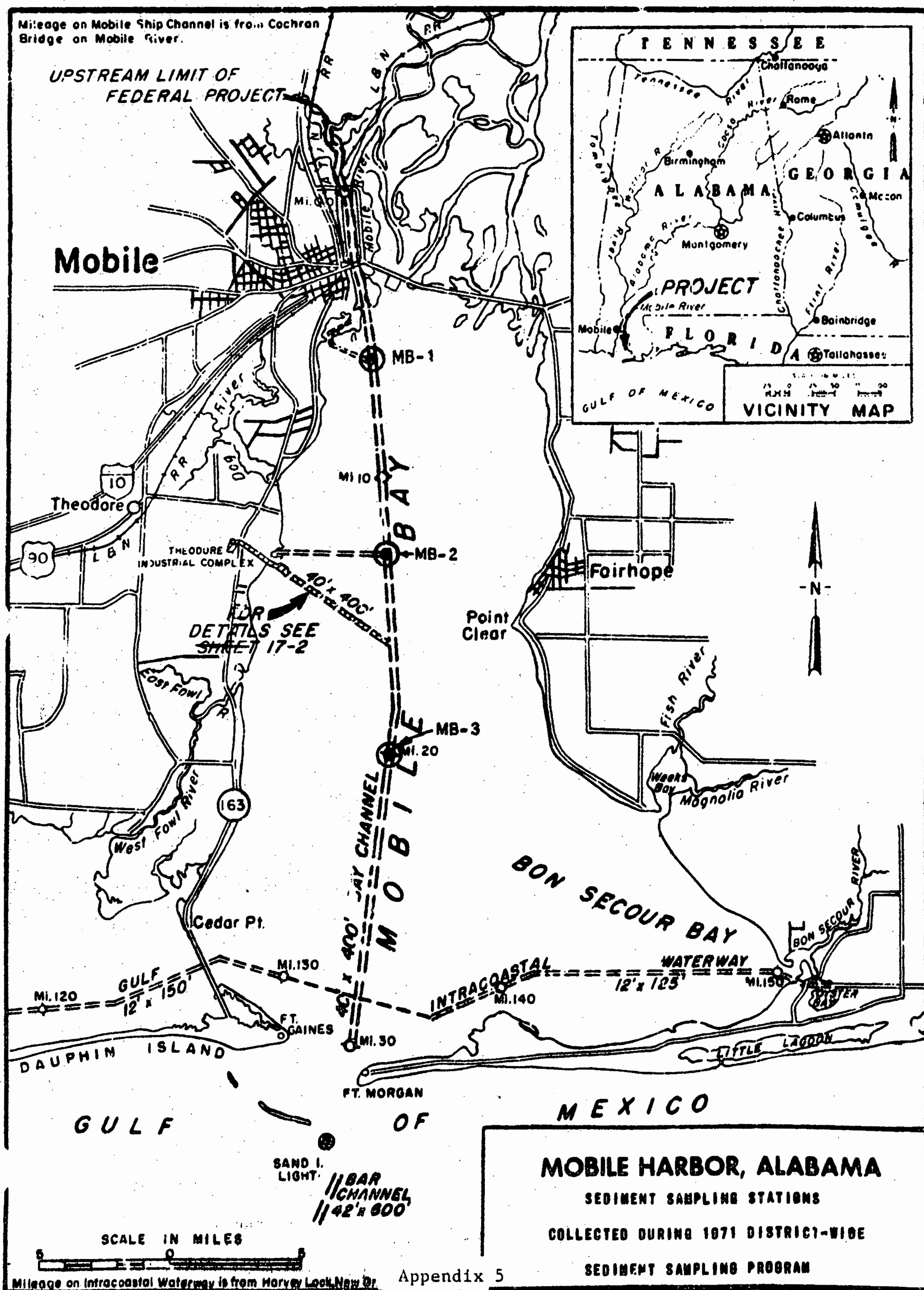
SEDIMENT SAMPLES

1971

SEDIMENT SAMPLING

DATA

(Surface Layer Sediments)


Mileage on Mobile Ship Channel is from Cochran Bridge on Mobile River.
UPSTREAM LIMIT OF FEDERAL PROJECT
Mobile
Mi. 0.0
Mobile River
MB-1
Mi 10
Theodore
THEODORE INDUSTRIAL COMPLEX
MB-2
40' x 400'
FOR DETAILS SEE SHEET 17-2
Fairhope
Point Clear
East Fowl R.
MB-3
Mi. 20
Fish River
Weeks Bay
Magnolia River
West Fowl River
BAY CHANNEL 40' x 400'
MOBILE BAY
BON SECOUR BAY
BON SECOUR RIVER
Cedar Pt.
GULF INTRACOASTAL WATERWAY
Mi. 120
12' x 150'
Mi. 130
Mi. 140
12' x 125'
Mi. 150
FT. GAINES
Mi. 30
DAUPHIN ISLAND
LITTLE LAGOON
FT. MORGAN
GULF OF MEXICO
SAND I. LIGHT
BAR CHANNEL 42' x 600'
SCALE IN MILES
Mileage on Intracoastal Waterway is from Harvey Lock, New Or.
TENNESSEE
Chattanooga
Rome
Atlanta
Birmingham
ALABAMA
GEORGIA
Macon
Columbus
Montgomery
PROJECT
Mobile River
Mobile
FLORIDA
Bainbridge
Tallahassee
GULF OF MEXICO
VICINITY MAP
MOBILE HARBOR, ALABAMA
SEDIMENT SAMPLING STATIONS
COLLECTED DURING 1971 DISTRICT-WIDE
SEDIMENT SAMPLING PROGRAM

CHEMICAL, HEAVY METALS, AND PESTICIDES
ANALYSES OF SEDIMENT SAMPLES
MOBILE HARBOR, ALABAMA

Parameter (dry weight basis)	Station (see map) MB-1	MB-2	MB-3
T.V.S. Formula (%)	7.60	7.55	7.90
Volatile Solids (%)	12.74	11.61	12.88
Total Organic Carbon (mg/kg x 10^3)	27.6	40.5	57.3
Chemical Oxygen Demand (mg/kg x 10^3)	64.1	63.6	67.1
Total Kjeldahl Nitrogen (mg/kg N)	2,370.0	2,830.0	2,650.0
Oil and Grease (mg/kg)	3,800.0	0.0	2,600.0
Lead (mg/kg)	32.0	37.0	21.0
Zinc (mg/kg)	179.0	250.0	97.0
Mercury (mg/kg)	0.26	0.41	0.64
Lindane (mg/kg)	ND	ND	ND
Heptachlor (mg/kg)	ND	ND	ND
Aldrin (mg/kg)	ND	ND	ND
Heptachlor Epoxide (mg/kg)	ND	ND	ND
Dieldrin (mg/kg)	ND	T	ND
Endrin (mg/kg)	ND	ND	ND
DDE (mg/kg)	ND	0.07	0.06
DDD (mg/kg)	0.02	0.03	0.03
DDT (mg/kg)	0.02	ND	0.02
Chlordane (mg/kg)	ND	ND	ND
Methoxychlor (mg/kg)	ND	ND	ND
Toxaphene (mg/kg)	ND	ND	ND
PCB (mg/kg)	0.1	0.1	0.1
Organo-Phosphate (mg/kg)	ND	ND	--

ND= None detected
T = Trace amount detected (0.001 ppm)
- = Not analyzed
PCB= polychlorinated biphenyls (Aroclor 1254)

1974

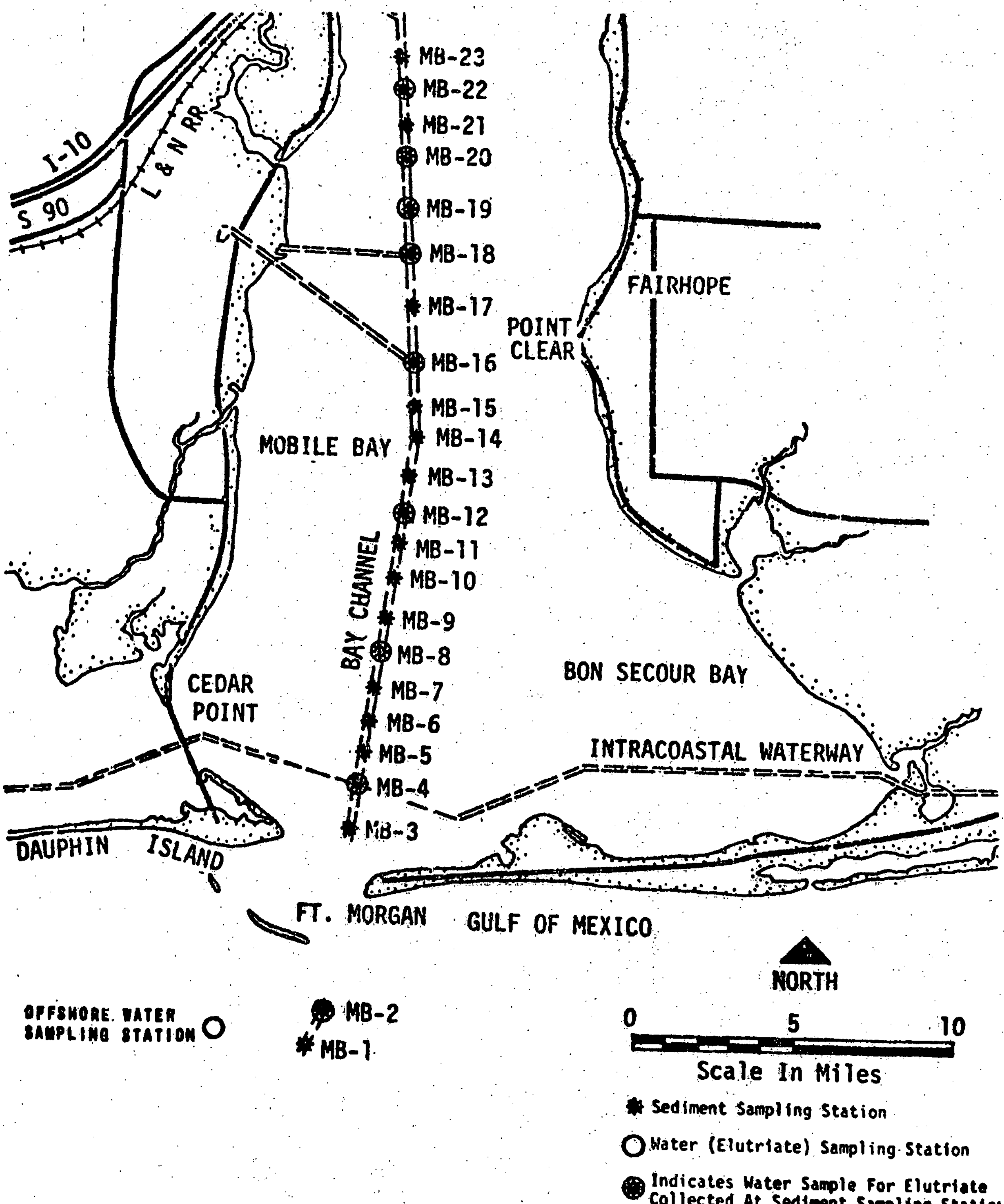
SEDIMENT SAMPLING

DATA

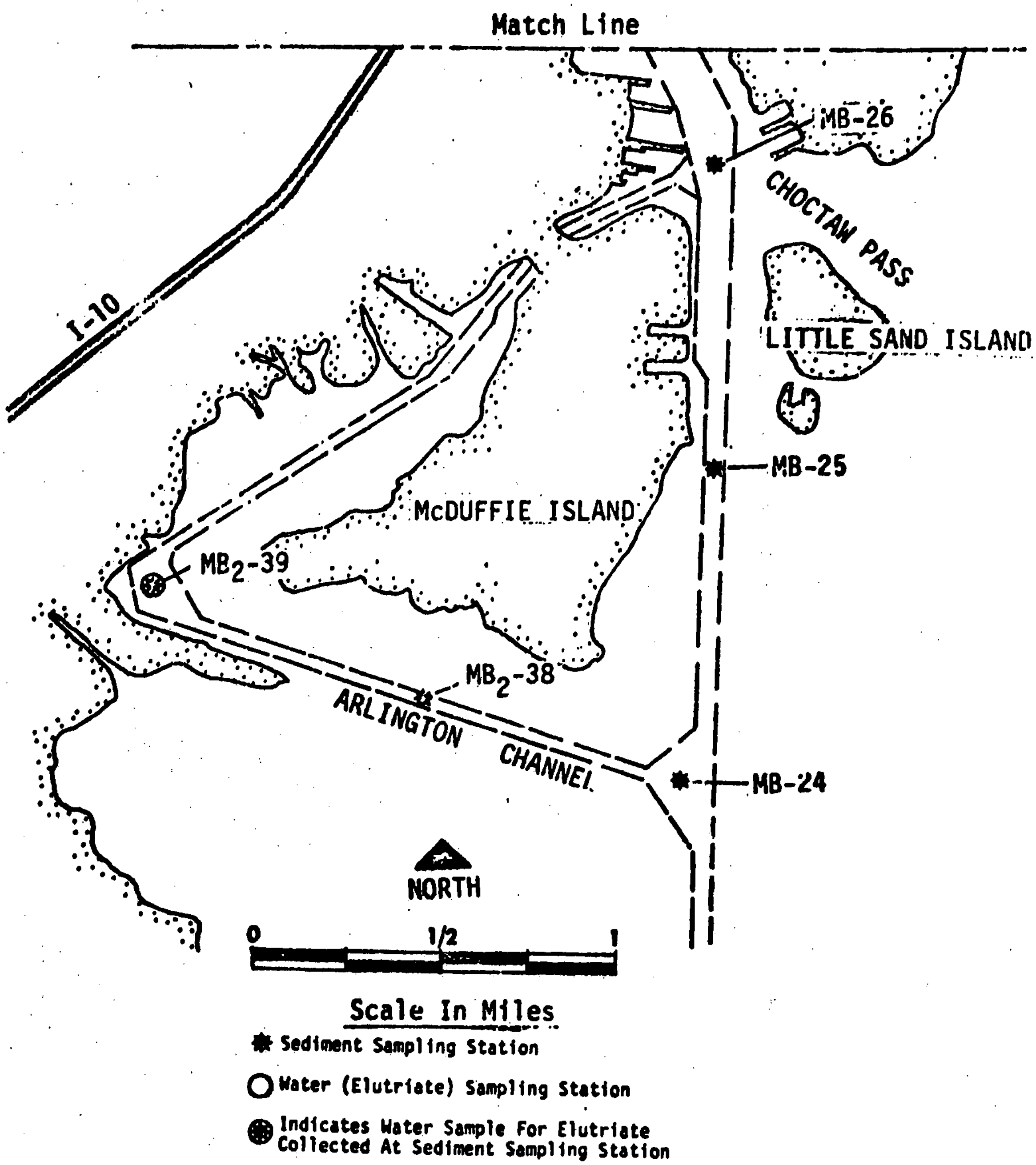
(Surface Layer Sediments)

Appendix 5

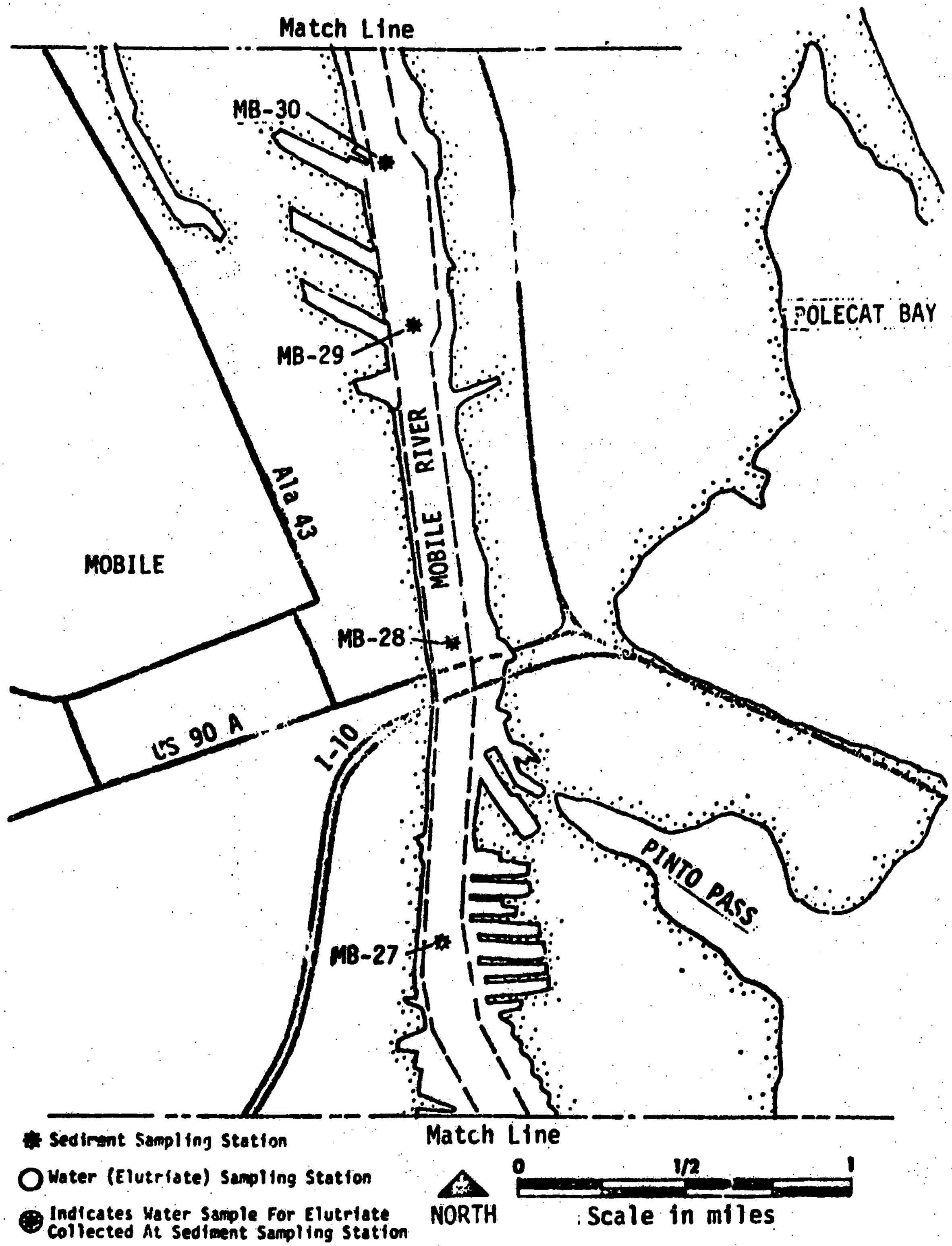
LOCATIONS OF SEDIMENT AND WATER SAMPLING STATIONS, MOBILE HARBOR, ALABAMA



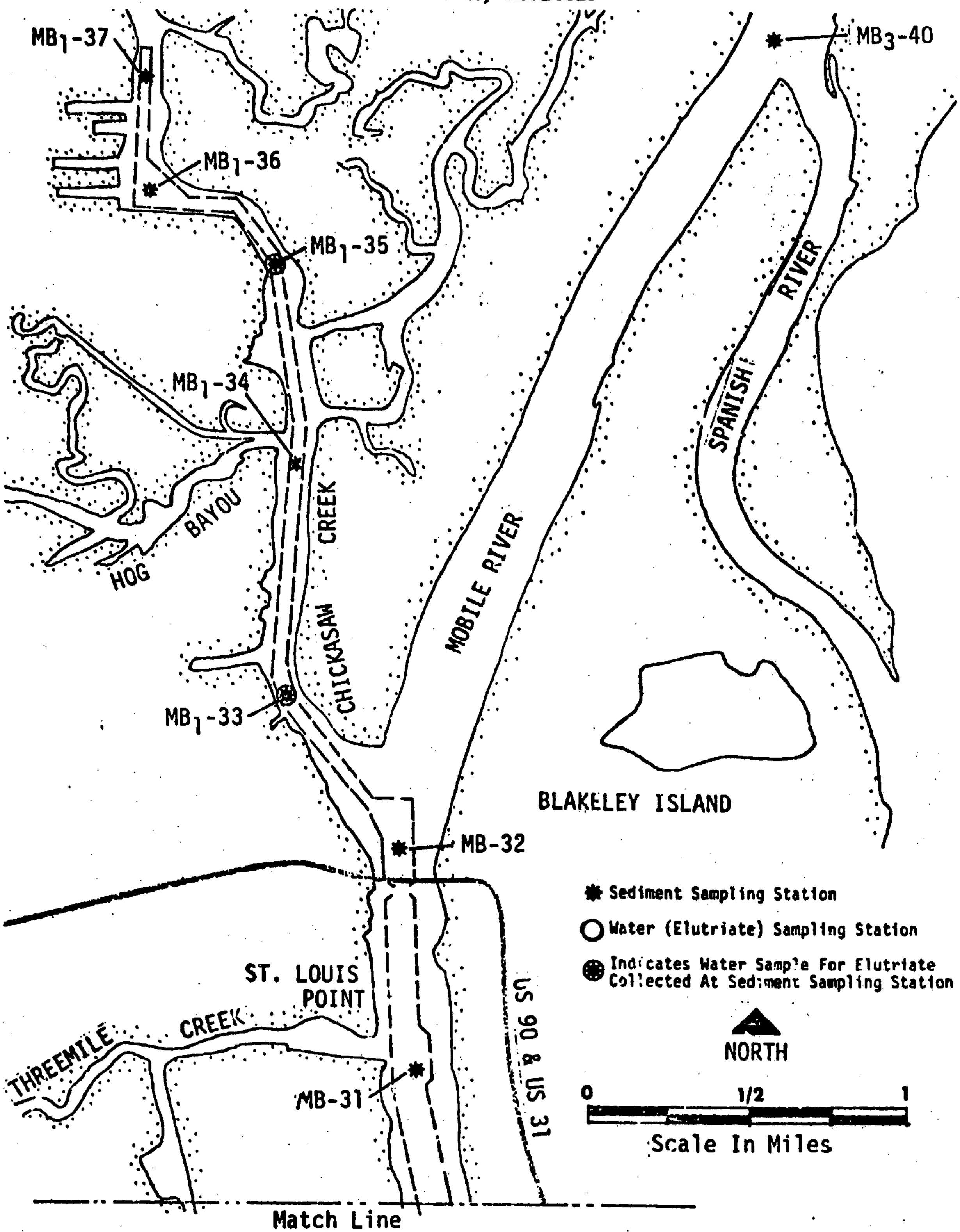
LOCATIONS OF SEDIMENT AND WATER SAMPLING STATIONS,
MOBILE HARBOR, ALABAMA



LOCATIONS OF SEDIMENT AND WATER SAMPLING STATIONS,
MOBILE HARBOR, ALABAMA

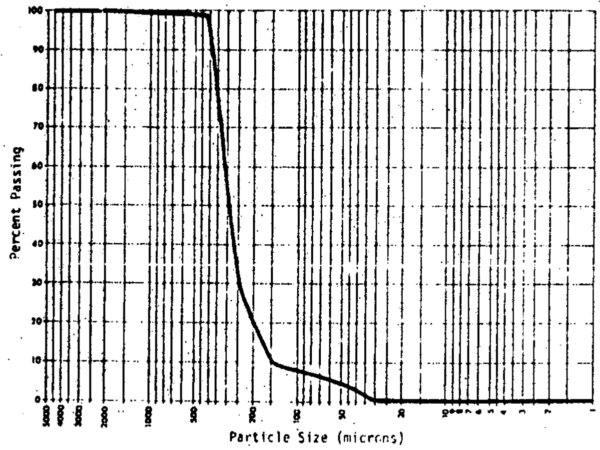


LOCATIONS OF SEDIMENT AND WATER SAMPLING STATIONS, MOBILE HARBOR, ALABAMA



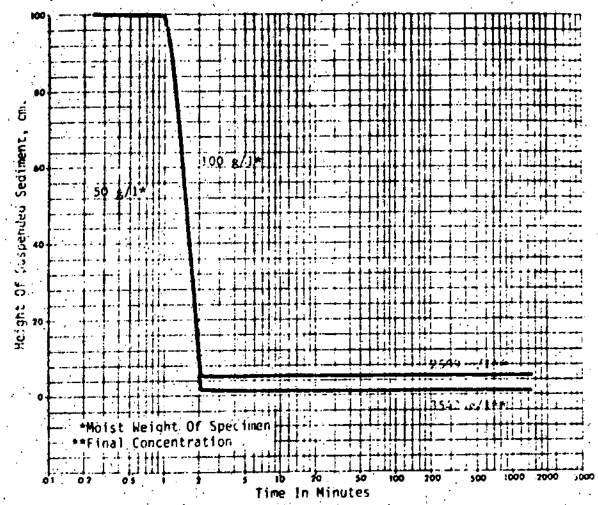
PHYSICAL ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

FIGURE 1-a



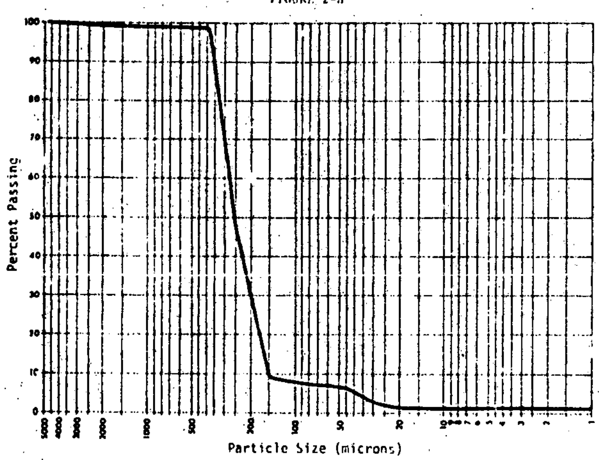
SAMPLE # MB-1	SPECIFIC GRAVITY 2.65
DATE 28 July 74	STANDARD CLASSIFICATION SP-SM
TIME 1250	FIELD DESCRIPTION OF SEDIMENT Sand
WATER DEPTH (ft.) 40	

FIGURE 1-b



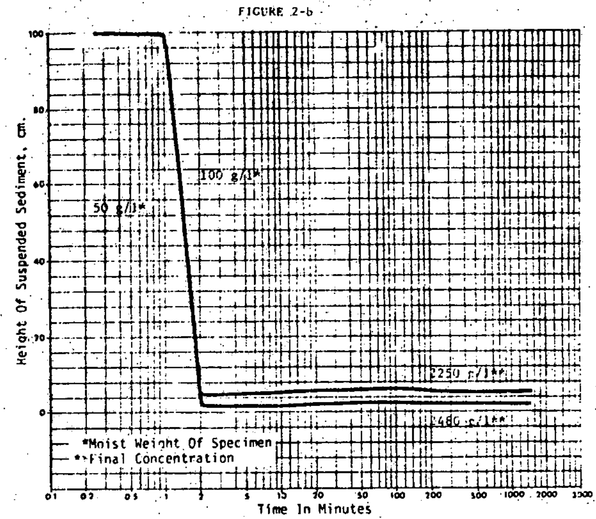
SEDIMENT SAMPLE # MB-1	
WATER SAMPLE # MB-1	

FIGURE 2-a



SAMPLE # MB-2	SPECIFIC GRAVITY 2.64
DATE 28 July 74	STANDARD CLASSIFICATION SP-SM
TIME 1230	FIELD DESCRIPTION OF SEDIMENT Sand and silt
WATER DEPTH (ft.) 41	

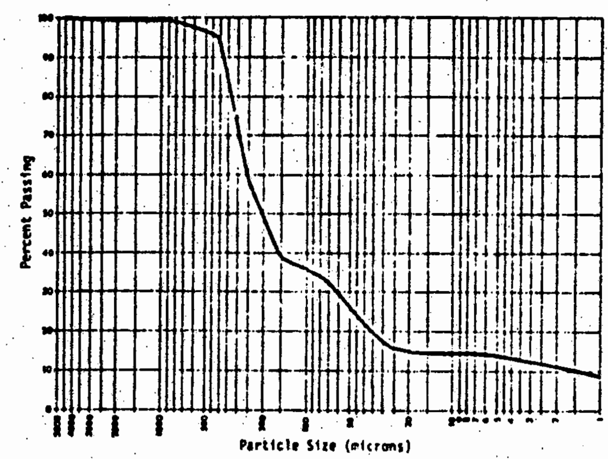
FIGURE 2-b



SEDIMENT SAMPLE # MB-2	
WATER SAMPLE # MB-2	

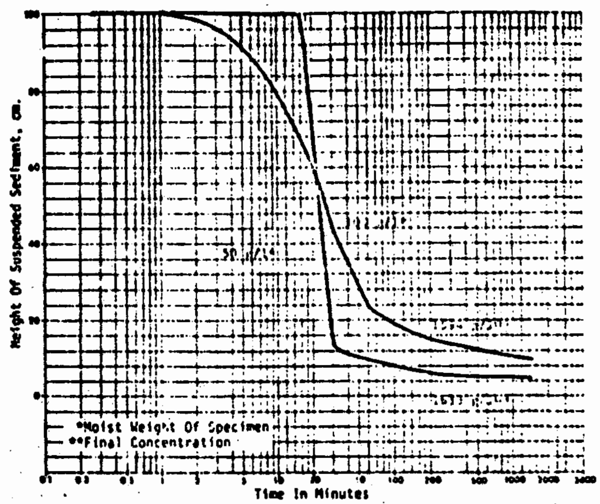
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 3-a



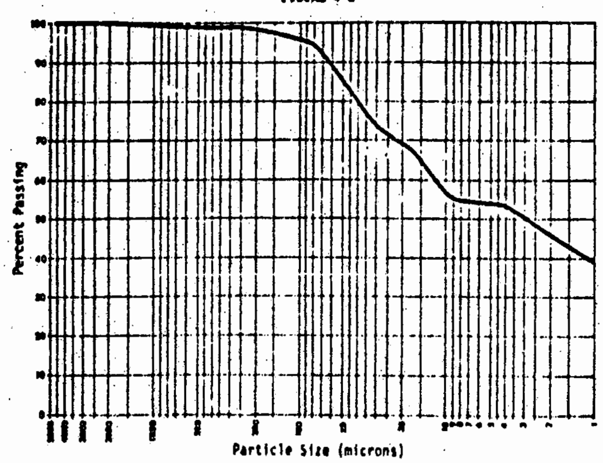
SAMPLE # MB-3	SPECIFIC GRAVITY 2.74
DATE 28 July 74	STANDARD CLASSIFICATION SM
TIME 1150	FIELD DESCRIPTION OF SEDIMENT Soft grey
WATER DEPTH (ft.) 45	silty ooze with some sand

FIGURE 3-b



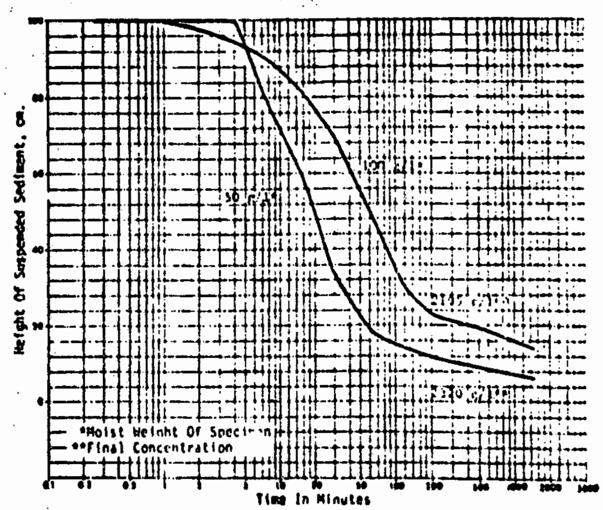
SEDIMENT SAMPLE # MB-3	
WATER SAMPLE # MB-3	

FIGURE 4-a



SAMPLE # MB-4	SPECIFIC GRAVITY 2.72
DATE 28 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1133	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 40	silty ooze

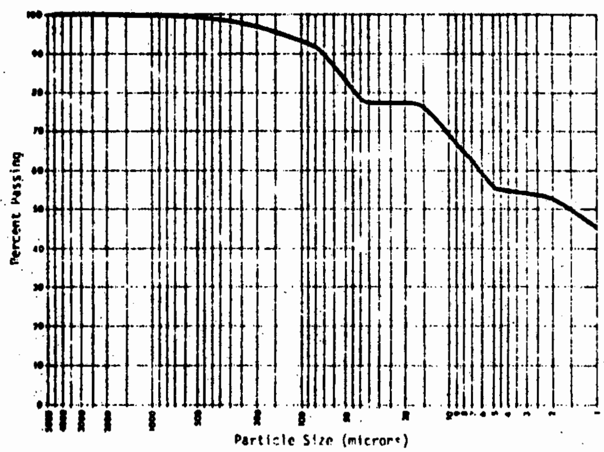
FIGURE 4-b



SEDIMENT SAMPLE # MB-4	
WATER SAMPLE # MB-4	

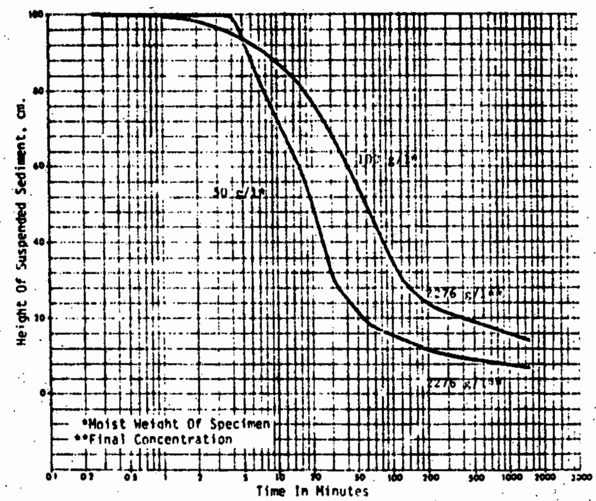
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 5-a



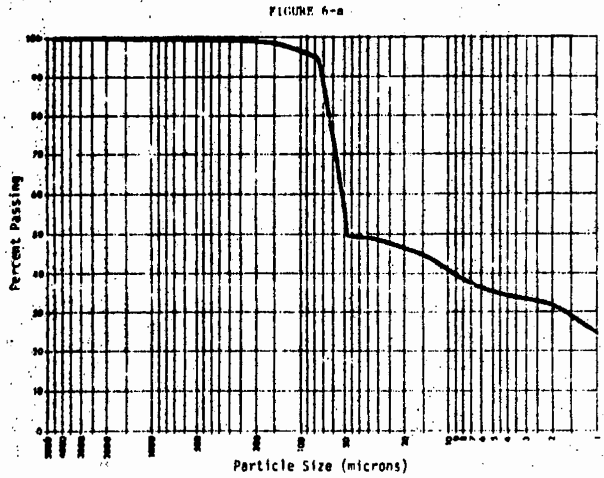
SAMPLE # MB-5	SPECIFIC GRAVITY 2.58
DATE 28 July 74	STANDARD CLASSIFICATION MH-CH
TIME 1125	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 41	silty ooze

FIGURE 5-b



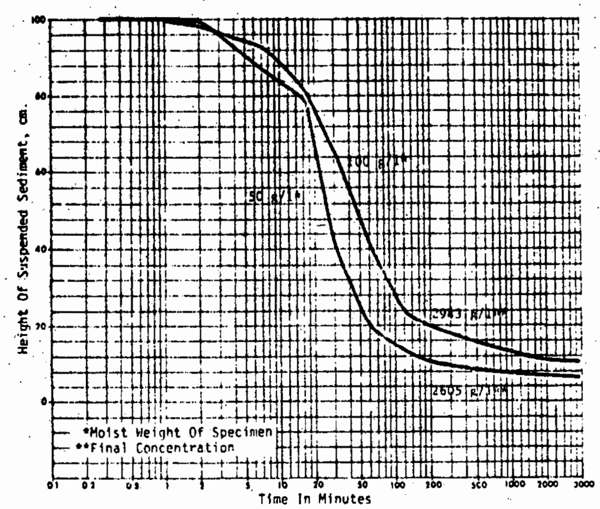
SEDIMENT SAMPLE # MB-5	
WATER SAMPLE # MB-5	

FIGURE 6-a



SAMPLE # MB-6	SPECIFIC GRAVITY 2.83
DATE 28 July 74	STANDARD CLASSIFICATION MH
TIME 1115	FIELD DESCRIPTION OF SEDIMENT Soft grey
WATER DEPTH (ft.) 43	silty ooze

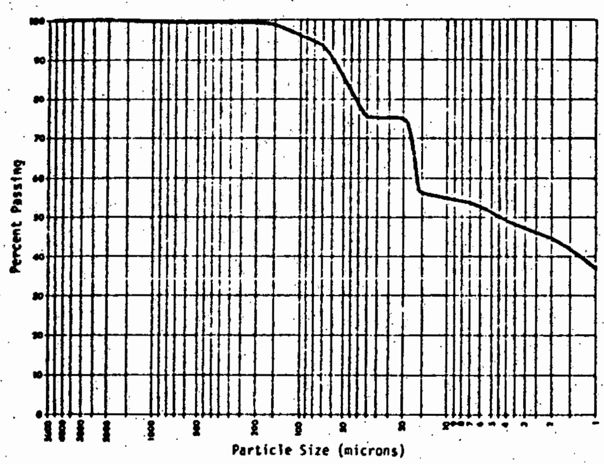
FIGURE 6-b



SEDIMENT SAMPLE # MB-6	
WATER SAMPLE # MB-6	

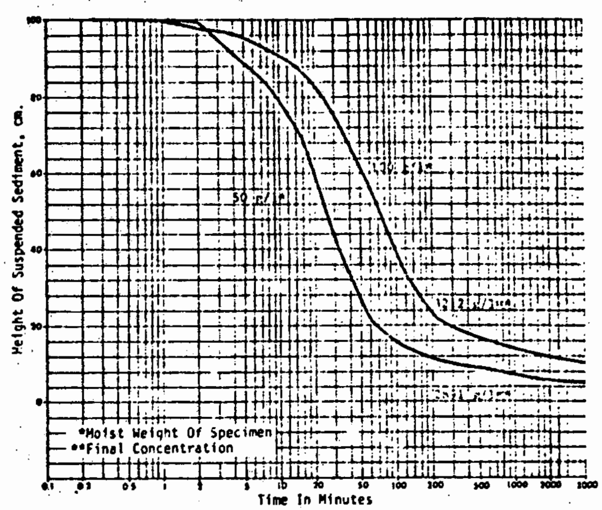
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 7-a



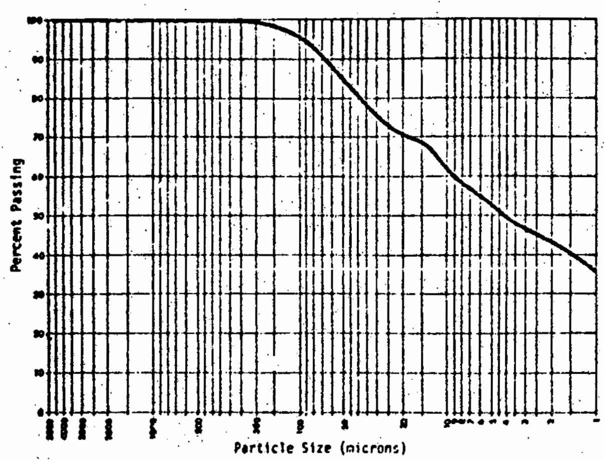
SAMPLE # MB-7	SPECIFIC GRAVITY 2.7
DATE 28 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1107	FIELD DESCRIPTION OF SEDIMENT Soft grey
WATER DEPTH (ft.) 42	silty ooze

FIGURE 7-b



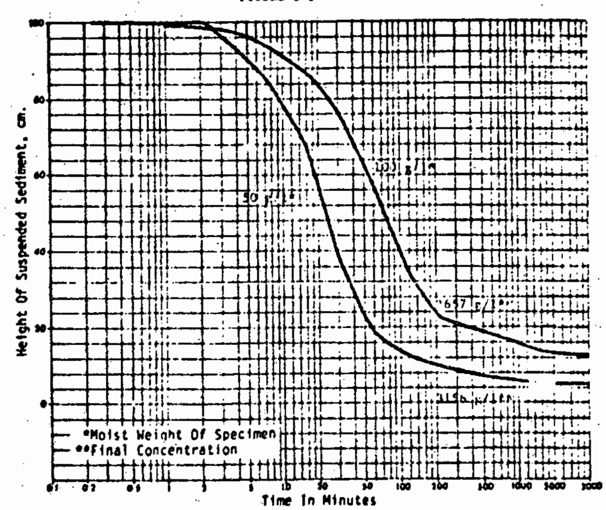
SEDIMENT SAMPLE # MB-7	
WATER SAMPLE # MB-7	

FIGURE 8-a



SAMPLE # MB-8	SPECIFIC GRAVITY 2.76
DATE 30 July 74	STANDARD CLASSIFICATION ML-CL
TIME 0949	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 40	silty ooze

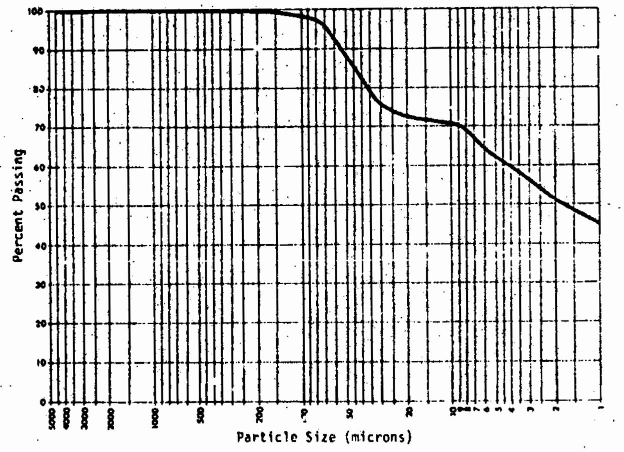
FIGURE 8-b



SEDIMENT SAMPLE # MB-8	
WATER SAMPLE # MB-8	

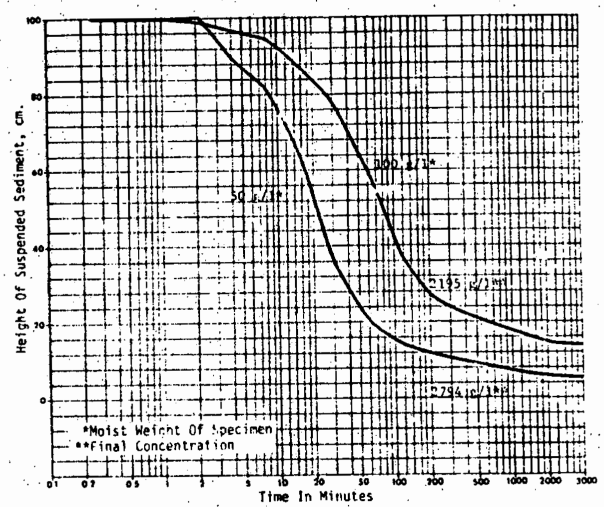
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 9-a



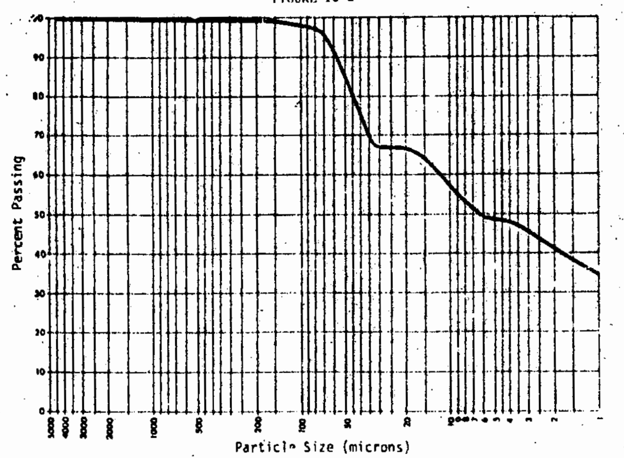
SAMPLE # MB-9	SPECIFIC GRAVITY 2.80
DATE 18 Aug. 74	STANDARD CLASSIFICATION ML-CL
TIME 1320	FIELD DESCRIPTION OF SEDIMENT Soft grey
WATER DEPTH (ft.) 44	ooze

FIGURE 9-b



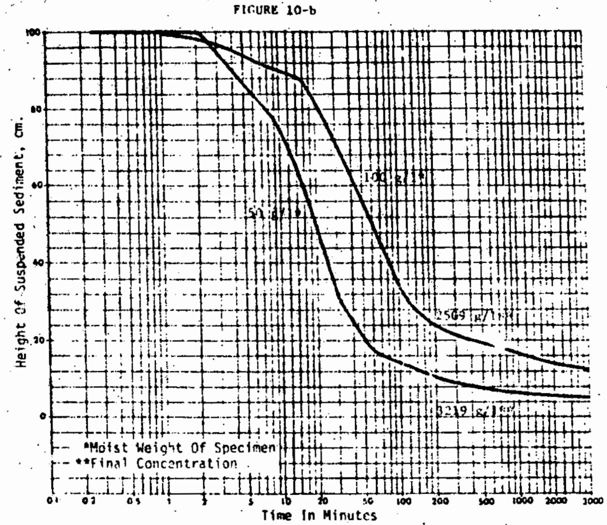
SEDIMENT SAMPLE # MB-9	
WATER SAMPLE # MB-9	

FIGURE 10-a



SAMPLE # MB-10	SPECIFIC GRAVITY 2.89
DATE 30 July 74	STANDARD CLASSIFICATION ML-CL
TIME 0930	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 42	silt

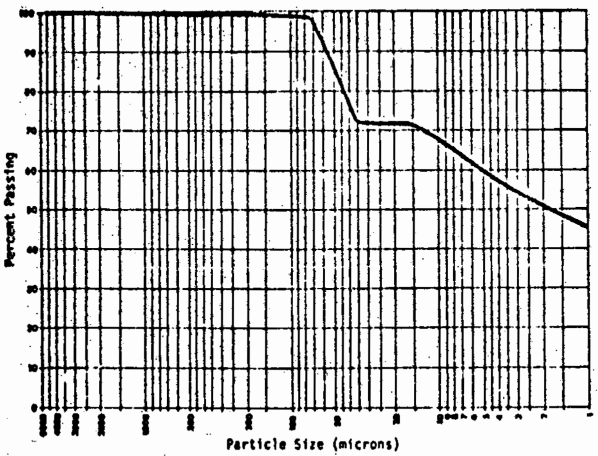
FIGURE 10-b



SEDIMENT SAMPLE # MB-10	
WATER SAMPLE # MB-10	

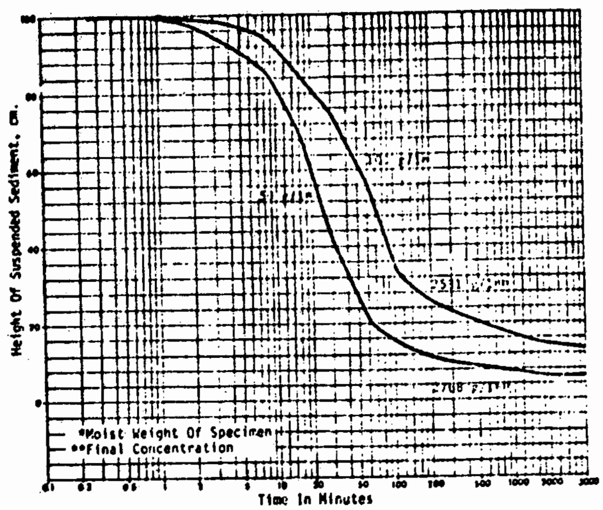
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 11-a



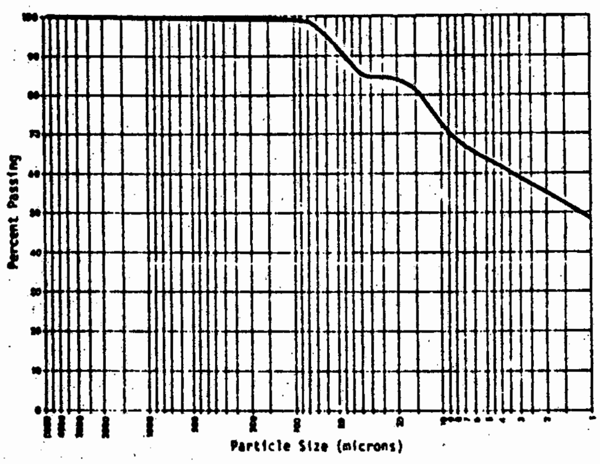
SAMPLE # MB-11	SPECIFIC GRAVITY 2.75
DATE 30 July 74	STANDARD CLASSIFICATION ML-CL
TIME 0940	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 40	silt

FIGURE 11-b



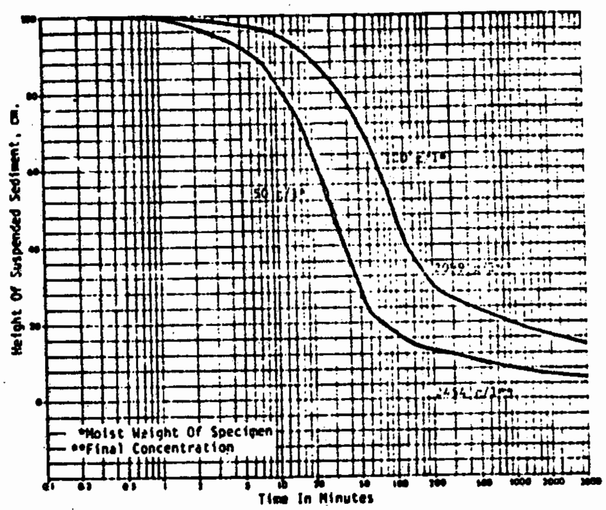
SEDIMENT SAMPLE # MB-11	
WATER SAMPLE # MB-11	

FIGURE 12-a



SAMPLE # MB-12	SPECIFIC GRAVITY 2.75
DATE 30 July 74	STANDARD CLASSIFICATION ML-CL
TIME 0945	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 41	silt

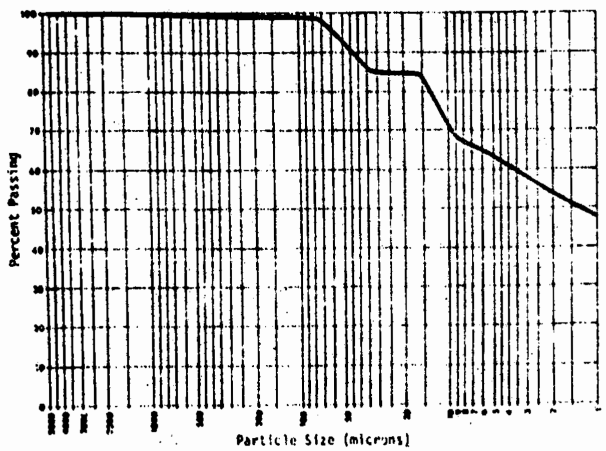
FIGURE 12-b



SEDIMENT SAMPLE # MB-12	
WATER SAMPLE # MB-12	

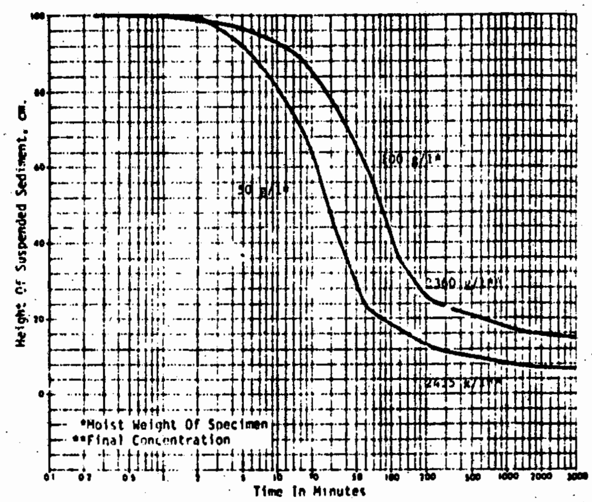
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 13-a



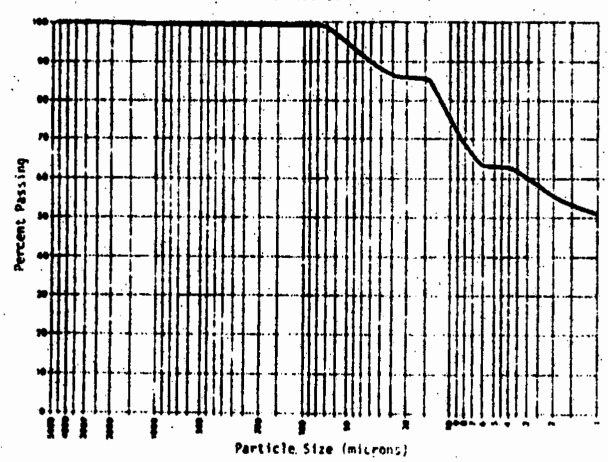
SAMPLE # MB-13	SPECIFIC GRAVITY 2.75
DATE 30 July 74	STANDARD CLASSIFICATION MH-CH
TIME 1312	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 42	silt

FIGURE 13-a



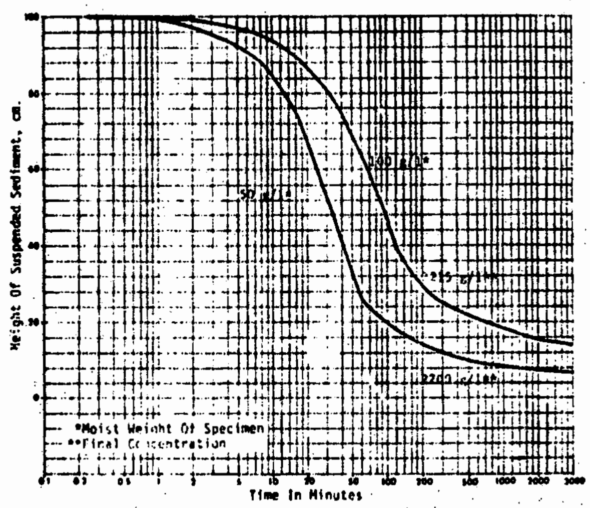
SEDIMENT SAMPLE # MB-13	
WATER SAMPLE # MB-13	

FIGURE 14-a



SAMPLE # MB-14	SPECIFIC GRAVITY 2.68
DATE 30 July 74	STANDARD CLASSIFICATION MH-CH
TIME 1025	FIELD DESCRIPTION OF SEDIMENT Soft brownish
WATER DEPTH (ft.) 41	grey silty ooze

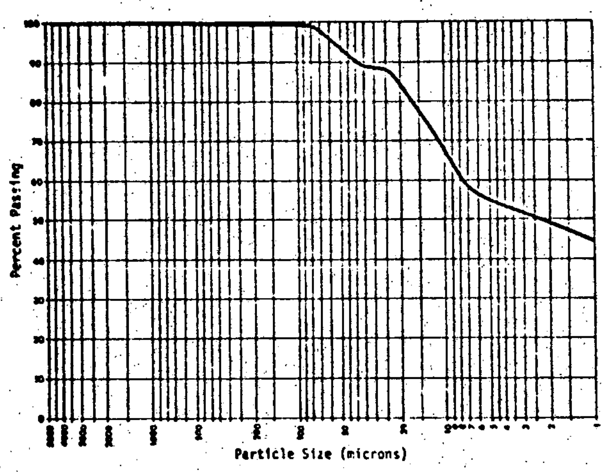
FIGURE 14-b



SEDIMENT SAMPLE # MB-14	
WATER SAMPLE # MB-14	

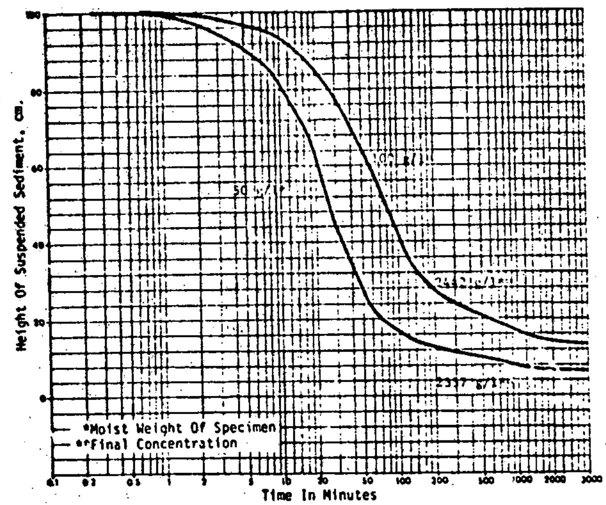
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 15-a



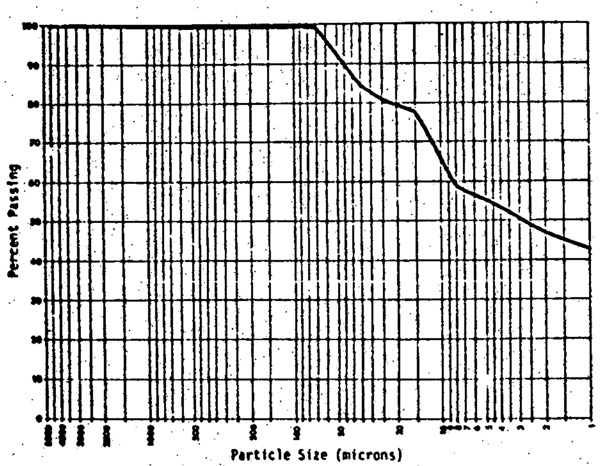
SAMPLE # MB-15	SPECIFIC GRAVITY 2.63
DATE 30 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1147	FIELD DESCRIPTION OF SEDIMENT Brown silt
WATER DEPTH (ft.) 42	with some grey soft clay

FIGURE 15-b



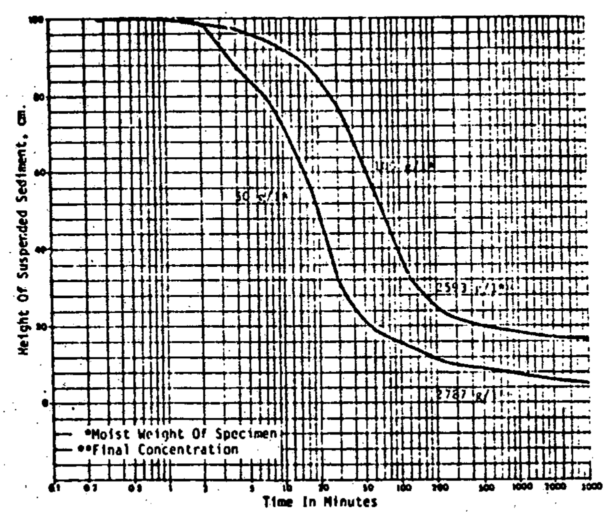
SEDIMENT SAMPLE # MB-15	
WATER SAMPLE # MB-15	

FIGURE 16-a



SAMPLE # MB-16	SPECIFIC GRAVITY 2.63
DATE 30 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1203	FIELD DESCRIPTION OF SEDIMENT Soft brownish
WATER DEPTH (ft.) 43	grey silty ooze

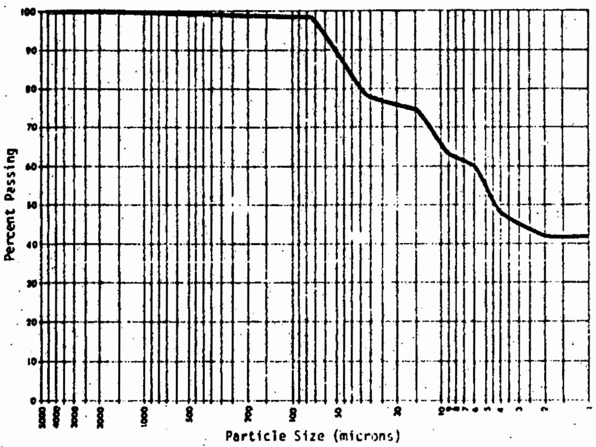
FIGURE 16-b



SEDIMENT SAMPLE # MB-16	
WATER SAMPLE # MB-16	

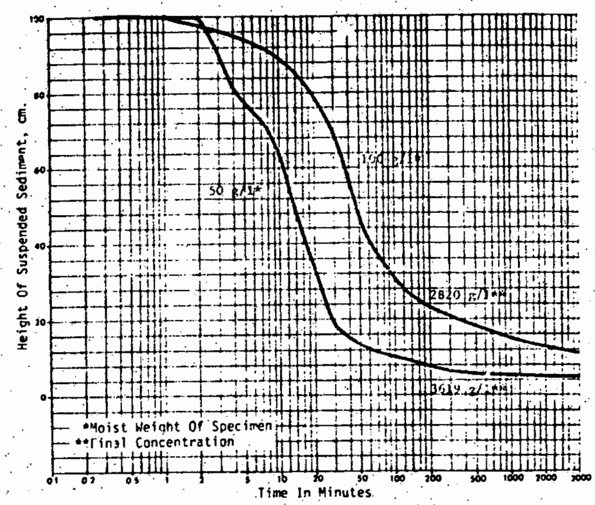
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 17-a



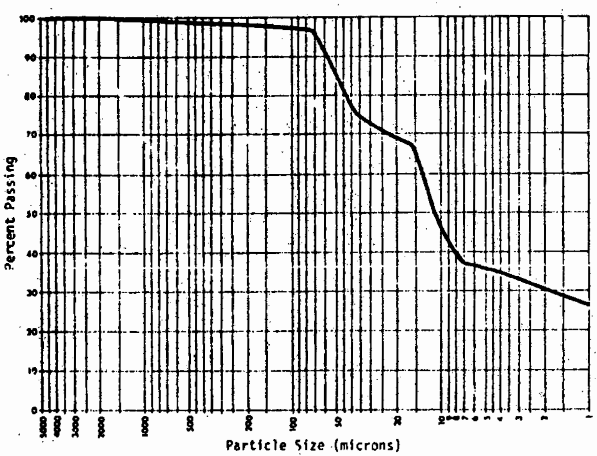
SAMPLE # MB-17	SPECIFIC GRAVITY 2.95
DATE 30 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1224	FIELD DESCRIPTION OF SEDIMENT Soft brownish
WATER DEPTH (ft.) 42	grey ooze

FIGURE 17-b



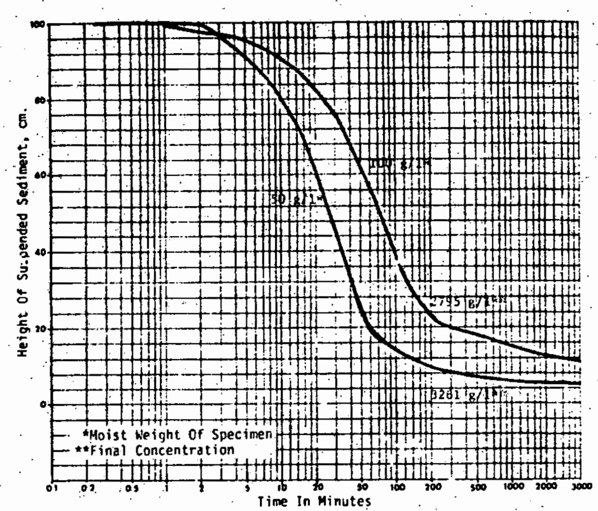
SEDIMENT SAMPLE # MB-17	
WATER SAMPLE # MB-17	

FIGURE 18-a



SAMPLE # MB-18	SPECIFIC GRAVITY 2.66
DATE 30 July 74	STANDARD CLASSIFICATION ML
TIME 1231	FIELD DESCRIPTION OF SEDIMENT Soft black
WATER DEPTH (ft.) 30	silty ooze

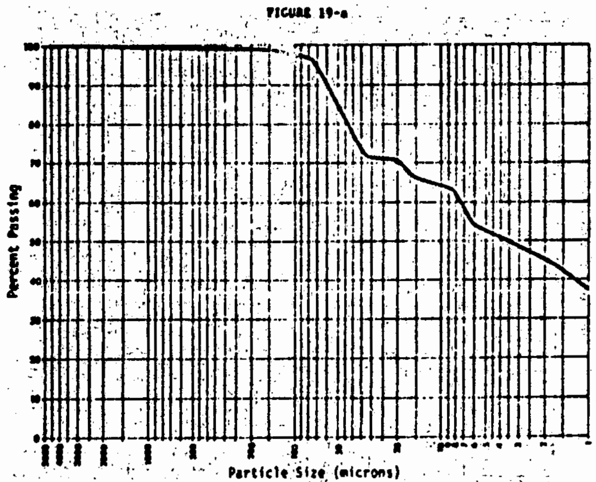
FIGURE 18-b



SEDIMENT SAMPLE # MB-18	
WATER SAMPLE # MB-18	

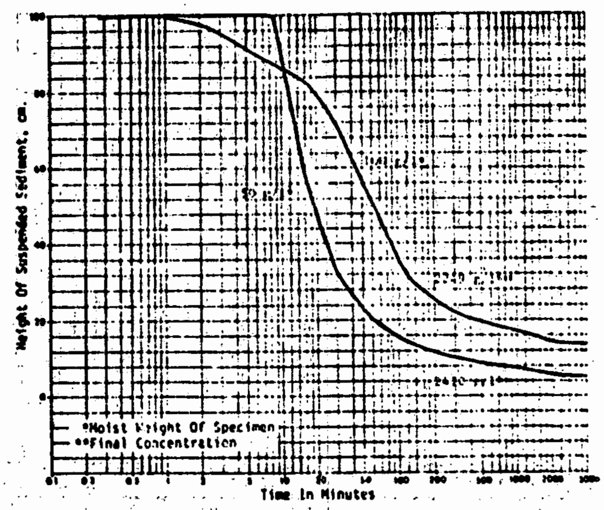
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 19-a



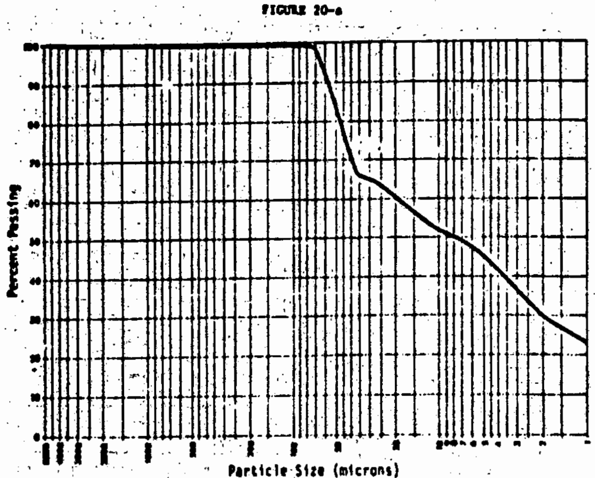
SAMPLE # MB-19	SPECIFIC GRAVITY 2.63
DATE 30 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1300	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 42	silty ooze

FIGURE 19-b



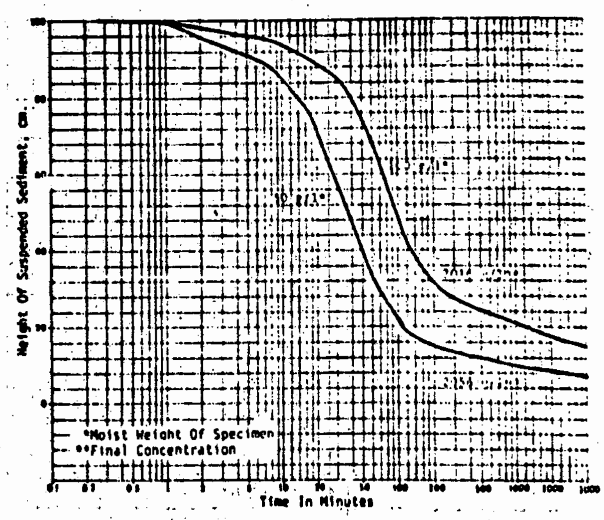
SEDIMENT SAMPLE # MB-19	
WATER SAMPLE # MB-19	

FIGURE 20-a



SAMPLE # MB-20	SPECIFIC GRAVITY 2.61
DATE 30 July 74	STANDARD CLASSIFICATION ML
TIME 1456	FIELD DESCRIPTION OF SEDIMENT Soft brown
WATER DEPTH (ft.) 43	ooze

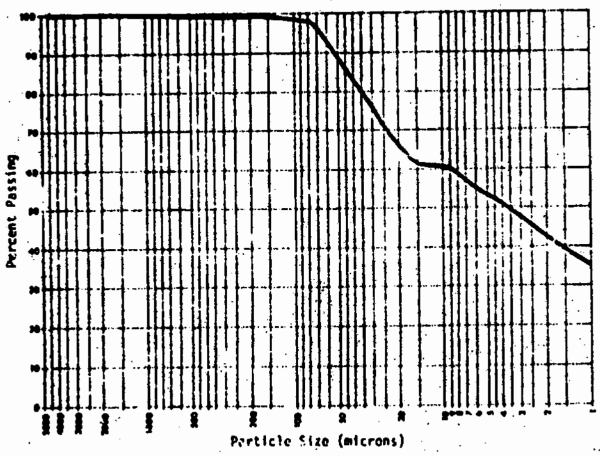
FIGURE 20-b



SEDIMENT SAMPLE # MB-20	
WATER SAMPLE # MB-20	

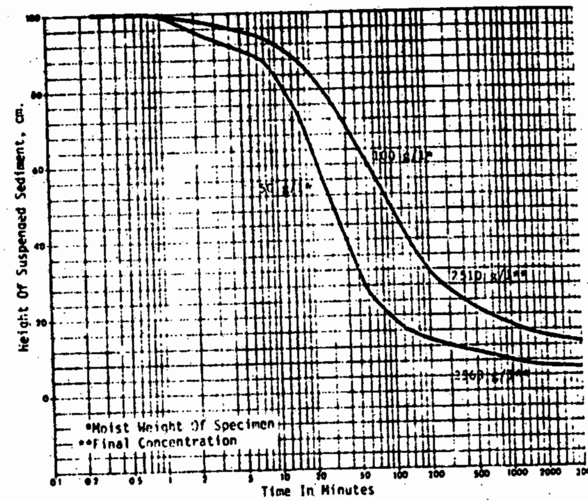
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 21-a



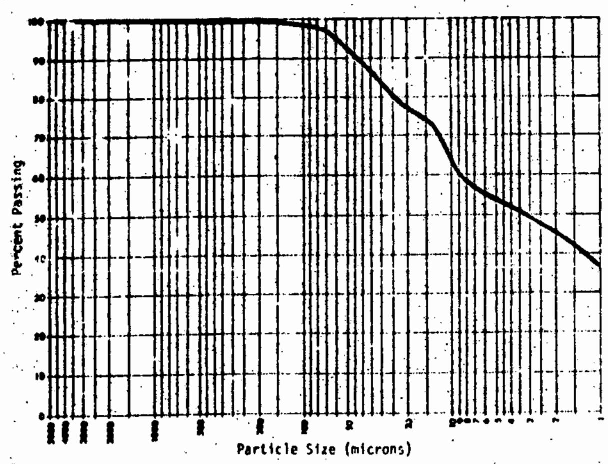
SAMPLE # MB-21	SPECIFIC GRAVITY 2.64
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1100	FIELD DESCRIPTION OF SEDIMENT Brownish grey
WATER DEPTH (ft.) 44	silty ooze

FIGURE 21-b



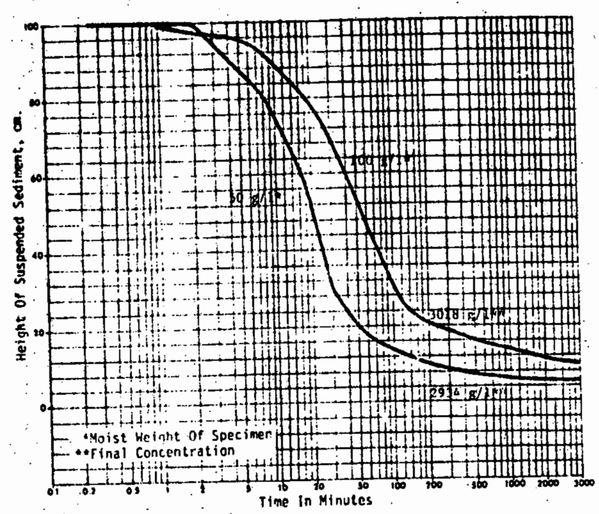
SEDIMENT SAMPLE # MB-21	
WATER SAMPLE # MB-21	

FIGURE 22-a



SAMPLE # MB-22	SPECIFIC GRAVITY 2.69
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1125	FIELD DESCRIPTION OF SEDIMENT Soft brownish
WATER DEPTH (ft.) 42	grey silt

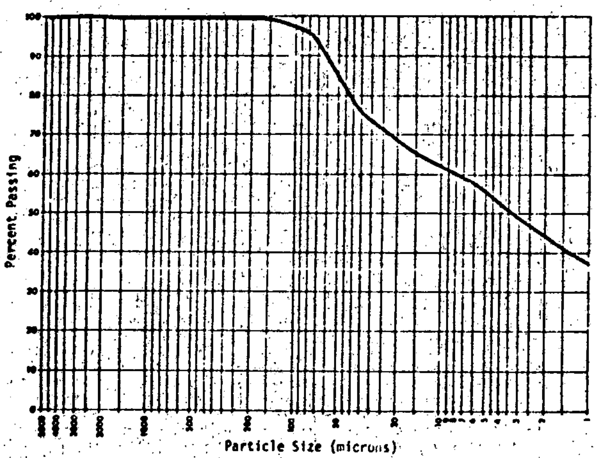
FIGURE 22-b



SEDIMENT SAMPLE # MB-22	
WATER SAMPLE # MB-22	

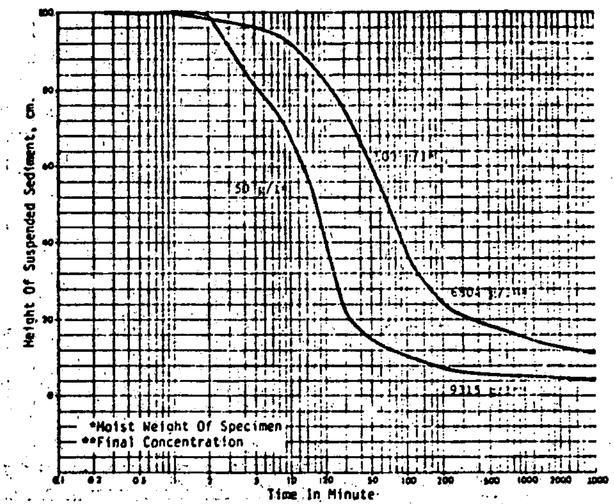
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 23-a



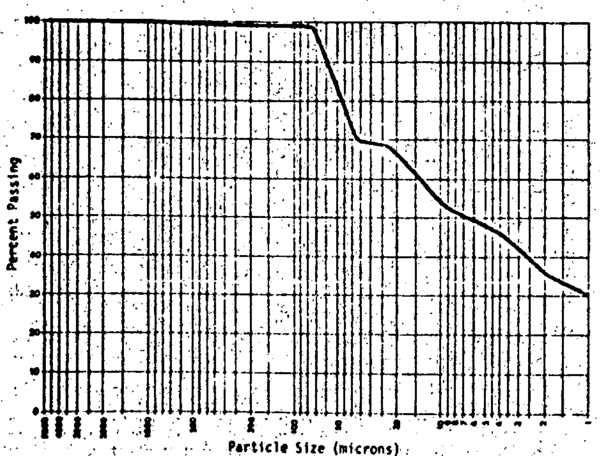
SAMPLE # MB-23	SPECIFIC GRAVITY 2.75
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1150	FIELD DESCRIPTION OF SEDIMENT Soft brownish
WATER DEPTH (ft.) 40	grey silt

FIGURE 23-b



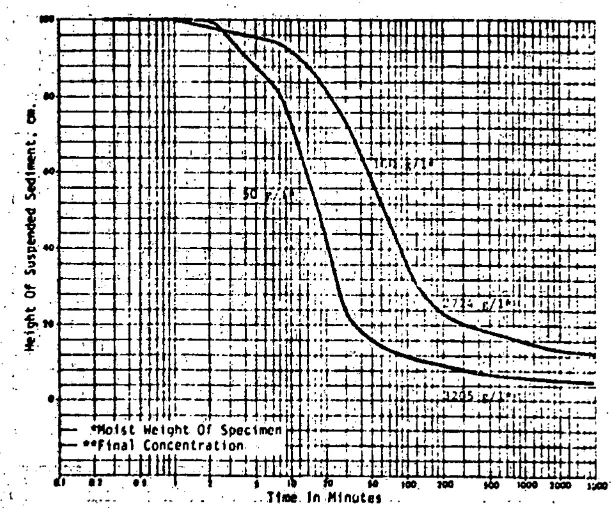
SEDIMENT SAMPLE # MB-23	
WATER SAMPLE # MB-23	

FIGURE 24-a



SAMPLE # MB-24	SPECIFIC GRAVITY 2.71
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1201	FIELD DESCRIPTION OF SEDIMENT Soft brownish
WATER DEPTH (ft.) 41	grey silt

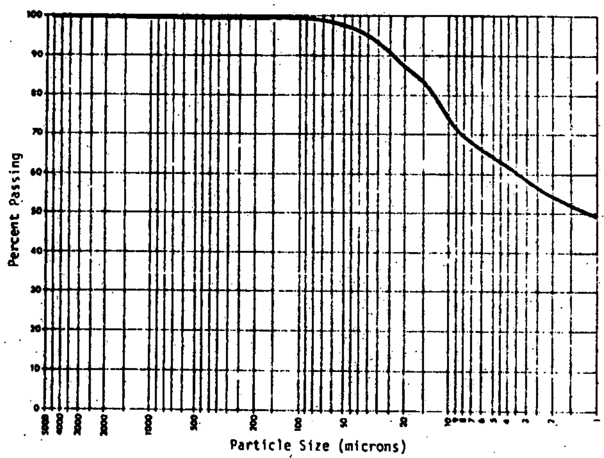
FIGURE 24-b



SEDIMENT SAMPLE # MB-24	
WATER SAMPLE # MB-24	

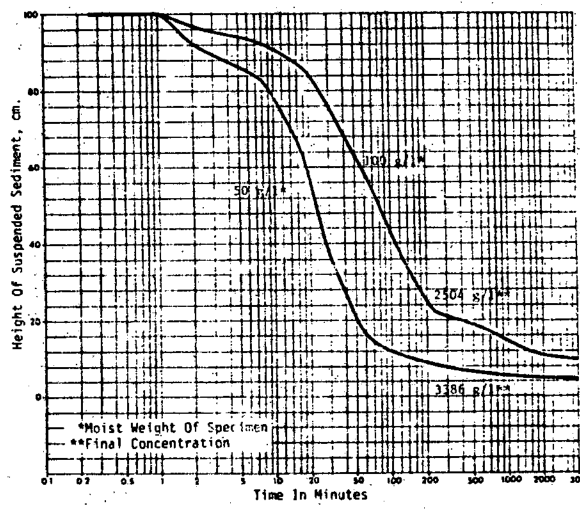
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 25-a



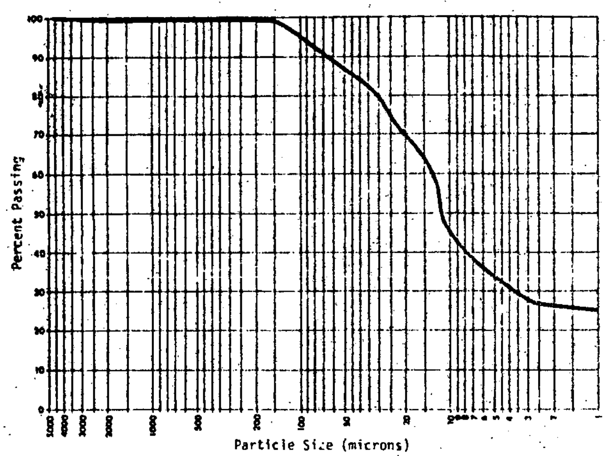
SAMPLE # MB-25	SPECIFIC GRAVITY 2.68
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1248	FIELD DESCRIPTION OF SEDIMENT Soft dark
WATER DEPTH (ft.) 44	brown silty ooze

FIGURE 25-b



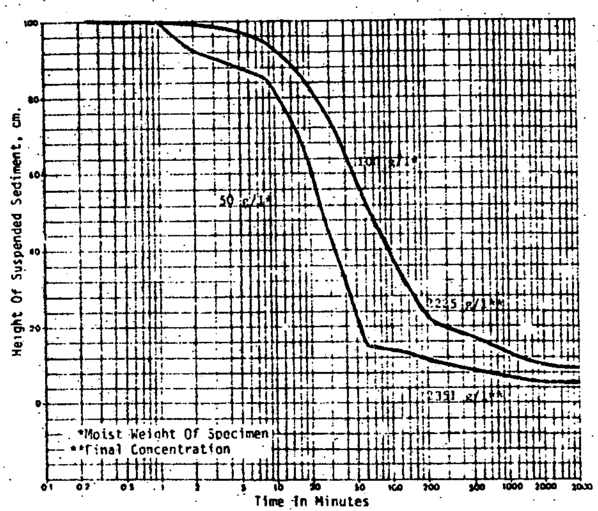
SEDIMENT SAMPLE # MB-25	
WATER SAMPLE # MB-25	

FIGURE 26-a



SAMPLE # MB-26	SPECIFIC GRAVITY 2.70
DATE 31 July 74	STANDARD CLASSIFICATION ML
TIME 1303	FIELD DESCRIPTION OF SEDIMENT Thin brown
WATER DEPTH (ft.) 45	silty crust with black ooze below

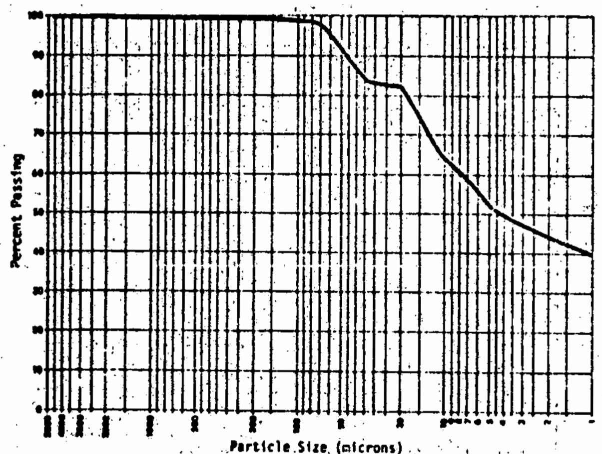
FIGURE 26-b



SEDIMENT SAMPLE # MB-26	
WATER SAMPLE # MB-26	

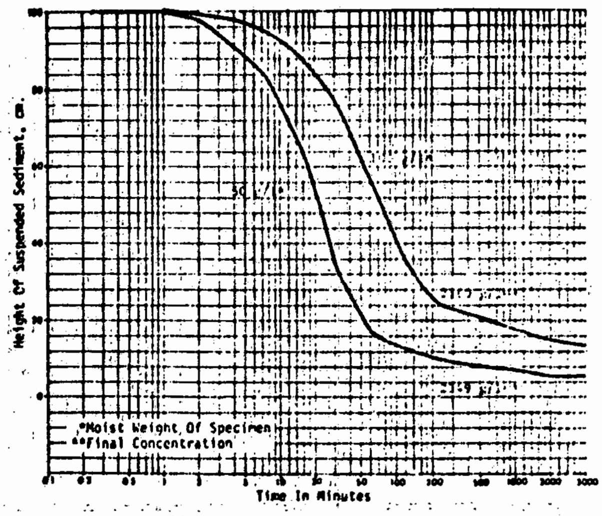
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 27-a



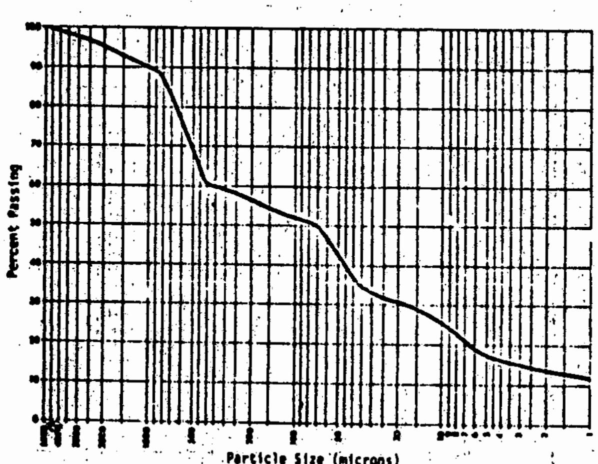
SAMPLE # MB-27	SPECIFIC GRAVITY 2.58
DATE 21 July 74	STANDARD CLASSIFICATION MH-CL
TIME 1310	FIELD DESCRIPTION OF SEDIMENT Thin brown silty crust with medium textured dark grey clay beneath
WATER DEPTH (ft.) 42	

FIGURE 27-b



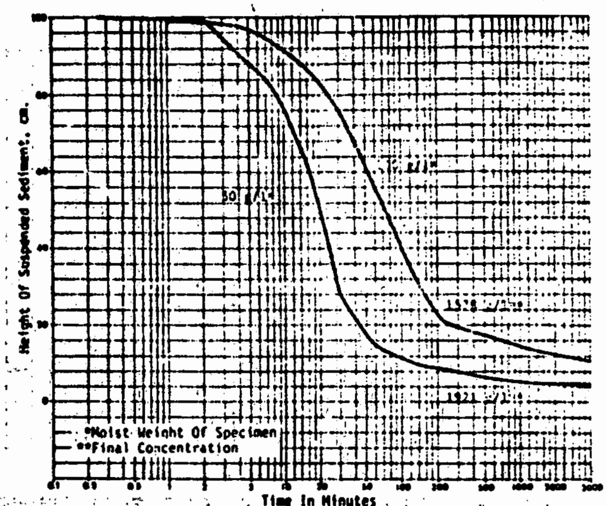
SEDIMENT SAMPLE # MB-27
WATER SAMPLE # MB-27

FIGURE 28-a



SAMPLE # MB-28	SPECIFIC GRAVITY 2.6
DATE 21 July 74	STANDARD CLASSIFICATION SM
TIME 1321	FIELD DESCRIPTION OF SEDIMENT Black silt
WATER DEPTH (ft.) 45	with some sand

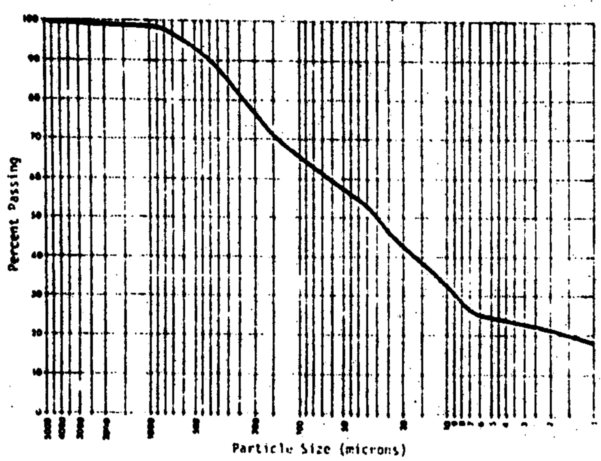
FIGURE 28-b



SEDIMENT SAMPLE # MB-28
WATER SAMPLE # MB-28

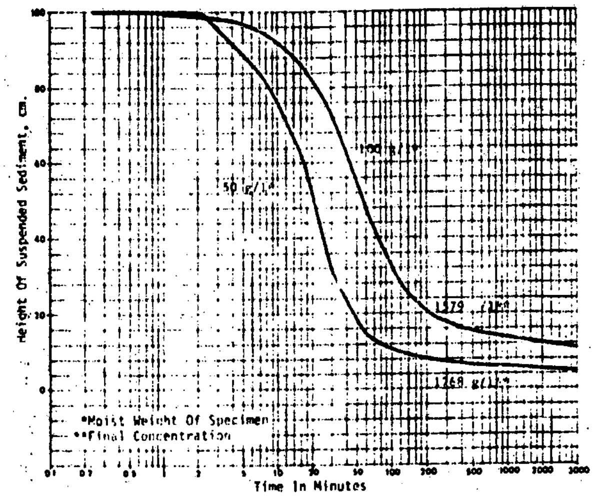
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 29-a



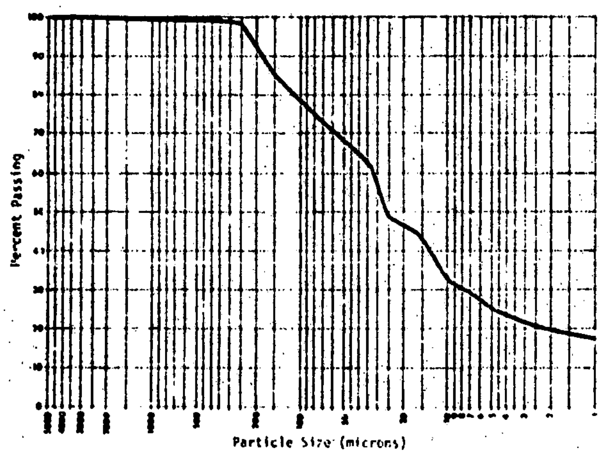
SAMPLE # MB-29	SPECIFIC GRAVITY 2.71
DATE 31 July 74	STANDARD CLASSIFICATION SM
TIME 1332	FIELD DESCRIPTION OF SEDIMENT Soft oily
WATER DEPTH (ft.) 41	black silty ooze and sand

FIGURE 29-b



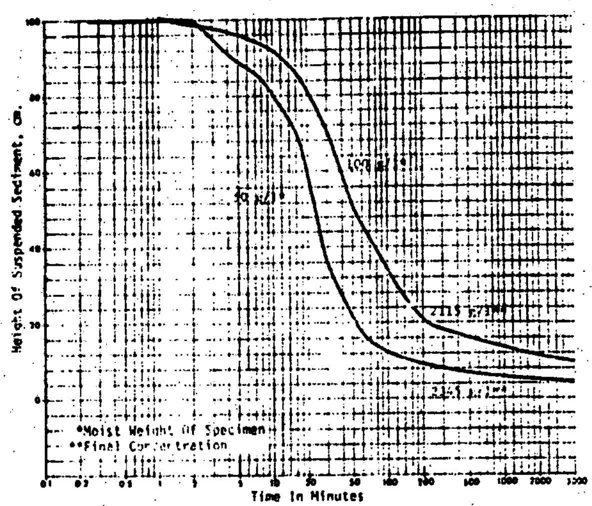
SEDIMENT SAMPLE # MB-29	
WATER SAMPLE # MB-29	

FIGURE 30-a



SAMPLE # MB-30	SPECIFIC GRAVITY 2.61
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1345	FIELD DESCRIPTION OF SEDIMENT Soft black
WATER DEPTH (ft.) 40	silty ooze

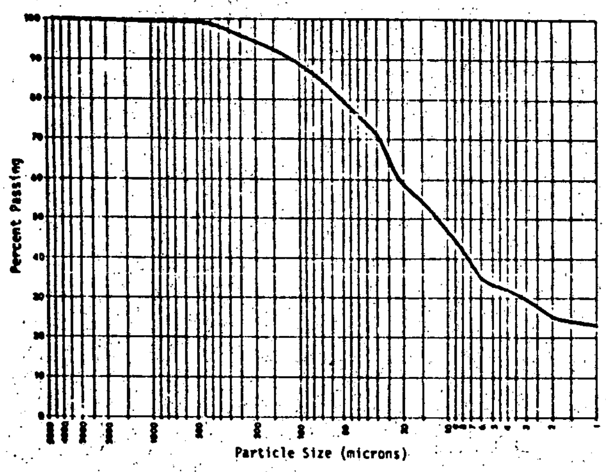
FIGURE 30-b



SEDIMENT SAMPLE # MB-30	
WATER SAMPLE # MB-30	

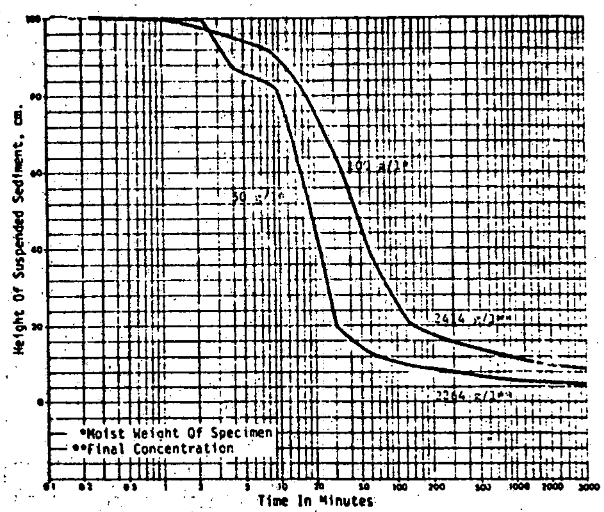
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 31-a



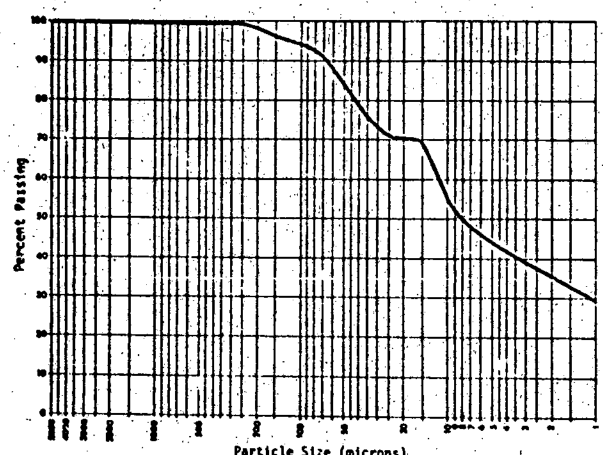
SAMPLE # MB-31	SPECIFIC GRAVITY 2.80
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1355	FIELD DESCRIPTION OF SEDIMENT Soft black
WATER DEPTH (ft.) 38	ooze with clumps of brown mud

FIGURE 31-b



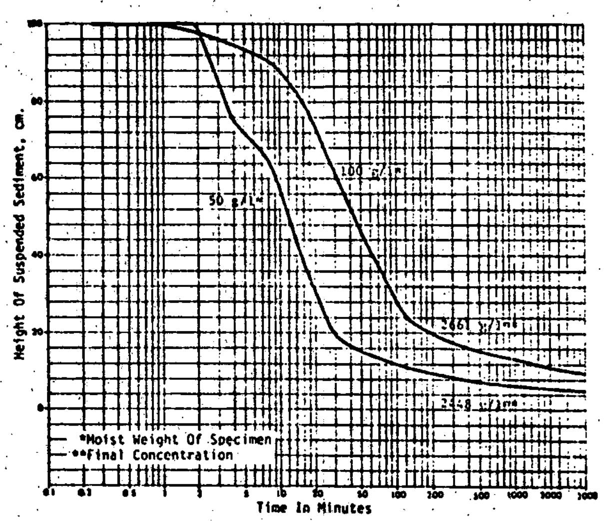
SEDIMENT SAMPLE # MB-31
WATER SAMPLE # MB-31

FIGURE 32-a



SAMPLE # MB-32	SPECIFIC GRAVITY 2.55
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1404	FIELD DESCRIPTION OF SEDIMENT Soft oily brownish black silt above with dark clay below
WATER DEPTH (ft.) 30	

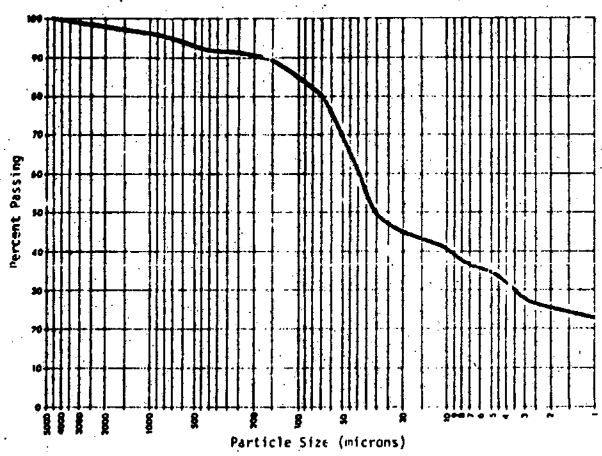
FIGURE 32-b



SEDIMENT SAMPLE # MB-32
WATER SAMPLE # MB-32

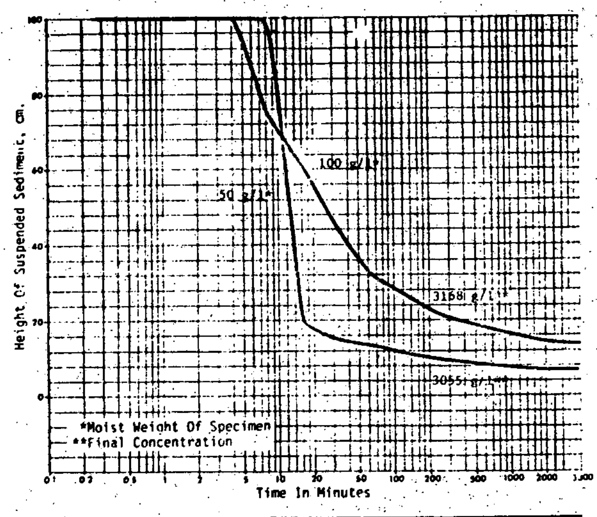
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 33-a



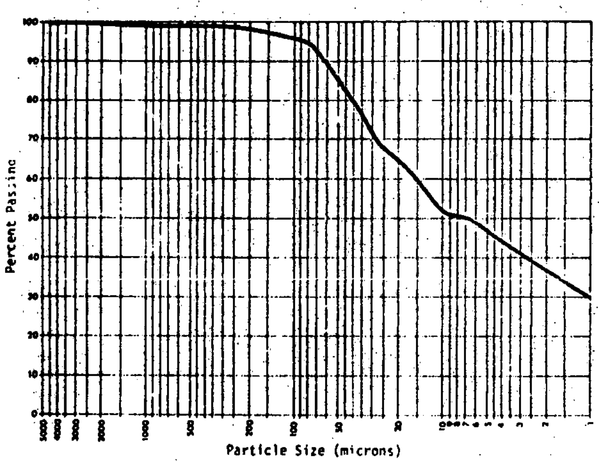
SAMPLE # MB1-33	SPECIFIC GRAVITY 2.38
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1452	FIELD DESCRIPTION OF SEDIMENT Black oily
WATER DEPTH (ft.) 27	silt above and brown ooze below

FIGURE 33-b



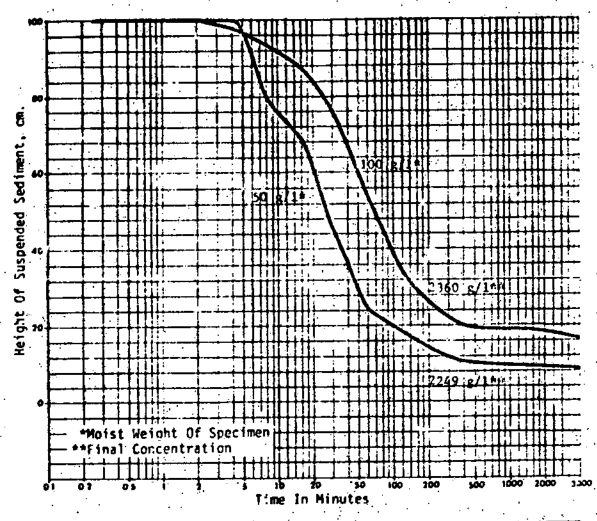
SEDIMENT SAMPLE # MB1-33	
WATER SAMPLE # MB1-33	

FIGURE 34-a



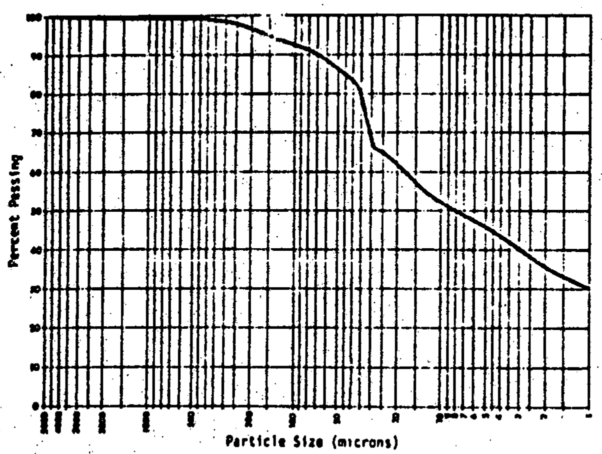
SAMPLE # MB1-34	SPECIFIC GRAVITY 2.49
DATE 31 July 74	STANDARD CLASSIFICATION ML-C
TIME 1506	FIELD DESCRIPTION OF SEDIMENT Soft black oily silty ooze on surface with brown ooze beneath
WATER DEPTH (ft.) 26	

FIGURE 34-b



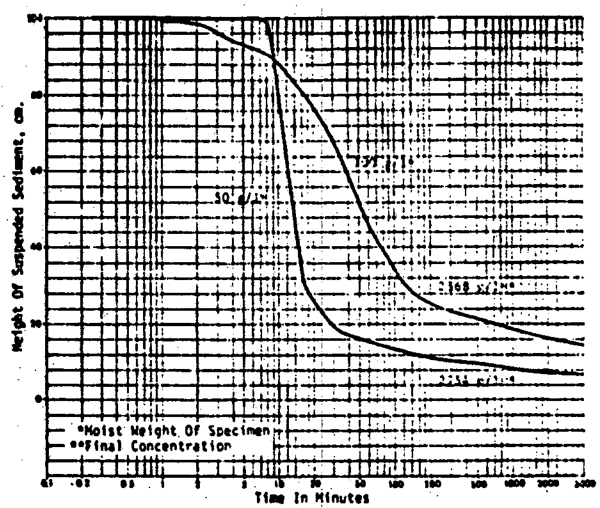
SEDIMENT SAMPLE # MB1-34	
WATER SAMPLE # MB1-34	

FIGURE 35-a



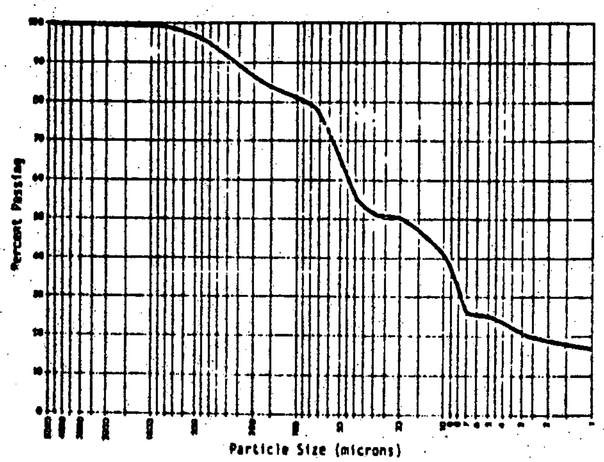
SAMPLE # MB_1-35	SPECIFIC GRAVITY 2.36
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1514	FIELD DESCRIPTION OF SEDIMENT Oily silt
WATER DEPTH (ft.) 30	with black and brown ooze

FIGURE 35-b



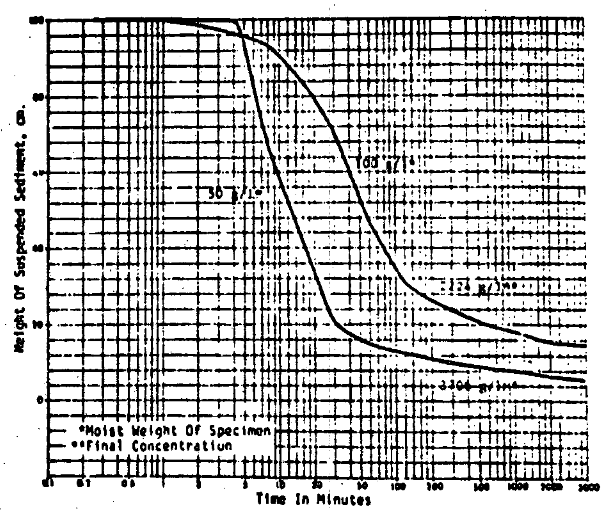
SEDIMENT SAMPLE # MB_1-35	
WATER SAMPLE # MB_1-35	

FIGURE 36-a



SAMPLE # MB_1-36	SPECIFIC GRAVITY 2.49
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1521	FIELD DESCRIPTION OF SEDIMENT Oily silt
WATER DEPTH (ft.) 29	

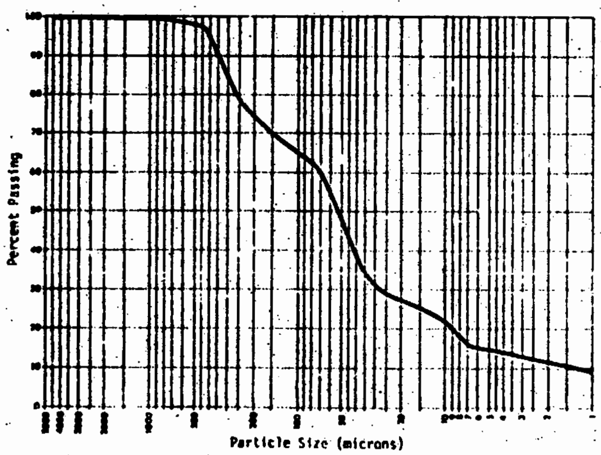
FIGURE 36-b



SEDIMENT SAMPLE # MB_1-36	
WATER SAMPLE # MB_1-36	

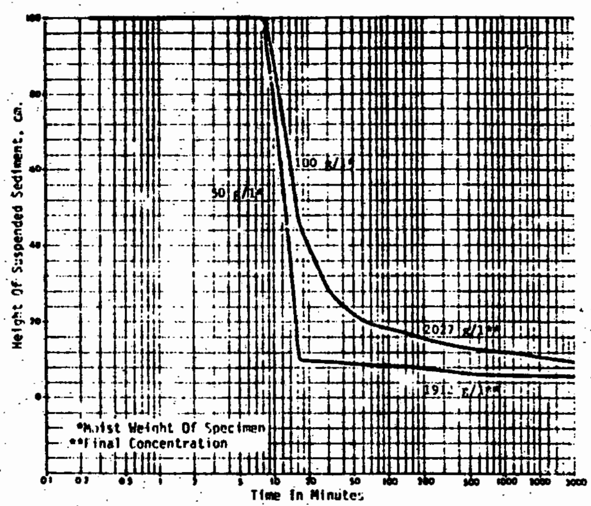
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 37-a



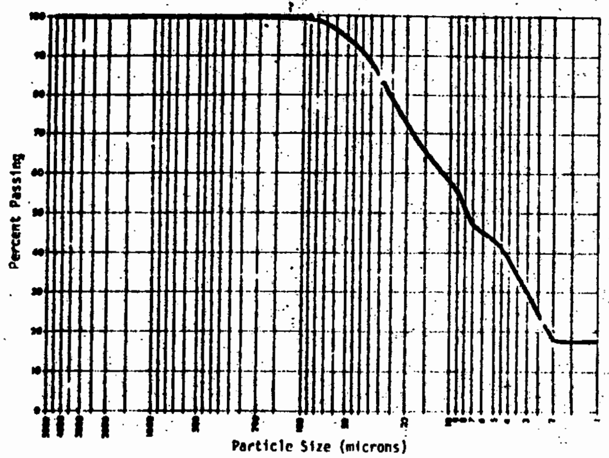
SAMPLE # MB_1-37	SPECIFIC GRAVITY 2.74
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1530	FIELD DESCRIPTION OF SEDIMENT Brown sand
WATER DEPTH (ft.) 15	with some clay

FIGURE 37-b



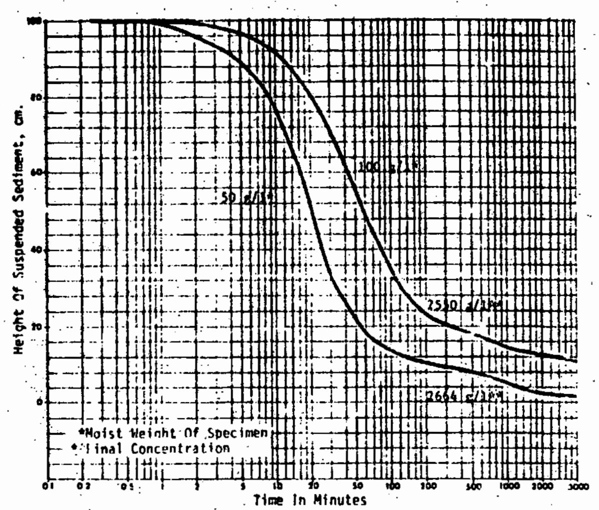
SEDIMENT SAMPLE #	MB_1-37
WATER SAMPLE #	MB_1-37

FIGURE 38-a



SAMPLE # MB_2-38	SPECIFIC GRAVITY 2.73
DATE 31 July 74	STANDARD CLASSIFICATION ML-CL
TIME 1240	FIELD DESCRIPTION OF SEDIMENT Soft dark
WATER DEPTH (ft.) 25	rown silty ooze

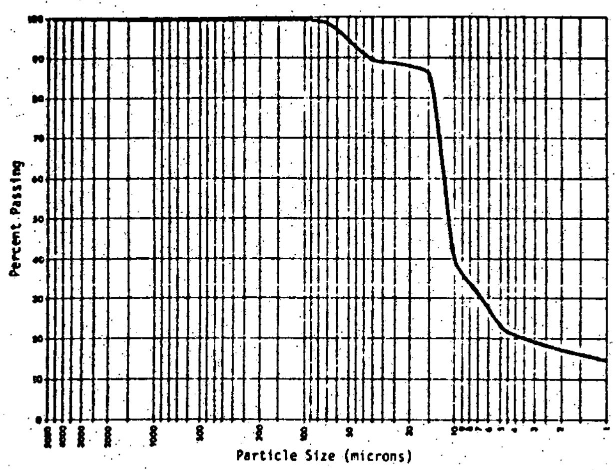
FIGURE 38-b



SEDIMENT SAMPLE #	MB_2-38
WATER SAMPLE #	MB_2-38

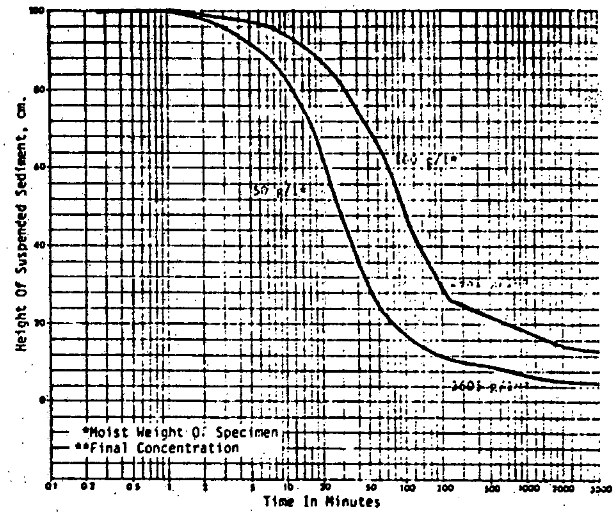
PHYSICAL ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

FIGURE 39-a



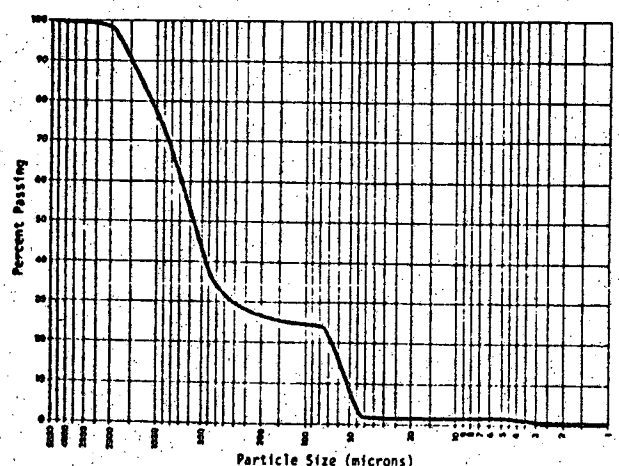
SAMPLE # MB2-39	SPECIFIC GRAVITY 2.77
DATE 31 July 74	STANDARD CLASSIFICATION ML
TIME 1222	FIELD DESCRIPTION OF SEDIMENT Soft black
WATER DEPTH (ft.) 28	oily silty ooze

FIGURE 39-b



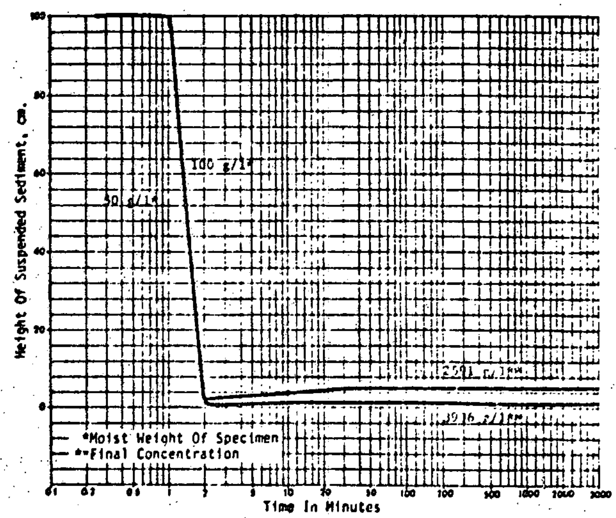
SEDIMENT SAMPLE # MB2-39	
WATER SAMPLE # MB2-39	

FIGURE 40-a



SAMPLE # MB3-40	SPECIFIC GRAVITY 2.56
DATE 31 July 74	STANDARD CLASSIFICATION SM
TIME 1420	FIELD DESCRIPTION OF SEDIMENT Brown sand
WATER DEPTH (ft.) 20	

FIGURE 40-b



SEDIMENT SAMPLE # MB3-40	
WATER SAMPLE # MB3-40	

TABLE 1

CHEMICAL ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

Sample #	Moisture %	Volatile Solids %	C.O.D. mg/kgx10^3	T.O.C. mg/kgx10^3	Total Phosphate mg/kg P	T.K.N. mg/kg N	Ammonia Nitrogen mg/kg N	Oil and Grease mg/kg	Eh mvolts
MB-1	16.97	[illegible]	2.04	0.76	18.25	257.0	39.8	436	450
MB-2	19.03	0.54	3.14	1.18	60.00	21.8	33.6	509	250
MB-3	37.26	2.67	22.98	8.61	34.50	112.6	44.8	740	250
MB-4	67.35	16.03	49.34	18.48	54.25	98.0	17.9	882	230
MB-5	68.62	13.45	40.54	15.18	89.25	1181.0	51.0	720	320
MB-6	68.54	13.18	40.43	15.14	51.25	1192.2	49.8	1100	450
MB-7	68.55	14.31	45.85	17.17	80.00	1289.1	218.4	763	450
MB-8	66.99	13.30	69.22	25.93	43.25	1076.9	51.5	600	520
MB-9	67.46	14.91	56.55	21.18	65.50	1054.5	13.4	993	-20
MB-10	66.23	12.75	28.13	10.54	93.75	275.5	21.8	1084	510
MB-11	70.87	10.74	47.44	17.77	55.75	888.7	12.9	1359	500
MB-12	68.65	9.78	33.84	12.67	51.25	558.3	18.5	1254	590
MB-13	67.40	7.72	12.52	4.69	67.00	1326.6	67.2	1153	565
MB-14	68.86	12.38	23.57	8.83	80.00	1195.6	12.3	1182	340
MB-15	69.44	13.30	28.27	10.59	65.50	1489.6	69.4	1126	185
MB-16	70.10	14.73	34.68	12.99	48.25	1179.4	156.2	1288	400

Note: Unless indicated, all results are expressed on a dry weight basis.

TABLE 1 (Cont'd)

CHEMICAL ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

Sample #	Moisture %	Volatile Solids %	C.O.D. mg/kgx10^3	T.O.C. mg/kgx10^3	Total Phosphate mg/kg P	T.K.N. mg/kg N	Ammonia Nitrogen mg/kg N	Oil and Grease mg/kg	Eh mvolts
MB-17	69.30	13.46	33.78	12.65	89.25	1259.4	21.8	502	365
MB-18	68.06	11.67	57.71	21.61	62.50	867	7.8	1196	520
MB-19	67.07	13.76	31.49	11.79	88.25	1210.7	12.3	1039	225
MB-20	68.00	15.06	37.81	14.16	80.00	889.8	9.0	950	-25
MB-21	70.04	12.87	2.87	1.07	96.00	109.8	44.8	708	351
MB-22	68.44	12.18	35.58	13.33	82.50	1483.4	47.0	520	250
MB-23	70.92	12.78	32.67	12.24	80.00	1163.1	59.4	861	190
MB-24	69.41	13.23	19.78	7.41	82.50	165.2	134.4	549	250
MB-25	66.44	9.81	2.56	0.96	116.00	44.2	34.2	784	205
MB-26	59.87	10.28	6.45	2.42	80.00	1055.0	112.0	459	260
MB-27	66.21	15.61	48.59	18.20	88.00	1169.8	157.9	367	380
MB-28	43.41	5.00	17.30	6.48	57.50	16.2	53.2	350	210
MB-29	43.44	5.01	2.88	1.08	65.50	705.0	51.5	362	210
MB-30	53.65	7.52	3.73	1.39	86.50	800.8	61.6	494	440
MB-31	53.98	7.14	1.87	0.70	85.50	850.6	72.8	535	265
MB-32	63.52	9.78	35.80	13.41	78.75	1371.4	67.2	565	255

Note: Unless indicated, all results are expressed on a dry weight basis.

TABLE 1 (Cont'd)

CHEMICAL ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

Sample #	Moisture %	Volatile Solids %	C.O.D. mg/kgx10^3	T.O.C. mg/kgx10^3	Total Phosphate mg/kg P	T.K.N. mg/kg N	Ammonia Nitrogen mg/kg N	Oil and Grease mg/kg	Eh mvolts
MB_1-33	76.62	23.34	125.66	47.06	129.50	2317.8	123.2	2147	220
MB_1-34	73.84	18.20	180.93	67.76	89.25	2749.0	63.8	1453	125
MB_1-35	73.69	16.08	130.26	48.79	109.25	2065.8	57.1	1437	310
MB_1-36	69.20	13.04	98.18	36.77	69.50	2074.2	65.0	4026	180
MB_1-37	50.67	5.56	62.86	23.54	40.00	869.7	39.2	527	360
MB_2-38	66.48	9.01	48.69	18.24	83.75	1315.4	102.5	549	240
MB_2-39	74.78	12.08	51.78	19.39	125.00	1315.4	17.9	1634	310
MB_3-40	19.59	0.66	1.02	0.38	7.00	106.4	56.6	326	220

Note: Unless indicated, all results are expressed on a dry weight basis.

TABLE 2

HEAVY METALS ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

Sample #	Moisture %	Hg mg/kg	As mg/kg	Cu mg/kg	Zn mg/kg	Cd mg/kg	Pb mg/kg	Ni mg/kg	Cr mg/kg	Fe^{++} mg/kg
MB-1	21.2	0.24	0.8	4.5	14.2	< 0.1	< 0.5	5.4	4.5	1.0
MB-2	19.4	1.11	1.3	2.6	1.1	< 0.1	< 0.5	5.3	22.7	<0.3
MB-3	31.2	0.31	1.8	7.0	5.7	< 0.1	< 0.5	4.0	17.0	0.8
MB-4	56.4	0.44	4.0	19.2	18.8	< 0.1	< 0.5	20.7	59.2	4.1
MB-5	54.5	0.51	5.6	18.4	18.2	< 0.1	< 0.5	27.9	56.8	1.0
MB-6	53.0	0.39	5.5	16.6	16.6	< 0.1	< 0.5	19.4	46.1	0.6
MB-7	45.2	0.60	6.7	17.6	18.8	< 0.1	< 0.5	30.6	64.8	1.2
MB-8	56.7	0.60	4.8	20.8	19.5	< 0.1	< 0.5	23.9	56.7	1.8
MB-9	63.9	0.33	6.2	17.8	17.1	< 0.1	< 0.5	21.0	48.5	0.6
MB-10	59.6	0.39	1.5	18.3	19.4	< 0.1	< 0.5	23.4	56.2	0.8
MB-11	56.5	0.89	3.9	16.8	19.9	< 0.1	< 0.5	23.7	51.7	0.3
MB-12	61.8	0.46	4.6	11.0	13.4	< 0.1	< 0.5	15.2	35.4	<0.3
MB-13	60.5	0.73	6.2	16.9	20.0	< 0.1	< 0.5	26.3	54.4	1.4
MB-14	76.5	0.70	8.8	16.0	18.1	< 0.1	< 0.5	27.1	54.3	0.4
MB-15	62.9	0.41	12.4	17.7	18.0	< 0.1	< 0.5	29.8	54.9	1.0
MB-16	59.3	0.50	0.9	19.9	21.5	< 0.1	< 0.5	26.5	57.1	1.0
MB-17	59.1	0.43	7.0	29.6	30.6	< 0.1	< 0.5	41.4	95.7	1.4

Note: Unless indicated, all results are expressed on a dry weight basis.

TABLE 2 (Cont'd)

HEAVY METALS ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

Sample #	Moisture %	Hg mg/kg	As mg/kg	Cu mg/kg	Zn mg/kg	Cd mg/kg	Pb mg/kg	Ni mg/kg	Cr mg/kg	Fe^{++} mg/kg
MB-18	70.4	0.36	8.0	18.9	20.2	<0.1	<0.5	23.7	49.2	0.9
MB-19	73.8	0.36	7.5	15.9	16.1	<0.1	<0.5	19.8	45.6	0.4
MB-20	54.2	0.92	9.8	17.6	20.8	<0.1	<0.5	22.5	50.8	1.2
MB-21	74.4	0.30	6.9	26.4	99.1	<0.1	<0.5	21.3	47.2	0.9
MB-22	56.7	0.28	2.4	17.8	25.0	<0.1	<0.5	17.4	40.9	1.6
MB-23	59.8	0.70	1.0	19.4	23.8	<0.1	<0.5	19.6	50.6	<0.3
MB-24	77.4	0.53	4.5	20.7	27.3	<0.1	<0.5	23.6	46.4	0.4
MB-25	64.1	0.58	1.0	19.5	26.7	<0.1	<0.5	23.0	47.0	0.4
MB-26	46.7	0.26	6.2	17.4	84.6	<0.1	<0.5	14.5	39.1	1.2
MB-27	54.2	0.26	5.3	19.0	20.8	<0.1	<0.5	21.6	45.0	0.3
MB-28	35.9	0.50	3.4	14.7	13.1	<0.1	<0.5	8.0	33.8	1.4
MB-29	33.7	0.13	2.0	7.5	11.8	<0.1	<0.5	12.4	22.1	1.3
MB-30	38.7	0.18	5.3	13.3	21.6	<0.1	<0.5	15.2	51.4	0.8
MB-31	41.5	0.16	1.0	13.6	74.6	<0.1	<0.5	12.5	40.4	6.0
MB-32	69.9	0.20	0.8	19.9	132.1	<0.1	<0.5	17.9	41.7	<0.3
MB_1-33	66.4	0.44	1.2	48.3	246.8	<0.1	<0.5	11.7	39.0	0.8
MB_1-34	66.6	0.67	5.2	47.2	134.8	<0.1	<0.5	21.1	41.2	<0.3

Note: Unless indicated, all results are expressed on a dry weight basis.

TABLE 2 (Cont'd)

HEAVY METALS ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

Sample #	Moisture %	Hg mg/kg	As mg/kg	Cu mg/kg	Zn mg/kg	Cd mg/kg	Pb mg/kg	Ni mg/kg	Cr mg/kg	Fe^{++} mg/kg
MB_1-35	59.8	0.30	1.3	50.3	136.9	<0.1	<0.5	14.5	35.4	<0.3
MB_1-36	50.1	1.50	1.0	36.8	149.0	<0.1	<0.5	13.0	42.8	0.7
MB_1-37	58.7	0.30	2.4	12.0	13.3	<0.1	<0.5	13.0	20.4	<0.3
MB_2-38	84.1	0.38	0.8	7.3	21.7	<0.1	<0.5	7.2	15.3	0.3
MB_2-39	79.3	0.50	7.3	30.4	31.2	<0.1	<0.5	22.9	46.8	0.8
MB_3-40	15.7	0.07	<0.3	0.9	1.9	<0.1	<0.5	4.[illegible]	2.9	<0.3

Note: Unless indicated, all results are expressed on a dry weight basis.

TABLE 3

BACTERIOLOGICAL ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

Sample #	Moisture %	Total Coliforms #org/g	Fecal Coliforms #org/g
MB-4	67.35	139140	< 61
MB-6	68.54	127701	< 64
MB-8	66.99	13632	2121
MB-10	66.23	9476	3553
MB-12	68.65	3828	1276
MB-14	68.86	192678	6101
MB-16	70.10	6689	5886
MB-18	68.06	16281	3131
MB-20	68.00	22500	6250
MB-22	68.44	23447	3169
MB-24	69.41	14057	3269
MB-27	66.21	29595	13318

Note: Results are expressed on a dry weight basis.

TABLE 6

PESTICIDES ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

SAMPLE # MB-2 MOISTURE % 41.57

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL (Units)
Aldrin	N.D.	0.229
Chlordane	N.D.	2.055
Dieldrin	N.D.	0.315
DDD (TDE)	N.D.	0.844
DDE	N.D.	0.815
DDT	N.D.	1.066
Endrin	N.D.	0.447
Heptachlor	N.D.	0.115
Heptachlor Epoxide	N.D.	0.193
Lindane	N.D.	0.118
Methoxychlor	N.D.	2.738
Mirex	N.D.	0.763
Toxaphene	N.D.	16.430
Diazinon	N.D.	0.341
Guthion	N.D.	9.926
Malathion	N.D.	4.929
Methyl Parathion	N.D.	5.839
Parathion	N.D.	5.819
PCB (AR 1242)	N.D.	2.875
PCB (AR 1254)	N.D.	5.405
PCB (AR 1260)	N.D.	9.627

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

SAMPLE # MB-4 MOISTURE % 65.39

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.438
Chlordane	N.D.	3.924
Dieldrin	N.D.	0.601
DDD (TDE)	16.184	1.405
DDE	21.567	1.036
DDT	15.313	1.666
Endrin	N.D.	0.853
Heptachlor	N.D.	0.219
Heptachlor Epoxide	N.D.	0.369
Lindane	N.D.	0.225
Methoxychlor	N.D.	5.227
Mirex	N.D.	1.457
Toxaphene	N.D.	31.362
Diazinon	N.D.	0.650
Guthion	N.D.	18.948
Malathion	N.D.	9.409
Methyl Parathion	N.D.	11.147
Parathion	N.D.	11.107
PCB (AR 1242)	N.D.	5.488
PCB (AR 1254)	60.533	4.574
PCB (AR 1260)	N.D.	18.376

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB-8 MOISTURE % 57.95

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.319
Chlordane	N.D.	2.856
Dieldrin	N.D.	0.438
DDD (TDE)	10.636	0.792
DDE	15.647	0.635
DDT	9.173	1.063
Endrin	N.D.	0.621
Heptachlor	N.D.	0.159
Heptachlor Epoxide	N.D.	0.269
Lindane	N.D.	0.164
Methoxychlor	N.D.	3.805
Mirex	N.D.	1.061
Toxaphene	N.D.	22.830
Diazinon	N.D.	0.473
Guthion	N.D.	13.793
Malathion	N.D.	6.849
Ethyl Parathion	2.532	0.866
Parathion	N.D.	8.086
PCB (AR 1242)	N.D.	3.995
PCB (AR 1254)	38.981	8.117
PCB (AR 1260)	N.D.	13.377

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

Ethyl Parathion is uncorrected for recovery level.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

SAMPLE # MB-12 MOISTURE % 59.70

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.333
Chlordane	N.D.	2.980
Dieldrin	N.D.	0.457
DDD (TDE)	7.859	0.911
DDE	7.905	1.159
DDT	5.086	0.744
Endrin	N.D.	0.648
Heptachlor	N.D.	0.166
Heptachlor Epoxide	N.D.	0.280
Lindane	N.D.	0.171
Methoxychlor	N.D.	3.970
Mirex	N.D.	1.107
Toxaphene	N.D.	23.821
Diazinon	N.D.	0.494
Guthion	N.D.	14.392
Malathion	N.D.	7.146
Methyl Parathion	N.D.	8.467
Parathion	N.D.	8.437
PCB (AR 1242)	N.D.	4.169
PCB (AR 1254)	N.D.	7.836
PCB (AR 1260)	79.258	11.928

Notes: Results are based on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB-16 MOISTURE % 66.39

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.399
Chlordane	N.D.	3.573
Dieldrin	N.D.	0.547
DDD (TDE)	18.136	1.092
DDE	16.130	0.893
DDT	13.706	1.389
Endrin	N.D.	0.777
Heptachlor	N.D.	0.199
Heptachlor Epoxide	N.D.	0.337
Lindane	N.D.	0.205
Methoxychlor	N.D.	4.760
Mirex	N.D.	1.327
Toxaphene	N.D.	28.563
Diazinon	N.D.	0.592
Guthion	N.D.	17.257
Malathion	N.D.	8.569
Methyl Parathion	N.D.	10.152
Parathion	N.D.	10.116
PCB (AR 1242)	N.D.	4.999
PCB (AR 1254)	N.D.	9.396
PCB (AR 1260)	88.050	14.302

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSIS OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB-18 MOISTURE % 58.62

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.324
Chlordane	N.D.	2.902
Dieldrin	N.D.	0.445
DDD (TDE)	8.078	0.718
DDE	18.490	0.887
DDT	N.D.	1.506
Endrin	N.D.	0.631
Heptachlor	N.D.	0.162
Heptachlor Epoxide	N.D.	0.273
Lindane	N.D.	0.167
Methoxychlor	N.D.	3.867
Mirex	N.D.	1.078
Toxaphene	N.D.	23.200
Diazinon	N.D.	0.481
Guthion	N.D.	14.016
Malathion	N.D.	6.960
Methyl Parathion	N.D.	8.246
Parathion	N.D.	8.217
PCB (AR 1242)	N.D.	4.060
PCB (AR 1254)	N.D.	7.632
PCB (AR 1260)	56.136	11.617

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB-20 MOISTURE % 55.84

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.303
Chlordane	N.D.	2.720
Dieldrin	2.605	0.446
DDD (TDE)	12.422	0.831
DDE	18.716	1.058
DDT	13.605	0.673
Endrin	N.D.	0.591
Heptachlor	N.D.	0.152
Heptachlor Epoxide	N.D.	0.256
Lindane	N.D.	0.156
Methoxychlor	N.D.	3.623
Mirex	N.D.	1.010
Toxaphene	N.D.	21.739
Diazinon	N.D.	0.451
Guthion	N.D.	13.134
Malathion	N.D.	6.522
Methyl Parathion	N.D.	7.726
Parathion	N.D.	7.699
PCB (AR 1242)	N.D.	3.804
PCB (AR 1254)	N.D.	7.151
PCB (AR 1260)	79.258	10.885

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB-22 MOISTURE % 54.44

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.294
Chlordane	N.D.	2.636
Dieldrin	N.D.	0.404
DDD (TDE)	15.617	0.731
DDE	19.349	0.586
DDT	23.842	0.981
Endrin	N.D.	0.573
Heptachlor	N.D.	0.147
Heptachlor Epoxide	N.D.	0.248
Lindane	N.D.	0.151
Methoxychlor	N.D.	3.512
Mirex	N.D.	0.979
Toxaphene	N.D.	21.071
Diazinon	N.D.	0.437
Guthion	N.D.	12.730
Malathion	N.D.	6.321
Methyl Parathion	N.D.	7.489
Parathion	N.D.	7.463
PCB (AR 1242)	N.D.	3.687
PCB (AR 1254)	69.289	7.491
PCB (AR 1260)	N.D.	12.346

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

SAMPLE # MB-26 MOISTURE % 48.58

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.261
Chlordane	N.D.	2.336
Dieldrin	1.8[illegible]4	0.383
DDD (TDE)	24.836	0.714
DDE	75.215	0.578
DDT	54.292	0.908
Endrin	N.D.	0.508
Heptachlor	N.D.	0.130
Heptachlor Epoxide	N.D.	0.220
Lindane	N.D.	0.134
Methoxychlor	N.D.	3.112
Mirex	N.D.	0.867
Toxaphene	N.D.	18.670
Diazinon	N.D.	0.387
Guthion	N.D.	11.280
Malathion	N.D.	5.445
Methyl Parathion	N.D.	6.636
Parathion	N.D.	6.612
PCB (AR 1242)	N.D.	3.267
PCB (AR 1254)	N.D.	6.142
PCB (AR 1260)	97.747	9.349

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB-29 MOISTURE % 49.11

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.263
Chlordane	N.D.	2.360
Dieldrin	N.D.	0.362
DDD (TDE)	42.105	0.721
DDE	52.575	0.584
DDT	99.728	0.918
Endrin	N.D.	0.513
Heptachlor	N.D.	0.132
Heptachlor Epoxide	N.D.	0.222
Lindane	N.D.	0.136
Methoxychlor	N.D.	3.144
Mirex	N.D.	0.876
Toxaphene	N.D.	18.864
Diazinon	N.D.	0.391
Guthion	N.D.	11.397
Malathion	N.D.	5.659
Methyl Parathion	N.D.	6.705
Parathion	N.D.	6.681
PCB (AR 1242)	N.D.	3.301
PCB (AR 1254)	N.D.	6.206
PCB (AR 1260)	66.037	9.446

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB-31 MOISTURE % 64.69

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.379
Chlordane	N.D.	3.401
Dieldrin	N.D.	0.521
DDD (TDE)	30.428	1.029
DDE	29.228	0.850
DDT	12.875	1.323
Endrin	N.D.	0.739
Heptachlor	N.D.	0.190
Heptachlor Epoxide	N.D.	0.320
Lindane	N.D.	0.195
Methoxychlor	N.D.	4.531
Mirex	N.D.	1.263
Toxaphene	N.D.	27.188
Diazinon	N.D.	0.564
Guthion	N.D.	16.426
Malathion	N.D.	8.156
Methyl Parathion	N.D.	9.663
Parathion	N.D.	9.629
PCB (AR 1242)	N.D.	4.758
PCB (AR 1254)	N.D.	8.944
PCB (AR 1260)	689.451	13.614

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

SAMPLE # MB-32 MOISTURE % 53.96

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.291
Chlordane	N.D.	2.[illegible]09
Dieldrin	N.D.	0.400
DDD (TDE)	25.047	0.723
DDE	35.998	0.550
DDT	53.446	0.971
Endrin	N.D.	0.567
Heptachlor	N.D.	0.146
Heptachlor Epoxide	N.D.	0.245
Lindane	N.D	0.150
Methoxychlor	N.D.	3.475
Mirex	N.D.	0.969
Toxaphene	N.D.	20.851
Diazinon	N.D.	0.432
Guthion	N.D.	12.598
Malathion	N.D.	6.255
Methyl Parathion	N.D.	7.411
Parathion	N.D.	7.385
PCB (AR 1242)	N.D.	3.649
PCB (AR 1254)	68.673	7.413
PCB (AR 1260)	N.D.	12.218

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB_1-33 MOISTURE % 64.53

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.378
Chlordane	N.D.	3.386
Dieldrin	N.D.	0.519
DDD (TDE)	N.D.	1.390
DDE	N.D.	1.342
DDT	N.D.	1.756
Endrin	N.D.	0.736
Heptachlor	N.D.	0.189
Heptachlor Epoxide	N.D.	0.319
Lindane	N.D.	0.195
Methoxychlor	N.D.	4.511
Mirex	N.D.	1.257
Toxaphene	N.D.	27.065
Diazinon	N.D.	0.561
Guthion	N.D.	16.352
Malathion	N.D.	8.320
Methyl Parathion	N.D.	9.619
Parathion	N.D.	9.586
PCB (AR 1242)	N.D.	4.736
PCB (AR 1254)	N.D.	8.903
PCB (AR 1260)	60.770	13.552

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES, MOBILE HARBOR, ALABAMA

SAMPLE # MB_1-36 MOISTURE % 55.29

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.300
Chlordane	N.D.	2.686
Dieldrin	N.D.	0.412
DDD (TDE)	21.648	0.821
DDE	45.386	0.671
DDT	7.629	1.045
Endrin	N.D.	0.584
Heptachlor	N.D.	0.150
Heptachlor Epoxide	N.D.	0.253
Lindane	N.D.	0.154
Methoxychlor	N.D.	3.579
Mirex	N.D.	0.998
Toxaphene	N.D.	21.472
Diazinon	N.D.	0.445
Guthion	N.D.	12.972
Malathion	N.D.	6.442
Methyl Parathion	N.D.	7.631
Parathion	N.D.	7.605
PCB (AR 1242)	N.D.	3.758
PCB (AR 1254)	N.D.	7.063
PCB (AR 1260)	924.588	10.752

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

SAMPLE # MB_2-39 MOISTURE % 71.12

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.464
Chlordane	N.D.	4.159
Dieldrin	2.782	0.682
DDD (TDE)	25.631	1.153
DDE	31.620	0.925
DDT	10.082	1.548
Endrin	N.D.	0.904
Heptachlor	N.D.	0.232
Heptachlor Epoxide	N.D.	0.391
Lindane	N.D.	0.239
Methoxychlor	N.D.	5.540
Mirex	N.D.	1.544
Toxaphene	N.D.	33.241
Diazinon	N.D.	0.689
Guthion	N.D.	20.083
Malathion	N.D.	9.972
Ethyl Parathion	3.454	1.260
Parathion	N.D.	11.773
PCB (AR 1242)	N.D.	5.817
PCB (AR 1254)	101.777	11.818
PCB (AR 1260)	N.D.	19.477

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

Ethyl Parathion is uncorrected for recovery level.

TABLE 4 (Cont'd)

PESTICIDES ANALYSES OF SEDIMENT SAMPLES,
MOBILE HARBOR, ALABAMA

SAMPLE # MB_3-40 MOISTURE % 23.10

PESTICIDE	CONCENTRATION PPB	MINIMUM DETECTABLE LEVEL
Aldrin	N.D.	0.174
Chlordane	N.D.	1.562
Dieldrin	N.D.	0.239
DDD (TDE)	N.D.	0.641
DDE	1.449	0.347
DDT	N.D.	0.810
Endrin	N.D.	0.339
Heptachlor	N.D.	0.087
Heptachlor Epoxide	N.D.	0.147
Lindane	N.D.	0.090
Methoxychlor	N.D.	2.081
Mirex	N.D.	0.580
Toxaphene	N.D.	12.484
Diazinon	N.D.	0.259
Guthion	N.D.	7.542
Malathion	N.D.	3.745
Methyl Parathion	N.D.	4.437
Parathion	N.D.	4.421
PCB (AR 1242)	N.D.	2.185
PCB (AR 1254)	22.018	4.438
PCB (AR 1260)	N.D.	7.315

Notes: Results are expressed on a dry weight basis.

N.D. = Non-detectable.

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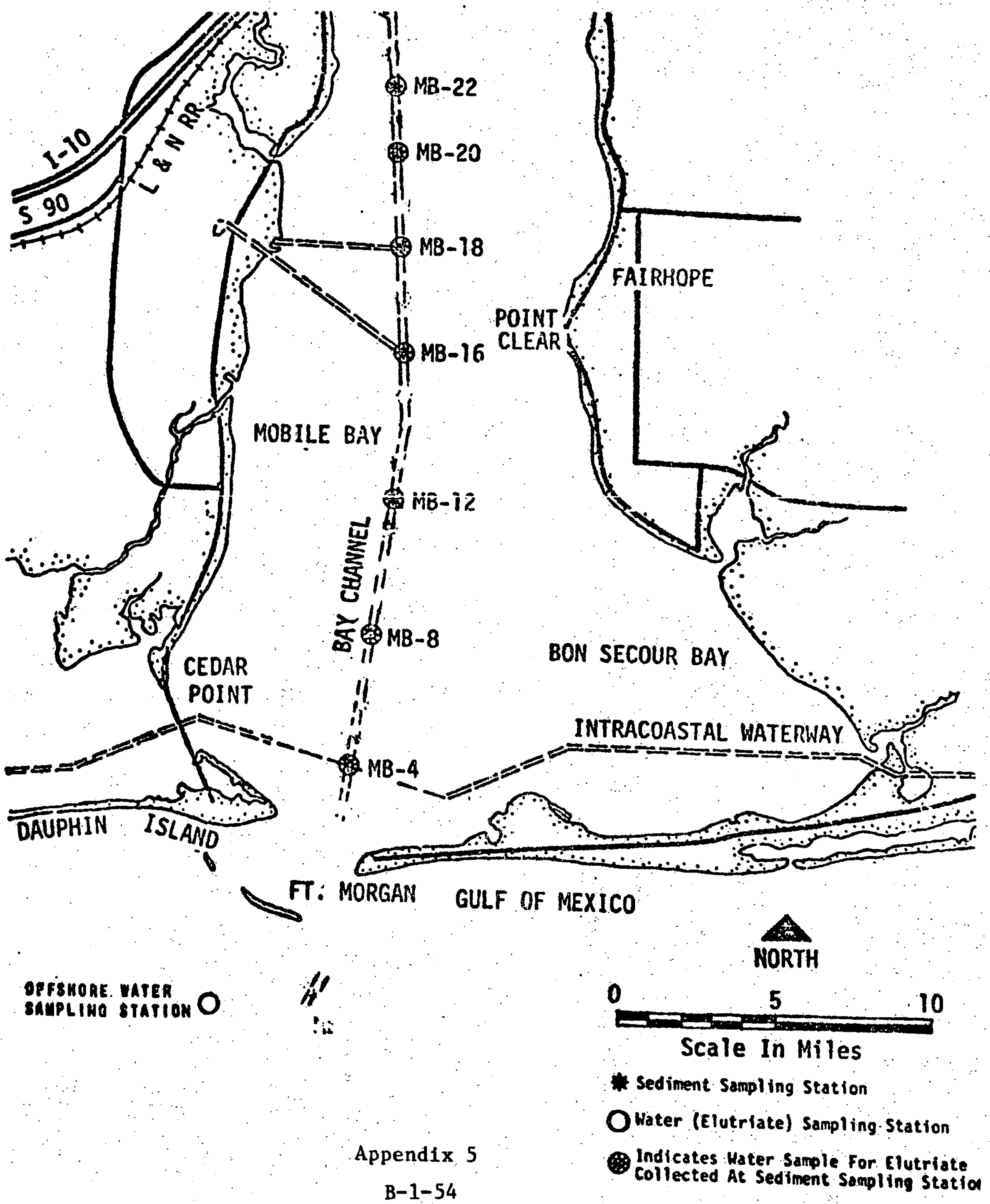
SEDIMENT SAMPLING
DATA

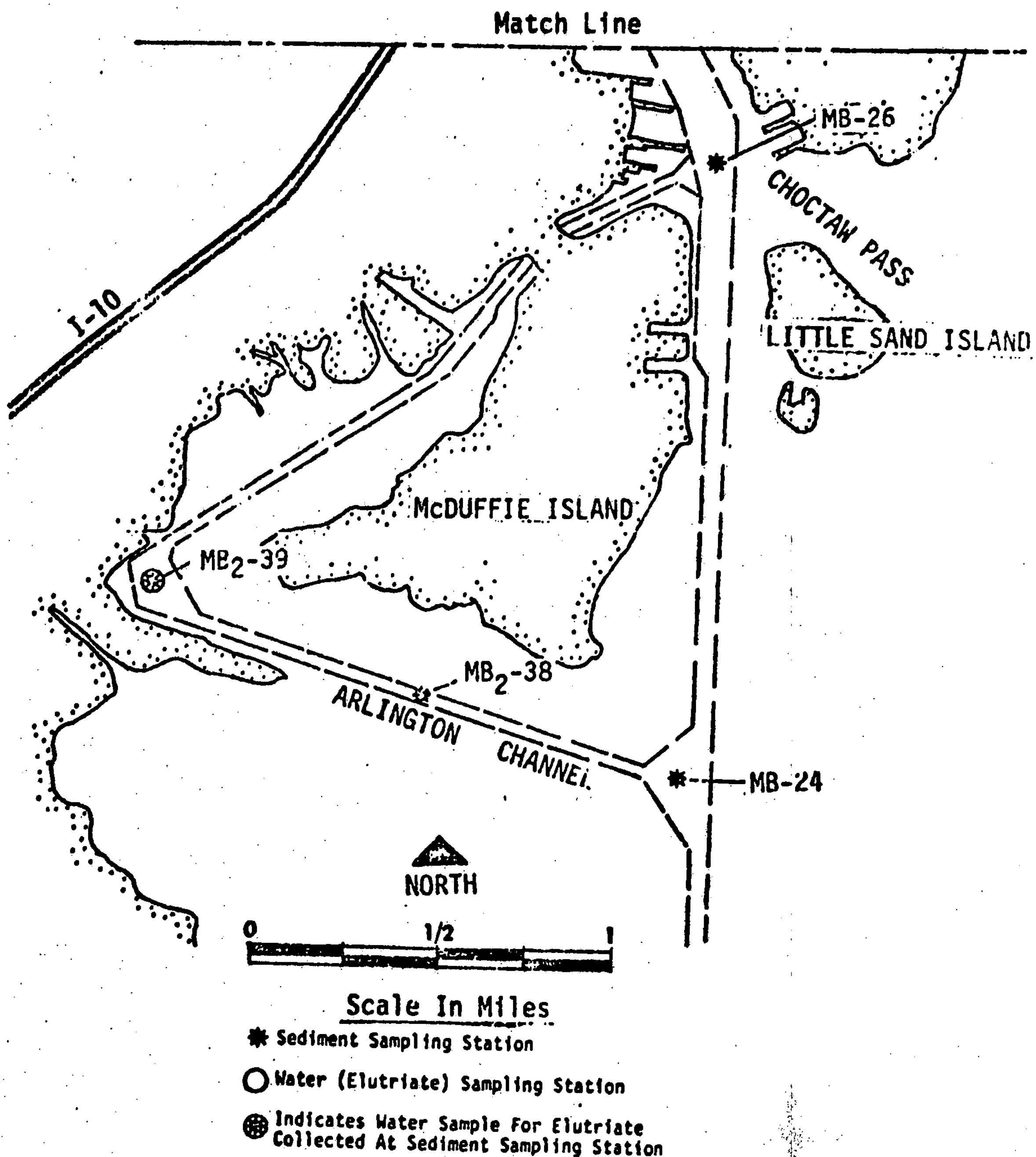
(Core Samples)

Appendix 5

LOCATIONS OF SEDIMENT AND WATER SAMPLING STATIONS, MOBILE HARBOR, ALABAMA



LOCATIONS OF SEDIMENT AND WATER SAMPLING STATIONS,
MOBILE HARBOR, ALABAMA



DATA SHEET

SAMPLE #	C.O.D. mg/kg x 10^3		T.O.C. mg/kg x 10^3		TOTAL PHOSPHATE mg/kg P	
	Wet Basis	Dry Basis	Wet Basis	Dry Basis	Wet Basis	Dry Basis
MB-4 (T)	21.54	52.46	8.07	19.65	18.48	45.00
MB-4 (M)	26.15	45.09	9.79	16.89	95.70	165.00
MB-4 (B)	29.23	51.50	10.95	19.29	31.22	55.00
MB-8 (T)	19.05	57.48	7.13	21.53	9.94	30.00
MB-8 (M)	21.43	53.63	8.03	20.09	23.98	60.00
MB-8 (B)	31.74	63.86	11.89	23.92	21.12	42.50
MB-12 (T)	19.05	60.09	7.13	22.51	45.17	142.50
MB-12 (M)	20.63	57.07	7.73	21.37	24.40	67.50
MB-12 (B)	39.68	76.38	14.86	28.61	14.29	27.50
MB-16 (T)	3.00	9.48	1.12	3.55	53.82	170.00
MB-16 (M)	21.06	55.63	7.89	20.84	25.56	67.50
MB-16 (B)	19.05	31.26	7.13	11.71	25.90	42.50
MB-18 (T)	18.05	47.14	6.76	17.66	36.38	95.00
MB-18 (M)	18.05	37.59	6.76	14.08	15.61	32.50
MB-18 (B)	18.80	29.97	7.04	11.22	34.50	55.00
MB-20 (T)	16.67	44.17	6.24	16.54	25.47	67.50
MB-20 (M)	19.84	45.96	7.43	17.21	36.69	85.00
MB-20 (B)	27.78	73.61	10.40	27.57	18.78	30.00
MB-22 (T)	15.08	29.87	5.65	11.19	49.23	97.50
MB-22 (M)	0.79	0.95	0.30	0.36	2.07	2.50
MB-22 (B)	1.59	1.91	0.60	0.72	2.08	2.50
MB-24 (T)	16.67	39.91	6.24	14.95	25.06	60.00
MB-24 (M)	0.79	0.99	0.30	0.37	8.00	10.00
MB-24 (B)	1.92	2.40	0.72	0.90	4.01	5.00
MB-26 (T)	12.70	21.90	4.76	8.20	30.44	52.50
MB-26 (M)	1.59	1.90	0.60	0.71	4.18	5.00
MB-26 (B)	3.97	5.26	1.11	1.97	7.55	10.00

DATA SHEET

Sample #	Total Kjeldahl Nitrogen mg/kg N		Volatile Solids %	Oil and Grease mg/kg	
	Wet Basis	Dry Basis		Wet Basis	Dry Basis
MB-4 (T)	478.3	1164.8	33.62	315	767
MB-4 (M)	743.8	1282.4	4.18	455	784
MB-4 (B)	467.2	823.2	0.27	331	583
MB-8 (T)	415.7	1254.4	28.73	372	1123
MB-8 (M)	368.1	921.2	24.05	277	693
MB-8 (B)	452.3	910.0	37.62	258	519
MB-12 (T)	569.8	1797.6	33.74	968	3054
MB-12 (M)	609.3	1685.6	67.49	548	1516
MB-12 (B)	439.3	845.6	25.00	247	475
MB-16 (T)	551.4	1741.6	40.75	251	793
MB-16 (M)	667.9	1764.0	56.60	3805	10050
MB-16 (B)	467.6	767.2	4.56	2675	4389
MB-18 (T)	516.8	1349.6	35.70	2826	7381
MB-18 (M)	494.8	1030.4	15.27	3376	7030
MB-18 (B)	400.4	638.4	4.40	3300	5261
MB-20 (T)	519.9	1377.6	11.17	3138	8315
MB-20 (M)	603.2	1397.2	52.38	3524	8163
MB-20 (B)	33.3	53.2	5.15	3158	5046
MB-22 (T)	575.4	1139.6	7.84	379	751
MB-22 (M)	51.0	61.6	0.26	32	39
MB-22 (B)	69.9	84.0	1.60	5916	7105
MB-24 (T)	12.9	30.8	10.37	405	970
MB-24 (M)	107.5	134.4	1.35	21	26
MB-24 (B)	13.5	16.8	1.50	102	127
MB-26 (T)	22.7	39.2	4.12	137	236
MB-26 (M)	51.5	61.6	0.31	358	428
MB-26 (B)	338.1	448.0	4.62	278	368

DATA SHEET

Sample #	Specific Gravity	Total Coliforms #org/g		Fecal Coliforms #org/g	
		Wet Basis	Dry Basis	Wet Basis	Dry Basis
MB-4 (T)	2.78	280	682	60	146
MB-4 (M)	2.72	---	---	---	---
MB-4 (B)	2.74	---	---	---	---
MB-8 (T)	2.86	31,000	93,543	35	106
MB-8 (M)	2.74	---	---	---	---
MB-8 (B)	2.76	---	---	---	---
MB-12 (T)	2.76	46,000	145,110	50	158
MB-12 (M)	2.84	---	---	---	---
MB-12 (B)	2.79	---	---	---	---
MB-16 (T)	2.80	500	1,579	25	79
MB-16 (M)	2.82	---	---	---	---
MB-16 (B)	2.71	---	---	---	---
MB-18 (T)	2.80	140	366	25	65
MB-18 (M)	2.77	---	---	---	---
MB-18 (B)	2.71	---	---	---	---
MB-20 (T)	2.75	960	2,544	530	1,404
MB-20 (M)	2.75	---	---	---	---
MB-20 (B)	2.79	---	---	---	---
MB-22 (T)	2.73	550	1,089	85	168
MB-22 (M)	2.66	---	---	---	---
MB-22 (B)	2.69	---	---	---	---
MB-24 (T)	2.61	70	168	64	153
MB-24 (M)	2.69	---	---	---	---
MB-24 (B)	2.71	---	---	---	---
MB-26 (T)	2.70	48	83	44	76
MB-26 (M)	2.64	---	---	---	---
MB-26 (B)	2.89	---	---	---	---

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DATA SHEET

Sample #	Hg ppm		As ppm		Cu ppm	
	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis
MB-4 (T)	0.24	0.58	1.17	2.86	3	8
MB-4 (M)	0.00	0.00	0.79	1.36	4	7
MB-4 (B)	0.00	0.00	0.22	0.38	5	8
MB-8 (T)	0.14	0.42	0.56	1.68	7	20
MB-8 (M)	0.04	0.10	1.84	4.60	8	20
MB-8 (B)	0.11	0.23	0.69	1.39	4	8
MB-12 (T)	0.16	0.49	0.61	1.92	3	10
MB-12 (M)	0.03	0.09	0.52	1.45	4	10
MB-12 (B)	0.10	0.19	0.65	1.25	5	9
MB-16 (T)	0.28	0.89	0.61	1.92	6	20
MB-16 (M)	0.12	0.32	0.73	1.92	8	20
MB-16 (B)	0.00	0.00	0.55	0.90	3	5
MB-18 (T)	0.03	0.09	1.09	2.84	8	20
MB-18 (M)	0.28	0.59	0.82	1.71	10	20
MB-18 (B)	0.36	0.57	0.46	0.74	3	5
MB-20 (T)	0.24	0.63	0.67	1.77	8	20
MB-20 (M)	0.69	1.60	0.75	1.73	9	20
MB-20 (B)	0.01	0.02	0.58	0.93	5	8
MB-22 (T)	0.31	0.61	0.72	1.43	< 1	1
MB-22 (M)	0.00	0.00	0.32	0.39	0	0
MB-22 (B)	0.00	0.00	0.20	0.24	0	0
MB-24 (T)	0.25	0.60	0.49	1.18	8	20
MB-24 (M)	0.00	0.00	0.05	0.06	5	6
MB-24 (B)	0.43	0.54	0.14	0.18	5	6
MB-26 (T)	0.19	0.32	0.27	0.46	3	6
MB-26 (M)	0.76	0.91	0.02	0.02	0	0
MB-26 (B)	0.00	0.00	< 0.01	0.01	6	8

DATA SHEET

(CONT'D)

Sample #	Zn ppm		Cd ppm		Pb ppm	
	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis
MB-4 (T)	21	50	0.3	0.7	4	10
MB-4 (M)	35	60	1.2	2.0	6	10
MB-4 (B)	3	5	0.5	0.9	6	10
MB-8 (T)	7	20	0.7	2.0	7	20
MB-8 (M)	4	10	0.2	0.6	8	20
MB-8 (B)	20	40	0.5	1.0	0	0
MB-12 (T)	32	100	1.0	3.0	6	20
MB-12 (M)	4	10	0.2	0.6	7	20
MB-12 (B)	21	40	0.4	0.7	16	30
MB-16 (T)	3	10	0.2	0.6	6	20
MB-16 (M)	4	10	0.2	0.6	8	20
MB-16 (B)	37	60	0.0	0.0	6	10
MB-18 (T)	4	10	0.3	0.9	8	20
MB-18 (M)	10	20	0.4	0.9	10	20
MB-18 (B)	31	50	0.1	0.2	6	10
MB-20 (T)	4	10	0.3	0.9	8	20
MB-20 (M)	9	20	0.4	0.9	9	20
MB-20 (B)	19	30	0.0	0.0	0	0
MB-22 (T)	30	60	0.5	0.9	10	20
MB-22 (M)	0	0	0.0	0.0	8	10
MB-22 (B)	7	8	1.7	2.0	8	10
MB-24 (T)	4	10	0.1	0.3	8	20
MB-24 (M)	8	10	1.6	2.0	8	10
MB-24 (B)	16	20	0.0	0.0	8	10
MB-26 (T)	17	30	0.0	0.0	0	0
MB-26 (M)	0	0	0.8	1.0	0	0
MB-26 (B)	15	20	1.5	2.0	8	10

DATA SHEET

(CONT'D)

Sample #	Ni ppm		Cr ppm		Fe^{++} ppm	
	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis
MB-4 (T)	8	20	8	20	0.0	0.0
MB-4 (M)	12	20	23	40	0.0	0.0
MB-4 (B)	6	10	11	20	0.2	0.3
MB-8 (T)	3	10	23	70	0.1	0.4
MB-8 (M)	4	10	28	70	0.0	0.0
MB-8 (B)	10	20	5	10	0.0	0.0
MB-12 (T)	6	20	16	50	0.3	0.8
MB-12 (M)	4	10	22	60	0.0	0.0
MB-12 (B)	10	20	16	30	0.0	0.0
MB-16 (T)	6	20	16	50	< 0.1	0.1
MB-16 (M)	4	10	19	50	0.0	0.0
MB-16 (B)	6	10	18	30	0.0	0.0
MB-18 (T)	4	10	23	60	0.0	0.0
MB-18 (M)	10	20	5	10	0.0	0.0
MB-18 (B)	6	10	13	20	0.4	0.6
MB-20 (T)	4	10	23	60	< 0.1	0.1
MB-20 (M)	4	10	17	40	0.0	0.0
MB-20 (B)	13	20	13	20	0.1	0.2
MB-22 (T)	10	20	45	90	0.2	0.4
MB-22 (M)	0	0	8	10	0.4	0.5
MB-22 (B)	0	0	17	20	0.0	0.0
MB-24 (T)	4	10	0	0	0.3	0.6
MB-24 (M)	0	0	32	40	0.2	0.2
MB-24 (B)	16	20	24	30	0.5	0.6
MB-26 (T)	6	10	12	20	0.2	0.4
MB-26 (M)	0	0	8	10	0.0	0.0
MB-26 (B)	8	10	15	20	0.0	0.0

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-4 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	99.42		2000	99.99
	850	99.37		850	99.90
	425	99.28		425	99.60
	250	98.99		250	97.78
	150	98.21		150	91.66
	75	95.57		75	78.93
	47	91.42		42	59.74
	33	89.06		30	56.32
	21	86.69		19	52.91
	12	79.61		11	51.20
	8	74.88		8	47.79
	6	32.36		6	34.13
	3	8.74		3	1.70
	1	6.37		1	1.70

(Bottom)	4750	100.00			
	2000	99.48			
	850	99.10			
	425	98.55			
	250	96.46			
	150	84.29			
	75	58.00			
	48	63.71			
	35	53.35			
	22	49.89			
	13	48.17			
	9	46.44			
	6	41.26			
	3	3.45			
	1	3.28			

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-8 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	99.83		2000	100.00
	850	99.80		850	100.00
	425	99.75		425	99.98
	250	99.64		250	99.88
	150	99.17		150	99.51
	75	96.70		75	96.93
	48	86.90		47	93.19
	34	84.00		34	88.28
	22	78.21		21	83.38
	13	26.07		13	51.50
	9	17.38		10	24.52
	7	14.48		7	17.16
	3	11.58		3	9.80
	1	8.40		1	7.11

(Bottom)	4750	100.00			
	2000	100.00			
	850	99.94			
	425	99.85			
	250	99.44			
	150	99.09			
	75	98.14			
	45	94.64			
	32	88.73			
	20	82.81			
	12	76.90			
	8	70.98			
	6	67.04			
	3	59.15			
	1	47.12			

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-12 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	100.00		2000	100.00
	850	100.00		850	100.00
	425	99.99		425	99.98
	250	99.98		250	99.96
	150	99.94		150	99.89
	75	99.50		75	99.17
	49	91.79		[illegible]7	92.94
	35	82.61		33	87.63
	22	67.31		21	84.97
	14	21.41		13	50.45
	10	18.35		9	23.90
	7	15.29		7	15.93
	3	12.23		3	10.62
	1	9.17		1	10.62
(Bottom)	4750	100.00			
	2000	100.00			
	850	99.92			
	425	99.63			
	250	99.53			
	150	99.45			
	75	99.18			
	44	91.49			
	32	84.02			
	20	82.15			
	12	74.68			
	8	69.08			
	6	67.21			
	3	56.01			
	1	5.60			

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-16 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	100.00		2000	100.00
	850	99.97		850	100.00
	425	99.93		425	99.98
	250	99.89		250	99.95
	150	99.76		150	99.95
	75	99.22		75	99.93
	48	92.22		47	92.49
	34	86.09		33	87.36
	22	73.83		21	84.80
	13	24.81		13	51.49
	9	21.75		9	48.76
	7	18.38		6	17.93
	3	12.25		3	10.24
	1	9.19		1	10.24

(Bottom)	4750	100.00			
	2000	99.99			
	850	99.96			
	425	99.86			
	250	99.60			
	150	95.02			
	75	68.78			
	47	63.50			
	35	52.13			
	22	48.89			
	13	60.26			
	9	43.85			
	6	42.23			
	3	25.98			
	1	12.99			

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-18 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	100.00		2000	100.00
	850	99.99		850	99.99
	425	99.89		425	99.98
	250	99.62		250	99.92
	150	99.41		150	99.23
	75	98.88		75	96.93
	47	90.43		45	92.56
	35	87.90		32	88.44
	21	85.37		20	84.32
	13	49.90		12	74.01
	9	24.57		8	69.88
	7	19.50		6	57.51
	1	9.37		3	20.41
				1	8.04

(Bottom)	4750	100.00			
	2000	99.56			
	850	99.26			
	425	97.55			
	250	93.42			
	150	91.62			
	75	86.43			
	48	63.92			
	34	57.61			
	22	54.45			
	12	51.29			
	9	48.45			
	6	46.87			
	3	40.88			
	1	17.52			

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-20 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	100.00		2000	99.99
	850	99.99		850	99.76
	425	99.94		425	99.74
	250	99.92		250	99.61
	150	95.53		150	98.71
	75	86.88		75	93.84
	50	77.12		47	88.30
	35	71.92		33	83.76
	23	64.13		21	79.22
	14	22.59		13	47.44
	10	17.39		10	20.20
	7	14.80		7	17.93
	3	9.60		3	11.12
	1	7.01		1	8.85

(Bottom)	4750	100.00			
	2000	100.00			
	850	99.96			
	425	99.91			
	250	99.78			
	150	99.19			
	75	94.49			
	43	81.98			
	31	72.68			
	20	68.03			
	12	60.28			
	8	55.63			
	6	52.53			
	3	44.78			
	1	33.93			

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-22 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	100.00		2000	99.95
	850	99.95		850	99.85
	425	99.85		425	62.72
	250	99.38		250	15.10
	150	86.93		150	4.50
	75	78.54		75	2.99
	47	77.44		17	2.93
	33	67.74		8	1.08
	22	61.91		5	1.08
	13	44.44		4	2.93
	9	23.09		3	3.50
	7	15.33		2	2.93
	1	7.56		1	2.93

(Bottom)	4750	100.00			
	2000	98.89			
	850	98.79			
	425	70.94			
	250	56.32			
	150	39.60			
	75	33.73			
	54	15.33			
	39	10.58			
	25	9.39			
	14	8.20			
	10	7.01			
	7	7.01			
	3	5.82			
	1	4.63			

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-24 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	99.99		2000	100.00
	850	99.98		850	100.00
	425	99.86		425	99.17
	250	95.59		250	61.99
	150	88.53		150	41.72
	75	85.70		75	29.98
	51	81.97		53	23.39
	36	77.13		38	15.96
	23	72.29		24	14.72
	14	33.61		14	13.49
	10	16.68		10	13.49
	7	11.84		7	12.25
	3	9.43		3	9.77
	1	9.43		1	2.35

(Bottom)	4750	100.00			
	2000	98.94			
	850	98.92			
	425	83.58			
	250	74.35			
	150	64.66			
	75	49.29			
	50	39.15			
	36	26.80			
	24	21.86			
	14	18.15			
	10	16.92			
	7	15.86			
	3	13.46			
	1	9.75			

DATA SHEET

Sample #	Particle Size µm	% Passing	Sample #	Particle Size µm	% Passing
MB-26 (Top)	4750	100.00	(Middle)	4750	100.00
	2000	99.72		2000	99.10
	850	98.39		850	94.28
	425	78.75		425	52.27
	250	50.24		250	21.06
	150	40.21		150	13.27
	75	38.70		75	12.03
	53	33.97		21	3.23
	37	32.27		11	2.03
	24	25.44		7	2.03
	14	13.48		4	2.03
	10	10.07		3	2.03
	7	8.36		2	2.03
	3	4.95		1	2.03
	1	3.24			

(Bottom)	4750	100.00			
	2000	99.96			
	850	99.11			
	425	90.56			
	250	79.68			
	150	75.56			
	75	72.69			
	43	61.55			
	31	57.77			
	19	56.51			
	11	50.22			
	8	47.70			
	6	45.19			
	3	18.75			
	1	6.16			

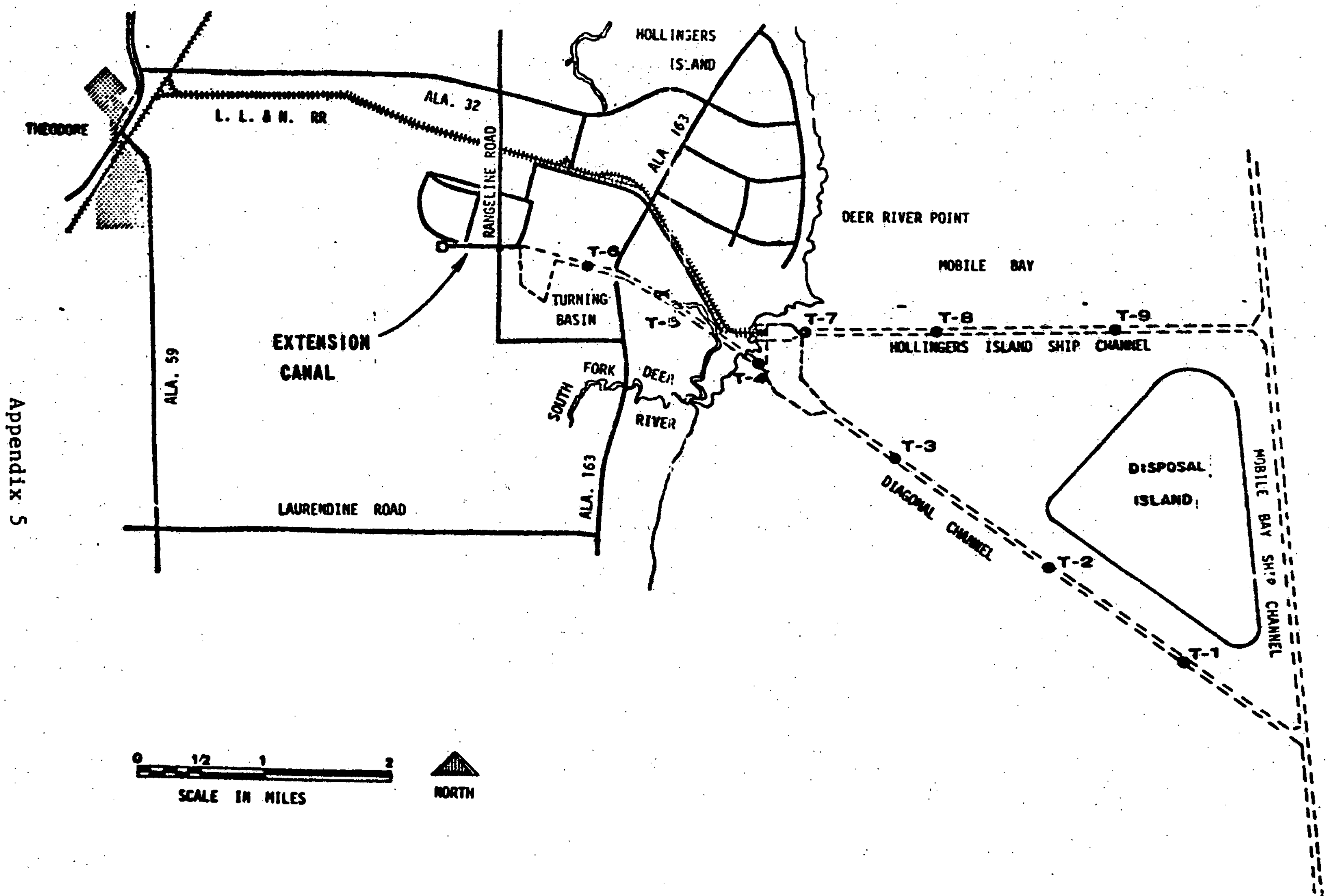

Figure 1 LOCATION OF STATIONS FOR SEDIMENT ANALYSIS, MOBILE BAY, ALABAMA

Table 8

CHEMICAL AND BIOLOGICAL ANALYSES OF SEDIMENTS IN PROJECT AREA

Sample	Total Kjeldahl Nitrogen mg/kg Wet Basis	Total Kjeldahl Nitrogen mg/kg Dry Basis	Total Phosphate mg/kg P Wet Basis	Total Phosphate mg/kg P Dry Basis	Oil and Grease mg/kg Wet Basis	Oil and Grease mg/kg Dry Basis	Volatile Solids %
T-1 Top	328.4	764.4	39.65	92.[illegible]	400	936	6.54
T-1 Middle	177.5	378.0	38.68	82.36	338	720	6.15
T-1 Bottom	11.9	25.2	36.39	76.90	13	27	24.75
T-2 Top	305.0	694.4	36.96	84.15	38	87	5.11
T-2 Middle	249.7	462.0	64.69	119.70	100	185	4.10
T-2 Bottom	159.3	218.4	120.61	165.33	20	27	4.33
T-3 Top	377.6	674.8	46.93	83.87	23	41	0.27
T-3 Middle	398.0	610.4	42.90	65.79	7	11	3.40
T-3 Bottom	98.3	126.0	41.30	52.95	38	49	1.98
T-4 Top	449.6	571.2	26.98	34.28	105	133	1.60
T-4 Middle	366.4	571.2	118.59	184.87	71	111	3.95
T-4 Bottom	263.7	352.8	35.72	47.79	68	91	6.37
T-5 Top	678.6	1,943.2	44.00	15.36	190	544	10.18
T-5 Middle	305.8	369.6	108.85	90.07	180	218	3.20
T-5 Bottom	429.1	694.4	136.51	84.36	37	60	5.42
T-6 Top	90.4	109.2	78.94	65.33	60	72	0.61
T-6 Middle	57.7	100.8	45.93	26.28	149	260	8.94
T-6 Bottom	44.8	81.2	90.55	49.97	161	292	20.15
T-7 Top	733.8	1,033.2	41.12	29.20	139	196	6.08
T-7 Middle	333.5	966.4	78.82	27.31	290	835	25.76
T-7 Bottom	56.3	109.2	41.68	21.49	201	390	3.93
T-8 Top	315.9	812.0	207.53	80.73	210	540	9.93
T-8 Middle	344.2	865.2	101.28	40.29	256	644	21.56
T-8 Bottom	115.5	277.2	91.20	37.99	203	487	14.50
T-9 Top	518.7	1,528.8	89.77	30.46	274	808	9.29
T-9 Middle	423.9	977.2	127.15	55.16	188	433	19.66
T-9 Bottom	660.7	1,495.2	71.15	31.44	244	552	30.33

Table 8 (Continued)

CHEMICAL AND BIOLOGICAL ANALYSES OF SEDIMENTS IN PROJECT AREA

Sample	Specific Gravity	Total Coliforms #org/g Wet Basis	Total Coliforms #org/g Dry Basis	Fecal Coliforms #org/g Wet Basis	Fecal Coliforms #org/g Dry Basis	C.O.D. mg/kg x 10^3 Wet Basis	C.O.D. mg/kg x 10^3 Dry Basis	T.O.C. mg/kg x 10^3 Wet Basis	T.O.C. mg/kg x 10^3 Dry Basis
T-1 Top	2.71	80	186	40	93	17.46	40.64	6.54	15.22
T-1 Middle	2.70					23.81	50.70	8.92	18.99
T-1 Bottom	2.67					25.40	53.68	9.51	20.10
T-2 Top	2.71	200	455	53	121	19.05	43.37	7.13	16.24
T-2 Middle	2.78					14.28	26.42	5.35	9.90
T-2 Bottom	2.73					6.35	8.70	2.38	3.26
T-3 Top	2.69	200	357	24	43	2.38	4.25	0.89	1.59
T-3 Middle	2.60					15.87	24.34	5.94	9.12
T-3 Bottom	2.65					19.05	24.43	7.13	9.15
T-4 Top	2.64	10,000	12,705	33	42	9.52	12.10	3.57	4.53
T-4 Middle	2.32					28.57	44.54	10.70	16.68
T-4 Bottom	2.76					7.94	10.62	2.64	3.98
T-5 Top	2.58	130	372	95	272	33.09	94.76	12.39	35.49
T-5 Middle	2.68					2.87	3.47	1.07	1.30
T-5 Bottom	2.65					23.31	37.72	8.73	14.13
T-6 Top	2.64	400	483	220	266	4.58	6.62	1.72	2.48
T-6 Middle	2.63					13.54	23.66	5.01	8.86
T-6 Bottom	2.60					19.05	34.52	7.13	12.93
T-7 Top	2.66	950	1,338	50	70	5.88	8.28	2.20	3.10
T-7 Middle	2.51					19.55	56.29	7.32	21.08
T-7 Bottom	2.70					15.04	29.18	5.63	10.93
T-8 Top	2.67	529	1,337	145	373	19.05	48.97	7.13	18.34
T-8 Middle	2.30					19.05	47.89	7.13	17.94
T-8 Bottom	2.67					21.06	50.55	7.89	18.93
T-9 Top	2.75	11,000	32,420	25	74	17.30	50.99	6.48	19.10
T-9 Middle	2.75					19.55	45.07	7.32	16.88
T-9 Bottom	2.77					25.40	57.48	9.51	21.53

Source: Gulf South Research Institute

Table 9

HEAVY METALS ANALYSES OF BOTTOM SEDIMENTS IN PROJECT AREA

Sample	Zn Weight % Dry Basis	Hg Weight % Dry Basis	As Weight % Dry Basis	Fe^{++} Weight % Dry Basis	Mn Weight % Dry Basis	Cd Weight % Dry Basis	Cu Weight % Dry Basis	Cr Weight % Dry Basis	Ni Weight % Dry Basis	Pb Weight % Dry Basis
T-1 Top	0.0118	0.000010	0.000119	0.0002	0.0359	0.0006	0.0007	0.0068	0.0028	0.0015
T-1 Middle	0.0111	0.000020	0.000154	0.0001	0.0206	0.0006	0.0007	0.0078	0.0025	0.0008
T-1 Bottom	0.0041	0.000015	0.000159	0.0001	0.0424	0.0006	0.0020	0.0014	0.0019	0.0013
T-2 Top	0.0045	0.000029	0.000107	0.0001	0.0497	0.0006	0.0002	0.0016	0.0017	0.0013
T-2 Middle	0.0028	0.000025	0.000111	0.0001	0.0255	0.0000	0.0018	0.0011	0.0011	0.0008
T-2 Bottom	0.0038	0.000004	0.000048	0.0001	0.0256	0.0000	0.0010	0.0010	0.0011	0.0007
T-3 Top	0.0013	0.000020	0.000067	0.0003	0.0162	0.0006	0.0003	0.0047	0.0013	0.0010
T-3 Middle	0.0027	0.000010	0.000133	0.0003	0.0149	0.0007	0.0011	0.0010	0.0099	0.0008
T-3 Bottom	0.0027	0.000000	0.000004	0.0012	0.0152	0.0006	0.0001	0.0019	0.0000	0.0004
T-4 Top	0.0015	0.000028	0.000024	0.0001	0.0423	0.0006	0.0010	0.0060	0.0004	0.0003
T-4 Middle	0.0011	0.000013	0.000109	0.0002	0.0139	0.0000	0.0007	0.0048	0.0015	0.0011
T-4 Bottom	0.0011	0.000000	0.000010	0.0001	0.0733	0.0006	0.0014	0.0007	0.0003	0.0008
T-5 Top	0.0043	0.000015	0.000070	0.0002	0.0112	0.0006	0.0018	0.0009	0.0009	0.0012
T-5 Middle	0.0049	0.000025	0.000000	0.0001	0.0373	0.0007	0.0001	0.0029	0.0004	0.0008
T-5 Bottom	0.0051	0.000020	0.000120	0.0001	0.0426	0.0006	0.0022	0.0015	0.0019	0.0014
T-6 Top	0.0017	0.000005	0.000103	0.0001	0.0159	0.0000	0.0002	0.0003	0.0000	0.0003
T-6 Middle	0.0050	0.000010	0.000138	0.0001	0.0302	0.0006	0.0021	0.0013	0.0015	0.0013
T-6 Bottom	0.0149	0.000005	0.000107	0.0001	0.0103	0.0006	0.0008	0.0085	0.0033	0.0015
T-7 Top	0.0155	0.000006	0.000021	0.0001	0.0149	0.0000	0.0003	0.0052	0.0008	0.0008
T-7 Middle	0.0064	0.000038	0.000135	0.0002	0.0315	0.0006	0.0025	0.0013	0.0012	0.0012
T-7 Bottom	0.0041	0.000025	0.000082	0.0064	0.0179	0.0000	0.0021	0.0011	0.0012	0.0010
T-8 Top	0.0097	0.000047	0.000130	0.0002	0.0587	0.0007	0.0026	0.0014	0.0017	0.0013
T-8 Middle	0.0085	0.000042	0.000175	0.0001	0.0695	0.0007	0.0029	0.0014	0.0015	0.0014
T-8 Bottom	0.0058	0.000030	0.000109	0.0001	0.0860	0.0006	0.0029	0.0012	0.0013	0.0018
T-9 Top	0.0092	0.000038	0.000159	0.0001	0.0822	0.0000	0.0031	0.0011	0.0014	0.0016
T-9 Middle	0.0203	0.000039	0.000120	0.0001	0.0694	0.0006	0.0010	0.0076	0.0018	0.0017

Source: Gulf South Research Institute

Table 10

PESTICIDE RESIDUES OF BOTTOM SEDIMENTS IN PROJECT AREA

Sample	Dieldrin ppb Wet Basis	Dieldrin ppb Dry Basis	DDD ppb Wet Basis	DDD ppb Dry Basis	DDE ppb Wet Basis	DDE ppb Dry Basis	DDT ppb Wet Basis	DDT ppb Dry Basis	AR 1254 ppb Wet Basis	AR 1254 ppb Dry Basis	Dicrotophos ppb Wet Basis	Dicrotophos ppb Dry Basis
T-1	1.900	4.222	N.D.	N.D.	1.467	3.667	N.D.	N.D.	12.667	31.667	N.D.	N.D.
T-2	1.800	3.857	N.D.	N.D.	1.600	3.429	N.D.	N.D.	16.000	34.286	N.D.	N.D.
T-3	1.800	3.375	N.D.	N.D.	<0.200	N.D.	N.D.	N.D.	<3.333	N.D.	N.D.	N.D.
T-4	1.600	2.000	N.D.	N.D.	0.733	0.917	N.D.	N.D.	12.667	15.833	N.D.	N.D.
T-5	1.400	4.200	N.D.	N.D.	0.400	1.000	N.D.	N.D.	11.467	34.400	0.840	1.120
T-6	0.933	1.167	N.D.	N.D.	<0.200	<0.250	N.D.	N.D.	<3.333	<4.167	N.D.	N.D.
T-7	1.067	1.455	N.D.	N.D.	<0.200	<0.273	N.D.	N.D.	<3.333	<4.545	N.D.	N.D.
T-8	0.733	1.833	10.933	27.333	7.533	18.833	0.600	1.500	20.667	51.667	N.D.	N.D.
T-9	0.933	2.800	16.467	49.400	0.084	16.800	0.933	N.D.	14.667	44.000	N.D.	N.D.

ND = None Detected

Source: Gulf South Research Institute

Table D-1

SAMPLING DATA FOR BOTTOM SEDIMENTS FROM NINE STATIONS LOCATED IN THE PROPOSED THEODORE SHIP CHANNEL, AND IN THE EXISTING HOLLINGERS ISLAND CHANNEL, MOBILE BAY, ALABAMA

SAMPLE	DATE	TIME	WATER DEPTH (FEET)	CORE LENGTH (FEET)	TOP (FEET)	MIDDLE (FEET)	BOTTOM (FEET)	PHYSICAL DESCRIPTION OF CORE
T-1	6/11/74	3:45 PM	11	13.33	0 - 3	5.0 - 8.0	10.0 - 13.0	Entire core is silty with some shell mixed in.
T-2	6/11/74	4:15 PM	11	15.00	0 - 3	6.0 - 9.0	12.0 - 15.0	Entire core is silty clay.
T-3	6/11/74	4:50 PM	11	13.25	0 - 3	5.0 - 8.0	10.0 - 13.0	0' - 1' is clayey silt; 1' - 11' is silty clay; 11' - 13' is fine sand.
T-4	6/11/74	5:20 PM	5.5	16.00	0 - 3	6.5 - 9.5	13.0 - 16.0	0' - 1.5' is sand; 1.5' - 11' is sandy clay; 11' - 16' is clay.
T-5	6/12/74	8:15 AM	14	14.50	0 - 3	5.75- 8.75	11.5 - 14.5	0' - 5' is silty clay ooze; 5' - 7' is sand with some clay; rest of core is solid grey hard clay with some sand.
T-6	6/12/74	8:40 AM	15	17.00	0 - 3	7.0 - 10	14.0 - 17.0	0' - 2' is sandy silt; 2' - 5' is brown sand; 5' - 17' is hard grey clay.
T-7	6/12/74	9:39 AM	16	14.00	0 - 3	5.5 - 8.5	11.0 - 14.0	0' - 2' is clay; 2' - 6' is soft black silt; 6' - 14' is black clay.
T-8	6/12/74	10:12 AM	11	13.00	0 - 3	5.0 - 8.0	10.0 - 13.0	0' - 4' is sandy silt; 4' - 7' is black soft sandy clay; 7' - 13' is black clay.
T-9	6/12/74	10:40 AM	11	15.50	0 - 3	6.25 - 9.25	12.5 - 15.5	0' - 3' is black soft silt; 3' - 15.5' is black clay.

TABLE D-2

PARTICLE SIZE AND DISTRIBUTION OF BOTTOM SEDIMENTS FROM THREE DEPTHS FROM NINE STATIONS IN THE PROPOSED THEODORE SHIP CHANNEL AND EXISTING HOLLINGERS ISLAND CHANNEL, MOBILE BAY, ALABAMA

SAMPLE	GRAIN SIZE ( )	% PASSING	SAMPLE	GRAIN SIZE ( )	% PASSING
T-1 Top	4,750	100.00	T-2 Top	4,750	100.00
	2,000	99.95		2,000	99.32
	850	99.89		850	98.89
	425	99.46		425	98.48
	250	97.83		250	98.19
	150	96.78		150	97.73
	75	94.52		75	96.52
	45	60.95		42	80.24
	32	56.34		30	75.73
	20	54.03		19	71.22
	12	52.08		11	64.46
	8	47.47		8	59.95
	6	42.86		5	57.70
	3	38.25		2	46.88
	1	29.49		1	40.12
T-1 Middle	4,750	100.00	T-2 Middle	4,750	100.00
	2,000	95.00		2,000	91.26
	850	94.84		850	89.91
	425	94.56		425	88.87
	250	94.32		250	87.20
	150	94.00		150	74.00
	75	93.33		75	65.03
	46	60.29		43	53.79
	32	60.29		31	50.27
	20	58.18		20	46.76
	12	53.96		11	45.00
	8	51.86		8	39.72
	6	47.64		5	37.97
	3	39.63		2	31.29
	1	33.30		1	26.01
T-1 Bottom	4,750	100.00	T-2 Bottom	4,750	100.00
	2,000	99.98		2,000	97.57
	850	99.97		850	96.96
	425	99.88		425	96.27
	250	99.45		250	94.88
	150	97.53		150	75.93
	75	94.34		75	48.36
	40	85.48		45	34.39
	30	81.25		32	31.70
	19	79.14		20	30.36
	11	71.00		8	29.01
	8	64.66		5	29.01
	5	60.43		2	23.91
	2	54.52		1	19.88
	1	50.29			

TABLE D-2 (cont'd)

PARTICLE SIZE AND DISTRIBUTION OF BOTTOM SEDIMENTS FROM THREE DEPTHS
FROM NINE STATIONS IN THE PROPOSED THEODORE SHIP CHANNEL
AND EXISTING HOLLINGERS ISLAND CHANNEL, MOBILE BAY, ALABAMA

SAMPLE	GRAIN SIZE ( )	% PASSING	SAMPLE	GRAIN SIZE ( )	% PASSING
T-3 Top	4,750	100.00	T-4 Top	4,750	100.00
	2,000	99.77		2,000	99.72
	850	99.74		850	99.17
	425	99.40		425	88.99
	250	96.77		250	57.09
	150	84.85		150	31.42
	75	63.75		75	19.49
	45	48.82		50	16.00
	32	43.52		36	12.19
	20	39.98		23	10.92
	12	34.67		13	8.38
	8	31.13		9	8.38
	6	29.36		6	8.38
	3	26.18		3	7.36
	1	19.10		1	4.95
T-3 Middle	4,750	100.00	T-4 Middle	4,750	100.00
	2,000	99.99		2,000	99.98
	850	99.95		850	99.97
	425	99.13		425	99.76
	250	94.07		250	98.93
	150	64.51		150	97.37
	75	44.78		75	94.34
	46	44.30		42	77.66
	33	41.51		30	72.75
	21	38.10		19	69.48
	12	33.46		11	64.57
	8	31.91		8	61.29
	6	28.81		6	56.96
	3	24.47		3	47.13
	1	21.37		1	44.68
T-3 Bottom	4,750	100.00	T-4 Bottom	4,750	100.00
	2,000	99.13		2,000	99.71
	850	98.90		850	99.70
	425	96.25		425	99.69
	250	80.45		250	97.95
	150	56.86		150	93.88
	75	46.41		75	83.28
	46	34.10		62	62.20
	33	31.45		36	58.27
	21	27.69		20	53.03
	12	23.84		14	50.40
	8	22.56		10	49.09
	6	20.00		4	43.00
	3	15.14		1	39.06
	1	13.64			

TABLE D-2 (cont'd)

PARTICLE SIZE AND DISTRIBUTION OF BOTTOM SEDIMENTS FROM THREE DEPTHS
FROM NINE STATIONS IN THE PROPOSED THEODORE SHIP CHANNEL
AND EXISTING HOLLINGERS ISLAND CHANNEL, MOBILE BAY, ALABAMA

SAMPLE	GRAIN SIZE ( )	% PASSING	SAMPLE	GRAIN SIZE ( )	% PASSING
T-5 Top	4,750	100.00	T-6 Top	4,750	100.00
	2,000	99.95		2,000	99.91
	850	99.91		850	97.18
	425	99.96		425	78.15
	250	97.79		250	41.76
	150	90.66		150	28.79
	75	81.18		75	26.44
	49	59.14		51	11.41
	34	59.14		36	9.00
	22	53.36		23	7.79
	12	50.47		13	7.79
	9	50.47		9	7.79
	6	44.68		6	5.55
	3	36.00		3	5.55
	1	29.79		1	4.04
T-5 Middle	4,750	100.00	T-6 Middle	4,750	100.00
	2,000	99.73		2,000	99.83
	850	99.62		850	99.78
	425	90.99		425	99.48
	250	77.59		250	98.20
	150	60.76		150	97.94
	75	50.19		75	97.92
	43	40.01		39	84.67
	31	37.62		28	81.47
	20	32.44		18	77.68
	11	30.44		10	72.43
	8	30.62		7	68.94
	5	28.23		5	65.71
	2	24.64		2	56.97
	1	20.87		1	49.72
T-5 Bottom	4,750	100.00	T-6 Bottom	4,750	100.00
	2,000	99.91		2,000	100.00
	850	99.88		850	99.96
	425	99.64		425	99.70
	250	98.80		250	98.86
	150	97.54		150	97.81
	75	95.33		75	95.30
	36	88.10		39	92.34
	26	84.87		28	86.86
	17	81.63		18	79.52
	10	76.77		11	74.03
	7	73.54		7	68.54
	5	68.93		5	65.16
	2	57.60		2	56.00
	1	49.11		1	46.30

TABLE D-2 (cont'd)

PARTICLE SIZE AND DISTRIBUTION OF BOTTOM SEDIMENTS FROM THREE DEPTHS FROM NINE STATIONS IN THE PROPOSED THEODORE SHIP CHANNEL AND EXISTING HOLLINGERS ISLAND CHANNEL, MOBILE BAY, ALABAMA

SAMPLE	GRAIN SIZE ( )	% PASSING	SAMPLE	GRAIN SIZE ( )	% PASSING
T-7 Top	4,750	100.00	T-8 Top	4,750	100.00
	2,000	100.00		2,000	99.99
	850	99.98		850	99.94
	425	99.81		425	99.55
	250	98.18		250	95.94
	150	95.32		150	89.88
	75	88.79		75	80.46
	36	78.07		32	77.37
	28	66.81		20	72.23
	18	61.17		12	67.09
	11	54.13		8	62.46
	7	50.12		6	57.32
	5	47.31		3	47.42
	2	38.86		1	39.71
	1	32.80			
T-7 Middle	4,750	100.00	T-8 Middle	4,750	100.00
	2,000	99.98		2,000	100.00
	850	99.98		850	99.99
	425	99.96		425	99.88
	250	99.87		250	98.82
	150	99.66		150	96.22
	75	98.71		75	90.72
	34	81.40		32	89.74
	21	78.44		20	87.10
	13	63.61		12	82.61
	9	45.82		8	74.69
	6	28.47		3	56.61
	3	19.57		1	45.79
	1	15.71			
T-7 Bottom	4,750	100.00	T-8 Bottom	4,750	100.00
	2,000	99.68		2,000	100.00
	850	99.42		850	99.97
	425	97.54		425	99.76
	250	87.18		250	98.23
	150	77.27		150	95.68
	75	72.57		75	91.70
	29	71.92		57	89.62
	19	68.08		35	87.27
	11	64.23		11	77.86
	8	58.47		9	68.45
	5	54.63		5	57.51
	2	46.95		2	52.81
	1	41.19		1	45.51

TABLE D-2 (cont'd)

PARTICLE SIZE AND DISTRIBUTION OF BOTTOM SEDIMENTS FROM THREE DEPTHS FROM NINE STATIONS IN THE PROPOSED THEODORE SHIP CHANNEL AND EXISTING HOLLINGERS ISLAND CHANNEL, MOBILE BAY, ALABAMA

SAMPLE	GRAIN SIZE ( )	% PASSING
T-9 Top	4,750	100.00
	2,000	100.00
	850	99.98
	425	99.87
	250	99.46
	150	98.48
	75	95.64
	30	95.60
	19	90.40
	11	75.96
	8	67.29
	6	61.52
	3	50.40
	1	44.62
T-9 Middle	4,750	100.00
	2,000	100.00
	850	99.97
	425	99.89
	250	99.31
	150	98.13
	75	95.34
	40	91.04
	29	88.78
	18	82.00
	11	75.22
	8	68.45
	5	63.93
	2	52.26
	1	43.93
T-9 Bottom	4,750	100.00
	2,000	100.00
	850	100.00
	425	99.95
	250	98.74
	150	98.61
	75	97.96
	40	93.80
	39	89.37
	29	84.89
	19	78.28
	7	71.63
	5	64.97
	2	54.22
	1	45.35

Source: Gulf South Research Institute

ATTACHMENT B-2

THREATENED FISH AND WILDLIFE

MOBILE BAY
U.S. ENDANGERED AND THREATENED SPECIES

Indiana bat 1/
Eastern cougar
Florida panther
Mississippi sandhill crane
Blue whale 2/
Finback whale
Humpback whale
Sperm whale
Southern bald eagle
American peregrine falcon
Arctic peregrine falcon
Brown pelican
Bachman's warbler
Ivorybilled woodpecker
Red-cockaded woodpecker
American alligator
Atlantic Ridley sea turtle
Hawksbill sea turtle
Leather back sea turtle

1/ Collected in area but habitat unavailable
2/ Gulf record is suspect

ENDANGERED AND THREATENED PLANTS AND ANIMALS OF ALABAMA 1/

ENDANGERED FISH

Alabama shovelnose sturgeon

THREATENED

Atlantic sturgeon
Blue sucker
Crystal darter
Freckled darter

SPECIAL CONCERN

Pygmy killifish

AMPHIBIAN AND REPTILES

ENDANGERED

Flatwoods salamander
Eastern indigo snake (probably extinct in Alabama)
Black pine snake
Florida pine snake
Atlantic loggerhead turtle
Green sea turtle

THREATENED

Dusky gopher frog
Alabama red-bellied urtle
Gopher turtle

SPECIAL CONCERN

River frog
Greater siren
Pine woods snake
Florida green water snake
Florida softshell turtle

1/ Species listed on Federal list are not duplicated.

BIRDS

ENDANGERED

Golden eagle
Osprey
Snowy plover

THREATENED

Reddish egret
Mottled duck

SPECIAL CONCERN

Little blue heron
Black-crowned night heron
Wood stork
Swallow-tailed kite
Cooper's hawk
Red-shouldered hawk
Merlin
Sandhill crane
Black rail
American oyster catcher
Swainson's warbler

ENDANGERED

Rhynchospora crinipes Gale
Lilium eridollae M. G. Henry
Epidendrum conopseum R. Br.
Ilex amelanchier M. A. Curtis
Psoralea simplex Nutt.
Oenothera grandiflora Ait.

THREATENED

Canna flaccida Salisb.
Cleistes divaricata (L) Ames
Xyris drummondii Malme.
Coreopsis gladiata Walter
Warea sessilifolia Nash
Sabatia brevifolia Raf.
Hypericum nitidum Lam.
Ludwigia arcuata Walter
Sageretia minutifolia (Michx.) Trel.
Sarracenia psittacina Michx.
Gordonia lasianthus (L) Ellis
Momisia iguanea (L) Rose and Standley

SPECIAL CONCERN

Lycopodium cernuum L.
Lycopodium flabelliforme (Feon.) Blanchard
Ophroglossum crotalophorioides Walt.
Chamaecyparis thyoides (L.) BSP
Eriocaulon lineare Small
E. texense Korn.
Pleea tenuifolia Michx.
Habenaria integra (Nutt.) Spreng.
Manisuris tuberculosa Nash
Liatris chapmanii (T & G) Kuntze
Cleome teniufolia Le Conte ex T. and G.
Clethra alnifolia var. alnifolia L.
Kalmia hirsuta Walt.
Rhododendron atlanticum (Ashe) Rehder
Quercus pumila Walt.
Eustoma exaltatum (L.) Griseb.
Sabatia foliosa Fernald
Hypericum reductum (Svenson) Adams
Pinguicula planifolia Chapm.
Pinquicula primulifolia Wood and Godfrey
Agalinus pseudophylla (Fennell) Shinners
Penstemon multiflorus Chapm.

SECTION C

PROBLEMS AND NEEDS

PROBLEMS AND NEEDS

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SECTION C

PROBLEMS AND NEEDS

1. Mobile Bay has played a prominent role in the history and growth and economic development of the study region. This estuary serves the residents of the region in a variety of ways. It is used for navigation and port facilities. Sport and commercial fishing and recreational boating are also important uses of Mobile Bay. The developed lands adjacent to the bay and the lower Mobile River and its tributaries serve as the location for valuable industrial sites. The bay, through its natural function and the design of man, also serves as a repository for municipal and industrial effluents and urban and industrial runoff. As growth and economic development continue, these competing uses of the estuarine water resource will cause ever-increasing stresses on the bay's environment. Effective water resources planning must delineate these competing economic and environmental uses of the bay, assess the demands and needs on this water resource, and formulate plans which will, to the maximum extent feasible, protect the natural qualities of the bay while responding to the problems and needs. The purpose of this section of the report is to present the water and related land resource problems and needs which should be considered further in planning for the future use of the bay estuarine system.

PUBLIC CONCERNS

2. A public meeting was held at Mobile, Alabama, on 25 April 1967 to afford local interests an opportunity to express their desires and to present their views and opinions regarding the advisability and justification for Federal participation in the improvements of navigation facilities for Mobile Harbor. The meeting was attended by 72 persons representing Federal, State, county, and local government agencies and other civic bodies, navigation interests, industry and local interests concerned with port development.

3. Proponents at the public meeting requested that the Federal project for Mobile Harbor be modified to include adoption and enlargement of the existing Theodore Channel to provide a channel 40 feet deep and 300 feet wide, and that such channel be extended by land cut into a turning basin with the Theodore Industrial Park. Local interests further requested that the turning basin opposite Magazine Point in Mobile River be enlarged and that an anchorage basin of sufficient size to accommodate 12 large oceangoing vessels be provided near the mouth of Mobile River. Local interests also requested the Corps of Engineers initiate such studies as may be necessary to determine the engineering and economic feasibility of providing a 50-foot depth in the Mobile Harbor channels. No opposition was expressed to improvement of the harbor; however, a request was made that all possible steps be taken to minimize adverse effects of dredged material disposal on fish and wildlife.

4. A second public meeting was held at Mobile, Alabama, on 22 November 1976 with over 140 persons in attendance. Alternative plans were presented for the disposal of dredged material, both for the new work and maintenance material which would result from the implementation of any channel improvement. All alternatives considered at this stage of the planning process were related to a 50-foot deep-draft channel with commensurate widths, anchorage basins, turning areas, and auxiliary barge and access channels. State officials, representatives of shipping interests, and local citizens either spoke or wrote letters in favor of the considered plans. Few of these speakers addressed their comments to the purpose of the meeting which was the discussion of proposed alternatives for deposition of dredged material. The majority of persons either ignored the question altogether or left the selection decision to the Corps of Engineers and directed their remarks to the economic necessity of expediting the improvement. Those who did address the topic endorsed the Brookley Expansion and Island Plan as the most desirable alternative.

5. **Several Federal and State agencies, environmental groups, and local citizens spoke or wrote letters expressing concern regarding, or opposition to, the development or certain dredged material disposal alternatives. Concerns** included the necessity or desirability of deepening Mobile Ship Channel, the potential environmental degradation of the bay and environs and the possibility of invalidating the Mobile 208 studies being conducted to determine the optimum location of waste discharge points within the bay. The Environmental Protection Agency, in general, sums up the views of those opposed. This agency prefers that the dredged material be transported to an approved disposal site in the Gulf of Mexico. It also states that open water disposal in the bay from both new work and maintenance dredging should be discontinued and that **island development** and navigational channel improvements should be supported by data generated not only from a mathematical model but also from the existing physical bay model.

EXISTING NAVIGATION PROBLEMS

6. Channel Constraints. The existing 40- by 400-foot navigation channel into Mobile Bay presents constraints to the movement of commerce into Mobile Harbor and the use of larger, more economical vessels in this commerce. The Mobile River Channel above the Bankhead and I-10 highway Tunnels is limited to 40 feet deep due to top elevations of these tunnels. Currently, liquid and dry bulk carriers with dead weight tonnage ranging **above** 80,000 tons, with widths in excess of 100 feet, with lengths in the order of 800 feet, and fully loaded drafts up to 43 feet are calling at Mobile Harbor. Because of the limiting channel depth of 40 feet these large ships are calling at Mobile Harbor lightloaded with concomitantly increased transportation costs. There are also navigation problems associated with the channel widths, especially in the vicinity of the McDuffie Island Coal Terminal. Since the construction and subsequent operation of this terminal, ships traversing this reach of the Mobile Ship Channel have had controllability problems. As ships approach McDuffie Island from the south, the bay waters become increasingly

shallow, hydraulic pressures which build up against the sides of the ships are equal until the ships reach the Arlington Channel. Due to this opening on the west side of the channel, the hydraulic pressures become unbalanced, causing difficulties in properly steering the ship. Steering problems are again encountered when ships pass the berthing area of the McDuffie Island Coal Terminal. The ship channel widens to the east immediately north of the terminal, and the hydraulic pressures are again unbalanced, creating further steering problems. The Harbor Master for the Port of Mobile has issued an advisory to the Mobile Bar Pilots Association suggesting that in the case of medium to large ships, one-way traffic be maintained in this congested reach of the channel. This practice is currently being followed. Outbound ships do not encounter steering difficulties to the same extent as incoming vessels because the hydraulic pressures tend to diminish as the ships move south of McDuffie Island toward the deeper waters of the open bay. However, these outbound ships do encounter navigation difficulties in that they are moving from a 700-foot-wide channel at the mouth of Mobile River to a 400-foot-wide channel in Mobile Bay through the vicinity of the McDuffie Island Terminal. The problem is further compounded by the turn from the river channel into the bay channel, and the vessels docked at the Coal Terminal, which flanks the west side of the channel, also create an unsafe condition.

7. Turning Basin Problems. The existing project for Mobile Harbor provides a turning basin 40 feet deep, 2,500 feet long and 800 to 1,000 feet wide opposite Alabama State Docks; a turning basin opposite Three-mile Creek, recently enlarged, under the authority of Section 5 of the River and Harbor Act approved 4 March 1915, to dimensions of 40 feet deep, 1,000 feet wide, and 1,600 feet long, and a turning basin 800 feet long and 600 feet wide opposite the old Brookley Air Force Base ocean terminal at the western terminus of the Arlington Channel. The two turning basins in Mobile River are used continually. The turning basin at the end of the Arlington Channel has not been used regularly since World War II when the Arlington Channel was used for deep-draft

navigation. At the presnt time there is need for a turning basin in the vicinity of the McDuffie Island Coal Terminal. The Alabama State Docks Department, when constructing the McDuffie Island Coal Terminal, dredged a turning basin on the east side of the channel near the northeast portion of Little Sand Island. The dimensions of this turning basin are approximately 27 feet deep, 800 feet long and 600 feet wide. The basin is adequate to turn light-loaded small vessels using the McDuffie Island Coal Terminal. However, the larger ships using the McDuffie Island Coal Terminal must use the turning basin 2 miles up river opposite the Alabama State Docks. This requires delays and excessive maneuvering and expenses for the larger vessels.

8. Anchorage Problems. At the present time, vessels are not permitted to anchor in the Mobile Bay Channel, the Mobile River Channel, nor the Entrance Bar Channel. An authorized anchorage area 32 feet deep, 100 feet wide, and 2,000 feet long on the west side of the Mobile Bay Channel adjacent to McDuffie Island has been abandoned for several years to facilitate access to adjacent terminal berths. The use of this area for an anchorage is precluded by the industrial use of McDuffie Island and the dock areas along this reach of the channel. Vessels calling at the Port of Mobile must wait their turn for their designated berth, at the terminal not in use or anchor in the Gulf of Mexico, south of and between the Mobile Entrance Safety Fairways. The lack of in-port anchorage areas prevents efficient utilization of the terminals' and hampers' overall port operations. This deficiency creates particular problems for the vessels awaiting berthing space at the liquid, dry bulk, or container terminals, that are too large to utilize unoccupied general cargo berths. General cargo vessels do not experience this problem at the present time since there is generally adequate berthing space available. At present, liquid and dry bulk terminals are operating at near capacity, making the future need for rapid movement of vessels through their berths more crucial. The problem is further compounded when foggy or inclement weather conditions prevent ships anchored in the gulf from coming into the harbor as soon as berthing space becomes available. An additional

factor is the need for an anchorage as a matter of safety. There is currently no place in Mobile Harbor, away from terminal facilities, to anchor a ship that is broken down, or that presents a potential hazard or safety problem.

9. Barge Marshaling Problems. There are three main barge marshaling areas in Mobile Harbor at the present time. Southern Marine Service, Inc., maintains a marshaling area for approximately 90-100 barges on the east bank of the Mobile River just north of the Cochrane Bridge. Federal Barge Lines maintains a marshaling area opposite the Alabama State Docks grain elevator with a capacity for about 45-50 barges. There is also a barge marshaling area on the western side of the McDuffie Island Coal Handling Facility. The area has a capacity of about 40-50 barges. The two marshaling areas in the Mobile River are barely adequate to handle barge marshaling needs in that section of the port. The marshaling area at McDuffie Island must handle both loaded and unloaded barges. The area is presently estimated to be adequate for loaded barges while an area of equivalent size is estimated to be needed for the marshaling and fleeting of empty barges.

10. Disposal of Dredged Material. The current practice for disposal of dredged maintenance material from Mobile River is in diked disposal areas. Maintenance material from the Mobile Bay Channel is deposited in open water disposal areas along the channel within Mobile Bay. Due to environmental objections to the use of wetland sites and due to industrial development, the areas for use as dredged material disposal sites are severely constrained. In conjunction with the nationwide Dredged Material Research Program being conducted by the U.S. Army Engineer Waterways Experiment Station at Vicksburg, the Mobile District and the Dredged Material Research Program are conducting a cooperative study to develop specific dewatering alternatives to extend the life of existing disposal sites along the Mobile River. Considering these efforts, the maximum useful life expectancy of the available dredged material disposal areas, including Pinto Pass, is only about 16 years. Environmental objections to the use of

Pinto Pass are still being considered. Accordingly, there is a pressing need for a long range disposal plan for dredged maintenance material from the Mobile River.

11. Dredged material from initial excavation of the Theodore Shop Channel, which is presently under construction, will be utilized to construct an island approximately 1300 acres in size that will contain future maintenance. The capacity of the island is estimated to be adequate for containment of all future maintenance from the authorized ship channel.

TERMINAL PROBLEMS

12. Public Terminals. The Alabama State Docks Department operates 26 general cargo terminals and three bulk terminals at the present time. The terminals are all located on the Mobile River, with the exception of the McDuffie Island Coal Terminal which is located on the Mobile Ship Channel just south of the mouth of the Mobile River. The general cargo terminals occupy 6000 feet of deep-water frontage on the west bank of Mobile River, beginning at the Bankhead Tunnel and extending to the Ideal Cement Company wharf, immediately north of Pier D. A total of 14,000 feet of deep-water berthing space for general cargo operations is available along the 26 berths. The public grain terminal is located on Alabama State Docks property immediately north of Pier C. The public grain terminal has 3 ships berths and a 2.5 million bushel storage capacity. The estimated annual throughput capacity of the grain terminal is about 2.5 million short tons per year. The Alabama State Docks Department recently signed a $5.8 million contract to upgrade facilities at the grain elevator. This represents part of a scheduled $6.5 million expansion program. This improvement will include the construction of a new truck dump and scales, a 40,000 bushel per hour elevator leg, a 40,000 bushel per hour grain cleaning system, and a digital weighing system. Combined, they will give the elevator an annual throughput capacity of over 3.5 million tons. Throughput has and is expected to keep up

with expanding capacity. Other completed improvements include a dust control system ($1.0 million), a leg scale conveyor (1.9 million), a new pit for unloading rail cars ($0.2 million), and a belt system extending from the barge unloading dock to the headhouse ($0.4 million), for a total of $3.6 million. Since 1975, total expenditures for upgrading facilities at the grain elevator have amounted to $16.0 million. The Alabama State Docks Bulk Ore Material Handling Plant, commonly referred to as "The Tipple" is located on Mobile River and on the south side of the mouth of Threemile Creek. This terminal has 13 acres of dry bulk storage with two ship berths. The annual throughput capacity of this terminal is estimated to be about 5.0 million short tons per year. The Alabama State Docks has under construction, at a cost of $3.1 million, an expansion which will increase one of the unloading facilities to 1500 tons-per hour. Other improvements that have been completed include an upgrading of the structure and conveyor system ($2.9 million), rebuilt docks ($2.7 million), an upgrading of the power system ($.3 million), and unloading towers ($.9 million), installation of dust control system ($1.1 million), construction of new pile walls ($.3 million), extension of the conveyor system, construction of new storage facilities ($1.5 million). Total expenditures for this facility since 1970 total $12.8 million. The McDuffie Island Coal Terminal, located south of the Bankhead and Interstate 10 Tunnels, will upon completon of facilities under construction, contain 1 ship berth and 70 acres of storage space. The facility is served by both barge and rail transportation. The annual throughput capacity of this coal terminal is estimated to be about 10.2 million short tons. The Alabama State Docks Department is committed to provide a public, deep-draft bulk terminal in conjunction with the construction of the authorized 40-foot deep-draft channel into the Theodore Industrial Complex. This is to be a public deep-draft bulk terminal at the turning basin to accommodate the loading and unloading of liquid cargo and storage for products such as inbound crude oil, outbound petroleum products and other liquid bulk commodities that might be shipped through Theodore by tankers.

13. Private Terminals. There are 14 private general cargo, bulk, and miscellaneous type terminals, located along the Mobile River area, that handle cargo moving inbound and outbound by deep-draft vessels. There is also one terminal with 6 ship berths located in the Port of Chickasaw for the movement of general cargo. The major bulk terminals include those belonging to the Amerada-Hess Oil Corp., Citmoco Service, Inc., Chevron Asphalt Company, the Mobile Bulk Terminal, Inc., and the Marine Bulk Handling Plant.

14. General Limitations. The problems that exist in the port facilities are manifold and complex. General cargo facilities are adequate in size and number to handle current and expected volumes. However, the general cargo terminals are in need of substantial renovation and repairs. At the present time, the liquid bulk terminals are adequate to supply the needs of existing companies engaged in the water transportation of petroleum and other miscellaneous liquids. The grain elevator modernization program discussed earlier will keep pace with the increased volume of grain passing through the port in recent years. There is still a need for additional ship berths and storage to meet the demand during the grain season. Ships currently are experiencing waiting times from 15 days to over a month because of congestion at this facility. Long-range plans by the State Dock to further expand facilities are being developed. The dry bulk handling plant at Threemile Creek (The Tipple) is also inadequate because of lack of storage space, number of berths, and inefficient handling facilities for loading and unloading vessels. This facility is old and necessary renovation and operation costs are high. Here too, improvements have been made to update antiquated facilities or maintain present capabilities rather than provide extensive new capabilities. The McDuffie Island Coal Terminal went into operation in May 1975. This facility is currently undergoing a major modification to double its storage capacity. Due to the world-wide energey situation and the unprecedented demand for coal, continued expansion is likely. Adequate area exists on McDuffie Island for substantial expansion of the facility.

15. There is no established Port Authority with overall regulatory authority for Mobile Harbor. Regulation of port operations is presently exercised by the harbor Master, an official of the Alabama State Docks Department and the U. S. Coast Guard. The Alabama State Docks Department presently operates the massive public docks as an arm of the State and has assumed a planning role for future public port needs. However, the department does not have legislative authority to control private developments, land uses, or enforce any comprehensive port utilization and development plan, or overall port operation.

EXISTING ENVIRONMENTAL PROBLEMS

16. Environmental problems and concerns can be classified into two major categories, those over which man has little or no influence, and those which are directly or indirectly caused by man's social and economic activities. In this study of navigation improvements to Mobile Harbor, the dominant area of environmental concern is the estuarine system comprised of Mobile Bay, the Mobile Delta and its various tributaries. Several natural processes are occurring which affect the environmental quality of Mobile Bay. In addition, man's activities have altered the natural processes and contributed to the environmental problems.

17. Natural Processes. The most significant natural process that is occurring in Mobile Bay is the natural sedimentation and filling of Mobile Bay. The inflow of sediment (4.7 million tons) to the headwaters of the bay is greater than that which flows out (1.4 million tons) of the bay to the Mississippi Sound and to the Gulf of Mexico. Based on bathymetry in 1847-1851 and 1960-1962, it was estimated that an average shoaling rate of 1.7 feet per century occurs in Mobile Bay. The natural process of Mobile Bay, on a geologic time scale, is the gradual southerly

movement of the delta, the gradual filling of the bay, and the changing of the character of the open bay to a region of coastal marshes laced with rivers and bayous. However, the short term effects are the gradually diminishing of bay depths and the creation of a high level of natural turbidity. The environmental consequences of the shoaling of Mobile Bay are generally adverse. From an esthetic, overall fishery and recreational boating point of view, the consequences are detrimental. Although the overall primary productivity would be increased by additional wetlands and marshes, the estuary's nursery value would be reduced. The remaining offshore fishery **could be reduced.**

18. Another natural process occurring on Mobile Bay is that of shoreline erosion. The erosion rates around the bay range from almost none up to 10 feet per year. Under normal weather conditions, erosion is usually not severe. However, during the tropical disturbances, erosion rates are greatly accelerated, resulting in severe erosion for much of the bay's shoreline.

19. Water Quality. The South Alabama Regional Planning Commission is preparing a regional waste water management plan for Mobile and Baldwin Counties under Section 208 of the Federal Water Pollution Control Act Amendments of 1972, P.L. 92-500. In defining the 208 planning process strategy, a detailed investigation of existing water quality problems was excerpted from the document entitled "Mobile and Baldwin Counties 208 Planning Process Strategy, Refined Technical Supplement" dated 17 Feb 1976. The water quality problems were identified by comparing existing water quality to standards prepared by the Alabama Water Improvement Commission.

20. Water quality data indicate violations of water quality standards for several parameters in the lower segment of Mobile River and the upper part of Mobile Bay. Dissolved oxygen, biochemical oxygen demand, and coliform bacteria are the most numerous violations. Some heavy metals (zinc and lead) and nitrate and phosphate also occassionally exceed the

standards. Eutrophication is visible in the upper part of Mobile Bay along the causeway. This condition is attributed partly to lack of circulation and flushing capacity, and the numerous semi-public and private package treatment facilities discharging in this segment of the bay. Conditions in portions of Chickasaw Creek and Threemile Creek are such that exceptions to the standards for dissolved oxygen have been made. Conditions in the upper part of Mobile Bay are such that it is permanently closed to shell fishing, but is classified for swimming.

21. Non-point source discharges have been recognized as having a significantly adverse impact on water quality. Non-point source discharges include urban storm water runoff, lagoon seepage, septic tank seepage, landfills and dumps, agricultural runoff, and silviculture. The South Alabama Regional Planning Commission has calculated that all non-point pollutants would have to be reduced by about 25 percent just to maintain existing (1976) water quality levels by the year 2000. In Mobile County, a concrete open channel drainage system has been adopted for control of flooding. Severe sedimentation has occurred as a result of this practice in several areas. Septic tanks have been a significant concern because of the topography and poor percolative quality of the soils. This is especially true in the southern parts of both counties where the major impact of the seasonal population is felt.

22. Physical Alterations of Mobile Bay. The alteration of Mobile Bay by man has also created environmental problems within the bay. The construction of the causeway across the northern bay and delta introduced a barrier to the free water exchange between the bay waters and the delta. As the causeway was developed, pollutants were introduced to the upper part of the estuary by the various commercial enterprises which line it. The construction of the solid fill causeway between the mainland and McDuffie Island in 1954 significantly reduced the flow and circulation in the Garrow's Bend area. This blockage and the excessive pollutant inflows seriously reduced the water quality in the area. However, significant improvement in water quality has resulted from the upgrading of the

McDuffie Island Sewage Treatment Plant and elimination of discharges of untreated industrial wastes. The construction, enlargement, and operation and maintenance of the Mobile Ship Channel over the last 150 years have also created alterations within Mobile Bay. During construction of the channel, new work and subsequent maintenance operation, materials have been deposited along both sides of the ship channel. In the northwestern portion of Mobile Bay, the new work material has formed underwater ridges parallel to the channel. This action has been assumed to have reduced the normal circulation in the upper bay and to have contributed to the dissolved oxygen deficits that occur naturally in the bay's bottom waters. This cumulative buildup alongside the channel tends to diminish gradually in the southerly direction until the ridge becomes insignificant in lower Mobile Bay.

23. The construction of the ship channel has also allowed the more saline Gulf of Mexico waters to extend further into Mobile Bay. This had tended to increase the salinities over a portion of the bay. In addition, the annual maintenance of the Mobile Ship Channel by hydraulic dredging creates additional turbidity within the bay and causes periodic disruptions to the aquatic and benthic environments of the bay.

24. Another environmental problem in the Mobile Bay estuarine zone is the continued pressure to develop the shoreline for industrial, port, commercial and private recreation, and home sites. These economic and social developmental pressures have resulted in the filling of shoreline, the conversion of wetlands to other uses and have meant a diminished supply of nutrients vital to the estuarine system. Since inception of the Mobile Harbor project, 1,287 acres of marsh and bottomlands adjacent to Blakeley and Pinto Islands have been filled. McDuffie Island and Little Sand Island were also formed by deposition of dredged material utilizing an additional 485 acres of marsh and bottomlands. Private development has removed additional area. Pollution has restricted the commercial use of several oyster beds in the bay while in other areas historically productive beds are frequently closed at the peak of the

harvest season. Modification of the bay's bottom has resulted in changes of benthic organisms within navigation channels. A large area of the bay bottom is used for the periodic deposition of dredged material from the main ship channel. The bay bottom is also a source for the mining of oyster shells. One dredge works in Mobile Bay on a continual basis and mines these shells for construction purposes. These stresses, when working alone, appear to have little effect on the ecology of the bay. However, when working together, comprise a serious area of concern for the bay's general environment and estuarine zone.

PROJECTED NAVIGATION NEEDS

25. The projected navigation needs for Mobile Harbor are related to the movement of liquid and dry bulk cargoes. Movements of general cargo and container cargo are not constrained by current channel dimensions and navigation facilities. However, existing and projected movements of liquid and dry bulk commodities are restricted by the present channel dimensions to smaller less efficient ships than would otherwise be available to the shipping industry. A discussion of the commodities that would benefit from increased channel depths is given below.

DRY BULK COMMODITIES

26. **Eight commodities which move through the Port of Mobile are** defined as dry bulk commerce. Those commodities moving through the port in 1975 which would not have benefited from a deeper channel include: bauxite, coke, ferro-phosphorous, scrap iron, and other miscellaneous commodities. New commerce which will be generated by the Tennessee-Tombigbee Waterway and the 40-foot Theodore project, but which will not benefit from **additional channel deepening** , includes: alumina, scrap

iron, ferro-silicon, copper ore, ferro alloys, manganese ore and steel billets. With the inclusion of 2 commodities which would benefit by the channel improvement project, namely coal **and iron ore, a total of** 14 dry bulk commodities will be moving through the port in the near future.

27. By 1986 it is expected that the total volume of dry bulk commerce alone for the port, including Theodore, will total 37.2 million tons.

28. Coal movements are projected to increase from **2,745,000** tons in 1975 to **20,555,000** tons by the year 2000. These movements are primarily export. There is some import of low sulfur coal for use in power plants in the region. Considering port limitations in foreign countries and that which would continue to move through the Panama Canal in small ships, movements of export coal that would benefit from deeper channels are projected to increase from **1,694,000** tons in 1975 to **12,838,000** tons in 2044. Iron ore shipments are projected to increase from 4,781,000 tons in 1975 to 10,475,000 tons in 2044. Of these total movements, it is estimated that 3,411,000 tons could have benefited from enlarged channels in 1975 and the projected tonnage that would benefit from enlarged channels in 2044 is estimated to be 7,473,000 tons. Total grain movements in

29. For analytical estimating purposes it is assumed that ships would maintain four feet of clearance over the channel bottom and would light-load up to five feet. Based on these criteria, dry bulk carriers that could use the 40-foot channel at Mobile Harbor would be limited to the 56,000 dead weight tons (DWT) class (light-loaded). This excludes 47% of the cargo tonnage capability of the world fleet from using the

existing Mobile Ship Channel. Deepening the channel to 45 feet would increase the size of ship that could use the channel to 81,000 DWT; to 50 feet, 110,000 DWT; to 55 feet, 144,000 DWT; and to 60 feet, 182,000 DWT.

LIQUID BULK COMMODITIES

30. The bulk liquid products that move through the port in deep-draft tankers are: crude oil, gasoline, and distillate and residual fuel oils. The crude oil is moving outbound and the refined petroleum products are moving inbound. The total volume of petroleum that moved through the port in 1975 was 2,701,000 tons, crude oil accounted for 2,409,000 tons. With the completion of the 40-foot channel at Theodore in 1982, an additional volume of petroleum will be generated for the port. This will include 9,595,000 tons of crude oil and 910,000 tons of refined petroleum products. Crude oil will be imported and the refined petroleum products will be outbound. By 1986 the total volume of petroleum for the port, including crude oil, will be 16,298,000 tons. The only liquid bulk products that would benefit by the channel improvement project would be the 9,595,000 tons of crude oil imported into Theodore. The movements of refined petroleum products and crude oil presently moving through Mobile Harbor are expected to increase to 10,770,000 tons by 2044. The refined petroleum and crude oil expected to move through Theodore will increase to 3,404,000 tons and 11,564,000 tons respectively, by the year 2044.

31. Assuming reasonable economies, proper safety, and operating clearances, ships using the ship channels must have 4 feet of clearance and can be light-loaded up to 5 feet. Based on these criteria, tankers of 57,000 DWT (light-loaded) are the maximum size that can use the 40-foot ship channel. This size limitation excludes 74% of the tonnage carrying capability of the world fleet of liquid bulk carriers. Deepening the channel to 45 feet would allow 83,000 DWT ships (light-loaded) to use the channel; to 50 feet, 114,000 DWT; to 55 feet, 149,000 DWT; and to 60 feet, 190,000 DWT vessels.

CHANNELS WIDTHS

32. Channel widths in the Mobile Ship Channel are presently inadequate, especially in the congested upper 3.5 mile reach of the bay channel where inconsistancies in the water prism create steerage problems. If the channel is deepened without increasing the width this situation would be worsened, since larger ships would be using the channel. Minimum channel width needs based on given traffic conditions can be established on the basis of waterway conditions and dimensions of typical vessels that would use a deeper channel. The most appropriate need or level for development is determined through analyses and trade offs of benefits, costs, safety, operating efficiency and environmental impacts. These analyses are addressed in subsequent sections of this report.

TURNING BASIN AND ANCHORAGE NEEDS

33. The obstruction of the Bankhead and I-10 Tunnels across Mobile River prohibit deepening of the ship channel beyond its present depth above their crossing. Therefore future bulk terminals utilizing the larger ships will, in all probability, be located south of the tunnels. At the present time there are no defined turning basins in the lower river. The development and growth in capacity of the Coal Handling Terminal on McDuffie Island accentuate the need for a turning basin in the lower river vicinity. The projected use of McDuffie Island by the Alabama State Docks Department for expansion of the coal facility and for other deep-draft dry bulk terminal uses makes the provision of a turning basin in this area to accommodate very large ships imperative for practical and efficient port operation. The Port of Mobile is presently without a defined intraharbor anchorage area. Vessels awaiting berths must lie at anchor in the Gulf of Mexico approximately 40 miles away from most berths. Not only are vessels inconvenienced and exposed to adverse weather, but they are also delayed in moving to berths following the departure of the preceding vessel. The need for an anchorage area for Mobile Harbor will also increase in the future as traffic increases. The

anchorage area should accommodate at least three vessels in order to facilitate efficient turn around at the coal, ore, and grain terminals, which by their design can accommodate limited numbers of vessels at a given time. An anchorage area is also needed to provide a waiting place for vessels using other port facilities and to provide an area where disabled ships, or ships in imminent danger, would have a safe place to anchor. This facility is also considered an essential need for overall port operating efficiency.

COMMODITY PROJECTIONS

34. The need for navigation channels and port facilities for Mobile Harbor is accentuated by a study of area economic projections of future commodity movements. Especially taxing demands will be made of the port upon estimated completion of the Tennessee-Tombigbee Waterway in 1986. Present and projected deep-draft commodity movements for Mobile Harbor and Theodore are shown in table C-1. The projected tonnage movements reflect unconstrained economic demands for commodities that would move through existing industries and terminals at Mobile Harbor.

TABLE C-1

ANNUAL VOLUME OF COMMERCE MOVING IN DEEP-DRAFT VESSELS THROUGH

THE PORTS OF MOBILE AND THEODORE

Tonnage (expressed in 1,000 short tons)

	Port		
Year	Mobile	Theodore	Total
1975	16,679		16,679
1978	29,218	11,476	40,694
1986	37,984	14,364	52,948
1991	41,144	14,804	55,948
2000	48,113	15,845	63,958
2010	52,005	17,201	69,206
2020	56,646	18,556	75,202
2030	62,169	19,911	82,080
2044	65,436	20,584	86,020

PORT EXPANSION NEEDS

35. The Alabama State Docks Department published its Long Range Development Plan for the Port of Mobile in May 1977. The port expansion needs expressed therein are those directly related to the movement of deep-draft commerce. This plan, recognizing present and future port needs, has endeavored to establish a methodology and systematic sequence for satisfying the port and tributary needs.

36. The major port expansion needs in Mobile Harbor for deep-draft commerce include increased capacity for movement of coal and various bulk ores, especially iron ore. There is also a need in Mobile to increase the capacity of liquid bulk facilities. The long range development plan for Mobile Harbor provides for needed expansion of the coal facility on McDuffie Island and the construction of new terminals for handling other bulk commodities. However, for petroleum movements to increase according

to projected needs, an increase in private terminal and storage facilities not presently programed will be required. General cargo facilities are adequate, in terms of capacity, to handle projected tonnage, although many facilities now or will, in the near future, require extensive renovation and repair. Construction of all of the facilities at Theodore have yet to be completed. Commitments by private interests have been made for terminal facilities to move all projected dry bulk commodities. The Alabama State Docks Department has been committed to construct a liquid bulk terminal and transfer facility at Theodore with adequate expansion potential for projected movements.

PROJECTED ENVIRONMENTAL MANAGEMENT NEEDS

RESOURCE MANAGEMENT

37. There is a need for overall regional management of the environmentally related land resources of the two county study areas. Mobile Bay and Alabama's Gulf Coast are endowed with an excellent climate, abundant marine resources, scenic beauty, and an advantageous location. Because of these outstanding features, activities within the coastal area are rapidly expanding: population, industry, commerce, energy development, recreation, tourism, fisheries, transportation, and agriculture. These activities are largely uncoordinated. Water pollution, air pollution, noise, competing land uses, and congestion all illustrate that uncoordinated growth places conflicting demands on coastal and estuarine resources. The management of the coastal and estuarine zone is under the authority of the Alabama Coastal Area Board and the South Alabama Regional Planning Commission. The goals of the Alabama coastal zone management program are:

- Develop coastal resources for the benefit of all Alabamians,

- Provide environmental protection for the citizens and the resources of the coastal area,

- Direct marine related research to solve problems in the coastal zone.

- Develop an equitable system to resolve conflicting demands on coastal resources, and

- Facilitate coordination of activities of the various agencies involved in the coastal zone.

REGIONAL WASTEWATER MANAGEMENT

38. The South Alabama Regional Planning Commission is currently responding to this need in preparing a regional wastewater management plan for Mobile and Baldwin Counties in accordance with Section 208 of Public Law 92-500. The critical water quality management needs of the region, identified and addressed in the 208 study, are listed below:

- The lower Mobile River Segment with Chickasaw Creek and Threemile Creek, because of point source discharges and the concentration of dischargers in this area.

- The upper part of Mobile Bay, because of the numerous semi-public and private discharges along the causeway and the eutrophication problem. This causeway also presents a prime area for resolution of an institutional problem. The permanent closure of the upper part of the bay to oyster harvesting and the dredging of the ship channel pose other problems to be addressed in the 208 study.

- The Theodore area, and specifically the point and non-point discharges from an industrially developing area.

. The non-point sources of discharge from urban industrial, commercial, residential, resort, agricultural, and silvicultura areas.

DREDGING OPERATIONS

39. The operation, management, and continual upgrading of the navigation channels, port, and dock facilities are vital to the economic and social well-being of the Mobile region. Construction of new facilities and maintenance of existing facilities require the dredging of large quantities of material. It is essential to sound environmental management to perform these dredging activities in such a manner as to reduce dredging impacts and to minimize environmental consequences of such actions. Thus a crucial need is the identification of a plan, not only for essential new work, but for long term maintenance dredging that will be compatible with the existing and desired environmental integrity of the Mobile Bay area.

SECTION D

FORMULATION OF PLANS

FORMULATION OF PLANS

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SECTION D

FORMULATION OF PLANS

1. This section of the report contains a step by step development of alternative plans to satisfy the need for deep-draft access to the Port of Mobile and to the Theodore Industrial area, the need for a turning basin and anchorage area near the mouth of Mobile River, and the need for a large marshaling area near McDuffie Island. It contains a listing of the criteria used for plan formulation and evaluation and discussion of the plan formulation methodology. The plans formulated during the various planning stages are described and the evaluations and analyses of the alternative plans are presented. This section contains the detailed socioeconomic and environmental effects assessment of the most feasible plans with a summary display of these effects. This section concludes with the selection of the recommended plan and the rationale for the selection.

FORMULATION AND EVALUATION CRITERIA

2. Federal policy on multi-objective planning, derived from both legislative and executive authorities, establishes and defines the national objectives for water resources planning, specifies the range of impacts that must be assessed, and sets forth the conditions and criteria which must be applied when evaluating plans. Plans must be formulated with due regard to benefits and costs, both tangible and intangible effects on environmental features and social well-being of the region, and with due regard to public acceptability and institutional capability for implementation.

3. The plan formulation for this study was performed within the framework established in the Water Resource Council's "Principles and Standards for Planning Water and Related Land Resources," which requires the systematic preparation and evaluation of alternative

solutions to problems under the objectives of National Economic Devlopment (NED) and Environmental Quality (EQ). The process also requires that the impacts of the proposed action be measured and the results displayed or accounted for in terms of contributions to four accounts: NED, EQ, Regional Development (RD), and Social Well-Being (SWB). The evaluation process will include the following "specified evaluation criteria" and the results will be displayed where significant to plan selection.

- Acceptability. Significant public support or opposition will be noted.

- Completeness. Investments and actions which are not part of the plan but which are necessary to obtain the plan's outputs will be considered.

- Effectiveness and Efficiency. These two related criteria center on the concept of achieving maximum net output where outputs and inputs are conceived broadly to include intangible factors. Effectiveness includes, in addition, the concept of technological feasibility.

- Certainty. The likelihood of obtaining contributions claimed under the four accounts mentioned above will be stated.

- Geographical Scope. The effect of the plan on areas beyond the study area will be indicated.

- NED Benefits/Cost Ratio. The ratio will be exhibited for all final plans.

- Reversibility. The degree of reversibility will be stated.

- Stability. A judgement will be made of each plan's stability.

TECHNICAL CRITERIA

4. The following technical criteria were applied in the various stages of the plan formulation process.

- Modifications to the existing project for Mobile Harbor, Alabama should be consistent with local, regional, and State plans for land-use and port expansion.

- The physical location of the Bankhead and Interstate Highway 10 Tunnels under the Mobile River limits navigation depths in the Mobile River to 40 feet below mean low water. Relocation costs for these tunnels are prohibitive and preclude consideration of the Mobile River north of these tunnels for deep-draft improvements.

- Modifications to the existing project should retain the existing channel alinements and fairways where practicable.

- Sound engineering practices and accepted criteria shall guide the formulation of all plans for improvement and the components thereof.

- Present Federal policy requires that local interests maintain berthing areas outside the boundaries or channel dimensions of the Federal project.

- Channel dimensions shall provide for safe and efficient operation of expected user vessels. Design depths shall be based on criteria for trim, squat, safety clearance and maneuverability of expected vessels. Navigation widths shall be based on engineering and economic criteria which include expected operation and navigation charateristics of the channel, extant navigation conditions, expected vessel sizes, traffic density, and past navigation experience on the Mobile Ship Channel.

ECONOMIC CRITERIA

5. Economic criteria have been established to ensure that economic efficiency plays a vital role in the plan formulation and selection process.

- The selected plan must have net national economic development benefits unless the deficiency is the result of benefits foregone as additional costs incurred to serve the objective of environmental quality.

- Each separable unit of improvement should provide benefits at least equal to its cost unless it is justifiable on a non-economic basis.

- Each plan, as ultimately formulated, should provide the maximum net benefits possible within the formulation framework.

- The costs of alternative plans are to be based on current unit prices.

- The costs and benefits should be in comparable economic terms to the fullest extent possible.

- Annual costs and benefits are to be based on a 50-year economic amortization period and the current discount rate of 6 7/8%, as determined by the Water Resources Council, based on the cost of Federal borrowing during the preceding 12 months.

- The annual charges will include the cost of operation and maintenance.

- Interest during construction is to be charged to any portion of the project having a construction period that exceeds two years.

SOCIOECONOMIC AND ENVIRONMENTAL QUALITY

6. The criteria for socioeconomic and environmental evaluations of water resources plans are contained in the National Environmental Policy Act of 1969 (PL91-190) and Section 122 of the River and Harbor and Flood Control Act of 1970 (PL91-611). The criteria prescribe that all significant adverse and beneficial economic, social, and environmental effects of planned developments be considered and evaluated during formulation. An ecological evaluation of any proposed discharge of dredged material will be conducted to determine the potential for environmental impacts. Studies will be conducted to fully implement the requirements of Sections 404 and 103 of Public Laws (PL) 92-500 and 92-532, respectively, and to comply with the intent of Executive Order 11990, Protection of Wetlands.

7. The following criteria were selected for the formulation and evaluation of plans relative to their contribution to environmental quality. Plans should be formulated to maximize the beneficial and minimize the adverse effects on:

- Manmade resources
- Water quality
- Air quality
- Aesthetics
- Terrestrial environment
- Wetlands
- Physical characteristics of Mobile Bay
- Salinity and circulation patterns in Mobile Bay
- Biological productivity of the Mobile Bay estuary
- Structure of biological communities and species diversity
- Commercial fisheries and shellfish

Plans should avoid detrimental environmental effects to the extent feasible and where adverse environmental impacts are unavoidable, they should be fully noted and analyzed to provide as much data as possible to enlighten the decision making process.

8. Social well-being is concerned with the direct and indirect effects of alternative plans on man and his life style. Criteria used to direct plan formulation and to assist in evaluation of the alternative plans included:

- Land use
- Local government finance
- Displacement of people
- Community cohesion
- Recreation opportunity

In addition, consideration should be given to protection of historical, archaeological, and other public interest areas. Plans should not significantly increase noise pollution during construction or create conditions that will tend to raise the overall noise level of the area over the project life. Provisions should be made during the planning process to allow public participation in plan formulation and plan selection.

PLAN FORMULATION METHODOLOGY

9. Formulation of plans for modifications to the Mobile Harbor, Alabama navigation project was performed generally in accordance with the formulation sequence diagram shown in figure D-1. The three stages of plan formulation included (1) Possible Solutions, (2) Development of Intermediate Plans, and (3) Development of Detailed Plans. Each stage contains the four basic planning steps: problem identification, formulation of alternatives, impact assessment of alternatives, and evaluation of alternatives. As shown in the diagram, task emphasis shifts from problem identification in Stage 1 of the study process to plan formulation in Stage 2 of the planning process to impact assessment and evaluation in Stage 3 of the planning process.

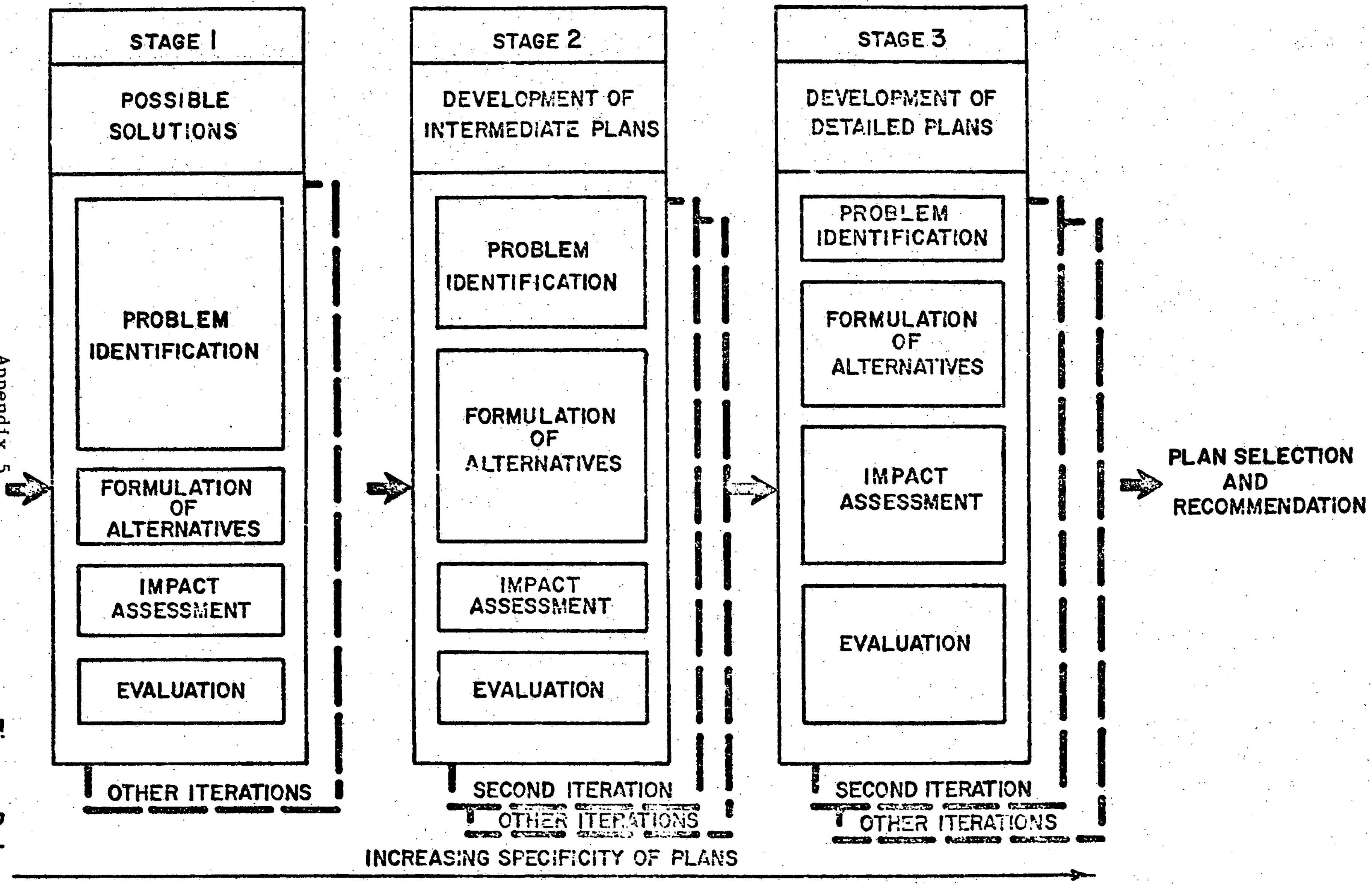


Figure D-1

GENERAL RELATIONSHIP OF PLANS FORMULATION STAGES AND FUNCTIONAL PLANNING TASKS

REGIONAL PROFILE AND PLANNING GOALS

REGIONAL PROFILE

10. A profile of the existing and projected physical, economic, social, demographic, and enviromental conditions in the two county study area was presented in Section B of this report. The regional profile provides the socioeconomic, physical, and environmental base required to define the "No Action" alternative - that is, the most likely future conditions which would exist if there were no modifications to the Mobile Harbor, Alabama project. The "No Action" alternative will provide a yardstick to assess the composite performance of alternative plans. Certain assumptions were made in the formulation of the "No Action" alternative which are essential to the understanding of the formulation and analysis of alternative plans:

- The authorized 40- foot deep and 400-foot wide Theodore Ship Channel is considered to be in place for the purpose of plan formulation and evaluation.
- The present practice for disposal of dredged maintenance material for the main bay channel will continue in its present form for the foreseeable future.
- The upland disposal sites for the Mobile River channel dredged maintenance material will reach their capacity in about 16 years and an alternative disposal method will be required.

REGIONAL GOALS

11. Planning within the framework of regional desires and preferences enables the formulation of plans which are more likely to be acceptable to the citizens of the region. The regional goals and planning objectives stated herein have been drawn from a much wider array of goals which have been formulated by the citizens of the region. Those pertinent to this study are listed below:

- Goals for Alabama, Alabama Development Office, 1975.

Natural Resources and Conservation:

Develop a natural resource program which will protect the natural environment for the social and economic betterment of the entire State.

Economic Development:

Encourge economic development in Alabama at greater than the national average, but at the same time protect and conserve natural and human resources to the best extent possible.

- South Alabama Regional Goals as approved and adopted by South Alabama Regional Goals Forum, December 15, 1971.

Economic Development:

Development within the Region, on the part of government, private enterprise, associations, news media and the citizenry, an attitude that is sympathetic to business and industry, while balancing respect for the natural environment, in order to provide to all employable workers jobs for which they are well suited. Retain enlightened and productive citizens. Make possible steadily rising living standards. Facilitate attainment and enjoyment of these standards by all residents and the sharing of them with visitors.

Promote economic growth in the local economy at a rate above the national, southeast and Alabama averages, which is non-inflationary, compatible with the regional economic environment, and balanced among agriculture, industry, commerce and services. Take full advantage of Mobile's unique situation as a riverport and seaport by coordinated improvements in the transportation system, such as the Tennessee-Tombigbee Waterway and port development.

Encourage location of new industrial enterprises through reasonable and adequately enforced local and regional zoning ordinances, appropriately design industrial parks in order to maintain ecological balance and to minimize impact upon the environment.

Environment :

Preserve and enhance the integrity and beauty of our environmental resources, assure their best use for the social and economic betterment of the entire community, and assure their availability for future generations.

● Goals for Development of Mobile Harbor by the Alabama State Docks Development

Expand terminal facilities for handling large ships such as lash and Seabee types and for large container ships operated by other carriers. Studies were requested to include the area adjacent to Brookley for potential development to contain future dredged disposal material and for use as a suitable industrial site. (See Appendix 3 , letter dated 1 November 1974. Alabama State Docks Department)

Construction of anchorage area in Mobile Harbor (See Appendix 3 , letter dated 6 October 1975, Alabama State Docks Department).

Early action to widen the main ship channel from Beacon 38 to Beacon 44 (New numbers on Beacon 74 to Beacon 84) from 400 to 500 feet wide (See Appendix 3 , letter dated 20 November 1975, Alabama State Docks Department).

PLANNING OBJECTIVES

12. The following planning objectives were applied in the first stage of the plan formulation process.

- More efficient and safe movement of existing and projected commence by deep draft vessels.
- Maintain and enhance environmental quality.
- Compliment regional goals for development of water and related land resources.

Specific features to be considered in formulating any plan include not only navigation improvements but also the possibility of investigating measures other than identified navigation problems. These measures are outlined below.

NAVIGATION MEASURES

Deepen and/or widen the main ship channel.
Widen and deepen the authorized Theodore Ship Channel.
Provide and maintain a barge marshaling area in Garrows Bend.
Provide an anchorage area near upper limits at Main Bay Channel.
Provide a turning basin below the Interstate 10 Tunnels.
Reduce traffic delays with a passing lane.

DREDGED MATERIAL DISPOSAL MEASURES

Construct islands or fill area adjacent to shore.
Open water disposal in the Bay and Gulf.
Upland disposal sites.
Recycle material off existing disposal sites.
Abate shore erosion with dredged disposal material.

WATER QUALITY MEASURES

Remove obstructions to improve water circulation.
Fill depressions in Bay to improve water quality.

FISH AND WILDLIFE MEASURES

Enhance the bay bottom,
Improve areas adjacent to causeway.
Establish additional oyster beds.

PORT DEVELOPMENT MEASURES

Offshore terminals.
Future expansion area.

PLANS OF OTHERS

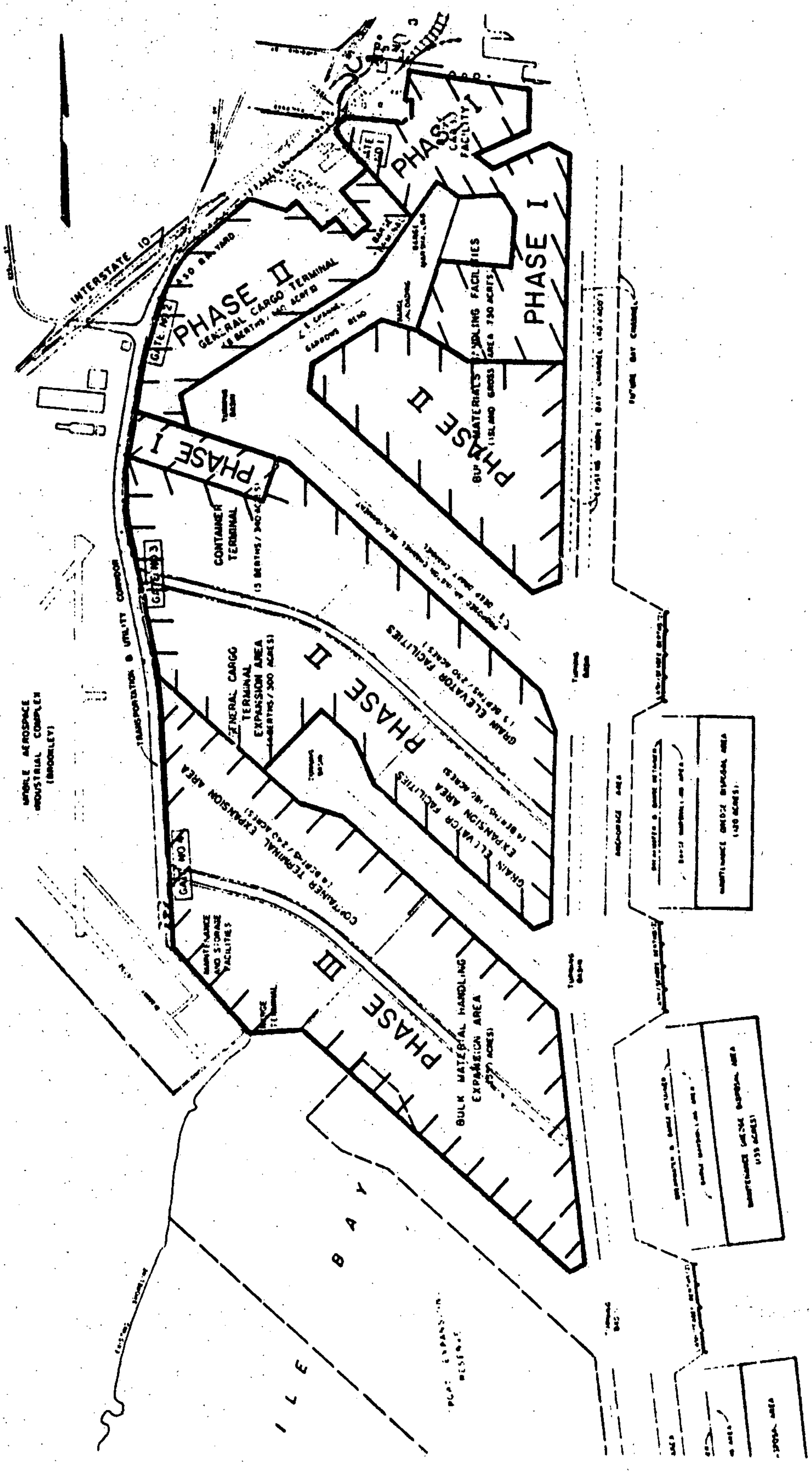
13. A plan (See figure D-2) was selected by a consulting firm hired by the State Docks Department to be further developed as the port expansion master plan. It features a realigned Arlington Channel and a paral'el ship channel into the proposed land mass opposite Brookley, with areas in Garrows Bend and adjacent to the maintenance dredge material disposal areas available for barge marshalling. This expansion plan represents a continuous land mass consisting of McDuffie Island (expanded to 730 acres), to Garrows Bend/I-10 area (590 acres before detailed planning), and the proposed land mass opposite Brookley (approximately 2,340 acres) for a total proposed expansion area of 3,660 acres. Phases I,II,and III are in order or recommended development of the property and defined below.

Phase I -- Preferably property under ownership of A.S.D. with soils conditions acceptable for immediate development. Facilities utilization must be commensurate with A.S.D. needs.

Phase II -- Property that could not be economically developed at this time because of either poor soils conditions or delay in acquisition. It also includes a portion of the proposed land mass to be filled by use of dredge material.

Phase III -- The remainder of the proposed master plan acreage which is all dredge-fill material.

The State Docks Department is actively pursuing this plan by purchasing land adjacent to Garrows Bend.



ALABAMA STATE DOCKS
LONG RANGE DEVELOPMENT PLAN
MOBILE, ALABAMA

Figure D-2

POSSIBLE SOLUTIONS

NO ACTION ALTERNATIVE

14. The "No Action Alternative", as far as this study is concerned is the development of the most probable future conditions that would exist if there were no modification to the existing navigation project. There will be environmental, economic, and social effects associated with the No Action Alternative. These effects will be presented in the Stage 3 analysis of the detail plans. The Stage 1 presentation of the No Action Alternative is primarily concerned with the question of what happens to the existing and projected commodity movements and navigation traffic if no Federal action is undertaken to modify the Mobile Harbor, Alabama project. Presented below are the possible scenarios:

- Light-loading of large vessels - The trend in vessel sizes in the world fleet is toward larger vessels. Many shipping companies which own larger ships use these larger vessels in harbors where the maximum loaded draft of the ship exceeds the channel dimensions of the harbor. In Mobile Harbor, this has become common practice for some bulk carriers. Ships with capacities up to 100,000 deadweight tons with potential loaded drafts considerabely in excess of 40 feet presently call on Mobile Harbor. These vessels are light-loaded, thereby increasing the transportation costs to these shippers. This trend toward larger vessels and light-loading of these vessels would be expected to increase if no modifications were made to the existing navigation channels for Mobile Harbor.

- Movement of smaller vessels at less efficiency- If the channel depth remains at 40 feet for Mobile Harbor the channel will become more congested because most of the bulk commodity movements will be in greater numbers of smaller vessels. By maintaining transportation costs at higher levels, this congestion eliminates the possibility of economic advantage to the Mobile region in navigation transportation savings.

ENVIRONMENTAL QUALITY ALTERNATIVE

15. An inventory analysis was made to determine those environmental resources which should be preserved, enhanced, protected or approached with care. Of primary concern in the formulation of the EQ alternative was the management of Mobile Bay such that no degradation of the water quality or fish and wildlife resources would take place. The following paragraph contains measures that have potential environmental enhancement effects.

16. Existing maintenance of the entrance channel provides sand that can be utilized to restore the eroded beaches of Dauphin Island; the ridges along the upper bay ship channel can be removed and material placed such that it will abate shore erosion along the western shore of Mobile Bay; a portion of the material taken from the ridges can be placed such that it will fill depressions in Mobile Bay that cause stratification of water and leads to desolved oxygen deficiencies; additional oyster beds can be established in areas found suitable for such; openings in the causeway can be created to improve the circulation in the bay area north of U. S. Highway 90; fresh water flow in Mobile Delta can be regulated to dilute the saline waters created by the existing ship channel; and an opening in the fill connnecting McDuffie Island to the mainland can be removed to improve circulation in the Garrows Bend area.

NAVIGATION DEVELOPMENT ALTERNATIVES

17. Various alternative plans for improving navigation were formulated.

- Provide an enlarged channel to the Port of Mobile. This alternative would involve deepening and/or widening the Mobile Bar and Bay Ship Channel into the mouth of Mobile River. Because of the restrictions of the Bankhead and Interstate 10 Tunnels, deepening of Mobile River would not be considered north of the tunnels.

- Provide an enlarged channel into the Theodore Industrial Area. This would involve deepening and widening the planned Theodore Ship Channel from the authorized 40-foot deep by 400-foot wide Bay Channel and 40-foot deep by 300-foot wide land cut channel.

- Provide a turning basin opposite McDuffie Island.

- Provide an anchorage area just south of McDuffie and Little Sand Islands.

- Adoption of the Garrows Bend Channel and McDuffie Island barge marshaling area for maintenance.

- Provide a passing lane along the main Bay Ship Channel in the vicinity of the Theodore Channel in lieu of enlarging the entire bay channel to reduce traffic delays.

- Provide additional width at the upper end of the main ship channel to eliminate handling problems and safety hazards in the area.

ALTERNATIVE PORT EXPANSION PLANS

18. A specific local planning objective for Mobile Harbor improvements is to complement regional goals for development of water and related land resources. One key need the Alabama State Docks Department has identified is that for additional area to expand harbor terminal facilities such that future cargoes moving from the Black-Warrior, Tennessee-Tombigbee and Alabama inland river systems can be adequately accommodated. In pursuing this objective attention was given to the following options.

- Offshore terminals for bulk commodities
- Tracts presently owned by the Alabama State Docks Department or private interests
- Land that can be purchased or created

19. To further pursue the objective of satisfying the need for additional expansion area the following basic criteria were developed by the Corps for assessing site selection.

- Economical and engineering feasibility
- Environmental and socioeconomic impacts
- Access to deep-draft channel (40' minimum)
- Accessibility to all modes of transportation
- Soils and foundation conditions
- Accessibility of ship anchorage and turning sites and barge marshalling areas
- Single tract or contiguous land track sizes and real estate cost

20. Our study was conducted to determine if the facilities currently being used or planned could be modified to provide the additional capacity needed. One technique considered was offshore vessel loading and unloading of liquid and slurry bulk commodities.

21. A possible alternative for import and export of crude and refined petroleum products would be an offshore terminal where large vessels could dock and the petroleum products could be moved to and from the shore-based facilities by pipeline. The States of Mississippi and Alabama have considered the possibility of such a facility. However, "Ameraport," a jointly sponsored offshore terminal authority, decided to shelve plans for the offshore terminal due to the inability to obtain large, long-term purchase commitments from refiners. A large grouping of refineries and/or demand for a single commodity such as crude oil would be necessary for such a plan to be viable.

22. A coal slurry marine transport system was investigated by the Corps to determine the feasibility of utilizing an offshore terminal for exporting metallurgical coal and thereby making available the existing site on McDuffie Island to accommodate large container ships and dry bulk vessels that require dry loading and unloading terminals. Private industry currently involved in the development of coal slurry systems was contacted to aid in assessing the feasibility of such an offshore terminal. No terminal for export and import of coal slurry exists at this time. Experience gained in the shipment of iron ore slurries provides some background experience, but is not entirely applicable. Existing iron ore export slurry facilities were developed due to the lack of practical alternative transport modes from the remote mining areas to any deep-draft harbor. For coal the development of total systems for receiving, storage, dewatering, repulping and pumping would be required for both export and receiving terminals. Some of the problem areas in developing this type of facility for coal handling are briefly discussed.

23. Availability of water for slurry at the coal source or storage site is often a problem for any considered slurry system. Water storage problems add to the overall slurry storage and handling

problems at the coal export terminal. The supply problem is further complicated by the water pollution, separation and disposal problems at the slurry receiving point. Water supply for a slurry-load shipboard system is complicated and expensive requiring a closed-loop loading system. In addition to supply and pollution problems, the legal, legislative and general political ramifications of securing pipeline rights-of-way through heavily developed port areas are often insurmountable.

24. Economical means for dewatering coal remain a subject for further engineering development except for specialized unique cases. An optimum slurry system dictates a specific coal source and composition, particle size, and product requirements. Dewatering problems appear to be the major source of difficulty and the major problem area recognized by potential coal slurry users. Typically, a coal slurry containing approximately 50 percent solids by weight would be pumped from shore to the ships in closed-loop submarine pipelines, assuming the vessel would be moored at a single point mooring buoy. Once the slurry is in the vessel, it is desirable that the mass be dewatered to a maximum degree consistent with the time available. This dewatering aspect is critical in order to insure carrying a maximum deadweight of coal cargo. The most favorable shipboard density presently achievable for wet coal is estimated to be about 75 percent dry coal by weight. Current users of U.S. exported metallurgical coal require that the water content not be greater than 6 percent by weight. To meet this requirement expensive dewatering facilities are necessary to be constructed at the user site. Because of these problems the costs for implementing a marine slurry transport system at Mobile Harbor would exceed the benefits of such a facility. This expense plus the additional costs of export slurry terminals and ship transport would price the U.S. coal out of the World coal market. In view of these constraints, no further consideration was given this option for port development.

25. Further studies were conducted by the Corps to identify potential port expansion areas. Consideration was given to areas extending from the gulf coast at the mouth of Mobile Bay to tracts north of Mobile including the eastern and western shores, the Theodore and Brookley Field areas and along the banks of the Mobile River and Chickasaw Creek. The following analysis was made by following the basic criteria stated earlier.

- Economical and engineering feasibility

The above discussion on an offshore terminal alternative for coal slurry transport systems points out the economic, environmental and the engineering problems associated with this type of system. The engineering state-of-the-art for conventional dry bulk loading and unloading is much more advanced and to date the dry bulk facilities are much more efficient. The economic need is not great enough for justification of a liquid bulk offshore facility to import large quantities of crude oil into this area at this time. The offloading of dry bulk or general cargo offshore is considered an unsafe practice, very dependent on favorable weather, and is not considered a viable alternative. In general, the most economical and engineeringly feasible port facilities to handle the present and future growth of Mobile Harbor are land based terminals that allow direct transfer from and to all modes of transportation. The advantages or viability of these type sites relate directly to the costs of sufficient areas and the degree or efficiency with which they can connect with existing transportation modes.

- Environmental and socioeconomic impacts

The areas north of Chickasaw Creek along the Mobile River are considered generally unsuitable because of anticipated cost of development and environmental restrictions, especially from the standpoint of using dredged material as land fill. A large amount of the area is wetlands and dredge and fill operations would have significant adverse environmental impacts. Cochrane Bridge, located immediately south of Chickasaw, is a transportation hazard to both vehicular and water transportation.

A port located on the east shore of the bay would be disruptive to the resort-residential communities located in that general area and would displace people, homes and farms. Considerable environmental disruption would be necessary to provide adequate channel, highway and rail connections. The primary disadvantage of port sites in the lower bay is that valuable shellfishing areas would be disrupted and/or destroyed by any major dredging and related construction.

Similar to the east shore, most areas along the west shore of Mobile Bay that might be selected as a port site would be generally disruptive to communities and displace significant numbers of residential homes along the shore. The only exceptions are the Theodore and Brookley areas where substantial areas have been set aside for industrially related activites.

- Access to deep-draft channel (40' minimum)

Any port site located north of the Bankhead and George C. Wallace (I-10) tunnels that could be considered would be limited to a 40-foot channel depth restriction imposed by the tunnels. No undeveloped areas of significant size remain on the existing 40-foot channel above the tunnels. Beyond Cochrane Bridge major dredging efforts and costs would be necessary to provide the 40-foot depth.

The east shore is anywhere from 4.5 to 14 miles from the existing ship channel. Improvements here would mean dredging a new channel for a considerable distance, with additional dredge material disposal problems and increased detrimental environmental impact resulting.

A major advantage any port located in lower Mobile Bay would have would be its proximity to deep water. Additional initial dredging costs, as well as maintenance dredging costs, would be greatly reduced. However, the only such sites that exist are Fort Gaines on Dauphin Island and the Fort Morgan Peninsula in Baldwin County. Both are important cultural resource sites and without reliable land transportation connections.

Except for the McDuffie Island-Brookley area in the northwest corner of the bay, the existing ship channel is a considerable distance from the west shore and would require a channel similar to the Theodore Channel for access to a port site. Most areas on the Theodore Ship Channel have been purchased by various industries and access to larger developable areas may require some channel extension. The Brookley area is about two miles from the main channel and present access is limited to the authorized but unmaintained 27 by 150 foot channel into the upper extremity of the industrial area. Fill of the Brookley waterfront area, as has been discussed at various times by city, state and private interests, would provide an area with deep draft navigation on the east side and potentially on three sides.

- Accessibility to all modes of transportation

The east bank of Mobile River is, in general, a poor site for port expansion primarily because of the lack of availability of existing or planned land transportation. No rail access is available to the area other than by ferry transfers.

The topography of the east shore of the bay, especially along the northeast shore, makes many sites undesirable, as well as requiring rail access to be very expensive due to minimum grade requirements.

Neither rail or adequate highway transportation is available on the east and west side of the lower bay area, and it would be extremely expensive and disruptive to construct. Along with this, land transportation costs "back to Mobile" would increase the general costs of shipping any commodity through Alabama State Docks facilities. The result being that Alabama State Docks Department would be less competitive than it could be in a location with quick access to other modes of transportation.

Topography is not a problem on the west shore of the bay. Highway transportation is available to various degrees. Rail transportation varies from being considered fair at the Theodore Industrial Complex to excellent at the Brookley area in Mobile.

- Soils and foundation conditions

The east bank of the Mobile River is considered a poor site for harbor expansion because there is not sufficient land depth with acceptable foundation soils. Foundation conditions with sufficient piling do not appear to be a significant factor in the other areas of the bay.

- Accessibility to ship anchorage and turning sites, and barge marshalling areas

The only areas in Mobile Bay that are currently accessible to anchorage and turning sites for ships are the Theodore Ship Channel, northwest bay area and the Mobile River Channel.

The Garrows Bend area and Mobile River Channel currently provide adequate barge marshalling, however, the Mobile River Channel has become congested such that future growth in this area is undesirable.

- Single tract or contiguous land tract sizes and real estate cost

Along the Mobile River and Chickasaw Creek, above the upper limit of the 40-foot project, a tract of 7,400 acres has been purchased by a private corporation for long range industrial development. An area of about 5,200 acres of this tract is low and marshy, requiring about 125 million cubic yards of fill to raise it to a usable elevation. The remaining 2,200 acres would require considerable grading and levelling before it would be suitable for industrial use. Construction of slips and access channels into the site would involve major railroad track relocations or bridge constructon. However, as mentioned earlier, the adverse environmental impacts of developing this site and the limited 40-foot depth access make the area undesirable for further consideration.

The Theodore Industrial Park was established for port and industrial expansion. With construction of a deep-draft ship channel from the main ship channel into the park area the Theodore area affords a great potential for development and expansion of heavy industry. As such this park will fulfill a substantial portion of Mobile's immediate and long range needs for additional deepwater oriented industry. Consistent with this basic objective, most of the developable areas adjacent to the deep-draft channel have already been purchased by private industrial development interests. State-owned land adjacent to the Theodore Ship Channel is limited to a site for a proposed public liquid bulk transfer facility, transporation arteries and a small parcel and dock at the bay shoreline. The development of any public dry bulk or container facility within the Theodore area would require the purchase of additional bay front lands, the relocation of numerous private homes and extension of the deep-draft channel along the shoreline.

There is no area available along the west bank of the Mobile River up to Chickasaw Creek because of existing Alabama State Dock facilities and private industry. The State Docks Department is presently acquiring land that is suitable for port expansion that is located northeast of Mobile Aerospace Industrial Park (Brookley) between I-10 and Carrows Bend, and north along the west bank of the Mobile River to a point immediately south of the tunnels. Due to McDuffie Island's location between this area and the main ship channel, its access to deep-draft water is limited. However, its acquisition will greatly enhance transfer capabilities between the upper river facilities, McDuffie Island and the Brookley Industrial Complex. Its acquisition will also meet certain near term deep-draft expansion needs of the Alabama State Docks Department as well as provide additional areas for barge terminals. Due to the lack of other available real estate for further expansion of public port facilities in the main harbor area of Mobile and the restrictions of other areas noted above, the State Docks' most practical alternative will be to ultimately look to the Brookley Industrial Complex or the reclamation of an area along its shoreline for long term needs.

Use of the existing Brookley area would ultimately displace existing non-water transportation oriented industries at the site, the University of South Alabama's Brookley training facilities and infringe upon the operation of the area's air traffic facilities. This course of action would ultimately lead to replacement of several types of facilities by port related facilities which may or may not result in net economic growth to the area. Replacement of the existing Brookley facilities would represent a loss of a highly desirable diversity of facilities that presently add to the community's economic, social and transportation makeup and are relatively non-polluting to the environment.

Creation of land by filling the Brookley near shore could provide foreseeable needs for port expansion areas, avoid displacement of the existing facilities and contribute significantly to solving the problems and costs associated with dredged material disposal from any significant deepening or enlarging of the ship channel. The Brookley expansion area would be of sufficient size and configuration to allow the design of unrestricted public port facilities that could be made readily accessible to all modes of transportation. This course of action would facilitate the development of basic plans most efficiently designed for their intended purposes as opposed to piecemeal developments dictated by their need and designed on a "best possible basis" to fit available space and the constraints of adjacent and often incompatible facilities. The primary disadvantage of the Brookley expansion plan would be its temporary effects on water quality during construction and the permanent loss of water bottoms occupied by the land mass. Physically, the area is characterized by submerged and emergent dredged material deposition mounds, borrow depression up to 50 feet in depth, and accumulations of debris that are pulled into the area as the result of the shadowing of river flow by McDuffie Island and remains of the Arlington Pier. Although recent recovery trends have been noted in the area, it continues to have persistently low dissolved oxygen in the borrow depression, and marine life and water quality have been degradated from years of pollution from the Garrows Bend area. Proper configuration and shaping of the area coupled with considered channel modifications could enhance tidal flushing into Garrows Bend and minimize entrapping effects such as presently exist as the result of McDuffie Island.

Fill of any wetland or water areas for expansion of port facilities is solely within itself environmentally undesirable. However, both NED and Regional Development benefits offset environmental losses and there appear to be no more practical alternatives in the upper harbor if significant additional areas are to be provided. Consideration of the area adjacent to Brookley Industrial Complex for fill and development is consistent with plans that are supported by the city of Mobile and the Alabama State Docks Department. The area would be adjacent to deeper channels and could be easily connected with existing highway, rail and intra harbor cargo transfer facilities. Accordingly, it is indicated that the Brookley expansion area is the more meritorious of areas that should be studied further to meet port expansion needs.

DREDGED MATERIAL DISPOSAL ALTERNATIVES

26. The following dredged material disposal alternatives were formulated.

- Mobile Bay Island or Fill Alternatives. The island and fill areas would be so designed to contain all new work and maintenance material for a 50-year period. These plans are shown on plates D-1 through D-5.

- Open Water Disposal. Two open water disposal concepts were considered. First was the removal of all new work and maintenance material to the Gulf of Mexico. Second was the disposal of all new work and dredged maintenance material along the channels in Mobile Bay in such disposal areas currently used. The first plan is illustrated on plate D-10 or 11. The second plan is shown on plate D-18. Shown on plate D-6 are the areas along the western bay shore where dredged material could be disposed to aid in abatement of shoreline erosion.

- Upland Disposal. This alternative involves removal of all new work and dredged maintenance material for a period of 50-years to upland disposal sites. This plan, with potential disposal areas, is illustrated on plate D-7 through D-9.

27. Evaluation of Dredged Material Disposal Alternatives. The investigation of various conceptual alternatives for dredged material excavation, transport and disposal comprised the core of the Stage I studies. An array of conceptual methods was investigated to determine the economic and environmental impacts associated with the various dredged material disposal methods. The conceptual methods concentrated on the removal of all new work and dredged maintenance material from the Mobile Bay estuarine system to upland disposal areas, diked or bulkheaded disposal areas, or Gulf of Mexico disposal areas. The development and evaluation of the various dredging alternatives were accomplished by a special A-E Contract study for the Mobile District Office. The various dredging, transport and disposal techniques considered are listed in table D-1. The study also included an economic rank, an environmental rank, and a relative unit cost comparison for each alternative. The relative rating of these alternatives are also shown in table D-1. The environmental analysis was based on the following factors:

- The creation of turbidity at the point of dredging.

- The creation of turbidity at the point of disposal of the material.

- The damaging effect of the placement of dredged material on submerged or upland areas which are valuable ecological resources.

- The damaging effect of distributing polluted materials in unpolluted areas.

- The visual pollution brought about by booster stations, connection stations, etc., in the bay.

- The visual pollution brought about by diked or bulkheaded disposal areas in the bay.

TABLE D - 1

CONCEPTUAL ALTERNATIVES FOR DREDGE

MATERIAL DISPOSAL *

Concept No.	Env. rank	Eco. rank	$/cy	Description
1	4th	8th	1.36	Conventional pipeline dredges discharging into diked upland disposal areas through a system of centrifugal booster stations. (Plates D-8 & D-9)
2	6th	5th	0.91	Conventional pipeline dredges discharging into dump scows for towing to the open Gulf of Mexico for dumping. (Plate D-10)
3	5th	2d	0.85	Endless chain bucket dredges discharging into dump scows for towing to the open Gulf of Mexico for dumping. (Plate D-11)
4	8th	6th	1.05	Conventional pipeline dredges discharging into a hydraulic conveyor made up of a submerged pipeline extending throughout Mobile Bay and to the Gulf of Mexico disposal area, and activated by one floating and one platform mounted, positive displacement, pumping station. (Plate D-12)
5	9th	4th	0.88	Conventional pipeline dredges discharging into a hydraulic conveyor made up of a submerged pipeline extending throughout Mobile Bay and to the

* Relative values derived during early study efforts.

TABLE D - 1 Cont'd

Concept No.	Env. rank	Eco. rank	$/cy	Description
				Gulf of Mexico disposal area, activated by one platform mounted, positive displacement, pumping station and a series of 13 centrifugal booster stations. (Plate D-13)
6	7th	10th	2.40	Conventional hopper dredges tranporting material to the open Gulf of Mexico disposal area. (Plate D-14)
7	3d	1st	0.83	Conventional pipeline dredges discharging into diked or bulkheaded disposal areas in Mobile Bay. (Plate D-15)
8	2d	9th	1.39	Hopper dredges equipped for direct, pump out discharging into diked or bulkheaded disposal areas in Mobile Bay. (Plate D-16)
9	1st	7th	1.28	Endless chain bucket dredges discharging into scows for towing to diked or bulkheaded disposal areas in Mobile Bay and there being pumped out into the areas. (Plate D-17)
10	8th	3d	0.87	A combination of Concepts 3 and 4. During initial construction dredging would be performed by bucket dredges, with material being towed in scows to the open Gulf of Mexico disposal area. Future maintenance would be performed by conventional pipeline dredges that would discharge into a positive displacement, submerged pipe for conveyance to the same Gulf of Mexico area.

28. The next task was to analyze and screen the conceptual disposal alternatives, so as to eliminate inferior and impractical alternatives from further consideration, in order to select the best alternatives for further consideration and reformulation. Concept 1, upland disposal of dredged material, was considered as a favorable concept from the standpoint of limited impacts on the estuarine ecosystems: however, the socioeconomic and environmental impacts associated with the large land masses involved for the storage of the dredged material and the effects of salt in upland systems, in addition to the high cost, render this concept of questionable value. Concept 2, the use of a modified pipeline dredge discharging to dump scows which would then remove the material to the Gulf of Mexico is an untried concept, although this plan exhibits promise from both cost and environmental considerations. Concept 3 utilizing bucket dredges is also favorable from cost considerations. Its major drawbacks, however, are that the endless chain bucket dredge is not commonly used in this country by the dredging industry, it generates a lot of noise and it causes considerable turbidity at the dredge site. Concepts 4 and 5, which use a submerged line, are not very favorable economically. Both of these methods employ untried techniques and sophisticated equipment, which raises questions as to their reliability. Concept 6, the use of a conventional hopper dredge is an extremely expensive method to perform this work. Sufficient hopper dredging equipment is not presently available for the amount of work involved in deepening the channel. Concept 7, which involves the use of conventional pipeline dredges discharging material into diked or bulkheaded disposal areas, is very favorable, both from cost and certain environmental considerations. The major drawbacks to the island concept are the loss of bay bottom and marine habitat and alteration of the circulation pattern of the bay which indicates the possible total alteration of the Mobile Bay estuarine system. Concept 8, which employs hopper dredges with direct pumpout, and concept 9, which uses endless chain bucket dredges and dum scows both use the diked or bulkheaded disposal areas in Mobile Bay. These methods are both favorable provided that disposal areas could be properly located, but are extremely expensive. As stated previously, there are problems with the dredging equipment for concepts 8 and 9. Hopper dredges are not available in quantities sufficient to perform a job of this magnitude. Endless chain bucket dredges are not commonly used by the dredging industry

in this country and could cause considerable pollution of the water column. Concept 10 offers some cost advantages, however, the main drawbacks are the use of foreign equipment and sophisticated and untried techniques for dredged material disposal. The open water disposal concept has major environmental drawbacks. This method of dredged material disposal is the most efficient economically. The major environmental concerns are increased turbidity in Mobile Bay and eventual disruption of circulation patterns caused by the accumulation of large quantities of new work along the sides of the Ship Channels.

29. <u>Selection of Alternative Dredged Material Disposal Concepts for Further Study</u>. Based on a policy of the United States Government, the use of foreign equipment to perform the dredging would not be allowed. This rules out concepts 3, 9, and 10 which all utilize the endless chain bucket dredge. Since hopper dredges are nither currently available or economical, concepts 6 and 8 were eliminated except for the entrance channels close to the gulf disposal sites. Since concepts 4 and 5, which involved the use of a submerged line and positive displacement pumping stations and/or booster stations, both necessitated untried and inflexible methods, and offered no significant cost advantages, these concepts were also eliminated. The remaining concepts carried forward then for reformulation and further analysis are as follows:

- Concept 1 Upland disposal with conventional pipeline dredges

- Concept 2 Modified pipeline dredges with a fleet of dump scows for gulf disposal

- Concept 3 Pipeline dredges to diked or bulkheaded disposal areas.
- Hopper dredging of the entrance channel
- Open Water Disposal Concept

  Pipeline dredges discharging new work and maintenance material into Mobile Bay in current disposal areas.

30. Socioeconomic and Environmental Assessment. This analysis consisted of evaluating the effects of the various dredged material disposal alternatives on certain sensitive socioeconomic and environmental parameters. At this stage of the planning process, a detailed effects assessment was not made. The socioeconomic and environmental parameters analyzed were those most critical in the evaluation and comparison of the alternative plans, and those most different between plans. Those socioeconomic and environmental parameters which the plans affected the same or nearly the same are not displayed. A summary of the Stage 1 socioeconomic and environmental effect assessment is presented in table D-2.

DEVELOPMENT OF INTERMEDIATE PLANS

31. The development of Intermediate alternatives focusing on advancing more specific plans for Environmental Quality, the enlargement of the Mobile Ship Channel and the enlargement of the authorized Theodore Ship Channel. The barge marshaling area and its entrance channel were dropped from considered plans since they are considered local responsibilities set aside for a localized use of delivering coal to the McDuffie Terminal. Alternatives for dredged material disposal evaluated at this stage of the planning process were arbitrarily related to a 50-foot deep-draft channel with commensurate widths, anchorage basins, turning areas and auxiliary barge and access channels. These efforts were oriented toward evaluating disposal plan effects on the bay's environment and the selection of the better plans to be applied with channel improvement alternatives. Although widths for various channel depths were established, overall plan optimization studies were not performed at this stage of the analysis but were reserved for Stage 3 studies. The primary emphasis in this stage was to identify specific environmental measures, assess the background data available and formulate the alternative that would best manage the total resources of the bay.

TABLE D-2

SUMMARY OF SOCIOECONOMIC AND ENVIRONMENTAL EFFECTS
DREDGE MATERIAL DISPOSAL ALTERNATIVES

EFFECT ON:	Mobile Bay Island or Fill	Open Water Disposal			Upland Disposal	Mobile Bay Island or Fill and Gulf Disposal		
	All new work and maintenance material to confined disposal islands located in Mobile Bay.	Removal of new work and maintenance material to Gulf of Mexico.	Disposal of new work and maintenance to Mobile Bay in accordance with current practice.	Removal of new work to Gulf of Mexico and disposal of maintenance material in Mobile Bay in accordance with current practice.	New work and maintenance material transported to upland disposal sites.	Maintenance material to Mobile Bay in accordance with current practices.	Maintenance material transported to Gulf of Mexico.	Shoreline disposal of some new work. Maintenance material to Mobile Bay in accordance with current practice.
Land Use	Three plans would create additional land adjacent to the Brookley area, which could be used for industrial and/or port expansion.	No significant effects.			This plan would affect potential land use. The designated areas would be used for disposal during construction and for maintenance over the project life, thus precluding their use for other purposes.	This plan would create additional land area adjacent to the Brookley area which would be used for industrial and/or port expansion.		Disposal areas along the western shore of Mobile bay will give waterfront landowners some protection.
Local Government Finance	The three plans which could create land for industrial and/or port expansion would have slightly beneficial effects on the ability of local government to finance infrastructure. Additional land should have high property value from potential location of industrial activity. If land used for port expansion, port revenue would be generated and costs would be incurred in developing port facilities.	No significant effects.			Potential tax revenues would be reduced. Real property and sales taxes will be foregone, thus directly affecting the ability of local government to provide services and facilities. Increases in property values would be restricted. The growth in demand for public services and facilities would be reduced in the disposal areas.	Same effect as Mobile Bay Island or Fill.		
Displacement of People	No significant effects	No significant effects			Designated disposal areas are sparsely populated but some displacement of farms, homes, and people would occur.	No significant effects		
Community Cohesion	No significant effects	No significant effects			Displacement of homes, farms, and people and changed land use would alter the pattern of social and economic cohesion.	No significant effects		There would likely be opposition to this plan by numerous landowners which could disrupt community cohesion.
Water Quality	Localized turbidity during construction of disposal islands. Minor release of heavy metals or other pollutants at the disposal areas. Possible alteration of circulation patterns.	Localized impacts of turbidity and minor release of heavy metals or other pollutants at gulf disposal area. Less significant than impacts of unconfined bay disposal of maintenance material	Adverse impacts of turbidity and minor release of heavy metals or other pollutants with disposal of large quantities of dredged material in Mobile Bay. Possible alteration of circulation patterns.	Localized impacts of turbidity and minor release of heavy metals or other pollutants at gulf and bay disposal areas. Impacts of gulf disposal of new work less significant than impacts of unconfined bay disposal of the material.	Shallow aquifers may be influenced by salt water in dredge material. Possible alteration of surface water when returning saline waters to estuary.	Localized turbidity during construction of upper bay islands and fill area and during gulf and unconfined bay disposal. Minor release of heavy metals or other pollutants at disposal areas. Impacts of gulf disposal less significant than impacts of unconfined bay disposal of new work material. Possible alteration of circulation patterns.	Localized turbidity during construction of upper bay islands and fill area and during gulf disposal. Minor release of heavy metals or other pollutants at disposal areas. Impacts of gulf disposal less significant than impacts of unconfined bay disposal. Possible alteration of circulation patterns.	Localized turbidity during construction of upper bay islands and fill area, during shoreline disposal during gulf disposal and during unconfined bay disposal. Minor release of heavy metals or other pollutants at the disposal areas. Possible alteration of circulation patterns.
Wetlands	Possible destruction of salt water marsh and grass beds during construction of upper bay island and fill areas.	No effects	No effects	No effects	Filling of fresh water swamp and possible filling of salt water marsh.	Possible destruction of salt water marsh and grass beds during construction of upper bay island and fill areas.	Possible destruction of salt water marsh and grass beds during construction of upper bay island and fill areas.	Possible destruction of salt water marsh and grass beds during construction of upper bay island and fill areas and along shoreline disposal areas.
Aquatic Environment	Loss of bay bottom habitat with island construction	Destruction of marine organisms at Gulf disposal area. Impacts less severe than impact of unconfined bay disposal.	Destruction of marine organisms with large quantities of material placed unconfined in bay.	Destruction of marine organisms at Gulf disposal area. Impact less severe than unconfined bay disposal of new work dredge material. Destruction of marine organisms associated with open water disposal of maintenance material in Mobile Bay. Impact more severe than under current practice because of larger quantity material involved.	Possible damage to fresh water habitat with return flows of saline water to estuary.	Loss of bay bottom habitat from island and fill areas in upper bay. Destruction of marine organisms at Gulf disposal area. Impacts less severe than unconfined bay disposal of new work dredge material from lower bay. Destruction of marine organisms associated with open water disposal of maintenance material in lower Mobile Bay. Impact more severe than under current practice because of larger quantity material involved.	Loss of bay bottom habitat from island and fill areas in upper bay. Destruction of marine organisms at Gulf disposal area. Impacts less than those of unconfined bay disposal.	Loss of bay bottom habitat from island and fill areas in upper bay. Adverse impacts on shallow water environment near shoreline disposal area. Destruction of marine organisms associated with open water disposal of maintenance material in lower Mobile Bay. Impact more severe than under current practice because of larger quantity material involved.
Terrestrial Environment	No adverse effects. Creation of wildlife habitat.	No effects.	No effects.	No effects.	Possible damage to vegetation by salt water from upland disposal areas. Destruction of wildlife habitat by construction of upland disposal areas.	No adverse effects. Creation of wildlife habitat.	No adverse effects. Creation of wildlife habitat.	No adverse effects. Aids in shoreline erosion problems. Creation of wildlife habitat.
Air Quality	Insignificant	No effects.	No effects.	No effects.	Possible obnoxious odors from upland disposal areas.	Insignificant	Insignificant	Possible obnoxious odors from shoreline disposal area.
Aesthetics	Displeasing appearance of diked or bulkheaded disposal areas in upper and lower Mobile Bay.	No effect.	No effect.	No effect.	Displeasing appearance of diked upland disposal areas and pipelines and booster stations required to transport dredged material.	Displeasing appearance of diked and bulkheaded disposal areas in upper bay.	Displeasing appearance of diked and bulkheaded disposal areas in upper bay.	Displeasing appearance of diked and bulkheaded disposal areas in upper bay and also shoreline disposal area.
Recreation	Possible creation of recreation areas on disposal islands. Loss of small boat recreation area in upper and lower Mobile Bay.	No effect.	No effect.	No effect.	Loss of recreation value of upland disposal areas.	Possible creation of recreation areas on disposal islands. Loss of small boat recreation area in upper Mobile Bay.	Possible creation of recreation areas on disposal islands. Loss of small boat recreation area in upper Mobile Bay.	Possible creation of recreation areas on disposal islands. Initial loss of recreation value of shoreline while material dries and consolidates. Loss of small boat recreation area in upper bay.

MODEL STUDIES

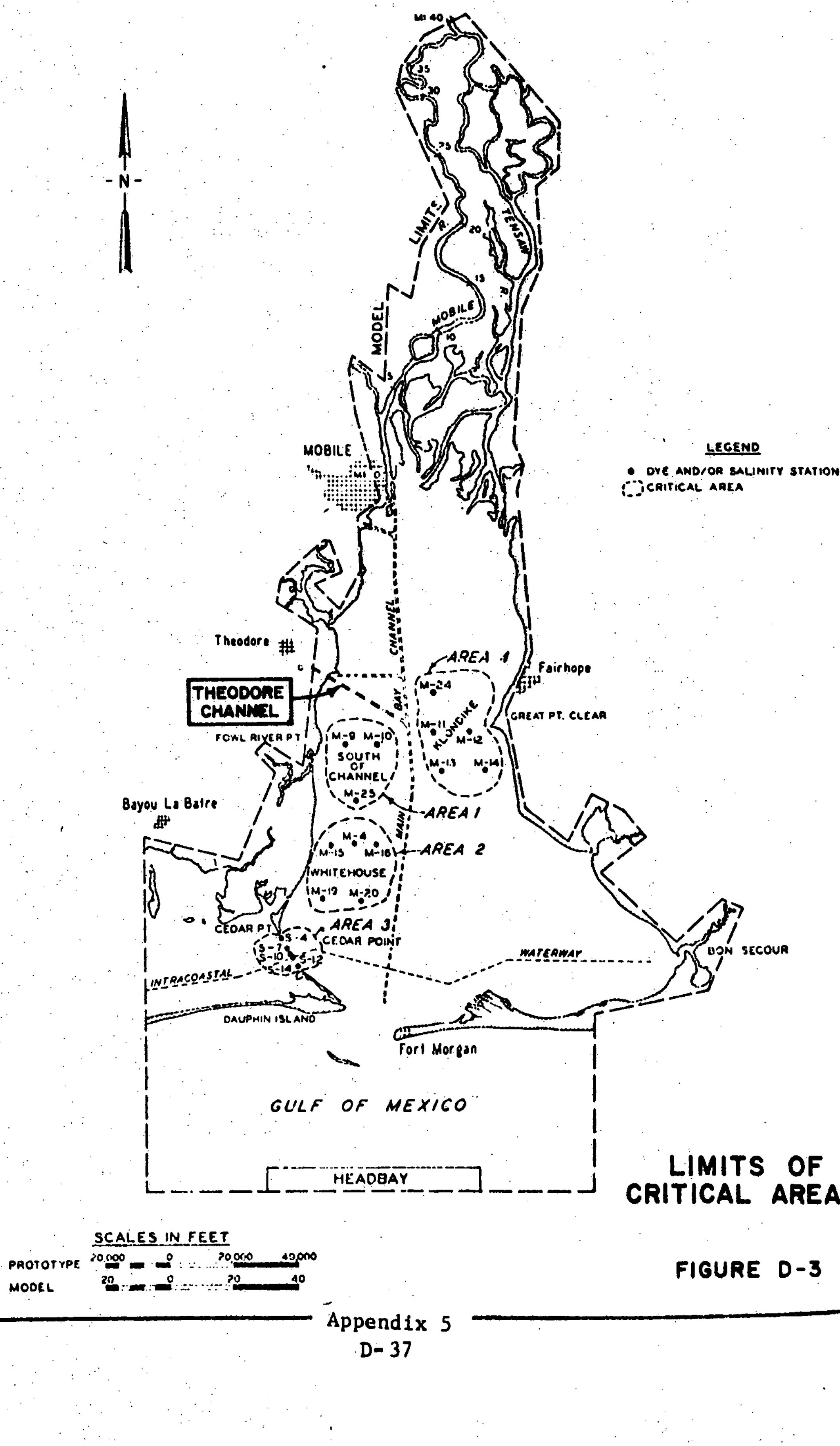
32. Seven of the dredged material disposal plans formulated during the Stage 1 analysis were evaluated on the physical model of Mobile Bay located at the Waterways Experiment Station at Vicksburg, Mississippi with 50 by 500 foot channels. These configurations represent the physical and hydraulic changes that could result from implementation of any of the previously selected concepts plus several additional combinations and variations. Five are Mobile Bay Island and Fill plans which are shown on plates D-1 through D-5. The sixth plan tested is shown on plate D-6 and represents a combination of Mobile Bay Island or Fill and Gulf Disposal Plans with the option for disposal of material along the shoreline. The seventh plan tested consisted of the 50-foot deep Mobile Bay and Theodore Ship Channels with only the proposed Theodore Disposal island in place. This seventh plan tested would represent the Gulf Disposal Plan or the Upland Disposal Plan. This plan is shown on plate D-7.

33. The primary environmental objective of the tests was to analyze the effect the larger channel and disposal alternatives would have upon salinity values within Mobile Bay. The portion of the model testing program that was available for Stage 2 analysis included the salinity changes in the bay with the seven tested plans during the most critical low freshwater inflow of 15,500 cubic feet per second (cfs). The base condition selected for evaluation of the seven plans included the existing project conditions for Mobile Bay with the 40-foot Mobile Ship Channel in place and also included the authorized 40-foot Theodore Ship Channel and disposal island in place.

34. Results of the model tests indicated that all plans caused similar salinity changes regardless of island placement. Generally, the changes under the low inflow conditions included an increase in salinity in the upper bay and a freshening of the lower bay areas. This finding indicates the changes are related more to the enlarged channel than island construction. None of the plans tested maintained the status quo throughout the bay. However, changes in some localities were considered more significant in regard to oyster production. The four oyster producing areas in Mobile Bay that were studied included Cedar Point, Whitehouse, Klondike, and South of Theodore Channel. These four areas and model boundaries are shown on figure D-3. Insofar as overall oyster well-being is concerned, the following ranking of importance, in terms of salinity change was used: Cedar Point Whitehouse Klondike = South of Channel. Table D-3 displays salinity data from these critical areas, obtained during the testing of each plan. Based upon the salinity results, no single plan proved to be significantly better than the others. The plans that showed the least salinity changes were the Mobile Bay Island or Fill Plans shown on Plates D-2 and D-3. These were closely followed by the Mobile Island or Fill and Gulf Disposal Plan or the Gulf Disposal Plan (plate D-7).

SCREENING AND FORMULATING OF STAGE 2 PLANS

35. The selection of plans for detailed consideration was based on the cost, environmental, and socioeconomic analysis performed, the input from the public at a meeting of the Mobile Harbor Advisory Committee on 5 August 1976, and a plan formulation public meeting held in Mobile, Alabama on 22 November 1976. Inferior plans were eliminated and those which exhibited promise from cost, environmental, and socioeconomic standpoints were selected for further consideration. The rationale for these selections follows.



LIMITS OF CRITICAL AREAS

FIGURE D-3

TABLE D- 3

Effects of Plans on Average Salinities in Areas 1, 2, 3, and 4

Total Freshwater Inflow - 15,000 Cubic Feet per second

(Total Salts, parts per thousand)

Plan	Depth	Area 1 (South of Channel) Area Average	Area 1 (South of Channel) Difference*	Area 2 (Whitehouse) Area Average	Area 2 (Whitehouse) Difference	Area 3 (Cedar Point) Area Average	Area 3 (Cedar Point) Difference	Area 4 (Klondike) Area Average	Area 4 (Klondike) Difference
Base	Surface	19.8		24.1		25.9		17.7	
	Bottom	23.6		26.5		27.2		22.1	
	Average	21.7		25.3		26.6		19.9	
1, Plate D- 1	Surface	21.5	+1.7	23.0	-1.1	25.7	-0.2	18.3	+0.6
	Bottom	23.0	-0.6	25.9	-0.6	27.4	+0.2	19.9	-2.2
	Average	22.3	+0.6	24.4	-0.9	26.6	0.0	19.1	-0.8
2, Plate, D- 6	Surface	21.5	+1.7	24.2	+0.1	26.9	+1.0	17.5	-0.2
	Bottom	22.6	-1.0	26.0	-0.5	27.9	+0.7	19.0	-3.1
	Average	22.1	+0.4	25.1	-0.2	27.4	+0.8	18.3	-1.6
3, Plate D- 2	Surface	19.5	-0.3	24.1	0.0	26.3	+0.4	18.6	+0.9
	Bottom	21.1	-2.5	26.0	-0.5	27.9	+0.7	20.7	-1.4
	Average	20.3	-1.4	25.1	-0.2	27.1	+0.5	19.7	-0.2
4, Plate D- 3	Surface	20.1	+0.3	23.7	-0.4	25.9	0.0	18.2	+0.5
	Bottom	21.1	-2.5	25.9	-0.6	27.2	0.0	20.4	-1.7
	Average	20.6	-1.1	24.8	-0.5	26.6	0.0	19.3	-0.6
5, Plate D- 4	Surface	20.5	+0.7	23.3	-0.8	26.5	+0.6	18.0	+0.3
	Bottom	21.3	-2.3	25.6	-0.9	27.9	+0.7	20.0	-2.1
	Average	20.9	-0.8	24.4	-0.9	27.2	+0.6	19.0	-0.9
6, Plate D- 5	Surface	19.6	-0.2	23.4	-0.7	24.7	-1.2	17.6	-0.1
	Bottom	20.3	-3.3	25.6	-0.9	26.4	-0.8	19.5	-2.6
	Average	19.9	-1.8	24.5	-0.8	25.6	-1.0	18.6	-1.3
7 Plate D-7	Surface	20.0	+0.2	23.2	-0.9	25.3	-0.6	19.0	+1.3
	Bottom	20.8	-2.8	26.0	-0.5	26.9	-0.3	21.3	-0.8
	Average	20.4	-1.3	24.6	-0.7	26.1	-0.5	20.2	+0.3

* Plan test value minus test value.

36. The Upland Disposal Plan was eliminated because of excessive costs and adverse socioeconomic and environmental effects. This plan was extremely expensive compared to the other alternatives. There were also severe socioeconmic and environmental effects associated with the large land areas required to store all of the dredged material over the life of the project.

37. A Theodore Rehandling Plan was investigated to determine if there would be savings by using the proposed Theodore disposal island as a place to store dredged material for drying and consolidation before transport to the Gulf of Mexico. In a detail investigation of this plan, the costs of double handling of the material made this plan more expensive than first indicated. Since this plan is very similar to the Mobile Bay Island or Fill and Gulf Disposal Plan with transport of the maintenance material to the Gulf of Mexico, yet more expensive than this plan, the Theodore Rehandling Plan was eliminated from further consideration.

38. The Mobile Bay Island and Fill Plans which consisted of 5 plans with disposal islands in upper and lower Mobile Bay had both advantages and disadvantages. The major drawback for these alternative plans is that they are extremely expensive. This is due in large part to the fact that a sheetpile or bulkheaded wall is considered necessary to retain the material in lower Mobile Bay, making the large disposal island in the lower bay extremely costly. This plan has advantages since all of the new work and maintenance material would be contained within diked or bulkheaded disposal areas. However, these plans, as a total concept, were eliminated from further consideration, mainly due to the excessive cost.

39. The Open Water Disposal Plan, (plate D-18) where all the new work and maintenance material from the channel enlargement would be deposited along the existing channels in Mobile Bay, is the least expensive of all plans. This open water disposal plan would cause environmental problems due

to the extremely large quantities of new work material deposited alongside the channel. These deposits of new work material alongside the channel would physically divide the bay, totally change its circulation patters, and water quality could be severely degraded in large areas.

40. Four remaining disposal plans, along with the Shoreline Disposal Option which could be implemented with any plan, were selected for further analysis in Stage 2 of the planning process. These alternative plans along with the "No Action" Plan and Environmental Quality Plan are all considered worthy of further study and are discussed in subsequent paragraphs.

41. During Stage 2 studies four separable NED navigation elements of Mobile Harbor were carried forward for further consideration. These are:

- Enlargement of Mobile Ship Channel to the mouth of the Mobile River to optimum dimensions.
- Enlargement of Theodore Ship Channel to optimum dimensions.
- Provision of turning basin opposite McDuffie Island.
- Provision of anchorage area opposite McDuffie Island.

Four of the structural alternatives are essentially four separate and distinct methods of dredged material disposal with each containing the navigation features listed above. Each of these alternatives along with the "No Action" and Environmental Quality plans are described below.

42. "No Action" Plan. The "No Action" Plan would involve no changes in the authorized navigation improvements for Mobile Harbor. Under this plan current trends is economic development, environmental quality, and port development would continue. The forecasted pattern

of port development and economic and environmental conditions are based on the following assumptions regarding future conditions of the Mobile Harbor project.

- The authorized 40- by 400- foot channel to the Theodore Industrial Complex will be constructed.

- The current practice of open water disposal of dredged maintenance material in Mobile Bay will continue.

- There will be a continuing and pressing need for disposal areas for dredged maintenance material from Mobile River.

- Port development for Mobile Harbor will take place in the vicinity of existing port facilities, at McDuffie Island, and along the Theodore Ship Channel in the Theodore Industrial Area.

- The commodities projected for the year 2044 will probably continue to move through the Port of Mobile; although, at greater costs and even though considerable traffic delays will occur due to the greater number of vessels.

The "No Action" Plan provides an alternative course of action for the citizens of the Mobile Region and will provide the base condition from which the costs, benefits, and socioeconomic and environmental effects of all other alternatives are measured. No costs or economic benefits are associated with the "No Action" Plan.

43. <u>Environmental Quality (EQ) Plan</u>. This plan was formulated to address the concerns of the pilots that handle the larger deep-draft vessels in the present restricted bay channel and also known environmental concerns and opportunities. The plan would widen the existing main bay channel up to the mouth of Mobile River. This would provide a safer channel and reduce the probability of

accidents.

44. The existing maintenance methods of Mobile Harbor would be modified as follows:

- Maintenance of the entrance channel provides sand that can be utilized to restore the eroded beaches of Dauphin Island.

- The existing ridges in the upper bay created by natural sedimentation and dredged material that was disposed of alongside the main bay channel can be removed and the material placed such that it will fill depressions in Mobile Bay that cause stratification of water Existing and future maintenance in the upper and lower bay channel will be carried to the Gulf of Mexico for disposal.

45. All new work dredged material will be transported by dump scows to a gulf disposal site or utilized to abate shoreline erosion along the western shore of Mobile Bay. The circulation in the bay can be further enhanced by providing additional openings in the U. S. Highway 90 causeway and by providing an opening in the fill connecting McDuffie Island to the mainland. Also, fresh water circulation in Mobile Delta can be modified to offset the effects of the existing saltwater wedge in the ship channel. These circulation alterations along with the idea of establishing additional oyster beds can be implemented with any structural plan; however, will require detailed studies prior to their recommendation.

46. <u>Brookley Expansion Area and Gulf Disposal Plan No. 1 (Plate D-19)</u>. This plan involves the construction of an expansion area in Mobile Bay, just south of McDuffie Island, adjacent to the Brookley Industrial Complex. An island would also be constructed on the east side of the ship channel extending southward from Little San Island. The expansion area adjacent to the Brookley

Complex will contain the new work material from the enlarged channel in upper Mobile Bay and will also have space reserved for maintenance material from the upper bay. The island on the east side of the channel would be constructed with a ring dike of new work material from the enlarged Mobile Ship Channel and would be sized to contain 50 years of dredged maintenance material from Mobile River. New work material from the enlarged Theodore, lower bay, and bar channels would be transported to the Gulf of Mexico for disposal. The maintenance material from these same areas would also be transported to the Gulf of Mexico for disposal. This plan was formulated to minimize open water disposal in the bay of new work dredged material and eliminate all open water disposal of dredged maintenance material in the bay.

47. Brookley Expansion Area and Gulf Disposal Plan No. 2 (Plate D-20). This plan involves all the same elements as the Brookley Expansion Area and Gulf Disposal Plan No. 1 except that maintenance material from the lower bay and Theodore Channels will be disposed of in Mobile Bay instead of the Gulf of Mexico. Disposal of maintenance material from the lower bay channel will be in the currently approved maintenance areas on either side of the channel. After capacity of the Theodore disposal island is reached, the maintenance material from the Theodore Channel will be disposed of south of the Theodore Channel and west of the lower bay disposal. Placing maintenance material in open water in the lower bay is not as environmentally acceptable as utilizing the gulf for disposal, however, the plan represents a realistic trade off due to the cost of transporting the material to the gulf. This plan in lieu of the unacceptable open water disposal plan, most closely meets the NED objectives.

48. Gulf Disposal Plan No. 1 (Plate D-21). This plan calls for the removal of all new work and dredged maintenance material from the enlarged Mobile Ship Channel and Theodore Ship Channel to the

Gulf of Mexico. The maintenance material from the authorized 40- by 400- foot Theodore Industrial Channel would be placed in the Theodore Disposal island being constructed in conjunction with the Theodore Ship Channel until its capacity would be reached. At such time that material would also be conveyed to the gulf for disposal. This plan makes no provision for storage of future maintenance material from the Mobile River Channel, however, it is oriented toward the EQ objectives in that it eliminates all open water disposal of dredged material in Mobile Bay. The tradeoffs of this plan are primarily the economic costs of transporting the dredged material to the gulf and the land enhancement benefits foregone.

49. Gulf Disposal Plan No. 2 (Plate D-22). This plan embraces all of the features of Gulf Disposal Plan No. 1 with the exception that maintenance material from the enlarged Mobile Ship Channel will all be discharged into Mobile Bay in accordance with current practice. Maintenance material from the Theodore Ship Channel will be disposed of in the disposal island and also into open water south of the Theodore Ship Channel and west of the Mobile Ship Channel.

ASSESSMENT OF INTERMEDIATE PLANS

50. Socioeconomic and Environmental Assessment. Implementatation of any of the four channel deepening alternatives would cause about the same socioeconomic effects. Construction of Brookley Expansion Area Plans No. 1 and No. 2 would induce more industrial development and port expansion in this area than would occur with the EQ or Gulf Disposal Plans. The four channel deepening plans would create an economic advantage for the Port of Mobile in comparison to other ports. The economic advantages would result in an increase in original economic and industrial development and would result in increased employment and demographic growth. Economic growth and

port expansion would occur at a slower rate in the absence of deeper ship channels to Mobile and Theodore. Either plan as compared with "No Action" has significant national and international effects in terms of world resource distributions and import-export balances. The preliminary environmental effects assessment of the channel deepening plans as compared to the "No Action" (no development) plan are presented in table D-4.

51. Cost Analysis. The cost analysis performed at this stage of the planning process was to the detail required to compare alternative plans fairly. The Stage 2 plans were not designed in detail but continued to be somewhat conceptual in nature. For this reason, the cost and benefit estimates for Stage 2 plans were not detailed in scope and serve only for relative comparison. These benefits and cost indicators are also given in table D-4. Further studies are required at this time to assess the costs and benefits of the channel widening (EQ) plan.

Table D-4

PRELIMINARY ENVIRONMENTAL ASSESSMENT - MOBILE HARBOR NAVIGATIONAL IMPROVEMENTS

CHANNEL MODIFICATIONS				
Environmental Effects	Mobile and Theodore Channels	Mobile Channel Only	Theodore & Lower Bay Channels Only	No Development
Hydrological	Significant changes in salinity gradients (see Disposal Alternatives salinity gradients). No other significant effects.	Significant changes in salinity gradients./1 No other significant effects.	Less changes in salinity gradients than with all main channels modified./1 No other significant effects.	No effects.
Archeological	No significant sites affected by Theodore Channel. Archeological survey may be required for widening Mobile Ship Channel; no known sites affected.	Archeological survey may be required for widening Mobile Ship Channel; no known sites	No significant sites affected by Theodore Channel. Archeological survey may be required for lower bay channel; no known sites affected.	No effects.
Natural Resources	Additional wetlands committed to Theodore Channel. Loss of bay bottom with wider Mobile Channel and Theodore Channel.	Loss of bay bottom with wider Mobile Channel.	Additional wetland and bay bottom committed to Theodore Channel. Also, loss of bay bottom if lower bay channel widened.	No effects
Ground Water	Deepening the Theodore Channel could affect shallow fresh water aquifers./2	No significant effects	Deepening the Theodore Channel could affect shallow fresh water aquifers./2	No effects with Mobile Bay Channel./2

GENERAL DISPOSAL ALTERNATIVES					
Section 404 Considerations/3	Brookley Expansion Area and Gulf Disposal Plan No. 1	Brookley Expansion Area and Gulf Disposal Plan No. 2	Gulf Disposal Plan No. 1	Gulf Disposal Plan No. 2	No Development
Physical Effects					
Wetlands	Destruction of at least 7 acres of saltwater marsh during construction of upper bay fill areas.	Destruction of at least 7 acres of saltwater marsh during construction of upper bay fill areas	No effects.	No effects.	Continued destruction of saltwater marsh areas in upper bay with the disposal of maintenance material from the river
Water Column	Minor turbidity during construction of island and fill areas, disposal of new work material in Gulf, and periodic disposal of maintenance material from lower bay at Gulf disposal site	Minor turbidity during construction of island and fill areas in upper bay, disposal of new work material in Gulf, and periodic disposal of maintenance material in lower bay.	Minor turbidity during disposal of new work material and periodic disposal of maintenance material at Gulf disposal site from bay channels.	Minor turbidity during disposal of new work material at Gulf disposal site, and periodic disposal of maintenance material adjacent to the channel in the upper and lower bay.	Minor turbidity during periodic disposal of maintenance material adjacent to the channel in the upper and lower bay.
Benthos	Destruction of benthic communities at island and fill areas and Gulf disposal site. Additional smothering due to mud flows. The communities could reestablish at the Gulf disposal site between maintenance dredging of the lower bay and at the areas subjected to mud flows.	Destruction of benthic communities at island and fill areas, Gulf disposal site, and lower bay disposal areas. Additional smothering due to mud flows. The communities could reestablish at the Gulf disposal site, areas subjected to mud flows, and at the lower bay disposal areas between maintenance dredging.	Destruction of benthic communities at Gulf disposal site. Additional smothering due to mud flows. The communities could reestablish between maintenance dredgings of the bay channels	Destruction of benthic communities at Gulf disposal site and bay disposal areas. Additional smothering due to mud flows. The communities could reestablish at the Gulf disposal site, and at the bay sites between maintenance dredgings.	Destruction of benthic communities during disposal of maintenance material in bay; however, reestablishment is fairly complete between dredgings.
Water Circulation	Minor alteration of surface current patterns in the upper bay. No significant effects at Gulf disposal site if the material is distributed over a broad area.	Minor alteration of surface current patterns in the upper bay. Possible continued alteration of circulation in lower bay due to disposal maintenance material adjacent to the channel./4 No significant effects at the Gulf disposal site if the material is distributed over a broad area	No significant effects if the material is distributed over a broad area.	Possible continued alteration of circulation in upper and lower bay due to disposal of maintenance material adjacent to the channel./4 No significant effects at Gulf disposal site if the material is distributed over a broad area.	Possible continued alteration of circulation in the upper and lower bay due to disposal of maintenance material adjacent to the channel./4

Continued on next page

Table D-4 (con't)

PRELIMINARY ENVIRONMENTAL ASSESSMENT - MOBILE HARBOR NAVIGATIONAL IMPROVEMENTS

GENERAL DISPOSAL ALTERNATIVES, (cont'd)

Section 404 Considerations/3	Brookley Expansion Area and Gulf Disposal Plan No. 1	Brookley Expansion Area and Gulf Disposal Plan No. 2	Gulf Disposal Plan No. 1	Gulf Disposal Plan No. 2	No Development
Physical Effects, cont'd Salinity Gradients	Salinity increases in upper bay and freshening of lower bay./5 Considering existing salinity gradients, no major adverse effects are expected at the four critical areas of the bay (see Figure 1). Cedar Point area and Klondike area approaching threshold of impact (Cedar Point +0.8 o/oo Klondike -1.6 o/oo).	Same as Brookley Expansion Plan No. 1.	Similar to Brookley Expansion Plan No.1 except less adverse changes in salinities at Cedar Point oyster reef (-0.5 o/oo). More adverse effect at South of Channel area (-1.3 o/oo) and White house (-0.7 o/oo).	Similar to Brookley Expansion Plan No. 1 except less adverse changes in salinities at Cedar Point oyster reef (-0.5 o/oo); more adverse change at South of Channel area (-1.3 o/oo) and White house (-0.7 o/oo).	No change in salinity gradients.
Chemical-Biological Interactive Effects Water Column	Minor release of heavy metals or other pollutants at island and fill areas during construction, and at Gulf disposal site during disposal of new work material and periodic disposal of maintenance material from the lower bay.	Minor release of heavy metals or other pollutants at island and fill areas during construction, at Gulf disposal site during disposal of new work material, and at disposal areas adjacent to the channel in the lower bay during disposal of maintenance material.	Minor release of heavy metals or other pollutants at Gulf disposal site during disposal of new work material and periodic disposal of maintenance dredged material from bay channels.	Minor release of heavy metals or other pollutants at Gulf disposal site during disposal of new work material, and at disposal areas adjacent to the channel in the upper and lower bay during periodic disposal of maintenance material.	Minor release of heavy metals or other pollutants at disposal areas adjacent to the channel in the upper and lower bay during periodic disposal of maintenance material.
Comparison of Sites Shellfish	Occasional commercial shrimping at Gulf disposal site. Nursery grounds for shrimp and crabs at upper bay fill areas. Significant sport shrimping at upper bay disposal area.	Occasional commercial shrimping at Gulf disposal site. Nursery grounds for shrimp and crabs at upper bay fill area. Significant crabbing area and major oyster reefs in vicinity of lower bay disposal areas. Significant shrimping at bay disposal areas.	Occasional commercial shrimping at Gulf disposal site.	Occasional commercial shrimping area at Gulf disposal site. Nursery grounds for shrimp and crabs in vicinity of upper bay disposal areas. Significant crabbing and shrimping areas and major oyster reefs in vicinity of bay disposal areas.	Significant shrimping near bay disposal areas. Nursery grounds for shrimp and crabs in vicinity of upper bay disposal areas. Significant crabbing areas and major oyster reefs in vicinity of bay disposal areas.
Fisheries	Commercial and sport fishing grounds at Gulf and bay disposal sites. Nursery, spawning grounds, and feeding site at upper bay disposal areas.	Commercial and sport fishing grounds at Gulf and bay disposal sites. Nursery, spawning grounds, and feeding site at upper bay disposal areas.	Commercial and sport fishing grounds at Gulf disposal site.	Commercial and sport fishing grounds at Gulf and bay disposal areas. Nursery, spawning grounds, and feeding sites in vicinity of upper bay disposal areas.	Commercial and sport fishing grounds at bay disposal areas. Nursery, spawning grounds and feeding sites in vicinity of upper bay disposal area.
Wildlife	Waterfowl habitat at island and fill disposal areas.	Waterfowl habitat at island and fill disposal areas.	None	Waterfowl habitat in vicinity of upper bay disposal areas.	Waterfowl habitat in vicinity of upper bay disposal areas.
Recreation	Boating, fishing, and swimming in bay and Gulf.	Boating, fishing, and swimming in bay and Gulf.	Boating, fishing, and swimming in Gulf.	Boating, fishing, and swimming in bay and Gulf.	Boating, fishing, and swimming in bay.
Threatened & Endangered	None endemic to vicinity of disposal areas.	None endemic to vicinity of disposal areas.	None endemic to vicinity of disposal areas.	None endemic to vicinity of disposal areas.	None endemic to vicinity of disposal areas.
Wetlands	Approximately 7 acres of saltwater marsh in upper bay at proposed fill area. Other saltwater marsh areas also in the vicinity of the fill area	Approximately 7 acres of saltwater marsh in upper bay at at proposed fill area. Other saltwater marsh areas also in the vicinity of the fill area	None	Saltwater marsh areas in vicinity of upper bay disposal.	Saltwater marsh area in the vicinity of upper bay disposal area and used for disposal of maintenance material from the river.

/1 Conclusions based on interpretation of results of model studies with all channels modified (also see Disposal Alternatives salinity gradients).

/2 Studies are currently being conducted to determine the effects on ground water of construction of the Theodore Channel.

/3 Due to the changing state of guidelines and regulations, further studies may be warranted in the future.

/4 A study is currently being conducted to analyze the buildup of dredged material placed adjacent to the channel and its effect on water circulation.

/5 Results based on model studies with the depth and width of the main channel through Mobile Bay and the Theodore Channel being 50 ft. x 500 ft.

Table D-4 (Con't)

Preliminary Environmental Assessement - Mobile Harbor Navigation Improvements (Economic Considerations)

General Disposal Alternatives	Preliminary Annual Benefits ($1,000,000)	Preliminary Annual Costs ($1,000,000)
Brookley Expansion Area & Gulf Disposal Plan No. 1	54	34
Brookley Expansion Area & Gulf Disposal Plan No. 2	54	24
Gulf Disposal Plan No. 1	54	46
Gulf Disposal Plan No. 2	54	31

ALTERNATIVES ELIMINATED

52. Certain alternative plans and measures of improvement to Mobile Harbor have been excluded from consideration because of inefficiency or their failure to meet the indicated needs in the study area. These alternatives are discussed in the following paragraphs.

53. Gulf Disposal Plan No. 2. This plan provides for placing maintenance material from the enlarged Mobile Ship Channel and Theodore Ship Channel in Mobile Bay. This plan neither yields the maximum net benefits, provides storage for maintenance from Mobile River, or meets the planning objective of improving water circulation in the bay.

54. Shoreline Disposal Option. A survey of property owners along the western shore of Mobile Bay was made to determine the interest in placing dredged material along the shoreline to abate the existing erosion problem. Various objections expressed included environmental damage, asthetic degradation, and restriction of reparion rights. A tabulation of these comments clearly indicated that such a solution was not desired or acceptable by the majority of shoreline property owners.

In view of the local objections, this disposal option was dropped from further consideration.

ALTERNATIVES CONSIDERED FURTHER

- Brookley Expansion Area and Gulf Disposal Plan No. 1 (Modified)
- Brookley Expansion Area and Gulf Disposal Plan No. 2 (Modified)
- Gulf Disposal Plan No. 1
- Channel Widening Plan (EQ)
- "No Action" Plan

55. The alternative plans retained for detailed analysis are all considered viable concepts. In terms of model tests, general assessments and other relative indicators these conceptial plans are indicated to be the better plans to study further. Within these concepts, appropriate channel dimensions remain to be determined before specific plans can be defined and optimized. These deriviations require the analysis of projected traffic and commerce and the application of engineering design criteria and guidance. These applications are discussed in the following paragraphs.

CHANNEL DESIGN

56. Design of channel features for Mobile Harbor requires an evaluation of existing and projected traffic conditions, physical factors affecting the channel, and the application of available criteria and professional judgement. Currently, design criteria exist only in the form of guides, established through case observations. The guides are presented in ranges established on the basis of operating conditions, traffic densities and vessel characteristics for the anticipated fleet. The application of these guides to the Mobile Harbor Study and analyses required to determine the channel alinement, depths and widths are discussed in the following paragraphs.

57. <u>Projected Traffic Characteristics</u>. Mobile Harbor is an international port handling wide varieties of general cargoes and dry and liquid bulk commodities. In evaluating projected vessel traffic through Mobile Harbor it is assumed that the fleet composition of dry bulk carriers and tankers operating out of the harbor would reflect those available within the world fleet for movement of their respective types of cargoes. Accordingly, the proportioning of the carrying capability for a given size vessel in relation to the world fleet applied to the projected annual tonnage movements through Mobile Harbor for any given year yields the number of trips for that particular size vessel that could be expected to be made into and out of the harbor for that year. However, on general cargo vessels the number of trips for any given year was based on the average cargo loaded or discharged at Mobile, which is 1311 tons per vessel. It was found there is no direct relationship between the size of general cargo vessel and the quantity of cargo loaded or discharged. Through this type of evaluation the total number of trips made into and out of the harbor, the number of trips made by a given vessel, and the respective percent of total trips made by a given vessel for various years were determined for the several channel depths being evaluated. An example of an analysis of the traffic applicable to all cargo vessels, for the year 2000 and a 55-foot deep channel is given in table D-5.

58. Channel Alinement. The alinement of the ship channel from the Gulf of Mexico through Mobile Bay to the main terminal areas on Mobile River and in the Theodore Industrial Complex consits of a series of straight tangents. With the exception of the turn of the Theodore channel from the main Bay channel (42 degrees) the maximum angle of any deflection between the mouth of Mobile Bay and the mouth of Mobile River is approximately 18 degrees. In view of the existing channel, the absence of any areas of unusually severe shoaling or existing turning difficulties and with appropriate easing of the turn into the Theodore channel, consideration of alternative alinements is not warranted. Model studies will be utilized in further studies to confirm the channel alinement at the lower end of the main bay channel and the turn into the Theodore channel. All improvements considered herein maintain the alinement of the existing channels.

59. Channel Depths. Useable channel depths are the main considerations of navigation improvements. The appropriate channel depth is ultimately determined through economic analysis of the most efficient drafts of available vessels that will be utilized by a particular commerce moving through a channel. Once specific movements are identified, the most efficient level of channel depth may be determined through an optimization analysis to determine which depth would yield maximum net benefits. This analysis is keyed to the static drafts of vessels that would use the channel. However, safe and efficient ship operation requires channel depths in excess of the vessel's loaded static draft. Where conditions warrant, allowances in design channel depths must be made for vessel squat and trim, sinkage due to fresh water, pitch and roll, abnormal tides, and operating safety clearances.

Table D-5

TRAFFIC ANALYSIS FOR THE YEAR 2000
(55-Foot Channel)

Assigned Vessel Size (DWT)	Registered Loaded Draft (feet)	Breadth (feet)	No. of Vessel Trips	Vessel Fleet Distributon (%)
5,000	24	55	645.6	17.60
10,000	27	63	368.9	10.08
15,000	29	69	991.8	27.07
20,000	31	74	465.6	12.70
25,000	33	79	281.1	7.68
30,000	34	83	288.8	7.88
35,000	36	87	91.7	2.50
40,000	37	90	55.2	1.51
45,000	38	94	66.8	1.83
50,000	40	97	38.0	1.03
55,000	41	100	39.9	1.09
60,000	42	103	40.2	1.10
65,000	43	105	40.2	1.10
70,000	44	108	36.5	0.99
75,000	45	111	30.6	0.83
80,000	46	113	9.3	0.25
85,000	46	115	81.9	2.23
90,000	47	118	13.3	0.36
95,000	48	120	5.4	0.15
100,000	49	122	12.0	0.33
105,000	50	124	10.7	0.30
110,000	50	126	6.1	0.17
115,000	51	128	9.8	0.27
120,000	52	130	4.0	0.11
125,000	53	132	8.7	0.23
130,000	53	134	4.7	0.13
135,000	54	136	7.8	0.22
140,000	55	138	2.9	0.08
145,000	55	140	3.9	0.11
150,000	56	142	2.1	0.07

60. Vessels typically navigate the Mobile Bay channel at speeds from 5 to 10 knots. At these speeds operators indicate that an allowance of 1 foot is adequate for trim and 0.5 foot for squat. Although Mobile Bay is a brackish water body, the tendency for the more dense salt water to follow the deeper channel minimizes the need for allowances for fresh water sinkage. Maximum tidal range in the bay is about 3.6 feet and prolonged low water conditions seldom fall below -0.5 m.l.w. In view of these minimal effects an allowance of 0.5 foot for brackish water and abnormal low water is adequate. Mobile Bay is relatively shallow and protected such that waves greater than 1 to 2 feet are not normally encountered and no allowance for pitching and rolling in Mobile Bay is necessary. In the gulf entrance channel waves of 4 to 5 feet are commonly encountered and an allowance of 2 feet for these factors is necessary. In both the gulf and bay channels a 2 foot operating safety clearance is considered appropriate to allow for vessel intakes and controllability. Accordingly, in addition to the vessel's loaded static draft, allowances of 4 feet in Mobile Bay and 6 feet in the gulf entrance channel are considered necessary for safe efficient operation. These allowances have proven satisfactory in the past with vessels weighing up to 100,000 DWT and are considered adequate for future traffic. The allowances are included in evaluations for all increments of channel depth considered for the various plans investigated and are reflected in vessel operating cost and benefit evaluations.

61. <u>Channel Widths.</u> The design width of a channel depends on whether a vessel is likely to meet and pass other vessels that must stay in the navigation channel, whether the channel is in a wide waterway, the characteristics of the bed and banks, the depth of the channel, the existence of yawing forces such as currents and waves at angles to the channel, and the characteristics of the vessels and their operators. While acknowledgeing no formulas for evaluating these factors and their complicated interrelationships, EM 1110-2-1607 references general guides presented in chapter 10 of the Committee on Tidal Hydraulics Report No. 3. In addition, the study of other waterways having commerce, traffic and physical conditions

similar to the one under study is suggested as a means of determining the appropriate balance between safe efficient operation and eocnomical construction. The EM cautions that accident-free operation of another waterway may reflect an overdesigned, uneconomical project as well as an appropriately designed project.

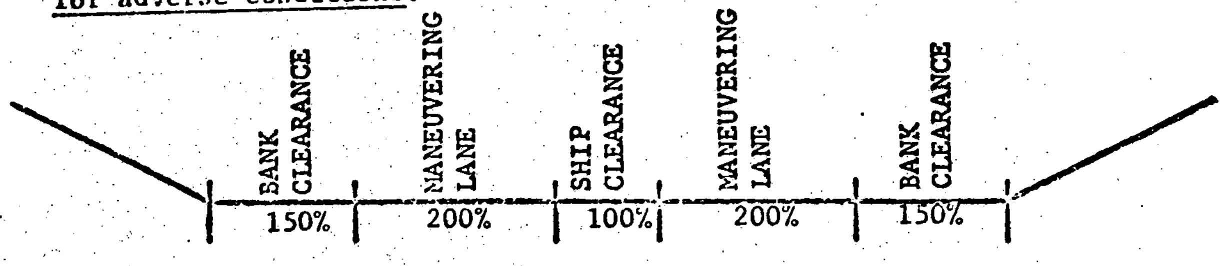
62. Guidance provided in the Committee on Tidal Hydraulics Report No. 3 indicates a range of channel widths that should be considered on the basis of user vessel characteristics and physical and hydraulic conditions in the channel area. These guides suggest ranges to be considered for vessel maneuvering lanes, bank clearances and, in cases where two-way traffic is involved, a vessel clearance lane. These allowances are discussed below and maximum and minimum conditions are illustrated in figure D-4 for two-way and one-way traffic, respectively.

63. The maneuvering lane is that portion of the channel required for a vessel to navigate a straight course. This lane should provide adequate width for the vessel to avoid encroaching on its safe bank clearance or approaching another ship so closely that dangerous interference between ships will occur. Model tests and vessel observations outlined in Tidal Hydraulic Report No. 3 indicated that maneuvering requirements for various vessels are mainly related to the vessels controllability. These tests indicated that the maneuvering lane may be as little as 160 to 180 percent of the vessel beam for those with good to average controllability where there are no currents at an angle to the channel, or winds or waves that cause vessel yaw. When vessels have poor controllability and yawing forces are likely to be experienced, 200 percent of the vessel beam is suggested for the maneuvering lane. In general, the controllability of various vessels was defined as follows:

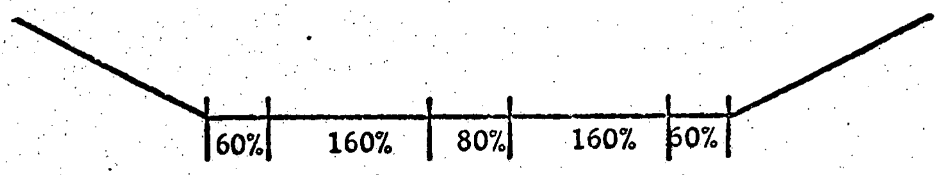
(Given in % of Vessel Beam)

Two-way traffic:

Maximum allowances for adverse conditions.

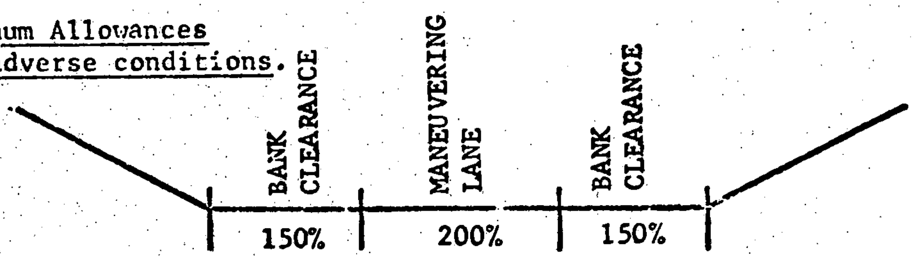


Minimum Allowances for Ideal Conditions.



One-way traffic:

Maximum Allowances for adverse conditions.



Minimum Allowances for Ideal Conditions.

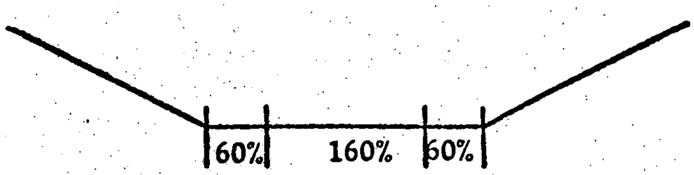


Figure D-4

1. Very good for naval fighting vessels and freighters of the Victory ship class,
2. Good for naval transports and tenders, T-2 tankers, new ore ships and freighters of the Liberty ship class,
3. Poor for old ore ships and damaged vessels.

Based upon this classification, the criteria shown in figure D-4 were recommended for a ship navigating the quarter-point of the channel. A maneuvering lane equal to 140 percent of the vessel's beam was recommended for a ship on the center line of the channel, regardless of controllability. Bank clearances are required to compensate for the positive pressures against the bow of a vessel and the negative pressures against its stern as it moves in proximity to a channel bank. Pressures are created by the hydraulic compression of the water as it is "squeezed" between the vessel and the bank at its bow and by the rapid evacuation of the water at the stern by the vessel's propellers. With adequate clearances this phenomenon can be compensated and equilibrium established through application of some degree of rudder. Again the bank clearance required by a vessel is dependent upon the vessel's controllability, its speed, the nature of the bank material, shoaling characteristics, the width and depth of the channel, and wind and hydraulic forces. Studies indicate that, where favorable conditions exist, the bank clearance would be as little as 60 percent of the beam of the vessels if they are known to handle well that close to the edge of the channel. Conversely, if strong currents, winds, and waves are known to occur frequently at an angle to the channel and the banks are composed of hard materials, clearances up to 150 percent of the vessel beam may be advisable.

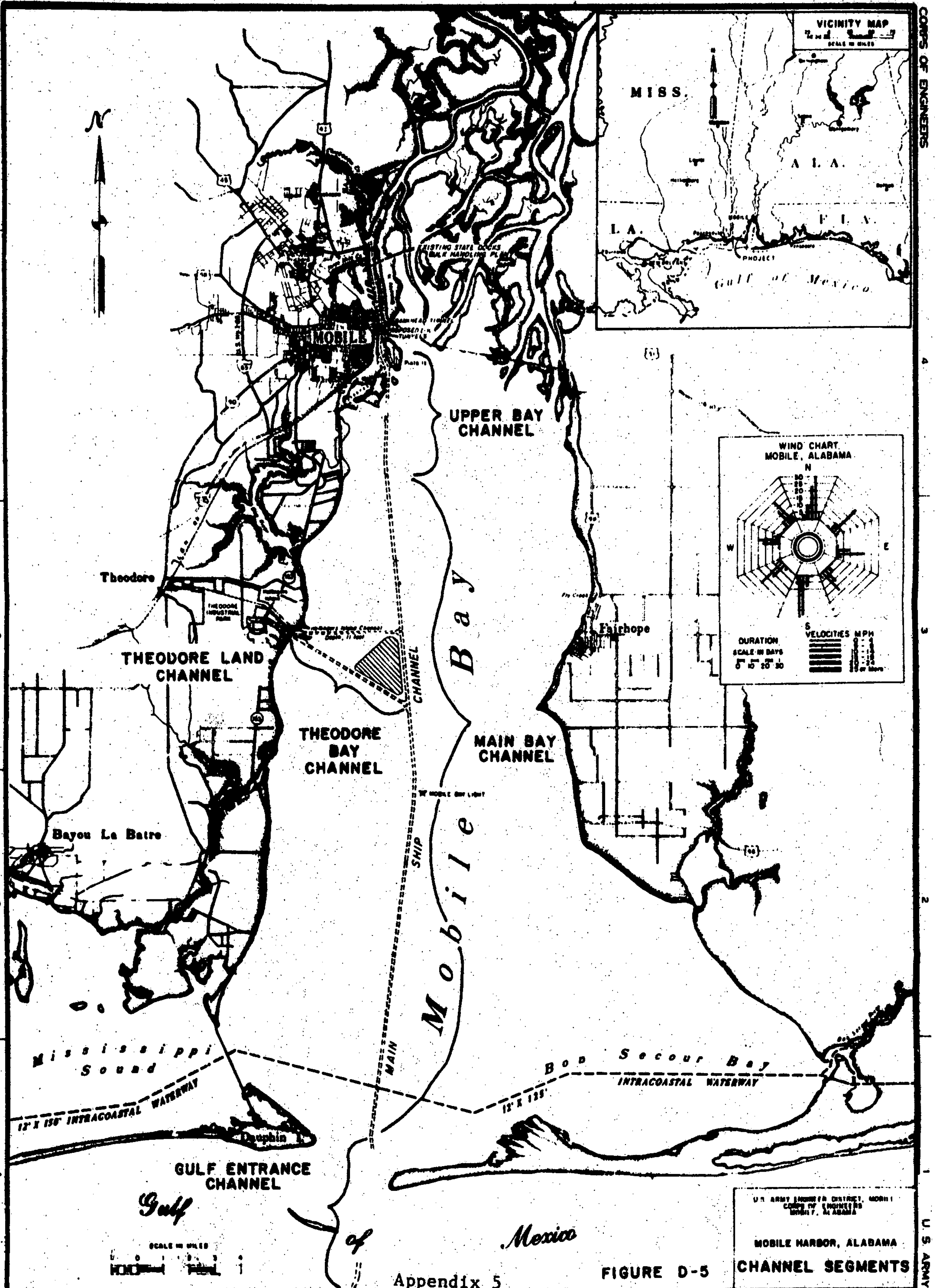
64. In cases where a channel is required to accommodate two-way traffic, a width allowance is necessary between the vessels to avoid adverse hydraulic interactions when passing. The tests outlined in Tidal Hydraulic Report No. 3 conclude that, in wide waterways which are well buoyed and not subject to strong currents or other yawing forces, a minimal ship

clearance of as little as 80 percent of the beam of the larger vessel may be satisfactory. However, a clearance of 100 percent of the beam is recommended for less ideal conditions.

65. The initial step in the design of a channel width is to utilize the above mentioned criteria as a guide in providing a minimum one-way width design that will safely accommodate the largest vessel expected to call at the port. This vessel is defined herein as the design vessel. For example, in selecting design vessels, a 150,000 DWT vessel with a draft of 51 feet (light-loaded 5 feet), a beam of 142 feet, and a length of 953 feet was considered the largest vessel that would utilize a 55-foot deep channel, and a 115,000 DWT vessel with a draft of 46 feet (light-loaded 5 feet), a beam of 128 feet, and a length of 879 feet was considered the largest vessel that would utilize a 50-foot deep channel.

66. The minimum one-way channel for the design vessel is adequate to safely pass a percentage of the smaller vessels with unconstrained two-way traffic, therefore, following the development of the one-way channel for the design vessel, further studies are required to investigate the potential for incrementally increasing the width to minimize traffic delays.

67. In defining conditions in Mobile Bay that must be considered in deriving an appropriate channel width, the channels are distinguishable as five segments: (1) the gulf entrance, (2) the main bay channel from the mouth of the bay to the upper most reach south of the mouth of the Mobile River, (3) the upper most reach in the bay consisting of about 4 miles through the vicinity of the Brookley Industrial Area and McDuffie Island, (4) the Theodore bay channel, and (5) the Theodore land cut channel. These segments are identified on figure D-5.


VICINITY MAP
MISS.
ALA.
FLA.
LA.
Gulf of Mexico
PROJECT
MOBILE
EXISTING STATE DOCKS
BULK HANDLING PLANT
UPPER BAY CHANNEL
WIND CHART
MOBILE, ALABAMA
N
W
E
S
DURATION
SCALE IN DAYS
VELOCITIES MPH
Theodore
Fairhope
THEODORE LAND CHANNEL
THEODORE BAY CHANNEL
MAIN BAY CHANNEL
Mobile Bay
MAIN SHIP CHANNEL
Bayou La Batre
Mississippi Sound
Bon Secour Bay
INTRACOASTAL WATERWAY
12' X 150' INTRACOASTAL WATERWAY
12' X 125'
Dauphin
GULF ENTRANCE CHANNEL
Gulf of Mexico
SCALE IN MILES
U.S. ARMY ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALABAMA
MOBILE HARBOR, ALABAMA
CHANNEL SEGMENTS
CORPS OF ENGINEERS
U S ARMY
FIGURE D-5

68. Vessels in an entrance channel are often subjected to varying magnitudes of external forces, including cross winds, cross currents, turbulent, rough waters with considerably higher waves than in sheltered bays, tides and currents. The vessels may be confronted with breaking waves, and inadequate visibility from fog and heavy rain. The existing gulf entrance consists of about 1.5 miles of channel from the Gulf of Mexico across the outer bar of Mobile Bay into the bay entrance. This segment of the channel is subject to gulf waves of 4 to 5 feet and coastline currents at angles to the channel. The channel is straight and well buoyed through the dredged sections. The possibility of yawing forces caused a value of 200 percent of the design vessel's beam to be used to compute the width of the maneuvering lane. Experience has shown that a greater bank clearance is needed for the wider channels that experience yawing conditions. The bank clearance lane should have a width of 150% of the beam of the design vessel. Figure D-6 shows a typical cross-sectional view of the gulf entrance channel for a design depth of 57 feet m.l.w. and a minimum width necessary to safely accommodate the design vessel.

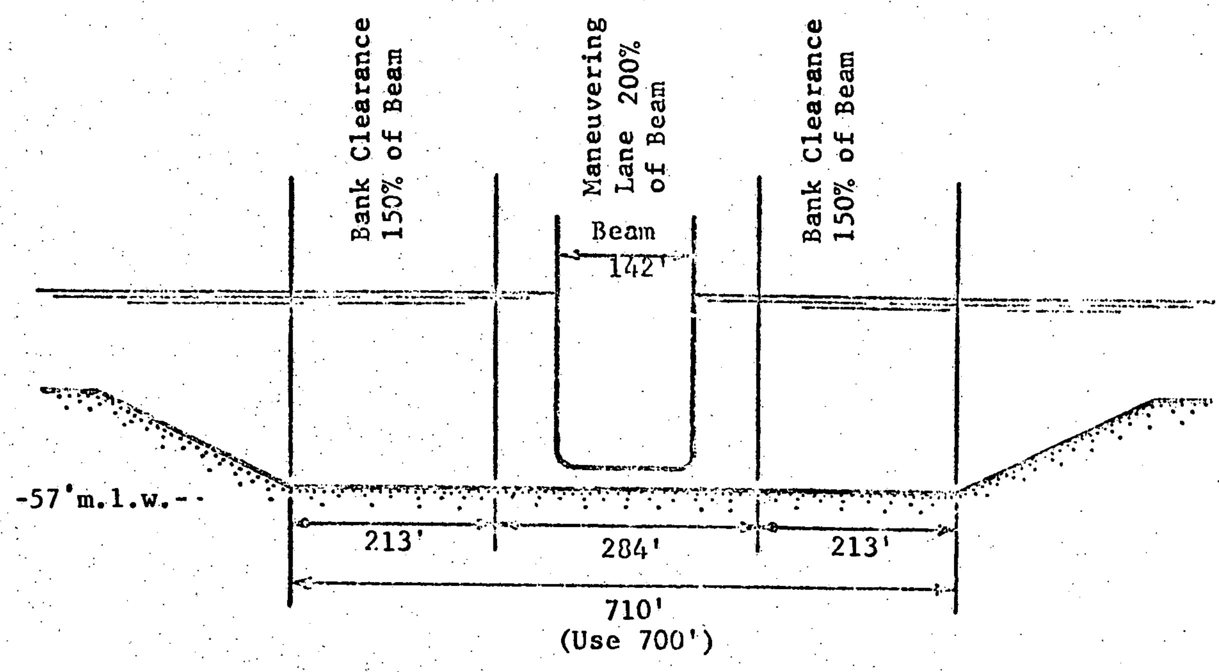


Figure D-6 Gulf Entrance Channel

69. The main Bay Channel consists of a series of straight tangents with minor deflection angles. The bay is a wide body of water, but under most weather conditions, is sufficiently protected to prevent wave actions which could significantly affect the maneuverability of deep-draft vessels. Prevailing winds are closely aligned with the channel. (See wind chart on figure D-5). Channel bottom and side materials consist of soft marine clays which present no hazards to vessels on contact. The 1 on 5 channel sidewalls are stable and shoaling does not significantly infringe on the channel width. Currents in the bay do not exceed 3 feet per second and are generally aligned with the channel. Adjoining water depths in the lower half of the bay are 10 feet of more. In the upper half of the bay gradual build-up from dredged material and natural sedimentation reduces the adjoining depth to 5 feet or less near the beginning of the upper bay tangent.

70. Considering that the design vessels have good controllability and will be operated both in and out of the bay by harbor pilots of skill and diligence, a conservative value of 180% of the design vessel's beam was used for the maneuvering lane. Soft bank material, minimum bank shoaling problems, and other favorable conditions within Mobile Bay, resulted in using 100% of the design vessel's beam to compute the bank clearance lanes. Figure D-7 illustrates the minimum channel width necessary for a 55-foot deep channel.

71. The upper tangent of the Mobile Bay Channel differs from the lower Bay channel in that it is subjected to increased outflowing currents from Mobile River and hydraulic cross-sectional constrictions created by past deposition of dredged material and natural sedimentation along both sides of the channel. In this area, build-up on the west side of

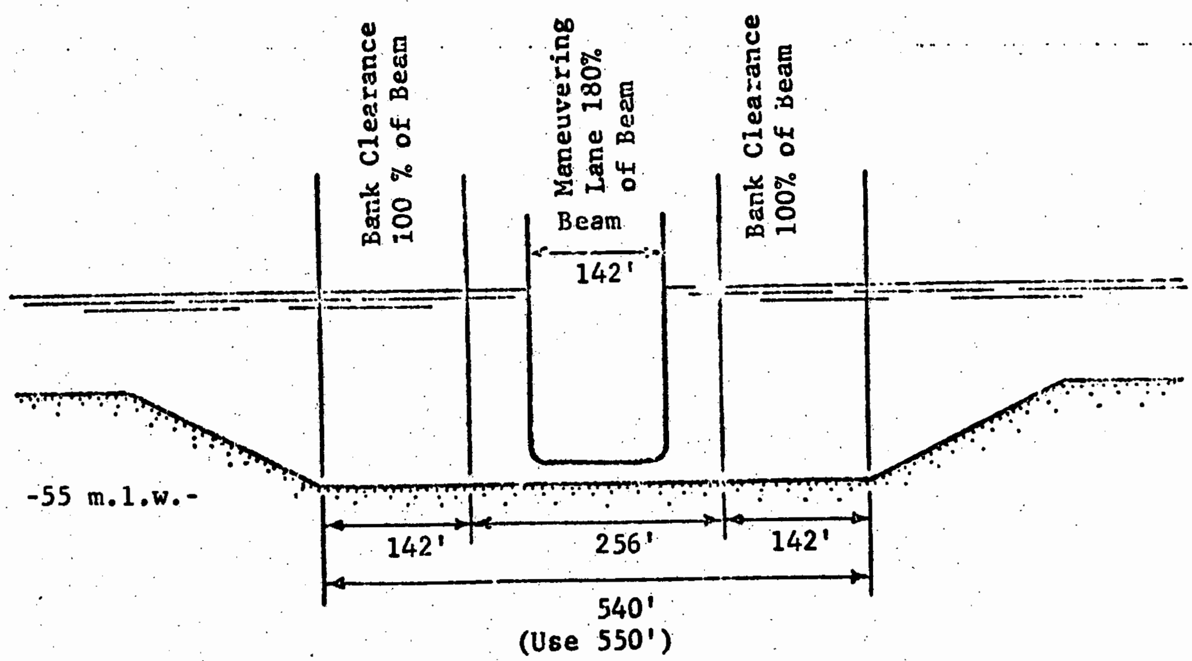


Figure D-7 Main Bay Channel

the channel is within 3 feet of the surface of the water with several small islands protruding above the surface. On the east side, build-up has reduced adjoining water depths to about 5 feet. The exit of the Arlington channel, the McDuffie berths, and an undefined borrow area along the east side of the channel shifts the hydraulic centerline of the channel and creates imbalances in the hull pressures of vessels transiting this area, thus creating steerage difficulties. Considerable problems have been reported in navigating this section of the channel, therefore, tug assistance is required. The width of the maneuvering lane should be 200% of the design vessel's beam because of poor controllability in this section of the channel. This considers the design vessel yawing 5° and an additional 40% of the vessels' beam. The vessel in this reach of the channel will be navigating the centerline of the channel and will be nearing its docking facility, therefore, the vessel will be moving relatively slowly. The increase in channel width coupled with other adverse conditions requires an incremental enlargement of the bank clearance over that required for the main bay channel. A value equal to 130% of the design vessel's beam was used to compute the bank clearance. Utilizing this design criteria, widths of 550, 600, 650 and 750 feet were computed for 45; 50; 55; and 60-foot depths in this section of the main bay channel.

72. The Theodore Bay channel differs from the lower main bay channel only with respect to the angles of the channel with prevailing currents and winds. While these are not considered critical, they do create a distinct increment of difference from the main channel. To allow for the potential yawing of the vessel the maneuvering lane width was designed using 190% of the beam of the design vessel. The bank clearance lanes were computed based on 100% of the design vessel's beam. Based on the above criteria channel widths of 450, 500, 550 and 600 feet were computed for channel widths of 45, 50, 55 and 60 feet deep.

73. The Theodore Land-Cut channel segment differs with the others because of its land cut constriction. However, this feature also shields the channel from all currents and most winds. The channel is considered stable, with minimal shoaling. Tug assistance will be utilized to move the vessels through this section of the waterway, therefore, minimum design criteria were used. A value of 160% of the design vessel's beam was used for the maneuvering lane and 80% of the vessel's beam was used for the bank clearance. Based on the above, a channel width of 400 feet would be computed for a channel 50 feet deep.

74. A summary of the minimum one way channel widths (rounded) for 45; 50; 55 and 60-foot deep channels for each of the main bay channel segments and the Theodore channels is given in table D-6.

Table D-6

MINIMUM CHANNEL WIDTHS FOR ONE WAY DESIGN VESSEL TRAFFIC

Channel Segment	Channel Depths (feet) 45	50	55	60
Gulf Entrance	550	650	700	800
Main Bay	450	500	550	600
Upper Bay	550	600	650	750
Theodore Bay	450	500	550	600
Theodore Land Cut	375	400	450	500

OPTIMIZATION OF CHANNEL WIDTHS

75. Further studies show that a vessel with a static loaded draft of 40 feet in a channel with a design depth of 55 feet m.s.l. would have 11 feet of vertical clearance beyond that required. This vertical clearance will create additional usable width along the 1 on 5 channel side slopes. Figure D-8 illustrates a channel cross-section with two 50,000 DWT vessels with 97 foot beams, the maximum size vessels that could safely utilize a 55-by 550-foot main bay channel related to previously defined unconstrained two-way traffic.

76. Model tests made during the Panama Canal investigation revealed that interaction between the passing vessels created no appreciable hazard when the distance between them was equal to the beam of the larger ship, therefore, a value of 100 percent of the larger vessel's beam was used to design the clearance lane. These criteria have been adopted to evaluate all passing situations in Mobile Harbor.

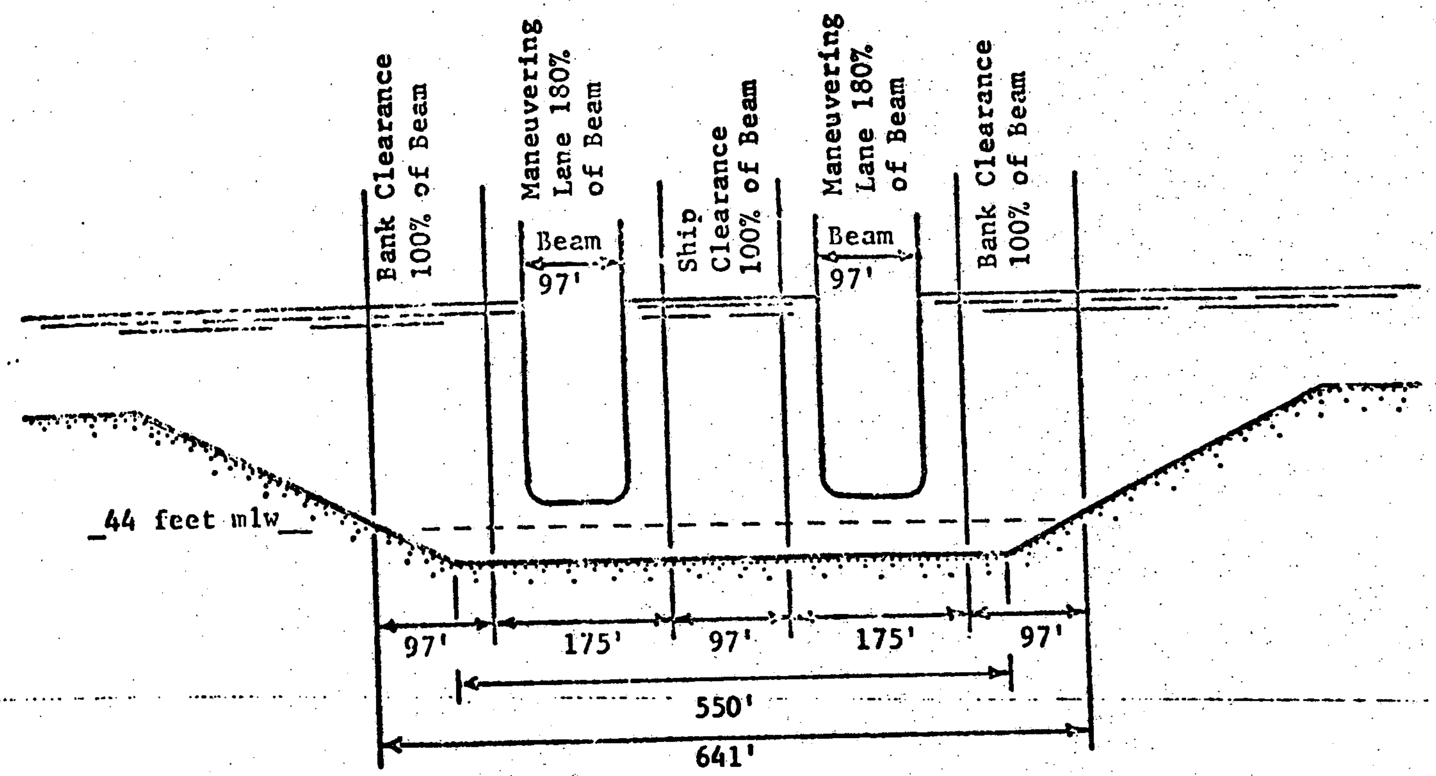


Figure D-8 Main Bay Channel

77. Assuming the year 2000 to be representative of the average traffic conditions that would be expected over the economic life of any improvements for Mobile Harbor (see figure D-9), the traffic analysis indicates that a total of 5347 loaded vessel trips per year, made in vessels ranging from 2,000 DWT to about 150,000 DWT, could be expected to travel a 55-foot channel. This equals an average of approximately 15 loaded vessels per day either entering or leaving the port. Based on the fact that Mobile Harbor is a year-round port and most of the commodities are not seasonal, a uniform annual distribution of vessels arriving at the port was assumed. A generalized curve reflecting the distribution of expected loaded trips by various size vessels is given in figure D-10. This figure indicates that 89 percent of the loaded vessels entering or leaving Mobile Harbor would be 50,000 DWT with a breadth of 97 feet or less and could pass safely in a 550-foot wide channel.

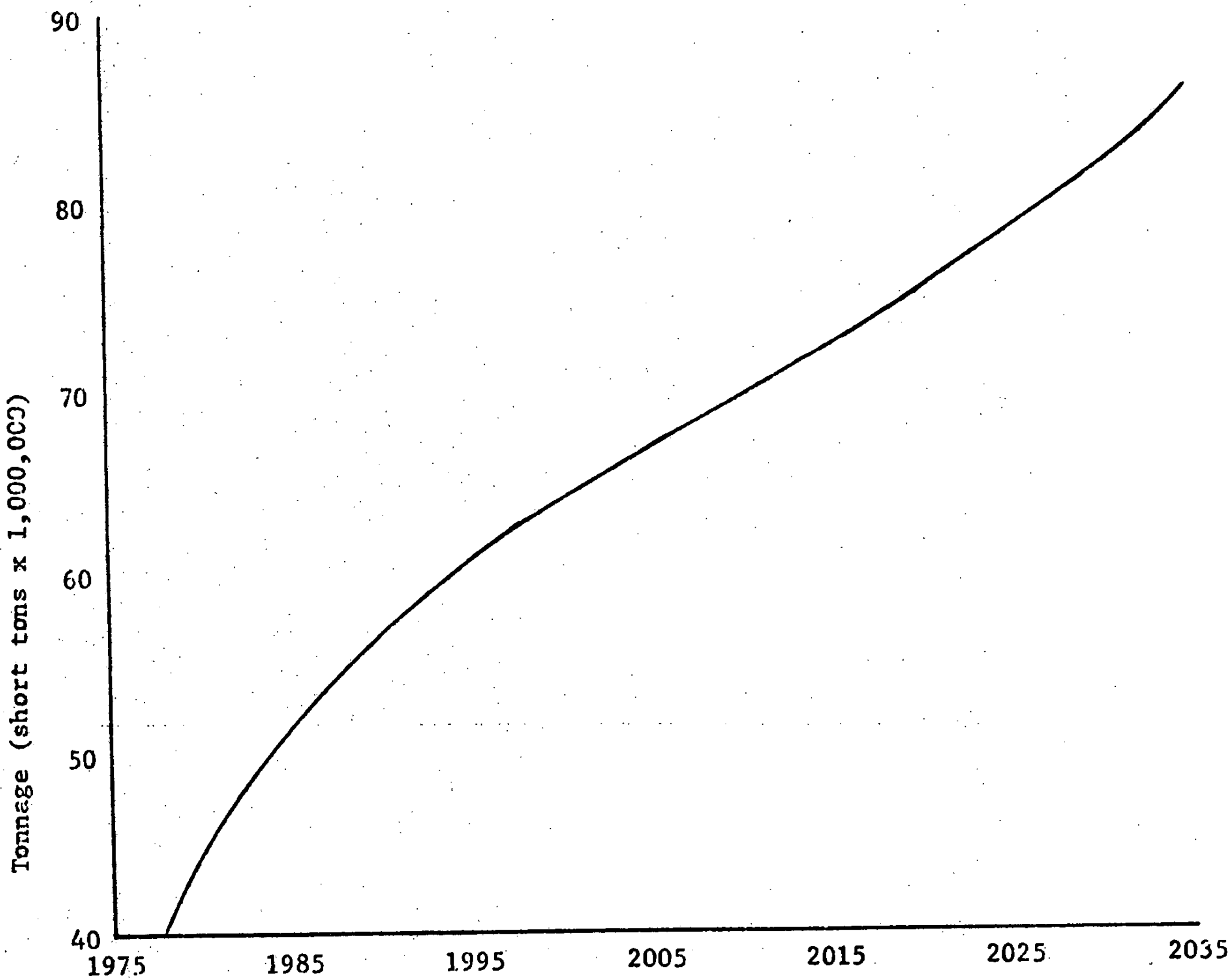
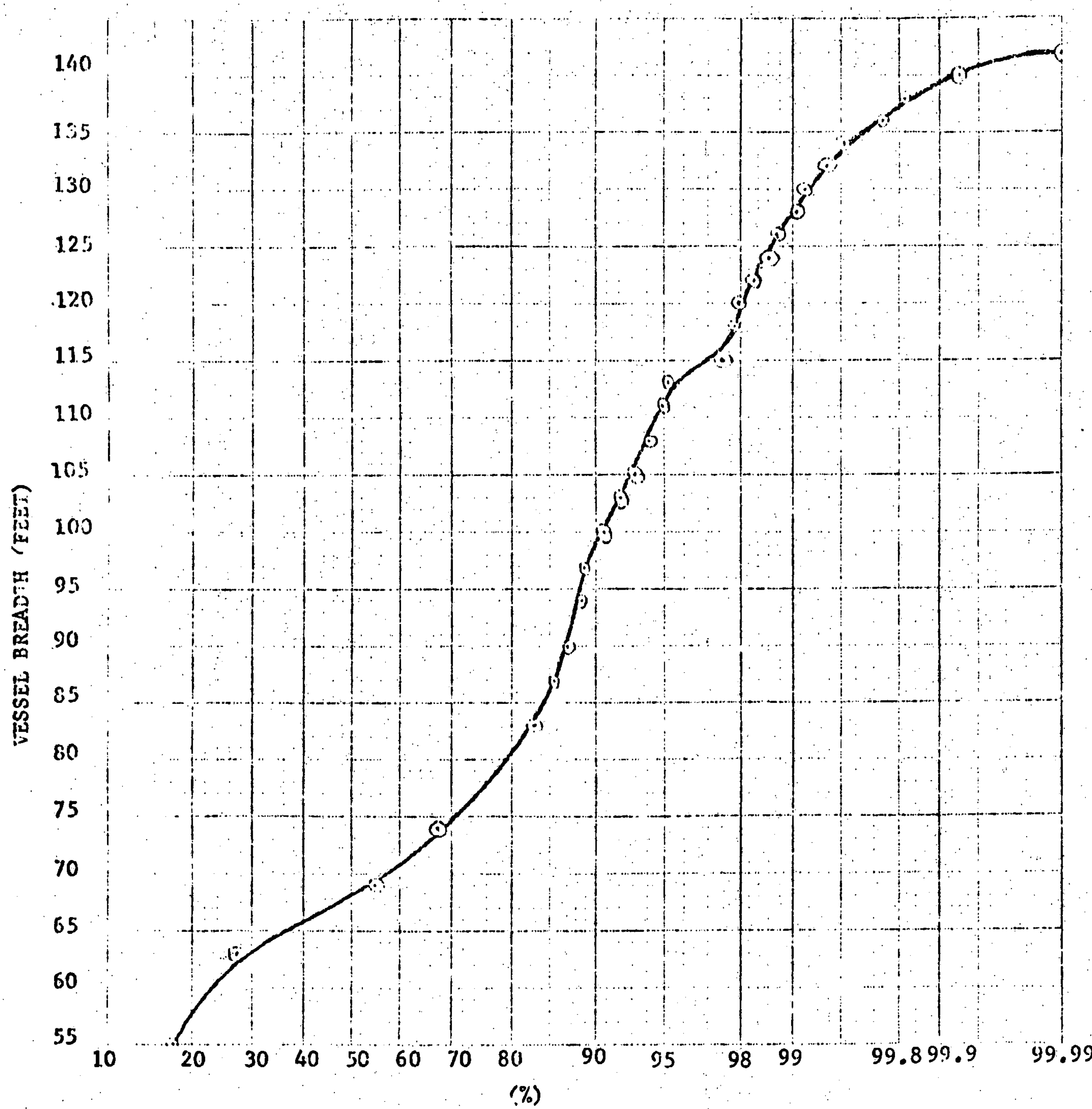


Figure D-9 Annual projected volume of commerce moving in Deep-Draft vessels through the ports of Mobile and Theodore.



Cumulative Frequency of Vessels Projected to call at Mobile Harbor in the Year 2000 with a 55 foot deep channel.

Figure D-10

78. To justify additional increments of channel width, the costs associated with delays of vessels too large to pass in the channel would have to offset the cost associated with construction and maintenance of the larger channels.

79. In order to best define the costs associated with delays that would be experienced because of vessels unable to pass in the main ship channel, a statistical computer program was designed to model the arrivals and departures of vessels for the years 2000 and 2035 at Mobile Harbor.

80. As noted earlier, approximately 5,347 loaded vessel trips were projected in the year 2000. Studies show that most of all of the dry bulk carriers and tankers will either enter or leave empty, whereas general cargo vessels are usually loaded both ways. Therefore, the total vessel trips, both inbound and outbound, were found to be approximately 6,743 annually. To be conservative in the statistical model, each of these vessel trips was assumed to be made by a loaded vessel.

81. Based on the distribution of vessels for the year 2000, the computer model generates from a poisson distribution a random vessel to enter from the gulf. This vessel, with assigned characteristics, surveys the channel for entering. If there is no vessel in the channel too large for it to pass, the incoming vessel will sail the channel, enter the port, and be assigned a time in port to be serviced. On leaving the port, the vessel will survey the channel in the same manner as when entering from the gulf. The computer calculates the delays experienced for both inbound and outbound traffic if the vessel has to wait before entering the channel. A general flow chart of this statistical model is shown as figure D-11.

82. Besides the assumptions previously mentioned, the following were made:

1. General cargo vessels would require 4 days inport, plus or minus one day.

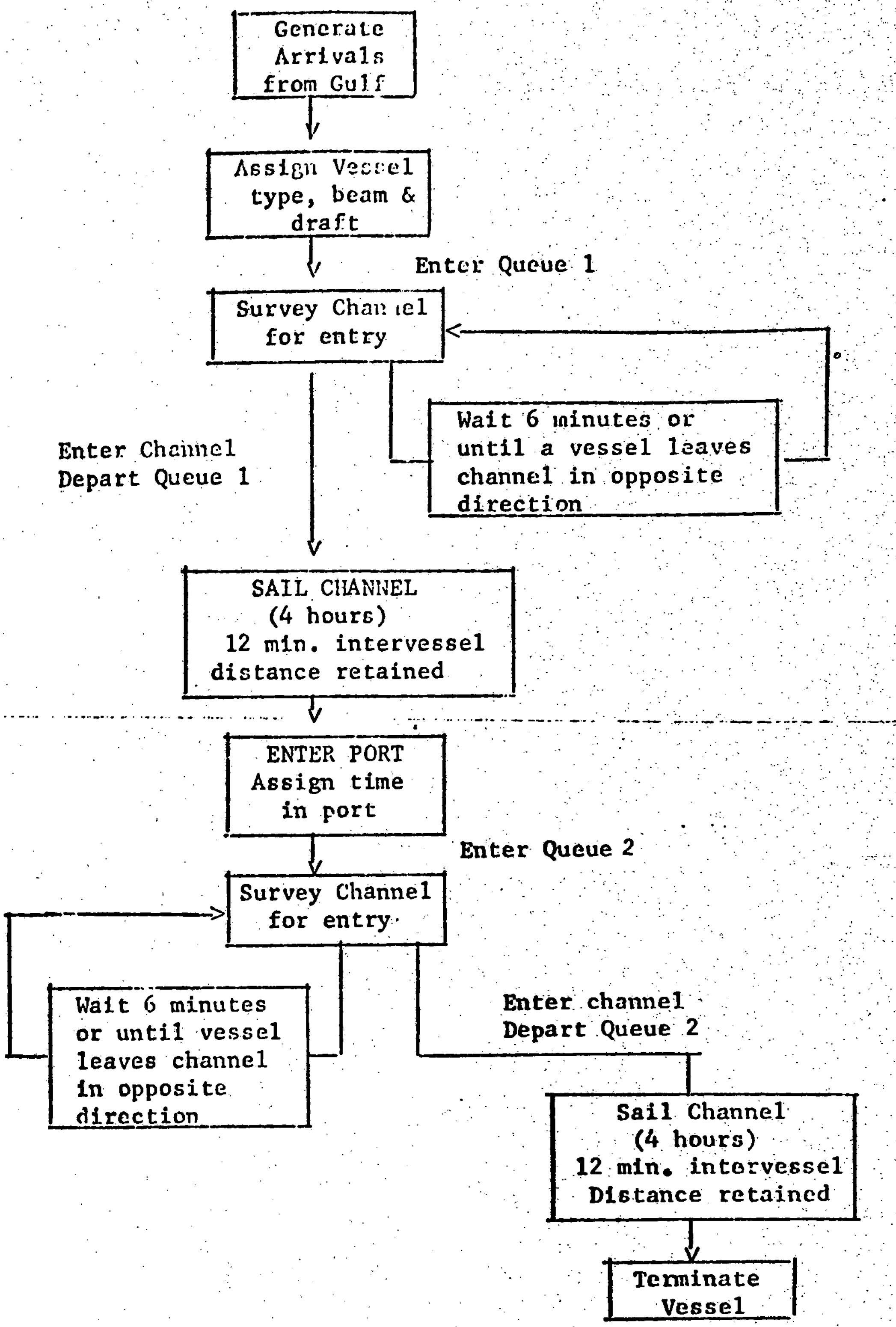


Figure D-11, General flow chart for the statistical channel delay model

2. Tankers would require 36 hours in port, plus or minus 12 hours.

3. Bulk carriers would require 72 hours in port, plus or minus 12 hours.

4. Vessels entering or leaving the port would survey the channel every six minutes. or until a vessel leaves the channel in the opposite direction, before it would enter the channel.

5. A minimum interval of 12 minutes would separate vessels following one another in the channel.

6. The weighted, average operating cost per hour for each vessel utilizing the 55-foot channel would be $595.

7. All vessels entering and leaving are fully loaded.

8. All vessels require 4 hours to traverse the channel (Use of Theodore Ship Channel and variance in ship speed is neglected).

NOTE: These last two assumptions conservatively increase the delay time for the model.

83. This statistical model evaluated both a 55-by 550-foot channel and a 55- by 600-foot channel to determine the delays that could be eliminated due to an incremental enlargement of 50 feet. Realizing that inherent inaccurancies exist in a model, a sensitivity analysis was conducted for each channel dimension modeled. These analyses indicate there is a 95 percent probability that in the year 2000 the actual delay time for a 550-foot channel width would be 0.68 ± 0.16 hours per vessel, and for a 600-foot channel the delay time would be 0.33 ± 0.06 hours per vessel.

84. Based on this analysis, the maximum reduction in delay cost could be computed using the maximum delay time for a 550-foot channel and the minimum delay time for the 600-foot channel.

Maximum Reduction = (0.84-0.27 hrs/vessel x 3372 vessels/yr x \$595/hr.

= \$1,144,000/yr

However, the expected annual reduction in delay cost for increasing the channel width by 50 feet would compute:

Expected Reduction = (0.68 - 0.33) hrs/vessel x 3372 vessels/yr x \$595/hr.

= \$702,000/yr.

85. Considering the initial investment and annual maintenance costs, it was found that enlarging the width of a 55-foot deep channel along the length of the main bay channel by 50 feet would increase annual charges by \$2,108,000. By comparing this cost to the expected reduction for the year 2000, which closely approximates the average annual reduction in delays, it was found that increasing the width of the 55- by 550- foot channel to reduce delays is not economically justified (BCR = 0.33).

86. A minimum width for channel depths of 45, 50, 55 and 60 feet was calculated to determine the minimum safe channel design. These values along with the design vessel used are shown in table D-7. The traffic delays were computed for the year 2000 and the year 2035 for each channel depth. The average annual delay was computed and then compared with the average annual changes for incrementally increasing the main bay channel width. These findings are shown in table D-8.

87. Discussed in a meeting with the Mobile Harbor Master and a harbor pilot were the judgement decisions incorporated in the channel design. Both concurred in the design as presented herein.

Table D-7
MOBILE HARBOR SHIP CHANNEL WIDTHS

	Beam of Design Vessel	Bank Clearance Lane	Maneuvering Lane	Bank Clearance Lane	Total Width Required (Computed)	Total Width Required (Rounded)
Main Bay Channel						
Percent of Beam		100	180	100		
45' depth	113	113	203	113	429	450
50' depth	128	128	230	128	486	500
55' depth	142	142	256	142	540	550
60' depth	155	155	279	155	589	600
Upper Bay Channel						
Percent of Beam		130	200	130		
45' depth	113	147	226	147	520	550
50' depth	128	166	256	166	588	600
55' depth	142	185	284	185	654	650
60' depth	155	202	310	202	714	750
Gulf Entrance Channel						
Percent of Beam		150	200	150		
47' depth	113	170	226	170	566	550
52' depth	128	192	256	192	640	650
57' depth	142	213	284	213	710	700
62' depth	155	232	310	232	775	800
Theodore Bay Channel						
Percent of Beam		100	190	100		
45' depth	113	113	215	113	441	450
50' depth	128	128	243	128	499	500
55' depth	142	142	270	142	554	550
60' depth	155	155	294	155	604	600
Theodore Land Channel						
Percent of Beam		80	160	80		
45' depth	113	90	181	90	361	375
50' depth	128	102	205	102	409	400
55' depth	142	114	227	114	455	450
60' depth	155	124	248	124	496	500

88. As a result of the channel widening studies it became apparent that significant transportation savings along with an increase in safety would result from just widening the main bay channel. The next step of this analysis was to redefine alternatives that warranted further study and compare the plans based on the channel design developed in the preceding analysis.

TABLE D-8

MAIN BAY CHANNEL WIDTH

Depth (feet)	Width (feet)	Annual Delay ($1,000)	Incremental Annual Delay ($1,000)	Incremental Annual Cost ($1,000)	Delay/Cost
45	450	8,515			
			3,185	1,652	1.93
45	500	5,332			
			2,402	1,652	1.45
45	550	2,930			
			1,672	1,652	1.01
45	600	1,258			
50	500	3,642			
			1,801	1,852	0.97
50	550	1,841			
			905	1,852	0.49
50	600	936			
55	550	1,393			
			681	2,108	0.32
55	600	712			
60	600	593			
			126	2,345	0.05
60	650	467			

DEVELOPMENT OF DETAILED PLANS

GENERAL

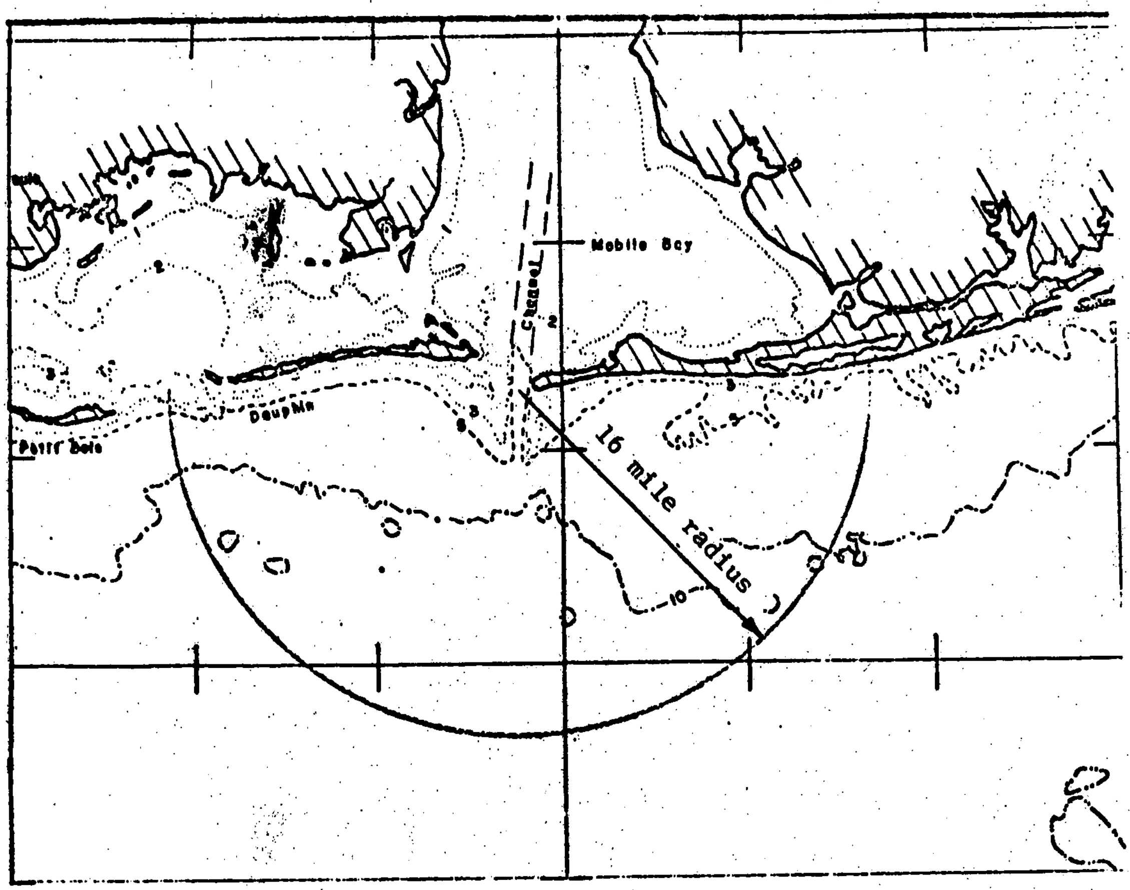
89. A detail cost estimate and benefit analysis was made to compare the level of development for each alternative selected for further study. At this stage of the study it became apparent that multiple use of a deeper channel into the Theodore Industrial Park and commodity movements to incrementally justify the enlargement could not be assured; therefore, no further consideration of this channel segment was made. Also, the cost estimates show it is not cost effective to construct an island on the east side of the upper bay channel below Little Sand Island to contain annual dredged disposal material. Transporting the maintenance material to the gulf is a more feasible to construct an island on to cost of constructing and protecting disposal island dikes. Costs developed for the detailed plans are based on the gulf dredged material disposal site being located within a 16 mile radius of the mouth of Mobile Bay (see figure D-12).

"NO ACTION" ALTERNATIVE

90. The "No Action" alternative perceives the continuation of existing conditions with no solution for present or future navigation problems. An analysis of this alternatives shows that more than 16 million dollars a year as an average over the period of analysis, will be lost from traffic delays or about 28 million dollars a year in saving from more efficient deeper draft vessels will be foregone. Since the present trends in deep draft shipping are toward use of larger vessels, the existing and projected problems could be expected to become more acute.

BROOKLEY EXPANSION AREA AND GULF DISPOSAL PLAN NO. 1, MODIFIED, Plate D-23

91. This plan provides for deepening and widening the entrance channel and the main bay channel, providing an anchorage area near the upper limits of the main bay channel, and providing a turning basin opposite McDuffie Island. This plan involves the construction of a fast land



DREDGE MATERIAL GULF DISPOSAL

FIGURE D-12

expansion area in Mobile Bay, just south of McDuffie Island, adjacent to the Brookley Industrial Complex. New work material dredged from the upper 7.4 miles of bay channel, the anchorage area and turning basin would be utilized to construct dikes along the perimeter of the Brookley disposal area and to construct fast land. The remainder of the new work material from the upper bay reach above Theodore Channel intersection would be transported by hydraulic pipeline dredge to fill the southern portion of the Brookley disposal area. New work material from the lower bay and entrance channels would be transported with dump scows to the Gulf of Mexico for disposal. The existing and future maintenance dredged material from the main bay channel would also be transported to the Gulf of Mexico for disposal. This plan was formulated to provide additional fast land for harbor development, minimize open water disposal in the bay of new work dredged material, and eliminate all existing and future open water disposal of dredged maintenance material in the bay.

92. Derivation of the optimum level of channel development required a detailed analysis of shipping needs, commodity movements and projections, and an economic analysis of vessel fleets that would operate with various channel widths and depths. These studies indicate that maximum net benefits could be achieved from a channel with dimensions commensurate with a 55-foot depth main channel through Mobile Bay. A comparison of annual benefits, annual costs and net benefits for the 45-, 50-, 55-, and 60- foot levels of development for the Brookley Expansion Area and Gulf Disposal Plan No. 1 is displayed in table D-9.

Table D-9

OPTIMIZATION OF BROOKLEY EXPANSION AREA AND GULF DISPOSAL PLAN NO. 1 (MODIFIED)

Channel Depth Feet	Annual Benefits	Annual Charges	Net Benefits
45	$12,597,000	$ 9,195,000	$3,402,000
50	22,646,000	15,252,000	7,394,000
55	33,130,000	22,028,000	11,102,000
60	38,956,000	34,435,000	4,521,000

93. The optimum level of development for the Brookley Expansion Area and Gulf Disposal Plan No. 1 would provide a channel 57 feet deep and 700 feet wide in the entrance channel and a channel 55 feet deep and 550 feet wide through Mobile Bay. Also, commensurate depth would be provided at the anchorage area opposite McDuffie Island and the turning basin to be provided in that vicinity.

94. With implementation of the 55- foot level of development approximately 1,047 acres of fast land constructed to an elevation of approximately 17.5 feet above mean low-water and 663 acres constructed to an elevation of approximately 15 feet m.l.w. of softer new work material would be provided adjacent to the Brookley Industrial Complex. This development is compatible with the Alabama State Docks long range development plan and will provide on the average $2,697,000 in annual regional land enhancement benefits. McDuffie Island would not be used due to its relatively low capacity and the marsh land that would be destroyed.

BROOKLEY EXPANSION AREA AND GULF DISPOSAL PLAN NO. 2, MODIFIED , (NED), Plate D-24

95. Traditional methods for channel modification in Mobile Bay were developed on the basis of economic efficiency and considered open water disposal of all the dredged disposal material in the bay. A plan such as this would maximize NED efficiency, however, this plan

has been dropped from consideration in the Stage 3 analysis since current standards do not consider it a viable, desirable or acceptable alternative. The plan was retained that maximizes NED efficiency provides for deepening and widening the entrance channel and the main bay channel; provides an anchorage area near the upper limits of the main bay channel; and provides a turning basin opposite McDuffie Island. The gulf entrance channel would be constructed by hydraulic hopper dredge and the material placed in the gulf disposal site. New work material dredged from the upper 7.4 miles of bay channel, the anchorage area and turning basin would be utilized to construct dikes along the perimeter of the Brookley disposal area and to construct fast land within the northern portion of the disposal area. The remainder of the new work material from the upper bay reach would be transported by hydraulic pipeline dredge to the southern end of the diked disposal area. New work material from the lower bay reach would be loaded on dump scows by a hydraulic cutterhead dredge and transported to the gulf for disposal in deep water. The maintenance material from the upper bay will be transported to the gulf for disposal and the maintenance material from the lower bay channel will be disposed of in the existing sites presently used for maintenance of the lower main bay channel.

96. As with the preceding alterative, optimization studies were performed to determine the level at development that would maximize net benefits. These studies indicate that maximum net benefits could be achieved from a channel with dimensions commensurate with a 55- foot depth main channel through Mobile Bay. A comparison of annual benefits, annual costs and net benefits for the 45; 50; 55-and 60-foot levels of development for the Brookley Expansion Area and Gulf Disposal Plan No. 2 is displayed in table D-10.

Table D-10

OPTIMIZATION OF BROOKLEY EXPANSION AREA
AND GULF DISPOSAL PLAN NO. 2

Channel Depth	Annual Benefits	Annual Charges	Net Benefits
45 feet	12,597,000	9,138,000	3,459,000
50 feet	22,646,000	15,192,000	7,454,000
55 feet	33,130,000	21,967,000	11,163,000
60 feet	38,956,000	34,335,000	4,621,000

97. The optimum level of development for the Brookley Expansion Area and Gulf Disposal Plan No. 2 would provide a channel 57 feet deep and 700 feet wide in the entrance channel and a channel 55 feet deep and 550 feet wide through Mobile Bay. Also, commensurate depths would be provided at the anchorage area opposite McDuffie Island and the turning basin to be provided in tha vicinity.

98. Approximately 1047 acres of fast land constructed to about +17.5 feet above mean low-water would be provided adjacent to the Brookley Industrial Complex. The plan would provide a disposal area for soft new work material dredged from the southern portion of the upper main bay channel. This development is also compatible with the Alabama State Docks long range development plan and will provide on the average $2,697,000 in annual regional land enhancement benefits. McDuffie Island would not be used to contain dredged material because of its limited capacity and the marsh areas that would be destroyed.

GULF DISPOSAL PLAN

99. The Gulf Disposal plan would enlarge the channels and construct the anchorage area and turning basin, as does the Brookley Expansion plans. This plan differs in that new work and maintenance material from the upper bay would be transported by dump scows and disposed of in the deep water of the gulf, the diked bay disposal area would not be constructed. New work and maintenance from the lower bay

would also be disposed of in the deep water of the gulf. The plan would reduce the present net rate of sedimentation in the bay and would prolong the bay's esturian life; however this plan does not provide any fast land development for future port development in the upper bay.

100. As with the preceding two alternatives, optimization studies were performed to determine the level of development that would maximize net benefits. These studies also identified the 55- foot level of development for the main bay channel as the cptimum plan. A comparison of different levels of development for the Gulf Disposal plan is displayed in table D-11.

Table D-11
OPTIMIZATION OF GULF DISPOSAL PLAN

Channel Depth	Annual Benefits	Annual Charges	Net Benefits
45 feet	$ 11,067,000	$13,463,000	$- 2,396,000
50 feet	20,644,000	18,054,000	2,590,000
55 feet	30,433,000	25,787,000	4,646.000
60 feet	35,260,000	33,784,000	1,476,000

CHANNEL WIDENING (Least Environmentally Damaging Plan)

101. This alternative plan would forego any channel deepening, however, it would consider widening the existing main bay channel to reduce traffic delays, provide an additional increment of safety and modify existing dredged disposal techniques to provide for removing all maintenance dredged material to the gulf for disposal. All new work dredged material would also be disposed of in the gulf.

102. This plan induces no transportation savings from deeper draft vessels but eliminates some traffic delays within the bay and makes a positive contribution to improving circulation in the upper bay. The plan reduces the sedimentation of the bay by removing to the gulf approximately 4.2 million cubic yards of dredged maintenance material

each year. This volume of maintenance material includes the maintenance of the existing project. It is questionable whether the plan would result in positive net environmental impacts; however, it is considered the least environmentally damaging alternative.

103. The additional annual charges for this alternative equals $1,395,000. Compared to a reduction in traffic delay costs of approximately $4,884,000 the channel widening plan has a benefit to cost ratio of 3.5 and $3,489,000 net benefits.

104. Other EQ measures that appear to have positive impacts on the bay involve features to improve circulation and water quality. Studies indicated that along the main channel between a point on the same latitude as the mouth of Dog River to a point about two miles to the north approximately 4.3 million cubic yards of material would have to be removed to eliminate the ridges between the channel and adjacent bay bottom. This material could be placed by hydraulic pipeline dredge into the existing depressions located in the upper bay thereby reducing the tendency of concentrated low oxygen water developing in the depressions. Preliminary studies indicate this measure would cost approximately $6,000,000 to implement. This equates to an average annual cost of $414,000. In view of the cost, uncertainty of existing impacts and benefits from measures such as this, model studies should be performed to more accurately determine the effects on circulation prior to implementing such measure. These model studies may show that creating openings in the causeway or other measure may achieve more desirable and effective results for less costs.

105. The establishment of additional oyster beds in Bon Secour Bay is another environmental measure that is considered desirable. However, this too depends on very accurate assessments of any changes to the circulation and resultant salinity variations that might be created by implementing any structural alternative. Model studies could furnish the needed data to investigate this need further.

EFFECT ASSESSMENT

106. Planning and formulation criteria dictate that plans considered for implementation be evaluated against the "without condition". This evaluation identifies impacts of the considered plans and determines the qualitative and, if possible, quantitative value of the change. The evaluation process also establishes the contributions of each plan to the planning objectives and systems of accounts. These evaluations permit a trade-off analysis and the ultimate identification of a selected plan.

107. The effect assessment phase of the evaluation process endeavors to assure that all known and possible significant effects are taken into consideration. Effect assessment is carried out in terms of the economic, social and environmental factors which could be associated with plans considered for implementation. Areas of measured impacts, as defined in Section B, include Mobile SMSA, the State of Alabama and the Nation.

"NO ACTION" PLAN

108. The "No Action" alternative assumes the continuation of current trends and provides the base for the evaluation of future alternative impacts. Analysis of this alternative develops the no project impacts and effects upon the study area. Projections based on the "No Action" condition are presented in the following paragraphs.

109. Demographic Aspects. Projections for the "No Action" alternative indicate that the population of the Mobile SMSA will continue to increase from 377,439 in 1970 to 463,050 by 1995, and 502,50C by 2044. OBERS projections indicate that by the year 2000 the population in Mobile County will reach 388,700 and Baldwin County, 88,000. It is reasonable to expect that continued industrial growth in the study area will result in future population growth principally through inmigration.

110. Regional Growth. Regional growth projections under present conditions for the SMSA are based on Series "E" national projections prepared by the Bureau of Economic Analysis. Employment and earnings by industrial projections indicate continued economic growth under the "No Action" alternative and are summarized in table D-12. Total employment in the study area is projected to increase from 182,700 in 1995 to 204,800 in 2044. Earnings by industry are expected to increase from $1.9 billion in 1995 to $4.1 billion in the year 2044. In 1995 the manufacturing sector is predicted to produce the highest earnings, 22 percent of the total, while the trade and service sectors earn 17 and 21 percent respectively. By 2044 the services sector is projected to have the highest earnings (26 percent) followed by manufacturing (21 percent) and government (17 percent).

111. Community growth. Planning for future growth is a major problem facing the Mobile SMSA. The South Alabama Regional Planning Commission (SARPC) has proposed certain goals as the ends towards which planned development may be directed. In summary these goals include: 1) a wide variety of suitable housing, 2) ample land and facilities to support economic growth, 3) protection, preservation, and enhancement of the regions' major physical and environmental features, 4) a permanent open space system to provide recreational and agricultural areas and a reserve for the protection and conservation of natural resources, 5) an integrated regional transportation system, 6) land use based on physical characteristics and location signficance, and 7) a sense of community identification and citizen participation in local and regional affairs. General goals for region wide community services and human development have also been formulated.

112. Under the "No Action" alternative it is projected that future growth in the study area will occur within developed suburban districts, along major transportation facilities near urban arears, and close to existing development-generating activities. Economic specialization is expected to continue necessitating the development of specialized employees. This trend is particularly applicable to downtown

Table D-12

PROJECTED POPULATION, EMPLOYMENT AND EARNINGS (1000s of 1967 Dollars) FOR MOBILE SMSA, 1995-2044

Item	1995	2020	2044
Total Population	463,050	502,500	502,500
Total Employment	182,700	204,800	204,800
Total Earnings	$1,925,450	$4,097,200	$4,097,200
Agriculture, Forestry and Fisheries	24,850	36,200	36,200
Mining	3,400	4,600	4,600
Contract Construction	141,200	269,600	269,600
Manufacturing	432,450	853,600	853,600
Transportaion, Communication and Public Utilities	163,250	314,100	314,100
Wholesale and Retail Trade	320,400	615,600	615,600
Finance, Insurance and Real Estate	115,850	264,900	264,900
Services	419,300	1,056,300	1,056,300
Government	304,200	681,900	681,900

Source: 1972 E OBERS Projections: Regional Economic Activity in the United States and Population and Economic Activity in the United States and Standard Metropolitan Statistical Area (1972), Bureau of Economic Analysis, U. S. Department of Commerce.

Mobile which is predicted to continue as the area's center for finance, communications, government, and service-related activities.

113. National economic development. Projections indicate that the Mobile SMSA will maintain its role as the primary business activities center in the 12-county BEA region. Because of its location at the hub of an interstate highway, rail, and water transportation system, the city of Mobile is expected to retain its position as the wholesale trade center for the region. It is assumed that under the "No Action" alternative the rate of growth for industries in the study area will at least equal or be greater than the national growth rate.

114. Transportation. A comprehensive plan for the development of transportation facilities has been proposed for the study area by the SARPC. The estimated cost for implementing this plan has been set at over $1 billion, with highway facilities in the Mobile urban area accounting for more than 90 percent of the total costs. Mass transit systems are also being considered to relieve the ever increasing traffic pressures placed upon the regions highways. The number of local commercial airline passengers is expected to increase tenfold between 1968 and 1995. To provide an adequate air transportation system for the area the expansion of the existing Bates Field Airport may be required, as well as the location of two additional airports in outlying areas. The Alabama State Docks has recently purchased 143 acres of waterfront property, rail lines, switching rights, and other facilities owned by the Illinois Central Gulf Railroad to facilitate better port rail traffic conditions. The railroad rights of way and switching rights will be turned over to the terminal railway, which is also owned and operated by the State Docks. This action will open the McDuffie Island coal terminal equally to all railroads serving the area. It will also provide shippers with free and unobstructed access to all the existing and planned Mobile River terminal facilities.

115. Projected waterborne commerce. Annual commerce shipped through the Port of Mobile by deep-draft vessels has increased from 14.4

million tons in 1966 to 16.7 million tons in 1975. Barge traffic has increased from 7.9 million tons in 1966 to 15.8 million tons in 1975. Upon completion of the Theodore Ship Channel (1982) 11.5 million additional tons of deep-draft commerce and 0.7 million tons of barge cargoes will be introduced into the harbor system. Assuming the "No Action" alternative, it is reasonable to expect continued increase in deep-draft and shallow-draft cargo commerce as a result of economic expansion in the study area. Projections have been made for the annual volume of commerce moving in deep-draft vessels to the Port of Mobile, These data are shown in table D-13 and include projections for commerce expected to move over the Theodore Ship Channel, now under construction. It is estimated that the 1975 deep-draft tonnage, augmented by the Theodore tonnage, will increase to 59.5 million tons by 1995 and grow to 86 million tons by the year 2044.

116. Completion of the Tennessee-Tombigbee Waterway in 1986 will bring additional water-borne barge commerce to the study area. The waterway is projected to carry 28.1 million tons of commerce during 1986 and 33.3 million tons by 1991. Approximately 40.6 percent of the total traffic, or 11.3 million tons in 1986 and 13.6 million tons in 1991, will be imported or exported through the Port of Mobile. Expansion of terminal and barge handling facilities is expected to occur to meet the increased demand for these facilities.

117. Noise. Noise in the Mobile Harbor area results primarily from truck and automobile traffic and the operation of heavy machinery associated with loading and unloading at the docks. Since harbor activity is expected to increase without the project, it is assumed that noise levels will also rise but not reach the tolerance levels discussed earlier in Section B of this appendix. Completion of Interstate 10 across the bay should lessen traffic noise. Traffic is expected to flow more evenly and the fact that the highway is elevated, and in an open space, should aid in the dissipation of vehicular noise.

118. Air Quality. Assuming that the "No Action" alternative prevails,

TABLE D-13

ANNUAL VOLUME OF COMMERCE MOVING IN DEEP-DRAFT VESSELS THROUGH THE PORTS OF MOBILE AND THEODORE (1975-2044)

(Short Tons)

Commodity	1975	1986	1995	2000	2010	2020	2030	2035	2044
					Years				
					Commerce for Port of Mobile				
Iron Ore	4,781,000	5,291,000	5,856,000	6,264,000	7,292,000	8,400,000	9,595,000	10,475,000	10,475,000
Copper Ore	-	13,000	15,000	16,000	20,000	24,000	28,000	31,000	31,000
Bauxite	1,872,000	2,671,000	2,781,000	2,840,000	2,984,000	3,172,000	3,507,000	3,550,000	3,550,000
Alumina	-	684,000	939,000	1,081,000	1,409,000	1,836,000	2,285,000	2,524,000	2,524,000
Manganese Ore	45,000	188,000	223,000	243,000	286,000	337,000	392,000	423,000	423,000
Ferro-Phosphorus	44,000	59,000	79,000	89,000	124,000	175,000	252,000	302,000	302,000
Ferro-Silicon	-	22,000	26,000	28,000	32,000	38,000	45,000	48,000	48,000
Scrap Iron	133,000	249,000	403,000	433,000	490,000	553,000	622,000	658,000	658,000
Coal	3,116,000	18,287,000	20,208,000	21,451,000	21,451,000	21,451,000	21,451,000	21,451,000	21,451,000
Coke	55,000	74,000	98,000	112,000	155,000	218,000	315,000	378,000	378,000
Grain	1,989,000	3,740,000	5,442,000	6,518,000	6,815,000	7,136,000	7,476,000	7,652,000	7,652,000
Petroleum (Incl. Crude Oil)	2,701,000	3,605,000	4,544,000	5,067,000	6,261,000	7,739,000	9,574,000	10,770,000	10,770,000
Commerce thru Gen. Cargo Terms.	1,407,000	1,870,000	2,314,000	2,577,000	3,174,000	3,916,000	4,805,000	5,250,000	5,250,000
Subtotal	16,143,000	36,853,000	42,928,000	46,719,000	50,493,000	54,995,000	60,347,000	63,512,000	63,512,000
Misc. Commerce (3%)	536,000	1,105,000	1,288,000	1,402,000	1,515,000	1,650,000	1,810,000	1,905,000	1,905,000
Total for Port of Mobile	16,679,000	37,958,000	44,216,000	48,121,000	52,008,000	56,645,000	62,157,000	65,417,000	65,417,000
					Commerce for Theodore				
Manganese Ore	-	548,000	726,000	825,000	1,011,000	1,200,000	1,389,000	1,483,000	1,483,000
Ferro Alloys	-	54,000	71,000	81,000	99,000	116,000	133,000	142,000	142,000
Steel Billets	-	111,000	160,000	187,000	251,000	312,000	373,000	404,000	404,000
Cement	-	958,000	1,350,000	1,568,000	2,147,000	2,725,000	3,303,000	3,592,000	3,592,000
Refined Petroleum Products	-	1,129,000	1,445,000	1,620,000	2,129,000	2,639,000	3,149,000	3,404,000	3,404,000
Crude Oil	-	11,564,000	11,564,000	11,564,000	11,564,000	11,564,000	11,564,000	11,564,000	11,564,000
Total for Theodore	-	14,364,000	15,316,000	15,845,000	17,201,000	18,556,000	19,911,000	20,589,000	20,589,000
Total for Mobile and Theodore	16,679,000	52,322,000	59,532,000	63,966,000	69,209,000	75,201,000	82,068,000	86,006,000	86,006,000

the study area will continue to experience a level of growth. Therefore, the Division of Air Pollution Control, Bureau of Environmental Health, which monitors Mobile County's air quality, is presently developing an Air Quality Maintenance Plan for the county. The plan, which is mainly concerned with particulates, will cover the twenty-year period from 1975 through 1995, and will indicate the amient air levels resulting from this increased growth. It will then determine what, if any, additional regulatory measures will be necessary. New industrial development in the county will be subject to stringent regulations and extensive studies will be required to insure that the standards will not be violated as a result of the new development. Since most of the study area's industrial growth is expected to occur in Mobile County, Baldwin County is not projected to experience serious degredation to its air quality. It's also expected that when final compliance with Federal automobile emission standards is achieved, there will be a substantial reduction in the photochemical oxidant level. Stringent controls of new industrial development will also be necessary to assure this.

119. <u>Housing</u>. With or without the considered project, the present pattern of residential development is expected to continue, with heavy growth areas to be located west of the city of Mobile and south to Theodore. The completion of I-10 across the bay should result in Baldwin County becoming more attractive to residential development.

120. A survey conducted for the South Alabama Regional Planning Commission indicates that, while there is a high demand for apartments in the city of Mobile, the greatest demand is for single-family dwelling units. The Planning Commission has established a number of housing goals including special home-purchasing assistance to low-income groups, rehabilitation of substandard housing, and the stimulation of a rate of housing construction adequate for an expanding population and to alleviate existing overcrowding. The Commission also hopes to prevent "urban sprawl" by encouraging residential growth in geographical groupings balanced by permanent open spaces.

121. Displacement of people. As previously stated, the Mobile Harbor area is expected to require additional dock facilities without regard to deepdraft navigation improvements in the Mobile Ship Channel. There is little residential development in the project area. Most of these existing houses are in a delapidated condition and are currently subject to urban renewal programs. Therefore, increased dock activity is not expected to affect the displacement of residential dwellings.

122. Esthetic Values. Under the "No Action" alternative, esthetic values in the project area are expected to undergo changes as the region responds to the need for industrially developed land and expanded harbor facilities. This expansion can be expected to reduce the amount of open space lands, to render the area less desirable for recreational activities.

123. Community Cohesion. Selection of the "No Action" alternative should not significantly affect future community cohesion in the Mobile SMSA. Certain groups within the region would be pleased with this decision while others would regard rejection of harbor improvements as a blow to the economic well-being of the study area.

124. History and archaeology. A decision not to implement any modifications to the Mobile Ship Channel now under consideration would not affect historical or archeological resources in the study since no new construction would take place.

125. Water and land use. As the population in the study area continues to increase, more land now used for other purposes will be converted to urban and built-up uses. This trend is expected to continue even with no additional harbor improvements. The bulk of new industrial development will probably occur as an extension of existing industrial areas in order to take advantage of existing power, water, highway, rail, or seaport facilities. Therefore industrial growth is projected to expand primarily along upper Mobile Bay, north along the Mobile River, and south in the Theodore Industrial Park. Concomitant commercial development is expected to occur in the areas of residential development previously discussed.

126. Anticipated growth will create conflicting demands for the study areas' fresh water resources. Much new industry is locating in the region to take advantage of this resource. Continued population growth will also require large amounts of fresh water.

127. Projected recreation uses. At present the general project area provides a variety of recreational opportunities, including hunting, fishing, swimming, boating, bird-watching, etc. Assuming "No Action", projected industrialization and increased water-borne commerce is expected to claim further undeveloped land in the project area. Estuarine areas and wetlands along the bay may continue to be lost, reducing available wildlife habitat, resulting in a lowering of species diversity and population densities, and lessening recreational opportunities for the outdoorsman. Also, increased barge and deep-draft vessel traffic associated with economic growth and the Tennessee-Tombigbee Waterway may interfere with some water-oriented activities.

128. Environmental Effects. Some ecological trends occurring today can be expected to continue even without the structural modifications under consideration for the Mobile Ship Channel. The profile of existing conditions for Mobile Bay, outlined in Section B of this appendix, indicates that considerable environmental stress regularly occurs in the bay's estuarine and marine ecosystem. The two most obvious indicators of this condition are the "jubilees" and the annual closure of the bay to the harvest of oysters. However, such events have been recorded since early historical development in the Mobile Area.

129. In the absence of changes to the existing project, future maintenance would continue to be performed according to current practice. Approximately 3,824,000 cubic yards of sediments would continue to be removed annually from the Mobile Bay channel and placed in open water on both sides of the channel along its entire length. Approximately 2,000,000 cubic yards of material would continue to be removed from the Theodore Ship channel and placed in the Theodore Island containment

area. Approximately 225,000 cubic yards would continue to be removed from the bar channel and placed by hopper dredge over 4.4 square miles of open gulf bottoms. Approximately 1,150,000 cubic yards would continue to be removed from the river channel. Material from this reach is currently placed in contained areas adjacent to the upper harbor. However, future capacity is limited and known available areas do not presently provide storage for more than an additional 16 years. Severe environmental constraints tend to retard further development of upper harbor disposal sites into adjacent wetland areas. Plans to accommodate this future requirement have not been developed by the concerned parties.

130. Disposal of material dredged from the bay channel will continue to disrupt the benthos within the disposal areas. Organisms include polychaete worms, nemertean, crabs, shrimp, mollusks, and echinoderms. Motile species normally either avoid or leave the disposal areas while the non-motile forms are directly covered by the dredged material, mud flow, or heavy siltation within 1,200 to 3,500 feet from the disposal site. Since recovery of the benthos does occur, the total ecosystem loss resulting from this disposal technique has not been fully documented. Applicable studies to date indicate that it is a relatively minor impact well within the resiliency of the estuarine system provided that existing circulation patterns are not altered. The approximate community structure of the dredged and disposal areas is essentially fully reestablished within nine to eighteen months, after each maintenance operation. Since maintenance at any one reach repeats on a two-year cycle, significant recovery and utilization characterizes the disposal sites, prior to resumption of pertubation by dredging.

131. Maintenance dredging in the Mobile Harbor channels with disposal in open water also results in a temporary increase in turbudity. A study by Brett (1975) indicated that dredged material placed in open water stabilizes within a nine-month period and then becomes difficult to resuspend because of the high concentrations of clay particles. It was also concluded from the study that turbidity produced by dredging

is transitory and lasts one to two days. This finding indicates a very short-term effect on light penetration and a consequent negligible effect on light dependent plankton populations and sight-feeding fish. This effect is also minimized in Mobile Bay by the high natural state of turbidity.

132. Water quality is also affected by the high chemical and biochemical oxygen demands associated with finely-sorted channel sediments. Resuspension of these sediments results in a temporary reduction in dissolved oxygen. The channel sediments contain moderately high concentrations of several trace elements. Windom (1973) concluded that dispersion of the sediments by dredging was not followed by metal release of any significant quantity, except possibly in the case of zinc and iron. It was further shown that variations in metal levels in the bay show no relation to dredging activities, but were more influenced by natural processes such as runoff. Increased levels of metals in the water column were found near the discharge end of the dredge pipeline, but were highly localized.

133. In order to determine the potential release of contaminants in the dredged material to the receiving water column, the Corps of Engineers and the Environmental Protection Agency developed the elutriate test. It is designed to quantify the increase in concentration of a given constituent in the proposed receiving water (dilution water) after a sediment sample has been added vigorously to the dilution water, simulating the actual dredging conditions. In 1974 surface layer sediment samples were collected from 27 stations in the Mobile Ship Channel to assess the effects of maintenance dredging and disposal of the material. Physical and chemical characteristics of these sediments are discussed in Section C of this appendix. Elutriate analyses (see attachment D-1) performed on eight of the sediment samples indicated that the nutrient related constituents, such as ammonia nitrogen, total Kjeldahl nitrogen, dissolved phosphorus, and total organic carbon most often demonstrated a potential to be released into the water column. It was concluded, from a nutrient standpoint, that

the release of the constituents would not be expected to create adverse water quality conditions in unconfined areas of Mobile Bay. A scavenging trend was noticed for metals in most of the samples analyzed, resulting in lesser concentrations in the elutriate waters than in the dilution or background waters. Based on the results of the elutriate test, it was found that there would be an increase in the concentrations of copper cadmium, lead, nickel, and iron, but the increase would be limited only to the area of the immediate discharge.

134. The impact of disposal from the bar channel is similar to the open-water bay disposal. The primary difference is that the emptying of the hopper dredge within this area has resulted in a buildup of the sea bottom. The process generates large clouds of suspended solids upon deposition. The time required for the induced turbidity to dissipate has not been specifically documented, but it is considered to be less than one day. Solid material from the dumping action traps and smothers many organisms living in and traveling through the water column above the dumping grounds, as well as bottom organisms. Fish are frequently seen jumping from the water within the area of the turbid water. It is not know whether they are being pursued by larger predators and have sought cover within the turbid water or if they are jumping to avoid the increased turbidity.

135. Since both Sand and Dauphin Islands are presently experiencing some erosion problems, it is highly probable that the present maintenance project will be coupled with some sort of beach nourishment program in the future. The principal impediment to the immediate implementation of such a program lies in the existing lack of a sufficient number of hopper dredges which have pump-out capability. As more dredges with this capability become available, the material from the outer bar would be pumped into the littoral drift system of Sand and Dauphin Islands.

136. Two samples have been taken along the bar channel during preparation of the Mobile Harbor Operation and Maintenance Environmental Impact Statement. The physical characteristics of both these samples are such

that they are excluded from the requirement of elutriate analysis and are considered acceptable for open-water disposal. This material is characterized by a very high percentage of coarse sand with approximately 7% silts and clays. The silts and clays are responsible for the turbidity increases during the loading and unloading of the hopper dredge.

137. Disposal of dredged material along the Bay Channel is thought to have modified circulation patterns in the bay (May, 1973). Jubilees are considered to be caused by salinity stratification in sinks created by shoals in the lower bay and by spoil banks from the ship channel. May reports that the natural shoaling and spoil from the channel have damed most of the bottom water on the eastern side of the bay preventing its regular exchange with the Gulf. Organic matter and woody debris accumulate in these sinks, and bacterial decomposition of this organic matter during summer when waters are stratified causes oxygen depletion in bottom waters of the sinks which, under certain conditions, may move shoreward causing a jubilee. The mortality caused by this phenomenon has not been assessed, nor has its impact on the trophic dynamics of the bay ecosystem been established. Recent surveys by the Corps suggest that the buildup of material alongside the channel is not as extensive as has been previously suggested. There has been a buildup of material in the upper third of the bay west of the ship channel and to a lesser extent on the east side. Evaluation of the surveys reveals that the presently existing volume of material along the channel is less than the volume of material involved in initial dredging alone. Consequently, it is considered that the lighter maintenance material does not accumulate but is redistributed by wind, wave, and tidal action. Disposal operations in the lower bay have not resulted in a significant accumulation of the dredged material. The Mobile Bay Technical Committee Report (1973) concluded that the apparent existence of depressed dissolved oxygen conditions prior to the construction of the ship channel indicates that the present physical modifications to the bay are not the sole causes of existing water quality conditions. The contribution that the ship channel and disposal mounds make on circulation patterns and water quality conditions is not known.

BROOKLEY EXPANSION AREA AND GULF DISPOSAL PLAN NO. 1, MODIFIED

138. The optimum level of development for this plan would be provided and maintained at an additional annual cost of $22,028,000. Net benefits from the plan would be $11,102,000. This plan would provide for disposal of the 143 million cubic yards of new work material as well as all future maintenance material over the 50- year economic life of the plan. Approximately 65.3 million cubic yards of new work dredged material would be placed in the diked disposal area in the upper bay and 77.8 million cubic yards of new work material will be transported to the gulf for disposal. An average of 4.7 million cubic yards of dredged maintenance material will be transported annually to the gulf for disposal. This includes 4 million cubic yards for the existing project and 0.7 million cubic yards induced by the alternative plan.

139. Direct benefits. Direct benefits that would be realized under this alternative plan are in the form of deep-draft transportation savings and land enhancement. Transportation savings will be realized during the construction period, however, for the purpose of this study thesebenefits were not considered. Also, the improved efficiency of the harbor will eliminate traffic delays due to constrained one-way traffic in the main channel, lack of anchorage areas in the upper harbor and limited turning areas.

140. Socio-economic Impacts of the Considered Plan. As previously discussed, certain socio-economic trends expected to occur in the area under the "No Action" plan would be incited by an unquantifiable amount with construction of this alternative plan. There would be an increase in population, employment, housing, industrial and commercial development, water borne commerce, and port expansion. As the population in the study area continues to grow more land now used for other purposes will be converted to urban and built-up uses. This is particularly true for the heavy growth areas west of Mobile and south of Theodore. Baldwin County is also becoming more attractive to residential growth. Concomitant commercial development is expected to occur in the areas of residential development. The location of the industrial spine in Mobile is not expected

to change significantly, although the demand for industrial land will increase. Industrial growth is projected to expand primarily along upper Mobile Bay, north along the Mobile River, and south in the Theodore Industrial Park. Expansion of port terminal and handling facilities is also expected to occur with the proposed upper bay disposal site being a primary area of expansion.

141. Demographic aspects. Any population increase as a result of deepening the main ship channel would be insignificant to the BEA region or the Mobile SMSA. Any increase that might result from the implementation of the Brookley fill area would occur in the SMSA.

142. Population density. No measurable impact.

143. Population mobility. The increased level of industrial and commercial activity in the project area is expected to be accompanied with an in-migration of population. An out-migration could occur, however, if adverse environmental effects were to result from implementation of the project or residential properties were purchased for industrial or commercial use.

144. National economic development. Implementation of a channel deepening plan would enhance national economy by improving transportation and handling facilities for ores and coal, among other items. The plan should also improve U.S. competition in foreign trade in these items. Transportation savings for imported materials would enhance the manufacturing competitiveness of the products proposed with the above bulk and other items.

145. Noise. Noise from highway traffic and industrial activities are not significantly high at present, but the level of noise from these sources is expected to increase as a result of project implementation. Noise from other sources is either negligible or of short duration. Construction noise, for example, may be intense, but is of only a temporary nature.

146. Esthetics. Esthetic effects which can be attributed to the Brookley Expansion plans generally fall into three categories: visual effects, odor and noise. Because of the disposal of dredged material adjacent to the Brookley shoreline human activities associated with terrestrial esthetic pursuits would be affected. Conversion of land use would be rendered less desirable for residential and recreational use from the standpoint of esthetic amenities.

147. Housing. Adequate land is available in the surrounding areas for residential developments associated with any population increase.

148. Displacement of people. Student housing units are located on state property near the proposed Brookley fill area. The state is aware that such developments in their immediate vicinity would not take place for a number of years and that the residents can be relocated without any social impact.

149. Health. The location of additional port facilities and increases in the number of workers in the area will increase the chances of industrial accidents. There is no apparent shortage of health facilities in this area.

150. Community Cohesion. Since the implementation of the Brookley fill area implies the displacement of some people, community cohesion as it now exists in the immediate area would be disrupted to a certain degree. The quality of life, life styles, and the relationships between persons in the community are not likely to change.

151. Selection of this plan would not be expected to significantly effect community cohesion in the Mobile SMSA. Certain groups within the region would regard the harbor improvements as a major boost to the economic well-being of the study area while others would be skeptical of alterations to the bay.

152. Anticipated growth will create conflicting demands for the study areas' fresh water resources. Much new industry is locating in the region to take advantage of the resource. Continued population growth will also require large amounts of fresh water.

153. Water quality. Water pollution associated with the increased development of the area will be a major concern. As indicated in Section B of this report a water quality management plan for Mobile and Baldwin Counties has been developed by the South Alabama Regional Planning Commission in compliance with Section 208 of PL 92-500. In order to effectively improve water quality and assure attainment of water quality goals, the 208 study indicated that a regional structure is needed to coordinate the various city and agency water quality plans and standards. Such a structure would also facilitate the study of point and non-point

sources of pollution and other water quality problems from a basin-wide perspective on a continuing basis. If the recommendations of the 208 study are adopted locally, certified by the Governor and approved by the Environmental Protection Agency, then the South Alabama Regional Planning Commission, in conjunction with the Alabama Water Improvement Commission, will be assigned the responsibility to carry out the area-wide management program.

154. Air Pollution. Since the study area is predicted to experience a continued growth level, the Division of Air Pollution Control, Bureau of Environmental Health, which monitors Mobile County's air quality, is presently developing an Air Quality Maintenance Plan for the County. The plan, which is mainly concerned with particulates, will cover the twenty-year period from 1975 through 1995, and will indicate the ambient air levels resulting from increased growth. It will then determine what, if any, additional regulatory measures will be necessary. New industrial development in the county will be subject to stringent regulations and extensive studies will be required to insure that the standards will not be violated as a result of the new development. Since most of the study area's industrial growth is expected to occur in Mobile County, Baldwin County is not projected to experience serious degredation to its air quality. It's also expected that when final compliance with Federal automobile emission standards is achieved, there will be a substantial reduction in the photochemical oxidant level. Stringent controls of new industrial development will also be necessary to assure this.

155. Environmental Effects. Primary environmental impacts of this plan would be associated with; (1) channel construction and subsequent maintenance dredging operations, (2) construction and stabilization of the expansion area in the upper bay, and (3) offshore disposal of dredged material.

156. Impacts of Channel Construction. About 700 acres of bay bottom and 520 acres of near shore bottom would be committed to the enlarged channel in addition to the areas in the existing channels. From a productivity viewpoint this impact is considered adverse since benthic

productivity is expected to diminish by approximately 80 percent. However, Swingle (1977) and others have indicated that the existing ship channel supports a more diverse fish fauna than the balance of the bay. Also, deep channels tend to provide a thermal refuge during the passage of cold fronts.

157. During construction and maintenance dredging of the channels some turbidity would be created along the bottom in the immediate vicinity of the dredge cutterhead. Huston (1976), studying a cutterhead dredge operating in Corpus Christi Ship Channel (predominantly clay material), found that little of the turbidity created by the cutter went into the upper water column, especially from depths of 30 or 40 feet. Increased turbidity caused by the cutterhead would be considered to be minor and of short duration.

158. A salinity wedge extends from the Gulf of Mexico along the bottom of the existing Mobile Ship Channel and up the Mobile River. The salinity concentrations vary seasonally according to river discharge with high concentrations (approximately 16ppt) extending as far upstream as river mile 10 during low flow. According to model studies the enlarged channel would allow more of the high salinity gulf waters to travel northward through the bay and thereby increase the salt wedge intrusion in the river. The upstream boundary of the wedge would remain somewhat unchanged, however, the lower 5 miles of the river would be subject to salinity intrusion for longer periods than presently experienced. The result could be a slight northward migration of the limits of some brackish saline species of flora and fauna along the Mobile River. The overall hydrological modifications to the bay related to the enlarged channel and disposal plan are discussed in more detail under the cumulative impacts subsection in following paragraphs.

159. Impact of Disposal in Bay. Under the Brookley Expansion plan, a total of approximately 1,710 acres of upper Mobile Bay bottoms would be covered with material dredged from the upper bay. The area is relatively shallow and ranges from four to six feet in depth, except for two deep holes. The area which would be filled constitutes approximately five percent of the bay's bottom that is less than six feet deep.

These bottoms are used in sport-shrimping effort and the shoreline furnishes recreational opportunities, including softshell crabbing, castnetting for mullet, and floundering. However, no quantification of the annual use of the area is available. Swingle, Bland, and Tatum in a study on the 16-foot trawl fishery reported that the majority of the sport fishing effort in the early spring and late fall was directed toward upper Mobile Bay and that approximately 14.7 percent of the 5,727 fishermen owning trawls launch in the Dog River-Deer River area. Some of these fishermen undoubtedly travel up the bay to shrimp and utilize this area. The effect of removal of this area from production in the estuarine system is not known. However, the area does serve as a significant nursery for many valuable species, especially shrimp.

160. Bottom sediments in the area are classified as silty sand, clayey silt, and sand-silt-clay mix. According to Parker (1973), the productivity of the benthos and nekton is closely tied to the kinds of sediments on or in which animals live. Unconsolidated sediments with the highest standing crops are usually poorly-sorted sand-silt-clays or clayey sands of sandy silts, while the poorest sediments for animal life are well-sorted, pure fine sands or clays (Parker, 1969). Parker (1973), however, included the upper third of Mobile Bay in his classification of areas which were least sensitive to increased or additional disturbance. May (1973) in a study on dredging indicated that both standing crop and diversity are lower on the west side of the bay than on the east side and that the ship channel seemed to form an effective barrier between the habitats.

161. Parker (1960) described the upper bay bottom which would be filled as supporting river-influenced, low-salinity benthic assemblages. Approximately 20% of the bay is characterized in this manner. The dominant benthic organism in this portion of the bay and down to Dog River is the brackish water clam, Rangia cuneata. Clams smaller than 30 mm are utilized as food by many fishes, crabs, and ducks. Hopkins, et al (1973) has examined Rangia as an overall indicator organism which

could be used to determine the effects of engineering works on the biota of coastal waters. The most critical factor in determining the future of Rangia population is in the pulsing of freshets into an embayment, which would not be changed by implementation of this alternative. Although the remaining population outside the fill area would not be directly affected, the fill would destroy a large percentage of the existing populations.

162. The Brookley Expansion area would abut an existing man-made fill area. This area is characterized by about 70 acres of marsh which has voluntarily established along the shoreline. Plant species mainly include Panicum sp., Phargmites communis (common reed), Juncus roemerianus (black needlerush) Hydrocotyle umbellato (pennywort), Iva frutescens (marsh elder), Myrica cerifera (wax myrtle), Quercus nigra (water oak), Zizania aquatica (wild rice), Spartina patens (salt meadow hay), Salix nigra (black willow), Cladium jamaicense (sawgrass), Baccharis halimifolia (groundsel tree), Typha latifolia (common cut-tail), Daubentonia punicea, and Pinus sp. As indicated by some of the above species, a large part of the wetlands area has been significantly disturbed by trash dumping and fill activities. Construction of the Brookley Expansion area disposal site would eliminate this wetland area. However, a well designed marsh establishment program could offset the wetlands loss.

163. A number of detailed studies have been conducted in Mobile Bay over the past decade evaluating the effects of open water disposal of dredged material. Recent studies conducted as a part of the overall COE Dredged Material Research Program have utilized both the elutriate and bioassay techniques of analysis. Results of these studies are summarized in following paragraphs.

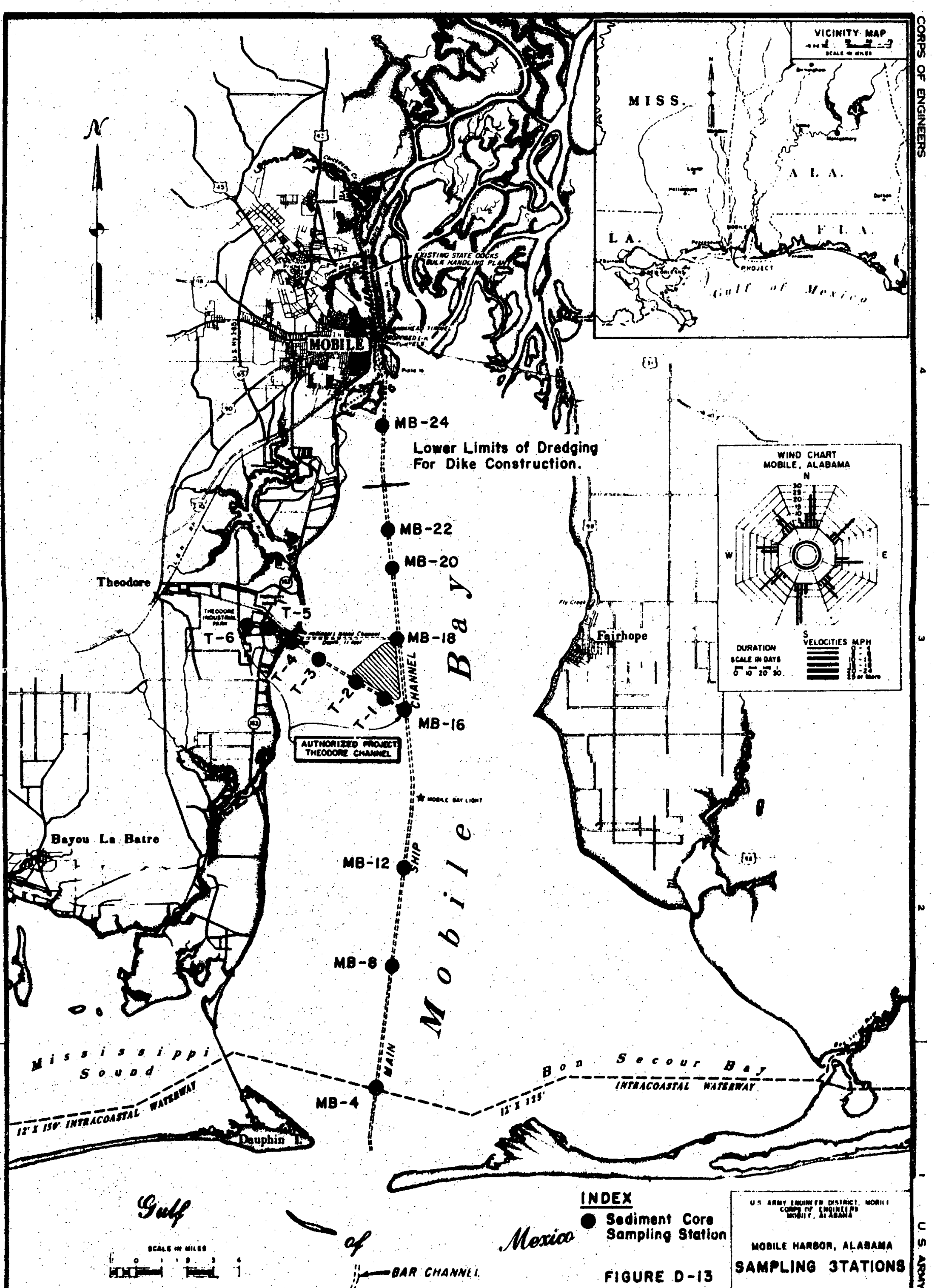
164. Windom (1973) investigated changes in heavy metals concentrations resulting from maintenance dredging of the Mobile Ship Channel. Metals studied were: iron, cadmium, copper, lead, mercury, and zinc. He conluded that dispersion by dredging is not followed by metal releases of any significant quantity except briefly in the case of zinc and iron. It was further determined that variations in levels of various metals in waters of Mobile Bay showed no relation to dredging activities but appeared to be more influenced by natural processes such as runoff. Slightly increased levels of metals in the water column were found near the discharge end of the dredge pipeline but these were very localized. May (1973) had similar findings when studying channel dredging in lower Mobile Bay. He concluded that the dredge effluent did not increase the levels of dissolved heavy metals.

165. Lee et.al. (1978) conducted a water quality study related to the June 1976 Mobile Ship Channel maintenance dredging near Middle Bay Light. Modified elutriate tests performed with the channel sediments and site water prior to dredging indicated that maganese and iron would be released to the water column. Both nickel and copper were removed from the waters while no significant changes occurred for cadmium, chromium, zinc, and lead. Total ammonium and ammonia also displayed a tendency to be released to the water column. Bioassays were performed with the elutriate waters to determine the effects on grass shrimp Palaemonetes pugio. No toxcity was observed during the 96-hour tests. Results of field tests of the actual dredge discharge were comparable to the elutriate tests but indicated only local increases in pollutional constituents in the water column directly associated with the initial mud-water matrix discharged from the dredge pipe. As a result of the Mobile Bay study and similar studies of other dredging projects, Lee et al concluded that the relatively rapid dispersion of any released contaminants at the disposal site creates a situation where the likelihood of significant toxicity or bioaccumulation of contaminants present in the dredged sediments is very small.

166. Shuba, Carroll, and Wong (1977) conducted algal bioassays utilizing

Dunaliella tertiolecta exposed to various combinations of elutriate and disposal site water concentrations for Arlington Channel. They asserted that an algal bioassay of the elutriate could indicate the bioavailability of constituents released from dredged material and the possible effect on phytoplankton productivity at the disposal site. Elutriate anaylses indicated ammonia-nitrogen, TOC and TIC were released from all of the Arlington Channel sediments sampled. Some orthophosphate was removed by all sediments. For the heavy metals, manganese and to a more limited extent lead and nickel were released for all sediments. Results of the bioassay analysis indicated a trend of inhibition to the growth of *D tertiolecta*. When nutrients were added to the elutriates growth yield increased significantly. Since ammonia nitrogen was released from all sediments a separate experiment was conducted using *D tertiolecta* and concentrations of ammonium up to 49 ppm. The ammonium study demonstrated that the concentrations of ammonium plus ammonia found in the elutriates were not toxic to the test algae. It was suggested that the algal growth in the bioassays could have been affected by the high concentrations of manganese in the elutriates.

167. In 1974 the Mobile District Corps of Engineers collected sediment core samples from along the alinement of the Mobile and proposed Theodore Ship Channels. Figure D-13 shows the location of the sampling stations in respect to the approximate limits of dredging for the channel construction. Analyses (data contained in Section B, Appendix 5 and Attachment D-1, Appendix 5 included physical, chemical, heavy metals, bacteriological, and pesticides by the bulk analyses technique, and elutriate analyses for chemical and heavy metals constituents. Results of the elutriate analyses for the sandy upper bay sediments were similar to the elutriate findings of Lee et al. (1978) and Shuba et al. (1977) in that the nutrient related constituents, such as ammonia nitrogen and total kjeldahl nitrogen, displayed the greatest potential to be released to the water column. Analyses of heavy metals in the dike construction material however, indicated only nickel and zinc would be released to the water column. The EPA Quality



VICINITY MAP
MISS.
ALA.
LA.
FLA.
PROJECT
Gulf of Mexico
WIND CHART
MOBILE, ALABAMA
DURATION
SCALE IN DAYS
VELOCITIES MPH
EXISTING STATE DOCKS BULK HANDLING PLANT
MOBILE
MB-24
Lower Limits of Dredging
For Dike Construction.
MB-22
MB-20
Theodore
THEODORE INDUSTRIAL PARK
T-5
T-6
MB-18
T-4
T-3
T-2
T-1
MB-16
CHANNEL
Fairhope
AUTHORIZED PROJECT
THEODORE CHANNEL
Bayou La Batre
Mobile Bay
MB-12
SHIP
MB-8
MAIN
Mississippi Sound
Bon Secour Bay
INTRACOASTAL WATERWAY
12' X 150' INTRACOASTAL WATERWAY
12' X 125'
MB-4
Dauphin I.
Gulf of Mexico
SCALE IN MILES
BAR CHANNEL
INDEX
Sediment Core Sampling Station
FIGURE D-13
U.S. ARMY ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALABAMA
MOBILE HARBOR, ALABAMA
SAMPLING STATIONS
CORPS OF ENGINEERS
U S ARMY

Criteria for Water, 1976, indicates that concentrations of nickel below 100 ppb should not be harmful to marine organisms. The concentrations of nickel associated with the dredging operation are well below that value (54.5 ppb). Although there are no specific criteria for zinc the increased concentrations would be relatively small. Based on the results of the previously discussed studies of dredging activities in Mobile Bay, any release of pollutional constituents to the water column would be expected to be transitory and limited to the immediate vicinity of the discharge point.

168. Lackey, et al. (1973) studied the effects of maintenance dredging of the Mobile Ship Channel on selected biological parameters. It was concluded from the study that the dredging did not influence the concentrations of coliform bacteria in the water around the discharge, in the sediments of the disposal area, or in the sediments elsewhere. Consequently dredging and disposal of the dredged material for the proposed project would not be expected to modify water quality from a bacteriological standpoint.

169. Water quality in the vicinity of the disposal operation will be affected by high chemical and biochemical oxygen demands associated with finely-sorted channel sediments. Resuspension of these sediments results in a temporary reduction in dissolved oxygen. Lee et al. (1978) associated depressed dissolved oxygen levels to the high suspended solid concentrations in the immediate vicinity of the dredge discharge point.

170. Increased turbidity and suspended solids concentrations would be associated with the island and expansion area during construction and stabilization. The term turbidity properly refers to optical properties of water having to do with light absorption and scatter, but turbidity is commonly attributed to suspended sediments alone. It is used in this sense to refer to a broad spectrum of conditions, varying from what can essentially be considered a highly fluid mud, having several grams of particulates per liter, to particle suspensions of a few milligrams per liter, which appear clear to the eye. Varying ranges of turbidity are

experienced in most aquatic ecosystems, including Mobile Bay (15-100+ JTU's), to which resident fauna and flora are adapted (Hirsch, et al. 1978). Background suspended solids values have been documented to range from 4 to 144 mgl (May, 1973) for Mobile Bay.

171. Nichols and Thompson (1978) conducted a study of turbidity and fluid mud flows associated with Mobile Ship Channel maintenance dredging near Middle Bay Light in June 1976. The discharge was conducted with a 24 inch pipe submerged five feet below the water surface at approximately a 30° angle. Results of the study indicated that the disposal increased suspended solids in near-surface water above background in a zone extending about 1,000 feet along the axis of a plume from the discharge point. Corresponding near-bottom concentrations extended more than 1,950 feet and laterally about 1,300 feet from the discharge point. The discharge plume disappeared within two hours after the dredge discharge was stopped. An estimated 99 percent of the dredged material accumulated as dense suspensions of fluid mud along the bay bottom with concentrations ranging from 10 to 480 g/l. The fluid mud extended more than 1,600 feet from the discharge point at a thickness of about five inches.

172. Brett (1975) conducted a sediment dispersion study of the maintenance dredging operation studies by Windom and Lackey. It was reported that the dredged material moved from the discnarge as a meandering stream and occasionally resurfaced. These patches of suspended material occurred for a maximum distance of 2,000 to 3,000 feet from the point of discharge. Mud flows were observed to move a distance of about 5,000 feet, while small concentrations of fine materials move up to 4,000 feet from the discharge. Brett also concluded that turbidity produced by dredging settles out within one to two days, and that the dredged material probably stabilizes in at least nine months and then becomes difficult to resuspend because of the high concentration of clay particles contained in the dredged material.

173. The disposal operations would increase suspended solids throughout the area during the period of construction and stabilization of the dikes which may involve a period of several years. Heavy suspended solid concentrations would be expected in the area of construction, but small quantities of colloidalsized particles of dredged material would be transported by currents and tides and could be expected to visibly increase turbidity over a wide spread areas of the bay. The area that would be influenced by excessive turbidity would include the disposal site and those areas which would be temporarily disrupted by mud flows. Under worst-case conditions, utilizing the findings of Brett (1975), during construction of the upper bay expansion area approximately 1,300 acres of water bottoms west of the ship channel off Brookley would be subject to impact by mud flow.

174. Conceptualized impacts of excessive turbidity and suspended material which may be encountered in the bay include interference with filter-feeding activities of invertebrates, irritation and clogging of the gills of fishes, and interference with plant photosynthesis due to shading effects. The response of aquatic organisms to turbidity are frequently difficult to determine because they may be due to a wide variety of causes, including, but not limited to, the following: concentration of suspended solids, the number of particules in suspension, their densities, size distribution, shape, minerology, sorptive properties or presence of organic matter and its form; inherent physical, chemical, and biological characteristics of each site; and antagonistic and synergistic effects. Other variables, such as the interaction between the solids, temperature, and dissolved oxygen, frequently affect aquatic organisms before and during the increase in turbidity. For a more precise understanding of the impacts due to turbidity suspended solids and mud flows on the natural resources of Mobile Bay, the following parameters are discussed in more detail: Habitat, primary productivity, benthic assemblages (benthos), invertebrates, plankton, nekton, fishes and aesthetics.

175. As discussed in paragraph 160 the area around the disposal site would be blanketed with a thin layer of material which would result in habitat alteration. According to St. Amant (1972) investigations in Louisiana into the effects of dredging activities on normal

benthic populations indicate that the findings in these areas differ to some extent and in many cases are highly variable. In general it is recognized that during the initial disposal operation those benthic organisms in the immediate vicinity of the discharge are severely disturbed and either scattered or destroyed. However, the disposal areas tend to restore themselves in a short period of time. This is expected since most of the animals are naturally short-lived and have a high reproductive capacity. This type of biological resilience furnishes the mechanisms required for survival of populations of such lower animal forms. St. Amant (1972) indicates that the disposal areas would be expected to be repopulated within a normal growth season.

176. Studies by Oliver, et al. (1977) indicate that organisms, especially polychaetes, initially recolonizing dredged material were not the same as those which had originally occupied the site and consisted of opportunitistic species whose environmental requirements were flexible enough to allow them to occupy the disturbed areas. According to studies by Hirsch et al. (1978) trends toward reestablishment of the original communities were noted within several months after disturbance and complete recovery was approached within one year. Vittor (1974) noted that in D'Olive Bay, Alabama, benthic invertebrate standing crop was decreased by dredging and the mud flow was responsible for significant prolonged loss of infauna biomass. Although an overall 28 percent decrease in benthic invertebrate biomass occurred, benthic species diversity was not significantly lowered.

177. Laboratory tests at the Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi indicate that most motile inhabitants of the substrate are able to move vertically through dredged material. However, the physical characteristics of the sediment overburden are very important in the process of vertical migration. The laboratory tests show that when dredged material is physically similar to that in which the animals normally occur, there is little problem in accomplishing vertical migration. During the tests the majority of animals were able to migrate vertically through approximately 12.5

inches of dredged material. Although these studies duplicate to some extent the conditions which might occur during a typical disposal operation, there are obviously some parameters which are not duplicated. However, generally it would appear that animals, especially polychaetes, do migrate through dredged material since they are found in the disposal material shortly after the operation ceases.

178. A decrease in the depth of the lighted or euphotic zone usually accompanies increased turbidity (Sherk, 1971). As a result, the most frequently cited negative aspect of dredged material disposal is the reduced photosynthetic activity due to the interference of light penetration. However, the addition of suspended material can also stimulate photosynthesis by increasing the available nutrients (Stern and Stickle, 1978). Turbidity and suspended materials produced as a result of natural and/or mans activities can therefore either promote or inhibit primary production, and can be of substantial importance. Because so little information is available on the relationship between dredging activities and primary productivity, it is difficult to relate the time duration of turbidity caused by dredging, and the dilution around the disposal site, to the time required for algal stimulation or inhibition. According to Flenner (1970) short term dredging, as in maintenance operations, usually produces only temporary effects, and upon cessation of dredging primary productivity returns to normal levels. Because of the amount of fines associated with the dredged material it is expected that phytoplankton productivity would essentially be eliminated in the immediate area of dike construction during the discharge operation and for a short time thereafter until the dikes become stabilized.

179. Suspended sediments may also affect the abundance of planktonic forms and be of direct harm to zooplankton, fishes, and motile invertebrates. Several studies suggest that suspended particles raised by dredging have no gross effects on the diversity or abundance of zooplankton nor the composition of fish eggs and larvae (Dovel, 1970; Goodwyn, 1970). However, other investigations indicate that periodic resuspension of silts and clays by repeated dredging or wind and wave action may adversely affect the general metabolism of adult plankters

and both metabolism and metamorphosis of fish eggs and larvae as well as other developmental stages (Shar, 1971, and 1972; Livingston, et al. 1972). Simon and Dyer (1972) indicate that clumping and flocculation of plankton with suspended particles and subsequent settling to the bottom decreases planktonic populations. Lackey, et al. (1973) and Markey, et al. (1975) report a transitory decrease in the immediate vicinity of the dredge discharge during maintenance dredging.

180. Turbidity and suspended material may affect fishes directly or indirectly. Direct effects according to Stern and Stickle (1978) could include lethal agents and those factors that influence physiological activities (reproduction, growth, development) or produce abrasive wear on tissue. Indirect effects include modifications to habitats and food chain organisms. Recent data, based upon weight/volume concentration of suspended solids, from several closely monitored laboratory studies are probably more indicative of natural responses of adult fishes to suspended solids (Stern and Stickle, 1978). The results of these studies have indicated that adult fishes, as well as invertebrates, are affected by a complex interaction between suspended solids, temperatures, and dissolved oxygen. A correlation exists between normal habitat and sensitivity to suspended solids with the most tolerant species being the bottom dwellers while the filter feeders are the most sensitive. High suspended solids would be less harmful in winter than in summer and fishes as a group are more sensitive to suspended solids than many of the invertebrates studied to date.

181. Based on Stern and Stickle (1978) and studies conducted in D'Olive Bay Alabama by Vittor (1974) most fishes usually migrate out of the dredging area and gross effects to fishes are rarely observed. Patterns of seasonal occurrence, abundance, species diversity, and conditions of the gill filaments among fishes exposed to dredging operations and dredged material disposal generally remain unchanged. Under normal circumstances fish avoid turbid waters and have the ability to clear membrance of accumulated silt upon entering undistrubed water. Most

studies have indicated that upon exposure to temporary increases in turbidity and suspended material similar to that encountered in areas where dredging or the disposal of dredged material has occurred no permanent effects were exhibited.

182. The turbidity associated with the open water dike construction and stabilization would be aesthetically displeasing to some people. Most complaints from the general public concerning maintenance dredging and shell dredging involve localized turbidity and/or disturbance which for a period of time may reduce localized fishing success in the vicinity of the operations. David (1971) found that although water pollution is perceived by the general public to be of increasing concern and that the public has rather definite ideas about what constitutes a description of pollution, very often aesthetic criteria are used. She discovered that the most widely used indicators of water pollution seem insufficient in light of the public definition of and concern about water pollution. Therefore, the degradation to asthetics associated with the project is of importance and would be minimized to the extent practicable.

183. Results of engineering and environmental monitoring studies to be conducted in conjunction with construction of the disposal island for the Theodore Ship Channel project will be utilized in development of the disposal plan for the upper harbor area. Also, results of the Mississippi Sound study currently being conducted will be beneficial to the Mobile Harbor project. These studies will be coupled with a bay usage study to be developed and conducted during Phase I planning. The purpose of the usage study will be to define biological productivity, gather water quality data, and predict recreational potential for various sections of the bay. This will provide a better comparative analysis of the environmental impacts of the bay disposal operations.

184. After completion of the open water dike construction the remaining new work material from the upper bay would be placed within the confines of the expansion area. The impacts of disposal would be minimal with sufficient ponding and proper placement of the weirs to provide drainage from the disposal areas toward the open portion of the bay.

185. Under the Brookley Expansion Area and Gulf Disposal Plan No. 1 58,654,000 cubic yards of new work material from the lower bay channel south to Theodore Channel and an average annual volume of about 4.1 million cubic yards of maintenance material from the entire bay channel would be excavated by hydraulic dredge utilizing dump scows and tow boats to transport the material to a gulf disposal area. During construction of the bar channel approximately 19,019,000 cubic yards of material would be removed by hopper dredge and dumped in a gulf disposal area. On an average annual basis about 0.7 million cubic yards of maintenance material would be dredged from the modified bar channel and placed offshore.

186. The location of offshore dredged material disposal sites would require approval by the EPA in accordance with the 11 January 1977 Ocean Dumping Criteria developed pursuant to the Marine Protection, Research and Sanctuaries Act of 1972, PL 92-534. In the selection of the disposal site the criteria requires that in addition to other necessary or appropriate factors determined by the EPA, the following factors would be considered:

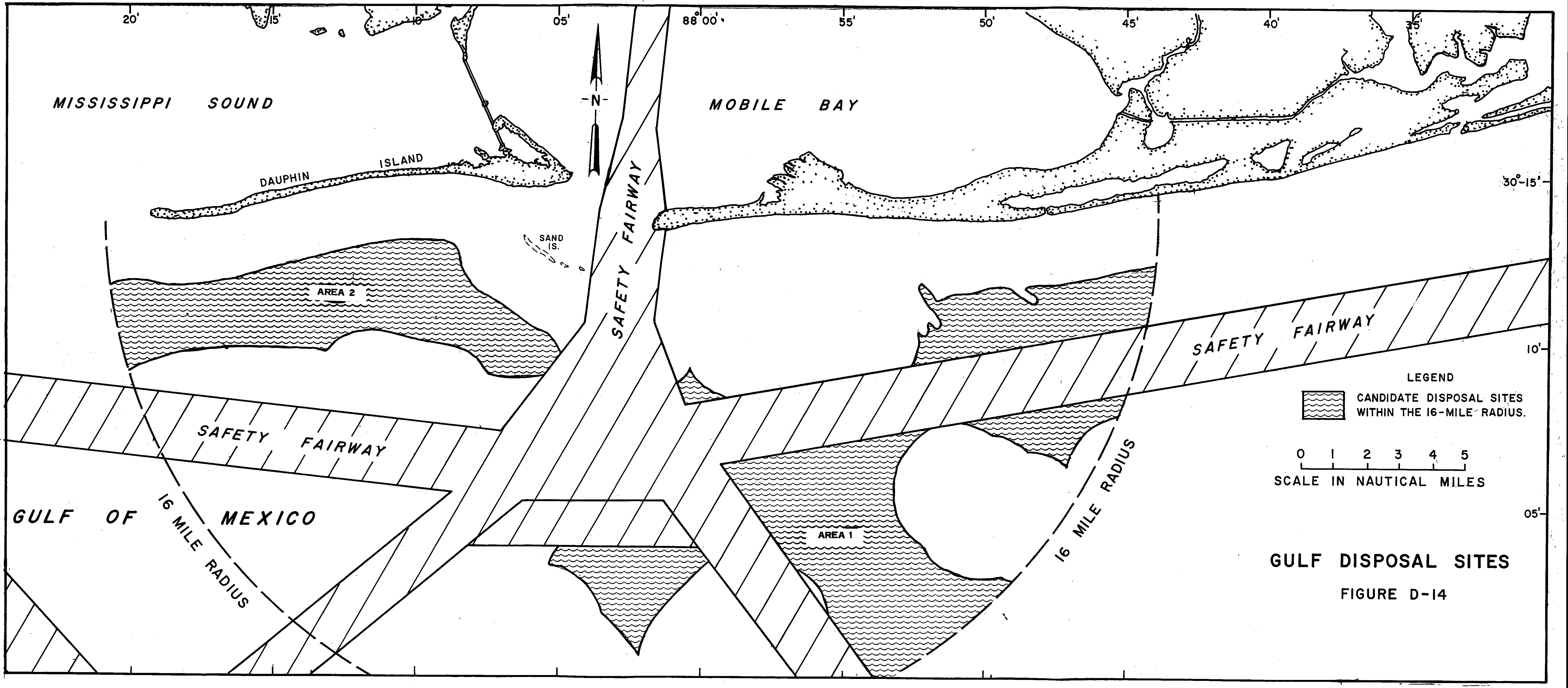
- Geographical position, depth of water, bottom topography and distance from coast;
- Location in relation to breeding, spawning, nursery, feeding or passage areas of living resources in adult or juvenile phases;
- Types and quantities of wastes proposed to be disposed of, and proposed methods of release;
- Feasibility of surveillance and monitoring;
- Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;
- Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);
- Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;
- The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;
- Potentiality for the development or recruitment of nuisance species in the disposal site;
- Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.

The results of a disposal site evaluation and designation study based on the above criteria would be presented in an environmental impact statement prepared by the EPA.

187. One area being considered for a new gulf disposal site is located about 16 miles southwest of the mouth of Mobile Bay in water exceeding 70 feet deep. The disposal area would cover approximately 24,600 acres. According to Vittor (1977) the area is characterized by a coarse to medium sand bottom with occasional clusters of shell hash. Two varieties of bivalve, Ammonia beccarii, abundant in the area, are tolerant to a high degree of stress. Their presence in abundance appears to reflect the influence of heavy sedimentation of fine material from the Mississippi and Mobile Rivers. However, it is doubtful that these forms could tolerate the large quantities of material resulting from the considered project. Personnel of the Dauphin Island Sea Laboratory have indicated that the general area is chacterized by a nepheloid layer at various times of the year, but that an abundant and diverse standing crop is quickly established whenever it is absent. This suggests a high degree of ecosystem resilience. Prevailing currents within 30 miles of Dauphin Island travel from east to west. Consequently, a gradual shifting of the lighter sediments to the west is expected.

188. A preliminary report, completed under contract by Tereco Corporation as a part of the Mississippi Sound Study, indicates suitable offshore sites are available, based upon the summation of published and pertinent unpublished information relative to environmental and biological characteristics of the of the nearshore sea bottom within the study area. As shown in figure D-14 the report focuses upon those specific areas where dredged material disposal is likely to cause the least damage to features and processes of greatest environmental and social value.

189. The 11 January 1977 Ocean Dumping Criteria established by the EPA require that elutriate tests and biological evaluations be performed prior to disposal of dredged material offshore. Elutriate results (Attachment D-1) for gulf disposal of the lower bay material were similar to that previously discussed for other bay sediments. The nutrient related constituents displayed a potential to be released to the water column along with a minor increase in some of the heavy metals concentrations. Sediments collected from the main bay channel near the intersection of the proposed Theodore Channel exhibited the



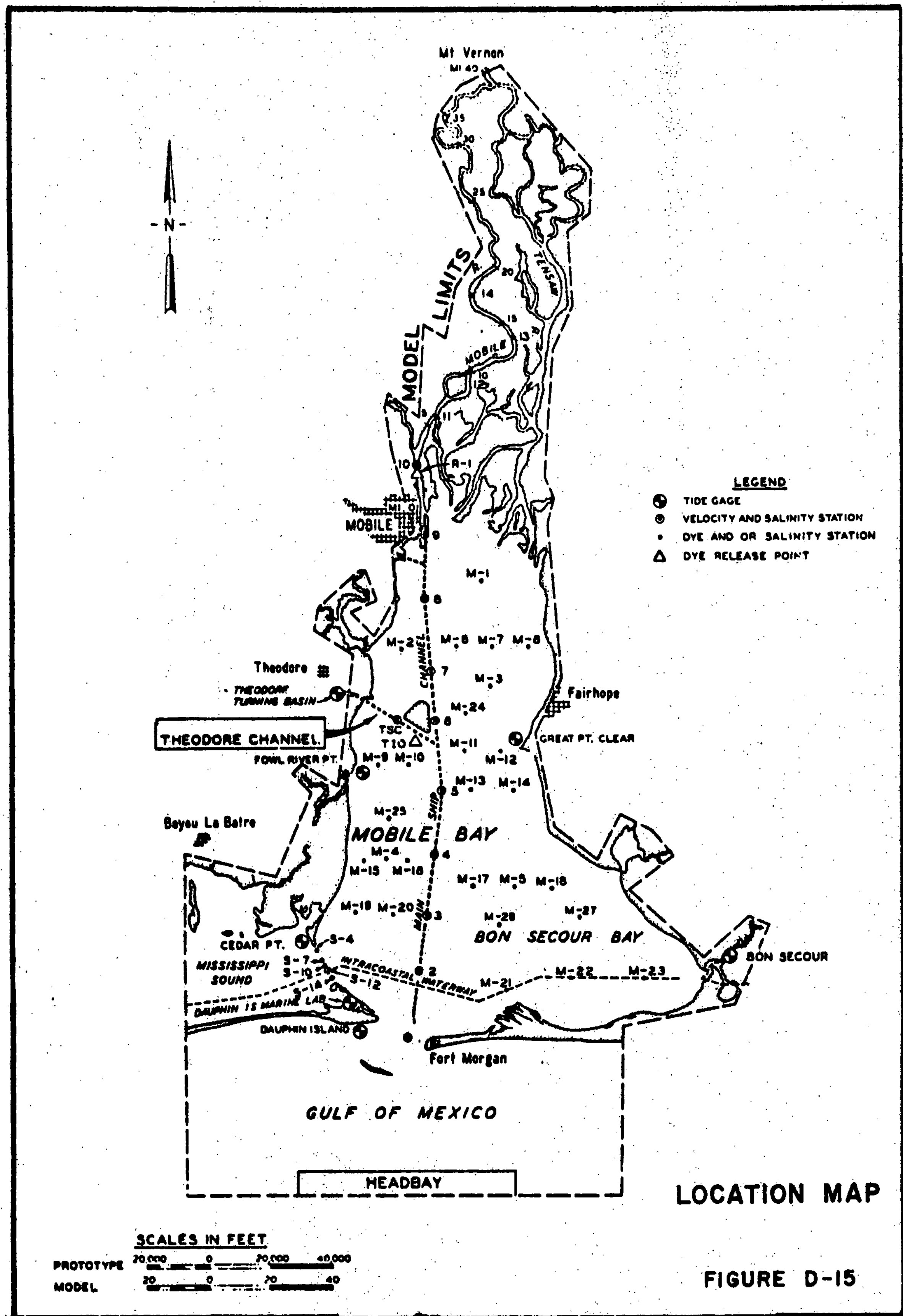
GULF DISPOSAL SITES

FIGURE D-14

greatest potential for undesirable effects on the water column. "Three phase" (liquid, suspended particulate, and solid phase) bioassay analyses required by the EPA were performed with these sediments to simulate a worst-case situation. Bioassay result, contained in Attachment D-2 indicate that there would not be any significant lethal effects from the dredged material on zooplankton, crustaceans, fish, infaunal bivalves, or infaunal polycheates. Also _Mercenaria mercenaria_ (infaunal bivalve) exposed to the solid phase of the dredged material did not demonstrate a potential for bioaccumulation of heavy metals, pesticides, or petroleum hydrocarbons.

190. As noted by letter of 2 November 1979, Appendix 3, the Environmental Protection Agency has issued a statement of concurrence on the availability of Gulf disposal sites within a reasonable distance to Mobile Bay as described in above paragraphs. Detailed site specific evaluations will be conducted next as a part of post authorization studies. The Mobile District COE is maintaining coordination with the EPA relative to the site designation requirements and procedures are being established for further disposal site evaluations. In addition, the EPA is currently preparing a "regional generic" EIS for the offshore area from Gulfport to Pensacola in order to establish site designation for maintenance material presently being placed in interim approved areas.

191. _Cumulative Impacts of the Considered Plan_. In order to determine the hydrological impacts of the considered plan, physical model studies were conducted at the Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. Elements studied included tides, velocities, surface currents, and salinities. Figure D-15 shows the location of the test stations used in the model. Initial tests were conducted for a number of disposal plans with a low freshwater inflow of 15,500 cubic feet per second (cfs). After initial studies were completed more detailed tests were conducted with a mean freshwater inflow of 63,500 cfs and a tide range of 2.3 feet at the Dauphin Island gage. Due to the substantial lead time required to complete the tests in phase with other studies for the project, the model studies were conducted prior to optimization of channel dimensions and refinement of disposal plans. As such, the tests were conducted with a 50-foot deep and a 500-foot wide channel as suggested by local interests and the upper bay disposal plans accounted for maintenance material from the upper harbor channel.



LOCATION MAP

FIGURE D-15

192. Although none of the model tests represented the dimension and exact disposal plans of this alternative, the features tested provided an increment of change adequate to identify patterns of change in the bay that could result from the physical modifications. Therefore, conclusions from the detailed model tests are as follows:

- There were only minimal changes in the tidal heights in the bay for this plan. Cedar Point showed the only significant difference with a low-water elevation of 0.4 feet higher than the base condition.
- Surface maximum ebb velocities were slightly (0.4 to 0.5 fps) decreased at sta 2,3, and 9 and slightly increased at sta 5 and 10. Sta 8 surface maximum ebb velocity increased from 3.0 to 3.7 fps due to the Brookley fill and the nearby disposal island. Surface maximum flood velocities were reduced from 2.3 to 1.7 fps at sta 2 and increased from 0.8 to 1.5 fps at sta 3. Bottom maximum ebb velocities were not greatly affected. Sta 6 and 8 showed slight decreases and sta 10 had a slight increase. Bottom maximum flood velocities were slightly reduced in the lower reach of the channel (sta 1, 2, and 3) and also in the upper reach at sta 9. Slight increaes occurred at sta 6 and 7.
- The percentage of total surface flow downstream was not significantly changed by this plan. However, the lower end of the channel was less ebb predominant (significant reduction at sta 3). The percentage of total bottom flow downstream was decreased throughout most of the channel length (bottom flow had an increased flood predominance).
- The surface current studies indicated that the disposal areas of the tested plan increased ebb velocities in the channel and also increased flow through the pass between Pinto Island and Little Sand Island. During strength of ebb, the diagonally cross channel velocities south of the disposal island are increased relative to the Gulf Disposal Plan.
- The average surface and bottom salinity over a tidal cycle in the bay increased for stations in the upper bay and near the channel. Average salinity in the lower bay was significantly reduced east of the navigation channel, while station salinities west of the channel usually increased. There seems to be an increased supply of saltwater from the enlarged channel and a greater storage of freshwater in the Bon Secour Bay area.
- Changes in maximum or minimum salinities in some regions were quite different from those of the average salinity. In many cases, the maximum salinity was more severely changed than was the average.

● The salinity intrusion length up the Mobile River was increased at the bottom depths for this mean freshwater inflow.

● The average surface salinity was increased in all four critical oyster bed areas. The maximum increase was 2.1 ppt. Bottom average salinities were increased at the areas south of the Theodore Channel and reduced at Whitehouse and Klondike critical areas. Status quo was maintained at Cedar Point critical area.

193. This alternative plan resulted in moderate changes in surface and bottom salinities in the upper bay. The greatest increases occurred near the channel for both surface (+2.5 ^{o}/oo) and bottom salinities (+3.4 ^{o}/oo). Although a moderate freshening of the bottom water of the nearshore stations was evident, the general trend was to increase the upper bay salinities. This finding, in conjunction with the widespread freshening of Bon Secour Bay (5.9^{o}/oo highest average top and bottom change at the station having the greatest change), strongly suggests that Mobile Bay's existing hydrographic characteristics would be significantly modified. The maximum freshening in Bon Secour observed at any one locality in the bay was at station M-5 (about four miles SSW of Mullet Point) and was 11.7 ^{o}/oo on the bottom over a single hour in the tidal cycle. Additionally, bottom salinities at this station were decreased at least 6 ^{o}/oo during 96% of the tidal cycle.

194. These changes are the apparent result of the deepened channel which increases the salt wedge intrusion up the Mobile River. The dense salt wedge apparently plugs much of the channel and restricts the southward flow of the less dense freshwater which is consequently diverted within the distributary system toward the eastern branch, the Tensaw, somewhere in the upper delta. This water sweeps the eastern shore and results in the overall freshening of Bon Secour Bay. An additional factor which intensifies the freshening effect apparently relates to the relationship of the channel size and the salt wedge in the lower bay. It is possible that the hydraulics of the enlarged channel prevent the salt wedge from creeping up and eastward into Bon Secour Bay, consequently reducing its supply of highly saline gulf water. This tends to increase the freshening effect since the lost saline waters would be replaced by riverine and partially mixed bay waters having less salt content. Although additional investigation is required, it is possible that this change would resemble

the manner in which the lower bay operated prior to ship channel construction.

195. The impacts resulting from this change are widespread and effect almost every environmental feature within the bay. Some of the changes are obviously beneficial, others are negative or harmful. The direction of most of the changes is unknown. Although the impacts cannot be analyzed in detail at this level of investigation, they include:

- A decrease in the waste assimilative capacity with the Mobile River.
- Increased turbidities along the eastern shore.
- Long-term alteration of marsh types within the Bon Secour Bay.
- Increased oyster producing area within Bon Secour Bay with the possibility of improved spatfall.
- Increased frequency of closure to shellfish harvesting of Bon Secour Bay.
- Unquantified changes in the overall nursery value of Mobile Bay.
- Alteration of the flushing characteristic of Mobile Bay as determined by dye diffusion studies.
- Alteration of larvel migratory pathways.

196. The basic goal of the model studies is to develop a plan that will maintain as near as possible the existing general pattern of circulation and the salinity regimen throughout the bay. Therefore additional model tests would have to be conducted for the proposed plan during phase I studies to determine the effects of the 55-foot deep channel and required mechanisms for offsetting significant hydraulic effects of the enlarged channel.

197. Two dredges could be operating continuously during construction of the alternative plan. In conjunction with this a possibility exists that a number of dredges could be simultaneously operating in various portions of Mobile Bay for an extended period. Presently, maintenance dredging of the existing Mobile Harbor project requires about eight dredge-months per year. Normally the work is accomplished with one dredge but occasionally two are employed. Inclusion of maintenance dredging from the proposed Theodore project would approach twelve dredge months per year, which would be accomplished with two or three dredges. The dredging of dead reef oyster shell is conducted in the bay on a year round basis.