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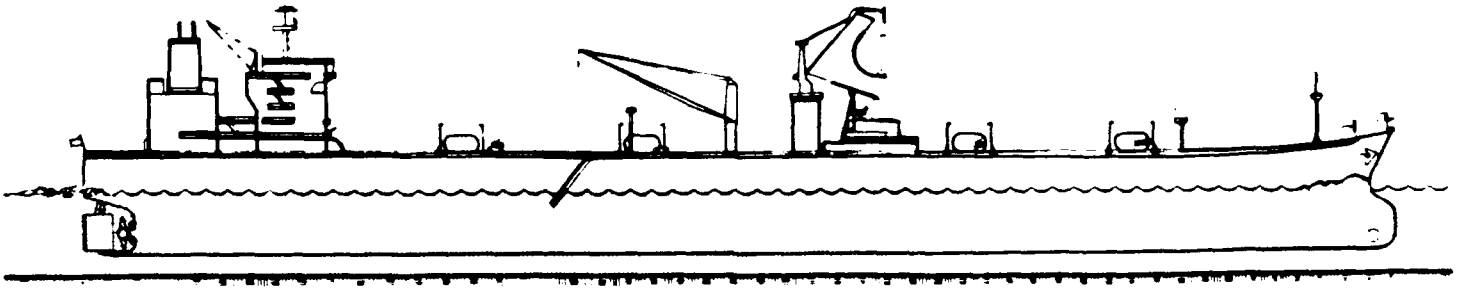
US Army Corps
of Engineers
Mobile District

GENERAL DESIGN MEMORANDUM

MAIN REPORT

IMPROVEMENT OF THE FEDERAL DEEP-DRAFT NAVIGATION CHANNEL

PASCAGOULA HARBOR, MISSISSIPPI



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Project background and histroy. A discussion of the reformulation process and results, followed by the detailed design of the recommended plan, with general information on economics and environmental effects.

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GENERAL DESIGN MEMORANDUM

IMPROVEMENT OF THE FEDERAL DEEP-DRAFT NAVIGATION CHANNEL
FOR
PASCAGOULA HARBOR, MISSISSIPPI

INTRODUCTION

1. This General Design Memorandum (GDM) will document the reformulation and detailed design of the Federal deep-draft navigation project for Pascagoula Harbor, Mississippi.

AUTHORITY

2. Improvement of the deep draft portion of the Federal navigation project for Pascagoula Harbor was authorized by Section 201 (a) of the Water Resources Development Act of 1986 (P.L. 99-662). The improvement plan authorized was that plan recommended by the Chief of Engineers Report dated 14 February 1986. This was the plan developed in the Mobile District Report Pascagoula Harbor, Mississippi, Feasibility Report, Improvement of the Federal Deep-Draft Navigation Channel, dated September 1984 and amended March 1985 (FR84).

3. Funds for Preconstruction Engineering and Design (PED) were allocated for Fiscal Year 1987 and the work covered in this General Design Memorandum was initiated in October 1986.

AUTHORIZED PROJECT

4. The plan recommended in FR84 and subsequently authorized consisted of:

A. Deepening and widening the gulf entrance channel to 44 feet by 550 feet from the 44-foot depth contour in the Gulf of Mexico to the bend at the southern end of Horn island Pass, deepening and widening Horn Island Pass to 44 feet by 600 feet between the bends at the southern and northern ends of that pass, for a distance of about 4-1/2 miles; relocating the Horn Island Pass reach about 500 feet westward; reconfiguring the impoundment basin in Horn Island Pass to provide a section within the channel limits 1500 feet long with a total depth of 56 feet to facilitate maintenance by hopper dredge, and allowing for future realignment of Horn Island Pass reach as natural conditions warrant. Both new work and future dredged material from the entrance channel would be placed in a disposal area between the 15- and 30-foot depth contours southeast of the east end of Horn Island.

B. Deepening the main ship channel to 42 feet from the bend at the northern end of Horn Island Pass, through Mississippi Sound and into the Pascagoula River, and terminating about 500 feet south of the grain elevator for a total distance of about 10 miles; widening the bend at the junction with the Bayou Casotte Channel from the present 150 feet to 250 feet to provide a total width at the bend of 600 feet and widening the bend at the mouth of Pascagoula River by 280 feet to provide a total width at the bend of 600 feet. Dredged material from the inner harbor new work would be placed in the Triple Barrel area, while material dredged between the mouth of Pascagoula River to Horn Island Pass would be placed in an approved area in the Gulf of Mexico. Future maintenance material would be disposed of in accordance with present practice.

C. Widening and deepening the Bayou Casotte channel to 42 feet by 350 feet from the junction with the main channel to the mouth of Bayou Casotte, a distance of about 3-1/2 miles; with additional widening at the mouth to provide a turning basin with a total turning diameter of 1150 feet,including the channel width; relieving the northern portion of the area between the junction with the main ship channel from the present 500 feet to 1000 feet, and widening the bend at the mouth of Bayou Casotte from the present 50 feet to 100 feet to provide a total width at the bend of 450 feet; new work material would be placed in an approved disposal area in the Gulf of Mexico. Future maintenance material from the inner harbor at Bayou Casotte, including the turning basin, would be placed in the Greenwood Island disposal area. Maintenance material from the Mississippi Sound leg of the Bayou Casotte channel from south of the bayou mouth to the junction with the Pascagoula River leg would be disposed of in accordance with present practice.

D. Mitigation for the unavoidable loss of 4 acres of emergent wetlands by restoring 6 acres of disturbed wetlands habitat to a more natural emergent nature.

PURPOSE AND SCOPE

5. This report presents the results of the final formulation and design of the project improvements. The purpose of this investigation was to develop adequate information to reaffirm the authorized plan or to justify a revised plan. The plan for the navigation channel improvements recommended in this GDM, when approved, will be the basis for the preparation and approval of plans and specifications. The economic analysis in Appendix C is adequate to justify the recommended plan and the technical analyses, Appendixes A and B, are sufficient for the final design of the project and the preparation of accurate cost estimates, Appendix E.

6. This report was prepared in accordance with the guidance in EM

1110-2-1150, "Engineering After Feasibility Studies" Change 1 dated 24 June 1985. Formulation of alternatives was in accordance with "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" dated 10 March 1982.

7. All information related to the deep-draft navigation channel was developed to the full PED level of detail and is suitable for the decision making process leading to production of plans and specifications and construction of that channel.

DESCRIPTION OF PROBLEM

8. The feasibility report established the need for improvements to the deep draft portion of the project. Preliminary investigations to confirm project economics, however, revealed significant changes in vessel traffic at the port, with consequent changes in the economic justification for the proposed work. The two most important changes were:

A. A long-term effect of the Russian grain embargo by the U. S. was drastic changes in foreign grain markets. The loss of exports resulted in a dramatic reduction in the bulk grain traffic, the major source of the savings justifying deepening the Pascagoula channel leg.

B. During the interim between the feasibility report and project authorization, Chevron USA retired their old lightering fleet and replaced those ships with two new ones designed to operate more efficiently in the existing channel. On initial contact, Chevron asserted, because of these lighter ship improvements, that they no longer benefitted from the proposed channel improvement.

9. As our investigation later developed, neither of the changes discussed in A and B were as serious as they originally appeared. Because of these apparent changes, however, it was determined that further investigations, and, possibly, reformulation of the project was in order. The final benefits developed are discussed in the ECONOMIC BENEFITS section and our investigations are discussed in detail in Appendix C, ECONOMIC ANALYSIS.

10. In 1984 we prepared a long-term dredged material disposal plan for inclusion in the Port of Pascagoula Special Management Area Plan. That plan considered the continued use and expansion of 3 upland disposal sites with extensive management techniques to increase the capacity of those sites. In 1985, the U.S. Navy announced the establishment of Naval Station Pascagoula, as part of the Gulf Coast Strategic Homeporting. That station was to be located on Singing River Island, the largest of the 3 disposal sites. The loss of this site, and the subsequent refinement of the long-term plan for the Triple Barrel area preclude the disposal of new work, or any additional quantity of maintenance material, in that area. Studies have been undertaken and the long-term plan revised to include gulf disposal of new work and maintenance material from mile 0.0 to mile 3.0 on the Pascagoula River Channel. The draft EIS concerning these activities was filed with the Environmental Protection Agency (EPA) on 27 July 1990. Final Designation of the Ocean Dredged Material Disposal Site (ODMDS) by EPA was completed 24 September 1991.

EXISTING CONDITIONS

GENERAL

11. Description of the Project Area. The deep draft portion of Pascagoula Harbor begins about 2 miles above the mouth of the Pascagoula River, in Jackson County, Mississippi, about 32 miles west of the entrance to Mobile Harbor, Alabama, and about 100 miles east of New Orleans, Louisiana. A branch channel runs from the turning basin at the north end of the Bayou Casotte Industrial Area to join the channel in Mississippi Sound about 5 miles southeast of the mouth of the Pascagoula River. The existing deep draft ship channel runs southward from Pascagoula through Mississippi Sound into deep water in the Gulf of Mexico. The geographical setting is shown on Plates 1 and 2. Barge traffic in the area is accommodated by the Gulf Intracoastal Waterway which passes through the middle of the sound.

REGIONAL PROFILE

12. Area Socioeconomics. Jackson County, one of Mississippi's three coastal counties, encompasses 731 square miles with an estimated population of 129,290 people as of 1987. The Pascagoula Metropolitan Statistical Area (PMSA), includes all of Jackson County. The PMSA has shown an increase in residents, from 31,401 in 1950 to 118,015 in 1980, for a total increase of 276 percent. The growth rate from 1980 to 1987 was nearly 10 percent as compared with 5 percent for the entire state and 14.1 percent for neighboring Gulfport and Biloxi.

13. Adult residents traditionally have depended on manufacturing as the major source of employment and income. The production of goods, especially durable goods, accounted for 34.5 percent of total employment for 1969 and 41.1 percent for 1978. Projections indicate a declining importance, however, as durable goods employment will range from 32.7 percent of total job holders in 1990 to 5.8 percent in the year 2035. The information, both historical and projected, for personal and per capita income echoes the patterns of employment.

14. A 1985 ranking indicated that the "quality of life" in the PMSA is not high. In the Places Rated Almanac published by Rand McNally, 329 cities were ranked on the basis of climate, housing, health, crime, transportation, education, the arts, recreation and economic forecasts. Overall, Pascagoula placed 271st, behind Mobile, Alabama, at 223rd and far behind New Orleans, Louisiana, at 53rd. Of the nine factors listed, it scored well only on the availability and costs of housing (35th) and on a comparatively low crime rate (52nd). In the category of economic forecasts, it placed 277th due to relatively low income levels, high state income

and sales taxes, and a projected 10 percent contraction of jobs over a 5-year period.

EXISTING DEVELOPMENT

15. Existing Federal Project. The present deep-draft navigation project, completed in August 1965, provides for:

A. An entrance channel 40 feet deep and 350 feet wide from the Gulf of Mexico through Horn Island Pass, including an impoundment area for littoral drift 40 feet deep, 200 feet wide, and about 1,500 feet long adjacent to the channel at the west end of Petit Bois Island;

B. A channel 38 feet deep and 350 feet wide through Mississippi Sound and Pascagoula River to a turning basin 38 feet deep, 2,000 feet long, and 950 feet wide (including the channel area) on the west side of the river below the railroad bridge;

C. A channel 38 feet deep and 225 feet wide from the ship channel in Mississippi Sound to the mouth of Bayou Casotte, and then 38 feet deep and 300 feet wide in Bayou Casotte for about a mile to a turning basin 38 feet deep, 1,000 feet long, and 1,750 feet wide;

D. Small craft channels in Pascagoula and Dog River are also part of the authorized project, but were not included in the feasibility study and, therefore, the authorized improvement.

E. Maintenance dredging of those segments of the Federal project within Mississippi Sound is performed by pipeline or mechanical dredge. Material from Bayou Casotte is placed in a diked upland disposal area on Greenwood Island. Material from the inner harbor at Pascagoula River is placed in a diked upland disposal area known as the Triple Barrel and in the gulf. Material from mile 1.75 to about mile 3 on the Pascagoula River leg, was once placed on Singing River Island in a diked upland disposal area but is now carried to the Pascagoula Ocean Dredged Material Disposal Site (ODMDS) in the Gulf of Mexico. Singing River Island was abandoned as a disposal site in 1987 to allow for development of the U.S. Naval Station Pascagoula. Material dredged from Mississippi Sound between the north end of the entrance channel to the mouth of Pascagoula River and Bayou Casotte is placed in open water disposal areas west of the channels. Provisions have also been made for placing this material in the ODMDS on an as needed basis. Material trapped in the impoundment basin in Horn Island Pass is pumped to an area west of the channel and over time has created a small island known locally as "Sand Island". Shoal material in the entrance channel is removed by hopper dredge and placed in the ODMDS.

16. Existing Port Facilities. The Pascagoula Harbor Complex has two port areas, to which the Naval Station is being added. Plates 1 and 2 show both areas and their relationship. The original port, Pascagoula Inner Harbor, is located at the mouth of the Pascagoula River at the north end of the Upper Pascagoula Channel, referred to hereafter as the Pascagoula Channel. This area is described below with an appropriate figure and is also shown in detail on Plate 3 and Chart C-2, in Appendix C, ECONOMIC ANALYSIS. The other area is the Bayou Casotte Inner Harbor industrial complex, located east of Pascagoula at the north end of the Bayou Casotte Channel. This area is also described below with a figure, and shown in detail on Plate 4 and Chart C-3. The new Naval Station Pascagoula is on Singing River Island. The island is shown in part on Plates 1, 2, and 5 and Chart C-4.

A. Pascagoula Inner Harbor. Ingalls Shipbuilding operates at the river mouth, with a large ship construction facility on the west bank of the channel and a large ship and submarine repair yard on the east bank (see Figure 1). These yards are used for constructing and launching new ships and repairing vessels with or without drydocking. The Jackson County Grain Terminal is owned by the Jackson County Port Authority (JCPA) and leased and operated by Louis Dreyfus Grain Corporation. Under the terms of the lease, this facility is operated as a public grain terminal available to all grain shippers on equal terms. The docks at the grain elevator are used for loading bulk and bagged grain onto ocean going vessels for export, and unloading grain barges from the Midwest. The terminal presently has a throughput capacity of 6 million tons per year and additional capacity can readily be added when demand justifies it. Public port and dock facilities here consist of four public terminals and warehouses designated as terminals "A", "B," "C," and "D" which are owned and operated by the JCPA. These terminals are mostly used for importing and exporting break-bulk cargo. RoRo (Roll on/Roll off) vessels use these facilities. M&M Pipe operates an oil drilling rig repair facility north of terminal "D" used for repairing all sizes of oil or natural gas drilling rigs. Other private docks, terminals, repair yards, fish houses with docks, etc., are owned and/or operated by F. B. Walker Shipyard, Hudship, Halter Marine, Mississippi Menhaden, Zapata Haynie Fish Meal Company, Standard Fish Meal Company, International Paper Company, Colle Towing Company, Havea Transport, Inc., and numerous other fishing and small boat repair facilities. Many of these are located on the river channel north of the deep draft portion. The Havea Transport facilities are used for importing liquid latex rubber.

B. Bayou Casotte Inner Harbor. Chevron U.S.A. Inc. operates a large petroleum and chemical refinery and both ship and barge docking facilities (see Figure 2). These docks are used for importing crude oil and shipping petroleum and chemical products out by tankers and barges, as well as petroleum coke in bulk carriers. In 1984 Chevron constructed new facilities at Bayou

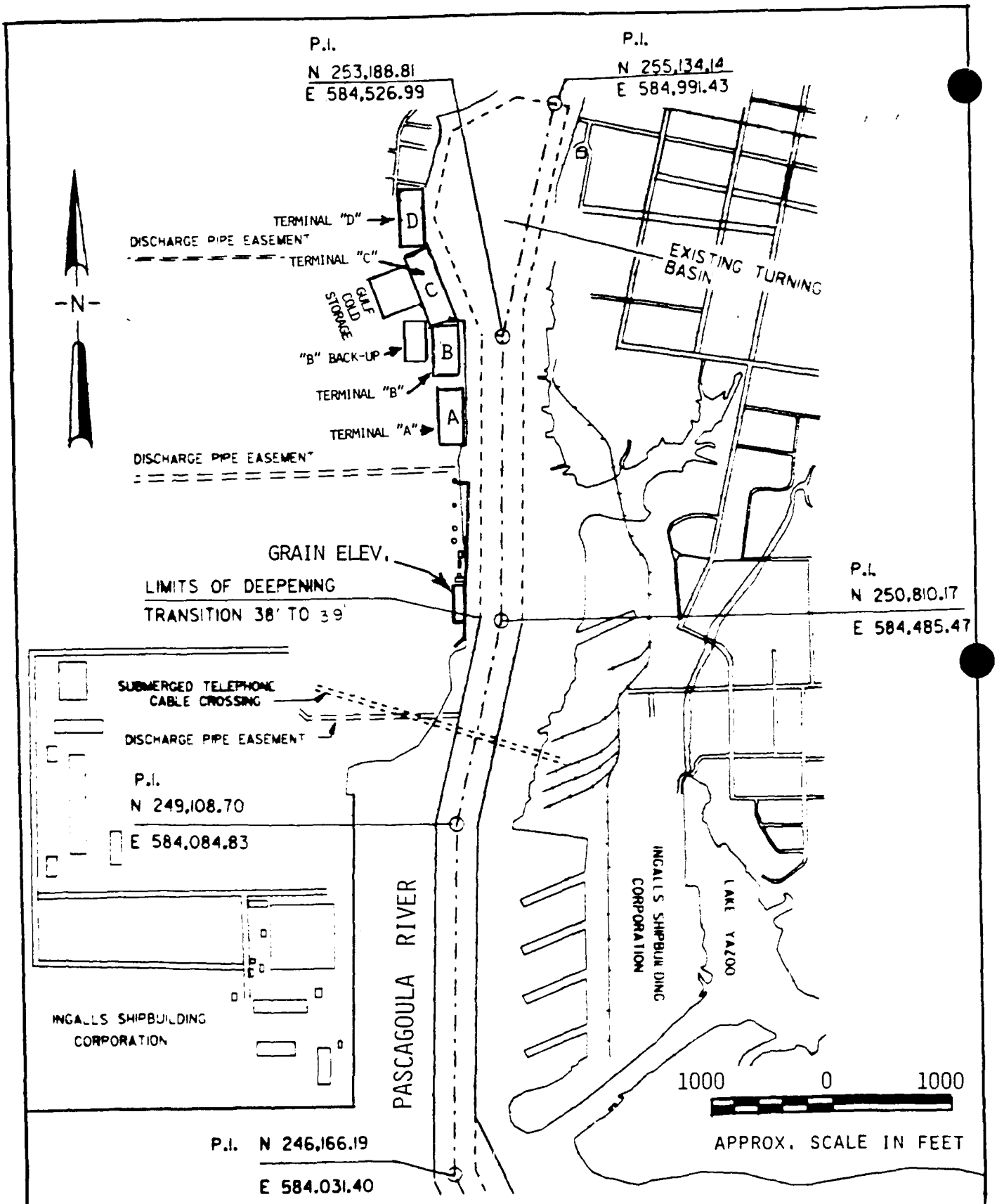

P.I.
N 253,188.81
E 584,526.99
P.I.
N 255,134.14
E 584,991.43
TERMINAL "D"
DISCHARGE PIPE EASEMENT
TERMINAL "C"
GULF COLD STORAGE
"B" BACK-UP
TERMINAL "B"
TERMINAL "A"
DISCHARGE PIPE EASEMENT
EXISTING TURNING BASIN
N
GRAIN ELEV.
LIMITS OF DEEPENING
TRANSITION 38' TO 39'
P.I.
N 250,810.17
E 584,485.47
SUBMERGED TELEPHONE CABLE CROSSING
DISCHARGE PIPE EASEMENT
P.I.
N 249,108.70
E 584,084.83
INGALLS SHIPBUILDING CORPORATION
PASCAGOULA RIVER
INGALLS SHIPBUILDING CORPORATION
LAKE YAZOO
1000 0 1000
APPROX. SCALE IN FEET
P.I. N 246,166.19
E 584,031.40
NOTE:
CONSTRUCTION OF TERMINAL "D" WILL BE COMPLETED 9/90.
PASCAGOULA RIVER
INNER HARBOR

FIGURE 1

Casotte for receiving and processing 17 million tons of foreign crude oil per year. The JCPA owns and operates terminals "E", "F", "G", and "H." LASH (Lighter Aboard SHip) and RoRo vessels are among the users of these facilities. First Chemical Corporation, and NuSouth, Inc., chemical companies, have plants and/or dock facilities at Bayou Casotte. First Chemical Corporation has a plant adjacent to the turning basin, but uses JCPA terminal "F" for docking, loading and unloading vessels. NuSouth, Inc., a chemical and fertilizer manufacturer, operates facilities on the northeastern side of the turning basin and Chicago Bridge & Iron owns a facility, presently closed, on the west side. NuSouth, Inc. uses their docks for bringing in phosphate rock from Tampa, Florida in ocean-going barges and dry bulk carriers and shipping out ammonia by tankers. (In the final stages of this analysis NuSouth closed their plant. Since some company has operated that plant for many years, it was assumed that it would be reopened soon and no changes were made in the analysis.) JCPA is planning to construct a new bulk terminal on Greenwood Island, but there was not enough information available to include it in this GDM.

C. U.S. Naval Station Pascagoula. In 1987 the U.S. Navy began construction of land and water based facilities on the northern portion of Singing River Island. When complete in 1991, the station will support 2 cruisers and 2 guided missile destroyers with a total ships' plus ashore complement of 2,142 personnel. Access to the station will be provided by a 37-foot deep channel from the main ship channel to a turning basin and berthing areas alongside the pier.

EXISTING AND WITHOUT-PROJECT CONDITIONS

17. General. The present trend in shipping is the use of larger vessels to realize economies of scale. The dimensions of the existing project channel require that large ships either light-load to enter and leave Pascagoula, or call elsewhere, limiting commerce at this port. All of the large ships would benefit from a deeper channel. Additionally, the present channel configuration and alignment causes several significant inefficiencies. One prominent problem that affects all large ships is, primarily, the width of Horn Island Pass, although this tends to combine with the width of the gulf approach channel. At present, the pilots will not take a large ship through the pass during darkness if it is loaded. Under ideal conditions they will take an unloaded ship through. The effects of ship size and other inefficiencies on the major commodities are discussed below.

18. Grain. Bulk grain is the third greatest user of dry bulk carriers. At present, 73 percent of all bulk carriers are 14 years or older. A younger fleet in larger sizes is emerging and 64 percent of all single voyage charters in this region are in 50,000 dead weight tonnage (dwt) or larger vessels. Vessels calling at

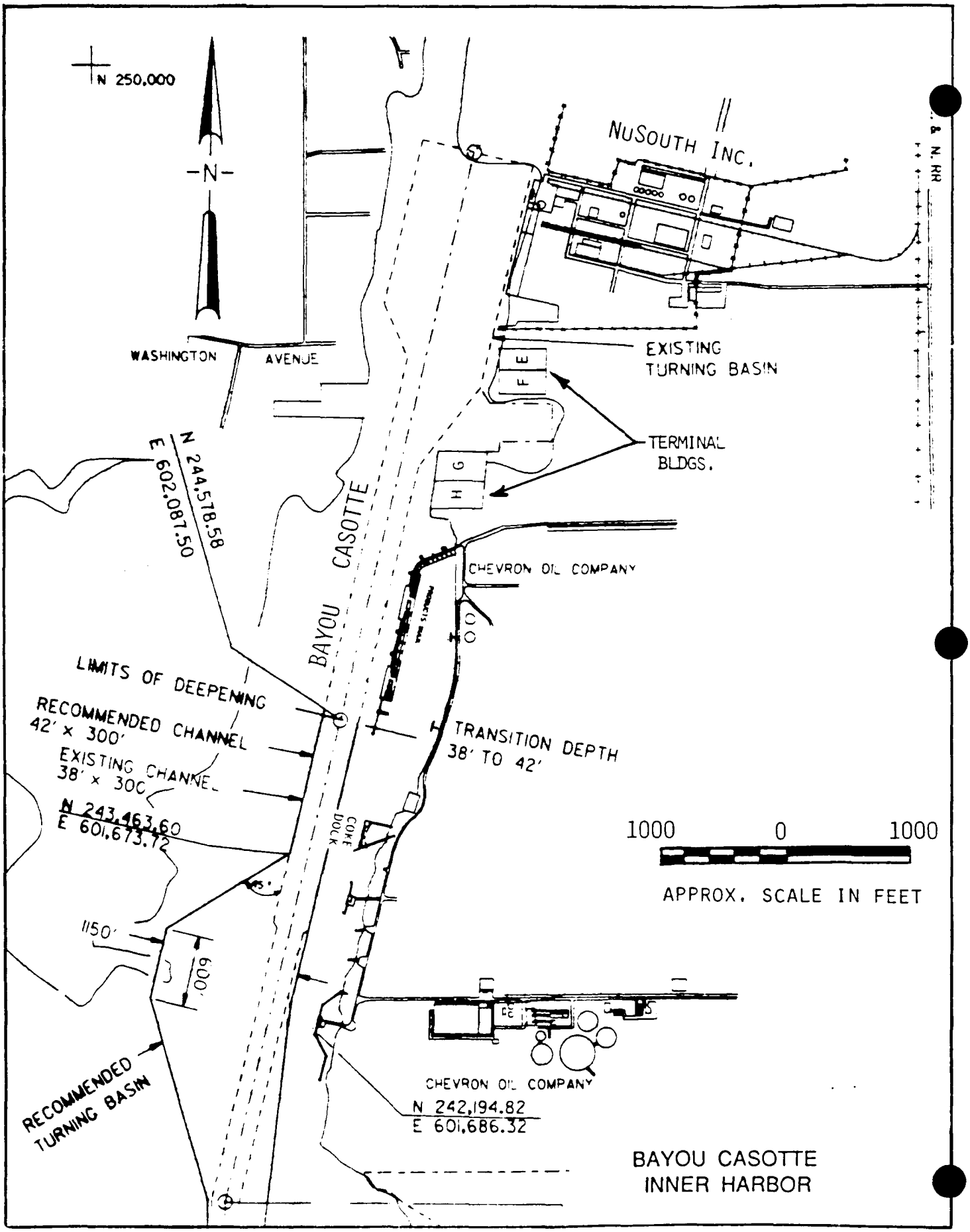

N 250,000
N
NUSOUTH INC.
WASHINGTON AVENUE
EXISTING TURNING BASIN
TERMINAL BLDGS.
N 244,578.58
E 602,087.50
BAYOU CASOTTE
CHEVRON OIL COMPANY
LIMITS OF DEEPENING
RECOMMENDED CHANNEL 42' x 300'
EXISTING CHANNEL 38' x 300'
TRANSITION DEPTH 38' TO 42'
N 243,463.60
E 601,673.72
COKE DOCK
1000 0 1000
APPROX. SCALE IN FEET
1150'
600'
RECOMMENDED TURNING BASIN
CHEVRON OIL COMPANY
N 242,194.82
E 601,686.32
BAYOU CASOTTE
INNER HARBOR

FIGURE 2

Pascagoula are restricted by channel width or cargo handling equipment to beams of 120 feet, which defines vessels having drafts of 50 feet or less. Under existing conditions these vessels characteristically load to a full 38-foot draft and arrange their schedule to depart on a high tide. This fleet is not projected to change over time. Without the project improvement the present practice of light loading the larger ships will continue. The practice of loading to a draft approximating project depth is expected to continue under any condition.

19. Petroleum Coke. This commodity uses essentially the same dry bulk carrier fleet available for the bulk grain. Ship selection is, however, somewhat more restricted since Chevron enforces their 2-foot keel clearance as a condition of their sales contract for the coke. These vessel are light loading to call at Pascagoula. No change in this fleet was projected. These ships are subject to delays at Horn Island Pass and the additional time required to traverse the length of Bayou Casotte to use the existing turning basin.

20. Crude Oil. In the interim between FR84 and this report, Chevron Shipping Company purchased 2 new 78,656 dwt tankers specifically designed for lighter service to their Bayou Casotte refinery. These new ships have greatly improved loading and discharge rates (over the older ships) and the dock pumps and piping systems were improved to match. They also have steering systems specifically designed for enhanced maneuverability and electronic navigation systems. These tankers are 785 feet long, have a beam of 122 feet, and a fully loaded draft of 40 feet. They are presently light loading to a 36-foot draft at Pascagoula since Chevron has a rigid safety rule requiring a 2-foot keel clearance. These ships make occasional fully loaded trips to their port at Empire, Louisiana. No change in this fleet was projected. These ships are also subject to delays at Horn Island Pass and the additional time required to traverse the length of Bayou Casotte to use the existing turning basin. Since they operate on a nominal 2-day cycle, these delays can be very significant.

BRIDGES AND UTILITY CROSSINGS

21. Bridges. One railroad bridge and three highway bridges cross the authorized Federal project for Pascagoula. However, all bridges are located north of the upper limit of the deep draft channel in Pascagoula River and have no effect on the modifications considered in this study.

22. Cable. A telephone cable belonging to the South Central Bell Telephone Company crosses the project above the mouth of Pascagoula River between the Ingalls shipyard and the grain elevator. The cable is laid on the bottom and must be moved for maintenance dredging. Installation was authorized by Department of the Army

permit. The owner's representative has stated that moving this cable for the proposed 1-foot channel deepening would be the same as moving it for maintenance and, therefore, it would be done at no expense to the Government.

23. Pipelines. Three submarine pipelines cross the project channels in Mississippi. All were authorized by Department of the Army permits. One 20-inch crude oil pipeline owned by the Chevron Pipeline Company (formerly owned by the California-Kentucky Pipeline Company) crosses the Bayou Casotte channel about 1 1/2 miles south of the bayou mouth and crosses the Pascagoula Channel about 3 1/2 miles south of the river mouth. The top-of-line (TOL) elevation at each crossing was permitted as 50 feet below mean low water (now mean lower low water - MLLW). Surveys for design showed that the permitted TOL elevation was not completely met during construction and the line is higher than it should be at several locations. Relocating this pipeline at the Bayou Casotte crossing was avoided by reconfiguring the channel in the immediate vicinity of the line. The Pascagoula Channel crossing must be relocated when and if that channel is deepened past the 1-foot increment recommended in this report. The two remaining pipelines, 12-inch and 16-inch natural gas lines, are also owned by the Chevron Pipeline Company (formerly owned by the Chandeleur Pipe Line Company). They cross the main channel about 3/4 mile south of the intersection of the other two channel (the "Y"). TOL was permitted for the 12-inch line at -50 feet MLLW and for the 16-inch it at -60 feet MLLW. In addition two "blanks" for future use, a 12-inch and a 20-inch, have been installed at the same location. Both "blanks" have a TOL elevation of -60 feet MLLW. Recent design surveys show those TOL elevations as being approximately correct. These lines are deep enough not to require relocating for any channel improvement within the foreseeable future.

MISSISSIPPI SOUND HYDRODYNAMICS

24. Circulation patterns within the study area are controlled by astronomical tides, winds, and freshwater discharges. The patterns within the immediate study area are better understood when they are grouped with the overall circulation patterns of Mississippi Sound and the adjacent gulf waters. In Mississippi Sound and the adjacent gulf, the average tidal range is 1.5 feet with a predominant diurnal period of 24.8 hours. The tidal wave progresses from south to north in the gulf. It enters the sound first through Horn Island Pass near Pascagoula, where the wave splits, traveling both eastward and westward, and causing as much as a 6-hour phase shift within Mississippi Sound. The eastward progressing high water reaches Pass aux Heron approximately one hour after entering the sound. The westward progressing high water reaches Lake Borgne approximately two hours after entering the sound.

25. Wind effects on circulation patterns are significant. The wind-induced current superimposed on the sound shifts the bifurcation area at Horn Island Pass either toward the east or west. The magnitude of this eastward or westward movement of the bifurcation area depends on the east/west wind component and phase of the tide. A wind with an eastern component induces a general westward current in the sound causing the bifurcation area to shift to the east (Petit Bois Pass) during the flood tide and to the west (Dog Key Pass) on the ebb tide. Winds with a western component set up a general eastward circulation pattern in the sound. The eastward movement of water forces a bifurcation further to the west at Ship Island Pass on flood tide and a split at Petit Bois Pass on the ebb tide. Winds with dominant north and south components have a minimal effect on overall circulation patterns. These wind components cause the development of eddies or vortices within the shallower areas of the sound, tending to disrupt and diffuse tidal currents. These eddies occur mostly in the area between Dog Keys Pass and Mobile Bay and are strongest in the eastern half of the sound.

26. Although winds with dominant north or south components have little effect on circulation, they are responsible for significant changes in water surface elevation. Winds with a strong northerly component may cause the water level to drop by several feet, depending on wind speed and duration. Winds with southerly components have the opposite effect.

27. Freshwater inflows have a negligible effect on the overall circulation patterns induced by the tides and winds. Comparison of high inflow conditions to low inflow conditions show the same general circulation patterns with an increase in velocities during high freshwater inflow (Corps of Engineers, 1983).

28. Water velocities range between 0 to 3 feet per second (fps) in the barrier island passes and between 0 to 0.8 fps in the sound. The region west of Biloxi and east of Petit Bois Pass have the higher velocities, while velocities near the Pascagoula area are the lowest. Generally, peak velocities throughout the sound increase by 40 percent per one foot increase in the tidal range. The east/west wind components tend to increase velocities in the sound between Biloxi and Mobile Bay. North/south wind components have small, localized, erratic effects on water velocities.

29. Wave intensity on the Mississippi-Alabama shelf is low to moderate with wave periods ranging from three to eight seconds and wave heights rarely over 7 feet. However, hurricane or storm conditions may produce larger waves.

GEOTECHNICAL CONDITIONS

30. Geology. Physiographically, the coastal zone within the study

area is designated coastal lowlands, ranging from sea level to about 30 feet in elevation. These essentially flat to gently undulating, locally swampy lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits which merge with the fluvial-deltaic plains of the streams in the area. Many tidally influenced creeks, rivers, and estuaries indent the lowlands. Pascagoula River occupied about the same position in the past as it does today; however, Escatawpa River followed a different course. A complex system of meanders near Orange Grove and Pecan and south of these locations indicate that Escatawpa River flowed due south-southeast and emptied into Grand Bay. Bayous Cumbest and Heron are remnants of the main Escatawpa River channels which built a sizeable delta into Grand Bay and Portersville Bay (Eleuterius, 1978).

31. The Miocene sediments that outcrop in the coastal area consist of consolidated greenish gray to mottled clays interbedded with sand and gravel zones. The sand and gravel strata contain water under artesian pressure and are a major aquifer in the coastal area. In onshore and nearshore areas the Miocene section is several hundred feet thick. Offshore it thickens to several thousand feet.

32. The Pliocene age Citronelle Formation unconformably overlies the Miocene deposits. The Citronelle Formation contains predominantly red to reddish orange and yellow gravelly sand. Interspersed in the gravelly sand are lenses of white, gray, orange, and brown sandy clay. The thickness of the Citronelle Formation varies from a few tens of feet in offshore areas, up to possibly 200 feet in the subsurface near Petit Bois Island.

33. Semi-consolidated to unconsolidated sediments (sand, silty sand, clayey sand and clay) of Pleistocene and Holocene age overlay the Citronelle Formation in the Mississippi Sound. These sediments vary from only a few feet thick nearshore to several tens of feet thick offshore near the barrier islands, and blanket the bottom of Mississippi Sound. The Holocene sediments range in thickness from 10 to 30 feet and are generally unconsolidated. Semi-consolidated Pleistocene age sediments underlie Holocene sediments and may be encountered at depths of 20 to 50 feet below sea level.

34. Geomorphology and Sediments. Otvos (1982) compared navigation charts prepared in 1853 with current navigation charts and concluded that bottom depths within Mississippi Sound have not changed appreciably, with the exception of the disappearance of an "L" shaped shallow area north of the west end of Horn Island and south of Belle Fontaine Point and the existence of dredged material disposal areas. Borings taken within Mississippi Sound along one transect from Bayou Casotte to the west end of Petit Bois Island delineate the depth of Holocene deposits (Otvos, 1976). The recent Holocene deposits are unconsolidated to poorly consolidated sandy or muddy sediment types that have accumulated over the last 10,000

years. Going from north to south, the Holocene deposits outcrop along the north shore and vary in thickness towards the south from 2 to 3 feet near the mainland, thickening to approximately 20 feet in the middle of the sound and increasing to 40 feet near west Petit Bois Island.

35. Pascagoula River flows directly into Mississippi Sound, draining a 9,400 square mile area. The average discharge of Pascagoula River is 15,200 cubic feet per second (cfs), which includes Escatawpa River. Between 1961 and 1981, the total sediment load entering Mississippi Sound from Pascagoula and Escatawpa Rivers ranged between 0.35 million tons per year and 3.9 million tons per year (Simons, Li and Assoc., 1983).

36. Several factors contribute to the sediment distribution within the Mississippi Sound portion of the study area. These include freshwater inflow from the Pascagoula River system, overall water circulation (wave, wind, tidal), reworking of eroded sediments, storm events, and flocculation of sediments. The silty sand/sandy silt association near Grand Batture Island reflects erosion of the relic Pleistocene from the old Escatawpa River delta. The sand/clay/silt mixture reflects the variability of circulation patterns within this area and the flocculation and settling process of suspended sediments within the water column. The silty clay/clayey silt zone, south of Belle Fontaine Point, probably is due to the flocculation and settling of sediments carried by West Pascagoula River. Horn Island to the south shelters this area from the waves, winds, tides, and storms originating in the Gulf of Mexico causing water velocities to decrease.

37. Bottom sediments along the navigation channel range from silt and clay (less than 62 microns) to fine to medium sands. The inner harbor facilities are within a silt/clay region. The Bayou Casotte Channel is primarily in a silt/clay region, while the Pascagoula Channel immediately south of the harbor, transitions to fine and very fine sands (62 to 250 microns). About two miles south of the harbor mouth the channel transitions back to silt and clay and then, near the junction (the "Y") with the Bayou Casotte Channel returns to sandy material. The upper half of the Mississippi Sound Channel (south of the "Y") is silt and clay and the lower half is sandy material. Medium and coarse sands lie along the mainland beaches west of Pascagoula River as well as along the barrier islands. East of Pascagoula River to Mobile Bay, fine sands, silts, and clays dominate the mainland border.

38. Petit Bois and Horn Islands have a broad, well-developed beach backed by dunes on the gulf side. Both beach and intermittent marsh, backed by dunes, occurs on the north shore of the islands. The interior of the islands is either broad, low sand flats, 1 to 2 feet above sea level, with marshes and shallow lakes or vegetated beach ridges 5 to 15 feet above sea level. Some of the lakes are intermittently connected with Mississippi Sound or the gulf. Winds

and currents from the east transport sand from the eastern ends to the western ends of the islands. The islands are more continuous than in the past indicating continuing reworking of relic sand sources from the continental shelf to the east. Erosion of the eastern ends of the islands and accretion on the western ends indicate considerable occurrence of longshore drift.

39. Surficial mapping of sediments indicates that the shelf source of sand is east of Mobile Bay, where the sand is continuous from the mainland to the shoal bottom (Shabica, 1978). The sands leave Mobile Point and enter the shoals of the submarine ebb-tidal delta south of the entrance into Mobile Bay. The sands are transported across the shallow northwest banks along the south shore of Dauphin Island. West of Dauphin Island, sands drift over a similar, but smaller ebb-tidal delta in Petit Bois Pass and continue westward.

40. The barrier island facies consist of well-sorted, medium-grained, mature quartz sand containing less than 3 percent feldspar and having a mineral suite rich in staurolite and kyanite (Hsu, 1960 in Boone, 1973). The average width of the facies is 2.5 miles, with an average thickness of 40 feet.

41. Immediately south of the Mississippi Sound barrier island system is a nearshore fine-grained facies similar in lithology to that of Mississippi Sound. Movement of sediment from these estuaries forms a fine-grained facies which overlaps the Mississippi-Alabama sand facies in a zone about 7 miles wide, south of the islands. Beach foreshore sand medians range between 0.33 to 0.56 millimeters (mm) on the north shores (lower energy, coarser sand) and between 0.21 to 0.40 mm on the south shores (higher energy, finer sand) of Horn and Petit Bois Islands. The textural inversion probably is due to the lesser amounts of fine sand available on the north beaches where the fine sand fraction is constantly moving. Because of the good sorting values, wave energies and sand supply appear to be in balance on both north and south shore beaches (Otvos, 1982).

42. The Mississippi-Alabama shelf is a triangular area, on the seaward side of the barrier islands, extending from the Mississippi River delta on the west to DeSoto Canyon south of Panama City, Florida, on the east. The shelf is about 80 miles wide in the west and narrows to about 35 miles in the east. The shelf is an extensive, almost flat plain bounded on the landward side by the relatively steep but narrow shoreface of the Mississippi Sound. The break in slope between shoreface and shelf occurs at a depth of about 20 feet along the barrier island system. A clayey silt/clay/clayey sand area exists south of Petit Bois Island possibly due to the fine-grained sediment from East Pascagoula River entering the gulf via the existing 38 feet deep navigation channel, and flocculating and settling due to the higher saline gulf waters. This area appears to have a lower velocity regime compared to contiguous areas.

43. Bayou Casotte Inner Harbor Soils. Within the turning basin and harbor of Bayou Casotte there is a wide distribution of sandy soils intermixed with fine-grained soils. The sandy soils include dark colored clayey sands (SC), silty sands (SM), and clean sands (SP). The fine-grained soils include clays of high plasticity (CH), low plasticity clays (CL), and clayey sands of high plasticity (SC-H). The organic soils (OH) and (OL) seem to be less abundant inside the harbor than outside in Mississippi Sound. These are plastic clays and silts which contain organic material in concentrations greater than 12% by weight. Shell fragments are intermixed throughout the sandy sediments of the turning basin and harbor.

44. Bayou Casotte Channel Soils (Mouth of Harbor to the "Y"). The side slopes and bottom of the existing channel are covered with a few feet of very soft, fine-grained organic silts (OL), and organic clays (OH), of medium to high plasticity. It appears that, in the area immediately adjacent to the channel, these same materials, as well as very soft clays, CH and CL, are present in layers down to an elevation of approximately -40 MLLW. From elevation -40 MLLW to -50 MLLW the sediments appear to be of a higher quality. They include mostly dark colored clayey sands (SC) with clean sands (SP) and silty sands (SM) intermixed. The clays CH, CL, and OH range in density from 79 to 120 pounds per cubic foot (pcf), but average 91 pcf. The sands (SP), silty sands (SM), and clayey sands average 125 pcf. (These values were obtained from vibrated samples.) It is estimated that 60 percent of a dredge cut to elevation -46 MLLW would consist of the less dense clays. (The maximum depth of -46 feet was derived from the authorized depth of 42 feet plus 2 feet of advanced maintenance plus 2 feet of allowable overdepth during dredging.)

45. Pascagoula Inner Harbor Soils. From the soil profile representing general stratigraphy of the harbor, it can be interpreted that most of the soils to elevation -46 MLLW consist of plastic clays (CH), ranging in consistency from very soft in the upper elevations to hard in the mid and lower elevations. Several borings show the presence of an upper layer of black organic clay (OH) capping the CH. Sandy material is not common inside the harbor. Except at the mouth of the harbor and the west side of the turning basin, sands are found only in the lower elevations, especially below -45 MLLW.

46. Pascagoula Channel Soils (Mouth of Harbor to the Outer Bar). The soils found in the Pascagoula channel within Mississippi Sound can be divided into three groups:

A. Soft, fine-grained, organic silts and clays, i.e., low plasticity silts (OL) and high plasticity clays (OH), containing organic material in concentrations greater than 12% by weight, with estimated in situ densities of 75 pounds per cubic foot.

B. Fine-grained soils, i.e., plastic clays (CH), silty lean

clays (CL), plastic clayey sands (SC-H) and clayey sands (SC) ranging in density from 79 pcf to 122 pcf. The CH and CL soils average 95 pcf, and the SC soils average 112 pcf in situ.

C. Sandy soils, i.e., silty sands (SM), and clean poorly graded sands (SP), which average 122 pcf (disturbed samples).

47. In considering design of the proposed channel improvement and quantity of material to be dredged, the soils of the first group are the least common and the poorest quality. They are usually found capping the other soils in layers 2 to 12 feet thick. Boring logs suggest that the highest concentration of these sediments will be found 4,000 feet either side of the Gulf Intracoastal Coastal Waterway.

48. Soils of the second group make up the largest quantity of material to be dredged. These soils are marginal in quality because they are primarily silts and clays, although they contain some sand lenses, shell, and shell fragments.

49. Soils of the third group are the highest quality, but are most commonly encountered at depths below -45 MLLW. The exception is the reach about 6,000 feet on either side of the "Y", where significant quantities of sandy material show up on the boring logs at around -38 MLLW.

50. Pascagoula Bar Channel Soils. Information for the existing channel was inferred from the borings performed in 1982 for the then proposed realignment of the bar channel. Outer Bar sediments consist of two types; coarse-grained and fine-grained fractions containing traces of shell. The coarser grained sediments include as a group clean sands (SP), silty sands (SM), and clayey sands (SC). This group of sediments is several feet thick, and covers the fine-grained group which consists of lean clays (CL), highly plastic clay-sands (SC-H), fat clays (CH), and silts (ML). Relatively speaking, the sediments from Petit Bois Island south into the Gulf of Mexico are of highest quality in the upper layers, down to elevation -50 MLLW, where the fine-grained soils were encountered.

51. Sediment Analysis Conclusions. The material to be dredged from the Pascagoula and Bayou Casotte channels might be used for construction of an island. Based on available data, however, this would be risky, partly because there is no experience with construction of this sort in Mississippi Sound.

52. Most of the clay soils down to the maximum project cut (-46 MLLW) do not appear to be conducive to significant clay ball formation. Only 2 of the 8 borings completed in Pascagoula channel in 1987 encountered clays with characteristics favorable for clay balls. None of the borings from the Bayou Casotte channel show such characteristics.

53. In the inner harbors, foundation conditions below -45 MLLW appear to be good for construction of structures supported on piles, based on the high blow counts exhibited by the splitspoon borings taken in the early sixties. Removal of 2 to 4 feet of material to deepen the existing harbor channels should not affect existing structures.

54. Sands in the bar portion of the proposed alignment passing the west end of Petit Bois Island could be used for beach nourishment. Most of the sands classify as poorly graded fine-grained sand (SP), and most of the sand grains fit in a narrow size range between 0.1 mm and 0.4 mm.

55. The recommended side slopes for channel excavation are 1 vertical to 5 horizontal, as is typically found in other gulf coast channels.

CLIMATE AND WEATHER

56. Climate. The study area has a humid, warm-temperate to sub-tropical climate, although occasional subfreezing temperatures do occur. Air temperatures are influenced by the Gulf of Mexico, with average annual temperatures ranging between 60°F to 70°F. Summer temperatures are influenced by the Bermuda High, a semipermanent high-pressure cell that extends over portions of the Gulf of Mexico near 30°N latitude. During the summer, southerly winds generated by the high-pressure cell have a high moisture content which tends to keep coastal temperatures lower than those of inland areas. Summer temperatures range between 70°F to 90°F. In the winter, winds are northerly and move in cold, continental air masses. Temperatures remain relatively mild, ranging from lows in the 40's to highs in the 60's (°F). The normal annual rainfall within the study area is among the highest in the United States. Rainfall amounts average between 55 to 64 inches. Rainfall is fairly evenly distributed over the year, being greatest during the thunderstorm season in July, averaging 7.6 inches, and least in October and November, averaging 3.5 inches, Thunderstorm frequency is one of the highest in the United States. Relative humidity is fairly constant throughout both the day and the year. Humidity is usually highest between 2400 and 0600 hours (83%) and lowest between 1200 and 2000 hours (62%) [O'Neil and Mettee, 1982].

57. Although wind direction tends to be variable throughout the year, the overall pattern is for northerly winds from September through February and southerly winds the remainder of the year. Throughout the year, wind speeds average 7-10 knots (Eleuterius, 1978).

58. Cloudiness tends to be highest in the winter and summer with lower values in the spring and fall. Much of the summer cloudiness

consists of convective cumulus or high, thin clouds. Winter cloudiness is generally associated with movement of extra tropical cyclones and their associated frontal systems. Periods of low visibility from November through May correspond with heavy fog periods. Winter fogs are fairly frequent along the Gulf Coast as the larger rivers and tributaries empty cold water into the warmer gulf waters. Heavy rains and high humidity during the summer are probably responsible for occasional low visibility.

59. Storms. A hurricane is a tropical cyclone with wind velocities of 75 mph or greater. Most hurricanes form in zones between 8 and 15 N latitude, where the sea surface temperature is high and the Coriolis force is strong enough to cause the spinning of winds around low-pressure centers. Hurricanes pose a definite threat to the study area from June through October, being most frequent during September. These late summer hurricanes tend to originate in the eastern North Atlantic near the Cape Verde Islands and are often severe. Those hurricanes arising in June and July usually originate in the western Atlantic or Caribbean and tend to be weak (US Army Corps of Engineers, 1981). A total of 58 hurricanes have affected the Gulf of Mexico coastline since 1711, an average of one hurricane every five years. The high winds typically generated by hurricanes are ordinarily not as destructive as the marked rise in water level, referred to as hurricane surge. Hurricane Frederic, the last hurricane to hit the Alabama Coast (12-13 September 1979), had record sustained wind speeds of 145 mph recorded at Dauphin Island. At Mobile, wind speeds were recorded at 101 mph. Heavy rains associated with hurricanes lead to increased river discharge and may affect coastal areas for several days. Rainfall associated with Hurricane Frederic amounted to 8.6 inches in Mobile on 12-13 September 1979. The highest recorded total was reported at Merrill, Mississippi, where 9 inches fell in a 24-hour period (US Army Corps of Engineers, 1981). Hurricane Camille, a small but devastating storm, came inland in the St. Louis Bay-Waveland area on 17 August 1969. Winds were estimated near 200 mph at the center of the hurricane with tides rising in excess of 22 feet. The storm almost completely destroyed the entire Mississippi Coast. A tropical storm is a cyclone with maximum sustained surface wind speeds between 39 and 73 mph. In a 183-year period, 18 tropical storms affected the coastal region. The probability of a tropical storm or hurricane affecting the 50-mile area between Biloxi, Mississippi, and Mobile Bay has been calculated as 13% for a tropical storm, 6% for a hurricane, and 1% for a severe hurricane each year (O'Neil and Mettee, 1982).

CULTURAL RESOURCES

60. Prior to the initiation of historic resources investigations associated with the proposed improvements to Pascagoula Harbor, very few systematic surveys had been undertaken to identify prehistoric and historic archeological sites or architectural

properties in the vicinity of Pascagoula. Currently there are thirty (30) properties listed on the National Register of Historic Places in Jackson County, Mississippi. The majority of these properties are located in the Ocean Springs, Mississippi Multiple Resource Area. Of the five National Register properties in the vicinity of Pascagoula, only the Round Island Lighthouse in Mississippi Sound is in proximity to the Pascagoula Harbor project.

61. In addition to the National Register properties, two prehistoric archeological sites (22Ja516 and 22Ja618) were known to exist on Greenwood Island. Surveys for historic properties had been limited to small scale inspections of nonadjacent tracts of land required to obtain federal licenses or permits.

62. The environmental setting of the Pascagoula area in both prehistoric and historic times would have been conducive to permanent human occupation, thus there is a high potential for numerous archeological sites dating to prehistoric, colonial period and historic times. Another type of historic resources that would be expected to occur in Mississippi Sound and the river and bayou segments of the Pascagoula Harbor project are shipwrecks.

ENVIRONMENTAL CONDITIONS

63. Wetlands. Estuarine and Gulf of Mexico open water areas dominate the delineated Pascagoula Harbor study area. These areas range in depth from less than 1 foot MLLW to depths greater than 60 feet and contain a variety of resources important to the functioning of the ecosystem. Emergent wetlands, including estuarine and palustrine forms, comprise approximately 16,500 acres of the study area. Three zones of emergent wetlands are identified within the study area with the saline and brackish wetlands predominate. The delineation between the saline, brackish, and fresh marshes is extremely difficult in the area due to the high freshwater inflows and highly variable salinity values.

64. Freshwater marshes containing reed, switch grass, wild rice, sawgrass, alligator weed, arrowhead, and cattails are present north of the Interstate Highway 10. These freshwater marshes intergrade with the extensive brackish marsh community of the Pascagoula River delta. The black needlerush is the dominant form in these marshes; other species include saltmeadow cordgrass, cattails, spike rush, reeds, bulrushes, marsh mallow, and sawgrass. These brackish marshes intergrade with the saline marshes also dominated by black needlerush. Smooth cordgrass is locally abundant in the intertidal zone of the saline marsh.

65. Saline and brackish marshes comprise a significant portion of the coastal area of mainland Jackson County. Within the study area an extensive saline marsh extends westward from the Alabama/Mississippi state line around Point aux Chenes Bay to just

west of Point aux Chenes where the development of the Bayou Casotte and Pascagoula Industrial areas precludes marsh development. The Pascagoula River delta area also supports diverse saline and brackish marshes. Saline marshes are present south of Highway 90 between the east and west mouths of the river. In the area north of Highway 90, brackish marshes are dominant and intergrade into freshwater marshes north of Interstate 10. Petit Bois and Horn Islands support saline marshes, along their protected shores, which appear to be zoned according to period of inundation.

66. Due to the high turbidity conditions within this area, submersed grass beds have limited distribution within the study area. These beds are restricted to shallow areas of less than 6 feet in depth primarily along the northern shores of Horn and Petit Bois Islands.

67. Forested wetlands occur on the flood plain of the Pascagoula and Escatawpa Rivers and their tributaries. Dominant vegetation in these areas varies, depending on the amount and duration of flooding. Within the study area, evergreen needle-leaved forests predominate and are characterized by white cedar, pond pine, sparkleberry, yaupon, and red maple. Broadleaf evergreen and deciduous forests make up the remainder of the forested wetlands in the study area. These areas are characterized by such species as swamp bay, sweet bay, swamp tupelo, water oak, laurel oak, sweet gum, southern magnolia, and tulip tree.

68. Barrier islands support two unique habitats; the maritime strand forest and the beach-dune associations. The land-water interface along Horn and Petit Bois Islands is characterized by beach conditions which support sea oats, morning glory, and pennywort. The beaches intergrade into extensive dune areas vegetated by saw palmetto, seaside rosemary, sea oats, morning glory, and pennywort. Landward of the dune system, the longleaf pine-oaks association is modified, consisting of fewer plants adapted to more rigorous growing conditions, such as coarse white sand and salt spray. This maritime strand forest is characterized by scrubby live oak, myrtle oak, seaside rosemary, seaside balm, slash pine, red cedar, and saw palmetto.

69. Fauna. A large number of organisms, including both terrestrial and aquatic forms, utilize the diverse habitats of the study area. Zooplankton, although extremely important to the functioning of the estuarine and coastal systems, are not well known in the study area.

70. The major fisheries landed along the Mississippi Gulf Coast are the anchovies, menhaden, mullet (Mugil cephalus), croakers, the shrimp and the oyster. Jackson County, primarily the ports of Pascagoula and Moss Point, receives greater than 85% of all Mississippi landings, including all industrial fish (menhaden), 95% of the mullet, trout, and red snapper, and 74% of the croakers

landed.

71. Oyster resources within the study area are restricted to Point aux Chenes Bay, Bangs Lake, and an area near the mouth of the West Pascagoula River. The West Pascagoula reef, which represents over 95% of the oyster resources of the study area, has been permanently closed to oyster harvest since the early 1960's due to poor water quality conditions. Brown and white shrimp and blue crab are commercially important estuarine dependent species which utilize the study area.

72. A number of amphibians and reptiles occur in the diverse habitats of the study area, including amphibians, salamanders, frogs, toads, snakes, and turtles. One species of note within the study area is the yellow-blotched sawback turtle which is restricted to the Pascagoula River drainage system.

73. The coastal-marshes, swamps, islands, and beaches of the study area support large populations of passerine birds, waterfowl, wading birds, and shore birds. Active nesting sites located within the study area include a black skimmer colony north of Ingalls near the East Pascagoula River, least tern colonies on Horn Island and Petit Bois Island, a black skimmer, Caspian tern, gull-billed tern, least tern, royal tern, and sandwich tern colony on Petit Bois, and a cattle egret, great egret, and Louisiana heron heronry on Petit Bois Island.

74. A number of coastal mammals utilize the study area including whales, rodents, and deer.

75. Threatened and Endangered Species. A number of species have been identified by the U.S. Congress and the State of Mississippi as being threatened or endangered due to decreasing abundance or requiring a habitat that is threatened. Within the study area, a number of these species may occur including the Atlantic sturgeon, the southern coal skink, the American alligator, Atlantic loggerhead turtle, leatherback sea turtle, green sea turtle, Kemps Ridley turtle, hawksbill sea turtle, eastern indigo snake, rainbow snake, yellow-blotched sawback turtle, black pine snake, peregrine falcon, bald eagle, brown pelican, Bachman's warbler, Mississippi Sandhill Crane, Florida panther, Florida black bear, finback whale, humpback whale, right whale, sci whale, and sperm whale.

76. Groundwater Resources. There are three main freshwater bearing aquifers in the coastal area of Jackson County. In ascending order, these aquifers are the Pascagoula, Graham Ferry, and Citronelle. Overlying these aquifers are terrace deposits and alluvium. There are no thick, consistent, traceable sand beds within the study area. Beds are irregular in both thickness and extent. Formations in these freshwater sections dip towards the south in Jackson County. The base of the freshwater zone varies from less than 1,000 feet to more than 2,000 feet below sea level

in Jackson County (Baughman et al., 1976). Jackson County uses more than 50 MGD from ground water sources for municipal and industrial purposes.

77. Dissolved solids concentrations are variable and generally increase with depth. Some wells in Jackson County produce water approaching or slightly exceeding the maximum allowable concentration of 1.2 milligrams per liter (mg/l) for fluoride. Chloride concentrations in excess of 250 mg/l are generally objectionable for municipal water supplies. Chloride concentrations in water from the Pascagoula Formation, in the vicinity of Pascagoula, exceeds 300 mg/l and has steadily increased over the years (Baughman et al., 1976). Increases in chloride concentration are an indicator of saltwater encroachment in the area, resulting from heavy withdrawals.

78. The Mississippi Bureau of Pollution Control (MBPC), 1982, has identified the Pascagoula and Moss Point areas as having problems resulting from overpumping. Water levels are declining in the Graham Ferry and Pascagoula Formations, with the greatest declines in the vicinity of the City of Pascagoula. Heavy pumping in Pascagoula and Bayou Casotte will perpetuate this condition. Salt water encroachment will be an increasing problem in the aquifers, as is now the case with the Pascagoula Formation in Pascagoula (Baughman et al., 1976).

79. Surface water quality is highly variable and dependent on several factors, including nonpoint and point source municipal and industrial loadings and their respective quality, rainfall and the associated high river discharge, degree of urbanization and concentration, and amount of dilution and/or mixing by the Pascagoula River. The Port of Pascagoula area, comprised of the Escatawpa River to Mile 10, the east and west Pascagoula Rivers to Mile 2 below the confluence with the Escatawpa River, and Bayou Casotte, is recognized to have one of the worst water quality problems within the State of Mississippi. This heavily industrialized area contributes 60 million gallons per day (MGD) municipal and industrial discharges to the surface waters.

80. All streams within this area are classified for use by fish and wildlife. The State of Mississippi has recognized the severity of the problem on the Escatawpa River near Moss Point by reducing the dissolved oxygen (DO) standard from 5.0 mg/l to 3.0 mg/l (Mississippi Bureau of Pollution Control, 1982). Bayou Casotte has been recognized by the State of Mississippi as having DO and bacteria problems related primarily to the Pascagoula/Bayou Casotte Sewage Treatment Plant. A new wastewater treatment plant is under construction for the Pascagoula/Bayou Casotte area which should relieve the problems mentioned above. Within the study area, Mississippi Sound is classified for recreational use and shellfish harvesting, except in an area along the mainland from Point aux Chenes Bay to west of the West Pascagoula River and the area around

the navigation channels which are closed to shellfish harvest.

81. As with any estuary, salinity values within the sound are highly variable in response to the freshwater inflows. During the spring (high inflow period), salinity varies between 1 and 29 ppt with a general decreasing trend from east to west in the sound. The summer, lower inflow period, can range between 5 to 29 ppt exhibiting the same decreasing trend as the spring. The system is well-mixed throughout the water column except within the Pascagoula navigation channel.

OBJECTIVES AND CONSTRAINTS

OVERALL OBJECTIVES

82. Planning objectives are the national, state, and local water and related land resource management needs specific to the study area, that can plausibly be addressed by this study, that would enhance national economic development with protection of the environment. The following planning objectives were derived from a large range of public and professional concerns and from the existing problems and needs of the area for use in FR84. Since they were still pertinent, they were retained for the reformulation studies.

A. Improve the economic efficiency of moving commodities in and out of Pascagoula Harbor.

B. Increase navigational safety in Pascagoula Harbor and reduce hazards to life and property.

C. Provide an adequate and acceptable dredged material disposal plan for project modifications and continued maintenance.

D. Restore fish and wildlife habitat resources to a modern historic condition.

E. Enhance the quality aspects of water, land, and air.

F. Reduce adverse impacts of current periodic dredging activities.

G. Reduce or prevent additional saltwater intrusion into the fresh groundwater aquifers.

H. Provide additional water-based recreation opportunities in the study area.

I. Protect, enhance, or create areas of natural beauty and human enjoyment on Petit Bois Island and Horn Island.

J. Avoid irreversible commitments of resources to future uses.

K. Manage, protect, preserve, or enhance valuable resources such as:

(1) oyster reefs
(2) productive marsh and wetlands
(3) sport fish habitat
(4) shrimp nursery grounds and migratory routes

PLANNING CONSTRAINTS

83. Planning constraints are those technical, environmental, economic, regional, social, and institutional considerations that influence or limit the response to the objectives.

84. Technical Constraints.

A. Plans must represent sound, safe, acceptable engineering solutions.

B. Plans must be in compliance with U.S. Army Corps of Engineers engineering regulations.

C. Plans must be realistic and state-of-the-art.

85. Economic Constraints.

A. The justifiable first cost of navigation improvements at the project is constrained by the level of average annual operational and vessel damage costs attributable to the existing channel.

B. Each separable unit of improvement or purpose of proposed plans must provide economic benefits at least equal to its cost, unless justified on the basis of enhanced environmental and/or social effects.

86. Environmental Constraints. Plans for Federal participation should be formulated to comply with the requirements of the following.

A. EO11593 on Protection and Enhancement of the Cultural Environment, 13 May 1971.

B. EO11990 on the Protection of Wetland Areas, 24 May 1977.

C. The National Environmental Policy Act (42 U.S.C. 4321 et. seq.).

D. The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et. seq.).

E. The Fish and Wildlife Coordination Act (16 U.S.C. 661 et. seq.).

F. The National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 et. seq.).

G. The Preservation of Historic Archaeological Data Act of 1974 (16 U.S.C. 469 et. seq.).

H. The Clean Air Act, as amended (42 U.S.C. 7609).

I. The Clean Water Act of 1977 (33 U.S.C. 1251 et. seq.).

J. The Coastal Zone Management act of 1972, as amended (16 U.S.C. 1451 et. seq.).

K. The Estuary Protection Act (16 U.S.C. 1221 et. seq.).

L. The Land and Water Conservation Fund Act (16 U.S.C. 4601 et. seq.).

M. The Marine Protection Research and Sanctuaries Act of 1972, as amended (16 U.S.C. 1401 et. seq.).

87. Sociological Constraints. Plans should be formulated in such a way as to minimize and, if possible, avoid:

A. Destruction of community cohesion.

B. Injurious displacement of people.

C. Disruption of desirable community growth.

D. Undesirable alteration of recreational opportunities.

INVESTIGATIONS

SHIP SIMULATION STUDY

88. A computer based mathematical model containing the hydrodynamic characteristics of the project area and those of the ships representative of major users was developed at the U.S. Army Engineers Waterways Experiment Station. Numerous model runs were made with the assistance of pilots from the Pascagoula Bar Pilots Association and a master from the Chevron Shipping Company. Details of this study are in Appendix B.

SOILS INVESTIGATION

89. Pascagoula Harbor is an established port with a long history. Consequently, the records of previous explorations are still on file and can be utilized. For the Bayou Casotte Channel 7 borings taken by the Mobile District Office in 1962 and 1963 were available. These borings were taken along the existing channel slopes and centerline to about -50 MLLW. In addition we were able to obtain the records of several borings by Vester J. Thompson, Jr., Inc., in 1976. These extended to -65 MLLW, and were apparently taken just outside of the limits of the existing channel.

90. For the Pascagoula Harbor and Channel 30 borings taken in 1963 to depths reaching to -50 feet MLLW were available. These borings were spaced along the harbor and that portion of the channel within the Mississippi Sound. Additional borings were taken in 1982 for the Feasibility Study. These included 2 borings in the approach channel to Horn Island Pass which were extended to about -70 MLLW. Also in 1982, 14 borings were taken along a proposed SSW alignment of the Pascagoula Outer Bar Channel. (This alignment, which later proved uneconomical, was tangent to the present channel alignment.) Drilling began off the west end of Petit Bois Island and continued at approximate 3,000-foot intervals for a distance of 7-1/2 miles to where the water depth exceeded 50 feet. These borings penetrated the marine sediments to about -65 MLLW.

91. Additional borings were taken in 1987 to supplement the available records. Sixteen (16) 20-foot long vibracore samples were taken in the Bayou Casotte and Pascagoula channels. Eight (8) were taken in the Bayou Casotte channel between the mouth and the "Y" at the Pascagoula Channel. Eight (8) borings were taken in the Mississippi Sound portion of the Pascagoula Channel. Several of those borings did not penetrate to project depth because they were taken on the channel slopes. Past borings, however, had been concentrated along the channel centerline and side slope information was needed. Although scheduled, borings in the outer bar channel could not be taken because heavy seas were occurring at the time.

CULTURAL RESOURCE INVESTIGATIONS

92. Cultural resources investigations were initiated for the Pascagoula Harbor project in 1983 for the feasibility studies. At that time, an underwater survey of the channel from the Gulf of Mexico through Mississippi Sound into the Pascagoula River and Bayou Casotte was conducted. Seven alternate open water disposal sites being considered at that time were included in the survey. As a result of that survey 7 clusters of anomalies and 6 individual anomalies were recommended for identification and evaluation. The total number of anomalies recommended by the Contractor for identification studies was 59. Subsequently, as a result of additional consultation with the Mississippi State Historic Preservation Officer (SHPO) in February, 1988, it was determined that underwater archeological investigation of the anomalies is not required, since all of the reported shipwrecks in the vicinity of the channel are of modern origin.

93. In addition to the underwater survey, a reconnaissance of 34 alternate upland disposal sites was conducted in 1983. Two prehistoric archeological sites, 22Ja516 and 22Ja618 located on Greenwood Island, were recommended as potentially eligible for the National Register. The Mississippi SHPO concurred in the National Register eligibility of the two sites in 1985. The archeological sites on Greenwood Island have been subjected to severe vandalism and shoreline erosion for a number of years. As a result of on site inspections of 22Ja516 and 22Ja618 by Mobile District archaeologists and representatives of the Mississippi SHPO, in 1989 it was determined that the sites no longer possess sufficient integrity to be considered eligible for the National Register of Historic Places.

94. Reconnaissance level studies of two shoreline protection disposal sites at Round Island and Grand Batture were completed in November 1987. As a result of these reconnaissances, the Mississippi SHPO did not object to development of the Grand Batture disposal area, but deferred final comment on the Round Island disposal area. The Mississippi SHPO will comment on disposal at Round Island when, and if, plans for placement of material in the vicinity of Round Island Lighthouse are finalized. As noted previously, Round Island Lighthouse is listed on the National Register of Historic Places. If additional upland disposal sites are proposed that were not examined during the 1983 reconnaissance, historic properties investigations of these areas may be required.

ENVIRONMENTAL INVESTIGATIONS

95. No investigations were especially required for PED. Other work directly connected with Pascagoula Harbor was already in progress and adequately addressed those situations. See the section on ENVIRONMENTAL CONSIDERATIONS for further discussions on that work.

SURVEYS

96. A complete survey was planned for early in PED to provide data for design. It was learned, however, that a complete condition survey recently had been taken for maintenance purposes. The plotted data appeared to be quite suitable for design so it was decided to use that survey instead. As it later developed, there were problems with the use of that data since the survey had been performed in several segments with different types of equipment, but these difficulties were overcome and that survey was used for channel design layout and computation of dredging quantities. As PED progressed, more precise data on the various pipeline crossings was required and a contract for an automated electronic survey was awarded on 31 May 1988 to obtain that data. When the results of that survey were submitted in September 1988, comparison with the original as-built drawings submitted for the permitting action revealed major discrepancies. That survey contractor proved unwilling to reconcile those differences. Since that data had become critical to the determination of relocation requirements, another survey contract was awarded on 1 October 1988 for surveys to be conducted by divers on the bottom using hydraulic probes to physically locate the various pipelines. Top of pipe elevation was determined from the probe and horizontal location was determined using the Starfix Satellite System. These surveys determined that only one pipeline would have to be relocated. Refer to the section on RELOCATIONS for additional details.

EVALUATION OF NAVIGATION BENEFITS

97. The detailed methodology and data used in computing the benefits for the channel improvements for Pascagoula Harbor are contained in Appendix C, ECONOMIC ANALYSIS. All references to economic data in this section pertain to that appendix. No changes in fleet were projected. All direct economic benefits claimed stem from reduced transportation costs to the existing fleet for exported grain from the Pascagoula channel and the imported crude oil and exported petroleum coke from the Bayou Casotte channel.

PRELIMINARY FEASIBILITY STUDY ALTERNATIVES

98. The feasibility studies preceding FR84 investigated a large number of alternative channel dimensions, alignments, and disposal areas or techniques. As a result of these studies, the plan recommended was determined to provide the greatest net economic benefit consistent with protecting the nation's environment. That plan was authorized by the Water Resources Development Act of 1986 (P. L. 99-662)

99. Initial Considerations. A large array of plans with various channel depths and widths and disposal sites were initially considered in feasibility studies. Included were those suggested by the public, and by state and local agencies as well as those conceived by the Corps of Engineers. Most of these plans were eliminated early in the studies while 5 were carried through for detailed analysis. Plans or plan features that were eliminated in early iterations included:

A. Channel Depth. A range of depths from 40 feet to 55 feet were considered. Economic analyses indicated that benefits would be maximized with a 42-foot channel. Other depths were eliminated.

B. Channel Width. Studies indicated, that with the exception of two reaches, widening was not justified. Widening the Bayou Casotte channel to 350 feet, widening of the Horn Island Pass leg of the Entrance Channel to 600 feet, and widening of the gulf leg of the Entrance Channel to 550 feet were justified. Other widths were eliminated.

C. Upland Disposal. In addition to the 3 existing upland disposal areas, 34 other upland sites in Jackson County were identified as possible disposal areas. All of these sites, except the 3 existing areas, were determined to be unsuitable for any one of a number of reasons, including habitat, size, or distance from dredging location.

D. Singing River Island (SRI) Size Increase. Enlarging the size of the SRI area from about 330 acres to about 1,790 acres, as suggested by the JCPA, was eliminated because significant environmental impacts would result from filling wetlands and submerged bottoms. In addition, numerical model investigations indicated localized changes in circulation patterns which could result in significant impacts to water quality.

E. Point aux Chenes Shoreline Extension. This alternative, also suggested by JCPA, would result in the creation of about 2,230 acres of fast land in the region south of the Tenneco site and the Chevron Refinery. This alternative was determined to have significant environmental impacts and, therefore, it was not considered further.

F. Island Creation. Three potential areas were identified in Mississippi Sound as suitable for the construction of dredged material disposal islands. However, we found that the proposed improvements would not produce enough suitable new work material to construct an island that would contain 50 years of maintenance material. Island construction was therefore eliminated from additional study.

G. Chevron Property Disposal. As proposed by the owner, this option would result in filling about 300 acres of wetlands. The environmental impacts would be significant and appropriate mitigation is not available within the general area. The alternative was eliminated.

H. Petit Bois Island Disposal. This option would have nourished the eroding north shore of Petit Bois Island with sand from the Entrance Channel. We found that there were extensive submerged grass beds growing just north of the island. This is a valuable resource which is not very abundant in Mississippi Sound. The beneficial environmental impacts from temporary stabilization of the eroding shoreline were outweighed by the adverse impacts from filling an area with submerged vegetation. This alternative was eliminated.

I. Mississippi Sound Disposal. Open water disposal of new work material was considered and eliminated because of environmental impacts associated with disposal of similar material in the past. Open water disposal of virgin material in this area of Mississippi Sound has resulted in significant changes in bathymetry, especially in areas near the mainland shoreline. Singing River Island, in fact, resulted from continued openwater disposal. These bathymetric changes are believed to have contributed to water quality problems in the area adjacent to the mainland and within Bayou Casotte. The use of several openwater disposal areas was discontinued in 1985 because of changes in bathymetry. The continued use of other openwater sites for disposal of maintenance material only is still acceptable.

J. Horn Island and Petit Bois Island Nourishment. Both islands are eroding. However, coordination with officials of the Gulf Islands National Seashore (GINS) revealed that direct reconstruction of those islands was contrary to GINS policy and could also pose legal problems under Mississippi law.

FINAL FEASIBILITY STUDY ALTERNATIVES

100. Detailed Investigations. Five alternative improvement plans were investigated in detail for FR84 and were included in the Draft Environmental Impact Statement (DEIS) filed with the U. S. Environmental Protection Agency July 27, 1984. Each of the five alternatives provided the same channel configuration:

A. An entrance channel 44 feet deep and 550 feet wide from the Gulf of Mexico to Horn Island Pass, widening to 600 feet through the pass to the transition to the sound channel, and including a 56-foot deep impoundment basin beneath the channel;

B. A channel 42 feet deep and 350 feet wide through Mississippi Sound and into Pascagoula River to just downstream of the grain elevator;

C. A channel 42 feet deep and 350 feet wide from the junction ("Y") in Mississippi Sound to Bayou Casotte; with a 42-foot deep, 1400-foot radius turning basin just inside the mouth of Bayou Casotte.

The depths indicated are nominal, or authorized, depths. Actual constructed depth would include 2 feet advanced maintenance and 2 feet allowable overdepth. In addition, a telephone cable and 3 pipelines were believed to require relocation.

101. The five alternatives differed significantly in the disposal sites proposed for use including:

A. Littoral zone disposal south of Horn Island,
B. Disposal in the Gulf of Mexico,
C. Open water disposal in Mississippi Sound,
D. Use of the Singing River Island, Double Barrel, and Greenwood Island disposal sites,
E. Use of the Tenneco site, and
F. Reconstruction of the Grande Batture Islands.

102. Littoral zone disposal of sandy material from the Entrance Channel near Horn Island would retard or arrest erosion on the eastern end of that island. Horn Island is a part of the Gulf Islands National Seashore managed by the National Park Service (NPS). This alternative was suggested by NPS and other coastal interests. This option included both new work and maintenance material and became a element of the recommended plan.

103. Disposal in the Gulf of Mexico was considered for three of the five alternatives. New work material from the Inner Harbors, the Upper and Lower Pascagoula Channels and the Bayou Casotte Channel and turning basin has been evaluated and is suitable for gulf disposal. This also became an element of the recommended plan.

104. Open Water Disposal of Maintenance Material. Open water disposal of new work material in this area of Mississippi Sound, as discussed above, has resulted in significant environmental impacts. For this reason, continued use of the existing sites was considered for maintenance material disposal only. Current practice for these sites appears to be consistent with environmental concerns. We are satisfactorily meeting the state requirement of an upper limit of -4 feet on the depth of these sites. The increase in future maintenance resulting from the improvement is estimated to be only 5% more than the current amount. It is believed, therefore, that no significant adverse impacts would result from continued use of these sites. This became an element of the recommended plan.

105. Use of the existing disposal areas, Singing River Island, Double Barrel, and Greenwood Island, was considered as a feature of the plans evaluated in detail for FR84. In the recommended plan, SRI and the Double Barrel area were to be used for disposal of new work material from the upper portion of the Pascagoula Channel. No new work would be performed within Bayou Casotte requiring the use of Greenwood Island. With loss of the SRI site, see below, the Double Barrel site, now called the Triple Barrel, was found to be inadequate for new work disposal.

106. In 1985, the State of Mississippi Bureau of Marine Resources entered into an agreement with the U. S. Fish and Wildlife Service, U. S. National Marine Fisheries Service, EPA, Corps of Engineers, and other State and Local agencies. This Special Management Area Plan (SMA) was prepared under the auspices of the Coastal Zone Management Act and contained three parts, a development plan for the Port of Pascagoula area, a mitigation plan, and a long-term dredged material disposal site management plan. The disposal site management considered techniques and practices which would extend the life of the three existing disposal areas. As part of this plan Singing River Island disposal site was expanded to 303 acres, restrictions were placed on the quantities of material and timing of placement into the site, and the requirement for extensive management techniques was initiated. The use of these sites in conjunction with the improvements to the project was consistent with the SMA Plan. As mentioned above and discussed in detail below, the Singing River Island disposal area is no longer under consideration in connection with the Federal navigation project.

107. In late 1985, the U. S. Navy announced the establishment of Naval Station Pascagoula on Singing River Island. As a result of this development a portion of the 330 acre disposal area is being converted to naval facilities. Following the 1987 maintenance

dredging of the Federal project, the Corps relinquished use of this site. Those materials formerly placed in the Singing River Island area will now be transported to the Gulf of Mexico for disposal.

108. Use of the Tenneco Site. Two of the alternatives evaluated in detail included the use of the Tenneco site (this property is no longer owned by the Tennessee Gas Transmission Company, but the Tenneco name has become common usage) for disposal of new work material from the Bayou Casotte channel. During coordination of the draft FR84 and DEIS, the Tennessee Gas Transmission Company stated that their plans for developing the site as a liquid natural gas facility would require construction earlier that the project improvements could take place. These alternatives, therefore, were determined to be non-implementable and dropped. Tenneco's plans did not materialize, the site reverted to the JCPA, and possible use was again considered during PED.

109. Restoration of Grande Batture. Another disposal option considered was the reconstruction of Grande Batture Island, which has eroded away during recent times. The cost of this option was much greater (about $20 million) than any other alternative evaluated in detail. Also, the plan was severely criticized by several Federal environmental agencies despite the significant environmental benefits expected to result from the reconstruction. The State of Mississippi, however, requested that this option be evaluated further during PED.

110. Considering the comments received during the coordination of the draft FR and DEIS, a final report (FR84) and FEIS was submitted in September 1984 and revised in March 1985 after higher level review. The FEIS was filed with EPA on July 12, 1985. This FEIS recommended the modified version of a plan evaluated in detail in the DEIS. That plan included the following disposal areas: littoral zone disposal near Horn Island of suitable sandy materials, both new work and maintenance; Gulf disposal of all suitable new work material from the Lower and Upper Pascagoula channels, Bayou Casotte and turning basin, and entrance channel; and disposal of maintenance material following current practice of confined disposal areas, open water in Mississippi Sound, and Gulf disposal. In response to comments from the State of Mississippi, the Corps agreed to reevaluate the reconstruction of the Grande Batture Island during PED. In addition, the state requested that the Corps investigate utilizing suitable dredged materials for restoration of a seriously eroded portion of Round Island.

PRECONSTRUCTION ENGINEERING AND DESIGN STUDIES

111. General. The General Design Conference established the need for a ship simulation study to determine if there were a more economical configuration of channel width or widths that would still meet the requirements of the navigation users. As discussed

in detail above, we were committed to further investigation of several options for the disposal of new work dredged material. Despite early problems with economic benefits, all preliminary indications were that the authorized 42-foot depth would remain the optimum depth and no depth restudy was planned. That did not remain the case. The feasibility studies had thoroughly disposed of a wide range of alternatives. Therefore, while reformulation to a more economical project was clearly indicated, it was considered that a fairly narrow range of project configurations and disposal options required further investigation. As our investigations proceeded, other possible modifications appeared and were analyzed. For convenience, those items are listed here, rather than in chronological order.

112. Initial Project Configurations Investigated included:

A. Reoptimization of the Pascagoula River channel leg. Loss of most of the bulk grain traffic, coupled with the costs associated with relocating the oil line crossing that leg and the modifications required at the grain elevator to accommodate larger ships, gave early indications of nonfeasibility. This will be discussed in greater detail below.

B. Relocation of the Bayou Casotte Turning Basin. New surveys showed a shallow cove, with accompanying deeper water, in the shoreline of Greenwood Island immediately north of the authorized location of the basin. Calculations indicated that a savings in dredging volume, about 664,000 cubic yards, could be realized by moving the basin to that location. This move would also reduce the amount of marsh lost during construction and, hence, the required mitigation. Coordinating this change with our partner, we learned that JCPA had immediate plans for expanding port development into that area. Relocating the basin northward would seriously interfere with their development plans. JCPA is plannning for industrial development on the entire west side og Greenwood Island, with the exception of the area presently set aside for the new turning basin. They also pointed out that the basin, if relocated, would restrict access between its landward edge and the base of the Greenwood Island disposal area dike. This would result in an additional site at the end of the island which could not be developed. Because of the serious impact on their plans, this change was dropped. Moving the basin southward would not produce any savings in dredging volume and would increase the basins exposure to wave action from the sound.

C. Incremental Justification of the Bayou Casotte Basin. Interviews with pilots and users indicated significant benefits for a stand alone justification for the proposed turning basin. The economics of that alternative were analyzed and will be discussed in greater detail below.

D. Incremental Justification of Horn Island Pass Modification. It was also learned that there were separable benefits for both relocating and widening Horn Island Pass. That analysis is presented in detail below.

113. Initial Disposal Options Investigated. We entered PED with commitments to reexamine the restoration of Grande Batture and Round Island. We knew, too, that the Tenneco Site was now again available. Because of the proximity of this site to the Bayou Casotte channel and the authorized turning basin, it offered an attractive possibility of reducing dredging costs and therefore warranted reevaluation. These alternatives and later developments are discussed briefly here for convenience.

A. Restoration of Grande Batture. Grande Batture Island was once approximately centered on South Rigolets Island, near the Alabama-Mississippi State line. The island was the boundary between Grand Bay, Alabama, and Pt aux Chenes Bay, Mississippi, and the more open waters of Mississippi Sound. The island has eroded away during recent time, leaving a long shoal area. With the loss of the island, the marshes which make up the shorelines of both bays are now undergoing a rapid loss. The Mississippi Department of Wildlife, Fisheries, and Parks, Bureau of Marine Resources, and the Alabama Department of Conservation and Natural Resources, Bureau of Marine Resources, strongly advocate rebuilding Grande Batture with material dredged for the project improvement.

B. The plan developed for FR84 would have used stone armoring on the sound face to prevent erosion. Placing that stone would, we thought, have required dredging access channels to barge in the construction equipment and stone. The cost of stone protection and the proposed channel construction was the source of much of the criticism for that plan. We held several meetings with the agencies during PED. To reduce cost and possibly avoid the previous conflict, a plan was developed using hay bales staked down around the perimeter of the area. These could act as a dike and weir combined, would cost much less than conventional diking, and would eliminate the need for access channels. Because of their short life, however, the use of hay bales was not acceptable to many of the resource agencies.

C. Unfortunately, the pumping distance from the Bayou Casotte Channel to Grande Batture results in a large increase in mobilization and demobilization (M&D) cost and unit dredging cost. The final cost estimate was still $20 million greater than the NED plan. In accordance with current directives applicable to disposal areas, we informed the agencies that the Corps was willing to construct this alternative, provided that the cost was not borne by the Federal navigation project. Further consideration of this proposal was prompted by the FY 1990 policy change which added fish and wildlife habitat restoration as a project function. That restoration is treated in detail beginning with paragraph 139.

D. Restore Round Island. Round Island is a small island in Mississippi Sound about 3-1/2 miles southwest of the City of Pascagoula. Old maps show it actually round, but within recent history it has elongated towards the northwest. The south end of the island, which is actively eroding, contains a historic lighthouse and the site of a former quarantine station. The island has eroded from an area of about 130 acres when the lighthouse was constructed to about 77 acres at present. Migration or erosion has removed the island from around the lighthouse and the lighthouse is now in danger of being undermined and destroyed. The City of Pascagoula has assumed custody of the island and is working to prevent the loss of the lighthouse.

E. A representative of the city requested that material from the new work be placed around the south end of Round Island to restore the eroded portion. While they are not clear on the amount of material desired, it would be on the order of 1 million cubic yards. Again, the problem is cost. Pumping material to Round Island would increase the unit cost by $1.00 per yard over the NED plan cost. There would be, also, an M&D cost of $537,000. As at Grande Batture, hay bales could be used to retain the material for the short term. Discussions with the city indicated that funds were not available and there seems to be no hope for this option. We will, however, coordinate further with the city during preparation of plans and specifications and make every effort to be of assistance.

114. Tenneco Site Disposal. Pipeline dredging, where feasible, usually costs less than any other dredging method. Because this site is adjacent to the Bayou Casotte channel and the authorized turning basin, material disposal via pipeline to the site seemed a viable alternative. Four alternative disposal site layouts were designed, ranging from minimal storage volume and wetlands impact to maximum storage with, consequently, maximum wetlands impact. These alternatives were evaluated to determine costs and environmental impacts associated with each and conceptual mitigation schemes were developed for each one.

A. The U. S. Fish and Wildlife Service (USFWS) evaluated the impact of each alternative on fish and wildlife resources. A supplemental Fish and Wildlife Coordination Act Report (FWCAR) ncluding their recommendations is in Appendix D. During preparation of the FWCAR the Corps and USFWS evaluated the site using the Habitat Evaluation Procedure (HEP) technique. Results of the HEP are included in the supplemental FWCAR.

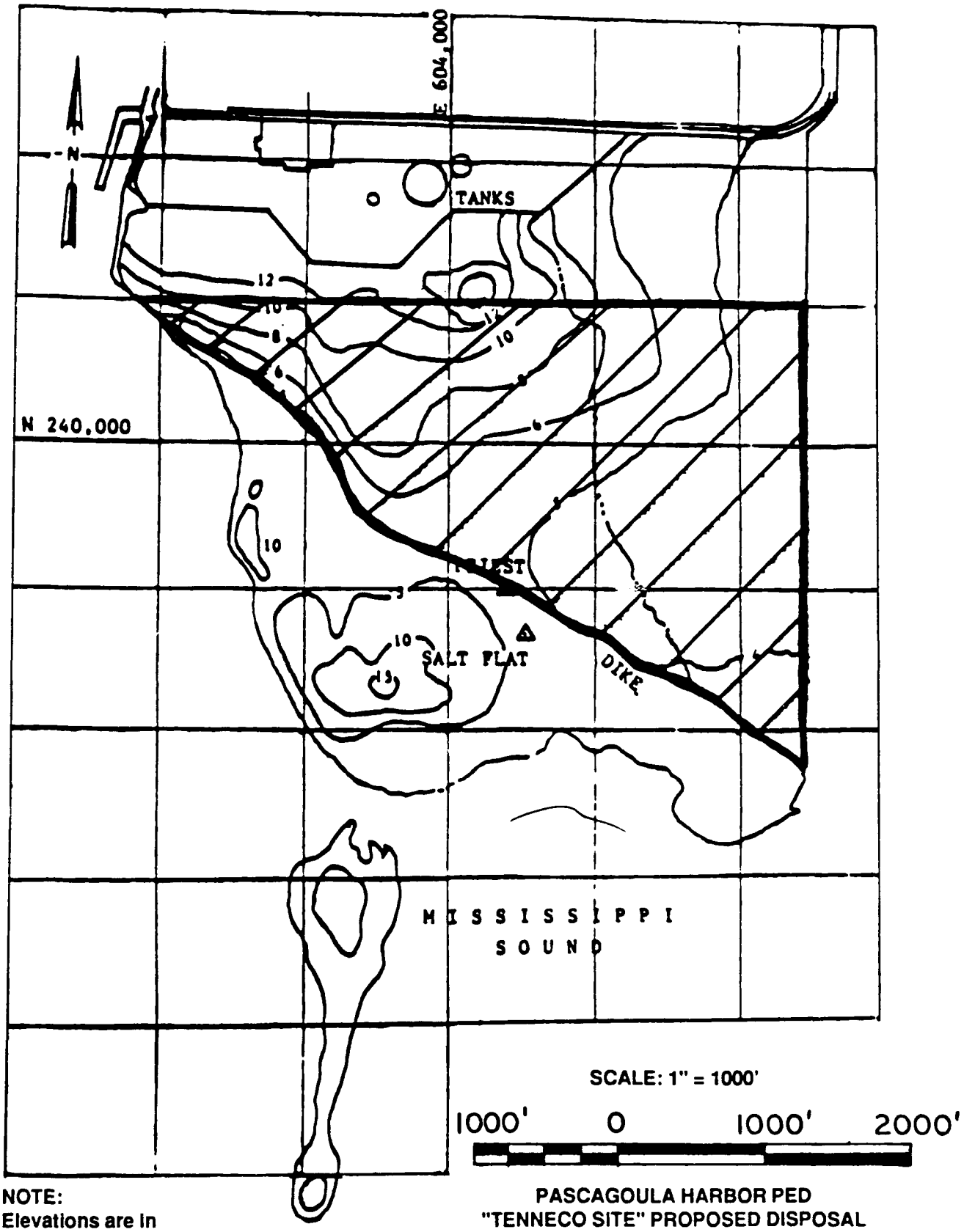
B. Alternative 1 (see Figure 4) would utilize the 175 acres within the existing dike. The old dike would be renovated and the top raised to 15 feet NGVD to produce a disposal capacity of 1,849,000 net cubic yards at a final fill elevation of 12 feet. About 11,550 feet of dike would be reconstructed and a new weir would be added. Stone protection would be required along 280

linear feet of dike exposed to wave action. The old weir would be replaced. Using this portion of the site would convert 116 acres of scrub/shrub wetlands and 14 acres of herbaceous wetlands to dry land. In addition, 45 acres of scrub/shrub uplands would be removed. Revegetation would likely occur, tending toward herbaceous grass and scrub/shrub uplands and this habitat would be available until future development of the site took place. An option which would approach full mitigation would be protection to the now eroding emergent wetlands by providing 7920 linear feet of low stone protection along the southern edge of the site. This would also provide some additional protection to the disposal area dike. The total cost to prepare this site for disposal was estimated to be $3,900,000. The dredging cost was estimated at $5,400,000 for disposal in that area, resulting in a total cost of $9,300,000. The cost for clamshell dredging, with disposal in the gulf, was estimated at $5,700,000, for an increased cost of about $3,600,000 for Tenneco disposal.

C. Alternative 2 (see Figure 5) would utilize about 183 acres of the site. With the same dike profile as Alternative 1, about 1,936,000 net cubic yards of material could be placed in the site. About 11,700 feet of dike would be constructed. Stone protection would be required along 3470 linear feet. This alternative would require filling about 29 acres of emergent wetlands, 72 acres of scrub/shrub habitat, 61 acres of scrub/shrub uplands, and 21 acres of herbaceous uplands. Partial mitigation could be provided through protection of the remaining 29 acres of emergent wetlands by providing about 4370 feet of stone protection and by removal of a 2000-foot section of the existing dike which would be utilized in the new dike construction. Construction cost, with only partial mitigation, would total $9,400,000. The increase in cost over gulf disposal would be $3,400,000.

D. Alternative 3 (Figure 6) would utilize about 248 acres of the total site. With the same dike profile, about 2,606,154 net cubic yards of material could be placed in the site. About 13,100 linear feet of dike would be constructed. This alternative would require filling about 34 acres of emergent wetlands, 127 acres of scrub/shrub wetlands, 5 acres of herbaceous wetlands, 61 acres of scrub/shrub uplands, and 21 acres of herbaceous uplands. Partial mitigation could be provided through protection of 24 acres of emergent wetlands by provision of 4370 linear feet of stone protection and by removal of a 1250-foot section of the existing dike to be used in the new dike construction. Construction cost, with only partial mitigation, would total $11,300,000. The increase in cost over gulf disposal would be $3,200,000

E. Alternative 4 (Figure 7) would utilize all 280 acres available at this site. With the same dike dimensions, about 2,966,051 net cubic yards of material could be placed in the site. About 14,600 feet of dike would be constructed and stone protection would be required along 8200 feet. This alternative would require

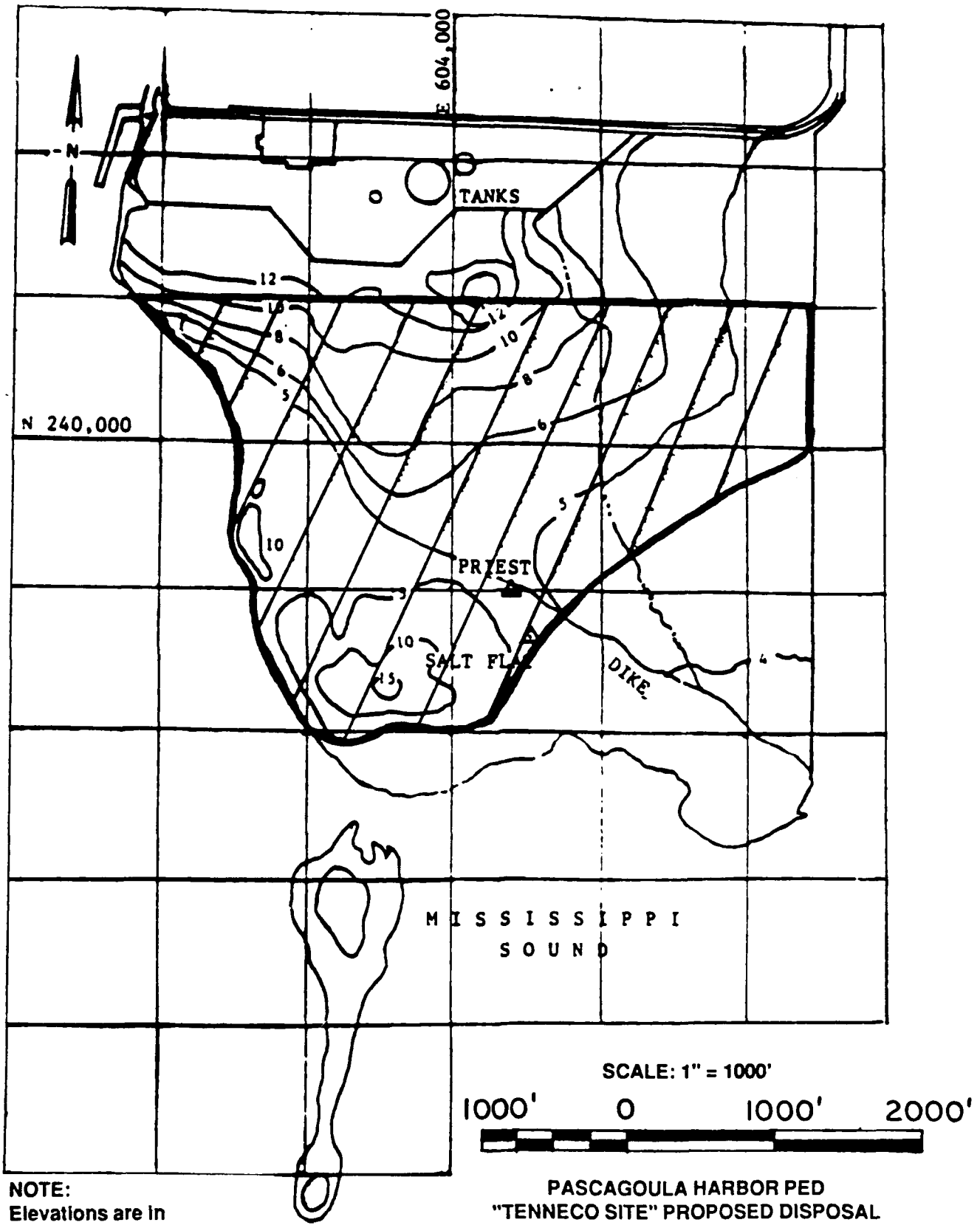


NOTE:
Elevations are in feet above NGVD.

PASCAGOULA HARBOR PED
"TENNECO SITE" PROPOSED DISPOSAL

DISPOSAL ALTERNATIVE
NUMBER ONE

FIGURE 4

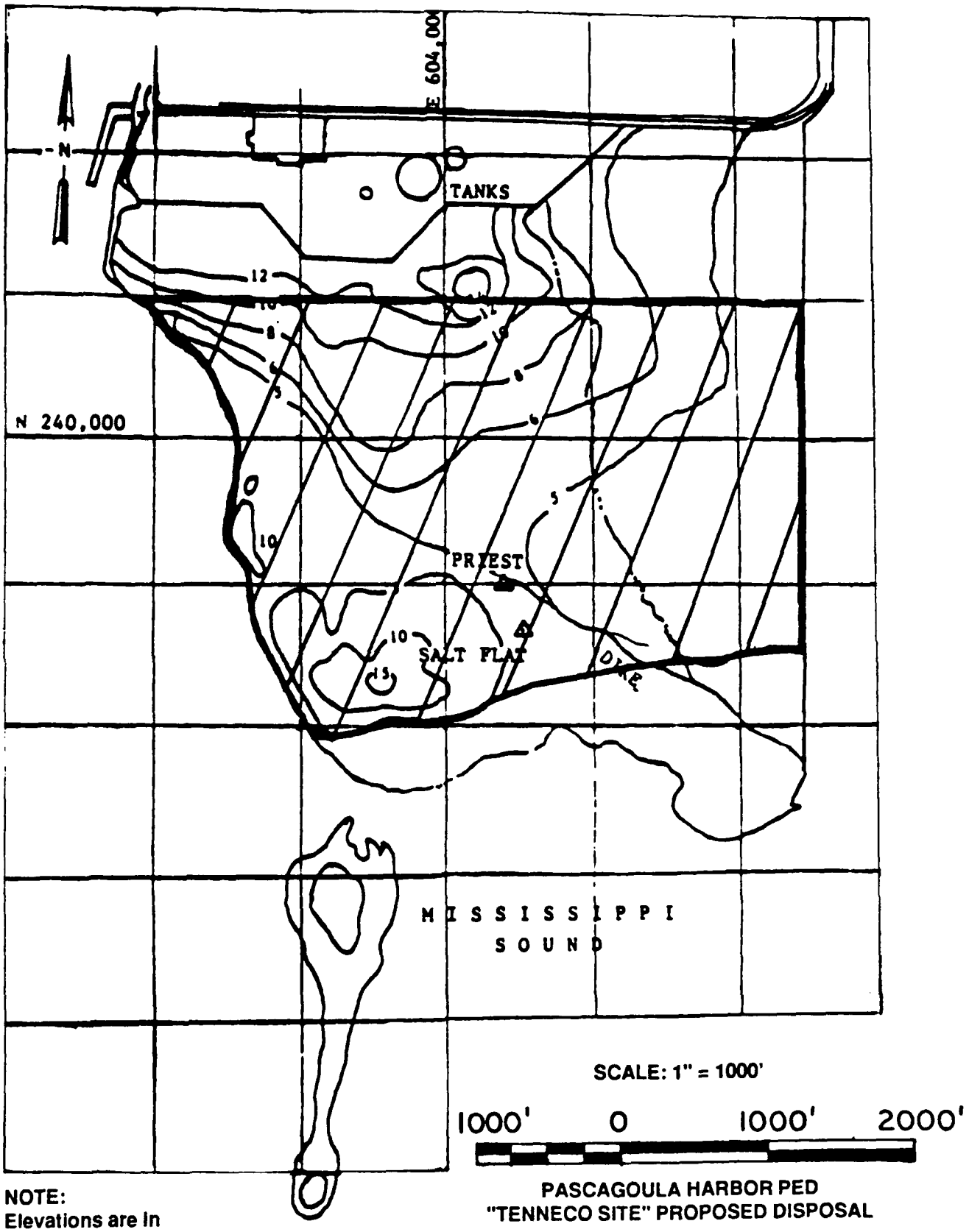


NOTE:
Elevations are in feet above NGVD.

PASCAGOULA HARBOR PED
"TENNECO SITE" PROPOSED DISPOSAL

DISPOSAL ALTERNATIVE
NUMBER TWO

FIGURE 5

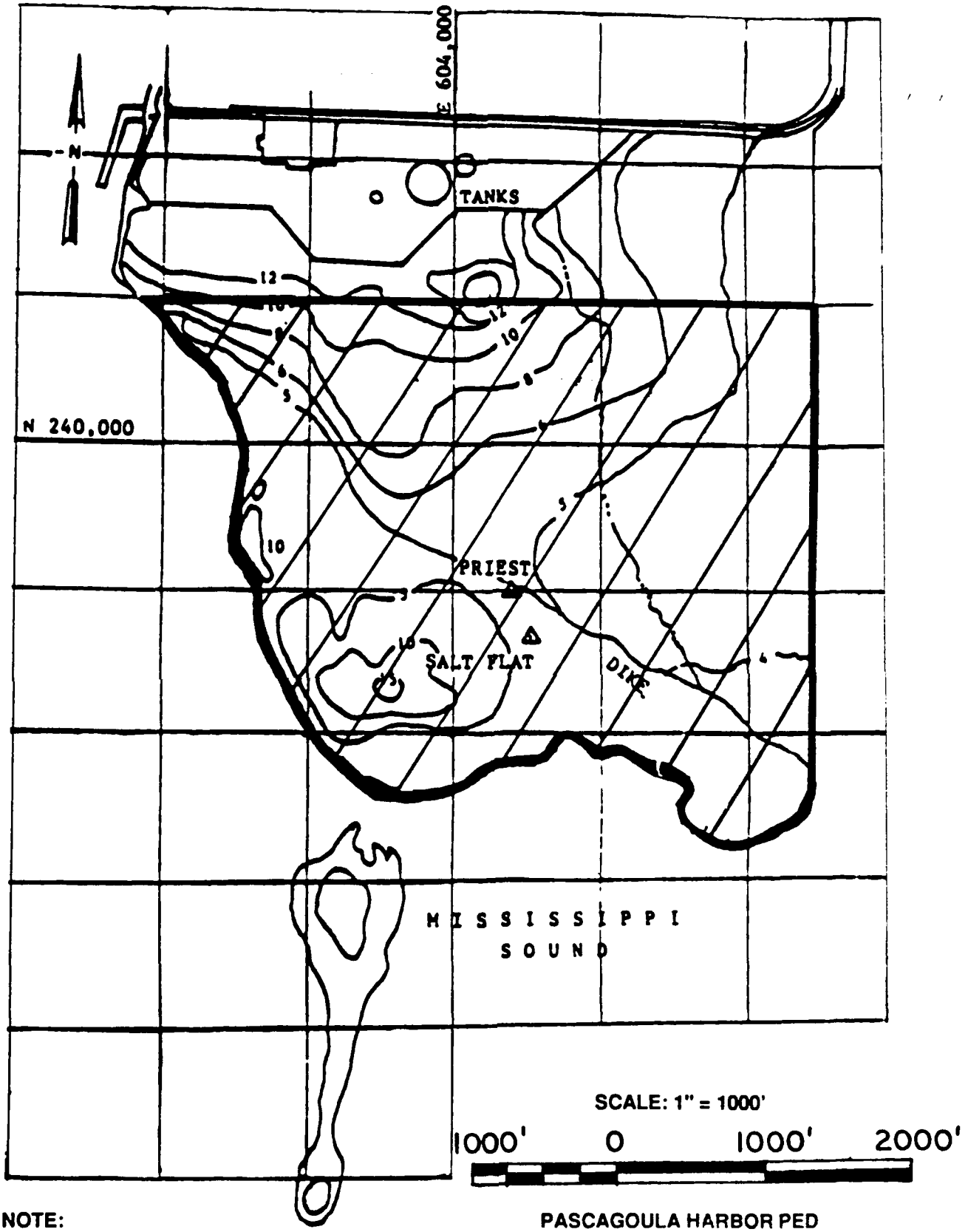


NOTE:
Elevations are in feet above NGVD.

PASCAGOULA HARBOR PED
"TENNECO SITE" PROPOSED DISPOSAL

DISPOSAL ALTERNATIVE
NUMBER THREE

FIGURE 6



NOTE:
Elevations are in feet above NGVD.

PASCAGOULA HARBOR PED
"TENNECO SITE" PROPOSED DISPOSAL

DISPOSAL ALTERNATIVE
NUMBER FOUR

FIGURE 7

the filling of approximately 58 acres of emergent wetlands, 127 acres of scrub/shrub wetland, 14 acres of herbaceous wetlands, 61 acres of scrub/shrub uplands, and 21 acres of herbaceous uplands. No on-site mitigation would be possible with alternative 4 since it would include the emergent wetland. Construction cost, with no allowance for mitigation, would be $12,200,000. The hypothetical cost increase (without mitigation) would amount to $3,000,000.

F. No specific mitigation was designed for Alternative 4 since nothing reasonable could be derived. Two options discussed included;

(1) Using the balance of the Bayou Casotte channel material for reconstruction at Grande Batture, or,

(2) Creation of wetlands from existing upland areas.

Reconstruction of Grande Batture is discussed elsewhere, however, this option does not seem practical in connection with the work at the Tenneco site. The possibility of locating sufficient upland areas suitable for wetlands creation in the vicinity of Pascagoula Harbor is remote. Alternative 4 would provide the greatest material capacity, but the impacts associated with its implementation cannot adequately be mitigated.

115. We concluded that even if the problems with mitigation were ignored, it was not economically feasible to utilize the Tenneco site for the present work.

116. Gulf of Mexico Disposal. Placement of material in the gulf was further considered and reevaluated during PED. New work material from the deep-draft channels within Mississippi Sound has been evaluated in accordance with current guidelines. The Section 103 evaluation for the transportation and disposal of this material is contained in Appendix D. Until recently, material from the entrance channel was placed in a small site west of this channel. This site was granted interim status in 1972 pending formal designation by the Environmental Protection Agency. The designation of an enlarged site was a cooperative effort of the Corps of Engineers, U. S. Environmental Protection Agency (EPA), and U. S. Navy. Site designation studies were accomplished during 1986 and 1987 and a Draft Environmental Impact Statement (DEIS) was filed with EPA on 27 July 1990. The final EIS was filed with EPA on 16 August 1991 and the site rfeceived final designation status 24 September 1991.(a) Mississippi Sound Disposal. For many years, maintenance material dredged from Horn Island Pass by pipeline dredge has been pumped across the channel to a disposal area, Area 10, on the east side. Constant use of this area has resulted in the small island located northwest of the western end of Petit Bois Island. During the consideration of alternatives, we learned that GINS would welcome disposal in that area, provided the material was placed further west so that there was reasonable

assurance that it would reach Horn Island. Using this currently certified area with a pipeline dredge offered savings over the use of a hopper dredge with littoral zone disposal. The use of that area for new work material was added, therefore, as an additional disposal option.

117. Preliminary Conclusions. At the end of the exercise discussed above, several conclusions were apparent.

A. Grande Batture Restoration did not appear to be an economically viable disposal option despite the desires of the various environmental agencies involved.

B. The Tenneco Site is not a practical disposal site. The costs of preparing the site for disposal plus the costs for mitigation for the loss of habitat far exceed any savings in dredging costs.

C. Gulf Disposal is the sole option remaining from those originally considered. Ocean disposal of dredged material is regulated under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA). New work material from the Inner Harbors, the Lower and Upper Pascagoula Channels, and the Bayou Casotte Channel and turning basin has been evaluated following guidelines specified in the MPRSA. The Section 103 evaluation for the transportation and subsequent disposal of this material is contained in Appendix D. Disposal of new work material in the Gulf of Mexico has remained an option through PED.

DETAILED EXAMINATION OF PLAN COMPONENTS

118. General. The ship simulation study performed by the Waterways Experiment Station was taken as the definitive engineering recommendation on the widths of channel increments and the amount of bend widening required. These studies are discussed in greater detail in the section, PROJECT DESIGN. Other elements susceptible to economic analyses are discussed in the following paragraphs.

119. Impoundment Basin(s) Configuration. Further study of the shoaling patterns at Horn Island Pass revealed that neither the existing nor the proposed impoundment basin adequately addressed the problem of shoaling from littoral material in that channel segment. Active shoaling extends beyond the southern limit of the existing basin to the first turn in the Bar Channel south of Petit Bois Island. In addition, an area of active shoaling was identified on the east side of the Bar Channel about 1-1/2 miles south of Petit Bois Island. To alleviate the problems caused by active shoaling in those two areas, we propose that the existing impoundment basin be relocated and extended, and that a new impoundment basin be created. We consider that relocating the existing basin and constructing a new one is justifiable on the

basis of good engineering judgement, since any reduction in future O&M costs must be determined from experience. Moreover, relocating the existing basin is essentially a no cost modification if performed in connection with the relocation of the Horn Island Pass channel leg. See below.

120. Relocation of Horn Island Pass. During feasibility studies, we noticed that the present channel was not following the pass thalweg and it appeared that a savings in new work dredging would accrue if the channel were moved about 500 feet westwardly. The more detailed surveys available for PED showed that a lesser move of only 300 feet would be required. It also appeared, however, that the bend widening at each end of the pass channel would add more dredging than the savings resulting from the move. A comparison of the channel relocation only, using the existing channel dimensions, showed that relocating the centerline 175 feet westwardly would result in a net increase of about 300,000 cubic yards in new work dredging at a cost of about $459,000. Using the old channel for the relocated impoundment basin would save about 350,000 cubic yards of annual maintenance material for the first 6 years following the relocation, resulting in a savings of about $262,000 for each of those years. That savings easily justifies the relocation.

121. Widening the Entrance Channel and Constructing Bayou Casotte Turning Basin. There are separable benefits that would accrue to widening the entrance channel, that is, the gulf approach reach and Horn Island Pass, and to providing a new turning basin at the mouth of Bayou Casotte. At the widths recommended by the simulation study, night passage would be possible for the larger ships that are now forced to wait for daylight because of the difficulty in navigating the entrance. Provision of the turning basin also would provide time savings. These benefits are truly separable only at the existing channel depth of 38 feet. At all other depths, both the turning basin and entrance channel widening must be provided to realize savings. Widening the entrance at the existing depth of 38 feet would have an estimated first cost of about $6,095,000, an annual cost of $656,000, and would provide annual benefits of $405,000. Providing a new turning basin at the present depth would have an estimated first cost of about $8,888,000, have an annual cost of $961,000, and would provide benefits of $944,000 annually. If both elements were constructed in combination, the first cost would be about $14,983,000, the annual cost would be $1,602,000, and annual benefits would be $2,834,000. In all other alternatives, these modifications in combination with increased channel depth result in greater net benefits than omitting them.

122. Deepening the Upper Pascagoula Channel. As indicated previously, bulk grain traffic, the major justification for improving this channel reach, has dropped drastically in recent years. In addition, improving this channel, beyond a nominal 1-foot deepening, would require two items of work with fairly high

costs. The 20-inch crude oil transmission crossing for this leg will require relocation if the channel is deepened more than 1 foot, since any greater depth will encroach into the required DOT safety zone. Relocating that pipeline results in a first cost of $1,886,000 (without contingencies, etc.) Modifications required at the grain elevator to realize the benefits of a deeper channel would also be required for an increase in depth greater than 1 foot. That cost varies with channel depth, but begins at $1,312,000 at a depth of 40 feet. Any increase in depth beyond 1 foot results in an increase in the local cost of about $4,128,000 with an annual cost of $445,000. Even ignoring the additional dredging cost, the benefits to the present traffic, which would increase by only $189,000 annually with increased depth, cannot sustain that increase.

123. Optimum Channel Depth. As PED studies progressed, there was an indication that the authorized depth of 42 feet might not be the economic optimum. We decided, at that point, to conduct a reoptimization exercise, the results of which are contained in Table 1. It developed later that there was an error in data supplied by a major user, which was corrected soon after that discovery was made, but since the work was by then nearly finished it was carried through to completion. With the exception of the Pascagoula Channel discussed above, it is clearly evident from the table that the optimum channel depth for the balance of the project is 42 feet.

124. Discussion of Alternative Comparison Data. The dredging quantities used were the final values and the dredging costs were computed using the program acceptable for Code of Accounts cost estimates. Pipeline relocation cost estimates were supplied by the Chevron Pipeline Company. Cost estimates for the necessary modifications at the grain elevator were supplied by the Port Engineer for JCPA. Because of the many alternatives investigated, some minor simplification was considered warranted to avoid excessive labor. Contingencies, Engineering and Design, and Supervision and Administration were entered as percentages of construction costs. Interest During Construction (IDC) was computed using the construction time. We believe that these steps have a negligible effect and that the comparisons and relative rankings shown are valid. These simplifications were not used in the final cost estimates discussed later, where the full Code of Accounts procedure was implemented. The costs used in Table 1 were updated to October 1991 price levels for the July 1991 revisions and the benefits shown are those resulting from the Chevron revisions which are discussed in detail in the ECONOMIC BENEFITS section. In addition, the new interest rate of 8 3/4 percent was used.

125. Alternatives Evaluated. The full array of alternatives evaluated and shown in Table 1 is listed below. As used elsewhere in this GDM, the depth listed is the nominal authorized depth and

assumes the usual allowances, including an additional 2 feet in the bar channel.

A. Alt 1 - At the existing depth of 38 feet, improve the bar channel by widening to 600 feet and relocating.

B. Alt 2 - At the existing depth of 38 feet, construct a new Bayou Casotte (BC) turning basin at the authorized location.

C. Alt 3 - At the existing depth of 38 feet, improve the bar channel and construct BC turning basin.

D. Alt 4 - Deepen the Main Channel and BC Channel to 40 feet. Keep Upper Pascagoula (UP) Channel at 38 feet. Do not improve bar or construct BC turning basin.

E. Alt 5 - Deepen Main Channel and BC Channel to 40 feet. Deepen UP Channel to 39 feet. Do not improve bar or construct BC turning basin.

F. Alt 6 - Deepen Main Channel and BC Channel to 40 feet. Deepen UP Channel to 40 feet. Do not improve bar or construct BC turning basin.

G. Alt 7 - Deepen Main Channel and BC Channel to 40 feet, including relocation of bar and construction of BC turning basin. Keep UP Channel at 38 feet.

H. Alt 8 - Deepen Main Channel and BC Channel to 40 feet, including relocation of bar and construction of BC turning basin. Deepen UP Channel to 39 feet.

I. Alt 9 - Deepen Main Channel and BC Channel to 40 feet, including relocation of bar and construction of BC turning basin. Deepen UP Channel to 40 feet.

J. Alt 10 - Deepen the Main Channel and BC Channel to 42 feet. Keep UP Channel at 38 feet. Do not improve bar or construct BC turning basin.

K. Alt 11 - Deepen Main Channel and BC Channel to 42 feet. Deepen UP Channel to 39 feet. Do not improve bar or construct BC turning basin.

L. Alt 12 - Deepen Main Channel and BC Channel to 42 feet. Deepen UP Channel to 40 feet. Do not improve bar or construct BC turning basin.

M. Alt 13 - Deepen Main Channel and BC Channel to 42 feet, including relocation of bar and construction of BC turning basin. Keep UP Channel at 38 feet.

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N. Alt 14 - Deepen Main Channel and BC Channel to 42 feet, including relocation of bar and construction of BC turning basin. Deepen UP Channel to 39 feet.

O. Alt 15 - Deepen Main Channel and BC Channel to 42 feet, including relocation of bar and construction of BC turning basin. Deepen UP Channel to 40 feet.

P. Alt 16 - Deepen Main Channel and BC Channel to 44 feet. UP Channel stays 38 feet. No bar improvement or BC turning basin.

Q. Alt 17 - Deepen Main Channel and BC Channel to 44 feet. Deepen UP Channel to 39 feet. Do not improve bar or construct BC turning basin.

R. Alt 18 - Deepen Main Channel and BC Channel to 44 feet. Deepen UP Channel to 40 feet. Do not improve bar or construct BC turning basin. (a) Alt 19 - Deepen Main Channel and BC Channel to 44 feet, including relocation of bar and construction of BC turning basin. Keep UP Channel at 38 feet.

S. Alt 20 - Deepen Main Channel and BC Channel to 44 feet, including relocation of bar and construction of BC turning basin. Deepen UP Channel to 39 feet.

T. Alt 21 - Deepen Main Channel and BC Channel to 44 feet, including relocation of bar and construction of BC turning basin. Deepen UP Channel to 40 feet.

126. Plan Selection. An examination of Table 1 clearly shows that Alternative 14 is the National Economic Development (NED) plan. Since no other plan has a feature that justifies its selection over the NED plan, the NED plan was selected as the basis of future planning and will be the recommended plan.

Table 1

EVALUATION OF FINAL ALTERNATIVES

Alternative Number	Description	Nominal Depth Feet	First Cost ($1000)	Annual Cost ($1000)	Annual Benefits ($1000)	Benefit/ Cost Ratio	Net Benefits ($1000)
1	Improve Bar Channel Only	38	$6,103	$1,020	$1,282	1.26	$262
2	Add Bayou Casotte Basin Only	38	$8,904	$951	$1,024	1.08	$73
3	Add Bar Channel and BC Basin	38	$15,007	$2,036	$2,491	1.22	$455
4	Deepen Main & BC Channels Keep PasCh @38ft. Less Alt3.	40	$17,056	$2,708	$2,366	0.87	($342)
5	Deepen Main & BC Channels Deepen PasCh to 39ft. Less Alt3.	40	$22,678	$3,284	$3,044	0.93	($240)
6	Deepen Main & BC Channels Deepen PasCh to 40ft. Less Alt3.	40	$24,744	$3,513	$3,233	0.92	($280)
7	Deepen Main & BC Channels Keep PasCh @38ft. Add Alt3.	40	$30,804	$4,159	$4,731	1.14	$572
8	Deepen Main & BC Channels Deepen PasCh to 39ft. Add Alt3.	40	$36,426	$4,764	$3,044	0.64	($1,720)
9	Deepen Main & BC Channels Deepen PasCh to 40ft. Add Alt3.	40	$38,492	$5,009	$5,408	1.08	$399
10	Deepen Main & BC Channels Keep PasCh @38ft. Less Alt3.	42	$24,034	$3,600	$3,746	1.04	$146
11	Deepen Main & BC Channels Deepen PasCh to 39ft. Less Alt3.	42	$29,656	$4,153	$4,424	1.07	$271
12	Deepen Main & BC Channels Deepen PasCh to 40ft. Less Alt3.	42	$31,721	$4,429	$4,613	1.04	$184
13	Deepen Main & BC Channels Keep PasCh @38ft. Add Alt3.	42	$38,859	$5,189	$6,017	1.16	$828
14	Deepen Main & BC Channels Deepen PasCh to 39ft. Add Alt3.	42	$44,481	$5,814	$6,694	1.15	$880
15	Deepen Main & BC Channels Deepen PasCh to 40ft. Add Alt3.	42	$46,547	$6,066	$6,883	1.13	$817
16	Deepen Main & BC Channels Keep PasCh @38ft. Less Alt3.	44	$34,625	$5,415	$4,338	0.80	($1,077)
17	Deepen Main & BC Channels Deepen PasCh to 39ft. Less Alt3.	44	$40,247	$6,032	$5,015	0.83	($1,017)
18	Deepen Main & BC Channels Deepen PasCh to 40ft. Less Alt3.	44	$42,313	$6,281	$5,204	0.83	($1,077)
19	Deepen Main & BC Channels Keep PasCh @38ft. Add Alt3.	44	$51,079	$7,219	$6,568	0.91	($651)
20	Deepen Main & BC Channels Deepen PasCh to 39ft. Add Alt3.	44	$56,701	$7,875	$7,246	0.92	($629)
21	Deepen Main & BC Channels Deepen PasCh to 40ft. Add Alt3.	44	$58,767	$8,139	$7,435	0.91	($704)

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127. Ship Simulation Study. The recommended channel width of 350 feet in the Feasibility Report was less than that indicated by COE criteria, but was recommended and approved for pertinent reasons. Obviously, a further reduction in channel width, particularly for the Bayou Casotte leg, that did not affect safe navigation, could result in appreciable construction cost savings. In addition, the information available during the feasibility stage indicated that the 4 pipelines crossing the channels would have to be relocated. This one relocation task was a major project cost and if it were possible to avoid relocating any of those lines that would result in a significant savings. At the 3 December 1987 General Design Conference it was decided that a ship simulation study was indicated. That study was conducted by the Waterways Experiment Station (WES) at Vicksburg, Mississippi, to determine:

A. The minimum channel width required for safe navigation by the design vessels;

B. The adequacy of the proposed bend widening and turning basin; and

C. To determine if relocation of a pipeline that crosses the Bayou Casotte Channel could be avoided.

128. The existing channels were first modeled with the simulator and verified by a pilot. After verification, various new channel configurations were modeled. Several simulation runs each were made by five professional pilots from the Pascagoula Bar Pilots Association and one representative from Chevron Oil Company for each portion of the Pascagoula and Bayou Casotte channels and for a wide range of conditions. Variables simulated were vessel type, channel widths, wind and tide conditions, cross currents, daytime and nighttime conditions, and loaded and unloaded conditions, for both inbound and outbound traffic. The proposed turning basin near the mouth of the Bayou Casotte harbor was modeled and several simulated turns were made by the pilots to determine if the dimensions of the proposed turning basin were adequate. The results of the simulation study are presented in detail in Appendix A1 to Appendix A, CHANNEL DESIGN.

129. Design Ships. Channel dimensions were based on the requirements for safe navigation by the most prevalent vessels using the channel. Because a wide variety of vessels call at the harbors on Pascagoula River and Bayou Casotte, the characteristics of several vessels were considered in the design of the recommended channel. The predominant vessels calling at the Pascagoula Inner Harbor are the bulk carriers that load grain at the port grain elevator there. The predominant vessels

calling at the Bayou Casotte Inner Harbor are the petroleum tankers used in lightering service by the refinery in the Bayou Casotte Industrial Area. There is, however, another vessel which frequently calls at Bayou Casotte and needs to be considered, the lighter aboard ship, or LASH vessel.

The ships selected were:

A. A bulk carrier with a length overall (LOA) of 850 feet, a beam width of 106 feet and a maximum draft of 47 feet;

B. A tanker with a LOA of 810 feet, a beam of 125 feet and a maximum draft of 40 feet; and

C. A LASH ship with a LOA of 893 feet, a beam of 100 feet and a maximum draft of 40.5 feet.

130. The bulk carrier was used as the design vessel for the Pascagoula Channel (from the intersection [the "Y"] of the Pascagoula and Bayou Casotte channels in Mississippi Sound to the entrance to Pascagoula Inner Harbor). The tanker and the LASH ship were both used as the design vessel, as appropriate, for the Bayou Casotte Channel (from the "Y" to the entrance to Bayou Casotte Inner Harbor). The characteristics of all three vessels were considered in the design of the Main Channel in Mississippi Sound from the "Y" through Horn Island Pass, and out into the Gulf of Mexico.

131. Channel Design, General. The final design of the various features in the authorized plan of improvement was determined through an evaluation of existing conditions, the results of the ship simulation study conducted by WES, the application of professional judgment, and design criteria from the U.S. Army Corps of Engineers' Engineer Manual (EM) 1110-2-1613 - Hydraulic Design of Deep Draft Navigation Projects. Factors used in the selection of the recommended plan included the bathymetry, present operating conditions, shoaling rates, projected traffic densities, and vessel characteristics for the anticipated fleet. The application of these factors and criteria were used to determine the channel depths and widths, bend widening, alignments and turning basin dimensions; and are discussed generally in the section of the GDM and in detail in Appendix B.

132. Bend Widening. All bends would be widened in accordance with the apex, or cutoff method described in EM 1110-2-1613. The simulation study recommended additional widening over that specified by the EM at the turn from Horn Island Pass to the Main Channel, just north of Petit Bois Island, and at the "Y". In addition, a gradual transition to the regular channel width was recommended from the bend widening north of Horn Island Pass and

from the widening at the "Y". The transition from the turn north of Petit Bois Island should extend 5000 feet north from the turn. The transitions at the "Y" would extend 3000 feet north from the "Y", up both the Pascagoula and Bayou Casotte channels. The recommended bend widening and transitions are shown on Plates 4 through 8 of the Main Report and Charts B-3 through B-7 of Appendix B. This ample widening should alleviate the navigation problems currently encountered in those bends.

133. Impoundment Basins. An impoundment basin 200 feet wide and 1700 feet long is presently being maintained at the existing project depth along the east side of the channel at Horn Island Pass. That basin was designed to trap littoral material being transported around both sides of Petit Bois Island and deposited into the channel. The history of that basin, however, indicated that shoaling occurs only in the southern portion of the basin, from about the tip of Petit Bois Island to its southern end, while the portion from the tip of the island to the north end of the existing basin remains deep.

134. The Feasibility Report recommended, and the authorized plan includes, a reconfigured basin beneath the pass channel. Surveys and dredging records, however, show that active shoaling extends beyond the southern limit of the existing basin to the first turn in the Bar Channel south of Petit Bois Island. An additional area of active shoaling has been identified on the east side of the Bar Channel about 1-1/2 miles south of Petit Bois Island. This appears to be an ebb shoal that deposits material back into the channel on a flood tide, creating maintenance problems. To alleviate the problems caused by active shoaling in those two areas, it is recommended that the existing impoundment basin be relocated and extended, and that a new impoundment basin be created.

135. The northern limit of the existing impoundment basin at the tip of Petit Bois Island would be moved about 600 feet to the south and the southern limit extended to the first turn south of island. The relocated impoundment basin then would 175 feet wide and 4630 feet long and would be constructed to the recommended project depth of 44 feet MLLW. Initial dredging would be minimal because the proposed impoundment basin was designed to occupy a portion of the Horn Island Pass channel that the existing channel now occupies.

136. A new impoundment basin would be located on the eastern side of the entrance channel about 1 1/2 miles south of Petit Bois Island. The new basin would be 200 feet wide and 2200 feet long and would also be excavated to the project depth of 44 feet MLLW. The locations of both the relocated and the proposed new impoundment basins are shown on Chart B-7. The recommended impoundment basins should be much more effective that the existing basin and thereby increase the time between maintenance

cycles for Horn Island Pass and the entrance channel segments and reduce annual maintenance costs.

137. Earlier Soils Investigations. The present work utilized previous investigations to the maximum extent. These included:

A. Bayou Casotte Harbor and Channel: Seven (7) borings taken along the existing channel slopes and centerline to about -50 MLLW by the Mobile District Office in 1962 and 1963. In addition, use was made of several borings taken just outside of the limits of the existing channel to -65 MLLW by Vester J. Thompson, Jr., Inc., in 1976.

B. Pascagoula Harbor and Channel: Thirty (30) splitspoon borings were taken in 1963 to depths reaching to -50 feet MLLW. These borings were spaced along the harbor and that portion of the channel within Mississippi Sound. Two (2) additional borings were taken in the approach channel to Horn Island Pass, in 1982, and extended to about -70 MLLW. Also in 1982, fourteen (14) submarine splitspoon borings were taken along a proposed SSW realignment of the Outer Bar Channel from the west end of Petit Bois Island for 7-1/2 miles to where water depth exceeded 50 feet. These borings penetrated the to about -65 MLLW.

138. Feasibility Study Soils Investigations. In 1987, 16 vibracore borings, 8 in the Bayou Casotte channel between the mouth of the harbor and the intersection with the Pascagoula channel and 8 in the Mississippi Sound portion of the Pascagoula channel, were taken using 20-foot sections of 4-inch diameter plastic pipe held vertically and vibrated into the bottom to retrieve a continuous core sample. Several of those borings did not penetrate to project depth because they were taken on the channel slopes. Past borings, however, had been concentrated along the channel centerline and it was felt that information on the sides was needed for the proposed widening. Additional borings could not be taken in the outer bar portion of the Pascagoula channel during this investigation because heavy seas were occurring at the time.

139. Optimum Channel Configuration. Preliminary economic analysis confirmed earlier results from FR84, i.e., that the optimum channel depth was 42 feet inside Mississippi Sound, with a depth increase in the Entrance Channel to allow for conditions there. The results of the ship simulation study were discussed above and in greater detail in Appendix A. A width of 450 feet was found to be adequate for the gulf entrance channel but Horn Island Pass would be widened to the authorized width of 600 feet. The main channel through Mississippi Sound and into the Pascagoula River would remain at 350 feet. A width of 300 feet, however, with a constriction to 250 feet at the pipeline crossing, was found adequate for the Bayou Casotte leg. Additional bend widening was recommended at bends and transitions

to eliminate problems disclosed by the simulation studies and to compensate for the reductions in channel width. All channel segments would be deepened to the appropriate authorized depths.

THE SELECTED PLAN

NED PLAN DESCRIPTION

140. The NED plan developed during the plan formulation process is shown in detail on Plates 4 through 9. The plan has the following features:

A. Channel Widths. Those channel widths indicated by the WES ship simulation study were used. The gulf approach leg of the Entrance Channel would be 450 feet wide. The Horn Island Pass leg of that channel reach would be 600 feet wide and relocated about 300 feet westwardly. If, as anticipated, the thread of deep water through the pass continues to migrate slowly westward, in the future Horn Island Pass would be realigned as natural conditions warrant. The Main Pascagoula Channel, from the transition at Horn Island Pass into the Pascagoula Inner Harbor would be 350 feet wide, the existing width. The Bayou Casotte Channel, from the junction with the Main Channel (the "Y") into the mouth of Bayou Casotte, would have a nominal width of 300 feet, excluding the 1500-foot length at the pipeline crossing which would be 250 feet wide, and the 1000-foot transitions between the 300-foot nominal width and the 250-foot crossing width.

B. Channel Depths. The Entrance Channel, from its origin in the gulf to the transition at the north end of Horn Island Pass, would be 44 feet deep, the nominal 42-foot project depth with 2 feet of additional depth as an allowance for wave action. The Lower Pascagoula Channel would be 42 feet deep. The Bayou Casotte Channel and the turning basin just inside the mouth of Bayou Casotte would also have a depth of 42 feet. The Upper Pascagoula Channel, however, from the "Y" to the grain elevator in the Inner Harbor, would only be deepened from 38 feet to 39 feet at this time.

C. Impoundment Basins. The existing impoundment basin at Horn Island Pass would be reconfigured by moving the northern limit about 600 feet to the south and extending the southern limit to the first turn south of the island. The relocated impoundment basin then would 175 feet wide and 4630 feet long and would be constructed to the recommended project depth of 44 feet MLLW. In addition, a new impoundment basin would be located on the eastern side of the entrance channel about 1 1/2 miles south of Petit Bois Island. The new basin would be 200 feet wide and 2200 feet long and would also be excavated to the project depth of 44 feet MLLW.

D. Transitions. The channel widths recommended for Pascagoula Harbor do not meet Corps of Engineers design criteria for the ship sizes presently in use there now or within the

projected future. The ship simulation study, however, indicated that the recommended widths are quite adequate for safe navigation provided widening at bends exceeds current Corps criteria. As a result, the widening shown at all bends is somewhat greater than normally would be recommended.

E. Improvement Limits. The improved channel would begin at the 44-foot depth contour in the Gulf of Mexico. The new work for the Upper Pascagoula channel would terminate at the channel Point of Intersection (PI) opposite the south end of the grain elevator (PI coordinates are N 250,810.17, E 584,485.47). In Bayou Casotte it was necessary to provide a short (about 1200 feet) channel extension north of the turning basin to provide full project access as far as the Chevron products dock. The Inner Harbor channel for Bayou Casotte was already 300 feet wide so there will be a depth transition from 42 feet to 38 feet at station coordinates N 244,578.58, E 602,087.50.

F. Dredged Material Placement. Since all other alternatives were proved unfeasible, new work dredged material would be placed in the Gulf of Mexico, with the exception discussed below. The material from dredging north of the northern transition at Horn Island Pass will be placed in the approved area in the Gulf of Mexico. The sandy material from Horn Island Pass will be placed either in Mississippi Sound near the east end of the island, if a pipeline dredge is used as anticipated, or would be placed in the near shore littoral zone area, if a small splithull hopper dredge is used. Material from the approach channel further into gulf is not suitable for nearshore placement and is in depths appropriate for the larger hopper dredges. That material, therefore, would also be placed in the gulf disposal area. Future maintenance material will be placed in upland disposal areas, open water in the sound and the littoral zone, and in the ODMDS, all in accordance with present practice.

RELOCATIONS

141. With the presently selected dimensions, the only relocation required will be the telephone line crossing the Pascagoula River between the grain elevator and Ingalls Shipyard. The owner states that, for the recommended 1-foot channel deepening, they will handle the cable as they do for ordinary maintenance dredging and that no significant cost will be incurred. Any future increase in the depth of the Pascagoula Channel, beyond the 1-foot increment presently recommended, will require relocating the crude oil pipeline crossing that leg.

DREDGING QUANTITIES

142. Table 2 following lists the construction dredging quantities

and the increase in future maintenance dredging attributable to the NED plan channel improvements. These quantities were computed from the survey discussed in paragraph 107. Since maintenance dredging is planned to immediately precede construction dredging, the computed quantities should accurately reflect constructions amounts. A preconstruction survey is planned, however.

Table 2
NED PLAN DREDGING QUANTITIES

Reach	Channel Dimensions ft	Construction Dredging Quantities 1000 cy	Incremental Maintenance Dredging Quantities 1000 cy
Upper Pascagoula	39X300	1,856	33
Bayou Casotte	42x300	6,419	369[1]
Lower Pascagoula	42x350	2,079	39
Transition	42x350 to 44x600	1,370	20
Horn Island Pass	44x600	756	(81)[2] 30[3]
Transition	44X600 to 44X450	1,133	40
Gulf Approach	44x450	2,910	548

[1]Includes Turning Basin quantity
[2]First 6 years.
[3]Balance of economic life.

COST OF THE SELECTED PLAN

143. The detailed Code of Account cost estimates are in Appendix E. The final estimated first cost for the deep-draft navigation channel is $44,100,000. Interest and amortization on the total amount including interest during construction (IDC), added to the estimated cost of future maintenance attributed to this work, yields an annual cost of $9,613,000. Since the final estimate of benefits for this plan was $11,067,000, the net remaining

benefits would be $1,454,000 and the benefit/cost ratio would be 1.2.

COST COMPARISON WITH AUTHORIZED PLAN

144. The congressionally authorized plan for deep-draft navigation improvements is presently estimated to cost $71,540,000 of which $42,583,000 would be the Federal cost and $28,957,000 would be the total non-Federal cost. As noted above, the estimated first cost for the deep-draft navigation channel plan developed for the reformulated NED plan is $44,028,000. Of that amount, $32,753,000 would be the Federal first cost and $11,275,000 would be the non-Federal cash share plus local costs. The cost reduction can be mainly attributed to: 1) a significant reduction in dredged material quantities from channel width reductions in the Bayou Casotte and Gulf Approach segments resulting from the ship simulation studies, and 2) eliminating 4 pipeline relocations that were in the original plan as the result of better surveys, stringent economic analysis, and the ship simulation study. In addition, there has been a slight improvement in dredging costs for gulf placement.

ECONOMIC BENEFITS

145. General. This section contains a summary of the benefits for the recommended improvements to the authorized Federal deep-draft project for Pascagoula Harbor. The detailed derivations of all benefits are contained in Appendix C, ECONOMIC ANALYSIS. All references to economic data in this section pertain to that appendix. Unless otherwise specifically noted, tonnages, capacities, rates, etc., are all in short (2,000 pound) tons.

146. There are 3 safety restrictions imposed on vessels using this harbor by the Pascagoula Bar Pilots Association. A clear comprehension of these restrictions is crucial to understanding this economic analysis. These restrictions are:

A. Vessels with drafts at or greater than 34 feet cross the bar only in daylight,

B. Vessels with lengths at or greater than 685 feet must be turned only in daylight, and

C. Vessels with a minimum speed exceeding 2 knots cannot pass the Chevron finished products loading area (Docks 1-5 in Bayou Casotte) while loaded. LASH and RoRo vessels can pass these docks only in daylight because of their higher minimum speed, great length, and high freeboard. (At present, only the Chevron lighters, which have variable pitch propellers, are capable of reducing speed to 2 knots.)

NAVIGATION IMPROVEMENT BENEFITS

147. Summary of Traffic. Commerce directly benefitting from channel improvement is expected to total 19 million tons annually during 1996-2046. Total annual commerce at this harbor is 30 million tons, however, all commodities expected to move in vessels with a draft of 38 feet or less were excluded from this benefit analysis. Three commodities; bulk grain, crude oil, and petroleum coke, are now carried in vessels which would benefit from an improved channel.

BULK GRAIN TRAFFIC

148. Existing Traffic. Bulk grain exports have ranged from a high of 3.8 million tons in 1979 to a low of 377,000 tons in 1983, which resulted from the Russian grain embargo imposed in 1980. Traffic has improved somewhat, in part due to a new bagging operation, but is still well below its former level.

149. Base Year Traffic. Louis Dreyfus Corporation officials

predict that pre-embargo bulk grain levels (3.8 million tons) can be reestablished for Pascagoula. For the base year, however, data were averaged for the 1979-1987 period, producing an annual value of 1,742,000 tons. From that amount, 46 percent was excluded for shipments to ports with channel depths of 38 feet or less or in shipload quantities requiring 38 feet or less. The remaining tonnage was increased by 1.13, the factor for a 2.48 compound growth for five years (1990-1995), to compute the 1995 base year traffic. The result is 1,063,300 tons for the first year the improved project is operational.

150. Without-Project and With-Project Traffic. This analysis assumed that Pascagoula grain traffic would mirror the projected U.S. rate. Pascagoula exports, therefore, would increase at 2.48 percent annually for the period 1990-1995, decrease to 0.45 percent for the next 25 years (1996-2020) and then remain constant from 2020 to the end of the period.

151. Existing and Without-Project Dry Bulk Carrier Fleet. No growth is expected in the world dry bulk carrier fleet which would call at Pascagoula for grain (or petroleum coke).

152. With-Project Dry Bulk Carrier Fleet. Present practice for the larger bulk carriers calling at Pascagoula is to load to full project depth and leave on the rising tide. This practice will continue with a deeper channel. An industry standard for an upper limit of five feet of lightloading was established in FR84. The projected future fleet included all vessels that could load to each alternative channel depth and, in addition, those larger ships which fell within the 5-foot lightloading criteria.

153. Economic Benefits. Average annual equivalent (AAE) benefits for bulk grain are estimated at $677,600 for a 39-foot channel. Any benefits to grain traffic from channel improvement other than depth are discussed below.

PETROLEUM COKE TRAFFIC

154. General. Chevron, U.S.A. Inc., produces a by-product of petroleum coke at an average rate of 4,000 tons/day or 1,460,000 tons/year. Storage is at dockside in an area holding 112,000 tons. Coke exports have approximated full plant production in recent years. Coke is sold F.O.B. dockside to a U.S. broker, SSM Carbon, Inc., who has the coke delivered to various European ports.

155. Traffic for Base Year, Without-Project, and With-Project Condition. No growth in coke exports is expected for the 1996-2046 period. Data shows that 75 percent of the coke traffic, 1,095,000 tons, would benefit from a deeper channel but the other 25 percent would still be restricted by depths at foreign ports.

156. Vessel Fleet. Coke would utilize a larger bulk carrier fleet than grain. Chevron requires that coke vessels operate with a 2-foot underkeel clearance and SSM Carbon concluded that all the ports to which they ship coke have channels over 40 feet in depth. These variations resulted in a slightly different vessel fleet for each alternative channel depth than for the grain fleet.

157. Economic Benefits. AAE coke benefits were estimated at $3,143,000 for a 42-foot channel. Benefits to coke traffic from other channel improvements are discussed separately below.

CRUDE OIL TRAFFIC

158. General. Chevron, U.S.A. Inc. operates a modern refinery with a 300,000 barrel/day (BPD) capacity (two 150,000 BPD processing units) in the Bayou Casotte Industrial Area adjacent to that channel. Maintenance shutdowns and other delays reduce the plant capacity to an average rate of 295.5 MBPD which requires about 17,000,000 tons of crude oil annually. Most of their supply is received by lightering from a VLCC or ULCC at anchor about 25 miles offshore. A new lighter fleet with two 78,656 dwt ships was placed in operation in 1988. These ships are designed to operate rather efficiently at a 36-foot draft, but have a fully-loaded draft of 40 feet. In addition, they have improved loading rates and discharge rates which match plant intake lines. These improvements reduced trip turnaround from 72 hours for the old fleet to 36 hours for the new fleet, excluding delays caused by channel dimensions.

159. Traffic for Base Year, Without-Project, and With-Project Condition. This refinery is approaching full capacity operation and would be presently operating at full capacity but for the minor problems resulting from the adaption period of the new lighters. Chevron officials believe that these problems will be surmounted and the refinery will be operating at full capacity before 1996, and continue at that level thereafter. No plant expansion is expected during the 50-year planning period. Inbound traffic would be 17,246,500 tons for the entire study period. Navigation conditions in all channel segments would remain essentially unchanged.

160. With-Project Unit Costs. More efficient use of the large lighters would reduce the number of trips required to unload the VLCC/ULCC's. VLCC/ULCC wait time could be reduced by eliminating the delays lighters incur at the bar and the round trip to the existing turning basin. Chevron officials maintain that these reduced delays will not allow the VLCC/ULCC's to be outchartered. Chevron data show that the lightering tankers can be outchartered for about 50 percent of the time saved from the reduced number of trips. The outcharter rate for these vessels is $1,098 per hour.

This rate was determined by the year 2000 replacement cost for these specialized vessels (replacement has been mandated by the double-skin requirement) and their replacements after a 25-year useful life (a Chevron safety requirement). (See Par 51, Appendix C.)

161. The lighter vessels average 230.5 trips per year. Total round trip time for a lighter is 42.42 hours. Travel time from Docks 6 and 7 to the turning basin would be reduced from 1.5 hours for the without-project condition with the present basin, to 0.5 hours with the new turning basin. Widening the bar would eliminate a 4.42 hour wait, with random arrivals at the bar, provided that widening is linked with the new turning basin. (Details are in Tables 34 and 35, Appendix C.) The lighters are subject to two of the pilots' restrictions; bar crossing and turning in daylight only.

162. Widening the bar without providing a new turning basin is not a viable alternative for this operation. If only the bar were widened, the loaded vessel must still wait an average of 3.95 hours. If the turning basin alone were provided, an average of only 0.47 hours would be saved since the inbound vessel would still have to wait at the bar (see Table 35A, Appendix C). With good weather, an empty tanker which has been turned can exit the channel and cross the bar at night.

163. Lightering Vessel Costs. For the without-project condition, costs were computed for 230.5 trips annually. For with-project conditions, these costs would be reduced by 50 percent of the number of trips saved (12.8 for the 42-foot alternative) plus the incremental fuel and tug costs and all port charges for these saved trips. To explain further, half the trips saved could be used for charter by another company or for Chevron traffic elsewhere. The other half of the time would result in no savings since the time freed would not be enough to allow outchartering.

164. VLCC/ULCC Costs. Chevron credits no savings to these ships. Onsite refinery storage capacity problems caused by constantly changing product mixes eliminates unloading the VLCC/ULCC's any faster under the with-project condition.

165. Economic Benefits. Total savings to crude oil traffic amount to $604,000 for the 42-foot channel. Incremental benefits from other project elements are discussed below.

INCREMENTAL NAVIGATION BENEFITS

166. Widening the Bayou Casotte Channel. The large vessels which use this 225-foot wide channel must reduce speeds for a safe transit. However, the pilots state that a wider channel would allow no increase in speed for inbound vessels since the entire

3.6 mile channel length is required either to stop at the southernmost Chevron dock, or to come to dead slow to pass this dock. A wider channel would allow only minimal speed increases for outbound vessels because of maneuvering difficulties at the "Y". Consequently, no direct transportation savings are generated by an increase in width.

167. Widening the Gulf Approach and Pass. The restrictions imposed by the bar pilots become critical when considering widening the bar channel. Depending on a vessel's arrival time at the bar and its physical characteristics it may have to wait for daylight, and in addition, may have a further wait imposed by interactions with other vessels. Interaction waiting could be either at the bar, at the dock, or at either, as follows:

A. Bar Waiting. Two vessels arrive simultaneously at the bar channel. One must wait on the other to enter the channel,

B. Dock Waiting. Two vessels have finished operations inside the harbor simultaneously. One must wait on the other to leave, and

C. Bar and Dock Waiting. One vessel is ready to enter the bar channel and another has finished operations inside the harbor simultaneously, or vice versa. One must wait on the other to clear the channel.

Tables 38, 38A, 38B, and 38C in Appendix C show the reduced interaction delays for 38-, 40-, 42-, and 44-foot deep channels, provided the bar channel is widened when the new turning basin is constructed in Bayou Casotte.

168. The annual benefits for widening the entrance channel total $1,282,000 for the 38-foot channel alternative and $1,102,000 for the 42-foot alternative. Benefits for all channel alternatives are shown in detail in Table 40, Appendix C, and summarized in the Actual Benefits column of Table 3 below.

169. New Bayou Casotte Turning Basin. The pilots' restrictions and interaction delays, both discussed at length above, affect waiting times. The new turning basin would reduce the travel time from a dock to the existing turning basin. Tankers must now travel an average of 1 mile through a congested industrial area to turn in the existing turning basin at the north end of Bayou Casotte and return the same route. These ships require 1.5 hours per round trip of which 0.5 hours is required to turn the ship. Travel time, 1 hour, would be saved with the new turning basin. Fuel savings would also result from the reduced travel time.

170. The lighters would also benefit by a reduction in the number of tugs required to assist in a round trip to the present turning

basin. Three tugs are required for safe passage to the present basin. Only 2 tugs would be required to turn a loaded tanker in the new basin and push it across the channel to Docks 6 or 7.

171. A chemical fertilizer plant is located on the east side adjacent to the existing turning basin. Their docks are on the east boundary of the turning basin and their mooring area is actually in the turning basin. This long standing practice was tolerated until recently because it had no effect on navigation. The basin, however, has a nominal width of 1000 feet and the new Chevron lighters are 785 feet long. Now vessels at the fertilizer dock must be shifted to piers E-G before a Chevron tanker can be turned. Historically, 10 ships per month were shifted at an average cost of $4,000, costs which would be avoided with a new turning basin. NuSouth, the most recent operator, closed during this analysis. The benefits were retained since some company has historically used this site. In December 1990, JCPA announced that the plant would be reopened early in 1991.

172. Coke vessels presently require 1.35 hours for the round trip to the turning basin. With the new turning basin, the coke vessels would have to be turned and then backed up from the basin to their dock. This results in only 0.5 hours saved per trip. Finished product tankers loading at Docks 3 or 5 would not realize travel time savings since they would be mid-way between the existing and new basins. Their use of the new turning basin would, however, enhance safety since they would not be passing through the congested northern portion of the industrial area.

173. Summary. There are physically separable benefits to deepening the channel(s), widening the bar and pass and providing a new turning basin on Bayou Casotte; however, the latter two are not operationally separable. Table 40, Appendix C, summarizes the AAE benefits for a total of $6,694,500 for a 39-foot channel on the Pascagoula leg and a 42-foot channel on the Bayou Casotte leg (with the other appropriate modifications included).

SENSITIVITY ANALYSIS

174. Commerce Projections. The benefits calculated are sensitive in two major areas: commodity projections and vessel operating costs.

A. High/Low Projections of Commerce. Several of the channel users could have technological expansions and/or demand-driven expansions.

(1) Grain Exports. LDC officials felt that the Pascagoula elevator is competitive with New Orleans or Mobile. The non-congested harbor, short channel and relatively low

port/handling charges offer major advantages. The near parity of Pascagoula rail rates with New Orleans barge rates could return this elevator to the 1979 level of 3.8 million tons of export grain with the same or new markets by 1995. This would mean that 2,128,000 tons would be exported to foreign destinations utilizing larger ships needing channel depths greater than 38 feet. On the other hand, the lowest projection for grain traffic would be no growth from the nine year average mentioned previously, or 940,700 tons annually.

(2) Crude Oil Imports. This Chevron refinery is technologically efficient and unique and is now operating at or near capacity. No future refinery growth is expected, however, their lightering operations and plant facilities could be improved. For example, a small increase in on-site storage capacity would allow productive use of the remaining time saved by the lighters for outcharters to other companies.

(3) Petroleum Coke Exports. A best-case scenario from the broker would have all the coke exported to ports with channel depths greater than 38 feet. The worst case scenario would be a minimum of 65 percent to those ports.

B. Change in Vessel Operating Costs. U.S. Army guidelines for deep draft vessel operating costs show cyclical operating costs as vessel demand and supply changes. If a trend analysis was used instead, these costs would be at least 10 percent higher for FY 1990. A 10 percent decrease was also tested. The results of these sensitivity tests are shown in Table 3 below.

Table 3

SENSITIVITY ANALYSIS
AVERAGE ANNUAL EQUIVALENT TRANSPORTATION BENEFITS
FOR
A 39' CHANNEL AT PASCAGOULA RIVER AND A 42' CHANNEL AT BAYOU CASOTTE
(October 1991 Prices; 8 3/4 % Interest)
($1,000)

	LOW SCENARIO	ACTUAL BENEFITS	HIGH SCENARIO
DEEPEN CHANNELS:	($)	($)	($)
Bayou Casotte:			
Crude Oil	604	604	1,811
Petroleum Coke	2,451	3,143	4,609
Pascagoula:			
Bulk Grain	610	678	745
Subtotal	3,665	4,425	7,165
WIDEN ENTRANCE:			
Bayou Casotte Vessels	923	1,025	1,128
Pascagoula River Vessels	69	76	84
NEW TURNING BASIN:	1,052	1,168	1,285
TOTAL BENEFITS	5,709	6,694	9,663
COST	6,012	6,012	6,012
Benefit/Cost Ratio	1.05	1.1	1.6
Net Remaining Benefits	303	682	3,650

ENVIRONMENTAL CONSIDERATIONS

175. General. The Final Environmental Impact Statement (FEIS) considering the improvements to the Pascagoula Harbor navigation project was coordinated with Federal, state, and local agencies and the concerned public in July 1985. This FEIS considered the range of alternatives discussed in this GDM.

176. Mitigation. As discussed in FR84, construction of the turning basin just inside the mouth of Bayou Casotte will result in the unavoidable loss of 4 acres of emergent wetlands. This action will be mitigated by restoring 6 acres of disturbed wetlands habitat on the tip of Greenwood Island to a more natural emergent nature.

177. Gulf Disposal Site Designation. A new enlarged ocean dredged material disposal site (ODMDS) in the Gulf of Mexico offshore of Pascagoula is currently under consideration. The Environmental Protection Agency (EPA) is responsible for designation of ODMDS under Section 1 of the Marine Protection, Research, Sanctuaries Act of 1972. A Draft EIS (DEIS) was prepared jointly by the Corps of Engineers and EPA and filed in July 1990 after coordination with Federal, state, and local agencies and the concerned public. The final EIS was filed with EPA on 16 August 1991 and the site received final designation on 24 September 1991. Final designation was published in the Federal Register for Tuesday, September 24, 1991.

178. Evaluation of Sediments for Ocean Disposal. The impact of disposal of sediments from the Pascagoula and Bayou Casotte channels has been evaluated following standard toxicity and bioaccumulation procedures. Results of these evaluations indicate that the toxicity of the sediments proposed for disposal is minimal. Although the organisms tested showed some ability to bioaccumulate certain parameters, the magnitude of this potential is not significant (see Appendix D.)

179. Environmental Monitoring Plans. A management and monitoring plan for the proposed Pascagoula ODMDS has been developed. The plan provides for protection of the marine environment through avoidance of unreasonable degradation and assurance of material suitability. This plan is being coordinated as part of the ODMDS DEIS discussed above. Other monitoring plans would be developed if required.

REAL ESTATE REQUIREMENTS

180. The bridges crossing the Federal project are north of the upper limit of the deep draft channel and would have not be affected by the improvements under consideration. The South Central Bell Telephone Company cable across the Pascagoula River lies on the bottom and must be moved frequently for routine maintenance dredging. A company representative has stated that they will move their cable for channel deepening at no cost to Government. The selected plan has avoided the relocation of the 20-inch crude oil pipeline at both of the upper channel leg crossings. When and if the Pascagoula Channel is ever deepened beyond the 1-foot increment recommended for the NED plan, that crossing will require relocating. The gas line crossings south of the "Y" were laid 10 feet deeper than the crude lines and are, therefore, safe from any channel deepening within the foreseeable future. There will be no relocations benefit payments under Public Law 91-646.

181. The area containing the 6 acres of substandard marsh set aside for improvement as mitigation for the 4 acres lost from the turning basin construction is at the southern tip of Greenwood Island. That marsh was designated during the feasibility study, is within property owned by the sponsor, and will require no acquisition of real estate. Depositing dredged material off the east end of Horn Island and in the littoral zone south of Horn Island, if done in accordance with the plans presented in this GDM, can be accomplished without the need for acquiring any real estate interest.

PHASED CONSTRUCTION

182. Rationale. During review of the final General Design Memorandum, the Jackson County Port Authority, as agent for the non-Federal sponsor, Jackson County, Mississippi, requested that a reduced increment of the recommended plan be constructed initially. Such a reduced plan would result in a non-Federal share of the cost more suitable to their present financial capability and would still produce significant and obvious benefits for the project users.

183. Phase I Details. The requested first increment consisted of the recommended improvements to the entrance channel and construction of the new turning basin at Bayou Casotte, but with all improvements at existing project depth. In greater detail, this would be:

A. Provide a turning basin with a total turning diameter of 1150 feet, including the channel width, at the mouth of Bayou Casotte. Future maintenance material from the inner harbor at Bayou Casotte, including the turning basin, would be placed in the Greenwood Island disposal area. Constructing the new turning basin at a nominal 38-food depth would not impact quite as much wetlands as the full 42-foot depth basin. We strongly recommend, however, that the 6-acre marsh restoration required for the 42-foot basin be implemented up front to avoid restoring small increments of marsh in the future.

B. Widen the gulf entrance channel to 450 feet from the 40-foot depth contour in the Gulf of Mexico (its present outer limit) to the bend at the southern end of Horn island Pass. Widen Horn Island Pass to 600 feet between the bends at the southern and northern ends of that pass, for a distance of about 4-1/2 miles and relocate the Horn Island Pass reach about 300 feet westward. If, as anticipated, the thread of deep water through the pass continues to migrate slowly westward, in the future Horn Island Pass would be realigned as natural conditions warrant. Reconfigure the impoundment basin at Horn Island Pass by moving the northern limit about 600 feet to the south and extending the southern limit to the first turn south of the island. The relocated impoundment basin then would 175 feet wide and 4630 feet long. No actual construction would be required as the basin was designed to lie within the present channel limits. In addition, a new impoundment basin 200 feet wide and 2200 feet long would be located on the eastern side of the entrance channel about 1 1/2 miles south of Petit Bois Island.

184. Future Construction. Additional phases of the authorized project would be constructed in justifiable increments, as related to priority of needs and the non-Federal sponsor's willingness and capability to participate.

185. Costs and Benefits. The full Code of Accounts cost estimate has been added to Appendix E, Cost Estimates. Construction Cost is estimated to be $15,800,000. Of that amount, $11,850,000 is estimated to be the Federal first cost and $3,950,000 is estimated to be the non-Federal cash contribution. With Interest During Construction added, the total Capital Cost is estimated to be $18,262,000. Using the current 8-3/4 percent interest rate, a 50-year economic life, and estimated incremental annual maintenance of $674,000, the annual cost is $2,293,000. The incremental benefits for this reduced alternative amount to $2,491,000, yielding a benefit/cost ratio of 1.1 and net remaining benefits of $198,000. As shown in Table 4 below, both Phase I and Phase II are incrementally justified.

Table 4

Incremental Analysis
for
Phased Construction

Phase I Channel Construction		Phase II Channel Construction	
Item	Cost $1000	Item	Cost $1000
Navigation Channel - First Cost	$15,800	Navigation Channel - First Cost	$28,300
IDC	$2,427	IDC	$4,427
Total Capital Cost	$18,227	Total Capital Cost	$32,727
Interest and Amortization	$1,619	Interest and Amortization	$2,907
Annual O&M - Channel	$674	Annual O&M - Channel	$811
Total Annual Cost	$2,293	Total Annual Cost	$3,718
Annual Benefits	$2,491	Annual Benefits	$4,209
Benefit/Cost Ratio	1.09	Benefit/Cost Ratio	1.13
Net Remaining Benefits	$198	Net Remaining Benefits	$491

PHASE I IMPLEMENTATION

186. Current practice is to remove material within the existing channel template during construction and charge that cost to a maintenance account. For Phase I construction, that practice can continue without problems.

187. For future phases of construction, any plan involving deepening channels within Mississippi Sound cannot follow present practice. Material from maintenance dredging is now placed in approved open water areas in the sound, which results in a significantly lower dredging cost than disposal in the Gulf of Mexico. Unfortunately, new work material cannot be placed in open water without significant bottom buildup. For future construction, therefore, maintenance dredging inside the sound would be planned to immediately precede construction dredging, which would be placed in the gulf. As far as the new work is concerned, this change in practice could result in a small decrease in the mobilization and demobilization cost for a pipeline dredge since such a dredge would already be onsite and in a favorable position to bid the new work.

188. After advertising and contract award, a pipeline dredge would move to Horn Island Pass to construct the improved pass channel from the north transition section in Mississippi Sound to the south transition section in the gulf. Material from this dredging would be pumped to the approved disposal area in Mississippi Sound off the eastern tip of Horn Island. That work would require about 5 months.

189. Depending on the most efficient scheduling, as the dredging in Horn Island Pass nears completion, a hopper dredge would come on site to dredge the Gulf Approach Channel from the transition at Horn Island Pass into project depth in the gulf. That material would be placed in the gulf disposal area. Work would require 2 months, at the end of which the hopper dredge would be finished.

190. Simultaneously with the commencement of work on the pass, a clamshell dredge and fleet of bottom dump barges would begin excavating the Bayou Casotte turning basin. That work would take 6 months.

191. The total time required for construction of the Phase I navigation channel improvement is presently estimated to be 2 years. Work necessary before construction includes a complete and comprehensive condition survey, preparation of contract plans and specifications, and advertising and bidding the construction contracts. Preparation of plans and specifications began in September 1991 and be completed in August 1992. If funding is approved, the construction contract will be awarded in January 1994 and construction would be complete by May 1996.

LOCAL COOPERATION

COORDINATION

192. From the beginning of PED in 1986 to present, frequent coordination meetings were held with the non-Federal sponsor and other concerned agencies to insure that their concerns were consideration in both preliminary and final plan reformulation and design.

VIEWS OF THE NON-FEDERAL SPONSOR

193. Sponsor Support. Jackson County, Mississippi, represented by their agent, the Jackson County Port Authority, is the non-Federal sponsor for the existing Federal project. The Jackson County Port Authority has indicated a willingness and ability to fulfill the required conditions of non-Federal sponsorship for Phase I of the recommended project modifications. The sponsor has reviewed the Draft Local Cooperation Agreement (LCA) and has provided Letters of Intent to support the first phase of the project. Copies of the letters are provided in Exhibit A at the end of this report.

194. Local Cooperation Provisions. Modifications to the existing Federal project for Pascagoula Harbor according to Phase I of the recommended plan of improvement are conditioned subject to the local sponsor providing the following items of local cooperation in accordance with the WRDA of 1986:

A. Pay 25 percent of the total costs of construction of general navigation features assigned to commercial navigation.

B. Pay an additional 10 percent of the costs of general navigation features of the project in cash over a period not to exceed 30 years, at an interest rate determined by the Secretary of the Treasury. The value of LERRD, if any, shall be credited against this additional 10 percent.

C. Provide to the United States all lands, easements, and rights-of-way including dredged material disposal areas, and perform all relocations or alterations of facilities determined by the Government to be necessary for construction, operation and maintenance of the project.

D. Perform or assure performance of all necessary utility alterations and relocations determined by the Government to be necessary for construction, operation, and maintenance of the project.

E. Provide or pay to the Government the full cost of

providing all retaining dikes, waste weirs, bulkheads and embankments, including all monitoring features and stilling basins, determined by the Government to be necessary for construction, operation, or maintenance of the project.

F. Provide and maintain adequate depths in vessel berthing areas and local access channels serving the terminals.

G. Prohibit erection of any structure within 100 feet of the project channel as authorized.

H. Hold and save the United States free from damages due to the construction and maintenance of the project, except for damages due to the fault or negligence of the United States or its contractors.

I. Comply with the applicable provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved January 2, 1971, as amended, in acquiring lands, easements, and rights-of-way for construction and subsequent operation and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

J. Comply with Section 601 of Title VI of the Civil Rights Act of 1964 (Public Law 88-352) and Department of Defense Directive 5500 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, in connection with the construction, operation, and maintenance of the project.

LOCAL SUPPORT

195. As indicated by the letters in Appendix A, Jackson County and the JCPA strongly support Phase I of the improvement of the deep-draft navigation channel. Local interests in general support the plan of improvement for the Federal navigation project at Pascagoula. Their support has been expressed at conferences and at public meetings. To date there has been no expressed opposition to the proposed work.

COST APPORTIONMENT

196. The construction cost for Phase I of the channel improvement is estimated to be $15,800,000. Of that amount $11,850,000 is estimated to be the Federal first cost. The non-Federal share of the first cost is estimated to be $3,950,000. Annual costs are estimated at $2,296,000. Annual costs include interest and amortization of the Federal and non-Federal investments, Interest During Construction on those investments, and the annual cost of both Federal and non-Federal maintenance. In addition, the non-

Federal sponsor must repay 10 percent of the Federal first cost of the navigation portion of the project, $1,185,000, over 30 years at an interest rate yet to be determined.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

197. Having reviewed all pertinent information and considered the effects of modifying Pascagoula Harbor, I conclude that:

A. All practical alternatives have been examined in arriving at a recommended plan.

B. Adverse environmental impacts of the recommended plan and the alternative plans have been considered and addressed.

C. The recommended plan is consistent with national policy, statutes, and administrative directives.

D. The recommended plan best serves the public interest.

RECOMMENDATIONS

198. General. I have carefully considered the technical information, engineering, environmental, and economic, developed during the PED studies leading to the publication of this GDM. I have also considered the views of the general public, the non-Federal sponsor, and the various agencies, especially the resource agencies.

199. Recommendations. I recommend that Phase I of the improvements to the existing Federal navigation project for Pascagoula Harbor, Mississippi, authorized by the Water Resources Development Act of 1986 (PL 99-662) be constructed to provide, at this time:

Widening the gulf entrance channel to 450 feet from the 40-foot depth contour in the Gulf of Mexico to the bend at the southern end of Horn Island Pass, a distance of about 4 miles, and adding a new impoundment basin 200 feet wide and 2200 feet long at existing project depth on the eastern side of the entrance channel about 1 1/2 miles south of Petit Bois Island; widening Horn Island Pass to 600 feet between the bends at the southern and northern ends of that pass, a distance of about 1-1/2 miles; relocating the Horn Island Pass reach 300 feet westwardly; relocating the impoundment basin at Horn Island Pass about 600 feet to the south and lengthening it to 4630 feet, so that the southern limit is at the first turn south of island, all at a width of 175 feet and at the existing project depth;

Provide a turning basin at the mouth of Bayou Casotte with a total turning diameter of 1150 feet, including the channel width.

Mitigation for the unavoidable loss of about 4 acres of emergent wetlands by restoring 6 acres of disturbed wetland habitat to a more natural emergent nature.

The first cost of the recommended plan for improving the deep draft navigation channel is estimated to be $15,800,000, of which the Federal first cost would be $11,850,000 under present cost-sharing policies. The exact amount of Federal and Non-Federal cost would be determined by the Chief of Engineers subject to cost-sharing and financing arrangements satisfactory to the President and the Congress.

200. Disclaimer. The recommendations contained herein reflect the information available at this time and current Department policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil Works construction program to the perspective of higher review levels within the Executive branch. Consequently, the recommendations may be modified before they are transmitted to higher authority as proposal for authorization and/or implementation funding.

FOR MICHAEL F. THUSS
Colonel, Corps of Engineers
District Engineer

ITC DEPUTY COM

ATTACHMENT A

LETTERS OF INTENT

PASCAGOULA HARBOR, MISSISSIPPI
GENERAL DESIGN MEMORANDUM

ATTACHMENT A - LETTER OF INTENT
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Port Of Pascagoula

July 10, 1990

Colonel Michael F. Thuss, USA
District Engineer, Mobile District
U. S. Army Corps of Engineers
Post Office Box 2288
Mobile, Alabama 36628-0001

Dear Colonel Thuss:

This letter constitutes a continuing expression of intent by the Jackson County Port Authority to act as Local Sponsor and cooperate with the Federal Government in constructing improvements to the Pascagoula Harbor deep draft navigation project within the modifications authorized by the Water Resources Development Act of 1986 (Public Law 99-662).

The Jackson County Port Authority is prepared to pay 25 percent of the costs of the general navigation features of the project during construction, as required under the provisions of Public Law 99-662. Also, the Port Authority will pay an additional 10 percent of the cost of the general navigation features of the project over a period not to exceed 30 years, with interest. It is understood, however, that the value of lands easements, rights-of-way, relocations, and dredged material disposal areas provided will be credited against the required 10 percent.

Additionally, the Jackson County Port Authority will provide all elements of local cooperation required, including all lands, easements, rights-of-way, relocations, and dredged material disposal areas necessary for the project. The authorization in Public Law 99-662 provides for future maintenance as continuation of present practice. As you know, we are presently working with our Congressional delegation to obtain financial relief on our costs for intensive management of the present upland disposal areas. If these discussions result in changes to our obligations for project maintenance under the current agreement, then we would expect the final Local Cooperation Agreement for the project improvements to be consistent with those changes.

Jackson County Port Authority
3033 Pascagoula Street P.O. Box 70
Pascagoula, Mississippi 39568-0070 (601) 762-4041

Prior to initiation of construction, the Jackson County Port Authority will enter into a binding agreement with appropriate representatives of the Corps of Engineers, which will address project construction, method of payment, and satisfy the requirements of Public Law 99-662 and any other pertinent acts.

Sincerely,

Paul Smith

PAUL W. SMITH
Port Director

mmt

Port Of Pascagoula

December 17, 1990

19 DEC 1990

Colonel Michael F. Thuss, USA
District Engineer, Mobile District
Department of the Army
Mobile District, Corps of Engineers
P. O. Box 2288
Mobile, Alabama 36628-0001

Dear Colonel Thuss:

Further to our letter of July 10, 1990 (copy attached) concerning the Port Authority's continuing expression of intent to act as Local Sponsor for constructing improvements to the Pascagoula Harbor deep draft navigation project, we wish to offer the following additional commitments.

The Port Authority agrees to be the Sponsor of Record for the portion of the project proposing restoration at the Grande Batture Islands. However, the port is not able to participate in cost-sharing, which will have to be funded from other sources.

Sincerely,

Paul Smith

PAUL W. SMITH
Port Director

Enclosure

mmt

Copy to: Mr. N. D. McClure, IV, Chief Planning Division
Mr. Walter Burdin, Project Manager, Coastal Section

Jackson County Port Authority
3033 Pascagoula Street P.O. Box 70
Pascagoula, Mississippi 39568-0070 (601) 762-4041

Port Of Pascagoula

August 13, 1991

Colonel Michael F. Thuss, USA
District Engineer, Mobile District
U. S. Army Corps of Engineers
Post Office Box 2288
Mobile, Alabama 36628-0001

Dear Colonel Thuss:

This letter constitutes a continuing expression of intent by the Jackson County Port Authority to act as Local Sponsor and cooperate with the Federal Government in constructing improvements to the Pascagoula Harbor Deep Draft Navigation Project, Phase I, within the modifications authorized by the Water Resources Development Act of 1986 (Public Law 99-662).

The Jackson County Port Authority is prepared to pay 25 percent of the costs of the general navigation features of Phase I of the Project during construction, as required under the provisions of Public Law 99-662. Also, the Port Authority will pay an additional 10 percent of the cost of the general navigation features of the project over a period not to exceed 30 years, with interest. It is understood, however, that the value of lands easements, rights-of-way, relocations, and dredged material disposal areas provided will be credited against the required 10 percent.

Additionally, the Jackson County Port Authority will provide all elements of local cooperation required, including all lands, easements, rights-of-way, relocations, and dredged material disposal areas necessary for the project. The authorization in Public Law 99-662 provides for future maintenance as continuation of present practice. As you know, we are presently working with our Congressional delegation to obtain financial relief on our costs for intensive management of the present upland disposal areas. If these discussions result in changes to our obligations for project maintenance under the current agreement, then we would expect the final Local Cooperation Agreement for the project improvements to be consistent with those changes.

Jackson County Port Authority
3033 Pascagoula Street P. O Box 70
Pascagoula, Mississippi 39568-0070 (601) 762-4041

August 13, 1991

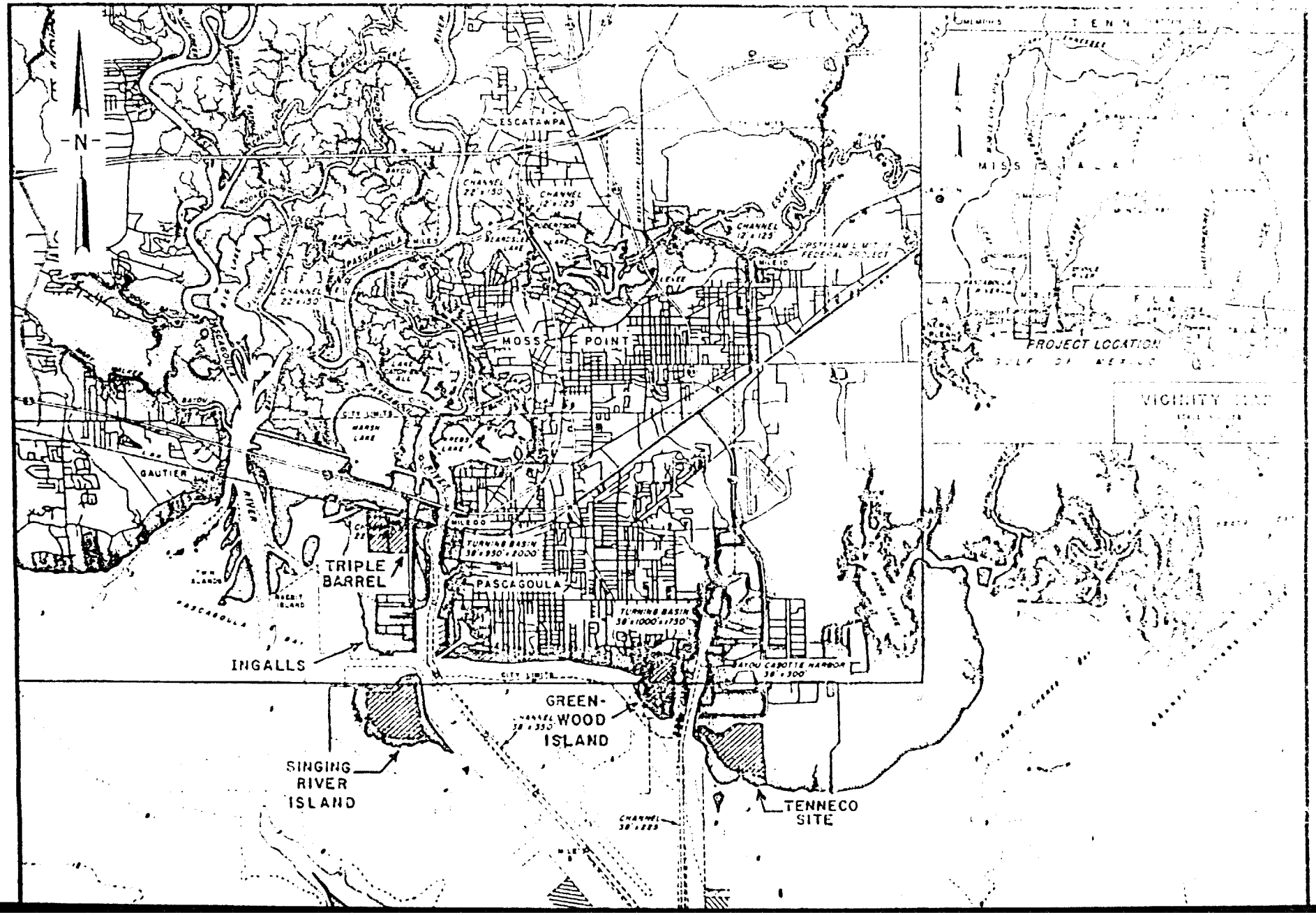
Prior to initiation of construction, the Jackson County Port Authority will enter into a binding agreement with appropriate representatives of the Corps of Engineers, which will address project construction, method of payment, and satisfy the requirements of Public Law 99-662 and any other pertinent acts.

Sincerely,

Fred S. Sherman
Executive Director

mmt

CORPS OF ENGINEERS



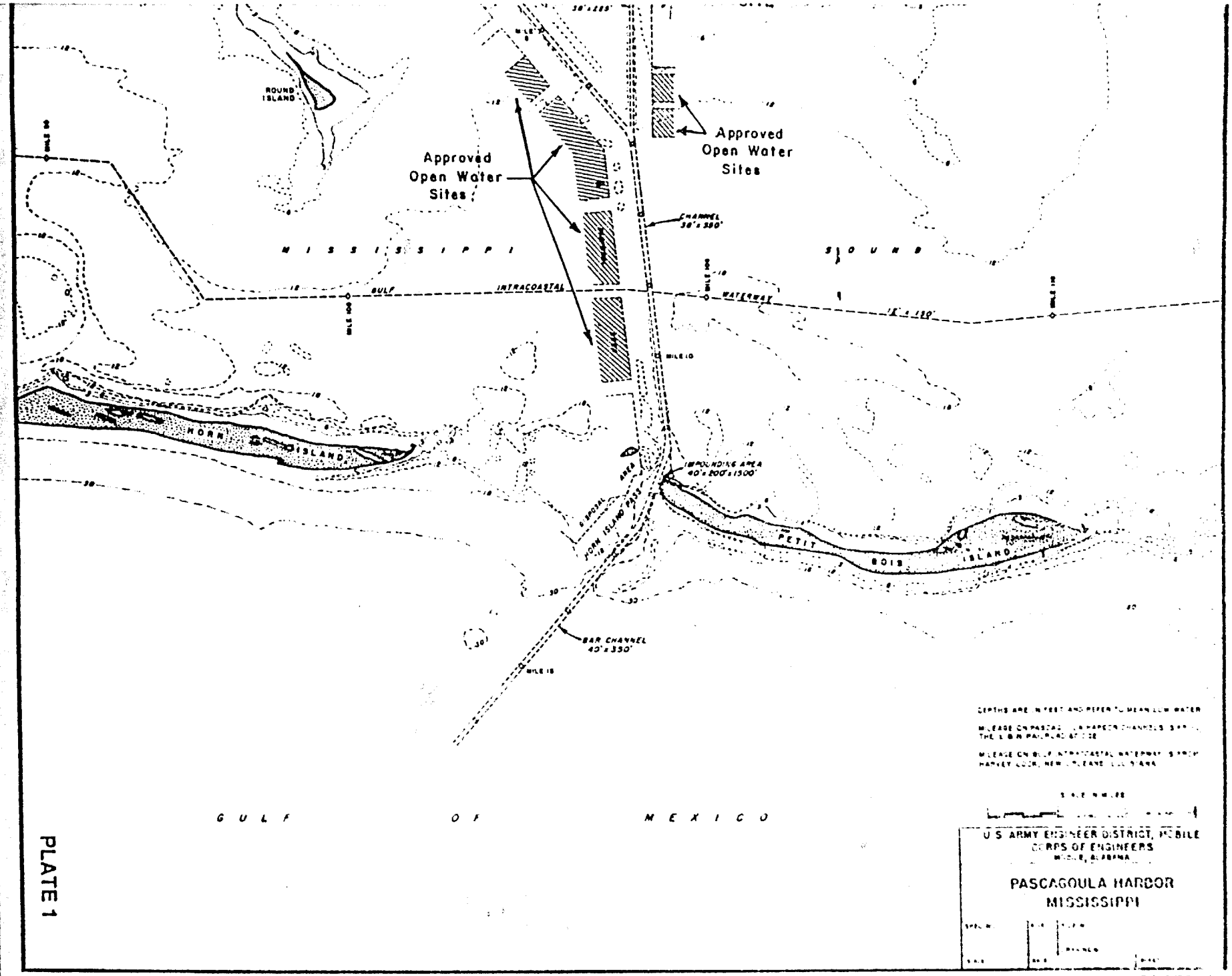
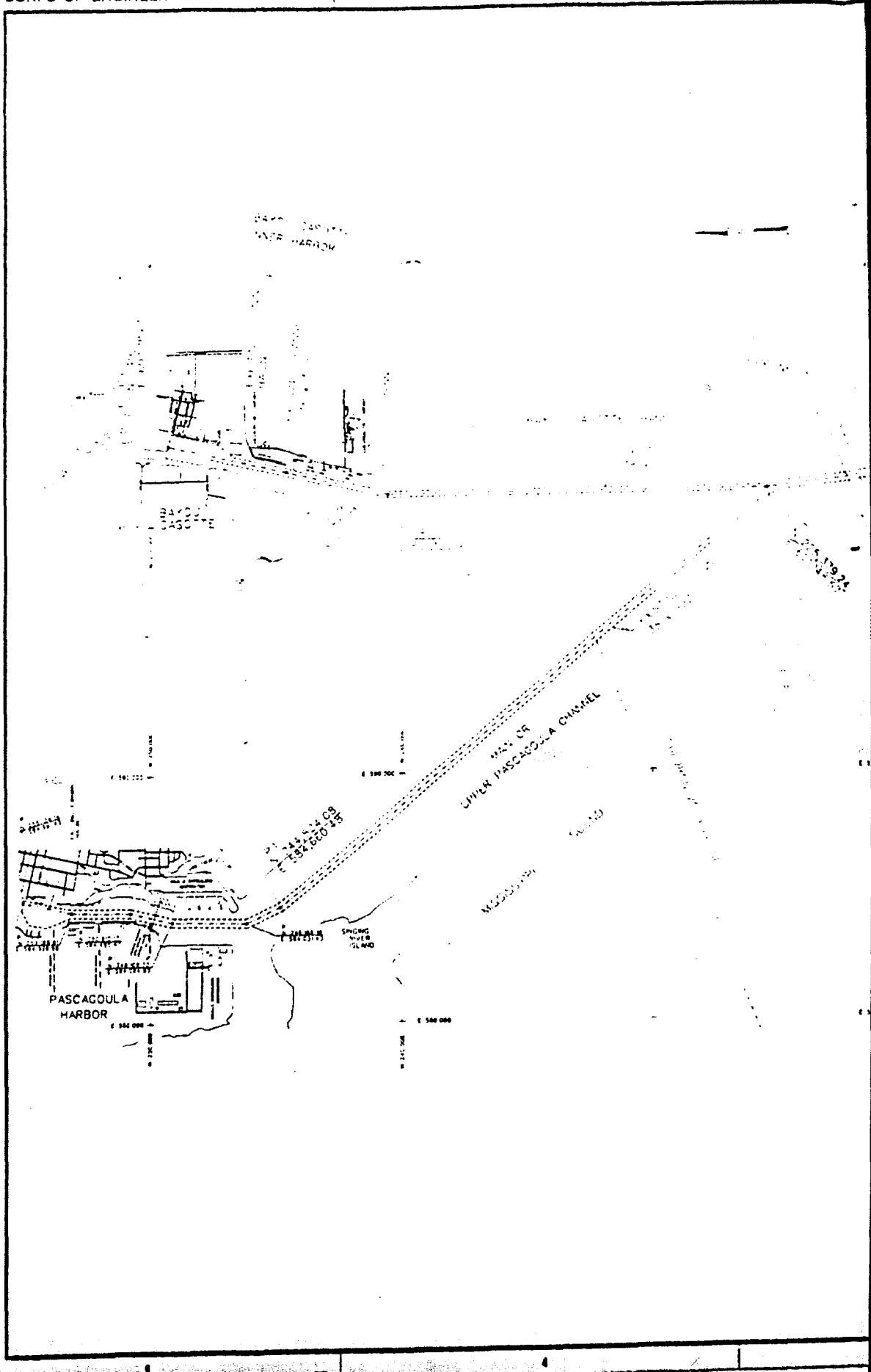
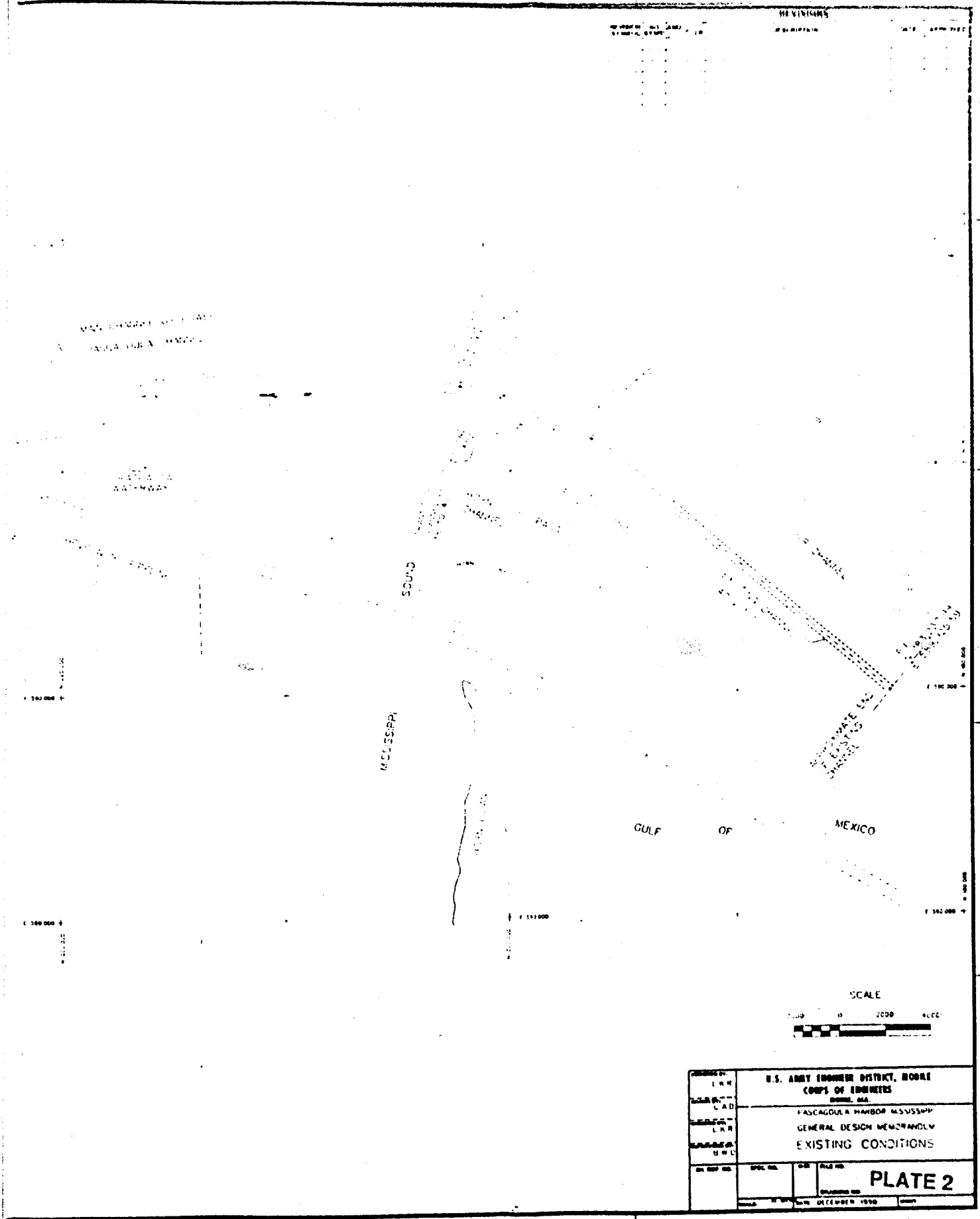

Approved
Open Water
Sites
Approved
Open Water
Sites
ROUND
ISLAND
MISSISSIPPI
SOUND
GULF
INTRACOASTAL
WATERWAY
CHANNEL
38' x 350'
MILE 10
MILE 15
MILE 20
HORN ISLAND
ANCHORAGE AREA
60' x 800' x 1300'
DISPOSAL
AREA
HORN ISLAND PASS
PETIT
BOIS
ISLAND
BAR CHANNEL
40' x 350'
GULF OF MEXICO
DEPTHS ARE IN FEET AND REFER TO MEAN LOW WATER
MILEAGE ON PASCAGOULA HARBOR CHANNELS SAME AS THE U.S.N. PASCAGOULA OFFICE
MILEAGE ON GULF INTRACOASTAL WATERWAY FROM HARVEY LOCK, NEW ORLEANS, LOUISIANA
STATUTE MILES
U.S. ARMY ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALABAMA
PASCAGOULA HARBOR
MISSISSIPPI
PLATE 1

PLATE 1


UPPER PASCAGOULA CHANNEL
PASCAGOULA
HARBOR

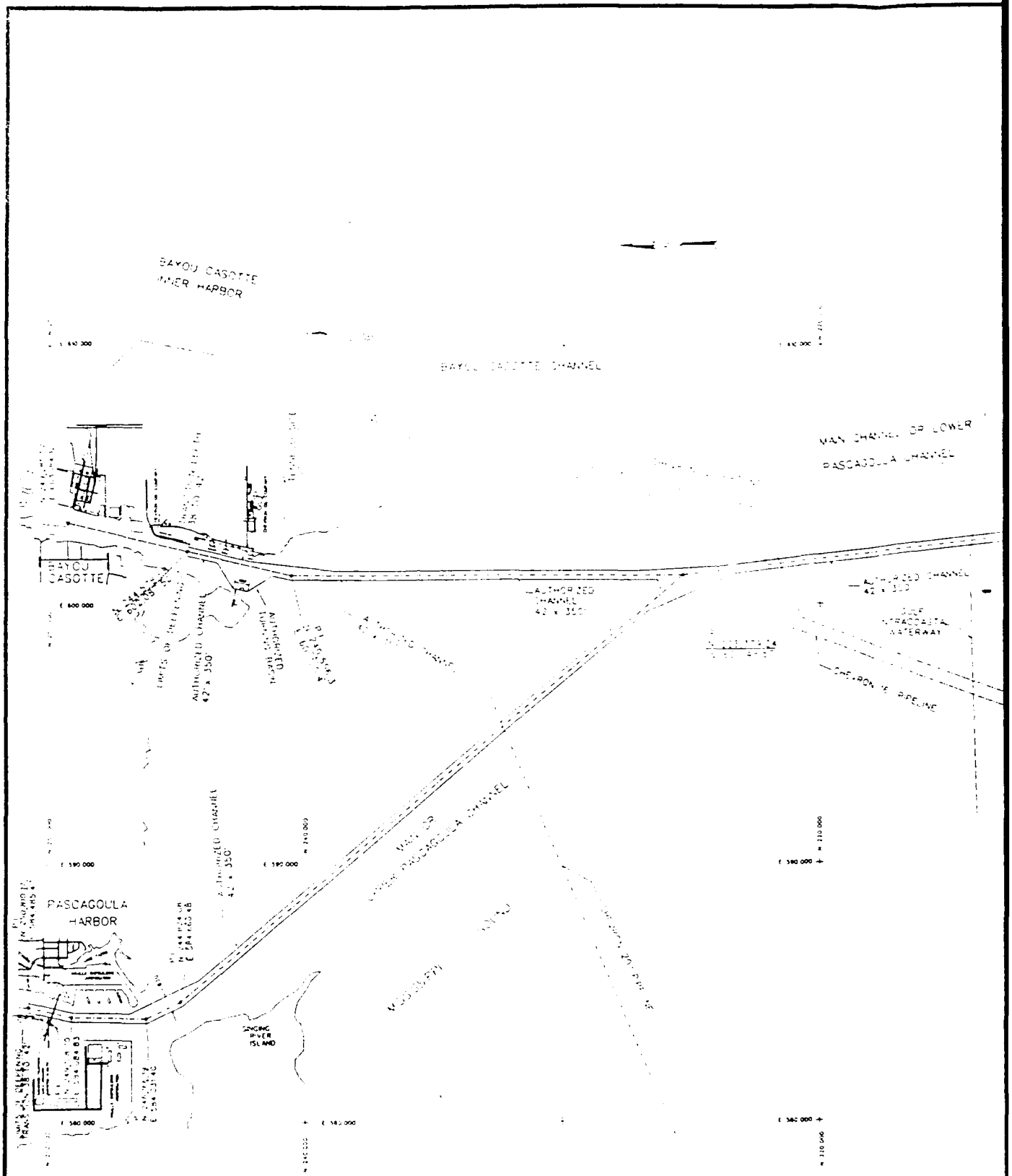


U.S. ARMY ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALA.

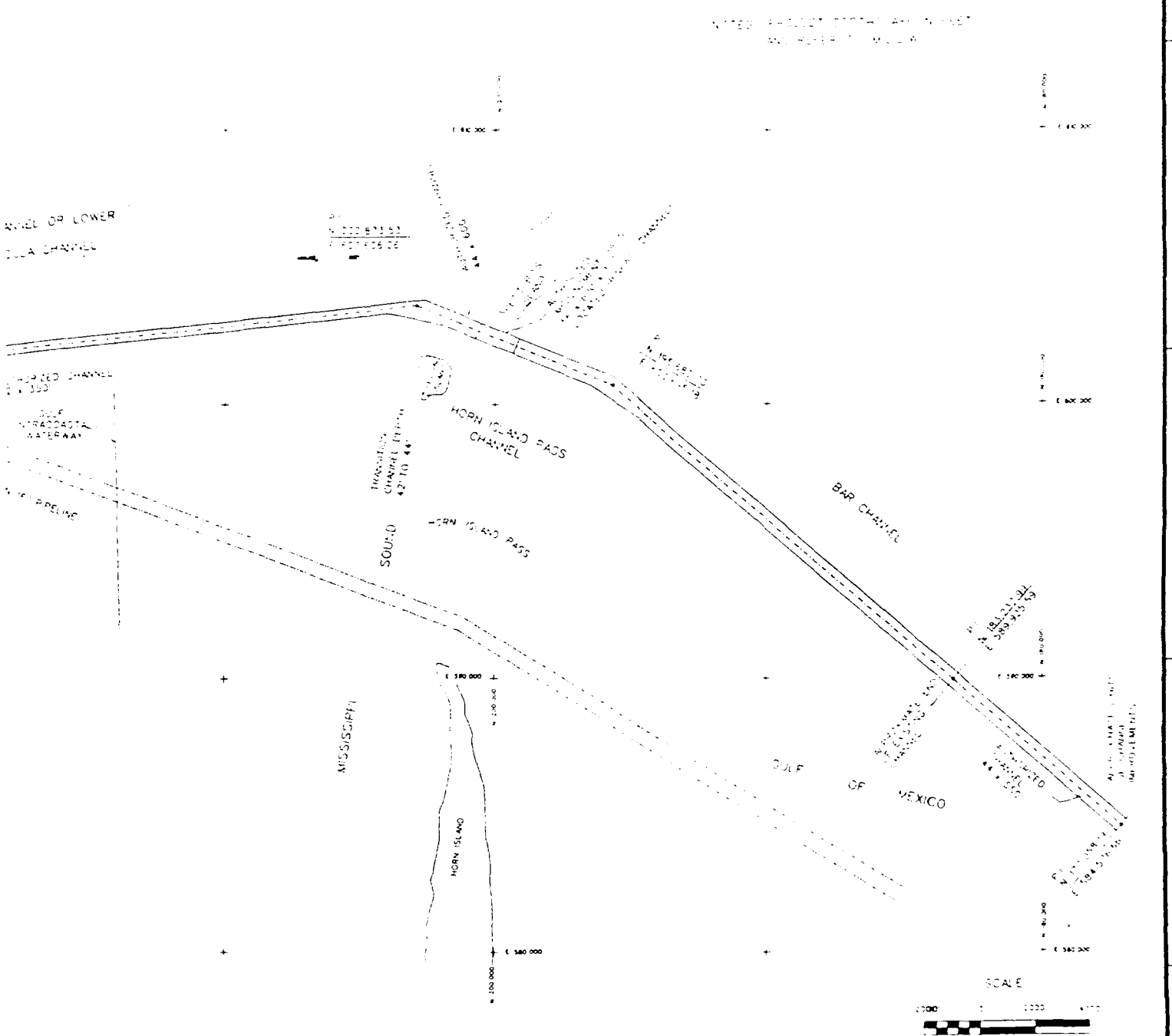
PASCAGOULA HARBOR MISSISSIPPI
GENERAL DESIGN MEMORANDUM
EXISTING CONDITIONS

PLATE 2

DECEMBER 1990


BAYOU CASOTTE
INNER HARBOR
BAYOU CASOTTE CHANNEL
MAIN CHANNEL OF LOWER
PASCAGOULA CHANNEL
BAYOU
CASOTTE
AUTHORIZED
CHANNEL
42' x 350'
AUTHORIZED CHANNEL
42' x 350'
PASCAGOULA
HARBOR
SINGING
RIVER
ISLAND
MAIN CH
LOWER PASCAGOULA CHANNEL
E 600 000
E 590 000
E 580 000
E 570 000
N 340 000
N 330 000

REVISIONS



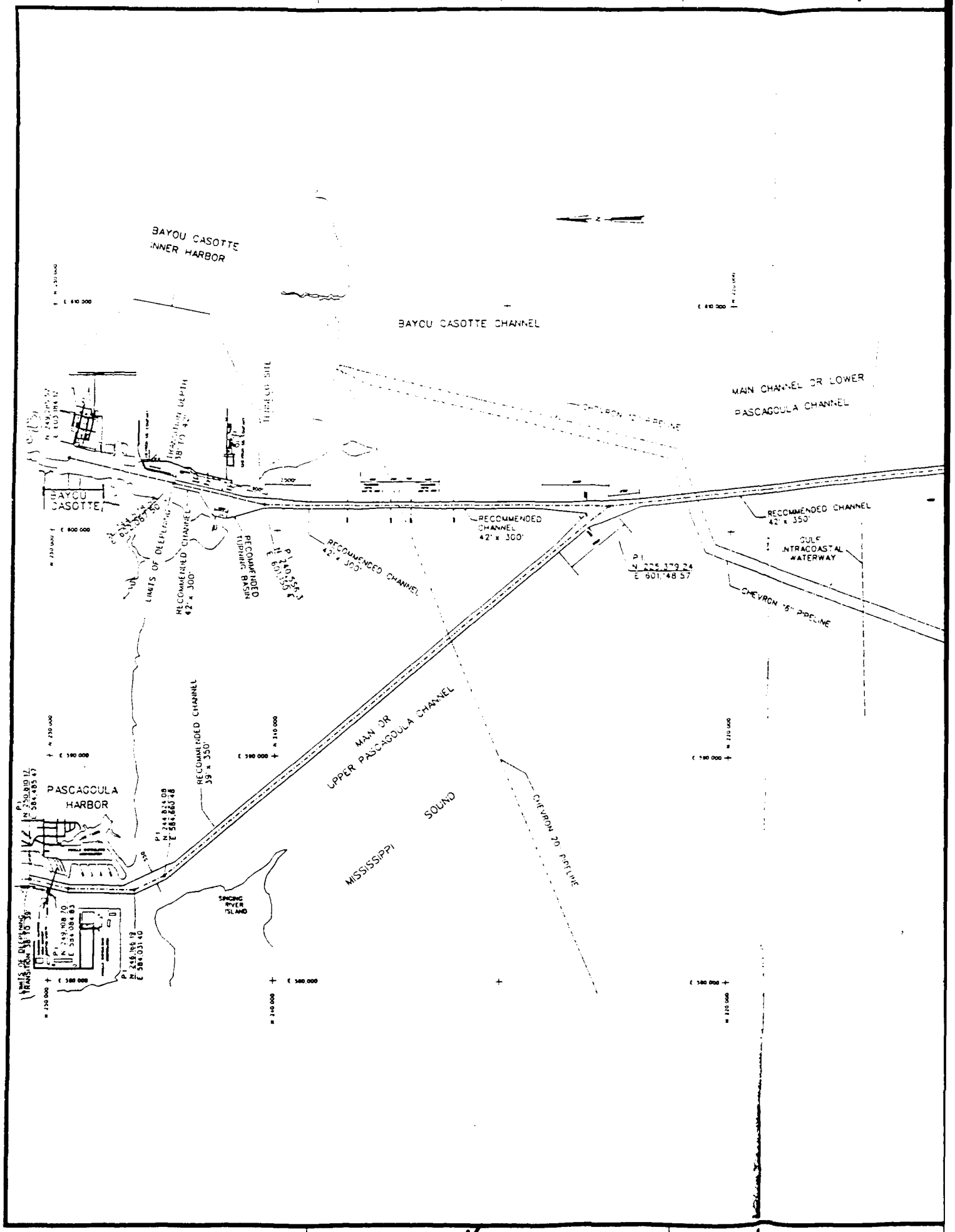
U.S. ARMY ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALA.

PASCAGOULA HARBOR, MISSISSIPPI
GENERAL DESIGN MEMORANDUM
AUTHORIZED PLAN

PLATE 3

DRAWN BY: L.K.H.
TRACED BY: S.A.D.
CHECKED BY: L.K.H.
SUPERVISED BY: D.W.O.

SPEC. NO. | DATE | FILE NO.
DRAWING NO.
SCALE AS SHOWN | DATE DECEMBER 1990 | SHEET


BAYOU CASOTTE
INNER HARBOR
BAYOU CASOTTE CHANNEL
MAIN CHANNEL OR LOWER
PASCAGOULA CHANNEL
CHEVRON 12" PIPELINE
BAYOU CASOTTE
LIMITS OF DEEPENING
RECOMMENDED CHANNEL
42' x 300'
RECOMMENDED BASIN
RECOMMENDED CHANNEL
42' x 350'
RECOMMENDED CHANNEL
42' x 300'
GULF INTRACOASTAL WATERWAY
CHEVRON "6" PIPELINE
RECOMMENDED CHANNEL
39' x 350'
MAIN OR
UPPER PASCAGOULA CHANNEL
PASCAGOULA
HARBOR
SOUND
MISSISSIPPI
CHEVRON 20" PIPELINE
SPICING
RIVER
ISLAND

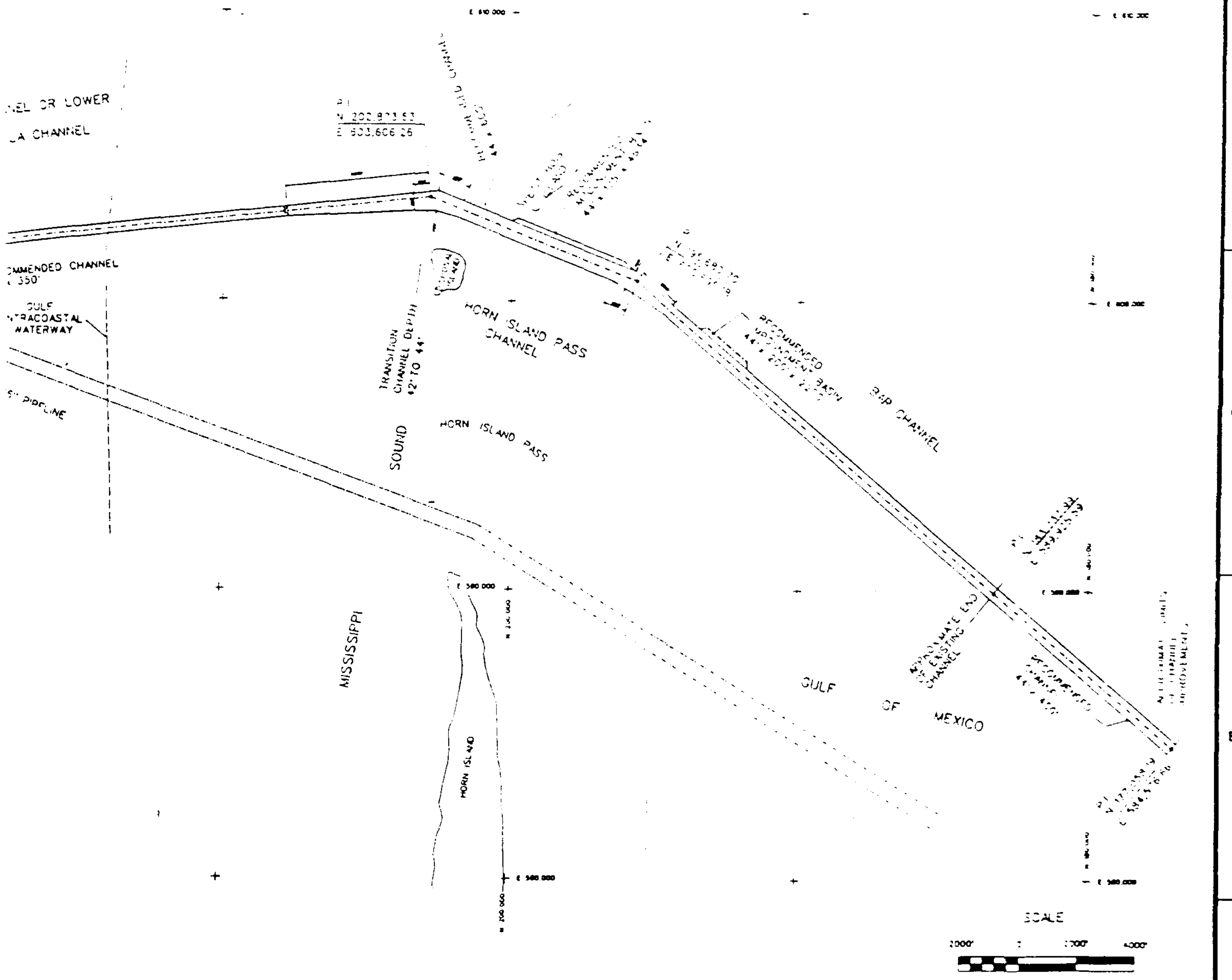
U. S. ARMY

REVISIONS

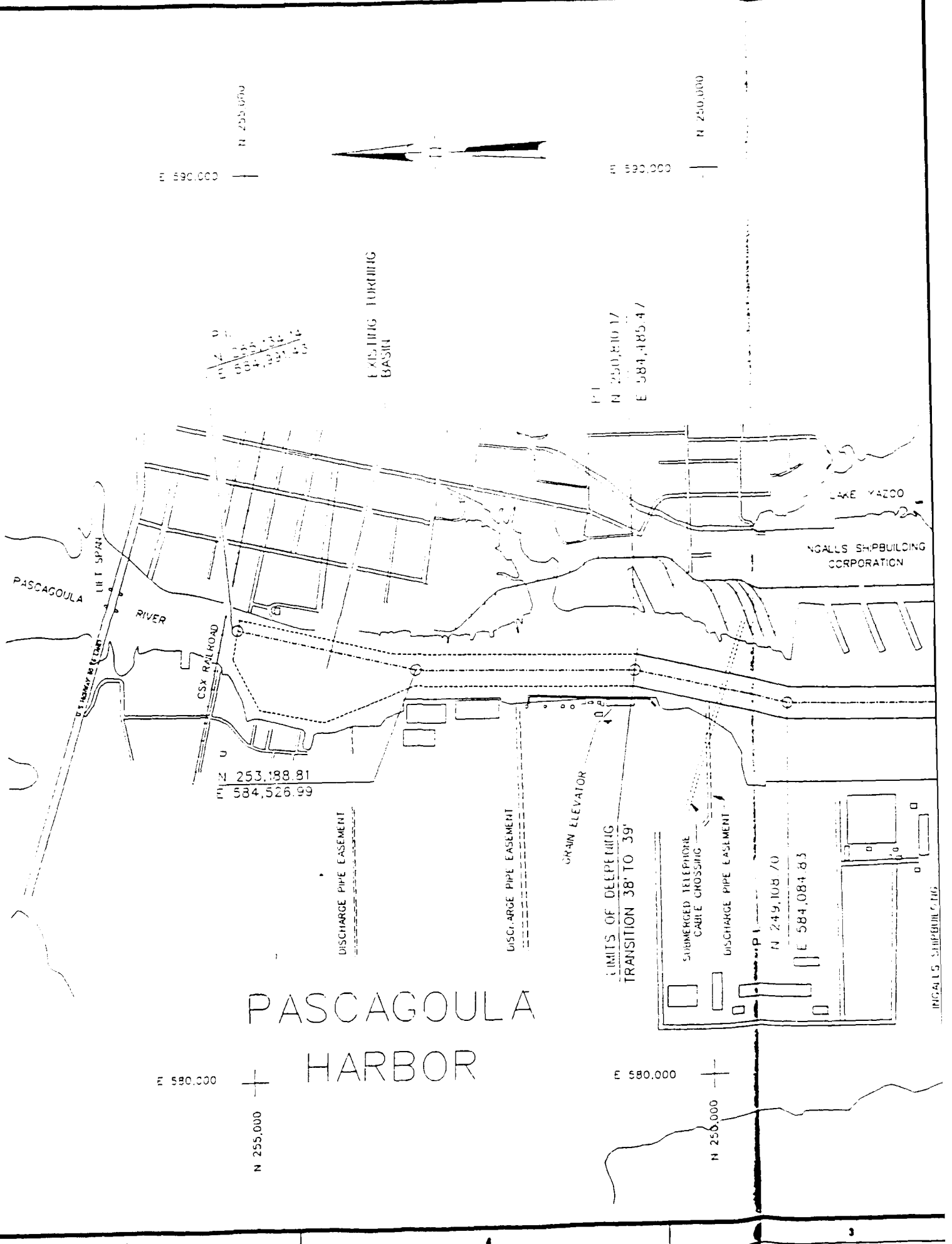
REVISION SYMBOL	NO. AND BY	DATE	DESCRIPTION	DATE	APPROVED

NOTES: SEE PLATE B4 FOR PASCAGOULA INNER HARBOR DETAIL
SEE PLATE B5 FOR BAYOU CASOTTE HARBOR DETAIL
SEE PLATE B6 FOR IWW INTERSECTION DETAIL
SEE PLATE B7 FOR HORN ISLAND PASS DETAIL
SEE PLATE B8 FOR TYPICAL SECTIONS

PROJECT DEPTHS ARE IN FEET AND REFER TO MLLW



DESIGNED BY: LKR	U.S. ARMY ENGINEER DISTRICT, MOBILE CORPS OF ENGINEERS MOBILE, ALA.
DRAWN BY: CAD	PASCAGOULA HARBOR, MISSISSIPPI
CHECKED BY: LKR	GENERAL DESIGN MEMORANDUM
SUBMITTED BY: HWO	RECOMMENDED PLAN
	PLATE 4
SCALE: AS SHOWN	DATE: DECEMBER 1990


N 255,000
E 580,000
N 250,000
E 580,000
EXISTING TURNING BASIN
N 250,810.17
E 584,485.47
LAKE YAZOO
INGALLS SHIPBUILDING CORPORATION
PASCAGOULA RIVER
LIFT SPAN
CSX RAILROAD
N 253,188.81
E 584,526.99
DISCHARGE PIPE EASEMENT
DISCHARGE PIPE EASEMENT
GRAIN ELEVATOR
LIMITS OF DEEPENING
TRANSITION 38' TO 39'
SUBMERGED TELEPHONE CABLE CROSSING
DISCHARGE PIPE EASEMENT
N 249,108.70
E 584,084.83
PASCAGOULA
HARBOR
E 580,000
N 255,000
E 580,000
N 250,000

U. S. ARMY

REVISIONS

SYMBOL	DESCRIPTION	DATE

LEGEND

EXISTING CHANNEL

RECOMMENDED CHANNEL

NOTES: SEE PLATE 88 FOR TYPICAL SECTIONS

PROJECT DEPTHS ARE IN FEET AND REFER TO M.L.L.W.

RECOMMENDED CHANNEL
38' x 350'

EXISTING CHANNEL
38' x 350'

P.I. N 244,824.00 E 584,660.42

550'

LAKE VACCO

INGALLS SHIPBUILDING CORPORATION

E 585,000

N 240,000

MISSISSIPPI SOUND

SINGING RIVER ISLAND

E 584,084.83

INGALLS SHIPBUILDING CORPORATION

P.I. N 246,166.19 E 584,031.40

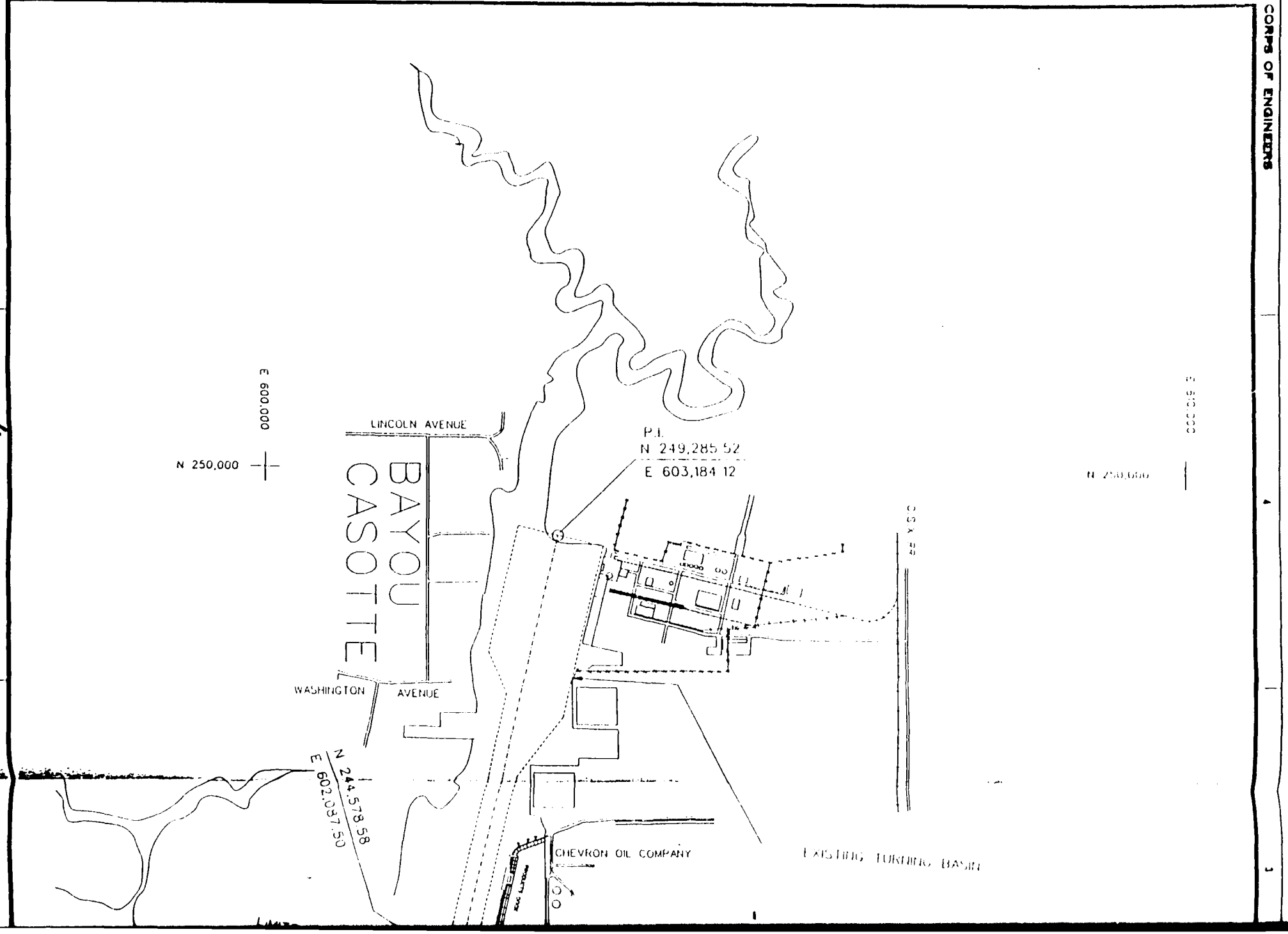
SCALE

500' 0 500' 1000'

E 580,000

N 245,000

DRAWN BY: L.K.R.	U.S. ARMY ENGINEER DISTRICT, MOBILE CORPS OF ENGINEERS MOBILE, ALA.
TRACED BY: C.A.D.	PASCAGOULA HARBOR, MISSISSIPPI
CHECKED BY: L.K.R.	GENERAL DESIGN MEMORANDUM
SUBMITTED BY: B.W.O.	PASCAGOULA HARBOR DETAIL
APPROVED BY:	PLATE 5
	DATE: DECEMBER 1990


E 600,000
N 250,000
LINCOLN AVENUE
BAYOU CASOTTE
WASHINGTON AVENUE
P.I.
N 249,285.52
E 603,184.12
N 244,578.58
E 602,087.50
CHEVRON OIL COMPANY
EXISTING TURNING BASIN
CORPS OF ENGINEERS

REVISIONS

SYMBOL	DESCRIPTION	DATE	APPROVED

E 610,000

N 240,000

LEGEND

EXISTING CHANNEL

RECOMMENDED CHANNEL

NOTES SEE PLATE 88 FOR TYPICAL SECTIONS

PROJECT DEPTHS ARE IN FEET AND REFER TO MLLW

EXISTING TURNING BASIN

CHEVRON OIL COMPANY

TRANSITION DEPTH 38' TO 42'

CHEVRON OIL COMPANY

N 242,194.82
E 601,686.32

N 240,556.6
E 601,150.4

N 239,836.88
E 601,300.19

1717'

EXISTING CHANNEL
38' X 225'

578.58
087.50

LIMITS OF DEEPENING

RECOMMENDED CHANNEL
42' x 300'

EXISTING CHANNEL
38' x 300'

N 243,463.60
E 601,673.72

600'

1150'

RECOMMENDED CHANNEL
42' x 300'

RECOMMENDED TURNING BASIN

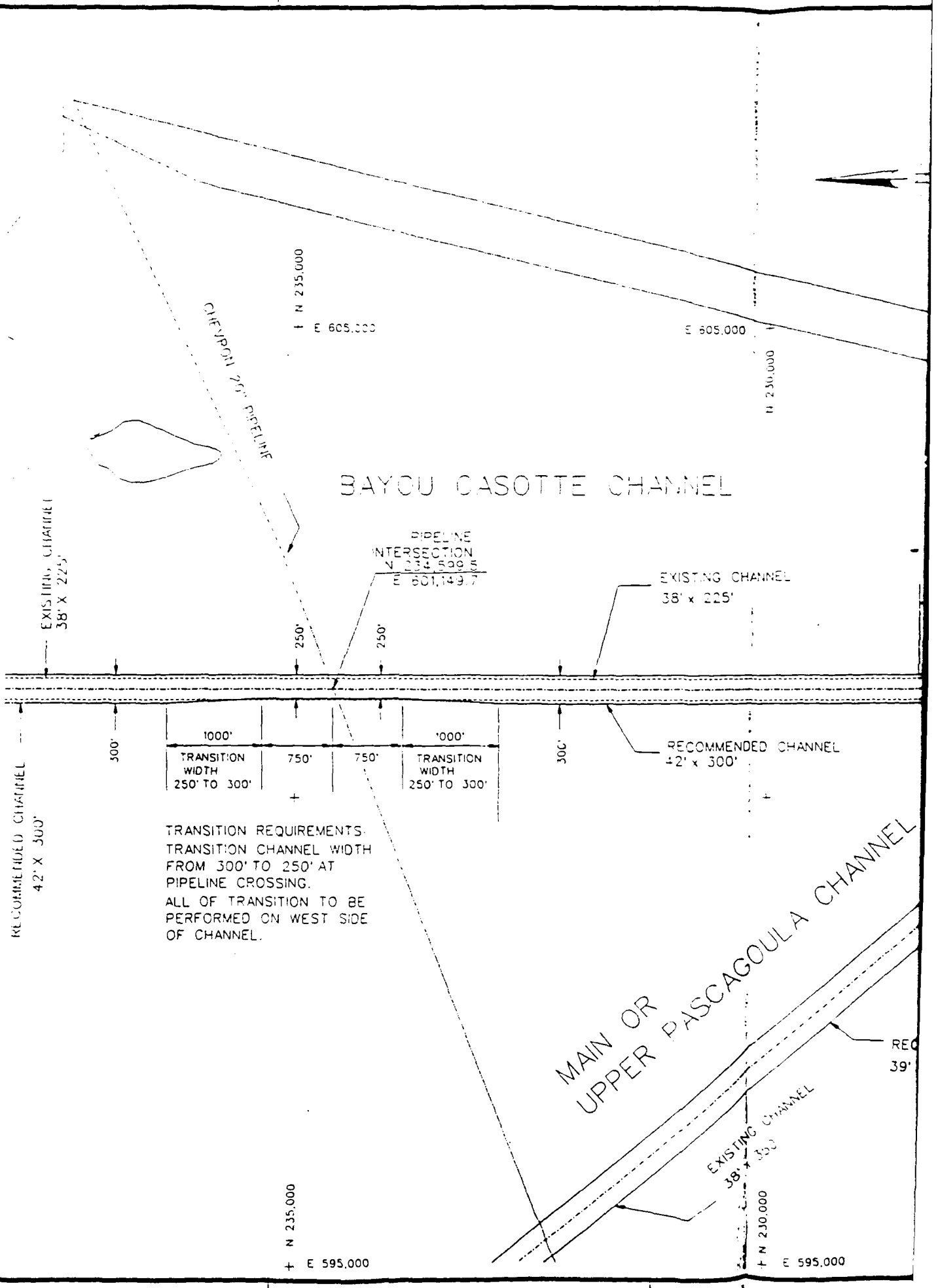
E 600,000

N 240,000

SCALE

500' 0 500' 1000'

DESIGNED BY: L.K.R.	U.S. ARMY ENGINEER DISTRICT, MOBILE CORPS OF ENGINEERS MOBILE, ALA.
DRAWN BY: L.A.D.	PASCAGOULA HARBOR, MISSISSIPPI
CHECKED BY: L.K.R.	GENERAL DESIGN MEMORANDUM
SUBMITTED BY: B.W.O.	BAYOU CASOTTE INNER HARBOR DETAIL
SUBM. APPD. BY:	SPEC. NO. / DATE / FILE NO. / DRAWING NO. PLATE6
SCALE: AS SHOWN	DATE: DECEMBER 1990 / SHEET


+ N 235,000
+ E 605,000
E 605,000
N 230,000
CHEVRON 20" PIPELINE
BAYOU CASOTTE CHANNEL
PIPELINE INTERSECTION
N 234,500.5
E 601,149.7
EXISTING CHANNEL
38' x 225'
250'
250'
EXISTING CHANNEL
38' x 225'
RECOMMENDED CHANNEL
42' x 300'
300'
1000'
TRANSITION WIDTH 250' TO 300'
750'
750'
1000'
TRANSITION WIDTH 250' TO 300'
300'
RECOMMENDED CHANNEL
42' x 300'
TRANSITION REQUIREMENTS:
TRANSITION CHANNEL WIDTH FROM 300' TO 250' AT PIPELINE CROSSING.
ALL OF TRANSITION TO BE PERFORMED ON WEST SIDE OF CHANNEL.
MAIN OR UPPER PASCAGOULA CHANNEL
REC
39'
EXISTING CHANNEL
38' x 350'
+ N 235,000
+ E 595,000
+ N 230,000
+ E 595,000

U. S. ARMY

REVISIONS

DESCRIPTION	DATE	APPROVED

LEGEND

---------- EXISTING CHANNEL

———— RECOMMENDED CHANNEL

N

NOTES SEE PLATE 88 FOR TYPICAL SECTIONS

PROJECT DEPTHS ARE IN FEET AND REFER TO M.L.L.W.

CHEVRON 12" PIPELINE

PIPELINE INTERSECTION
N 221,649.99
E 601,666.74

PI
N 225,377.04
E 601,149.57

MAIN CHANNEL
LOWER PASCAGOULA

EXISTING CHANNEL
38' X 350'

3000'

1370'

550'

CHANNEL

CHANNEL

RECOMMENDED CHANNEL
42' X 350'

PIPELINE INTERSECTION
N 222,052.55
E 601,511.86

CHEVRON 16" PIPELINE

N 220,000
E 600,000

500'
3000'

SCALE
500' 0 500' 1000'

RECOMMENDED CHANNEL
39' X 350'

N 225,000

E 595,000

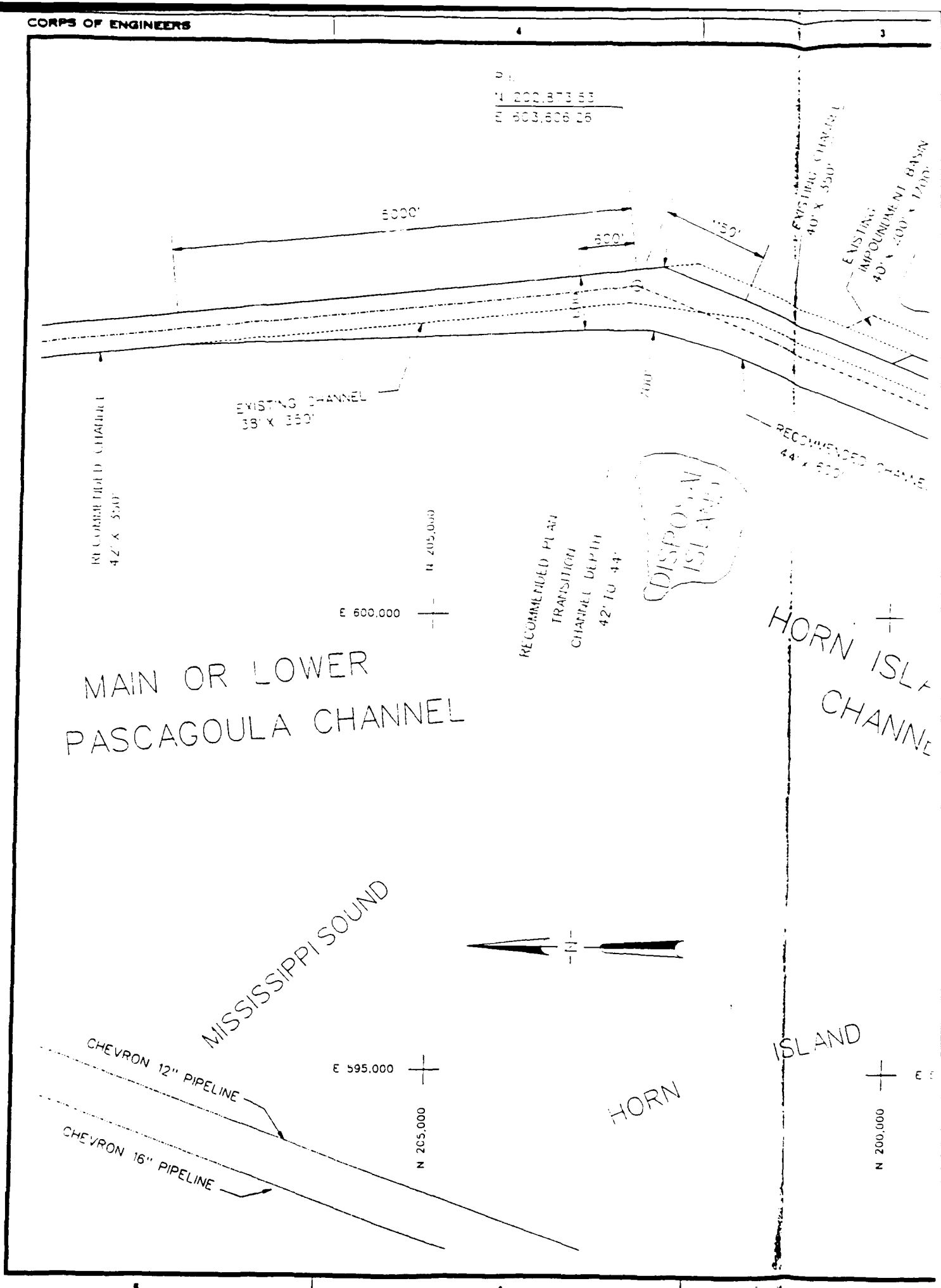
+ E 595,000

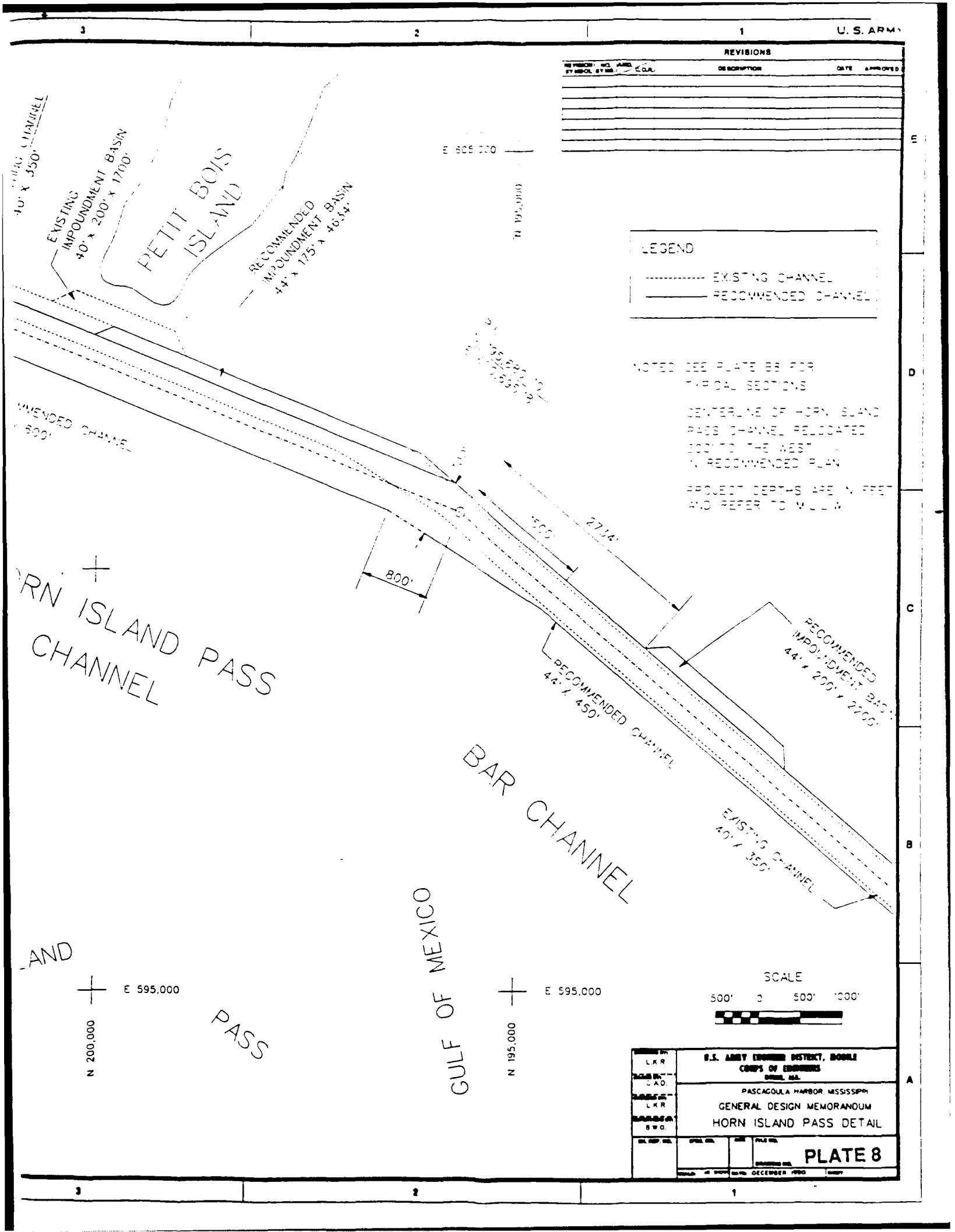
U.S. ARMY ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALA.

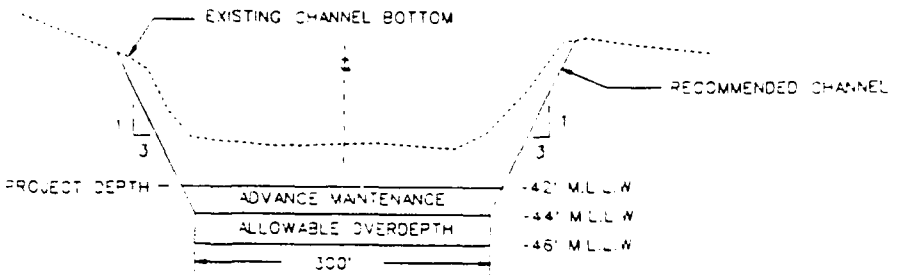
PASCAGOULA HARBOR, MISSISSIPPI
GENERAL DESIGN MEMORANDUM
BAYOU CASOTTE CHANNEL
AND "Y" DETAIL

PLATE 7

DECEMBER 1980

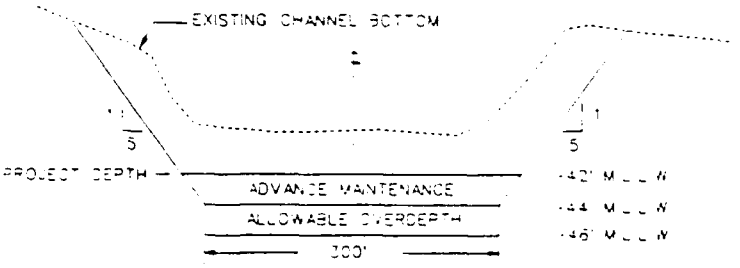

N 202,873.53
E 603,606.26
5000'
350'
EXISTING CHANNEL
38' X 350'
RECOMMENDED CHANNEL
42' X 350'
EXISTING CHANNEL
40' X 350'
EXISTING
IMPOUNDMENT BASIN
RECOMMENDED CHANNEL
44' X 350'
RECOMMENDED PLAN
TRANSITION
CHANNEL DEPTH
42' TO 44'
E 600,000
N 205,000
MAIN OR LOWER
PASCAGOULA CHANNEL
HORN ISLAND
CHANNEL
MISSISSIPPI SOUND
E 595,000
N 205,000
HORN ISLAND
N 200,000
CHEVRON 12" PIPELINE
CHEVRON 16" PIPELINE


REVISIONS
DESCRIPTION
DATE
APPROVED
EXISTING CHANNEL
40' x 350'
EXISTING IMPOUNDMENT BASIN
40' x 200' x 1700'
PETIT BOIS ISLAND
RECOMMENDED IMPOUNDMENT BASIN
44' x 175' x 46.54'
E 605,000
N 195,000
LEGEND
EXISTING CHANNEL
RECOMMENDED CHANNEL
NOTES: SEE PLATE 88 FOR TYPICAL SECTIONS
CENTERLINE OF HORN ISLAND PASS CHANNEL RELOCATED 200' TO THE WEST OF RECOMMENDED PLAN
PROJECT DEPTHS ARE IN FEET AND REFER TO MLLW
AMENDED CHANNEL
' 600'
800'
500'
2714'
HORN ISLAND PASS CHANNEL
RECOMMENDED IMPOUNDMENT BASIN
44' x 200' x 2200'
RECOMMENDED CHANNEL
44' x 450'
BAR CHANNEL
EXISTING CHANNEL
40' x 350'
AND
E 595,000
N 200,000
PASS
GULF OF MEXICO
E 595,000
N 195,000
SCALE
500' 0 500' 1000'
U.S. ARMY ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALA.
PASCAGOULA HARBOR, MISSISSIPPI
GENERAL DESIGN MEMORANDUM
HORN ISLAND PASS DETAIL
PLATE 8
DECEMBER 1980
L K R
C A O
L K R
B W O



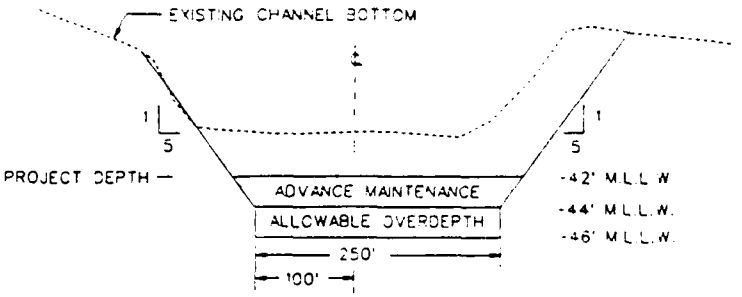
TYPICAL SECTION

BAYOU CASOTTE INNER HARBOR
NOT TO SCALE



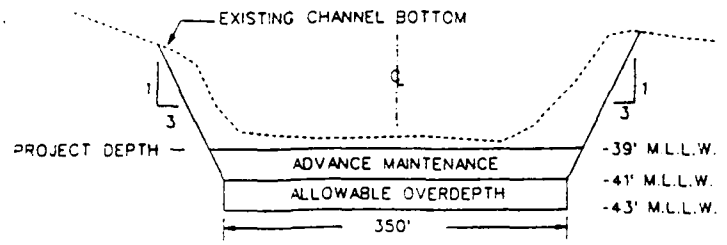
TYPICAL SECTION

BAYOU CASOTTE CHANNEL
NOT TO SCALE



TYPICAL SECTION

BAYOU CASOTTE CHANNEL
AT PIPELINE CROSSING
NOT TO SCALE

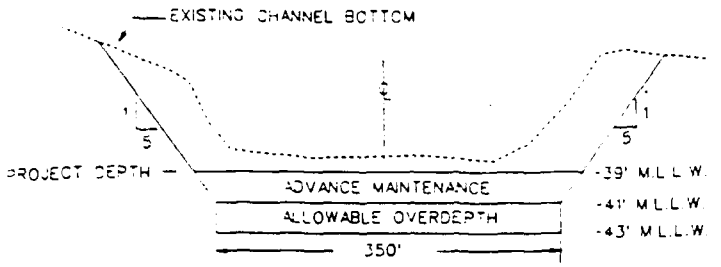


TYPICAL SECTION

PASCAGOULA INNER HARBOR CHANNEL
NOT TO SCALE

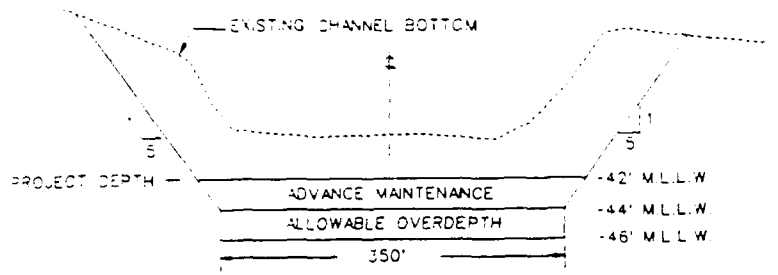
U. S. ARMY

REVISIONS			
BY	NO.	DESCRIPTION	DATE

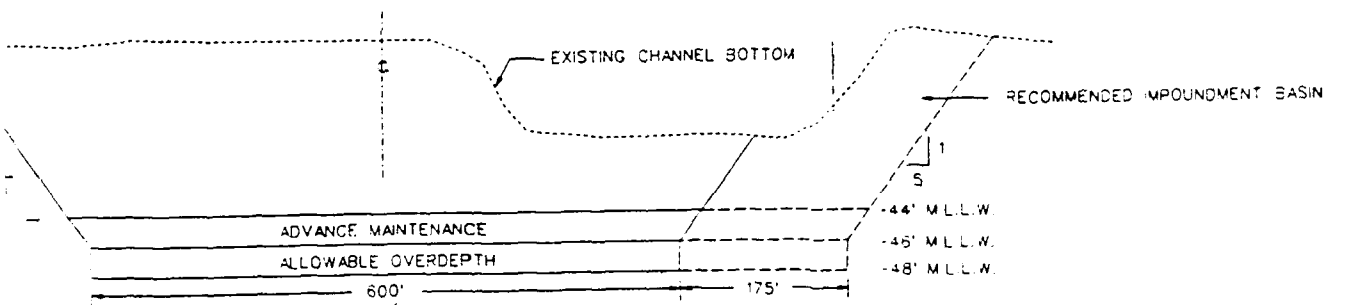


TYPICAL SECTION
UPPER PASCAGOULA CHANNEL
NOT TO SCALE

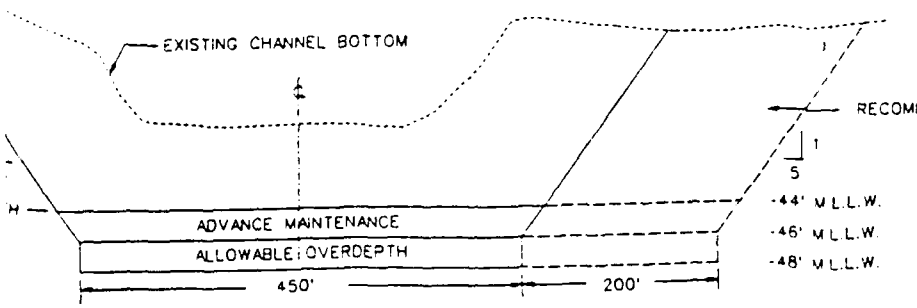
NOTES: ALL SECTIONS
FACING INBOUND
DEPTHS ARE IN FEET
AND REFER TO
MEAN LOWER LOW WATER (M.L.L.W.)



TYPICAL SECTION
LOWER PASCAGOULA CHANNEL
NOT TO SCALE



TYPICAL SECTION
HORN ISLAND PASS CHANNEL
NOT TO SCALE



TYPICAL SECTION
BAR CHANNEL
NOT TO SCALE

L.K.R.	U.S. ARMY ENGINEER DISTRICT, MOBILE CORPS OF ENGINEERS MOBILE, ALA.
C.A.D.	PASCAGOULA HARBOR, MISSISSIPPI
L.K.R.	GENERAL DESIGN MEMORANDUM
B.W.O.	TYPICAL SECTIONS
	PLATE 9
	DECEMBER 1980