FLOOD CONTROL, MISSISSIPPI RIVER & TRIBUTARIES

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

US Army Corps Of Engineers
Vicksburg, Memphis and
New Orleans Districts

CAPE GIRARDEAU, MISSOURI TO HEAD OF PASSES, LA

FINAL

JULY 1998

VOLUME I:

PROJECT REPORT

SUPPLEMENT NO: 1 TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT MISSISSIPPI RIVER AND TRIBUTARIES PROJECT MISSISSIPPI RIVER LEVEES AND CHANNEL IMPROVEMENT

APPENDICES 1-4

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT
AND SEEPAGE CONTROL

SUPPLEMENT NO. 1 TO THE
FINAL ENVIRONMENTAL IMPACT STATEMENT
MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER LEVEES AND CHANNEL IMPROVEMENT

TABLE OF CONTENTS

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL

PROJECT REPORT
JULY 1998

U.S. ARMY CORPS OF ENGINEERS
VICKSBURG DISTRICT
VICKSBURG, MISSISSIPPI

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
RECOMMENDED PLAN
PERTINENT DATA SUMMARY

Item	Description
Recommended Plan	Plan 4--Environmental Design (Avoid and Minimize)
Level of Protection	Project Design Flood
Cost	$656 million first cost; $911 million fully funded
Construction Items	128
Levee Enlargement	263 miles
Seepage Control Items	131.5 miles (berms, relief wells, slurry trench cutoffs)
Environmental Design Project Features	Relocating borrow areas to less environmentally sensitive locations
	Draining and reforesting selected borrow areas
	Incorporating aquatic features into remaining borrow areas
	Using relief wells or slurry trench cutoffs in lieu of berms (where practicable)
	Enlarging berms with dredged material (where feasible)
Bottom-Land Hardwood Wetlands and Nonwetlands Affected	Approximately 4,800 acres (less than one-half of 1 percent of total project area bottom-land hardwoods)
Mitigation Lands	Approximately 5,900 cleared acres reforested

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL

PROJECT REPORT

Table of Contents

Table of Contents (Cont)

Table of Contents (Cont)

Table of Contents (Cont)

LIST OF TABLES

LIST OF FIGURES

Table of Contents (Cont)

LIST OF APPENDIXES

Table of Contents (Cont)

LIST OF APPENDIXES (Cont)

a/ Also includes Project Report and Environmental Impact Statement Supplement.

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL

PROJECT REPORT

STUDY AUTHORITY

1. The Mississippi River Mainline Levees Enlargement and Seepage Control Project Report and Supplemental Environmental Impact Statement (SEIS) to the Mississippi River and Tributaries (MR&T) Mississippi River Levees and Channel Improvements EIS of 1976 is a joint effort of the U.S. Army Corps of Engineers, Memphis, New Orleans, and Vicksburg Districts, conducted with the oversight of the Mississippi River Commission. Vicksburg was designated as the lead District in the conduct of the studies.

2. The comprehensive MR&T Project has four major elements--levees and floodwalls to contain floodflows; floodways to pass excess flows past critical Mississippi River reaches; channel improvement and stabilization to provide efficient navigation alignment, increased flood-carrying capacity, and protection of the levee system; and tributary basin improvements. Project authority is the Flood Control Act of 1928, as amended, including, but not limited to, the Flood Control Acts of 1936, 1938, 1941, 1946, 1950, 1954, 1962, 1965, and 1968 and the Water Resources Development Act of 1986. The Mississippi River Levees (MRL) feature--the subject of these investigations--has been under construction since 1928 and the engineering and construction capability exists to complete the project in the year 2020.

3. The MR&T Mississippi River Levees and Channel Improvement EIS was filed with the Council on Environmental Quality in April 1976. Based on additional environmental laws and regulations enacted since 1976, information from other Federal agencies, and litigation by private environmental groups, the decision was made to supplement the 1976 Final EIS to cover construction of all remaining Mississippi River mainline levees and seepage control.

STUDY PURPOSE AND SCOPE

4. This report discusses the findings of studies conducted for the SEIS for the MR&T Mississippi River Mainline Levees Enlargement and Seepage Control.

5. The MR&T Project in the alluvial valley between Cape Girardeau, Missouri, and Head of Passes, Louisiana, provides protection from floods by means of levees, floodwalls, floodways, reservoirs (in Yazoo and St. Francis Basins), bank stabilization, and channel improvements in and along the river and its tributaries and outlets insofar as affected by backwater of the Mississippi River. When completed, 35,000 square miles will be protected from the Mississippi River project design flood (PDF).

6. The overall document is comprised of a Project Report, an SEIS, and supporting documentation. The Project Report consists of problem identification, plan formulation, impact assessment, evaluation of alternatives, a mitigation plan, and recommendations. The SEIS discusses anticipated impacts of the proposed work. The supporting documentation includes 17 technical appendixes. The report has been prepared in general accordance with Engineer Regulation 1105-2-100, "Guidance for Conducting Civil Works Planning Studies," (28 December 1990), including the Economic and Environmental Principles for Water and Related Land Resources Implementation Studies (3 February 1983), and the Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies (10 March 1983), commonly referred to as the Principles and Guidelines.

7. Levee construction to protect the Lower Mississippi Valley began along the Mississippi River in the 1700's, and a line of protection was established by 1844. However, numerous flood events crevassed portions of the system on various occasions and raising and strengthening of the system continued into the 1920's. In response to the devastating flood of 1927, Congress passed the Flood Control Act of 15 May 1928 (House Document [HD] 90/70/1) authorizing the MR&T Project. This Act was later modified and amended in subsequent Acts. The authorizing legislation is summarized in Table 1.

8. Mississippi River mainline levees were first constructed by settlers at New Orleans in the early 1700's. By 1735, the levees on both sides of the river extended from about 30 miles above New Orleans to about 12 miles below the city. By 1844, in spite of several damaging floods, the levee system was continuous, except for a gap at Old River from 20 miles below New Orleans to the mouth of the Arkansas River on the west bank and to Baton Rouge on the east bank. Federal construction of the Mississippi River mainline levees began in earnest shortly after passage of the Flood Control Act of 1928 and has continued ever since. The MR&T project is designed to contain the MR&T PDF in the lower Mississippi River valley. The PDF is a hypothetical flood that was developed in the mid-1950's by a joint study effort between the Mississippi River Commission and the National Weather Service which analyzed several combinations of storm patterns over the Mississippi River drainage basin to determine the design flood to be used in designing the MR&T levee system in the lower Mississippi River Basin. The flood selected was designated the 58A-EN PDF and was defined as ". . . the greatest flood having a reasonable probability of occurrence." The effects of existing, as well as proposed, reservoirs within the total drainage basin were considered in developing the design flood. The Mississippi River mainline levees protect the lower Mississippi River valley against the PDF by confining flow to the leveed channel, except where it enters backwater areas, overflows several levees designed to overtop and fill tributary basins, or is diverted purposely into four project floodway areas. The mainline levee system, comprised of levees, floodwalls, and various control structures, is approximately 1,610 miles long.

TABLE 1
AUTHORIZATION DOCUMENTS

Document	Summary
Flood Control Act of 1928 (Public Law 391-71) (House Document [HD] 90/70/1 and Committee Document [CD] 28/70/2)	Authorizes the raising and strengthening of levees above Bonnet Carre, LA, so as to provide--in connection with the Bonnet Carre Spillway, the Birds Pt.-New Madrid Floodway, Boeuf Basin, and Atchafalaya Basin Floodways, levees on the south bank of the Arkansas and Red River, and an increase in the carrying capacity of the Mississippi River--protection to all lands in the delta against the greatest flood predicted as possible. Below Bonnet Carre the levees would be strengthened but not raised above the existing grade. Local interests are to give assurances that they will provide minor maintenance of all flood control works after their completion, except controlling and regulating spillway structures, including special relief levees; and provide without cost to the United States all rights-of-way for levee foundations and levees on the Main Stem of the Mississippi River between Cape Girardeau and the Head of Passes. Minor maintenance is defined as cutting grass, removal of weeds, local drainage, and minor repairs of main river levees.
Flood Control Act of 1936 (Public Laws 678-74 and 738-74) (CD 1/74/1)	Authorizes the raising and enlarging of the levee between the head of the Atchafalaya River and the Head of the Morganza Floodway. Authorizes the United States to reimburse responsible local agencies for the costs of land acquired for levee foundations. Authorizes construction of access roads to and on levees for inspection and maintenance. Authorizes the Tiptonville-Obion Levee.

TABLE 1 (Cont)

Document	Summary
Flood Control Act of 1938 (Public Law 671-75) (CD 1/75/1)	Authorizes construction of a levee upstream from Cairo along the Ohio to high ground and the diversion of the Cache River into the Mississippi. Authorizes construction of measures to correct underseepage and wavewash and an extension of the levee roadway system.
Flood Control Act of 1941 (Public Law 228-77) (HD 359/77/1)	Specifies that the east bank Mississippi River Levees in the Yazoo Basin south of the Coahoma-Bolivar County line shall have 3 feet freeboard over the project flood. Specifies that the grades of the Yazoo and Red River Backwater levees shall be such that their construction will not jeopardize the safety and integrity of the main Mississippi River Levees. Section 3(g) removes all restrictions as to the cost of the Mississippi River Levee project and provides flexibility in the use of authorized appropriations. Separates maintenance requirements from construction and provides that future maintenance expenditures shall not reduce authorization. Provides that the cost of rights-of-way and flowage easements required for future setbacks of main line Mississippi River Levees shall be a Federal responsibility. (Confirmed by Flood Control Act of 1944, Public Law 534-78.)

TABLE 1 (Cont)

Document	Summary
Flood Control Act of 1944 (Public Law 534-78) (HD 509/78/2)	Section 4 authorized the Chief of Engineers under supervision of Secretary of the Army, to construct, maintain, and operate public park and recreational facilities in reservoir areas under the control of the War Department. (This Section was amended by Section 207 of Flood Control Act of 1962.)
Flood Control Act of 1946 (Public Law 526-79) (HD 188/72/1, 757/79/2, and 138/80/1)	Modifies the MR&T project by incorporating in it the Tiptonville-Obion Levee authorized by the Flood Control Act of 22 June 1936 and authorizes its extension to include drainage improvements. Authorizes construction of the St. Johns Bayou Levee. Authorizes construction of a levee to protect the Vicksburg-Yazoo area. Authorizes provision for drainage where drainage is impaired by authorized levee construction.
Flood Control Act of 1950 (Public Law 516-81)	Extends improvements in Flood Control Act of 1928 to include Mississippi River Levees in the Parish of Orleans. Authorizes the filling of Grants Canal in Lake Providence. Provides $200,000,000 for increased costs of construction for the MR&T project.
Flood Control Act of 1954 (Public Law 780-83)	Modifies the project for Vicksburg-Yazoo Area (HD 85/83). Modifies the project for the Birds Pt.-New Madrid, MO, Floodway to provide for closure of the front line levee and a closure structure (HD 183/83/1).

TABLE 1 (Cont)

Document	Summary
Flood Control Act of 1962 (Public Law 85-874)	Provides flexibility in the use of monetary authorizations and places MR&T on the same basis as the normal basin authorizations. Section 207, amended Section 4 of Flood Control Act 1944 to authorize the Chief of Engineers, under the Secretary of the Army, to construct, maintain, and operate public park and recreational facilities at water resource development projects under the control of the Department of the Army, to permit the construction of such facilities by local interests (particularly those to be operated and maintained by local interests), and to permit the maintenance and operation of such facilities by local interests.
Flood Control Act of 1965 (Public Law 89-298)	Authorizes enlargement of Birds Pt.-New Madrid, MO, Floodway Front Line levee, Cairo-Mound City, IL; and other improvements.
Flood Control Act of 1968 (Public Law 90-483)	Modifies the project to provide pumping plants and other drainage facilities in Cairo, IL, and vicinity. (Goose Pond and 10th Street pumping plants were constructed under this authority; Cache and Wilson Point Pumping Plants were authorized under prior authority.)
River Basin Monetary Authorization and Miscellaneous Civil Works Amendments Act of 1970 (Public Law 91-282)	Provides $167,000,000 additional monetary authorization for the Flood Control, MR&T project.
River Basin Monetary Authorization Acts of 1971, 1974, 1975, 1976, and 1977 (Public Laws 92-222, 93-251, 94-101, 94-347, and 95-189)	Provides $97,000,000 additional monetary authorization for the Flood Control, MR&T project. Also among other provisions, "Modified the project to provide that local cooperation to be furnished in connection with the Obion River Diversion aspect of the Tiptonville-Obion River, TN, project shall consist of requirement that local interests agree to maintain the completed works in accordance with Section 3 of the Flood Control Act of 1928, and hold and save the United States free from damages due to construction works."

TABLE 1 (Cont)

Document	Summary
Water Resources Development Act of 1986 (Public Law 99-662)	Section 906(b)(1) authorized the Secretary of the Army to mitigate damages to fish and wildlife resulting from any water resources project under his jurisdiction. The acquisition of lands or interests therein by condemnation is prohibited under this authority for projects at least 10 percent complete by the date of enactment of this Act.

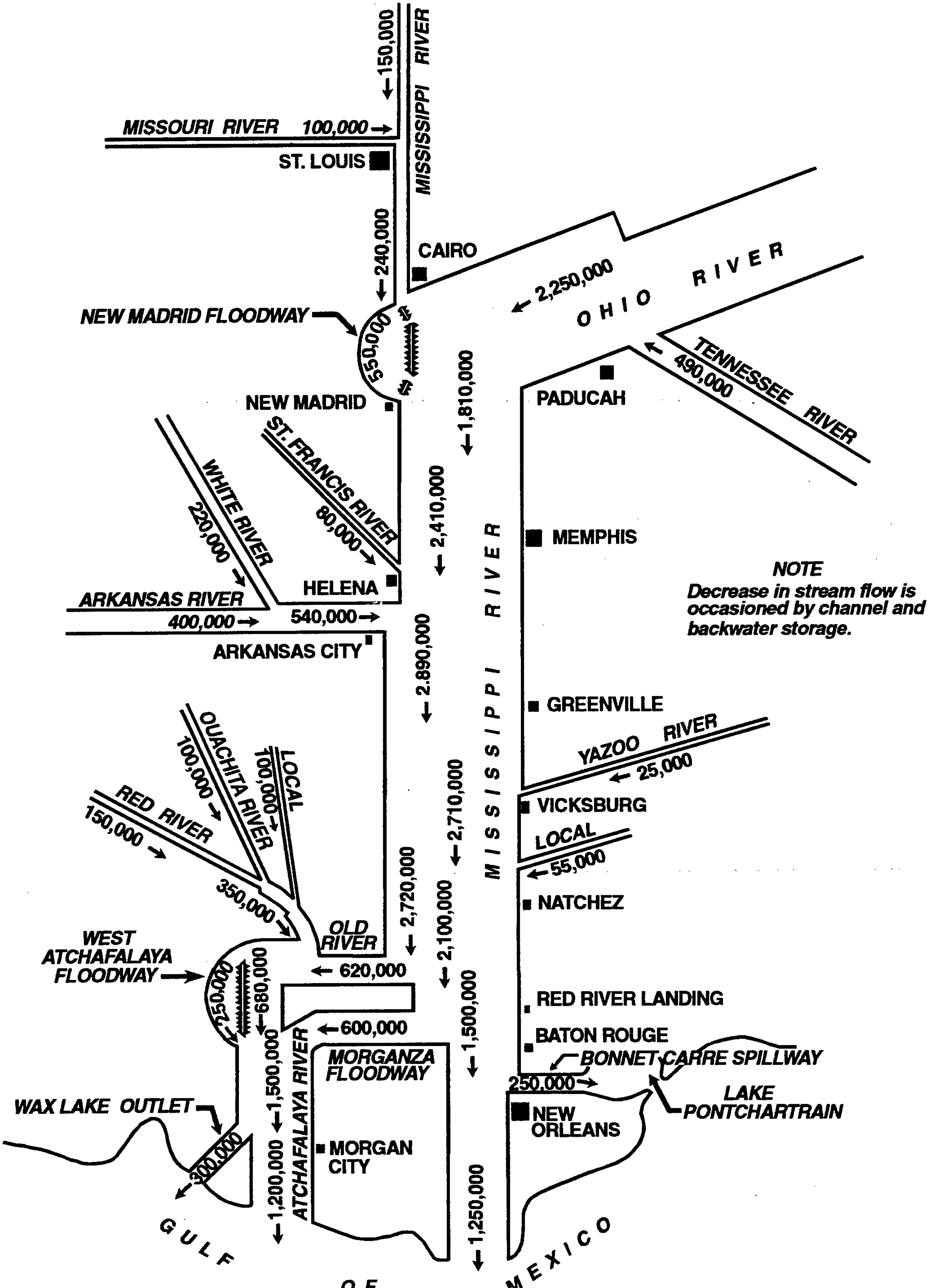
9. A new project design flowline was developed during the mid-1950's using the flows from the 58A-EN PDF and Mississippi River channel and overbank hydraulic data from the 1945 and 1950 flood conditions. This design flowline derived from using these channel conditions represented a very efficient postcutoff channel and was designated the 1956 Project Design Flowline. Levees were subsequently designed and constructed based on this flowline until the occurrence of the 1973 flood.

10. Prior to the 1973 flood, the Mississippi River mainline levees had been designed based on hydraulic and hydrologic studies completed in 1956. The 1956 study included the hypothetical arrangement of observed storms to produce the maximum flows that can be reasonably expected to occur. It made allowances for existing and proposed reservoirs throughout the Basin. This flood is known as the 58A-EN Project Design Flood. These flows and the very efficient postcutoff channel conditions were used to establish flood profiles used for levee grade design and the resulting profile (or flowline) referred to as the 1956 Project Design Flowline. Levees were subsequently designed and constructed based on this flowline.

11. The project design flood flows computed in 1956 have not been revised, remain applicable to present day conditions on the lower Mississippi River, and are the design flows upon which the current levees are designed. Figure 1 presents a schematic description of the project design flows for the lower Mississippi River and tributaries.

12. The lower Mississippi River Basin did not experience a major flood after completion of most of the levees to the 1956 grades until 1973. The flood of 1973 began with above normal stages and above normal rainfall in the fall of 1972. As high water increased during the fall and winter, it became apparent that the stage-discharge relationship for the Mississippi River was several feet higher than the relationship for which the levee system had been designed. This increase in stage-discharge relationship was partially attributed to a loss of some of the efficiency gained from the Mississippi River cutoffs which had been constructed in the 1930's and 1940's.

13. During 1973, a study was undertaken to adjust the 1956 PDF flowline using hydrologic data collected in the flood event. Stage-discharge information developed from the 1973 flood indicated channel capacity of the lower Mississippi River had deteriorated beyond that predicted in the 1956 analysis. The adjustments to the 1956 Project Design Flowline were completed in 1973 and a new design flowline was established as the 1973 adjusted Project Design Flowline which was then used to raise the most deficient problem areas. The paper, "1973 Adjustments to the 58A-EN Project Design Flood Flowline-MR&T Project" defined changes in the 1956 flowline. The 1974 high water and 1975 flood produced additional hydrologic data of value in further refining the 1973 analyses. The resulting flowline developed from this study is the Refined 1973 MR&T Project Design Flood Flowline.



PROJECT DESIGN FLOOD
(58A - EN)
CUBIC FEET PER SECOND
SEPT 1958

Figure 1

14. The refined 1973 PDF flowline projected a need for continued raising of portions of the levee system to protect the lower valley against the PDF. This flowline is the basis for the design of the mainline levee system currently under construction and for all remaining unconstructed levees. Remaining deficient mainline levees by reach are shown on Plates 10-46 (Appendix 4). The locations of the most deficient portions of the levees are in the vicinity of Mayersville, Mississippi, on the east bank and at Lake Providence, Louisiana, on the west bank. Construction work items to correct these deficiencies are discussed in Appendix 6.

15. The 1993 and 1995 floods on the upper Mississippi River revealed significant upward changes in stage-discharge relationships on the upper Mississippi River. The higher than expected water surface elevations experienced during the flood of 1995 on the reach of the Mississippi River above Cairo, Illinois, indicated that significant changes in the flood plain have occurred from the conditions used to develop the 1956 PDF flowline. Therefore, the MR&T Project design flowline from Cairo to Cape Girardeau was revised in 1996. The revision was based on available data and analyses of river hydraulic and hydrologic parameters. Two private levees (Powers Island levee and the Miller City levee) located in the Upper Mississippi River Commerce to Birds Pt. reach are factors in the changed flood plain conditions. Earlier, these private levees have tended to fail during floods, permitting partial conveyance of flow through the flood plain. In recent years, these levees have demonstrated greater resistance to failure, resulting in higher than expected flowlines against the project levee. Table 1-1 presents PDF flowline elevations for selected locations along the Mississippi River through time. Table 1-2 presents changes in the design levee grades over time for selected locations along the Mississippi River. Levee grades include freeboard which is added above the design flowline grade to take into account wave action, prop wash, and/or other uncertainties which could be experienced in extreme floods.

16. Numerous levee setbacks have been required through the years because of the ever-moving Mississippi River. Since 1915, levee setbacks have continually increased acreages to lands between the Mississippi River mainline levees. To date, the approximate cumulative total is 50,000 acres of land added between the levees. A 1996 study of levees in the Vicksburg District indicated that 17 major levee setbacks since 1915 have resulted in 43,000 acres being added to the riverside flood plain.

STUDY AREA

LOCATION

17. The study area extends from Cape Girardeau, Missouri, to Head of Passes, Louisiana, at the Gulf of Mexico. This lower Mississippi River valley is a relatively flat plain which has about 35,000 square miles of alluvial lands bordering the river. This valley begins just below Cape Girardeau and extends approximately 600 miles to the Gulf of Mexico. The valley varies in width from 30 to 125 miles and includes parts of seven states--Missouri, Illinois, Tennessee, Kentucky, Arkansas, Mississippi, and Louisiana.

PROJECT AREA

18. The project area fits within the study area. The project area extends 600 miles from Cape Girardeau to Head of Passes at the Gulf of Mexico. The width of the project is all lands riverside of the landside toe of the Mississippi River levees (on both sides) and an area 3,000 feet landside of the landside toe on both sides. The project area is included in parts of seven states--Missouri, Illinois, Tennessee, Kentucky, Arkansas, Mississippi, and Louisiana.

PHYSIOGRAPHY

19. The Mississippi River has the third largest drainage basin in the world, exceeded in size only by the watersheds of the Amazon and Congo Rivers. It drains 41 percent of the 48 contiguous states of the United States. The Basin covers more than 1,245,000 square miles which includes all or parts of 31 states and 2 Canadian provinces. The main stem Mississippi River channel below Cairo, Illinois, carries runoff from approximately 922,000 square miles of drainage area concentrated at Cairo by the upper Mississippi and Ohio Rivers. Between Cairo and the Gulf of Mexico, the Mississippi River system flow is augmented by runoff from approximately 324,000 square miles of intervening drainage area.

20. The study area is part of the rich, Deltaic region of the lower Mississippi River, which with its fertile soil, constitutes one of the most productive farming regions in the United States. The lower Mississippi River and its alluvial valley became part of the coastal plains area during the last glacial advance of the Pleistocene Period when sea level was several hundred feet lower than present. During and subsequent to this time period, as early as 5,000 to 6,000 years ago, the Mississippi River overtopped its banks and deposited tremendous amounts of sand, silt, and clays in the valley, gradually filling it with layers of alluvium.

21. Today, the topography of this area is characterized by a flat to slightly undulating surface underlain by Holocene and Pleistocene alluvial and terrace deposits. With over 53,000 square miles of total alluvial valley, approximately 35,000 square miles had been subject to inundation prior to levee initiation in the 1700's. The Deltaic plain ranges in elevation from below sea level in the New Orleans area to 320 feet, National Geodetic Vertical Datum (NGVD), in the upper reaches near Memphis. The middle Delta near Vicksburg starts at elevation approximately 100 feet, NGVD, and rises to approximately 200 feet, NGVD, in the upper reaches.

22. The lower Mississippi River has approximately 35,000 square miles of alluvial valley which is subjected to floodwater if not protected by levees. Sweeping across its flood plain in huge arcs, the Mississippi River divides the plain into large flood basins which are generally bounded by the bluffs of the valley wall on one side and the meander ridges of the river on the other. On the western side of the river, the Arkansas/White, Atchafalaya, Red, and St. Francis River

Basins are present. The eastern river basins include the Obion, Forked Deer, Big Black, and Yazoo River Basins. Meander scars throughout the valley indicate many former courses made by the Mississippi River and show visible signs that the western levees have crevassed more frequently than the eastern.

MORPHOLOGY

23. Prior to man's development of the levee system along the Mississippi River in the 1700's and 1800's, overflows from the Mississippi River deposited a part of the sediments it transported. Most of the sediments were deposited adjacent to the river, forming low "natural levees," with decreasing amounts deposited away from the stream. For this reason, the banks of the river were generally 10 to 15 feet above the lowlands farther back from the river. Because of the natural levees, drainage was generally away from the Mississippi River except where tributary streams join the river. This resulted in drainage away from the river to low ground near the valley walls and bottom-land drainage by streams running parallel to the river and joining it through major tributaries or at points where the river meanders close to the valley wall. This pattern of parallel drainage was well developed in the Mississippi River alluvial valley.

24. Soils in the valley are truly alluvial from a geological point of view and consist mainly of sands and silts, grading progressively to very fine sands and silts in the lower portion of the area. Scattered through these sand and silt deposits are extensive deposits of clay. As is typical of a stream flowing through alluvial valleys, the lower Mississippi River over time has developed a highly sinuous course, creating numerous meander loops and bends. It has also shifted its channel from time to time so that parts of the alluvial plain have been reworked many times, thus contributing to the complexity of the soil structure and hydrology of the area. This meandering has also produced a number of oxbow lakes.

CLIMATE

25. The climate is generally mild throughout the study area. Summers are typically long, hot, and humid, and winters are short and moderate. During winter months, the prevailing wind is from the north and northwest. In other seasons, winds are from the south and southwest. The normal annual temperature averages about 60 degrees F. Observed temperature extremes in the area range from 115 to -16 degrees F. The heaviest rainfall in the lower Mississippi River Valley occurs during the months of December to April, while minimum rainfall occurs normally during August through October. Severe rainfall, producing locally intense runoff, however, can occur at any time of the year. The normal length of the frost-free growing season is approximately 7 months. In the northern portion of the study area, average snowfall is 8 to 10 inches, with most of it falling from January to February. The southern region might experience freezing rain and snow only one or two times annually with snow depths ranging from 1 to 3 inches.

PLAN FORMULATION

EXISTING CONDITIONS

Socioeconomic Setting

26. An economic base area was developed consisting of the area considered to be physically, socially, environmentally, or economically impacted by the main stem levee project. This economic base area, which extends roughly from Cape Girardeau to the Gulf of Mexico encompasses approximately 50,000 square miles in seven states--Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. This economic base area was used to develop the socioeconomic profile for the area. The project area or environmental study area discussed in later paragraphs consists of all lands and waters between the Mississippi River mainline levees, including 3,000 feet landside, beginning at Cape Girardeau and extending downstream to Head of Passes.

27. The study area is favored with an abundance of natural resources. Highly productive agricultural lands, wildlife and fishery resources, forested areas, lakes and streams, and wetland areas are the most valuable physical resources in the region. Other features include stream tributaries, abandoned channel oxbow lakes, back swamps, natural levees, and rolling hill land.

28. The land area in the project area is approximately 32 percent cleared lands (cropland and pasture) while other nonurban uses such as forest lands, water, wetlands, and other lands represented approximately 63 percent. Urban land, which comprised the remainder, included developed areas such as residential, commercial, industrial, and other built-up urban-related areas.

29. A major natural resource of the study area is the abundance of water. The study area includes several main stem tributaries. Along with underground aquifers, these provide practically limitless water supplies to the area. However, some localized problems with aquifer drawdowns are occurring. These problems are being addressed by several Federal and state agencies. Also, numerous streams, lakes, ponds, and wetland areas are scattered throughout the area which provide habitat for wildlife and opportunities for outdoor recreation as well as esthetic enhancement of the communities.

30. Forests and forestry products have historically played an important role in the development of the lower Mississippi River valley. The accessibility of forest lands, the availability of local markets, and the presence of excellent road and river systems have all contributed to the rapid development of the production of forest resources in the study area. Through the years as land

clearing practices increased, forest acreages declined. Forests are becoming increasingly restricted to areas where flooding, poor drainage, and soil conditions make it unsuitable for other uses. In recent years, since the emergence of manufacturing, trade, and service industries, forestry production is not as important as it once was to the local economies.

31. Forest land in the study area consists primarily of bottom-land hardwoods, mostly the oak-gum-cypress type. Other forest types include oak-hickory, loblolly-shortleaf pine, longleaf-slash pine, and elm-ash-cottonwood. The fertile lands of the Deltaic region produce some of the finest hardwood forests in the Nation, providing viable sources for the lumber, pulp, veneer, and miscellaneous forest products industries. Bottom-land hardwood areas also support outdoor recreation and valuable wildlife habitat, such as deer, turkey, small game, and nongame species.

32. The lower Mississippi River valley is rich in minerals, supplying approximately 20 percent of the Nation's mineral output. Major contributors to national mineral production are natural gas, petroleum, lead bromine, salt, and sulphur. Other minerals produced in this area are natural gas liquids and nonmetallic minerals such as abrasives, barite, cement, clay, gemstones, lime, sand, gravel, and stone.

33. Population for the study area exceeded 4.6 million in 1990. Historically, population totals for the overall region have gradually increased. However, there have been some periods of outmigration in localized rural areas where the number of persons moving out of an area was greater than the combined number of immigrating residents and the natural population growth. The Mississippi Delta suffered the greatest reduction in the total number of persons living in the area. However, growth statistics show the overall study area population has increased by over 500,000 people since 1960 or 14 percent over the 30-year period.

34. Population growth within the study area has fluctuated from area to area based on varying factors. In many cases, areas within counties in close proximity to large metropolitan centers have enjoyed substantial population growth. This is evident in reviewing the population trends of counties which encompass Baton Rouge, Monroe, and New Orleans, Louisiana, and Memphis, Tennessee. These centers offer a diversified economic base of jobs, industry, and services which provide for the basic needs of a large population--employment, income, and housing.

35. Although the area is predominantly rural, there are 55 cities within the study area that have populations of 10,000 people or greater. Additionally, there were an estimated 109 towns with populations between 2,500 and 10,000 people in 1990. Five Metropolitan Statistical Areas (MSA's) are located within the economic base area which include Baton Rouge, Monroe, and New Orleans, Louisiana; Memphis, Tennessee; and Pine Bluff, Arkansas. The MSA's serve as the major commercial, services, and industrial centers for their regional areas. In addition to their close proximity to the Mississippi River, each of the major metropolitan centers has international air service and is accessible by multiple interstate and Federal highway systems.

36. Economic conditions can be described by parameters such as labor force and employment, earnings and income, agricultural activity, and industrial and business activity. The civilian labor force in the study area increased from 1.5 million people in 1970 to approximately 2.1 million in 1990--an increase of over 38 percent. Paralleling the labor force, unemployment figures have also increased over the last 20 years. Unemployment rose from 5.7 percent in 1970 to 9.1 percent in 1990. Total employment in the study area represents the number of wage and salary employees and the number of proprietors. Total employment in the study area in 1990 was estimated at 1.9 million. Total employment in the study area has grown over 33 percent since 1970, increasing from 1.4 to 1.9 million in 1990.

37. Total earnings in the study area in 1990 were estimated to be $64.4 billion. Major sectors contributing toward total earnings are the services, transportation, manufacturing, retail trade, government, and farming industries. Although farming and forestry have historically been major enterprises in the past, services and manufacturing have become increasingly important to the economy over the last decades. Much of this is due to increased efforts toward mechanization and industrialization of production processes and the infiltration of a diversity of industries into the region. Services and manufacturing were the leading contributors to earnings in 1990 comprising 24.3 and 16.8 percent, respectively. Total personal income of the study area totaled over $77.9 billion in 1989 (in constant 1996 dollars). On a per capita basis, this results in an income of approximately $17,000 per person.

38. Favorable agricultural characteristics have been significant factors in the development of land use patterns in the study area. Historically, agricultural resources have been important to the economy of the region. However, along with industrial expansion and the increased commercialization and mechanization of farms, farming operations have followed a national trend of consolidation resulting in fewer farms with larger acreages. In 1992, there were 34,249 farms in the study area comprising a total of 17.8 million acreages with an average size per farm of 518 acres. In comparison, there were 44,030 farms totaling 19.1 million acres in 1978 averaging 434 acres per farm. These numbers reflect a 22 percent decrease in the number of farms, a 7 percent decrease in the total land in farms, and a 19 percent increase in farm size. The total value of farm products sold in the study area was $4.9 billion (constant 1996 dollars) in 1992--a 23 percent decrease over the $6.4 billion reported in 1978. As a major contributor to the economies of many counties in the study area, agricultural production, especially in the rich Mississippi River Delta, remains a viable industry in the region.

39. Approximately 4,700 manufacturing establishments were reported in the study area in 1992. The majority of the manufacturing activity is located around the larger metropolitan centers and urbanized area--Baton Rouge, Memphis, Monroe, New Orleans, and Pine Bluff. Value added by manufacturing is the principal measure reflecting the value of industrial production of an area. The value added by manufacturing for the study area was estimated to be $28.4 billion in 1992, an 8 percent increase over the value reported for 1977 of $26.2 billion.

Retail and wholesale trade represents the economic and business activity in the area based on the sales volume of merchandise. Retail and wholesale trade together accounted for 22 percent of the total employment in the study area in 1990. Retail sales, defined as the total of merchandise sold plus receipts from repairs and other services to customers, increased from $34.2 billion in 1977 to $35.4 billion in 1992, an increase of about 3 percent. During this same time, the number of retail establishments increased by over 1,600 firms. Although the number of wholesale establishments in the study area has continued to grow, wholesale sales have decreased significantly since 1977. Wholesale trade dropped from approximately $76.6 billion in 1977 to $31.6 billion in 1992, a 59 percent decline.

Hydrologic Setting

40. Principal Mississippi River tributaries include the upper Mississippi River, Ohio River, St. Francis River, Obion River, Forked Deer River, Arkansas/White River, Yazoo River, and Big Black River. The lower Mississippi River valley is a relatively flat plain with approximately 35,000 square miles of alluvial lands which were subject to inundation during extensive flood periods prior to manmade protective works initiated in the 1700's. The study area includes the portion of the Basin extending from Cape Girardeau south to Head of Passes at the Gulf of Mexico. The project area is all lands riverside of the landside toe of the Mississippi River mainline levees (on both sides) and an area 3,000 feet landside of the landside toe on both sides which follows the Mississippi River from the vicinity of Cape Girardeau to below New Orleans. Precipitation occurring within study boundaries produces runoff which flows into the Mississippi River main stem via the above-named major tributaries or via minor drainage ways.

41. The Mississippi River mainline levees are designed to protect the alluvial valley from the PDF by confining floodflows within the leveed floodway, except where it enters the backwater areas or is diverted intentionally into the floodway areas. The mainline levee system is comprised of levees, floodwalls, and various control structures. When major floods occur and the carrying capacity of the Mississippi River leveed channel is exceeded, additional conveyance through the Bird's Pt.-New Madrid Floodway, and relief outlets through the Atchafalaya Basin, Morganza, and Bonnet Carre Floodways are utilized as well as the storage capacity of flat lowlands at the junctions of tributaries with the Mississippi River. These "backwater areas" are in effect reservoirs that store water during times of floods. They are protected from lesser floods by backwater levee systems that are designed to be overtopped near the crest of the PDF in order to reduce the peak flow of the PDF and allow safe passage within the mainline levee system. The system design which utilizes backwater storage at appropriate times in the PDF hydrograph has significantly reduced the need for even higher mainline levees.

42. Precipitation in the study area is usually abundant and well distributed. Normal annual precipitation ranges from 46 to 62 inches from north to south. During winter and spring, intrusions of polar air into the region are usually accompanied by widespread and persistent

cloudiness and general rainfall, plus some thunderstorm activity within the frontal zone. Autumn brings the least precipitation to the region. Flooding in the lower alluvial valley usually occurs from the middle of December through July. This is the result of the spring rains and the melting of the snow pack in the upper Mississippi River and Ohio River Basins.

43. The lower Mississippi River valley is subject to frequent and severe floods. Major floods on the lower Mississippi River may result from a combination of floodflows from the upper Mississippi River, the Ohio River, and/or other major tributaries of the lower Mississippi River. The flood season on the Mississippi River is usually from the middle of December through July. Major floods on the Ohio River generally occur between the middle of January and the middle of April. Major floods from the upper Mississippi and Missouri Rivers usually occur between the middle of April and the last of July and from the Arkansas and White Rivers between the first of April and end of June.

44. Writings of early explorers and settlers indicate frequent flooding in the alluvial valley. Fragmentary records indicate that great floods occurred in 1782, 1785, 1796, 1809, 1815, 1823, 1844, 1849, 1858, 1862, 1867, and 1882. Major floods of recent years happened in 1903, 1912, 1913, 1916, 1922, 1927, 1937, 1945, 1950, 1973, 1975, 1979, 1983, 1993, 1995, 1996, and 1997. The largest flood at St. Louis occurred in 1785 and based on fragmentary records, the maximum discharge was estimated to be about 1,340,000 cubic feet per second (cfs). The largest flood at Cairo occurred in 1937 with a discharge of 2,002,000 cfs. The largest flood at Arkansas City, Arkansas, occurred in 1927 with an estimated confined discharge of 2,472,000 cfs. The largest flood at the latitude of Red River Landing occurred in 1927 with an estimated confined discharge of 2,345,000 cfs.

Environmental Setting

45. General.

a. The Mississippi River mainline levee project area contains significant environmental resources. These resources are described in the MR&T Mississippi River Levees and Channel Improvement Final EIS filed with the Council on Environmental Quality in April 1976. This information has been updated through investigations undertaken for preparation of the SEIS. Evaluations of wetlands, terrestrial resources, endangered species, Neotropical migrants, bats, water quality, aquatic resources, waterfowl, cultural resources, and recreation/esthetics were conducted. A complete analysis of these resources is documented in the SEIS and the appendixes accompanying this report.

b. Investigations conducted included all remaining levee enlargement and seepage control works. For purposes of environmental analysis, the Mississippi River mainline levee project area consisted of all lands and waters within 3,000 feet landside of the landside toe of the levees in each Corps District. The project area also included several additional levees, a floodwall, and a floodway in the Memphis District. The project areas for these related works consisted generally of lands between various streams and levees and all lands within 3,000 feet on their landside. Land use for the project area is presented in Table 2.

TABLE 2
PROJECT AREA LAND USE
(acres)

Land Use	Nonwetland	Wetland	Total
Forested	385,456	636,254	1,021,710
Cropland	537,704	231,556	769,260
Urban/Industrial	71,570	4,594	76,164
Scrub/Shrub	23,939	43,440	67,379
Tree Plantations	27,887	22,584	50,471
Sandbar	3,790	45,600a/	49,390
Pasture	22,854	19,536	42,390
Levee	26,990		26,990
Herbaceous	3,469	11,043	14,512
Marsh		5,925	5,925
Bare Soil	1,742	1,825	3,567
Subtotal	1,105,401	1,022,357	2,127,758
Open Water			518,086
Total			2,645,844

a/ Jurisdictional (regulated) water of the United States, but may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

46. History.

a. The Mississippi River has always been a threat to the security of the inhabitants of the valley through which it flows. The first European explorer in the region, Hernando de Soto, viewed the Mississippi River in 1541, and in 1543 the first record of a flood on the river was made. The necessity of flood control was recognized immediately by early settlers in the lower

Mississippi River valley. When Bienville founded the city of New Orleans in 1717, his engineer, de la Tour, opposed the location of the city on the site selected because he knew that the settlement would be periodically overflowed by the river. Bienville overruled this objection, so de la Tour undertook the construction of the first levee system to be erected on the Mississippi River. The work was not completed until 1727.

b. As settlements developed along the river, the levee system was extended. By 1735, the levees on both sides of the river extended from approximately 30 miles above New Orleans to approximately 12 miles below the city. Although the system represented extraordinary effort, the works were of insufficient strength and were crevassed at many points by the unusually high water of that year. By 1812, when Louisiana was admitted to the Union, the levee system extended up the river to Baton Rouge on the east bank and to the vicinity of Morganza, 40 miles upriver from Baton Rouge, on the west bank. By 1844, in spite of several damaging floods, the levee system was continuous, except for a gap at Old River, from 20 miles below New Orleans to the mouth of the Arkansas River on the west bank and to Baton Rouge on the east bank. Efforts thus far to control Mississippi River floods had been almost entirely local in nature, with individual landowners bearing all costs.

c. The need for more substantial Federal participation in improvements to the river for navigation and flood control was generally recognized by 1879. The necessity for coordination of engineering operations through a centralized organization was apparent. That year, Congress established the Mississippi River Commission, which had as its assigned duties ". . . to take into consideration and mature such plan or plans and estimates as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade, and the postal service . . . ."

d. The flood of 1916 resulted in passage of the first Flood Control Act, approved 1 March 1917. This Act authorized the construction of levees for the control of floods and affirmed the policy of local cooperation. A major flood occurred in 1926 followed by the 1927 flood, the most disastrous in the history of the lower Mississippi River valley. This disaster awakened the national conscience to the dire need for flood control in the lower valley. Out of it grew the Flood Control Act of 1928, which committed the Federal Government to a definite program of flood control.

Terrestrial Resources

47. Detailed analyses of terrestrial resources were made with the objectives to (a) determine baseline (preproject) habitat suitability for selected wildlife species in the project area, (b) estimate potential impacts for each species by comparing the "without-project" conditions and the alternative "with-project" conditions, and (c) estimate the need for any compensation measures. The terrestrial detailed analysis is contained in Appendix 10.

a. The bottom-land hardwoods that comprise the forested lands between the Mississippi River levees are important environmental features. These areas are dominated by cottonwood, sycamore, willow, ash, and elm.

b. Semiaquatic mammals that inhabit the area include such species as muskrat, nutria, swamp rabbit, mink, river otter, and beaver. Other land mammals present include white-tailed deer, striped skunk, cottontail rabbit, and bobcat. Aquatic foragers such as herons, egrets, and migratory waterfowl also use the area. Wood ducks are a common resident of the area. Typical species that use the agricultural lands include cottontail rabbit, mourning dove, raccoon, and redwing blackbird.

c. Bottom-land hardwoods have been identified as a significant terrestrial resource in the project area. The total acreage of bottom-land hardwoods in the project area is 1,021,710 acres. To evaluate impacts to bottom-land hardwoods, Habitat Evaluation Procedures (HEP) were used. HEP is an accounting system for quantifying and displaying habitat availability for fish and wildlife. HEP is based on Habitat Suitability Index (HSI) models that describe the habitat requirements of a species or group of species. HSI models use measures of appropriate variables to rate the habitat on a scale of 0 (unsuitable) to 1.0 (optimal). In a typical HEP study, a number of evaluation species are chosen for each area that meets a specified standard of homogeneity; e.g., cover type, of interest in the project area. Species may be chosen because of their ecological, recreational, or economic value or they represent groups of species that have similar habitat needs.

d. A HEP team composed of biologists from the Corps; the U.S. Fish and Wildlife Service (FWS); the Arkansas Game and Fish Commission; Louisiana Department of Wildlife and Fisheries; the Mississippi Department of Wildlife, Fisheries and Parks; and Kentucky Department of Fish and Wildlife Resources, charged with the responsibility of managing wildlife resources that could be affected, performed the HEP analysis. Six species were selected for evaluation of wildlife impacts by the project. These species were selected by terrestrial HEP teams to represent the wildlife community that uses the bottom-land forests in the project area. The evaluation species include the barred owl, fox squirrel, Carolina chickadee, pileated woodpecker, wood duck, and mink.

e. After cover types in the project area were mapped, habitat variables contained in the HSI models for each species were measured from maps, aerial photographs, and by onsite sampling. HSI values were then calculated, and the initial or baseline number of habitat units (HU's) was determined for each species. One HU is equivalent to 1 acre of optimal habitat; therefore, the number of HU's for a species is calculated as the number of acres of available habitat times its suitability (HU = HSI x acres). Estimates of future habitat conditions were made for the without-project condition and for each with-project alternative. Impacts on each species were then determined by calculating the difference in average annual habitat units (AAHU's) which are the annualized products of habitat quality, acres, and time between the with- and without-project alternatives.

Wetlands

48. Wetlands analyses were conducted with the evaluation objectives to (a) identify wetland functions, (b) evaluate wetland functions, (c) assess the effects of alternatives on wetland functions, (d) determine environmental design (reforestation) benefits, and (e) determine appropriate compensation measures to offset unavoidable impacts. This detailed wetlands analysis is discussed in Appendix 13.

49. The project area includes approximately 1,022,357 acres of wetlands. The area for which a jurisdictional determination of wetlands was made includes all lands riverside of the landside toe of the Mississippi River mainline levees (on both sides) from near Cape Girardeau to Head of Passes and an area 3,000 feet landside of the landside levee toe on both sides. The 1987 Corps Wetlands Delineation Manual with supplemental guidance was the basis for determining the extent of jurisdictional wetlands for vegetated areas. Other waters of the United States were also included in the jurisdictional maps. Wetlands on agricultural lands were identified using the procedures in the National Food Security Act Manual (3d Edition). Because of the project's regional scale, offsite procedures were used to establish the approximate extent of jurisdiction. The Natural Resources Conservation Service (NRCS) was consulted for the offsite jurisdictional determination on agricultural lands. Offsite determination was entered into a Geographic Information System (GIS) and used to produce preliminary jurisdictional maps which were ground-truthed by an interagency team represented by the Corps, NRCS, Environmental Protection Agency (EPA), and FWS. Because of the extensive project area, assumptions were made about vegetation, soils, and hydrology based upon preliminary field investigations and available statistical data. These assumptions were validated by an interagency team during the field review process.

Aquatic Resources

50. Existing and proposed borrow areas were evaluated to determine the potential effects to aquatic resources. Results of these investigations are contained in Appendix 8.

51. Aquatic habitat is provided by the Mississippi River, its tributaries, a large number of oxbow lakes, plus an even greater number of borrow areas and wetlands. Oxbow lakes range in size from a few acres to more than a thousand acres. Borrow areas typically range in size from approximately 10 to 200 acres with the average size approximately 100 acres. As project construction alternatives involved excavation of additional borrow areas, extensive investigations were conducted by the U.S. Army Engineer Waterways Experiment Station to determine the impacts of the project on aquatic resources. HEP was used to quantify the habitat quality of existing and potential borrow areas (Appendix 8). An interagency team selected five evaluation species which represented a broad range of habitat preferences,

reproductive biology, and trophic levels. Models were developed to predict fish abundance from 1981, 1996, and 1997 field data. HSI values, ranging from zero to one, were developed for each species from these data. A HSI value of one represents optimal habitat quality. HU's for each species were determined by multiplying the HSI value by the borrow area acreage.

Water Quality

52. The creation of borrow areas is the major project feature affecting water quality. An evaluation of water quality in existing borrow areas was conducted in detail to assist in estimating expected water quality in the proposed new borrow areas. This investigation is addressed in detail (see Appendix 17).

53. To estimate water quality in the project area, an evaluation of water quality was conducted on 17 riverside and 5 landside existing borrow areas along the Mississippi River. In addition to the borrow areas, nine oxbow lakes or abandoned river channels along the Mississippi River were also evaluated. Of the riverside borrow areas, 11 are located in Louisiana, 4 in Mississippi, and 2 in Arkansas. All five of the landside borrow areas are located in Louisiana. Of the oxbow lakes/abandoned channel, one is in Missouri, one in Tennessee, one in Arkansas, three in Mississippi, and three Louisiana. The study examined water, sediment, and fish tissue quality in the borrow areas and oxbow lakes. In general, water quality within the sampled existing riverside borrow areas was good to excellent, but water quality in existing landside areas was poor due to elevated levels of pesticide in fish tissue. No pesticides in concentrations above trace amounts were detected in any of the borrow area water samples. While some metals were detected in the water samples, only iron in one borrow area exceeded national criteria. All other detected metals concentrations were well below both acute and chronic criteria. Water quality in new borrow areas, depending on their location, is expected to be good. Fish tissue quality in the landside borrow areas was poor. High levels of DDE have been observed in landside borrow areas and other aquatic habitats.

Waterfowl

54. The loss and degradation of breeding and wintering habitat have been identified as the major waterfowl management problems in North America. Therefore, quantifying the impacts of the Mississippi mainline levee enlargement project to the winter waterfowl carrying capacity and foraging habitat in the project area is the primary purpose of this analysis. The impact methodology for this analysis was based on food as an index of wintering waterfowl carrying capacity. The waterfowl analysis was conducted by FWS. Their report constitutes Appendix 9.

Endangered Species

55. The FWS identified the pallid sturgeon (Scaphirynchus albus), fat pocketbook pearly mussel (Potamilus capax), interior least tern (Sterna antillarum), bald eagle (Haliaeetus leucocephalus), and wood stork (Mycteria americana) as endangered species occurring in the project area. A portion of the project area is also within the historic range of the threatened

Louisiana black bear (Ursus americanus luteolus). A Biological Assessment prepared for these species concluded that construction of proposed alternatives would not likely impact these species. This was based on a review of appropriate literature and scientific data for each of the species in question and the inclusion, as appropriate, of specific conservation measures to ensure that the proposed construction would not adversely impact any of the species in question. Detailed review is addressed in Appendix 11. FWS concurred with the Corps determination that the proposed levee enlargement work items would not adversely affect the above-mentioned species (see Appendix 2).

Cultural Resources

56. A literature and records review was performed to collect data pertaining to cultural resources identified within and adjacent to 128 proposed work items. Research focused on previously conducted cultural resources inventories in the vicinity of the project area, archeological sites, and cemeteries located within the project area and recorded standing structures and National Register of Historic Places properties situated within the project corridor. A study corridor encompassing 1.2 miles centered on each individual project work item was searched for evidence of cultural resources. When identified, historic properties were mapped on U.S. Geological Survey topographic quadrangle maps. Results of this survey were extensive due to the large geographic area and are contained in Appendix 15.

Neotropical Birds

57. A review of Neotropical migratory bird species composition and available habitat was used to assess the impacts to these species. Neotropical migratory birds generally include those species that breed in the Neoarctic faunal region and winter in the Neotropics. An estimated 184 species of Neotropical migratory birds representing 33 families are known to regularly occupy or use the study area. This list includes 14 species considered to be of management concern. Investigations indicate that the primary impact to Neotropical migratory birds would be the conversion of breeding, resting, and foraging habitat to project features. Results of these investigations are addressed in Appendix 12.

Bats

58. Investigations of bats was undertaken separately from investigations of terrestrial resources. Of the approximately 2.6 million acres in the project area, approximately 2.0 million acres were identified as providing bat habitat. Land use types providing bat habitat that could change as the result of project construction alternatives include forested, cropland, scrub/shrub, tree plantation, pasture, levee, and herbaceous. Fourteen species of bats were included in the analysis. A complete listing of these species and potential impacts of project alternatives to bat species is included in Appendix 14. No endangered or threatened species of bats are likely to

be present in the study area. Two such species--the gray bat (Myotis grisescens) and the Indiana bat (Myotis sodalis)--are the closest to the study area. However, it is unlikely that either of these two species utilize the area.

Recreation/Esthetics

59. A vast array of recreational resources is available in the Mississippi River corridor. There are more than 250 state-managed areas including parks, natural areas, historic sites, fish and wildlife areas, scenic areas, and trails. More than 3 million visitors a year take advantage of these resources. Federally owned recreational resources administered by the National Park Service (15 areas) and FWS (21 refuges) together receive more than 9 million visits each year. Boating, sightseeing, and hiking are the most popular activities on the upper river. Approximately 59 boat-launch access points into the river are along the project area. Several thousand acres of land along the river corridor provide hunting, birdwatching, fishing, and other recreational opportunities. Every year, more than 6 million people participate in boating, the single most popular activity. For all activities, there is a total of 11 million recreation visits per year in the Mississippi River corridor.

60. In urban areas like New Orleans and Memphis, project lands provide walking and biking trails as an integral part of the recreation development along the river. Within the lands between the levees, numerous timber companies have leased land to hunting clubs, and state wildlife management lands are also available to the public. Fishing and hunting activities are within these clubs and managed lands. These recreation activities provide numerous public access points along the river. In addition to hunting activities, numerous borrow areas, oxbow lakes, and boat-launching sites provide access to the Mississippi River thus providing an abundance of fishing opportunities. Boat access points to the river exist along the total length of the project. However, the majority are situated between Cape Girardeau and Memphis.

61. The Mississippi River offers a wide range of conditions esthetically attractive to people of varied tastes. The River is the most visually outstanding aspect of the project area landscape. Large bodies of water serve as an important element of visual composition because of their horizontal extent, color, and texture. The Mississippi River's sinuosity provides the additional visual characteristic of surprise. Inactive parts of the river, such as oxbows, fulfill a similar role. The natural and cultural land uses within the project area complement the river by their contrasting geometry, color, and texture, or are esthetically significant in their own right, as with bottom-land hardwood forests. The relatively natural land uses, such as bottom-land hardwood forests, also provide for any species of wildlife which can be considered esthetically significant components of the landscape.

62. The project area contains many manmade features which either contribute to or detract from the esthetic quality of the project area, depending upon the eye for beauty of the particular individual. The River is constrained on the west bank by levees for almost the entire distance

from Cape Girardeau to the Gulf of Mexico. The east bank has considerably fewer miles of levee. Other manmade features along the river include revetments constructed on both banks to protect the river channel. From Cairo to the Gulf of Mexico, dikes have been built into the river, most several hundred feet long, but some as long as 1 mile. These dikes have greatly influenced the development of sandbars as a result of the still water areas created by the dikes. Other manmade features are the river crossings for roadways, railroads, and overhead utilities. The project area is relatively poor in architecturally outstanding manmade structures which can be considered esthetically pleasing since it is used primarily for flood control, protection of adjacent areas, and navigation. The manmade features which exist in the project area are generally of a utilitarian nature.

FUTURE WITHOUT-PROJECT CONDITIONS

Socioeconomic Setting

63. From a national perspective, socioeconomic trends are assumed to reflect reasonably full employment; the absence of natural disasters, wars, epidemics, etc.; long-term growth in output; and continued migration into the Sunbelt states. Regional earnings and income should approach the national average as industrialization trends continue.

64. Based on the current economic condition, three major economic indicators were projected to give an idea of the direction of future growth in the study area--population, employment, and income. Population growth is a direct reflection of the economic growth of an area. Population levels are good indicators of the size of an urban area and its land use needs such as residential, commercial, and other urban uses. Population statistics are also the basis for any other economic parameters such as per capita income (PCI), persons per household, population density, etc.

65. Population in the study area is projected to increase from 4.6 million people in 1990 to approximately 4.9 million by the year 2040, representing an increase of almost 7.3 percent. While the trend for the overall study area is projected for low growth over the 50-year period, some local areas are expected to experience a slight decrease in population over this period. The majority of the population increase in the study area is expected to occur in the Tennessee portion of the study area with an estimated increase in population of approximately 200,000 persons over the next 50 years. Other areas expected to have higher than average population growth include the Arkansas and Illinois study areas which are expected to grow by approximately 16 percent each and the Missouri study area which is projected to increase by 15 percent. The lowest growth is projected in the Louisiana study area. The number of persons residing in this region is expected to remain close to the same.

66. Employment projections indicate growth in the study area to be somewhat sluggish over the next 50 years. This component of the economic sector is only projected to increase by 30,000 persons, from approximately 1,860,500 in 1990 to 1,890,600 in 2040, or 2 percent. This slow growth is due in part to expected declines in Louisiana portions of the study area over the next 50 years. Total employment is expected to increase, but at a low rate. Projection statistics indicate that total employment within the Tennessee and Illinois study areas will grow by 12 and 8 percent, respectively. Additionally, aside from Louisiana, total employment in many rural areas is projected to grow at a modest rate.

67. Income forecasts show PCI to increase substantially in all areas of the study area over the next 50 years. Overall, PCI is projected to increase from $17,000 in 1990 to $25,300 (constant 1996 dollars) by 2040, or approximately 49 percent.

Hydrologic Setting

68. The future without-project hydrologic condition includes no new construction to include seepage control, frontal protection, or levee height increase except normal maintenance and repair. Existing levees, berms, and floodways would remain in place as the only flood protection. Levee failures could begin at a flood of as little as 2.2 million cfs at Vicksburg, Mississippi, considerably less than the PDF of 2.7 million cfs. Levee failures during a PDF would be devastating, particularly to the States of Missouri, Arkansas, Louisiana and Mississippi. Levee system repairs after failure would consist of restoration to current conditions, thereby setting the stage for another catastrophic event.

Environmental Setting

69. Land clearing for agricultural development is being discouraged, and since most of the remaining forested lands in the project area are classified as wetlands which fall under "Swampbuster" provisions of the 1985 Farm Bill, land clearing should essentially stop. Therefore, the terrestrial and wetland resources of the area should stabilize. Aquatic habitat will retain its current productivity and should improve as more land is taken out of production through farm programs. Waterfowl resources should improve as local and government groups plan and implement strategies to improve waterfowl habitat in the area. Water quality should improve as sedimentation is reduced and more environmentally suitable pesticides and herbicides are developed. Pesticides used previously still persist in the environment, but the levels of concentration are decreasing and now fall below the minimum contamination levels. In summary, environmental resources of lands located riverside of the Mississippi River levees should change little in the future.

PLANNING OBJECTIVES

70. The overall goal of this project is to provide flood protection to the lower Mississippi River Valley from the PDF beginning at Cape Girardeau, Missouri, to Head of Passes, Louisiana, with an environmentally sustainable project. The following objectives emanating from this goal have been developed through problem analysis and a public involvement program and have provided the basis for formulation of alternatives, environmental design, impact assessment, evaluation and selection of a recommended plan, and development of compensatory mitigation for unavoidable losses.

a. Provide flood protection from the PDF.

b. Develop an environmentally sustainable project.

(1) Avoid and minimize adverse environmental impacts through design procedures.

(2) Compensate concurrently with construction for unavoidable fish and wildlife habitat and wetland losses.

PLANNING CONSTRAINTS

71. To determine the scope of these investigations, the improvements on the Mississippi River Mainline Levees Enlargement and Berm Construction Project, scheduled for construction during FY 97 and 98 were assumed to be complete. The FY 97 and 98 items are shown in the following tabulation:

FY 97 - VICKSBURG DISTRICT
Wilson Point-Point Lookout, Louisiana, Item 483-R, Levee Enlargement and Berm
Stateline-Wilson Point, Louisiana, Item 506-R, Levee Enlargement and Berm
Carolina-Valewood, Mississippi, Item 502-L, Levee Enlargement and Berm
Tallula-Magna Vista, Mississippi, Item 475-L, Relief Wells
FY 97 - NEW ORLEANS DISTRICT
Plaquemines West-Second Lift, Louisiana, Mile 66.0 to 52.8-R, Levee Enlargement and Concrete Slope Paving
Marchand-Darrow, Louisiana, Mile 181.0 to 175.0-L, Levee Enlargement and Concrete Slope Paving
Remy-Garyville, Louisiana, Mile 150.0 to 141.7-L, Levee Enlargement and Concrete Slope Paving

FY 97 - MEMPHIS DISTRICT
Commerce-Birds Pt., Missouri, Upper Mississippi River 28 to 38-R, Relief Wells
Below Charleston, Missouri, Upper Mississippi River 5.0-R, Relief Wells
Stovall, Mississippi, Item 640-L, Slurry Trench Cutoff
FY 98 - VICKSBURG DISTRICT
Wilson Point-Point Lookout, Louisiana, Item 489-R, Levee Enlargement and Relief Wells
Valewood-Carlisle, Mississippi, Item 496-L a/, Levee Enlargement and Berm

a/ Items 493-L, 495-L, 497-L, and 498-L were combined to create Item 496-L.

72. Developing alternatives for completing the project in an environmentally sustainable manner was subject to a "reasonableness" constraint; i.e., the work must be acceptable to local project sponsors (levee boards), local landowners, and the public (concerned citizens). The work must be accomplished in a cost-effective manner while being environmentally and engineeringly viable.

73. The proposed Tiptonville-Obion Levee Extension and Obion River Diversion work item was authorized for construction by the Flood Control Act of 24 July 1946 and amended by the River Basin Monetary Authorization Act of 1971. The authorized levee extension would be located along the left bank of the Mississippi River in Dyer and Lauderdale Counties, Tennessee. The levee would extend from the existing levee, which ends near the Dyer-Lauderdale County line, approximately 7.6 miles to the mouth of the Middle Fork of the Forked Deer River. Approximately 21 miles of the Tiptonville-Obion Levee were completed in the early 1960's, but construction was stopped at the Dyer-Lauderdale County line because of a lack of support from Lauderdale County residents and adverse environmental impacts. Additional detailed studies would be required to determine if there is a flood control plan for this area that is feasible and acceptable to local and environmental interests. The Memphis District does not anticipate implementing this feature; therefore, this proposed work item was not included in the SEIS analysis.

FORMULATION OF PRELIMINARY PLANS

FORMULATION AND EVALUATION CRITERIA

74. Summarized in this section are the plan formulation analyses conducted to select a plan to resolve the problems and concerns and fulfill the needs of the study area. The following paragraphs present the evaluation criteria used in formulating a plan, alternative solutions considered, and the procedure used to eliminate alternatives.

75. Alternative plans were formulated and evaluated by Corps personnel; cooperating Federal, state, levee boards, and local agencies; and through scoping meetings with the public, in accordance with various technical, economic, environmental, and socioeconomic criteria. When applied, these criteria provide the means for responding to the problems and needs of the area by selecting a plan in the best public interest, consistent with other developments in the area, and for developing an environmentally sustainable project.

76. Federal policy on multiobjective planning, derived from both legislative and executive authorities, establishes and defines the national objectives for water resources planning, specifies the range of impacts that must be assessed, and sets forth the conditions and criteria which must be applied when evaluating plans. Plans must be formulated considering effects on the environment, construction costs, and social well-being of the community, implementability, and satisfying the required level of flood protection for the MRL.

77. Plan formulation criteria include published regulations and principles adopted by the Water Resources Council and Corps regulations. Other criteria used are in compliance with the Principles and Guidelines, the National Environmental Policy Act, and Executive Orders 11988 and 11990.

Technical Criteria

78. The following criteria were adopted in developing the plans:

a. Contracts awarded and scheduled for FY 97 and 98 would be considered complete. (These work items would each be addressed with individual Environmental Assessments.)

b. Plans for the remaining unconstructed features of MRL will be formulated to identify and address:

(1) The required level of flood protection.

(2) Use of the latest and most innovative engineering design criteria.

(3) Use of the latest and most innovative avoid-and-minimize environmental design criteria.

c. The economic life of the project was assumed to be 100 years.

d. Environmental impacts are attributable to the remaining unconstructed features of the Mississippi River mainline levees; however, the FY 97 and 98 completed items identified in paragraph 71 are also included.

Economic Criteria

79. Economic criteria are to show:

a. The significance of the project on the socioeconomic environment in the area adjacent to the Mississippi River mainline levees.

b. Develop a consistent data base of socioeconomic growth and development parameters for the socioeconomic environment of the region.

Environmental Criteria

80. The following environmental criteria are applicable to the formulation and evaluation of plans:

a. Plans should be formulated to the maximum extent practicable to avoid and minimize impacts to fish and wildlife habitat and wetlands.

b. The environmental impacts of any proposed action should be evaluated. Any adverse environmental effects which could not be avoided would be identified for compensation.

c. Unavoidable fish and wildlife and wetland impacts will be mitigated concurrently with construction at 100 percent Federal cost.

Socioeconomic Criteria

81. The following socioeconomic criteria are applicable to this study:

a. Consideration should be given to evaluating and preserving historical, archeological, and other cultural resources.

b. Consideration should be given to safety, health, community cohesion, and social well-being.

c. Improvement of leisure activities and public facilities should be evaluated.

d. General public acceptance of potential plans should be determined by coordination with interested Federal and non-Federal agencies, various groups, and individuals by means of public meetings, newsletters, field inspections, informal meetings, letters, and other public involvement procedures.

PRELIMINARY SCREENING

82. Alternatives were developed and evaluated by an interdisciplinary planning team including engineers, economists, archeologists, and biologists. Each of the alternatives was developed through a multiobjective process to provide flood protection from the PDF.

83. The affected public provided assistance in identifying alternatives to be evaluated. In addition to alternatives specified in the Consent Decree, alternatives were developed at six scoping meetings that were held in Baton Rouge, Louisiana; Vidalia, Louisiana; Greenville, Mississippi; Memphis, Tennessee; Newbern, Tennessee; and Cape Girardeau, Missouri. Alternatives investigated to provide a mainline levee enlargement and berm construction project include no action, nonstructural, and structural measures. These alternatives are discussed in the following paragraphs.

No-Action Alternative

84. No new construction; i.e., seepage control, frontal protection, and levee height increases would occur. Only normal maintenance, repair, and replacement would be done. Thus, existing levees, berms, and floodways would remain in place as the only flood protection. Therefore, the increased threat of catastrophic flooding over that of structural plans would continue and the citizens would be living in apprehension of future levee overtopping or failures. Local levee boards and the Corps would continue to expend funds in flood-fight efforts, including temporarily raising levee reaches and sandbagging sand boils.

85. As part of a report prepared in FY 97 at the direction of the U.S. Senate, limited studies were conducted to determine the expected damages from crevasses in the Mississippi River mainline levees at Mayersville, Mississippi, and Lake Providence, Louisiana. These investigations provide an indication of how catastrophic the impacts from a levee failure would be to the rest of the study area. Levee system repairs after failure would consist of restoration to current conditions, thereby setting the stage for another catastrophic event.

86. Crevasses near the small towns of Mayersville and Lake Providence, located in the central Delta region, would cause catastrophic flooding over approximately 25,000 square miles, directly affecting approximately 114,000 people, 40,000 residences, and 1,600 businesses in 12 counties and parishes along the river. Plate 47 (Appendix 4) shows the flood plain area that would be inundated with a levee failure at Lake Providence, Louisiana, and Plate 48 (Appendix 4) illustrates the alluvial area that would be inundated with a levee crevasse at Mayersville, Mississippi. Results of damage analyses indicate levee crevasses could potentially cause direct flood damages approaching $5.0 billion--almost $2.0 billion in the areas along the east bank of the Mississippi River and $3.0 billion on the west bank.

87. A summary of flood damages/losses is depicted in Table 3.

TABLE 3
LEVEE CREVASSE AT MAYERSVILLE, MISSISSIPPI,
AND LAKE PROVIDENCE, LOUISIANA
SUMMARY OF FLOOD DAMAGES/LOSSES
($000)

Damage/Loss Category	Lake Providence Levee Crevasse	Mayersville Levee Crevasse	Total Damages/Losses
Structure Damages	1,139,746	426,264	1,566,010
Business Losses	1,031,039	569,989	1,601,028
Public Utilities	79,782	29,838	109,620
Road and Bridge Damages	22,809	8,365	31,174
Agricultural Losses	447,144	468,247	915,391
Noncrop Damages	60,823	37,846	98,669
Traffic Rerouting	72,162	3,604	75,766
Emergency Costs	50,403	39,840	90,243
Evacuation and Subsistence Costs	26,821	21,200	48,021
Reoccupation Costs	42,471	33,570	76,041
TOTALS	2,973,200	1,638,763	4,611,963

88. Secondary and tertiary impacts could increase the total effect on the local economy to almost $10 billion. This would have a devastating effect on the economy of this region and the Nation. Both agricultural and industrial interests would be adversely affected and would require a significant amount of time to recover. Millions of dollars in business losses would occur with thousands of additional people indirectly impacted by the setback in commerce. Traffic corridors such as Interstate 20; U.S. Highways 61, 65, and 84; and other corridors, including railroads, could be closed for months, forcing the rerouting of thousands of vehicles. The true cost of this disaster cannot be fully explained in economic terms. However, given the high probability of loss of life and the devastation experienced by individual families and communities, there would be both a huge toll in human suffering and economic activity which could take years to overcome.

89. This event would impact about 15 percent of the Mississippi River levee economic base area. Mississippi River levees failures at other locations would cause even more astronomical damages and impacts region wide. In the total Mississippi River levee economic base area, there are approximately 4.6 million people and 1.6 million residences in 85 counties and parishes. This is 40 times the number of people and structures affected in the crevasse study. Based on the case study, damages to the entire study area and Nation could approach $300 billion.

90. Since the no-action alternative would not provide protection from the PDF and is unacceptable to Congress and the general public and thus unimplementable, no further consideration was given to the no-action option.

Plan 1 - Nonstructural Alternative

91. Plan 1 represents a nonstructural option to structural flood damage reduction. Basically, only two types of practicable nonstructural measures for flood protection exist--those which reduce existing damages and those which reimburse for existing damages and reduce future damage potential. Those nonstructural measures which reduce damages were not applicable to levee overtopping and catastrophic levee failure. The nonstructural measure which compensates or reimburses for existing damages that was addressed was purchasing easements in lieu of providing flood protection from the PDF. Existing levee protection would be maintained as in the no-action alternative. However, should the levee be overtopped and catastrophic levee failures occur, the levees would not be reconstructed.

92. Again, considering only the aforementioned Mississippi River levees breaks at Lake Providence, LA, and Mayersville, MS, purchase of flowage easements could be required on approximately 16 million acres. Assuming only a nominal cost per acre would yield a cost in the multibillion dollar range for this single component of this isolated event. Emergency disaster activities, traffic rerouting, and road and bridge structure and public utilities damages would also be overwhelmingly costly. In view of the magnitude of these costs, no attempt was made to estimate real estate acquisition costs, Public Law 91-646 costs, and expenses associated with acquiring any improvements that would be damaged by flooding, nor were provisions made to accommodate such factors as farm program disaster payments. This was unnecessary since easements would be purchased only from willing sellers and "at-risk" activities would be allowed to continue on easement lands.

93. Additional long-term major maintenance costs would be expected to be incurred during the remaining economic life of the project. However, the economic aspects of augmentation of the easement area as unforeseen levee breaks occurred were not calculated. Over time, more acreage could become subject to flooding. Additional easements would have to be acquired, and potentially some lands previously encumbered could require increased easement payments for more frequent flooding incurred due to upstream levee failures, which would be impossible to predict.

94. Nonstructural alternatives such as acquisition of flowage easements can be utilized only if they further a project purpose or there is some legal obligation for them. Flowage easements were considered as a substitute for provision of PDF protection through levee raising. Such an alternative would not accomplish the congressionally mandated project purpose to provide a prescribed level of flood protection. In view of this and considering the prohibitive implementation and continuing costs and certain public unacceptability, a nonstructural plan would not be implementable. It was given no additional consideration.

STRUCTURAL ALTERNATIVES

95. Three structural alternatives were addressed in the preliminary screening-- Plan 2, landside borrow; Plan 3, traditional method (riverside borrow); and Plan 4, environmental design (avoid and minimize) to construct levee enlargement and seepage control.

Plan 2 - Landside Borrow

96. This alternative presumes continuing construction of levee enlargement and raising, seepage control, and frontal protection. All borrow material would be obtained from landside of the levee. Three landside borrow schemes were investigated:

a. Plan 2A - Traditional landside borrow.

(1) Plan 2A consists of purchasing rights-of-way for traditional rectangular borrow areas 8 to 10 feet deep in a band 2,000 to 3,000 feet from the landside toe of the levee where feasible (see Plate 49, Appendix 4). A minimum distance of 2,000 feet from the landside levee toe to the closest borrow area is required to prevent underseepage problems and a maximum of 3,000 feet from the landside levee toe was used as the outer limit on the distance to haul borrow for levee and berm construction.

(2) Suitable material would be excavated and used to enlarge the levee as shown on Plate 49 (Appendix 4) or to construct berms. The landside rights-of-way would be expensive. The extended borrow haul distance would also increase costs.

(3) Water quality in the landside borrow areas would likely be poor due to runoff from adjacent agricultural fields. The runoff would carry high loads of suspended sediments, nutrients, and organochlorine pesticides. Existing landside borrow areas have high levels of DDE. Fish tissue levels of DDE from samples acquired as a part of these studies approach the FDA action levels for fish consumption and are two orders of magnitude above the no observable effects level for these pesticides.

b. Plan 2B - Traditional landside borrow with forested buffer.

(1) This alternative consists of a deep (average 8 feet) borrow area which would be protected by a forested buffer zone approximately equal in area to the borrow, with a protective berm around the outside of the buffer to prevent chemicals from entering the borrow area (see Pate 50, Appendix 4). As in Plan 2A, the required location for the borrow area is 2,000 to 3,000 feet landside of the levee toe.

(2) Plate 50 (Appendix 4) shows the excavated borrow area with the material used to enlarge the levee. The forested buffer area and protective dike are shown on the borrow area periphery. This design would isolate the borrow from the local drainage which carries pesticides, thereby improving water quality. However, this requires additional cost for engineering and design and lands and damages.

c. Plan 2C - Landside shallow borrow. Landside shallow borrow allows for draining the borrow area so that it can be forested. Borrow excavation is limited to 3 feet deep and shaped to drain and connect to local drainage, thereby providing habitat for tree growth. As in the previous landside borrow areas, the required location is in a band 2,000 to 3,000 feet from the landside toe of the levee. Plate 51 (Appendix 4) shows a typical layout of borrow area location, excavation and levee enlargement, and forested borrow. This shallow borrow greatly expands the required borrow area acreage, increasing lands and damages costs commensurately.

Plan 3 - Traditional Method

97. Plan 3 is the traditional historical method to construct levee enlargements and berms. New and innovative designs to reduce the cross-sectional area of the levees have been incorporated and, where possible, the levee enlargement is located to the side requiring the least amount of material.

98. The borrow areas are normally located riverside as close to the construction site as engineeringly feasible (proper soil for levee embankment) and excavated as deep as soil layers will allow (see Plate 52, Appendix 4). This plan requires no special configuration or location of the borrow areas other than for engineering purposes. No provisions are made for drainage or environmental enhancement of the borrow areas. However, past experience has shown that a majority of the resulting borrow areas permanently hold water which is replenished or "flushed" periodically by normal river fluctuations.

99. The traditional method analysis consisted first of printing GIS maps that contain the following data layers: base topographic features, land cover mapping, jurisdictional wetland mapping, and items of work. The items of work layer included enlargement footprints, berm footprints, and original borrow areas. To develop the layout of the plan described as Plan 3, the engineering design team located the borrow areas for the traditional method on the items of work mapping layer.

Plan 4 - Environmental Design (Avoid-and-Minimize)

100. Plan 4 is an environmental design which incorporates measures to avoid and minimize environmental damages to bottom-land hardwoods and wetlands. To develop the layout of the plan, interdisciplinary teams of state and Federal agencies representatives, local sponsors, and Corps staff were formed. They initially focused on relocating the construction borrow areas using the following placement prioritization criteria as a guide.

a. Landside cropland from willing sellers.

b. Landside cropland when riverside locations were unavailable.

c. Riverside prior-converted cropland.

d. Riverside tree plantations.

e. Riverside farmed wetlands (cropland).

f. Riverside farmed wetlands (pasture).

g. Riverside herbaceous wetlands.

h. Riverside forested nonwetland.

i. Riverside forested wetland.

j. Landside and riverside bottom-land hardwoods with black bear presence.

k. Landside cropland condemnation.

101. However, as various methods of construction were evaluated for each work item, it became apparent that the prioritization criteria could not be strictly and consistently applied to the entire MRL study area. For example, in the New Orleans District, the area between the top bank of the river and the levee is relatively narrow and often developed, whereas in the Vicksburg District, these areas are relatively wide and undeveloped. Riverside land use in the Vicksburg District is split between cropland and forested, but in the Memphis District, the riverside land use becomes predominantly cropland. Rather than apply the prioritization scheme mechanically, the study team evaluated each individual item and applied the avoid-and-minimize techniques as was most reasonable, considering the environmental, economic, and engineering solutions available for that item.

102. The teams also considered other innovative design approaches for reducing bottom-land hardwoods and wetlands effects. When environmentally, economically, and engineeringly feasible, existing berm material may be used to enlarge the levee (see Plate 53, Appendix 4) and replace the excavated berm with material dredged from the river (see Plates 54 and 55, Appendix 4). As shown on Plate 54, the only environmental loss would be temporary and comprised of a narrow path in which to lay the dredge pipe from the river to the berm site while pumping dredged material. Plate 29, Appendix 4, shows the locations of work items 498.0-L, 497.0-L, 495.0-L, and 493.0-L (these four items have been combined and renamed work item 496.0-L) and the dredge site locations in the Mississippi River to be used for borrow to construct these work items. The use of relief wells or cutoff trenches to control seepage instead of berms could be used if engineeringly and environmentally feasible. The relief wells or cutoff trenches would only temporarily affect the environment during construction.

Preliminary Screening

103. During the preliminary screening process, a typical reach consisting of several proposed work items was selected to prepare preliminary design and cost estimates. This was done because it was not practical to prepare preliminary design and cost estimates on 5 complete plans, each comprising 128 different construction items. In selecting the typical reach for the preliminary screening, items which included dredging, cutoffs, or relief wells were not chosen because they represented less than 5 and 20 percent, respectively, of the total construction items. The typical or average levee raise was 2.5 to 3 feet and included either seepage berm enlargement or new seepage berm construction. Items 424R, 422R, 377R, and 374R were selected because they best fit this average criterion. Preliminary design and cost estimates for each alternative were prepared for these items. Preliminary design identified improvements required for each alternative of the typical reach--levee enlargement (footprint area and cubic yardage) and berm construction or enlargement (footprint area and cubic yardage). A summary of the estimated total costs for this typical reach are shown in Table 4 for comparison.

TABLE 4
PRELIMINARY SCREENING OF STRUCTURAL ALTERNATIVES
($ million)

Items	Plan 2A	Plan 2B	Plan 2C	Plan 3	Plan 4
Lands and Damages	1.2	2.1	2.9	0.8	0.7
Relocations	0.8	0.8	0.8	0.8	0.8
Levees and Seepage Control	15.8	16.2	18.2	12.6	15.1
Engineering and Design	4.5	4.6	5.2	3.6	4.3
Supervision and Administration	1.8	1.8	2.1	1.4	1.7
TOTAL	24.1	25.5	29.2	19.2	22.6

104. The cost comparison shows the landside borrow alternatives (Plans 2A, 2B, and 2C) to be the least economical. The landside borrow costs for the typical reach are $24.1 million. Plan 4 (avoid and minimize) has an estimated cost for the typical reach of $22.6 million. Plan 3 (typical borrow) has the least estimated cost of $19.2 million.

105. Besides being the most costly alternatives, landside borrow options would be unacceptable and unimplementable. One reason is resistance from landowners refusing to accept locating borrow areas in their cultivated fields. Therefore, the potential for willing sellers project-wide is greatly reduced. Condemnation would thus be required. The disparity in the willing seller versus condemnation approach is reflected in their first and last, respectively, listing in the borrow area placement prioritization developed by the interdisciplinary teams (paragraph 101). Local sponsors would also resist landside borrow. In Louisiana, state law provides the levee districts borrow from the batture, and in Mississippi, levee boards own lands that were previously purchased for borrow purposes. The local public would also generally look with disfavor upon removal of these landside cultivated lands from the property tax rolls.

106. In addition, the aforementioned poor water quality, as well as other environmental reasons, serve to disqualify landside borrow. The excavated areas would be isolated and would exhibit far fewer fish and wildlife attributes than riverside borrow areas periodically flooded by the river.

107. Therefore, Plan 2 (landside borrow) was eliminated because of several major reasons--(a) the most expensive first cost, (b) the objections to this alternative by the local sponsors and landowners, and (c) the lack of environmental advantages to landside borrow.

108. Plans 3 and 4 were carried into the final array of plans because they are the most viable and implementable.

PRESENTATION AND EVALUATION OF FINAL ARRAY OF PLANS

109. Plan 3, Traditional Method, and Plan 4, Environmental Design (avoid-and-minimize), were analyzed in detail and detailed costs for the 128 work items developed.

110. Mitigation quantities were also determined and costs calculated for unavoidable fish and wildlife impacts. Table 5 illustrates the first costs comparison.

TABLE 5
FIRST COSTS
($ Million)

Item	Plan 3	Plan 4
Lands and Damages	33.7	24.3
Relocations	8.2	8.1
Levees and Seepage Control	399.5	462.3
Pumping Plant	6.4	6.4
Engineering and Design	108.3	95.6
Supervision and Administration	47.2	45.9
Mitigation	19.9	8.8
Total	623.2	651.4

Screening of Plans 3 and 4

111. Using all the data stored within the GIS layers, both Plans 3 and 4 were analyzed for their effects on wetlands and bottom-land hardwoods. These impacts for each plan are shown in Table 6.

TABLE 6
WETLANDS AND BOTTOM-LAND HARDWOODS IMPACTS
PROJECT TOTALS

Alternative	Total Acres Affected	Wetland Acres Affected	Bottom-land Hardwood Wetland Acres Affected	Bottom-land Hardwood Wetland and Nonwetland Acres Affected	Bottom-land Hardwood Wetland and Nonwetland Acres Avoided	Wetland Acres Avoided
Plan 3	24,956	11,654	7,927	11,582	N/A	N/A
Plan 4	19,900	7,328	2,761	4,834	6,748	4,326

112. The total acreage affected by Plan 3 is 24,956 with approximately one-half of this area being wetlands and/or bottom-land hardwood wetlands. Plan 4 affects 19,900 acres with only slightly more than one-third being wetlands and/or bottom-land hardwood wetlands. Plan 4, by avoiding and minimizing environmental losses, reduces the total affected acreage by 20.2 percent, the wetlands by 37.1 percent, and bottom-land hardwoods by 58.3 percent.

113. The total project area encompasses 1,021,710 acres of bottom-land hardwoods. Table 7 breaks this total down to 636,254 acres of bottom-land hardwood wetlands and 385,456 acres of bottom-land hardwood nonwetlands. Plan 3 affects 1.1 percent and Plan 4 affects less than one-half of 1 percent of the total bottom-land hardwoods in the project area.

TABLE 7
TOTAL BOTTOM-LAND HARDWOODS
PROJECT AREA
(Acres)

Bottom-land Hardwood Wetlands	Bottom-land Hardwood Nonwetlands	Bottom-land Hardwoods Total
636,254	385,456	1,021,710

Recommended Plan Selection

114. The recommended plan selection was based on the alternatives that would provide flood protection from the PDF along with minimization of environmental losses. Both Plans 3 and 4 provide the required flood protection. However, Plan 4 minimized unavoidable losses to the environment.

115. The comparison cost of Plans 3 and 4 presented in Table 5 shows that Plan 4 is approximately 4.6 percent more costly than Plan 3. However, Plan 4 (avoid and minimize) construction techniques have dramatically reduced the environmental impacts. Plan 4 has a 37.1 percent reduction in damages to wetland acres over Plan 3 and 58.3 percent damage reduction to bottom-land hardwoods acreages over Plan 3. Therefore, Plan 4 was selected due to its superior environmental sustainability while only costing slightly more than Plan 3.

Wetlands and Bottom-Land
Hardwoods Impacts of Recommended Plan

116. The total project area encompasses 1,022,357 acres of wetlands with Plan 4 construction affecting less than one-half of 1 percent. There are 1,021,710 acres of bottom-land hardwoods and Plan 4 affects less than one-half of 1 percent. These figures are shown in Table 8.

TABLE 8
PROJECT AREA TOTAL WETLANDS AND BOTTOM-LAND HARDWOODS
VERSUS PLAN 4 AFFECTED WETLANDS AND BOTTOM-LAND HARDWOODS

Total Wetlands Acres	Plan 4 Affected Wetlands Acres	Total Bottom-land Hardwoods Acres	Plan 4 Affected Bottom-land Hardwoods Acres
1,022,357	7,328	1,021,710	4,834

<u>Mitigation</u>

117. The unavoidable wetlands and bottom-land hardwoods losses were identified and acreages shown in Table 6. Plan 3 affects 11,654 acres of wetlands and 11,582 acres of bottom-land hardwoods. Plan 4 affects 7,328 acres of wetlands and 4,834 acres of bottom-land hardwoods. These and associated terrestrial and waterfowl losses were used to compute the compensatory mitigation to be completed during construction at full Federal cost.

118. A mitigation plan was developed to fully compensate unavoidable environmental losses to significant resources for future construction and for work items constructed during FY 97 and 98.

119. Results of the mitigation analysis (Appendix 1) reflect that unavoidable losses could be offset by reforesting frequently flooded agricultural lands. Approximately 5,900 acres of cleared lands within the project area would be reforested to fully compensate unavoidable losses to significant resources. The preferred method of acquisition would be by fee title; however, other methods such as use of public lands and easements on private lands, etc., would be considered on a case-by-case basis in coordination with other Federal, state, and local agencies.

DESCRIPTION OF RECOMMENDED PLAN

120. The proposed action includes 128 potential work items, 31 items in the Memphis District, 85 in the Vicksburg District, and 12 items in the New Orleans District. The proposed work for the Memphis District includes 31.8 miles of levee enlargement and 74.3 miles of seepage control measures construction; within the Vicksburg District, 216.8 miles of levees would be enlarged and raised to grade with placement of approximately 57.4 miles of seepage control measures; and in the New Orleans District, improvements would include enlargement of 14.2 miles of deficient levees, and construction of 0.1 mile of berm. The MCACES cost was prepared for Plan 4 with the first cost being $656,492,116 and the fully funded cost $911,291,702. These costs include $8.8 million for Federally funded mitigation.

PLAN COMPONENTS

121. Plan components depend upon site composition, foundation conditions, proximity to the Mississippi River, height deficiency, availability of suitable borrow, and land use. Preliminary design addressed all these components in selecting the construction methods, techniques, and layouts of each work item. Prior to construction, all work items will be designed in detail for preparation of plans and specifications for contract award.

OPERATION AND MAINTENANCE REQUIREMENTS

122. Operation and maintenance requirements for the MRL project will remain as is; i.e., the local levee boards will continue to perform all minor operation and maintenance at local sponsor cost and the Corps will be responsible for major maintenance.

123. The one cost that has been included for relief wells is the operation and maintenance cost to periodically clean and maintain the wells. Because these wells flow so infrequently in comparison to relief at a reservoir dam, a reasonable estimate of cost to maintain the approximate 5,000 relief wells included in this plan would be $1,000 per well every 12 years. This would amount to a $420,000 per year program. This program should have highest priority to ensure that the wells are maintained to ensure safety of the levees.

PLAN ACCOMPLISHMENTS

124. Plan accomplishments include protection from the PDF and an environmentally sustainable project with all unavoidable environmental losses compensated by mitigation at full Federal expense during construction.

125. Through incorporation of sound environmental design and compensation features, the project will result in improving the overall environment of the study area. For example, while some 4,800 acres of existing bottom-land hardwoods will be impacted by project construction, some 5,900 acres of cleared agricultural land will be acquired and reforested with bottom-land species which will develop into highly productive wildlife habitat. Also, over 3,000 acres of riverside borrow area will be designed for reforestation, resulting in high quality bottom-land hardwood wildlife area. Therefore, there will be over 4,000 more acres in highly productive bottom-land hardwoods as a result of the project. Additionally, approximately 6,700 acres of high quality riverside aquatic habitat will be created by constructing borrow areas, resulting in high quality fishery and waterfowl habitat. In summary, terrestrial, waterfowl, aquatic, and wetland resources in the project area will experience a net increase in value, as a result of environmental design and compensation features. None of the ten major resource categories evaluated will experience a net loss in value over the life of the project as a result of project construction.

PLAN IMPLEMENTATION

INSTITUTIONAL REQUIREMENTS

126. The draft report has been reviewed by Federal, state, and local agencies and concerned members of the public. Public meetings have been held to solicit comments from the affected and interested public. These comments are addressed in this final report.

DIVISION OF PLAN RESPONSIBILITY

127. Implementation of the recommended plan will be the responsibility of the Federal Government. Implementation of the mitigation plan will also be the responsibility of the Corps in conjunction with other Federal and state agencies who assist with fish and wildlife resources. Local sponsors will provide construction lands, easements, rights-of-way, relocations, and borrow areas.

VIEWS OF LOCAL SPONSOR AND OTHER AGENCIES

128. Public comments on the draft report and draft SEIS are addressed in Appendix 5. The Fish and Wildlife Planning Aid Report is included as Appendix 2.

SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

129. Appendix 5 also contains a summary of coordination activities of the Memphis, Vicksburg, and New Orleans Districts during the conduct of these investigations. Intense coordination has been maintained between the Memphis, Vicksburg, and New Orleans Districts and the Mississippi River Commission, and in addition, state and Federal agencies. Technical teams meetings occurred frequently throughout the study, six public scoping meetings were held in May 1997, three public information meetings were held in October 1997, and six public meetings were held in March 1998.

RECOMMENDATION

130. Recommend this Project Report be approved as the basis for continuing future Mississippi River levees construction.

Robert Crear
Colonel, Corps of Engineers
District Engineer
Vicksburg District

Gregory G. Bean
Colonel, Corps of Engineers
District Engineer
Memphis District

William L. Conner
Colonel, Corps of Engineers
District Engineer
New Orleans District

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL

SUPPLEMENT NO. 1 TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

JULY 1998

U.S. ARMY CORPS OF ENGINEERS

VICKSBURG DISTRICT
VICKSBURG, MISSISSIPPI

MEMPHIS DISTRICT
MEMPHIS, TENNESSEE

NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA

SUPPLEMENT NO. 1
MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT
AND SEEPAGE CONTROL

TO THE
FINAL ENVIRONMENTAL IMPACT STATEMENT
MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER LEVEES AND CHANNEL IMPROVEMENT

The responsible lead agency is the U.S. Army Corps of Engineers (USACE). The final Supplemental Environmental Impact Statement (SEIS) is a joint effort of the USACE Vicksburg, Memphis, and New Orleans Districts. Responsible cooperating agencies include the U.S. Fish and Wildlife Service; Natural Resources Conservation Service; and the U.S. Environmental Protection Agency.

Abstract: The Refined 1973 Mississippi River and Tributaries (MR&T) Project Design Flood (PDF) Flowline demonstrates the need to enlarge and improve portions of the levee system to protect against the PDF. The 1973 flowline is the basis for the design of the mainline levee system currently under construction. The scope of the proposed action includes all remaining levee enlargement and seepage control measures on the mainline levee system. The SEIS evaluates potential direct, indirect, and cumulative impacts for an array of alternatives including No Action, Nonstructural Alternative (Plan 1), and Structural Alternatives (Plan 2), Traditional Method (Plan 3), and Avoid and Minimize (Plan 4).

The recommended plan is Plan 4. The proposed work for Plan 4 in the Memphis District includes 31.8 miles of levee enlargement and 74.3 miles of seepage control construction; within the Vicksburg District, 216.8 miles of levees would be enlarged and raised to grade with placement of approximately 57.4 miles of seepage control measures; and in the New Orleans District, improvements would include enlargement of 14.2 miles of deficient levee and construction of 0.1 mile of berm. The proposed action includes 128 potential work items, 31 in the Memphis District, 85 in the Vicksburg District, and 12 in the New Orleans District. The recommended plan has a first cost of $656 million.

The proposed levee enlargements and seepage control measures would provide protection against the PDF, reducing the likelihood of catastrophic damages to agricultural properties, urban structures and property, and rural residences. Unavoidable adverse impacts to terrestrial, wetland, and waterfowl resources would result from the recommended plan; however, extensive environmental design and avoid and minimize features have been incorporated into the recommended plan to reduce environmental effects.

The recommended plan includes the construction of approximately 6,727 acres of borrow areas designed to improve aquatic habitat and fishery values and the reforestation of approximately 3,041 acres of borrow areas to provide wetland functional values and wildlife habitat. Significant unavoidable environmental losses would be fully compensated for by the acquisition and reforestation of approximately 5,863 acres of frequently flooded agricultural lands. These mitigation lands would compensate 100 percent of the wetland losses, 252 percent of the

terrestrial losses, and 412 percent of the waterfowl losses. The mitigation lands combined with the environmental design features would provide a net gain of 4,070 acres of bottomland hardwoods and 6,727 acres of aquatic habitat over the life of the project. As a result of the environmental design and compensation features, the recommended plan would result in a net gain in terrestrial, wetland, waterfowl, and aquatic resources in the project area.

THE OFFICIAL CLOSING DATE FOR THE RECEIPT OF COMMENTS IS 31 August 1998.
If you would like further information on this statement, please contact:

Mr. Marvin Cannon
U.S. Army Corps of Engineers
Vicksburg District
Planning Division - Environmental Branch
4155 Clay Street
Vicksburg, MS 39183-3435

Telephone: (601) 631-5437
E-mail: marvin.cannon@mvk01.usace.army.mil

Mr. Gary Young
U.S. Army Corps of Engineers
Vicksburg District
Planning Division - Environmental Branch
4155 Clay Street
Vicksburg, MS 39183-3435

Telephone: (601) 631-5960
E-mail: gary.young@mvk01.usace.army.mil

SUMMARY

SUPPLEMENT NO.1
MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

TO THE
FINAL ENVIRONMENTAL IMPACT STATEMENT
MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER LEVEES AND CHANNEL IMPROVEMENT

This final Supplement No. 1 to the Final Environmental Impact Statement (SEIS) was prepared by Geo-Marine, Inc. for the U.S. Army Corps of Engineers (USACE), Vicksburg District, under Contract No. DACW38-92-D-0018, Delivery Order No. 0011. The SEIS and supporting technical appendices are a joint effort of the USACE Vicksburg, Memphis, and New Orleans Districts with the Vicksburg District designated as the lead District. The SEIS augments the Final EIS, Mississippi River and Tributaries (MR&T) Project, Mississippi River Levees and Channel Improvement filed with the Council on Environmental Quality (CEQ) in April 1976.

The MR&T project has four major elements--levees to contain floodflows; floodways to pass excess flows past critical Mississippi River reaches; channel improvement and stabilization to provide efficient navigation alignment, increase flood-carrying capacity, and protection of the levee system; and tributary basin improvements. Prior to the 1973 flood, the Mississippi River mainline levees were designed and constructed based on the Project Design Flood (PDF) Flowline established from engineering studies completed in 1956. Stage-discharge information developed from the 1973 flood indicated that channel capacity of the lower Mississippi River had deteriorated. Therefore, after the 1973 flood, a study was undertaken to refine the project design flowline and resulted in the Refined 1973 MR&T PDF Flowline. This flowline demonstrated the need to enlarge and improve portions of the levee system to protect against the PDF. The Refined 1973 MR&T PDF Flowline is the basis for the design of the mainline levee system currently under construction.

The proposed action is to construct the remaining Mississippi River mainline levee enlargements and seepage control measures. The mainline levee system is an integral part of the overall MR&T project. The project area for the proposed action is within the Lower Mississippi River Valley between Cape Girardeau, Missouri and Head of Passes, Louisiana. Main stem project features are present along the Lower Mississippi River Valley in Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana. The SEIS evaluates potential direct, indirect, and cumulative impacts for an array of alternatives including No Action, Nonstructural, and Structural alternatives.

The SEIS defines significant resources of concern, evaluates impacts to significant resources from proposed flood protection and damage reduction alternatives and addresses mitigation measures to implement concurrently with project construction. The Project Report and mitigation, Section 404(b)(1) evaluation, public involvement, engineering, socioeconomics, aquatic, waterfowl, terrestrial, endangered species, neotropical migrants, wetland functional analysis, bats, cultural resources, recreation/esthetics, and water quality technical appendices support this SEIS and are referenced extensively. These appendices are incorporated by reference and should be referred to for specific methodologies and other detailed information.

Major Conclusions

Plan 4 - Avoid and Minimize, is the recommended plan. The recommended plan provides protection against the PDF flood thereby providing protection benefits to agricultural land, rural residences, urban structures, and property. This plan involves 31.8 miles of proposed levee enlargement and 74.3 miles of seepage control measures within the Memphis District; within the Vicksburg District, 216.8 miles of levees would be enlarged and raised to grade with placement of approximately 57.4 miles of seepage control measures; and in the New Orleans District, improvements would include enlargement of 14.2 miles of deficient levee, and construction of 0.1 mile of berm. The recommended plan includes 128 potential work items, 31 in the Memphis District, 85 in the Vicksburg District, and 12 in the New Orleans District. The recommended plan has a first cost of $656 million. Other alternatives addressed in the SEIS include Nonstructural Alternative (Plan 1), Structural Alternatives (Landside Borrow - Plan 2 and Traditional Method - Plan 3), and No Action.

In implementing the recommended plan, construction would be based on the engineering and environmental data of each proposed work item with avoid-and-minimize measures applied to the fullest extent practicable. This includes environmental design measures to avoid and minimize environmental damages to bottomland hardwoods (BLH). The general avoid and minimize design considerations involve relocating borrow areas, to the maximum extent practicable, to less environmentally sensitive areas.

Existing berm material would be used to enlarge the levee where it is environmentally, economically, and engineeringly feasible. Also, use of relief wells or cutoff trenches instead of berms to control seepage would be used where engineeringly and environmentally feasible. The relief wells or cutoff trenches would further minimize environmental effects from construction and operation.

In addition to the avoid and minimize features, the recommended plan also includes reforestation of selected borrow areas and incorporation of aquatic design features in the remaining borrow areas created during construction. An estimated 3,041 acres of borrow areas would be reforested in the Vicksburg and Memphis Districts. There was no opportunity for reforestation in the New Orleans District. Approximately 6,727 acres of borrow areas would incorporate aquatic design features to provide optimal habitat value to aquatic resources.

Unavoidable adverse impacts to terrestrial, wetland, and waterfowl resources would result from implementing the recommended plan; however, benefits to aquatic resources of the project area would result. Project design features have been developed, as presented in the SEIS, to reduce adverse impacts; however, compensatory mitigation measures would be implemented. Mitigation for the recommended plan includes reforestation of 5,200 acres of frequently flooded agricultural lands in the Vicksburg District, 639 acres in the Memphis District, and 24 acres in the New Orleans District. These mitigation lands would compensate 100 percent of the wetland losses, 252 percent of the terrestrial losses, and 412 percent of the waterfowl losses. The mitigation lands combined with the environmental design features would provide a net gain of 4,070 acres of bottomland hardwoods and 6,727 acres of aquatic habitat over the life of the project. The avoid and minimize features, in conjunction with 5,863 acres of compensation, would significantly reduce construction impacts and provide a net gain in terrestrial, wetland, waterfowl, and aquatic resource values over the life of the project.

Areas of Controversy

Some controversy exists over whether a nonstructural plan should be implemented to reduce flood damages and avoid environmental impacts in the project area, especially the clearing of BLH. To compensate or reimburse for existing damages, flowage easements could be purchased in lieu of providing flood protection from the PDF. As a projection of initial nonstructural requirements and cost, potential Mississippi River levee breaks at Lake Providence, Louisiana and Mayersville, Mississippi were analyzed. Such levee breaks could require the purchase of flowage easements on approximately 16 million acres. Assuming only a nominal cost per acre would yield a cost in the multibillion-dollar range for this single component of the overall flowage easement needs of the project area. Emergency disaster activities, traffic rerouting, and road and bridge structure and public utilities damages would also be overwhelmingly costly. In view of the magnitude of these costs, no attempt was made to estimate real estate acquisition costs, Public Law 91-646 costs, or expenses associated with acquiring any improvements that would be damaged by flooding, nor were provisions made to accommodate such factors as farm program disaster payments. Additional long-term major maintenance costs would be expected to be incurred during the remaining economic life of the project. However, neither the economic aspects of anticipated future levees rehabilitation due to crevasses nor additional augmentation of the easement area as unforeseen levee breaks occurred were calculated. Over time, more acreage would become subject to flooding. Additional easements would have to be acquired and some lands previously encumbered could require increased easement payments for more frequent flooding incurred due to upstream levee failures.

Nonstructural alternatives such as acquisition of flowage easements can be utilized only if they further a project purpose or there is some legal obligation for them. This alternative would not accomplish the congressional mandate to provide a prescribed level of flood protection. In view of this and considering the prohibitive costs, a nonstructural plan would not be implementable.

Some controversy also exists over the use of landside borrow. Twelve of the proposed items include landside borrow areas. Comments have been received requesting the USACE to locate all borrow areas landside of the levee. Comments and responses on this issue are contained in Appendix 5.

Unresolved Issues

There are no unresolved issues.

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

FINAL SUPPLEMENT NO.1 TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

FINAL SUPPLEMENT NO.1 TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

FINAL SUPPLEMENT NO.1 TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

FINAL
SUPPLEMENT NO.1 TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT AND SEEPAGE CONTROL

FINAL SUPPLEMENT NO.1 TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

MISSISSIPPI RIVER MAINLINE LEVEES ENLARGEMENT
AND SEEPAGE CONTROL

FINAL
SUPPLEMENT NO.1 TO THE
FINAL ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

LIST OF TABLES (CONTD.)

TABLE OF CONTENTS

LIST OF TABLES (CONTD.)

1.0 INTRODUCTION

1.1 General

The U.S. Army Corps of Engineers (USACE), Memphis, Vicksburg, and New Orleans Districts are jointly proposing to construct the remaining authorized levee enlargements and seepage control measures for the Mississippi River Levees (MRL) feature of the Mississippi River and Tributaries (MR&T) Project. This Supplement No. 1 to the Final Environmental Impact Statement (SEIS), MR&T Project, Mississippi River Levees and Channel Improvement presents direct, indirect, and cumulative environmental impacts of the recommended plan and other alternatives to the proposed action. The Final Environmental Impact Statement for the MR&T Project was filed with the Council on Environmental Quality in April 1976 (USACE 1976).

The MR&T Project has four major elements: 1) levees to contain floodflows; 2) floodways to pass excess flows past specific Mississippi River reaches; 3) channel improvements to provide an efficient navigation alignment and protect the levee system; and 4) tributary basin improvements. The MRL feature of the MR&T project is made up of 1,610 miles of existing levees and berms along the Mississippi River.

The project area is located in the Lower Mississippi Valley, a flat alluvial plain of about 35,000 square miles (Appendix 4, Plate 2). The valley begins just below Cape Girardeau, Missouri at Thebes Gap and extends 600 miles to the Gulf of Mexico. Valley width varies from about 30 to 125 miles. Portions of seven states are located in the area: Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana. The main hydrologic features of the project area are the Mississippi River and its major tributaries (see Appendix 6).

The project area for this SEIS is a long narrow corridor of about 2.6 million acres extending along the Mississippi River from near Cape Girardeau, Missouri to the Gulf of Mexico. It includes all lands and waters lying between the mainline Mississippi River levees, or bluffs where levees are absent, plus a zone extending 3,000 feet landside of the levees. The distance between the MRL levees that bound the project area ranges from about 1 to 15 miles. The project area is subject to periodic flooding from the Mississippi River and consists of large expanses of bottomland hardwood forests and agricultural lands interspersed with urban areas.

1.2 Mississippi River and Tributaries Project Authority

The Mississippi River Commission (MRC), created by Congress in 1879, was first authorized to spend Federal funds in 1880 for work on tributaries as necessary to protect the upper limits of any alluvial basin from floods. The 1916 flood prompted passage of the Flood Control Act of 1917. This Act stipulated that local interests were to furnish right-of-way, contribute a substantial percentage of construction costs, and maintain completed works. The second Flood Control Act, passed in 1923, clarified the jurisdiction of the MRC (USACE 1976).

The flood of 1927 was the most disastrous in the history of the Lower Mississippi River Valley, inundating about 26,000 square miles. This disaster emphasized the need for flood control in the Lower Valley and resulted in the Flood Control Act of 15 May 1928 (House Document [HD] 90/70/1), which committed the Federal Government to a definite program of flood control. This Act authorized general and progressive channel stabilization and river regulation from Cape Girardeau, Missouri, to Head of Passes, Louisiana. The MR&T project dates from this Act, which authorized the expenditure of $325 million for construction of a Federal project to provide flood control in the alluvial valley of the Lower Mississippi River and navigation from Cairo, Illinois to Head of Passes, Louisiana. Local interests were charged with furnishing rights-of-way for levees and minor maintenance after construction (USACE 1976).

Subsequent legislation and the experience of four major floods have resulted in many modifications to the 1928 Act. The Flood Control Act of 1928 has been amended by numerous acts, including the Flood Control Acts of 1934, 1936, 1938, 1941, 1946, 1950, 1954, 1962, 1965, and 1968, and the Water Resources Development Act of 1986. A summary of the authorization documents is given in Table 1 of the Project Report (Volume I). Levee construction was initiated by MRC in the 1880's and the engineering and construction capability exists for completion in 2020.

1.3 Historical Perspective of Flood Control in the Lower Mississippi River Valley

The Lower Mississippi River Valley is subject to frequent and severe floods. Major floods on the Lower Mississippi River may result from flooding on the Upper Mississippi River, or the Ohio River, or both, augmented by contributions from other major tributaries of the Lower Mississippi River. The flood season on the Mississippi River is usually from the middle of December through July. Major floods on the Ohio River generally occur between the middle of January and the middle of April. Major floods from the Upper Mississippi and Missouri Rivers usually occur between the middle of April and the last of July; and, from the Arkansas and White Rivers between the first of April and the end of June.

The first European explorer in the region, DeSoto, viewed the Mississippi River in 1541, and in 1543 the first record of a flood on the river was made. The necessity of flood control was recognized immediately by early settlers in the Lower Mississippi River Valley. When Bienville founded New Orleans in 1717, his engineer, de la Tour, opposed the location because the settlement would be periodically overflowed by the river. Bienville overruled this objection, so de la Tour began constructing the first levee system on the Mississippi, in New Orleans. The levee, completed in 1727, was 3 feet high, 5,400 feet long, and 18 feet wide at the top, and had a roadway on its crown.

As settlements developed along the river, the levee system was extended. By 1735, the levee lines on both sides of the river extended from 30 miles above New Orleans to 12 miles below the city. The expense of constructing this system was borne by those who owned land fronting the river. Although the system represented extraordinary efforts, the works were of insufficient strength and were crevassed at many points by the flood of 1735, which lasted for almost six months. In 1743, the French colonial government required landowners to complete their levees by January 1, 1744, or forfeit their lands to the French Crown. By 1812, when Louisiana was admitted to the Union, the levee system extended up to Baton Rouge on the east bank and to the vicinity of Morganza, 40 miles upriver from Baton Rouge, on the west bank. By 1844, in spite of several damaging floods, the levee system was continuous from 20 miles below New Orleans to the mouth of the Arkansas River on the west bank, except for a gap at Old River, and to Baton Rouge on the east bank. Many isolated levees also extended along the lower part of the Yazoo Basin. Efforts thus far to control Mississippi River floods had been almost entirely local in nature, with individual landowners bearing all costs.

Federal efforts to improve the Mississippi River for navigation began in 1820, when Congress appropriated funds for the preparation of a survey, maps, and charts of the Ohio and Mississippi Rivers. By this time, river navigation was well developed; the steamboat had made its appearance eight years before, and the need for navigational improvements on the nation's major rivers was becoming increasingly apparent.

In 1824, the USACE began removal of snags in the Mississippi River below the mouth of the Missouri. Intermittent surveys and attempts at navigation improvements followed. As the importance of the river grew and the country expanded, Congressional attention was increasingly directed to river improvements as a Federal responsibility, but the emphasis remained almost entirely on navigation. By the mid-1840's, flood control was also considered, and began to gain official recognition through conventions and proposed legislation.

The destructive floods of 1849 and 1850 created widespread concern in the Lower Mississippi River Valley, focusing national attention on the problem. The result was Congressional passage of the Swamp Acts of 1849 and 1850. These acts granted states all unsold swamp and over-flowed lands within their borders and provided that funds derived from sale of these lands be applied to drainage, reclamation, and flood control projects. This attempt to secure flood protection failed from lack of coordination between the States and the levee districts involved. In 1850, as a further expression of national interest, Congress appropriated $50,000 for a river survey by the USACE.

During the Civil War, flood control work halted and many levees were destroyed by floods or by the contending armies. By 1878, hundreds of miles of mainline levee had disappeared entirely or been rendered inoperative. The need for more substantial coordinated Federal participation in navigation and flood control improvements was generally recognized by 1879. The need to coordinate engineering operations through a centralized organization was apparent. On 28 June 1879, Congress established the MRC " . . . to take into consideration and mature such plan or plans and estimates as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade, and the postal service . . ."

In 1880, in its first report, the MRC recommended navigation and flood control improvements. The following year Congress appropriated $1 million to the MRC for the construction of improvement works, stipulating that the funds be spent only for deepening or improving the river channel.

Levee work for channel improvement began in 1882 and marked the beginning of construction of a coordinated levee system for the Lower Mississippi River. By 1906, navigation improvement of the lower reaches of the river had been effected by dredging, bank protection with heavy willow mattresses had been successfully developed, and extensive levee work was being conducted below Cairo. However, flood control benefits remained incidental.

As a result of the devastating floods of 1912 and 1913, the President directed the MRC to submit a special report on flood prevention. This report considered levees, reservoirs, cutoffs, outlets, diversion channels, and reforestation, with levees identified as the only practical method for immediate relief. Congress did not authorize a comprehensive flood control plan for the alluvial valley, and MRC operations remained limited primarily to levee repair and navigation channel maintenance. The Flood Control Act of 1928 provided the authority for levee construction for flood control purposes.

1.4 Project Purpose and Need

The Mississippi River mainline levees protect the Lower Mississippi River Valley from the Project Design Flood (PDF) by confining flow of the leveed channel, except where it enters natural areas or is diverted purposely into the floodway areas. The PDF is defined as the greatest flood having a reasonable probability of occurrence. The Mississippi River mainline levees were designed and constructed based on studies completed in 1956. Details on the establishment of the 1956 flow line are contained in Appendix 6 of the Project Report.

The major flood event of 1973 resulted in reevaluation of the flowline elevations. Following the flood event, a study was undertaken to adjust the 1956 flowline using hydrologic data collected during the flood. The resulting adjusted 1973 Project Design Flowline was then used to raise the most deficient problem areas. Subsequently, detailed hydrographic and overbank surveys were made to accurately define the geometric properties of the leveed channel and overbank area. The 1974 high water and 1975 flood produced additional hydrologic data of value in the analyses. Further study, using the design flows determined in 1956 which were ascertained to be applicable to current river conditions, included the use of a math model, a physical model and other related studies. The water surface data obtained from the math model was supplemented with data from the physical model. The other studies included a detailed analysis of the magnitude of the "loop" effect that could be expected for flows of the magnitude of the project flood and an analysis of the magnitude of the additional loss of channel efficiency (future deterioration) that could be expected. The "loop" effect and future deterioration were added to water surface elevations obtained from the math and physical models. The resulting flowline is the Refined 1973 MR&T Project Flood Flowline (USACE 1998f). This flowline is the basis for the design of the levee system under construction. The Vicksburg District Refined 1973 Project Design Flood Flowline and existing levee grades are shown on Plates 3a, 3b, and 3c in Appendix 4.

The 1993 and 1995 floods revealed significant upward changes in stage-discharge relationships on the Upper Mississippi River. The higher than expected water surface elevations experienced during the flood of 1995 on the reach of the Mississippi River above Cairo, Illinois indicated that significant changes in the floodplain have occurred from the conditions used to develop the 1956 PDF. Therefore, the MR&T Project design flowline from Cairo to Cape Girardeau was revised in 1996. The revision was based on available data and analyses of river hydraulic and hydrologic parameters. Two private levees (Powers Island levee and the Miller City levee) located in the Upper Mississippi River Commerce to Birds-Point reach are factors in the changed floodplain conditions. Earlier, these private levees have tended to fail during floods, permitting partial conveyance of flow through the floodplain. In recent years these levees have demonstrated greater resistance to failure, resulting in higher than expected flowlines against the project levee. Table 1-1 presents PDF flowline elevations for selected locations along the Mississippi River through time.

With the revision in flowline elevations, there have been concurrent revisions to the project design levee grades. No further revisions to the flowline are anticipated for an indefinite period of time. The project levee grade is the top elevation of the levee, which is higher than the project flowline due to freeboard. Design freeboard is the vertical [design] height of a levee above the estimated flowline of the PDF. The actual height of an existing levee above the maximum flowline of the PDF is the available freeboard. Table 1-2 presents changes in design levee grade over time for selected locations along the Mississippi River.

Table 1-1. PDF Flowlines Through Time for Select Locations.			
Location	1956 Flowline Elevations Ft (NGVD)	1973 Refined Flowline Elevations Ft (NGVD)	1996 Flowline Elevation Ft (NGVD)
Commerce	344.6	–	345.3
Cairo	333.2	333.0	333.0
New Madrid	307.2	307.9	–
Memphis	236.5	237.8	–
Helena	204.3	204.2	–
Arkansas City (New Location)	154.1	157.7	–
Vicksburg (Bridge)	104.4	109.2	–
Natchez	80.0	85.3	–
Red River Landing	61.0	64.8	–
Baton Rouge	45.3	46.1	–
Carrollton Gage	19.8	19.8	–
Fort Jackson	7.5	9.2	–

Source: USACE 1998f

Table 1-2. Design Levee Grades Through Time.								
	Elevation (Feet, NGVD)							
LOCATION	1861	1899	1914	1928	1941	1956	1973	1996
Commerce	–	–	–	–	–	347.6	–	348.3
Cairo	–	–	–	–	–	335.2	335.0	335.0
New Madrid	–	–	–	–	–	310.2	31.9	–
Memphis	–	–	–	–	–	239.5	240.8	–
Helena	–	–	–	–	–	207.3	–	–
Arkansas City (Old Location)	–	155.0	157.2	160.2	159.6	158.8	162.5	–
Vicksburg (Bridge)	–	–	–	–	107.0	107.4	112.2	–
Natchez	–	–	–	–	84.1	83.0	88.3	–
Red River Landing	54.3	57.1	61.1	64.1	64.1	64.0	68.8	–
Baton Rouge	–	–	–	–	–	48.3	49.1	–
Carrollton Gage	–	–	–	–	–	25.5	25.4	–
Fort Jackson	–	–	–	–	11.5	13.2	—	–

Source: USACE 1998f.

The 1973 PDF flowline and the 1996 reanalysis of the project flowline in the Commerce to Cairo reach indicate that the mainline levee system is deficient by varying amounts in various reaches. The purpose of the proposed action is to raise and stabilize portions of the levee system to protect against the PDF. Table 1-3 identifies the deficient levees by reach with the range of the deficiencies. The locations of the most deficient portions of the levees are in the vicinity of Mayersville, Mississippi on the east bank and Lake Providence, Louisiana on the west bank.

1.4.1 Public Concerns

The primary public concerns associated with implementing the proposed action are flood damage reduction and environmental protection. Significant flooding in the project area adversely impacts urban and industrial areas, rural residences, agricultural lands, drainage systems, public roads and bridges, and agricultural support services creating health, safety, and economic problems. Natural resource protection is also a significant public concern, particularly potential impacts to bottomland hardwoods (BLH) and their associated wildlife, wetland, and waterfowl values.

1.5 Planning Objectives

The goal of this SEIS is to evaluate potential direct, indirect, and cumulative impacts of providing flood protection to the Lower Mississippi River Valley from the PDF beginning at Cape Girardeau, Missouri, to Head of Passes, Louisiana, with an environmentally sustainable project. Objectives have been developed through problem analysis and a public involvement program and have provided the basis for formulation of alternatives, environmental design, impact assessment, evaluation and selection of a recommended plan, and development of compensatory mitigation for unavoidable losses. The objectives developed through project planning and public involvement include:

a. Provide flood protection from the PDF and maintain the structural integrity of the MRL system;
b. Develop an environmentally sustainable project by avoiding and minimizing adverse environmental impacts to the maximum extent practicable through modification of engineering designs and incorporation of environmental features; and
c. Compensate for unavoidable adverse effects on significant environmental resources of the project area concurrent with project construction.

1.6 Relevant Environmental Protection Statutes

The SEIS was prepared according to appropriate Federal environmental laws, Executive Orders, and policies including, but not limited to, the National Environmental Policy Act of 1969 (NEPA); the National Historic Preservation Act of 1966, as amended; the Archeological and Historical Preservation Act of 1974, as amended; and the Endangered Species Act of 1973 as amended. The status of compliance for the recommended plan with pertinent environmental laws, executive orders, memorandums of agreement, and permits is summarized in Table 1-4.

Table 1-3.
Levee Deficiencies by Reach.

Item Name	Approximate River Mile(s)[a]	Reach Length (miles)	Deficiency Range (feet)
New Orleans District Floodwall, LA	102L	0.5	3.0-5.0
Carrollton Levee Enlargement, LA	100.2-104L	1.8	1.5
Jefferson Heights, LA	104.3L	0.8	Cross Section Only
Hohen-Solms - Modeste, LA	179-185R	3.6	1.8
Carville-Marchand, LA	181-189L	1.2	1.1
Reveille-Point Pleasant, LA	198.5-205R	2.6	Cross Section Only
Baton Rouge Front Levee, LA	230L	0.2	3.0-5.0
5th Louisiana Levee District Enlargement, LA	317-319.4R	3.5	1.5
Vidalia-Morville, LA	357R-365R	11.7	3.8-7.0
Upper Lake Concordia - Vidalia, LA	366R-367R	7.8	2.0-5.0
Waterproof-Upper Lake Concordia, LA	368R-377R	14.3	2.5-5.0
St. Joseph-Waterproof, LA	380R-393R	15.3	2.0-3.5
Yucatan-Lake Bruin, LA	398R-401R	7.9	2.8-5.0
Point Pleasant-Yucatan, LA	407R-411R	9.5	1.8-3.0
Bayou Vidal-Elkridge, LA	414R-421R	10.5	2.2-3.0
Reid Bedford-King, LA	422R-428R	9.2	3.0-6.5
Willow Point-Youngs Point, LA	445R-461R	18.8	3.5-7.5
Brunswick-Halpino, MS	452L-460L	8.6	2.8-4.0
Magna Vista-Brunswick, MS	462L-467L	11.3	3.1-6.0
Tallula-Magna Vista, MS	475L-A-475L-B	10.0	3.3-4.0
Wilson Point-Point Lookout, LA	480R-489R	14.3	6.0-8.0
Carlisle-Tallula, MS	481L-490L	8.8	3.5-5.0
Valewood-Carlisle, MS	493L-498L	10.5	4.5-8.0
Carolina-Valewood, MS	502L	7.6	3.6-5.0
State Line-Wilson Point, LA	503R-506R	7.7	4.2-7.5
Lake Jackson-Palmetto, MS	509L-511L	7.1	2.0-3.5
Above Lakeport-Harwood, AR	520R-528R	8.6	2.0-4.0
James-Longwood, MS	521L	4.6	2.0-2.5
Avon, MS	526L	0.7	2.0-3.0
Sunnyside, AR	531R	3.2	3.0-3.5

Table 1-3. Levee Deficiencies by Reach.			
Item Name	Approximate River Mile(s)[a]	Reach Length (miles)	Deficiency Range (feet)
Leland-Vancluse, AR	536R	6.0	1.5-2.5
Luna-Leland, AR	541R	2.3	1.0-6.0
Below Arkansas City, AR	555R	0.5	0.5
Cairo, IL	2-13L (Upper MS)	11.0	0.4
Below Commerce, MO	30-39R (Upper MS)	10.0	1.0-3.0
BP-NM Floodway	890R	0.8	Levee Extension
St. Francis Levee District	743R	3.5	0.3
Tiptonville-Obion	820L-805L	6.5	Levee Extension

[a] R=right bank; L=left bank

Source: USACE 1998r.

Table 1-4

Compliance Status of the Recommended Plan Relative to Environmental Requirements and Protection Statutes

Item	Compliance
Federal Statutes	
Archeological and Historic Preservation Act	Partial Compliance
Clean Air Act, as amended	Full Compliance
Clean Water Act, as amended	Partial Compliance[a]
Coastal Zone Management Act, as amended	Full Compliance
Comprehensive Environmental Response, Compensation, and Liability Act of 1980	Full Compliance
Endangered Species Act, as amended	Full Compliance
Federal Water Project Recreation Act, as amended	Full Compliance
Land and Water Conservation Fund Act, as amended	Not Applicable
Marine Protection, Research and Sanctuaries Act	Not Applicable
National Historic Preservation Act, as amended	Partial Compliance
National Environmental Policy Act, as amended	Partial Compliance[b]
Rivers and Harbors Act	Full Compliance
Watershed Protection and Flood Prevention Act	Full Compliance
Wild and Scenic Rivers Act, as amended	Not Applicable
Farmland Protection Policy Act	Full Compliance
Native American Graves Protection and Repatriation Act	Partial Compliance
Executive Orders, Memorandums, etc.	
Flood Plain Management (E.O. 11988)	Full Compliance
Protection of Wetlands (E.O. 11990)	Full Compliance
Environmental Effects Abroad of Major Federal Actions (E.O. 12114)	Not Applicable
Environmental Justice in Minority Populations and Low-income Populations (E.O. 12898)	Full Compliance
State and Local Policies	
State Water Quality Standards	Partial Compliance[a]
State Air Quality Standards	Full Compliance
Land Use Plans	
No known land use plans would be affected by any of the alternatives.	

NOTES: Compliance categories:

Full Compliance. All requirements of the statute, E.O., or other policy and related regulations have been met at this stage of planning.

Partial Compliance. Some requirements of the statute, E.O., or other policy and related regulations remain to be met at this stage of planning.

Not Applicable. Statute, E.O., or other policy not applicable.

[a] Full compliance would be achieved upon issuance of each state's respective Water Quality Certification.

[b] Full compliance would be achieved upon issuance of the Record of Decision

1.6.1 Clean Water Act

The Section 404(b)(1) evaluation concluded that the proposed depositions of dredged and fill material associated with construction would be in compliance with the guidelines established by the Environmental Protection Agency (EPA) (Appendix 3). Pursuant to Section 404, public meetings to allow public comment on the discharge of dredged or fill material were conducted. Prior to construction a Section 401 water quality certificate will be obtained from each state in which a discharge will occur.

1.6.2 Executive Order on Floodplain Management

Executive Order (E.O.) 11988 directs Federal agencies to reduce flood loss risk; minimize flood impacts on human safety, health and welfare; and restore and preserve the natural and beneficial values served by floodplains. Agencies must consider alternatives to avoid adverse effects and incompatible development in the floodplain. If the only practical alternative requires action in the floodplain, agencies must design or modify their action to minimize adverse impacts.

Plan formulation included structural, non-structural, and no-action alternatives. There was no alternative for location of project works outside the floodplain. All structural alternatives would adversely impact the natural environment. However, the proposed levee enlargement and seepage control measures were designed to minimize environmental impacts (e.g., reduce clearing of BLH and construction within wetlands).

1.6.3 Executive Order on Wetlands

E.O. 11990 directs Federal agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands if a practical alternative exists. Furthermore, agencies shall consider the action's effect on (a) public health, safety and welfare; (b) maintenance of natural systems, including conservation and long-term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources; and (c) other wetland uses.

The proposed construction areas (rights-of-way and borrow areas) were located to minimize the impacts to BLH and farmed wetlands. The recommended plan includes compensation for unavoidable adverse wetland impacts that would be implemented concurrently with project construction.

1.6.4 Hazardous, Toxic, and Radioactive Wastes

Army Regulation 200-1, April 1990, and memorandum, ENVR-EH, 1 November 1990, subject: Real Property Transactions and Preliminary Assessment Screening (PAS), require a PAS for all real property transactions where the property is within the United States and involves a non-Army party.

A PAS determines whether hazardous, toxic, and radioactive wastes (HTRW) are stored, released, or disposed of on-site. The PAS develops sufficient information to (a) adequately assess health and safety risks, (b) define the nature, magnitude, and extent of any environmental contamination, and (c) identify potential liabilities of the real property transaction.

The risk of encountering HTRW within the boundaries of proposed work items of the Vicksburg and New Orleans Districts is low (Appendix 6) . The Memphis District has four work items with potential HTRW concerns. Project plan alternatives and HTRW response alternatives must be conducted for these items.

1.6.5 Consistency with Coastal Zone Management Program

The New Orleans District has determined that construction of the Carrollton feature (including a feasible 3.5-acre borrow area) is consistent, to the maximum extent practicable, with the guidelines of the approved state of Louisiana's Coastal Resource Program. The New Orleans District intends to mitigate for all lost wetland functions and all wildlife habitat losses associated with the borrow area. These losses would be mitigated within the Louisiana Coastal Zone. The mitigation would consist of the reforestation of approximately five acres of open land and low quality wooded wetlands with higher quality BLH species within the Bonnet Carre Spillway in St. Charles Parish (USACE, New Orleans District 1998). By letter of April 7, 1998, the Louisiana Department of Natural Resources, Coastal Management Division, agreed with the determination of the New Orleans District.

2.0 ALTERNATIVES

2.1 General

This chapter of the SEIS describes the alternatives that were evaluated. Several alternatives were developed to meet the purpose and needs for the proposed MRL construction work and to fulfill the specific project objectives. These were developed and evaluated by an interdisciplinary planning team of engineers, economists, archeologists, and biologists based on technical considerations and public concerns. A No Action Alternative, a Nonstructural Alternative, and three structural alternatives were developed and evaluated relative to the project objectives.

2.2 No Action

With the No Action Alternative, no new construction work to enlarge levees or provide for additional seepage control or frontal protection would be carried out, other than normal maintenance, repair, and replacement work. Existing levees, berms and floodways would provide the present degree of flood protection to the valley. The No Action Alternative would not provide protection from the PDF. The threat of catastrophic flooding and the attendant economic damages and impacts to the human environment from the PDF would remain. Local levee boards and the USACE would continue to expend a significant amount of public funds to fight floods, including temporarily raising levee reaches and sandbagging sand boils.

To provide data on the damages that would result from a failure of the MRL system, a study was conducted in FY 1997 at the direction of the U.S. Senate. Economic and social damages were estimated for crevasses in the MRL mainline levees at Mayersville, Mississippi, and Lake Providence, Louisiana located in the central Mississippi Delta region. The MRL levees at these two locations are presently below the elevation of the PDF and could be crevassed during overtopping of the deficient levee section by floodwaters. These levee failures would result in catastrophic flooding over approximately 25,000 square miles, directly affecting approximately 114,000 people, 40,000 residences, and 1,600 businesses in 12 counties and parishes along the river (USACE 1998r). The floodplain areas that would be inundated by these two failures of the MRL levees shown in Appendix 4, Plates 47 and 48. It was estimated that these two levees crevasses could potentially cause flood damages approaching \$5.0 billion--almost \$2.0 billion in the areas along the east bank of the Mississippi River, and \$3.0 billion on the west bank. These single events could impact 15 percent of the Mississippi River levee economic base area.

Mississippi River levees failures at other locations would cause even more astronomical damages and impacts region wide. In the total Mississippi River levee economic base area, there are approximately 4.6 million people and 1.6 million residences in 85 counties and parishes. This is 40 times the number of people and structures affected by the two hypothetical levee crevasses that were studied in detail. Based on this case study, damages to the entire project area could approach \$300 billion (USACE 1998r). Levee system repairs after such failures would only restore the levee grades to current conditions, leaving the valley still vulnerable to future floods.

2.3 Plan 1 - Nonstructural Alternative

Plan 1 represents a nonstructural alternative to structural flood damage reduction. The only practical non-structural measures for the project area are those that reduce existing damages and those that reimburse individuals or businesses for existing damages and reduce future damage potential. Non-structural measures which reduce damages were not applicable to levee overtopping and catastrophic levee failure. The Nonstructural Alternative that was developed includes the purchase of easements in lieu of providing flood protection from the PDF. Existing levee systems would be maintained as in the No Action Alternative. However, should the levee be overtopped and catastrophic levee failures occur, the levee would not be reconstructed.

Data from evaluation of the hypothetical levee failures presented in Section 2.2 were used to make an initial projection of flowage easement requirements and costs (USACE 1998r). This study indicated the need for flowage easements on 16 million acres to compensate for the damages for these two levee failure events alone. Assuming only a minimal cost per acre, these easements would cost in the multi billion dollar range. Emergency disaster activities, traffic rerouting, and road and bridge structures and public utilities damages would also be overwhelmingly expensive. In view of the large magnitude of these costs, no attempt was made to estimate real estate acquisition costs, Public Law 91-646 costs, or expenses associated with acquiring any improvements that would be damaged by flooding nor were provisions made to accommodate such factors as farm program disaster payments. This was unnecessary since easements would be purchased only from willing sellers and "at-risk" activities would be allowed to continue on easement lands.

Additional long-term major maintenance costs would be expected to be incurred during the remaining economic life of the alternative. However, the economic aspects of augmentation of the easement area as unforeseen levee breaks occurred were not calculated. Over time, additional easements would have to be acquired and potentially some lands previously encumbered could require increased easement payments for more frequent flooding incurred due to upstream levee failures.

2.4 Structural Alternatives

2.4.1 Plan 2 - Landside Borrow

Plan 2 includes continuing construction of the remaining levee enlargement, seepage control, and frontal protection items with all borrow material to be obtained from landside of the levees. Three landside borrow schemes were investigated: traditional landside borrow; traditional landside borrow with a forested buffer zone; and shallow landside borrow areas.

2.4.1.1 Plan 2A - Traditional Landside Borrow

Traditional landside borrow consists of purchasing rights-of-way for traditional rectangular borrow areas 8 to 10 feet deep in a band 2,000 to 3,000 feet from the landside toe of the levee where feasible (see Plate 49, Appendix 4). A minimum distance of 2,000 feet from the landside levee toe to the closest borrow area is required to prevent underseepage problems and a maximum of 3,000 feet from the landside levee toe was used as the outer limit on the distance to haul borrow for levee and berm construction. Suitable material would be excavated and used to enlarge the levee as shown on Plate 49 (Appendix 4) or to construct berms. The landside rights-of-way would be expensive. The extended borrow haul distance would also increase costs.

2.4.1.2 Plan 2B - Traditional Landside Borrow with Forested Buffer

This alternative consists of constructing deep (average eight feet) borrow areas and establishment of a forested buffer zone. The buffer zone would be approximately equal in size to the borrow area and would have a peripheral berm to reduce the amount of runoff containing agricultural chemicals from entering the borrow area (see Pate 50, Appendix 4). As for Plan 2A, borrow areas would be located within 2,000 to 3,000 feet of the landside levee toe. This design would isolate the borrow areas from the local drainage which carries pesticides, thereby improving water quality. However, this requires additional cost for engineering and design and lands and damages and would reduce replacement of borrow area waters lost to evaporation and seepage, especially during dry conditions.

2.4.1.3 Plan 2C - Shallow Landside Borrow Areas

Landside borrow areas would be excavated to a minimum depth of three feet, drained and reforested (Appendix 4, Plate 51). Borrow areas would be located within 2,000 to 3,000 feet of the landside toe of the levee. The use of shallow borrow areas would significantly increase rights-of-way requirements and project costs.

2.4.2 Plan 3 - Traditional Levee Construction Method

Plan 3 would consist of traditional methods for levee enlargement and the construction of berms and other seepage control features. There would be no new levee construction. New and innovative environmental design features would be used to reduce the cross-sectional area of the levees and to enlarge levees on the side requiring the least amount of material. Borrow areas would normally be located on the riverside of the levee at the nearest sites with suitable soils, and borrow pits would be excavated as deep as soil conditions would permit (Appendix 4, Plate 52). This plan would require no special configuration or location of the borrow areas other than for engineering purposes. No provisions would be made for drainage and reforestation or other environmental enhancement features for the borrow areas. However, studies have shown that many existing riverside borrow along the MRL areas are productive fish and wildlife habitat.

2.4.3 Plan 4 - Avoid and Minimize

Plan 4 considers innovative design and construction approaches to levee enlargements and seepage control. Construction would be based on the engineering and environmental data of each proposed work item with avoid-and-minimize design applied to the fullest extent practicable. This includes environmental design measures to avoid and minimize environmental damages to BLH. These measures include relocating borrow areas to less environmentally sensitive areas. Selected relocated borrow areas would also include environmental features such as varying depths, irregular shoreline, islands, and peripheral forested buffer as shown on Plate 56 (Appendix 4). Like Plan 3 borrow areas, a majority of Plan 4 riverside borrow areas would be replenished by normal river fluctuations.

Existing berm material would be used to enlarge the levee (see Plate 53, Appendix 4) where it is environmentally, economically, and engineeringly feasible. The excavated berm would be backfilled with material dredged from the river (see Plates 54 and 55, Appendix 4). The temporary narrow path for the dredge pipeline from the river to the berm site would minimize environmental effects. Plate 29, Appendix 4, shows the locations of proposed work items 498.0-L, 497.0-L, 495.0-L, and 493.0-L (these items have been combined and renamed Item 496-L) and the proposed dredge site locations in the Mississippi River that would be used for borrow to construct these work items. The use of relief wells or cutoff trenches to control seepage instead of berms would be used where engineeringly and environmentally feasible. These measures would further minimize environmental effects .

2.5 Evaluation of Alternatives

A preliminary screening of the No Action, Nonstructural and Structural Alternatives was performed using the planning objectives and input from the public involvement program. As a result it was determined that Plan 1 (Nonstructural Alternative) and Plan 2 (Landside Borrow) did not merit further analysis, while the No Action Alternative, Plan 3 (Traditional Method), and Plan 4 (Avoid and Minimize) would be evaluated in detail.

2.5.1 The Preliminary Screening of Alternatives

Plan 1 (Nonstructural Alternative) would not meet the planning objectives. Protection from flooding from the PDF would not be provided. In addition, Plan 1 would be prohibitively expensive and would have significant adverse effects on the economy and society of the Lower Mississippi Valley. This alternative would be unacceptable to a majority of the public and local interests. Given these considerations, Plan 1 would not be implementable and, therefore, was eliminated from further consideration and detailed analysis.

Plan 2 (Landside borrow) was eliminated from further study for several reasons, including: (a) it would have the highest cost due to the greater land value; (b) it would not be acceptable to a majority of land owners and local sponsors in the project area; (c) environmental benefits would be relatively small compared to other structural plans; and (d) the adverse environmental impact associated with the risk to public health from the consumption of fish containing high levels of pesticides.

Many landowners would object to locating borrow areas in their cultivated fields and taking this land out of production. Therefore, the potential for willing sellers project-wide would be greatly reduced and the use of land condemnation to acquire rights-of-way would likely increase. In addition, the local public would not generally favor removal of additional lands from property tax rolls in a region where large amounts of land have already been taken by the Federal Government for various projects. Many local sponsors would also resist landside borrow because of statutory requirements and prior commitments. In Louisiana, state law allows levee districts to obtain borrow material for levees from the batture. In Mississippi, levee boards already own considerable amounts of land previously purchased for use on levee rights-of-way and borrow areas.

Poor water quality would be a concern in landside borrow areas and these areas would not experience periodic flooding. Consequently, landside borrow areas would have lower fish and wildlife habitat values and less recreation and sport and commercial fishery benefits than riverside borrow areas. Studies have demonstrated that MRL borrow areas that flood more frequently and for longer durations have higher quantities of sport and commercial fishes (Cobb et al., 1985). Landside borrow areas would have no value as a nursery for riverine fishes nor would they contribute nutrients to the river system. Environmental design features to significantly increase the habitat value of landside borrow areas would be very expensive because of the relatively large amount of land that would be required for this purpose.

2.5.2 Comparison of Plans

Plan 4 was selected as the recommended plan because it would provide flood protection from the PDF, minimizes unavoidable environmental impacts to a larger degree than Plan 3 (see Chapter 4) and, compared to the No Action Alternative, would provide a net gain in wetland, terrestrial, waterfowl and aquatic resources as a result of environmental design features and compensatory mitigation (see Section 5). Plan 3 would impact 24,956 acres with approximately 50 percent of these lands being wetlands and/or BLH wetlands. Plan 4 would impact 19,900 acres with approximately 33 percent of these lands being wetlands and/or BLH wetlands. Plan 4 reduces the total impacted acreage by 20.2 percent, wetlands by 37.1 percent and BLH by 58.3 percent. The no-action alternative would avoid any adverse impacts and the existing environmental values would continue over the 100-year period of analysis.

2.6 Recommended Plan

Plan 4 (Avoid and Minimize) is recommended for construction of the remaining MRL levee items. This plan fully meets all of the planning objectives and is considered cost effective and implementable. With this plan, borrow areas would be relocated to less environmentally sensitive areas to avoid and minimize impacts to BLH forests and wetlands. The MRL levees would be constructed to the design grade as determined by the Refined 1973 Project Design Flowline. In addition, where water seepage threatens levee stability, berms or other seepage control measures would be installed. Relief wells or cutoff trenches would be used in lieu of berms where engineeringly feasible to further minimize environmental effects. Stability berms would also be constructed at levee locations with poor soil foundations.

Plan 4 is an environmental design that incorporates measures to avoid and minimize environmental damages to BLH and wetlands. To develop the layout of the plan, interdisciplinary teams of state and Federal agencies representatives, local sponsors, and USACE staff were formed. They initially focused on relocating the construction borrow areas using the following placement prioritization criteria as a guide:

a. Landside cropland from willing sellers.
b. Landside cropland when riverside locations were unavailable.
c. Riverside prior-converted cropland.
d. Riverside tree plantations.
e. Riverside farmed wetlands (cropland).
f. Riverside farmed wetlands (pasture).
g. Riverside herbaceous wetlands.
h. Riverside forested non-wetland.
i. Riverside forested wetland.
j. Landside and riverside BLH with black bear presence.
k. Landside cropland condemnation.

However, as various methods of construction were evaluated for each work item, it became apparent that the prioritization criteria could not be strictly and consistently applied to the entire MRL study area. For example, in the New Orleans District, the area between the top bank of the river and the levee is relatively narrow and often developed, whereas in the Vicksburg District these areas are relatively wide and undeveloped. Riverside land use in the Vicksburg District is split between cropland and forested, but in the Memphis District the riverside land use becomes predominantly cropland.

Rather than apply the prioritization scheme mechanically, the study team evaluated each individual item, and applied the avoid and minimize techniques as was most reasonable, considering the environmental, economic, and engineering solutions available to the team.

In addition to the avoid and minimize features, the recommended plan also includes reforestation of selected borrow areas and incorporation of aquatic design features in the remaining borrow areas created during construction. An estimated 3,041 acres of borrow areas would be reforested in the Vicksburg and Memphis Districts. There was no opportunity for reforestation in the New Orleans District. Approximately 6,727 acres of borrow areas incorporate aquatic design features to provide optimal habitat value to aquatic resources.

The mitigation plan includes the reforestation of approximately 5,200 acres of frequently flooded agricultural lands in the Vicksburg District, 639 acres in the Memphis District, and 24 acres in the New Orleans District. The avoid and minimize features in conjunction with 5,863 acres of compensation would significantly reduce construction impacts and fully offset unavoidable environmental impacts. The mitigation lands would compensate 100 percent of the wetland losses, 252 percent of the terrestrial losses, and 412 percent of the waterfowl losses. The mitigation lands combined with the environmental design features would provide a net gain of 4,070 acres of BLH and 6,727 acres of aquatic habitat over the life of the project.

More detailed information on the engineering features of the recommended plan is contained in Appendix 6. A summary of proposed features of the recommended plan by USACE District is presented in the following paragraphs.

2.6.1 Features of the Recommended Plan

2.6.1.1 Memphis District

The Memphis District has 31 work items. The breakdown by state includes 6 items in Illinois, 1 item in Kentucky, 2 items in Tennessee, 3 items in Mississippi, 13 items in Missouri, and 6 items in Arkansas. Through Fiscal Year (FY) 97, the Memphis District has completed, to approved grade and section, 606 miles of the authorized 637.8 miles of mainline Mississippi River levees. Approximately 1.1 miles of new levee construction was completed in FY 97. No new levee construction is planned for FY 98. Through FY 97, approximately 266.5 miles of seepage control features (berms, relief wells, and slurry trench cutoffs) have been constructed in the Memphis District, out of the authorized 340.8 miles planned. In FY 98, approximately 5 miles of additional seepage control works are scheduled to be completed, which leaves about 70 miles remaining after FY 98. The proposed work for individual items is described in detail in paragraphs 97 -129 of Appendix 6.

The Drinkwater Pumping Station is located within the Memphis District in Mississippi County, Missouri, approximately five miles southwest of Cairo, Illinois on the right descending bank of the Mississippi River. The facility provides a drainage outlet for the Big Lake Basin area into the Upper Mississippi River at approximately River Mile 22. Under existing conditions the plant has two 75 cubic feet per second (cfs) pumps for a total capacity of 150 cfs, permitting drainage of the basin during high water conditions in the Upper Mississippi River. The capacity of the plant must be increased to accommodate increased seepage flows from the installation of seepage control measures. Without increasing the station capacity to accommodate the seepage flow, approximately 5,400 acres of agricultural lands would be negatively impacted. The additional pumping capacity necessitated by the relief wells is estimated to be approximately 150 cfs. The increased pump capacity would result in a with-project exceedance duration curve about equal to that for existing conditions. Final design capacity of the plant may vary, resulting in an actual exceedance duration curve slightly different from that presented in Appendix 6. The *Water Control/Operations Manual* for Drinkwater Pumping Station would be modified to minimize any changes to current landside hydrology with the additional pumps in place. Detailed information on the Drinkwater Pumping Station is given in paragraphs 48 - 50 of the Appendix 6.

The proposed Tiptonville-Obion Levee Extension and Obion River Diversion work item was authorized for construction by the Flood Control Act of 24 July 1946 and amended by the River Basin Monetary Authorization Act of 1971. The authorized levee extension would be located along the left bank of the Mississippi River in Dyer and Lauderdale Counties, Tennessee. The levee would extend from the existing levee, which ends near the Dyer-Lauderdale County line, approximately 7.6 miles to the mouth of the Middle Fork of the Forked Deer River. Approximately 21 miles of the Tiptonville-Obion levee were completed in the early 1960's, but construction was stopped at the Dyer-Lauderdale County line because of a lack of support from Lauderdale County residents and adverse environmental impacts. Additional detailed studies would be required to determine if there is a flood control plan for this area that is feasible and acceptable to local and environmental interests. The USACE Memphis District does not anticipate implementing this feature; therefore, this proposed work item was not included in the SEIS analysis.

2.6.1.2 Vicksburg District

The Vicksburg District has 85 work items. They include 37 items in Mississippi, 11 items in Arkansas, and 37 items in Louisiana. Through FY 97, the Vicksburg District has completed, to approved grade and section, 240 miles of the authorized 460.4 miles of Mississippi River levees and 251.8 miles of the authorized 309.2 miles of seepage control measures. Work currently under construction and scheduled for award in FY 98 totals about 32.3 miles of levees and 13.4 miles of berms, which leaves approximately 188.1 miles of levees and 44 miles of berms remaining after FY 98. The proposed work for individual items is described in detail in paragraphs 130 -215 of Appendix 6.

2.6.1.3 New Orleans District

The New Orleans District has 12 work items, of which all are in Louisiana. Through FY 97, the New Orleans District has completed to approved grade and section almost 478 miles of the authorized 511.6 miles of Mississippi River levees. Work currently under construction and scheduled for award in FY 98 totals about 20 miles, which leaves approximately 14 miles remaining after FY 98. The 1.2 miles of berms authorized are virtually complete. The proposed work for individual items is described in detail in paragraphs 216 - 228 of Appendix 6.

2.7 Comparative Impacts of Alternatives

Table 2-1 presents a summary of the direct, indirect, and cumulative impacts, beneficial and adverse, for the No Action Alternative and Plans 3 and 4 (Structural Alternatives).

Table 2-1.
Comparative Impacts of Alternatives.

Resource Items	No Action	Plan 3 Traditional Construction	Plan 4 Avoid and Minimize
Waterfowl	Existing conditions would continue - 29,741, 332 average annual DUDs	Average annual loss of 215,580 DUD in the Memphis District and 323,539 in the Vicksburg District.	Average annual loss of 134,942 DUD in the Memphis District and 199,440 in the Vicksburg District. Compensation would be 1,423 ac of BLH reforestation.
Terrestrial Resources	Existing conditions would continue - 1,021,710 ac of BLH habitat within the project area.	Net loss of 19,565 AAHUs. 11,584 ac of BLH converted.	Net loss of 6,861 AAHUs. 4,834 ac of BLH converted. Mitigation would be 2,326 ac of BLH reforestation. Additional 3,041 acres of borrow areas reforested with BLH as environmental design.
Bats	Existing conditions would continue.	Species specific impacts - an increase in cleared areas would benefit species utilizing these areas but would adversely impact woodland dependent species.	Species specific effects - reforestation would benefit species inhabiting woodlands but negatively impact species utilizing open areas.
Neotropical Migrants	Existing conditions would continue.	Conversion of breeding, resting, and foraging habitat to project features.	Conversion of breeding, resting, and foraging habitat to project features. Reforested areas would replace lost habitat.
Wetland Resources	Existing conditions would continue - 1,022,357 ac of wetlands	Conversion impacts on 8,995 ac of forested and 2,659 ac of farmed wetlands. Results in a loss of 54,075 AAFCUs.	Conversion impacts on 3,691 ac of forested and 3,637 ac of farmed wetlands. Results in loss of 25,035 AAFCUs. Mitigation would be 5,863 ac of BLH reforestation. Additional 3,041 acres of borrow areas reforested in BLH as environmental design.
Aquatic Resources	Existing conditions would continue. Aquatic borrow area habitat would remain at 10,073 ac and 32,085 AAHUs	An additional 11,817 ac of aquatic habitat. Net gain of 30,549 AAHUs.	Addition of 6,727 ac of aquatic habitat that incorporate aquatic design features to provide optimal habitat value per ac -Net gain of 27,381 AAHUs.

Table 2-1.
Comparative Impacts of Alternatives.

Resource Items	No Action	Plan 3 Traditional Construction	Plan 4 Avoid and Minimize
Endangered Species	Existing conditions would continue.	BA concluded no affect. USFWS concurred.	BA concluded no affect. USFWS concurred.
Cultural Resources	No construction-related impacts. Existing conditions continue.	No impact expected. All sites eligible for or listed on the NRHP would be avoided. Where unavoidable, mitigation as coordinated with respective SHPOs would be utilized.	No impact expected. All sites eligible for or listed on the NRHP would be avoided. Where unavoidable, mitigation as coordinated with respective SHPOs would be utilized.
Water Quality	Existing conditions continue.	No significant impacts expected to current water quality.	No significant impacts expected to current water quality.
Air Quality	Existing conditions continue. No direct impacts.	Short-term adverse impact due to increases in mobile emissions from construction work.	Short-term adverse impact due to increases in mobile emissions from construction work.
Socio-economics Resources	Continued risk of flooding of agricultural lands, rural residences, and urban structures and property - loss of crops, damage to property, and reduction in land values.	Flood reduction and catastrophic protection benefits to agricultural land, rural residences, and urban structures and property. Significant adverse impacts expected.	Flood reduction and catastrophic protection benefits to agricultural land, rural residences, and urban structures and property. Unavoidable significant adverse impacts would be fully offset through compensation.

Notes:
HU = Habitat Unit(s)
AAHU = Average Annual Habitat Unit(s)
BLH = Bottomland Hardwood
FFAL = Frequently Flooded Agricultural Land
AAFCU = Average Annual Functional Capacity Unit(s)
NRHP = National Register of Historic Places
SHPO = State Historic Preservation Office
DUD = Duck Use Day(s)

3.0 AFFECTED ENVIRONMENT

3.1 General Description

The project area extends approximately 600 miles and encompasses about 1,000 miles of the Mississippi River, from Cape Girardeau, Missouri to Head of Passes, Louisiana (Plate 2, Appendix 4). For purposes of environmental analysis, the project area consisted of all lands and waters within this 600 mile extent between the levees and all lands and waters adjacent and within 3,000 feet of the landside toe of the levees. The project area is dominated by forested wetlands (i.e. BLH) and agricultural lands (Table 3-1). It was assumed that current land distribution would be the without project condition over the project life.

Table 3-1.
Project Area Land Use (Acres).

Land Use	Nonwetland	Wetland	Total
Forested	385,456	636,254	1,021,710
Cropland	537,704	231,556	769,260
Urban/Industrial	71,570	4,594	76,164
Scrub/Shrub	23,939	43,440	67,379
Tree Plantations	27,887	22,584	50,471
Sandbar	3,790	45,600[a]	49,390
Pasture	22,854	19,536	42,390
Levee	26,990	0	26,990
Herbaceous	3,469	11,043	14,512
Marsh	0	5,925	5,925
Bare Soil	1,742	1,825	3,567
Subtotal	1,105,401	1,022,357	2,127,758
Open Water			518,086
TOTAL			2,645,844

[a]Jurisdictional (regulated) water of the United States but may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

3.1.1 General Features of the Lower Mississippi River

The Mississippi River has the third largest drainage basin in the world, exceeded in size only by the watersheds of the Amazon and Congo Rivers. It drains 41 percent of the 48 contiguous states. The Basin covers more than 1,245,000 square miles which includes all or parts of 31 states and two Canadian provinces. The main stem Mississippi River channel below Cairo, Illinois, carries runoff from approximately 922,000 square miles of drainage area concentrated at Cairo by the upper Mississippi and Ohio Rivers. Between Cairo and the Gulf of Mexico, the

Mississippi River system flow is augmented by runoff from approximately 324,000 square miles of intervening drainage area.

The Mississippi River Alluvial Valley averages approximately 60 miles in width varying from 30 to 125 miles. It projects inland from the Gulf of Mexico to the confluence with the Ohio River and gradually decreases in width upstream to about 40 miles at the confluence of the Ohio River. The Alluvial Valley is divided into a series of basins and sub-basins which have influenced development in the valley. Other prominent features include the steep bluffs that border portions of the valley and the uplands such as Crowleys and Sikeston Ridges which occur within the valley.

More detailed information on the tributaries and other water bodies, physiography, geology, and climate of the Lower Mississippi River Valley project area is given in the 1976 Final EIS (USACE 1976) and the Project Report for this SEIS (USACE 1998r) and are incorporated by reference, herein.

3.1.2 Significant Resources

The project area contains significant environmental resources. These were defined through agency and public scoping process as BLH forests, waterfowl, terrestrial resources, bats, neotropical migrants, wetlands, aquatic resources, endangered species, cultural resources, water quality, air quality, socioeconomics, and recreation/esthetics. Detailed descriptions of these resources and analyses of impacts are contained in the appendices accompanying this SEIS. General background information on biological resources of the project is given in the following reports: (a) 1976 Final EIS (USACE 1976), *(b) Environmental Inventory for the Mississippi River, Cairo Illinois, to Venice, Louisiana* (USACE 1973), (c) *Fishery and Ecological Investigation of Main Stem Borrow Pits along the Lower Mississippi River* (Cobb, *et al.* 1984), *(d) Environmental Design Considerations for Main Stem Levee Borrow its Along the Lower Mississippi River.* (Aggus and Ploskey 1986), *(e) Bird and Mammal Use of Main Stem Levee Borrow Pits Along the Lower Mississippi River* (Mississippi River Commission 1986) and (f) *A Physical Description of Main Stem Levee Borrow Pits Along the Lower Mississippi River* (Buglewicz, *et al.* 1988).

3.2 Waterfowl Resources

The Lower Mississippi River floodplain was historically a vast and diverse expanse of BLH forests, swamps, and bayous extending from southern Illinois and southeastern Missouri to the Gulf of Mexico and encompassed approximately 24 million acres. This area provided wintering habitat for a variety of waterfowl species, including dabbling ducks (genus *Anas*), diving ducks (genus *Aythya*), and geese (genus *Anser*, *Chen*, and *Branta*). As the area was developed and converted to cropland, much of the original diversity was lost. Waterfowl adapted to these changes and began utilizing flooded cropland and borrow areas.

Table 3-2 summarizes the available foraging habitat acres within the project area. The waterfowl analysis was conducted by the USFWS based on the caloric value of foraging habitat available to migratory waterfowl (Appendix 9). Impacts were measured in duck use days (DUD). One DUD is equal to the quantity of food required to feed one duck for one day.

Table 3-2. Acres of Habitat Available for Waterfowl Foraging (flooded 1 November - 28 February)[a].				
Land Use	Memphis	Vicksburg	New Orleans	Total
Soybeans	26,940	9,658	4,945	41,543
Rice	1,151	999	0	2,150
Corn	6,286	2,415	0	8,701
Moist Soil/ Fallow	4,145	4,532	525	9,202
Forested	61,785	47,338	25,193	134,316
TOTAL	100,307	64,942	30,663	**195,912**

[a]Riverside and landside of mainline levee system.

Based on the available waterfowl foraging habitat, there are 29,741,332 DUDs available under existing conditions within the project area. These DUDs would still be available over the project life with implementation of the no-action alternative.

3.3 Terrestrial Resources

3.3.1 Terrestrial Habitat

General terrestrial habitat types within the project area include agricultural land, forest land, and developed/residential areas. Agricultural lands and developed areas provide limited habitat for a few species (with the exception of waterfowl, see Appendix 9). BLH are the most significant terrestrial resources within the project area. The two dominant BLH communities are riverfront BLH and mixed BLH. Dominant species of the riverfront BLH communities include cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), and black willow (*Salix nigra*) while dominant mixed BLH species include pecan (*Carya* sp.), green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*), hackberry (*Celtis occidentalis*), oaks (*Quercus* spp.), and elm (*Ulmus* spp.) Other forested communities include tree plantations (e.g., cottonwood plantations).

Semi-aquatic mammals that inhabit the terrestrial habitat within the project area include such species as muskrat, nutria, swamp rabbit, mink, river otter, and beaver. Other land mammals present include wild turkey, white-tailed deer, striped skunk, cottontail rabbit, and bobcat. Aquatic foragers such as herons, egrets, and migratory waterfowl also use the area and wood ducks are a common resident. Typical species that use the agricultural lands include cottontail rabbit, mourning dove, raccoon, and opossum.

The USFWS Habitat Evaluation Procedure (HEP) was used to quantify baseline conditions and evaluate impacts to forested terrestrial habitats (Appendix 10). This study analyzed wildlife habitat data collected within the areas of direct impact (e.g., levee enlargement footprint areas and borrow areas). The HEP evaluation produced a habitat suitability index (HSI) value from 0.0 (unsuitable habitat) to 1.0 (optimum habitat) for each evaluation species. Habitat units are determined by multiplying the HSI values by the acres affected. One HU represents one acre of optimal habitat. Table 3-3 summarizes the terrestrial habitat quality of the impact areas within the project area. There are 1,072,181 acres of forested habitat (BLH and tree plantations) in the project area, representing 2,396,799 HUs. More specific information on the methodology and other details of terrestrial HEP evaluation are contained in Appendix 10. Implementation of the no-action alternative would avoid impacts to forested lands and the existing HUS would continue to be available over the project life.

3.3.2 Bats

Life history and habitat data for 14 species of bats were included in the review of potential impacts to these species (Appendix 14) . Bat habitat in the project area can be grouped into three broad categories: cleared land, open water, and woodlands (Table 3-4). While there are differences in the life histories of the 14 bat species, some generalized information was included for all species. Bats are nocturnal and venture out of daytime roosts when the weather is warm enough to feed in the evening, or night, on insects. Roosts that can be used include such places as crevices, buildings, garages, culverts, bridges, hollow trees, foliage of trees, loose bark on trees, and Spanish moss. Feeding areas can include areas above ponds and streams, areas near treetop level at the forest edge, zones among the canopy, and over clearings. Some species may migrate from north to south in the fall and hibernate in suitable retreats. Species in the southern part of their ranges can occasionally venture out on mild winter days. Young are usually born from late April to early June. Predators on bats can include such species as opossums, snakes, owls, and other predatory birds. Additional species-specific information regarding bats can be found in Appendix 14. Implementation of the no-action alternative would avoid the impacts to the bat habitat listed in Table 3-4.

3.3.3 Neotropical Migrants

Tropical deforestation and habitat degradation where neotropical migratory birds breed in North America have been proposed as causes of observed population declines of these species. However, there still remains some scepticism among scientists that the reported population declines represent actual threats to neotropical migrants. Additionally, the apparent overall population declines in certain species of migrants may be the result of regional population fluctuations related to regional breeding conditions rather than to any population-wide phenomenon.

Neotropical migratory birds known to regularly use or occupy the project area include 184 species representing 33 families (Appendix 12). Fourteen species are considered to be of management concern based on classifications made by the USFWS (1987, 1991). Species of management concern include the least bittern, American bittern, white-faced ibis, northern harrier, peregrine falcon, gull-billed tern, black tern, yellow-billed cuckoo, olive-sided flycatcher, loggerhead shrike, golden-winged warbler, cerulean warbler, prothonotary warbler, and Swainson's warbler. For additional information regarding neotropical migratory bird species, refer to Appendix 12.

Table 3-3.
Terrestrial HSI Values for Existing Conditions [a]

Evaluation Species	HSI for Riverside BLH	HSI for Landside BLH	HSI for Riverside and Landside Plantations
Memphis District			
Barred owl	0.67	0.46	N/A [b]
Fox squirrel	0.40	0.64	N/A
Carolina chickadee	0.86	0.84	N/A
Pileated woodpecker	0.35	0.21	N/A
Mink	0.58	0.00	N/A
Wood duck	0.47	0.00	N/A
Vicksburg District			
Barred owl	0.54	0.49	0.04
Fox squirrel	0.52	0.38	0.02
Carolina chickadee	0.64	0.64	0.00
Pileated woodpecker	0.28	0.28	0.00
Mink	0.74	0.62	0.00
Wood duck	0.40	0.07	0.00
New Orleans District			
Barred owl	0.36	N/A [c]	N/A [b]
Fox squirrel	0.13	N/A	N/A
Carolina chickadee	0.48	N/A	N/A
Pileated woodpecker	0.00	N/A	N/A
Mink	0.67	N/A	N/A
Wood duck	0.00	N/A	N/A

[a] HSI values were determined for the woodland zones that could be impacted by the project.
[b] No tree plantations would be affected.
[c] No avoid-and-minimize measures would result in a decision to relocate borrow areas in wooded landside areas.

Table 3-4. Existing Bat Habitat.			
	Memphis District	Vicksburg District	New Orleans District
Cleared Land[a]	502,146	286,792	99,935
Open Water[b]	1,340	5,794	2,939
Woodlands[c]	381,257	552,350	138,574

[a] Agricultural, pasture, herbaceous, and scrub/shrub lands.
[b] Aquatic borrow areas.
[c] Bottom-land hardwoods and tree plantations.

3.4 Wetland Resources

Significant nonmonetary values have been given at the national and international levels to preservation of BLH wetlands. In addition, Executive Order (E.O.) 11990 states that Federal agencies shall avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands.

Wetlands on agricultural lands were identified using procedures in the National Food Security Act Manual (3rd Edition). Because of the project's regional scale, offsite procedures were used to establish the approximate extent of jurisdiction. The Natural Resource Conservation Service (NRCS) was consulted for the off-site jurisdictional determination on agricultural lands. Offsite information was entered into a geographic information system (GIS) and used to produce preliminary jurisdictional maps which were ground-truthed by an interagency team represented by USACE, NRCS, Environmental Protection Agency (EPA), and USFWS. Because of the extensive project area, assumptions were made about vegetation, soils, and hydrology based upon preliminary field investigations and available statistical data. Detailed information on the assumptions and process used in the delineation is provided in Attachment 1 of Appendix 13.

Wetlands within the project area provide multiple functions including wildlife habitat, short- and long-term water storage, water velocity reduction, sediment detention, nutrient removal, prevention of shoreline erosion, and export of organic carbon to downstream aquatic ecosystems (USACE 1998m). A technical evaluation of the proposed project's impacts on wetlands was conducted using a semi-quantitative method developed by the Wetland Evaluation Work Unit of the Wetland Research Program at the USACE, Waterways Experiment Station (Appendix 13). Wetland functions evaluated were short-term water storage, long-term water storage, water velocity reduction, sediment detention, onsite erosion control, nutrient and dissolved substance removal, and organic carbon export. Wetland functional impacts were expressed as functional capacity units (FCU), which reflect both the quantity and quality of wetland functional values. FCUs were determined by multiplying the functional capacity index value for each function by the affected acreage. Forested and farmed wetland functional index values ranged from zero to one, with one representing optimal wetland value.

The project area is approximately 2,645,844 acres, of which 518,086 acres are open water and 1,022,357 acres (approximately 48 percent), are wetlands. Forested and cropland cover types account for 85 percent of the project area wetlands (Table 3-5). About 62 percent of the forested and 30 percent of the cropland areas of the total project area are wetlands (USACE 1998a). Existing wetland acreage represents 4,874,372 FCU's. These FCUs would still exist over the project life with implementation of the no-action alternative. Project wetland maps are in Appendix 4.

Table 3-5.
Project Area Wetlands.

Land Use	Wetland Acres	Total Acres
Forested	636,254	1,021,710
Cropland	231,556	769,260
Urban/Industrial	4,594	76,164
Scrub/Shrub	43,440	67,379
Tree Plantations	22,584	50,471
Sandbar	45,600	49,390
Pasture	19,536	42,390
Levee	0	26,990
Herbaceous	11,043	14,512
Marsh	5,925	5,925
Bare Soil	1,825	3,567
TOTAL	1,022,357	2,127,758

Source: USACE 1998m and Geo-Marine, Inc.

3.5 Aquatic Resources

The rise and fall of the Mississippi River produces spawning and rearing habitat for a variety of fish species throughout the alluvial flood plain. Oxbow lakes, borrow areas, and other permanent waterbodies benefit from this seasonal fluctuation and are replenished annually. There are approximately 43,000 acres of oxbow lakes created by cutoff channels (Banks 1996). The entire study area contains approximately 518,000 acres of open water (river, lakes, borrow areas, etc.). There are currently 38,000 to 42,000 acres of borrow areas in the lower Mississippi River (Baker et al., 1991), of which 10,000 acres hold water permanently.

Ninety-five distinct taxa of macroinvertebrates have been collected in borrow areas along the lower Mississippi River (Cobb et al., 1984). The borrow areas had similar species assemblages, but the relative abundance of taxa varied widely among borrow areas. *Chaoborus punctipennis, Tanypus stellatus*, and tubificid worms were the most abundant taxa. The average standing stock of benthic macroinvertebrates was comparatively high (19.8 mg/sample), providing an important food source for various fish species. The most diverse major groups of benthic macroinvertebrates were Diptera (33 taxa in 28 genera), Tubificidae (12 taxa in seven genera), and Naididae (12 taxa in five genera). Cobb et al. 1984 also compared borrow area data to data collected on Mississippi River flood plain lake assemblages, and concluded that it appeared the borrow areas along the lower Mississippi River had benthic macroinvertebrate assemblages similar in taxonomic composition to natural flood plain lake habitats.

Cobb et al. 1984, collected 58 fish species, but recent collections yielded 80 fish species in the borrow areas. The 80 species included 67 species observed by Baker et al. 1991 and 67 species observed by Killgore et al. (Appendix 8) in 1998. Of the 67 species documented by

Baker et al. 1991, 13 were not observed by Killgore et al, 1998. Killgore et al. 1998 collected additional species that were previously undocumented from the Lower Mississippi River Basin. In addition, 16 species were apparently restricted to borrow areas with riverine connections. Killgore et al. also reported that landside borrow areas contained substantially fewer species (27) than those that maintained seasonal riverine connections (67). The 80 fish species now known from the borrow areas suggests an icthyofauna second only to the lower reaches of tributary streams (Baker et al. 1991).

Cobb et al. 1984 found the number of fish per acre was 36 percent greater in riverside borrow areas than landside borrow areas. Killgore et al. also reported greater numbers of fish collected in riverside borrow areas. Cobb et al. 1984 reported an average of 595 pounds per acre of fish in the borrow areas, ranging from 51 to 3199 pounds per acre. The standing stock in the riverside borrow areas (774 pounds per acre) was significantly greater than that of landside borrow areas (448 pounds per acre). The standing stock of fish per acre in these borrow areas is often greater than most water bodies in the southern United States (Cobb et al. 1984). These areas are not only species rich and capable of producing large fish numbers and standing stock values, but they serve as important spawning and nursery areas (Cobb et al. 1984 and Killgore et al. 1998). Refer to Appendix 8 for more detailed discussions and citations.

In addition to the aquatic values provided by riverside borrow areas, they also provide valuable bird and mammal habitat. The U. S. Army Engineer Waterways Experiment Station (1986) conducted a 2-year bird and mammal borrow area utilization study in which they observed 23 mammal and 186 bird species utilizing borrow areas. Of the 186 bird species, 15 were waterbirds (herons, egrets, etc..), 16 were waterfowl, 17 were shorebirds (plovers, pipers, etc..), 7 were seabirds (gull and terns), 17 were raptors, owls, and vultures, 4 were upland species, 7 were woodpeckers, 9 were other nonperching birds (belted kingfishers, yellow-billed cuckoos, etc..), and 93 were songbirds. Ninety-four percent of all bird observations were of perching land birds (songbirds). Sixty-seven species were observed nesting in borrow area habitat. Individual bird observations were greatest at borrow areas with openland/scattered trees with no understory/intensively grazed, >1 mile from the river, and >30 acres. Waterbirds, shorebirds, and seabirds made greatest use of open borrow areas with scattered trees or pasture. The waterfowl, raptors, nonperching birds, upland gamebirds, and songbirds preferred wooded borrow area habitats. Because these groups represent the majority of the bird species, total species preference was for wooded habitats.

The 23 mammals included the beaver, bobcat, coyote, long-tailed weasel, mink, muskrat, nutria, racoon, red fox, river otter, eastern cottontail, eastern gray squirrel, eastern fox squirrel, swamp rabbit, white-tailed deer, armadillo, black bear, eastern chipmunk, opossum, rice rat, spotted skunk, striped skunk, and white-footed mouse. Mammals used all parts of borrow areas (extending 30 yards from all sides of the water's edge), including pools, levees, log and debris, islands, and berms and roads. Mammals at borrow areas had their greatest occurrence in ungrazed, bottom-land hardwood habitats, >1 mile from the river, and >30 acres.

Birds and mammals occurred in greater diversity at borrow areas surrounded by bottom-land hardwoods with good understory, infrequently flooded, >1 mile from the river and >30 acres. Some of the key recommendations that are compatible with design features for aquatic borrow areas are (a) allow for irregularly shaped shorelines, (b) create islands in the borrow area, and (c) create irregular bottoms, gently sloped shorelines areas, and shallow-water areas.

HEP was used to quantify the habitat quality of existing and potential borrow areas (Appendix 8). An interagency team selected five evaluation species which represented a broad range of habitat preferences, reproductive biology, and trophic levels. Models were developed to predict fish abundance from 1981, 1996, and 1997 field data. HSI values, ranging from zero to one, were developed for each species from these data. A HSI value of one represents optimal habitat quality. HUs for each species were determined by multiplying the HSI value by the borrow area acreage. There are approximately 10,000 acres of existing borrow areas that permanently hold water representing 32,085 HUs (Table 3-6). These HUs would still exist over the project life with implementation of the no-action alternative.

Table 3-6.
Existing Borrow Area Acres and Habitat Units by District.

District	Existing Acres	Habitat Units
Vicksburg	5,794	16,918
Memphis	1,340	4,087
New Orleans	2,939	11,080
TOTAL	**10,073**	**32,085**

3.6 Threatened and Endangered Species

The USFWS identified five threatened and endangered species of concern: pallid sturgeon (*Scaphirhynchus albus*), fat pocketbook pearly mussel (*Potamilus capax*), interior least tern (*Sterna antillarum*), bald eagle (*Haliaeetus leucocephalus*), and wood stork (*Mycteria americana*) (USACE 1998k). A copy of the USFWS coordination letter listing the species of concern for the project area is included as Attachment 2 to Appendix 11. Pursuant to Section 7 of the Endangered Species Act, a biological assessment (BA) for all species was prepared and is presented in Appendix 11. A portion of the proposed project is within the historic range of the threatened Louisiana black bear (*Ursus americanus luteolus*). A BA was prepared for the Louisiana black bear (USACE 1998k) and concluded that, with conservation measures included, the proposed project would have no direct, indirect, or cumulative adverse effect on the bear. The USFWS concurred with the "no effect" conclusion (Attachment 1 to Appendix 11).

3.6.1 Pallid Sturgeon

The pallid sturgeon was listed as endangered by the USFWS in September 1990. It is one of the largest fish found in the Missouri, Middle and Lower Mississippi, Platte, Kansas, Yazoo, Big Sunflower, Atchafalaya, and Yellowstone Rivers. The pallid sturgeon inhabits large, turbid, free-flowing riverine habitat with rocky or sandy substrates and is suspected to favor portions of streams where the strongest currents occur. In Mississippi, there are only two museum records of pallid sturgeon; one for the Mississippi River and one for the lower Big Sunflower River (USACE 1998k). For more information, refer to the pallid sturgeon section in Appendix 11.

3.6.2 Fat Pocketbook Pearly Mussel

The fat pocketbook pearly mussel was listed as endangered by the USFWS in June 1976. There are few published distribution records for the fat pocketbook pearly mussel with the majority of historic information based on museum collections. These collections appear to be from three areas: the Upper Mississippi River (above St. Louis, Missouri); the Wabash River, Indiana and Illinois; and the St. Francis River, Arkansas. Museum records indicate that the fat pocketbook pearly mussel is a large river species which requires flowing water and stable substrate, though it has been found in sand, mud, and fine gravel (USACE 1998k). For more information, refer to the fat pocketbook pearly mussel section in Appendix 11.

3.6.3 Interior Least Tern

The interior least tern was listed as Federally endangered in June 1985. Least terns are migratory shore birds that breed and rear young on islands along the Mississippi, Missouri, Arkansas, and Ohio River systems. Recent surveys indicate terns move in response to habitat changes. These surveys have also revealed much larger population numbers than expected, especially in the Lower Mississippi River. Interior least terns nest on large, isolated sandbars or on the upstream and high downstream sandy points of islands. Depending upon Mississippi River stages, the number of nesting colonies has ranged from a low of 37 to a high of 72. Forty-three nesting colonies were observed on approximately 700 miles of the river from near Cape Girardeau, Missouri to River Mile 300 (Old River Control Structure) during a 1994 survey (USACE 1998k). Interior least tern habitat is sparse below river mile 300 and coastal least tern populations become dominant below Baton Rouge, Louisiana. For more information, refer to the interior least tern section in Appendix 11.

3.6.4 Bald Eagle

The USFWS reclassified the bald eagle from endangered to threatened throughout the 48 contiguous states in July 1995. With the exception of extreme northern Alaska and Canada and central and southern Mexico, the bald eagle historically ranged throughout North America. Although breeding in bald eagles varies with latitude, the general tendency is for winter breeding in the south with a progressive shift toward spring breeding in northern locations. In the 17 years since it was listed throughout the 48 contiguous states, the bald eagle has increased in number and expanded in range. Scattered nests are known to currently exist along the Mississippi River within the project area (USACE 1998k). For more information, refer to the bald eagle section in Appendix 11.

3.6.5 Wood Stork

The wood stork was listed as Federally endangered in February 1984. The wood stork may have formerly bred in all the coastal southeastern states from Texas to South Carolina. Currently, United States breeding is restricted primarily to Florida. Another distinct, nonendangered population breeds from Mexico to northern Argentina. A post-breeding dispersal brings birds (Mexican population) north up the Mississippi River Valley. The current population of birds is believed to number 11,000 adults. Mexican immigrants number approximately 1,000 to 5,000 birds, depending on the year (USACE 1998k). For more information, refer to the wood stork section in Appendix 11.

3.7 Cultural Resources

Proposed work items received a literature and records review aimed at identifying significant cultural resources sites possibly affected by the proposed action. A report which details the methodologies and results of the literature and records review is contained in Appendix 15. A number of historic and/or prehistoric archeological deposits, and other cultural resources sites including standing structures and cemeteries are in the project area. Approximately 70 archeological sites, four cultural resources sites with standing structures, and six cemeteries dating to historic times are located at or very near the proposed work items. These resources, some of which are listed in, or potentially eligible for listing in, the National Register of Historic Places (NRHP), are described in Appendix 15 (USACE 1998o).

3.8 Water Quality

3.8.1 Mississippi River

The primary source of pollutants in the Mississippi River is nonpoint agricultural, and includes pesticides, herbicides, and fertilizers (EPA, 1988: USGS, 1996). However, water quality in the Mississippi River is within acceptable ranges most of the time.

From 1987 through 1992, the water quality of the Mississippi River and some of its tributaries was intensively studied by the U.S. Geological Survey (USGS), and as ample information already exists, no new general analysis of the water quality in the Mississippi River has been conducted for this study. From 1987-1990, USGS sampling was conducted between Winfield, Missouri (located approximately 62 miles upstream of St. Louis, Missouri), and New Orleans, Louisiana. During 1991-1992, the sampling program was expanded to include the Upper Mississippi River between Minneapolis, Minnesota, and Winfield, Missouri. Results of this sampling program (presented in multiple reports and summarized in USGS Circular 1133, *Contaminants in the Mississippi River, 1987-92*, indicated that nitrate, most likely from fertilizer, was the only nutrient compound that represents a problem within the Mississippi River system. USGS also concluded that nitrate concentrations in many tributaries in Iowa, Minnesota, and northern Illinois approach, and occasionally exceed, the EPA drinking water standard of 10 milligrams per liter (mg/L). For trace metals, the analysis concluded that concentrations dissolved in the water of the Mississippi River were well below EPA standards for drinking water and water that supports aquatic life. However, trace metals in the suspended sediments exceeded the pollution guidelines at many of the main stem sampling locations. While pesticides were detected and may have briefly exceeded health-based limits for drinking water, concentrations generally were highest during runoff from the first storms after application of the pesticides. The average annual concentrations of all pesticides measured in the Mississippi River were well below health-based limits (Appendix 17).

Table 17-2 (found in Appendix 17, provides historic water quality data for the Mississippi River at Memphis (17-2A), Vicksburg (17-2B), New Orleans (17-2C), and Venice (17-2D)) provides some indication of the water quality in the river and supports the conclusions by USGS. Nitrate levels exceed the Mississippi River benchmark of 1.0 mg/L at all stations in 75 percent of the samples. Total Kjeldahl Nitrogen (TKN) levels exceed the 1.0 mg/L benchmark in 50 percent of the samples at Memphis and in more than 25 percent of the samples at the other stations. Total phosphorus levels exceed the Mississippi River benchmark of 0.3 mg/L in 10 to 25 percent of the samples. Two sets of mean and range statistics are provided for dissolved trace metals in Table 17-2. The more recent data were compared to the aquatic life criteria. The FWA criteria are not exceeded at any station for any trace metal. Most of the states in the study area use only the FWA criteria to determine if a body of water supports aquatic life.

Although the FWA criteria are not exceeded by any trace metals, the FWC for some trace metals are occasionally exceeded. The FWC criterion for cadmium is exceeded by the 90th percentile level at Memphis and Vicksburg, while the FWC criterion for copper is exceeded by the 90th percentile level at Memphis. The FWC criterion for mercury is exceeded by the 90th percentile level at every station. The other percentile ranges exceed the FWC for mercury, but only the 90th percentile represents detected quantities. The detection limit for mercury also exceeds the FWC for mercury. Interpretation of data when the criterion is below the detection limit is difficult at best. The USGS used ultra clean sampling techniques during their study of Mississippi River contaminants. By using those techniques, they were able to achieve detection limits below the 0.012 ug/l FWC for mercury. Although some individual samples exceeded the FWC criterion, the average value at most stations was below the FWC level. Overall, the trace metal levels in the Mississippi River at all stations indicate that the waters support propagation of aquatic life. Pesticides were infrequently detected at all stations. The means of the detected samples for most pesticides are zero. This means that no pesticides were detected and that the value was incorrectly reported as zero with no "U" code. Only three pesticides were detected at all four stations. Each pesticide was detected only once. The three pesticides were dieldrin, DDT, and endrin. The detected value for each pesticide exceeded the respective FWC criteria.

Comparison of the historical data to the more recently collected data of the USGS and this study reveals significant differences. These differences are particularly evident in the trace metal data. While the historical data indicates some exceedances of water quality criteria, the more recent data indicates that the Mississippi River seldom exceeds any of the aquatic life criteria. These changes, which represent an improvement in water quality, are likely from two sources. The first is a real improvement in water quality resulting from better treatment of wastewater. The second is an apparent improvement resulting from better analytical techniques, which have lowered the limits of detection of many trace metals.

3.8.2 Borrow Areas

Water quality of existing borrow areas within the project area was determined by evaluating 17 riverside and five landside borrow areas along the Mississippi River within the project area (USACE 1998q). These borrow areas were created from previous levee work. One landside area and 12 riverside areas were evaluated during 1996. Five existing riverside areas (three in the Memphis District and two in the New Orleans District) and four additional landside borrow areas, all in the Vicksburg District, were studied in 1997. Three of the 12 areas in the Vicksburg District that were evaluated in 1996 were reexamined during 1997. In addition to the borrow areas, nine oxbow lakes or abandoned river channels along the Mississippi River were evaluated in 1997. Of these lakes and channels, four were in the Memphis District, four in the Vicksburg District, and one in the New Orleans District. Results of water quality analyses for existing borrow areas within the project area are briefly discussed in the following paragraphs and detailed in Appendix 17.

Since riverside borrow areas and the Mississippi River are hydraulically connected during high water, it is likely that a relationship exists between water quality of the riverside borrow areas and river. However, the hydraulic connection is not continuous and water quality in borrow areas can vary from that of the Mississippi River. A definitive relationship could not be established due to the limited water quality data set available and the many variables such as time of year, flow rate, etc., upon which water quality is dependent. Water quality samples (both water and sediment) were collected by the Vicksburg District at each of 13 borrow areas during May 1996. Samples consisted of one water and one composite sediment sample from most of the borrow areas. Duplicate samples were taken at several locations for quality control purposes. Samples were collected from each borrow area on only one day and reflect the conditions at the sampling time. These samples may be more representative of seasonal water quality than average water quality data. Samples were analyzed by the USACE Waterways Experiment Station, Environmental Laboratory, Analytical Laboratory Group. Parameters analyzed included *in-situ*, physicochemical including nutrients, and priority pollutants (pesticides, PCBs, and metals). Thirteen priority pollutant metals, four nonpriority pollutant metals, 19 pesticides, and seven PCBs were quantified in both the water and sediment samples for each of the 13 borrow areas sampled in 1996 and an additional 103 priority pollutants were analyzed in the water samples of five of these borrow areas.

During 1997, the water quality study was expanded to include three existing riverside borrow areas in the Memphis District, two in the New Orleans District, four existing landside borrow areas in the Vicksburg District, and oxbow lakes/abandoned channels in all three Districts. Three riverside borrow areas were sampled in the Memphis District and two in the New Orleans District. Sediment samples were collected from the borrow areas and analyzed for nutrients and selected priority pollutants (trace metals, pesticides, herbicides, and 103 additional organic compounds). In addition, due to relatively high mercury levels discovered in sediments of some of the borrow areas sampled in 1996, fish tissue samples were collected from these borrow areas and analyzed for the same priority pollutants as sediments.

The Mississippi River oxbow lakes and abandoned channel areas, like the borrow areas, are fished by recreational fishermen and would likely have similar sediment mercury levels. Both sediment and fish tissue samples were collected from these areas. Nine oxbow lakes/abandoned channels were sampled including Island No. 8, Chisolm Lake, Brandywine, and Tunica Lake in the Memphis District; Lake Whittington, Palmyra Lake, Yucatan Lake, and Lake Mary in the Vicksburg District; and Raccourci Lake in the New Orleans District.

Analysis of water quality samples indicated the quality of the water samples was good. No pesticides in concentrations above trace amounts were detected in any of the borrow area water samples. While some metals were detected in water samples, only one pond exceeded national criteria (BP-5 for iron). All other detected metals concentrations were well below both acute and chronic criteria.

The sediment quality within the sampled areas was good even though samples from some borrow areas did exceed National Oceanic and Atmospheric Administration (NOAA) benchmarks. The two most notable exceedances were the high levels of mercury found in the sediment of one riverside borrow area (BP-18) in 1996 and of ppDDE found in the sediment of the landside area (LBP-1). The mercury level in BP-18 and the ppDDE level in LBP-1 exceeded their respective 50th percentile benchmarks.

A resampling of BP-18 in 1997 indicated a mercury level of an order of magnitude lower than the 1996 level. The mean mercury concentration for all the sampled borrow areas falls between the 10th and 50th percentile benchmarks. BP-18 is located in the reach of the Mississippi River that the USGS has reported to contain the highest mean dissolved mercury concentrations within the entire river. That mean was less than three parts per trillion (pptr) higher than the 12 pptr FWC criterium. Due to the somewhat higher dissolved mercury levels in that reach of the Mississippi River, the observed sediment mercury concentration may not be representative of the potential sediment mercury concentrations in future borrow areas in other reaches of the river. While the 10th percentile benchmark was exceeded for other metals within several sampled areas, none exceeded the 50th percentile benchmark. A high level of ppDDE in LBP-1 is not surprising since this borrow area is located on the landside of the levee within a heavy agricultural area. The magnitude of ppDDE detected within this borrow area is similar to levels detected during other Vicksburg District studies in the Yazoo Basin. Concentrations of ppDDE of this magnitude and even greater were detected within some rivers and oxbow lakes within the intensely developed agricultural areas of the Mississippi Delta. Based on EPA studies, these high levels of DDE in fish from landside borrow areas could cause chronic reproductive problems in fish and potential health risk to consumers of the fish. No pesticides were detected in sediment samples at greater than trace amounts within any of the riverside borrow areas.

3.9 Air Quality

Under the authority of the Clean Air Act (CAA), the EPA has established nationwide air quality standards to protect public health and welfare, with an adequate margin of safety. These standards, known as the National Ambient Air Quality Standards (NAAQS), were developed for six "criteria" pollutants: ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter less than 10 microns in diameter (PM_{10}), sulfur dioxide (SO_2), and lead (Pb). The standards were presented in terms of concentration (e.g. ppm) determined over various periods of time (averaging times). Short-term standards (one-hour, eight-hour, or 24-hour periods) were established for pollutants with acute health effects, while long-term standards (annual average) were established for pollutants with chronic health effects.

Under the CAA, state and local agencies may establish air quality standards and regulations of their own, provided these are at least as stringent as the Federal requirements. However, the states within the project area have no state-specific AAQS for selected criteria pollutants.

Individual states are required to establish a State Implementation Plan (SIP) designed to eliminate or reduce the severity and number of NAAQS violations. The underlying goal of the SIP is to bring air quality conditions into compliance with AAQS and maintain compliance thereafter. The CAA Amendments of 1990 established a workable framework to achieve attainment and maintenance of health-protective NAAQS under Title I. Title I sets provisions for the attainment and maintenance of the NAAQS under the General Conformity Rule of the CAA, Section 176(c). The Rule states that activities must not: 1) cause or contribute to any new violation; 2) increase the frequency or severity of any existing violation; or 3) delay timely attainment of any standard, interim emission reductions or milestones in conformity to an implementation plan's purpose of eliminating or reducing the severity and number of violations of the NAAQS or achieving attainment of NAAQS. Significant projects are identified as emission sources which exceed major stationary source thresholds, which vary according to the pollutant and the severity of the nonattainment area. The rule does not intend to cover less significant, or *de minimis* projects.

The existing air quality within the project area was evaluated using information provided by the appropriate state's latest air quality regulations, annual reports, and correspondence with state agency air quality personnel. Individual work items within the Memphis and Vicksburg Districts are located within zones classified as in attainment for the priority pollutants and as a result, air permitting requirements are not currently required for mobile emission sources used in the proposed project construction. Although emissions would be exempt from permitting requirements, good engineering practices such as wetting access roads and stockpiles would be implemented throughout the construction period to minimize air pollution. Some work items within the New Orleans District are located within zones classified as non-attainment and applicability determinations would be required for each work item located within these non-attainment areas. All construction practices conducted as part of this project would be required to comply with current state air quality regulations and standards (Appendix 6).

3.9.1 Memphis District

All of the 31 proposed work items would occur in Air Quality Control Regions (AQCRs) classified as "in attainment" for priority pollutants (Appendix 6).

3.9.2 Vicksburg District

Currently, all 85 proposed work items in the three states (Arkansas, Louisiana, and Mississippi) within the Vicksburg District occur in AQCRs classified as being in attainment for priority pollutants (Appendix 6).

3.9.3 New Orleans District

The parishes in the New Orleans District in which work items are proposed include Concordia, East Baton Rouge, Iberville, Ascension, St. John, St. Charles, Jefferson, Orleans, and Plaquemines. The parishes of Concordia, St. John, Assumption, and Plaquemines are classified by the Louisiana Department of Environmental Quality (LDEQ) as being in attainment for priority pollutants. The parishes of St. James, St. Charles, Jefferson, and Orleans are classified by LDEQ as in attainment but operating under a full maintenance plan approved under section 175A of the CAA. The parishes of East Baton Rouge, Iberville, and Ascension are classified by LDEQ as being in non-attainment for O_3 (Appendix 6, LDEQ 1998).

An applicability determination, as per Louisiana Administrative Code (LAC) 33:III.1405 B, was made for separate items of the proposed project for the category of general conformity in accordance with the Louisiana General Conformity, SIP. Results can be found in Appendix 6, Section 9.

3.10 Socioeconomic Resources

3.10.1 Introduction

This section provides a socioeconomic profile of the project area and contains a general discussion of existing conditions in terms of economic and demographic resources. Parameters examined include population, housing, employment, per capita income, earnings, agricultural production, industrial expansion, and business volume. The socioeconomic environment prevalent in each USACE District portion of the project area is also discussed.

An economic base area was developed consisting of the area considered to be physically, socially, or economically impacted by this project. This economic base area, which extends roughly from Cairo, Illinois, to the Gulf of Mexico, encompasses approximately 50,000 square miles of land area in all seven states.

All data in this section, unless otherwise noted, were obtained from the Bureau of Census for the year presented with the *County and City Data Book* as the primary source. All monetary values are presented in constant 1996 dollars. A socioeconomic overview for 1990 conditions is presented in Table 3-7 summarizing general economic and demographic characteristics of the project area.

3.10.2 Population and Housing

Population for the overall area exceeded 4.6 million in the year 1990. Historically, population totals for the overall region have gradually increased. However, there have been some periods of outmigration in localized rural areas where the number of persons moving out of an area was greater than the combined number of immigrating residents and the natural population growth.

Historical population data for the area are displayed by USACE District in Table 3-8 for the years 1960 to 1990. Growth statistics show the overall project area population has increased by over 500,000 people since 1960 or 14 percent over the 30-year period. This has been a consistent growth with the exception of the last decade. Each District project area, except Vicksburg, has also experienced increases.

Population in the New Orleans and Memphis Districts increased by over 28 and 15 percent, respectively, while the Vicksburg District experienced a loss of nine percent. Overall, the rural Mississippi Delta suffered the greatest reduction in the total number of persons living in the area.

Population growth within the region has fluctuated from area to area based on varying factors. In many cases, areas within counties in close proximity to large metropolitan centers have enjoyed substantial population growth. This is evident in reviewing the population trends of counties which encompass Baton Rouge, Monroe, and New Orleans, Louisiana, and Memphis, Tennessee. In contrast, many rural areas have experienced significant declines in population.

Although the overall region is predominantly rural, there are 55 cities within the project area that have populations of 10,000 people or greater. Additionally, there were an estimated 109 towns with populations between 2,500 and 10,000 people in 1990. In addition, there are also five Metropolitan Statistical Areas (MSA's) designated in the region which include at least some portion of the economic base area. MSA's which are located totally within the economic base area are Baton Rouge, Monroe, and New Orleans, Louisiana; Memphis, Tennessee; and Pine Bluff, Arkansas.

Population density for the total area was estimated to be 93 persons per square mile in 1992 (Table 3-9). Other estimates are as follows: 42 persons per square mile in the Vicksburg District project area; 95 persons in the Memphis District; and 215 persons in the New Orleans District. Despite the large percentage of the urban population in the area, the number of persons per square mile was generally less than the average state densities for each project area. This indicates that the rural population is dispersed over a relatively large geographical area for most of the project area counties.

Table 3-7. 1990 Socioeconomic Statistics for the Total Project Area by District [a].				
Socioeconomic Category	Vicksburg District	Memphis District	New Orleans District	Total Area
Number of Counties/Parishes	36	31	18	85
Land Area (Square Miles)	22,396	17,944	8,993	49,333
Total Population	930,291	1,704,010	1,937,085	4,571,386
Number of Population Centers [b]	12	18	25	55
Total Number of Households	318,802	629,817	696,215	1,644,834
Median Household Value ($) [c]	47,500	67,600	81,200	69,500
Total Employment	329,523	739,942	791,059	1,860,524
Per Capita Income ($) [c]	10,700	14,400	22,400	17,000
Total Earnings ($million)[c]	9,636	25,247	29,555	64,438
Total Number of Manufacturing Establishments	957	2,195	1,570	4,722
Total Value Added by Manufacturing ($million) [c]	3,584	12,408	12,391	28,383
Total Number of Farms	13,124	16,010	5,115	34,249
Total Value of Farm Land and Buildings ($million) [c]	6,669	4,300	2,118	13,087
Total Value of Farm Products Sold ($million) [c]	2,113	2,288	526	4,927

[a] Statistics presented for 1990 represent the closest year census data were available.
[b] With greater than 10,000 persons.
[c] Values expressed in constant 1996 dollars.

Source: USACE 1998g.

Table 3-8.
Historical Population Statistics.

Project Area by District	Population by Year (No.)				
	1960	1970	1980	1990	1960-1990 Growth (%)
Vicksburg District (Total)	1,027,276	966,247	996,501	930,291	-9.4
Arkansas Project area	175,013	175,300	186,088	173,376	-0.9
Louisiana Project area	283,026	287,980	315,302	300,216	6.1
Mississippi Project area	569,237	502,967	495,111	456,699	-19.8
Memphis District (Total)	1,477,527	1,555,722	1,668,652	1,704,010	15.3
Arkansas Project area	387,767	368,327	370,903	352,148	-9.2
Illinois Project area	10,490	8,741	8,840	7,523	-28.3
Kentucky Project area	11,256	10,183	8,971	8,271	-26.5
Mississippi Project area	12,891	35,885	53,930	67,910	426.8
Missouri Project area	242,704	217,343	234,148	228,782	-5.7
Tennessee Project area	812,419	915,243	991,860	1,039,376	27.9
New Orleans District (Total)	1,508,189	1,722,995	196,738	1,937,085	28.4
Louisiana Project area	1,508,189	1,722,995	196,738	1,937,085	28.4
TOTAL AREA	**4,012,992**	**4,244,964**	**4,632,533**	**4,571,386**	**13.9**

Source: USACE 1998g.

Another component of the population which can provide insight into significant social developments that influence the economic activity of an area is housing. According to Census statistics depicted in Table 3-10, the total number of households or residences in the area was estimated to be 1.6 million in 1990, and an average of 2.8 persons per household.

The median value of a residence in the area was $69,500 in 1990. This represents approximately $114 billion in total residential structure values in the overall economic base area. Median household values in 1990 estimated by project area in each USACE District were as follows: Vicksburg District, $47,500; Memphis District, $67,600; and New Orleans District, $81,200.

Table 3-9.
1992 Population Density.

Project Area by District	Persons Per Square Mile
Vicksburg District	42
Arkansas Project area	38
Louisiana Project area	46
Mississippi Project area	41
Memphis District	95
Arkansas Project area	42
Illinois Project area	37
Kentucky Project area	40
Mississippi Project area	144
Missouri Project area	50
Tennessee Project Area	254
New Orleans District	215
Louisiana Project area	215
TOTAL AREA	**93**

Source: USACE 1998g.

3.10.3 Employment and Income

Labor force statistics are presented in Table 3-11 by civilian labor force, employment, and unemployment rates. The size of the civilian labor force in the total area increased from 1.5 million people in 1970 to approximately 2.1 million in 1990, an increase of over 38 percent in 20 years. Total employment in the area has grown over 33 percent since 1970, increasing from 1.4 million in 1970 to 1.9 million in 1990.

Employment by industry in the area is presented in Table 3-12 by percent distribution to the total employment for the year 1990. According to the Bureau of the Census, wholesale and retail trade was the prime contributor to the economic base of the area in 1990, comprising 22 percent of the total employment. In 36 counties, it was the number one employer of persons; ranking second, the manufacturing sector consisted of 16 percent of the total employment in the overall area and was the top employer in 41 of the area counties.

Total personal income, the principal component of gross national product, is an excellent indicator of economic activity within an area. Personal income totaled over $77.9 billion in 1989 (in constant 1996 dollars) (Table 3-13). On a per capita basis, this results in an income of approximately $17,000 per person.

Table 3-10.
1990 General Housing Characteristics.

Project Area by District	Total Number of Households	Persons Per Household	Median Value of Households ($) [a]
Vicksburg District	318,802	3	47,500
Arkansas Project area	60,543	3	49,100
Louisiana Project area	105,467	3	43,000
Mississippi Project area	152,792	3	49,900
Memphis District	629,817	3	67,600
Arkansas Project area	128,438	3	52,000
Illinois Project area	2,957	3	29,900
Kentucky Project area	3,378	2	42,200
Mississippi Project area	23,273	3	77,700
Missouri Project area	87,944	3	49,700
Tennessee Project area	383,827	3	76,800
New Orleans District	696,215	3	81,200
Louisiana Project area	696,215	3	81,200
TOTAL AREA	1,644,834	3	69,500

[a] Values are expressed in constant 1996 dollars.

Source: USACE 1998g.

Table 3-11.
1990 Labor Force Statistics

Project Area By District	Civilian Labor Force (No. of persons)	Total Employment (No. of persons)	Unemployment Rate (%)
Vicksburg District	371,176	329,523	11
Arkansas Project area	72,221	65,089	10
Louisiana Project area	122,128	109,214	11
Mississippi Project area	176,827	155,220	12
Memphis District	801,067	739,942	8
Arkansas Project area	151,228	137,611	9
Illinois Project area	2,800	2,434	13
Kentucky Project area	3,204	2,890	10
Mississippi Project area	35,009	33,128	5
Missouri Project area	103,174	95,101	8
Tennessee Project area	505,652	468,778	7
New Orleans District	873,425	791,059	9
Louisiana Project area	873,425	791,059	9
TOTAL AREA	2,045,668	1,860,524	9

Source: USACE 1998g.

Table 3-12. 1990 Employment by Industry.							
		Distribution By Industrial Sector [a] (%)					
Project Area By District	Total Employment (No.)	1 *Ag*	2 *Mfg*	3 *Trade*	4 *FIRE*	5 *Health Services*	6 *Public Admin*
Vicksburg District	329,523	7.5	18.6	20.1	4.4	8.1	5.2
Arkansas Project area	65,089	6.6	23.3	18.5	3.7	7.6	6.4
Louisiana Project area	109,214	6.6	13.8	21.6	5.7	9.7	4.3
Mississippi Project area	155,220	8.4	20.0	19.8	3.7	7.1	5.4
Memphis District	739,942	3.6	18.9	22.1	5.3	8.8	4.6
Arkansas Project area	137,611	8.4	22.2	21.1	4.4	7.1	3.7
Illinois Project area	2,434	7.1	12.2	18.4	3.7	9.0	8.6
Kentucky Project area	2,890	7.1	34.1	18.2	3.5	5.2	2.8
Mississippi Project area	33,128	2.0	19.2	25.0	4.4	5.1	3.3
Missouri Project area	95,101	6.6	22.5	21.2	3.9	8.7	3.1
Tennessee Project area	468,778	1.7	17.2	22.5	5.9	9.6	5.2
New Orleans District	791,059	1.6	11.6	22.2	6.5	8.8	5.4
Louisiana Project area	791,059	1.6	11.6	22.2	6.5	8.8	5.4
TOTAL AREA	1,860,524	3.4	15.8	21.8	5.6	8.7	5.1

[a] Based on distributions of those industrial sectors as reported by the U.S. Census Bureau.

Note: 1 Agriculture
2 Manufacturing
3 Wholesale and Retail Trade
4 Finance, Insurance, and Real Estate
5 Health Services
6 Public Administration

Source: USACE 1998g.

Table 3-13. 1989 Personal and per Capita Income Statistics		
Project Area by District	Total Personal Income ($) [a]	Total Per Capita Income ($) [b]
Vicksburg District	9,923	10,700
Arkansas Project area	1,997	11,500
Louisiana Project area	3,419	11,400
Mississippi Project area	4,507	9,900
Memphis District	24,456	14,400
Arkansas Project area	3,982	11,300
Illinois Project area	79	10,600
Kentucky Project area	101	12,200
Mississippi Project area	1,058	15,600
Missouri Project area	2,815	12,300
Tennessee Project area	16,421	15,800
New Orleans District	43,479	22,400
Louisiana Project area	43,479	22,400
TOTAL AREA	77,858	17,000

[a] Expressed in millions of constant 1996 dollars. Source: USACE 1998g.
[b] PCI is derived by dividing personal income by population.

Per capita income (PCI), which is used as a measure of the relative support the economy provides for the population of an area, was estimated to be $17,000 in the total region in 1989. The New Orleans District represented the highest PCI in the area with $22,400 in 1989. In comparison, the PCI within the Memphis and Vicksburg Districts was estimated to be $14,400 and $10,700, respectively, in 1989. These figures correspond to an estimated PCI of $18,700 for the U.S. for the same year.

Agricultural production, as noted previously in Table 3-12, is a significant resource in the region. In 1992, the economic base area contributed 17.8 million acres of land toward the production of agricultural goods utilized worldwide. Among the major agricultural commodities supplied by the region are cotton, soybeans, rice, corn, and catfish. General agricultural characteristics for the year 1992 are displayed in Table 3-14.

The total value of farm products sold was valued at $4.9 billion in 1992, a 23 percent decrease over the $6.4 billion reported in 1978. The Memphis District project area represented 46 percent of the sales from farm products sold for the area in 1992 followed closely by the Vicksburg District with 43 percent.

Table 3-14 1992 General Agricultural Statistics				
Project Area by District	Total Number of Farms (No.)	Average Size of Farms (Acres)	Total Land in Farms (Acres in 000)	Total Value of Farm Products Sold ($)[a]
Vicksburg District	13,124	598	7,844	2,113
Arkansas Project area	2,336	588	1,375	370
Louisiana Project area	4,893	460	2,249	581
Mississippi Project area	5,895	716	4,220	1,162
Memphis District	16,010	523	8,371	2,288
Arkansas Project area	5,317	783	4,164	1,189
Illinois Project area	218	378	82	19
Kentucky Project area	164	590	97	24
Mississippi Project area	488	286	140	29
Missouri Project area	5,107	455	2,322	661
Tennessee Project area	4,716	322	1,566	366
New Orleans District	5,115	301	1,540	526
Louisiana Project area	5,115	301	1,540	526
TOTAL AREA	34,249	518	17,755	4,926

[a] Expressed in millions of constant 1996 dollars.

Source: USACE 1998g.

With 4,722 manufacturing establishments reported in 1992, manufacturing activity has contributed significantly to the well-diversified industrial base in the area. Of these, the Vicksburg District project area accounted for 957 manufacturing firms; Memphis District, 2,195; and New Orleans District, 1,570. As expected, the majority of the manufacturing activity in the region hubs around the larger metropolitan centers and urbanized areas--Baton Rouge, Memphis, Monroe, New Orleans, and Pine Bluff.

Selected services, which represent service industries such as hotels and motels, repair services, and dental, medical, and legal services, are also indicators of business activity. Selected services ranked first in the area in total earnings in 1990 accounting for 18 percent of the total. As with other business activity in the economic base area, major service industries are located near the large metropolitan areas--New Orleans, Memphis, Baton Rouge, Pine Bluff, and Monroe.

3.10.4 Land Use

Land Use data for the socioeconomic impact analysis were generated to depict the general type of land use prevalent in the MRL economic base area. Readily available satellite surveys by the USACE GIS in 1997 were used to identify the existing land use. Based on their availability and extensive efforts, time, and costs required to survey the entire 85-county economic base area, these data were deemed sufficient to reflect the physical characteristics of the area. Results of this analysis , presented in Table 3-15, include a survey of 16.9 million acres of land in the 31.6 million-acre economic base area, representing approximately one-half of the total area. Cleared lands (agricultural land and pastures) accounted for the majority of the land use distribution in the MRL economic base area (72 percent) in 1997. Other non-urban uses (forest lands, water bodies, wetlands, and other non-urban lands) represented 26 percent of the total land use while urban land comprised the remainder. Urban land consists of developed land such as residential, commercial, industrial, and other built-up urban-related areas. Specific land use acreage for the MRL project area were previously displayed in Table 3-1. These data, which include 100 percent of the 2.6 million-acre project area, consists of all lands between the levees and all lands and waters adjacent to and within 3,000 feet of the landside toe of the levees.

Table 3-15.
1997 Sample of Land Use Distributions in Rural Areas (percent).

Project Area By State	Urban Use	Non-urban Use							Total Land
		Cleared Land			Other Land			Total	
		Cropland	Pasture	Total	Woodland	Water	Total		
TOTAL	2	64	8	72	21	5	26	98	100

Source: USACE 1998g.

3.11 Prime Farmlands

Farming is one of the dominant land uses in the project area with 769,260 acres in agricultural production and 42,390 acres in pasture. Requests were made to the NRCS Area or State Soil Scientist within each of the seven states of the project area to quantify the amount of important farmland potentially impacted by the proposed alternatives described in plans 3 and 4. This request was made pursuant to coordination requirements of the Farmland Protection Policy Act. Responses (completed AD-1006 forms) were received from Illinois, Tennessee, Missouri, and Louisiana.

3.12 Hazardous, Toxic, and Radioactive Wastes

3.12.1 General Information

All HTRW assessments were conducted following guidelines and procedures outlined in the regulation, "Hazardous, Toxic, and Radioactive (HTRW) Waste Guidance for Civil Works

Regulation 1165-2-132, Water Resources and Authorities for Hazardous, Toxic and Radioactive Waste for Civil Works Projects (14 June 1996), and the American Society for Testing and Materials, E1527-97, Standard Practice for Environmental Site Assessments: Phase 1 Environmental Site Assessment Process (ASTM, 1997). ER 1165-2-132, state that civil works project funds are not to be employed for HTRW-related activities except when specifically provided by law or where HTRW contaminated areas or impacts cannot be avoided. The objective for conducting HTRW assessments is to identify HTRW problems early in a project design to ensure appropriate consideration of HTRW problems that can be addressed in the reconnaissance, feasibility, preconstruction engineering and design, land acquisition, construction, operations, maintenance, repair, replacement and rehabilitation phases of Civil Works Projects.

Memphis, Vicksburg, and New Orleans Districts conducted HTRW assessments on 128 proposed work items located within the MRL Project boundaries extending from Cape Girardeau, Missouri, to Head of Passes, Louisiana, near the Gulf of Mexico. Based on these assessments, the overall risk associated with HTRW for this project is low. The following paragraphs provide a synopsis of each District's HTRW assessment. An overview of the methodologies and significant findings is contained within Section 9 of Appendix 6.

3.12.2 HTRW Significant Findings

3.12.2.1 Memphis District

The following list highlights potential HTRW problems and their corresponding work item within the Memphis District.

- The Mississippi County Landfill (Commerce to Birds Point Levee Grade Raise Project).
- Unregulated dump located near Borrow area #3 (Miston Seepage Berms Project).
- Drums near Seepage Berm #2 (Butler Seepage Berms Project).
- Potential Soil contamination (Blue Lake Relief Wells Project).

No National Priority List (NPL) or Treatment, Storage, and Disposal (TSD) sites were identified within one mile of the 31 proposed work item sites. Although a record search produced some sites of concern within the one-mile radius for the project corridor, none appear to be within proposed work item site boundaries.

3.12.2.2 Vicksburg District

All of the sites listed below have been identified by the Mississippi Department of Environmental Quality (MSDEQ) as potential hazardous sites that are located within a half-mile of the proposed work sites. These sites are presently being evaluated by MSDEQ for the acceptance of proper remediation or evaluating the required remediation to be performed on these sites. None of the sites appear to be within any of the proposed work item site boundaries. The following list highlights potential HTRW problems within the Vicksburg District.

- Aboveground and underground storage tanks in Greenville, Mississippi; Broadway Linen Service (Work Item 543-L Berm Construction).
- Contaminated groundwater at site near Greenville, Mississippi; formerly Scott Petroleum (Work Item 543-L Berm Construction).
- Contaminated soil in Greenville, Mississippi; Walcotte Chemical Warehouse (Work Item 543-L Berm Construction).

- Contaminated groundwater in Greenville, Mississippi; formerly Reliance Electric (Work Item 543-L Berm Construction).
- Contaminated groundwater in Greenville, Mississippi; Gold Kist, Inc. (Work Item 543-L Berm Construction).
- Contaminated soil in Greenville, Mississippi; USG Interiors (Work Item 543-L Berm Construction).
- Contaminated soil near Refuge, Mississippi; Mississippi Department of Transportation - Refuge Plantation (Work Item 531-L Relief Well Construction).
- Contaminated soil near Refuge, Mississippi; Mississippi Department of Transportation - Spraggins Air Strip (Work Item 531-L Relief Well Construction).
- Potential soil and groundwater contamination near Wayside, Mississippi; Rhone-Poulenc Research Farm (Work Item 526-L (Levee Enlargement and Berm Construction).

A record review revealed 10 leaking underground storage tanks (LUSTs) within Greenville, Mississippi. The majority of the tanks listed have been removed and closed in accordance with MSDEQ regulations. With the use of levee realignments and relief well construction, the risks associated with encountering HTRW resulting form these LUSTs are low.

Aerial reconnaissance revealed no signs of stressed vegetation, stained soils, drums, tanks, debris, or illegal dumping on the majority of the proposed work sites. However, three sites located near work items 367-R, 368-R, and 495-L showed signs of potential environmental concern.

- Drums with unknown contents (Work Item 367-R Levee Enlargement and Relief Well Construction).
- Leaking ASTs (Work Item 367-R and 368-R Levee Enlargement and Relief Well Construction).
- Environmental concerns (Work Item 495-L Levee Enlargement and Dredge Berm Construction).

3.12.2.3 New Orleans District

The early development and longtime operation of the Darrow Oil and Gas Field have presented many possibilities for spills and petroleum-related problems. A total of 227 wells (22 active) are located near the Carville to Marchand Levee Enlargement site. Additionally, nine inactive hazardous or industrial non-hazardous waste disposal wells and one active hazardous waste disposal well are located in the project vicinity. Many of the pipelines on site have potential leakage problems. The following list highlights potential HTRW problems and their corresponding work item within the New Orleans District.

- Pipeline crossings (Reveille to Point Pleasant).
- Old Inger superfund site (Carville to Marchand Levee Enlargement).
- Wastewater treatment pipeline (Carville to Marchand Levee Enlargement).
- Contaminated groundwater; Borden Chemical Company (Carville to Marchand Levee Enlargement).
- Contaminated soil; BASF Wyandotte (Carville to Marchand Levee Enlargement).
- Contaminated soil; CosMar (Carville to Marchand Levee Enlargement).
- Contaminated groundwater; Arcadian Fertilizer (Carville to Marchand Levee Enlargement).
- Aboveground storage tanks (Fifth Louisiana Levee District, Concordia Parish, LA).

- Diesel fuel spills; Bisso Marine (Carrollton Levee Enlargement).
- Small quantity hazardous waste generator; Transocean Terminal Operators, Inc. (Carrollton Levee Enlargement).

No TSD sites were identified; however one superfund site was identified immediately adjacent to the Carville-Marchand work item. Coordination with the LDEQ indicated that the site is under remediation, and isolated. The proposed levee work would pose low HTRW concerns.

3.13 Recreation and Esthetics

3.13.1 Recreation

3.13.1.1 Recreation Background

In 1991, surveys conducted for the USFWS indicated that half of the people in the U.S. 16 years old or older enjoyed some type of wildlife-related recreation. Project area lands are an integral part of the natural resource base within the Lower Mississippi River Valley (Appendix 16).

3.13.1.2 Recreation Opportunities

An array of recreational resources are available in the Mississippi River corridor. These resources include more than 250 state-managed areas including parks, natural areas, historic sites, fish and wildlife areas, recreation areas, scenic areas, and trails. More than three million visitors a year take advantage of these state resources. Federally-owned recreational resources administered by the National Park Service (15 areas) and the USFWS (21 refuges) together receive more than nine million visits each year. Boating, sightseeing, and hiking are the most popular activities. Approximately 59 developed boat-launch access points into the river are in the project area. Over one million acres of land along the river corridor provide hunting, birdwatching, fishing, and other recreational opportunities. Every year more than six million people participate in boating, the single most popular activity. For all activities, there is a total of 11 million recreation visits per year in the Mississippi River corridor (Appendix 16).

Lands between the levees provide many outdoor recreational opportunities. These lands provide hunting, fishing, and nonconsumptive uses such as observing and photographing wildlife, and birdwatching. Some of the lands contain wetlands, BLH forests, croplands, pastures, scrub vegetation, and marshes. All these classifications contribute to recreation opportunities. In addition, existing borrow areas provide habitat for wildlife and fisheries.

3.13.2 Esthetics

3.13.2.1 Esthetics Background

The Mississippi River offers a wide range of conditions esthetically attractive to people of varied tastes. The river is the most visually outstanding aspect of the project area landscape. Large bodies of water serve as an important element of visual composition because of their horizontal extent, color, and texture. The natural and cultural land uses within the project area complement the river by their contrasting geometry, color, and texture, or are esthetically significant in their own right, as with the BLH forests. The relatively natural land uses, such as BLH forests, also provide habitat for many species of wildlife which can be considered esthetically significant components of the landscape.

3.13.2.2 Esthetic Resources

Bluffs and adjacent hills provide some of the most impressive scenic opportunities along the river. Examples include the area in west Kentucky above Hickman and along the river from Reelfoot Lake to Memphis. Bluffs begin where the Obion and Forked Deer Rivers meet in Tennessee and provide the eastern boundary from there to Memphis. Proceeding south, there are Petit Gulf Hills, Ellis Cliffs, Tunica Bluff, Balls Bluff, and Mobile Ridge. Bluffs exist on the east side of the river from Vicksburg to Baton Rouge. There are overlooks and cliffs ending with Scott Bluffs at Southern University in Baton Rouge.

The project area also contains many manmade features which either contribute to or detract from the esthetic quality of the project area. The river is constrained on the west bank by levees for almost the entire distance from Cape Girardeau to the Gulf. The east bank has considerably fewer miles of levee. The east bank levee in the Reelfoot Lake area extends from Hickman, Kentucky, southward to the Obion River, except for a small reach of high ground north of Tiptonville, Tennessee. Almost all of the east bank is leveed from Memphis to Vicksburg, with no MR&T levees from Vicksburg to Baton Rouge. Below Baton Rouge, approximately 90 percent of the east bank of the river is leveed. Other manmade features along the river include revetments constructed on both banks to protect the river channel. From Cairo, Illinois, to Old River Control Structure, dikes have been built into the river, most several hundred feet long, but some as long as one mile. Almost all dikes are under water at midbank stage; however, many are not only visible at lower river stages, but have greatly influenced the development of sand islands and bars as a result of the still water areas created by the dikes. Below Old River Control Structure, dike construction has been limited.

Other major manmade features are the river crossings for roadways, railroads, and overhead utilities. These are landmarks along their river stretches, and can be either esthetically pleasing, or from some points of view, detrimental. The project area is relatively poor in architecturally outstanding manmade structures which can be considered esthetically pleasing, since it is used primarily for flood control, protection of adjacent areas, and navigation. The manmade features which do exist in the project area are generally of a utilitarian nature.

The levees provide visual access to the project area and adjoining lands where visibility is limited by the nearly level terrain. Bridges perform a similar function for the river and batture. In addition, bridges and large flood control structures may have an esthetic value to some observers as engineering works.

Other manmade features which contribute to the esthetic experience of the project area are archeological and historical sites. Although not always visually impressive in themselves, once understood, these places can provide an appreciation of the past.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter assesses the expected adverse and beneficial environmental impacts associated with the proposed action. Where possible, quantitative impacts have been assessed.

4.1 Land Use Impacts

Total Land Use Impacts by plan is given in Table 4-1. Cropland and forested land use categories have the greatest impacted acres. However, Plan 4 increases cropland impacts by 1,225 acres and decreases forested impacts by 6,745 acres. Plan 4 reduces total land use impacts by 5,056 acres. Implementation of the no-action alternative would avoid impacts to these land use categories and their associated environmental values. Compared to Plan 4, the no-action alternative would result in 4,070 fewer forested acres over the life of the project.

Table 4-1
Total Land Use Impacts

Land Use	Plan 3	Plan 4
Cropland	8,778	10,003
Forested	11,579	4,834
Herbaceous	387	260
Levee	739	676
Marsh	44	25
Open Water	586	1020
Pasture	727	688
Scrub/Shrub	581	409
Tree Plantation	636	1,104
Urban/Industrial	235	220
Outside Project Area	664	661
Totals	**24,956**	**19,900**

Although avoidance was used on levee enlargement and seepage control features, the greatest opportunity to avoid and minimize impacts was associated with borrow areas. The total acreage required for borrow area construction was reduced by approximately 3,500 acres (Table 4-2). Wetland impacts were reduced in all wetland types except cropland and tree plantations. This resulted from the reduction in the number of acres required for borrow area and the relocation of borrow areas to less environmentally sensitive areas. Impacts to forested wetlands were reduced by approximately 5,000 acres through the avoid and minimize techniques. Impacts to all forested lands was reduced by approximately 6,400 acres, and impacts to croplands increased by approximately 2,400 acres.

4.2 Waterfowl Resources

Specific to wintering waterfowl, impacts would occur from levee enlargement, seepage control, and borrow area construction. These impacts are direct in that an acre-for-acre change in land use occurs. The proposed action would not cause an indirect effect by reducing flooding of winter waterfowl habitat but would result in direct losses of winter habitat. Plan 3 would impact 1,019 acres of waterfowl foraging habitat, and Plan 4 would impact 1,136 acres (Table 4-3). Plan 3 would result in an average annual loss of 215,580 DUD in the Memphis District and 323,539 in the Vicksburg District. Plan 4 would result in an average annual loss of 134,992 DUD in the Memphis District and 199,440 in the Vicksburg District. Construction in the New Orleans District would not affect duck foraging habitat. Environmentally designed borrow areas including the shallow fringes around constructed islands and the shallow areas with 10:1 slopes, would provide some value as waterfowl foraging areas (USACE 1998i). Implementation of the no-action alternative would avoid impacts to over 1,000 acres of waterfowl foraging habitat. However, compared to Plan 4, the no-action alternative would forgo a 1,201,505 increase in waterfowl DUDs.

Table 4-2 Land Use Impacts From Borrow Area Construction				
Land Use	Wetland		Nonwetland	
	Plan 3	Plan 4	Plan 3	Plan 4
Cropland	1,483	2,789	2,312	3,388
Forested	6,718	1,735	2,469	1,064
Herbaceous	196	107	22	31
Levee	0	0	16	0
Marsh	19	1	0	0
Open Water	0	0	359	838
Pasture	385	271	155	202
Scrub/Shrub	323	190	93	85
Tree Plantation	312	371	236	537
Urban/Industrial	8	0	11	11
Totals	**9444**	**5464**	**5673**	**6156**

Table 4-3. Waterfowl Foraging Habitat Impacts.			
Land Use	DUD per acre	Acres Impacted	
		Plan 3	Plan 4
Vicksburg District			
Rice	580	18	31
Corn	970	9	17
Soybean	253	333	588
Fallow	1,037	253	195
Memphis District			
Rice	580	38	12
Corn	970	7	18
Soybean	253	217	203
Fallow	1,037	144	69
Total	**N/A**	**1,019**	**1,136**

4.3 Terrestrial Resources

4.3.1 Terrestrial Habitat

Direct adverse impacts to terrestrial resources would result from land-use conversion impacts to BLH habitat. BLH forests would be cleared for levee, seepage control, and borrow area construction. Impacts of the project to BLH were determined by calculating the change in acreage between the without-project alternative and each structural alternative. The total loss of BLH (without compensation measures) for Plans 3 and 4 would be 11,584 acres and 4,834 acres, respectively. In addition, Plan 3 would impact 636 acres of tree plantations and Plan 4 would impact 1,104 acres of tree plantations in the Vicksburg District.

In HEP, habitat units (HU) are a function of habitat quality (HSI) and habitat area (acres). One HU represents one acre of optimal habitat. The estimated net impacts in average annual habitat units (AAHUs) for Plans 3 and 4 by District are presented in Table 4-4.

The impacts of each alternative by District were combined for the entire project area (Table 4-5). Implementation of Plan 3 would result in the loss of 19,565 AAHUs (0.8 percent reduction). Plan 4 would result in the loss of 6,581 AAHUs (0.3 percent reduction). Implementation of the no-action alternative would avoid the clearing of BLH and preserve the associated terrestrial values. Compared to Plan 4, the no-action alternative would forgo a 4,070 acre increase in BLH over the life of the project. For more specific information on the terrestrial impact evaluation, see Appendix 10.

4.3.2 Bats

Changes in land and water areas would affect the array of bat species differently (Table 4-6). The loss of forest lands would directly reduce the potential number of trees that are hollow, those with loose bark, and those with dense foliage which provide roosting areas for most bat species in the project area. Loss of forested areas would also affect those species that feed in or above the canopy. Cleared areas utilized by bats include agricultural, pasture, herbaceous, and scrub/shrub lands. Changes to these cleared areas (i.e., agriculture to open water) would be expected to adversely affect three bat species that feed in cleared areas over land, but would positively affect those species that forage over water. Following the implementation of environmental design features and the mitigation plan, more woodlands would exist in the project area than under existing conditions. These reforestation efforts would adversely effect species that feed over cleared areas. However, the majority of species feed and/or roost in woodlands and would benefit from these reforestation efforts by the year 2035. Implementation of the no-action alternative would avoid the loss of cleared and woodland habitats, but it also would prevent the creation of additional open water habitat.

Table 4-4. Net Change in Terrestrial AAHUs by District [a]		
Species	Plan 3 (AAHUs)	Plan 4 (AAHUs)
Memphis District		
Barred owl	-1,785.93	-280.75
Fox squirrel	-826.05	-234.74
Carolina chickadee	-2,400.56	-406.21
Pileated woodpecker	-919.81	-141.09
Mink	0.0	+ 31.26
Wood duck	-1,112.93	-131.76
Total Combined AAHUs	**-7,045.28**	**-1,163.29**
Vicksburg District		
Barred owl	-3,965.13	-1,864.62
Fox squirrel	-3,767.02	-1,728.86
Carolina chickadee	-4,728.45	-2,182.38
Pileated woodpecker	-2,068.70	-954.79
Mink	+4,530.62	+2,058.68
Wood duck	-2,516.96	-1,021.9
Total Combined AAHUs	**-12,515.64**	**-5,693.87**
New Orleans District		
Barred owl	-6.0	-6.0
Fox squirrel	-2.0	-2.0
Carolina chickadee	-8.0	-8.0
Pileated woodpecker	0.0	0.0
Mink	+12.0	+12.0
Wood duck	0.0	0.0
Total combined AAHUs	**-4.0**	**-4.0**

[a] A minus denotes a loss in AAHUs and a plus denotes a gain in AAHUs.

Source: USACE 1998.

Table 4-5. Net Changes in Terrestrial AAHUs by Species and Plan [a]		
Species	Plan 3 (AAHUs)	Plan 4 (AAHUs)
Barred owl	-5,757.06	-2,151.37
Fox squirrel	-4,595.07	-1,965.60
Carolina chickadee	-7,137.01	-2,596.59
Pileated woodpecker	-2,988.45	-1,095.88
Mink	+4,542.62	+2,101.94
Wood duck	-3,629.89	-1,016.00
Total Combined AAHUs	**-19,564.86**	**-6,861.16**

[a] A minus denotes a loss in AAHUs and a plus denotes a gain in AAHUs.
Source: USACE 1998j.

Table 4-6. Net Effects to Bat Habitat by Plan		
Habitat Type	Plan 3 (Acres)	Plan 4 (Acres)
Memphis District		
Cleared Land [a]	-3,607	-2,854
Open Water [b]	0	+60
Woodlands [c]	-3,078	-514
Vicksburg District		
Cleared Lands [a]	-2,616	-7,423
Open Water [b]	+11,800	+6650
Woodlands [c]	-9,125	-5,416
New Orleans District		
Cleared Lands [a]	0	0
Open Water [b]	+17	+17
Woodlands [c]	-17	-17

NOTE: Minus denotes a loss of habitat acreage; plus denotes a gain in habitat acreage.
[a] Agricultural, pasture lands, herbaceous lands, and scrub/shrub lands.
[b] Aquatic borrow areas.
[c] Bottom-land hardwoods and tree plantations.

4.3.3 Neotropical Migrants

The primary impact to neotropical migratory birds would be the conversion of breeding, resting, and foraging habitat to project features. Based on the estimated responses, a decrease in forested habitat would be the greatest negative impact to these species. However, no significant adverse impacts to neotropical migratory birds would be expected to result from the proposed project following implementation of proposed environmental design measures and reforestation efforts.

The USFWS has recorded the breeding activity of known colonial waterbirds within the Vicksburg and Memphis District study boundaries. These colonies often return to nest in the same general location from year to year. No known colonies are located within Plan 4 proposed work areas and only one colony is located within 0.5 mile from proposed work. Therefore, no significant adverse direct or indirect impact to colonial waterbirds would be expected to result from the proposed work, although positive benefits would accrue following borrow area construction. Implementation of the no-action alternative would avoid clearing of forested habitat and its associated environmental values. It would also prevent an increase in forested habitat over the life of the project.

4.4 Wetland Resources

A semi-quantitative method developed by the Wetland Evaluation Work Unit of the Wetland Research Program at the USACE Waterways Experiment Station was used to evaluate functional impacts to forested and farmed wetlands. Wetland functions evaluated were short-term water storage, long-term water storage, water velocity reduction, sediment detention, onsite erosion control, nutrient and dissolved substance removal, and organic carbon export. Wetland functional impacts were expressed as functional capacity units (FCUs), which reflect the quantity and quality of wetland functional values. FCUs were determined by multiplying the functional capacity index value (FCI) of each function and the acreage affected. Forested and farmed wetland functional index values ranged from zero to one, with one representing optimal wetland value.

Although wetland functional benefits would be provided by the borrow areas that incorporate aquatic design features, they were not quantified for this project. Methodologies to quantify these functional values will likely be developed and future projects may more clearly identify these benefits.

Impacted wetland acreage for Plan 3 would represent 1.1 percent of project area wetlands (Table 4-7). Forested wetlands and tree plantations would account for 71 percent and cropland and pasture would account for 22 percent of the wetlands directly impacted by Plan 3. Scrub/shrub, herbaceous, and marsh cover types would cumulatively represent 6 percent of the impacts, and urban areas represent 1 percent.

Impacted wetland acreage for Plan 4 would represent 0.7 percent of project area wetlands (Table 4-7). Forested wetlands and tree plantations would account for only 44 percent and cropland and pasture would account for 49 percent of the wetlands directly impacted. Scrub/shrub, herbaceous, and marsh cover types would represent 6 percent of the impacts, and urban areas, 1 percent.

Table 4-7. Wetland Acreage Impacts by Plan					
Land Use	Wetland Acres	Plan 3		Plan 4	
		Acres	Percent[a]	Acres	Percent[a]
Forested	636,254	7,929	1.2	2,760	0.4
Cropland	231,556	2,094	0.9	3,220	1.4
Sandbar	45,600[b]	0	0.0	13	0.0
Scrub/Shrub	43,440	406	0.9	245	0.6
Tree Plantations	22,584	331	1.5	498	2.2
Pasture	19,536	420	2.7	306	2.0
Herbaceous	11,043	289	2.6	167	1.5
Marsh	5,925	40	1.2	21	0.6
Urban/Industrial	4,594	87	1.9	65	1.4
Bare Soil	1,825	0	0.0	0	0.0
Total	**1,022,357**	**11,654**	**1.1**	**7,340**	**0.7**

[a] Percent of respective wetland land-use category.
[b]Jurisdictional (regulated) water of the United States but may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

Source: USACE 1998m and Geo-Marine, Inc.

For purposes of determining FCUs, all wetland cover types except croplands, pasture, and urban cover types, were combined in a forested cover type. The remaining categories (crop land, pasture, and urban) were combined in a farmed cover type (USACE 1998h). Using this approach, wetland acres directly impacted by Plan 3 represent approximately 1 percent of the total wetlands in the project area with 8,995 acres of forested wetlands and 2,659 acres of farmed wetlands directly impacted by this plan (Table 4-8. Approximately 75 percent of the forested wetland impacts of Plan 3 would occur in the Vicksburg District and 25 percent in the Memphis District (Table 4-8). About 66 percent

Table 4-8. Wetland Acreage Impacted by District and Plan.				
District	Forested[a]		Farmed[b]	
	Plan 3	Plan 4	Plan 3	Plan 4
Vicksburg	6,723	3,428	1,687	2,543
Memphis	2,255	246	972	1,094
New Orleans	17	17	0	0
Total	**8,995**	**3,691**	**2,659**	**3,637**

[a] Includes forested, tree plantations, scrub/shrub, herbaceous and marsh cover types.
[b] Includes cropland, pasture, levee and urban cover types.

Source: USACE 1998m.

of the impacted farmed wetlands would occur in the Vicksburg District with the remainder in the Memphis District. A loss of 54,075 average annual functional capacity units (AAFCUs) would result from implementation of Plan 3.

Plan 4 would cumulatively impact approximately 3,691 acres of forested wetlands and 3,637 acres of farmed wetlands or 0.7 percent of the total project area wetlands. Approximately 93 percent of the direct forested wetland impacts and 70 percent of the direct farmed wetland impacts would occur in the Vicksburg District (Table 4-8). The remaining 7 percent of forested wetland impacts would be located in the Memphis District except for 17 acres of forested wetlands (less than 1 percent of the forested wetland impacts of Plans 3 and 4) which would occur in the New Orleans District. Proposed work items in the New Orleans District would not impact farmed wetlands. Plan 4 would result in the loss of 25,035 AAFCUs, a reduction in wetland impacts of 29,040 AAFCUs compared to Plan 3.

Louisiana and Mississippi would have the largest number of forested and farmed wetlands impacted by Plans 3 and 4, accounting for 72 percent of Plan 3 impacts and 76 percent of Plan 4 impacts (Table 4-9). Illinois, Kentucky, and Tennessee would have the smallest acreage impacts, each having less than 130 wetland acres impacted by Plan 3 and less than 75 acres by Plan 4.

Table 4-9

Wetland Acreage Impacted by State.

State	Forested		Farmed	
	Plan 3	Plan 4	Plan 3	Plan 4
Arkansas	1,150	166	199	411
Illinois	43	29	39	42
Kentucky	110	0	19	0
Louisiana	3,227	1,816	868	1,378
Mississippi	3,477	1,493	786	925
Missouri	963	187	714	853
Tennessee	25	0	34	28
Total	**8,995**	**3,691**	**2,659**	**3,637**

Source: USACE 1998m

About 90 percent of the impacted wetlands for Plans 3 and 4 would occur riverside of the levee (Table 4-10). Approximately 80 percent of the impacted riverside wetlands in Plan 3 would be forested, and 50 percent in Plan 4 would be forested. About 50 percent of the impacted wetlands landside of the levee for Plans 3 and 4 would be forested. Implementation of the no-action alternative would avoid all wetland functional impacts. Compared to Plan 4, the no-action alternative would forgo an increase of 3,041 acres of forested wetland functional value associated with reforesting selected borrow areas.

Table 4-10. Impacted Wetlands Riverside and Landside Distribution				
Plan	Riverside		Landside	
	Forested	Farmed	Forested	Farmed
Vicksburg District				
Plan 3	6,401	1,409	322	278
Plan 4	3,138	2,292	290	251
Memphis District				
Plan 3	2,022	681	233	291
Plan 4	148	952	98	142
New Orleans District				
Plan 3	17	0	0	0
Plan 4	17	0	0	0
Total				
Plan 3	8,440	2,090	555	569
Plan 4	3,303	3,244	388	393

Source: USACE 1998m and Geo-Marine, Inc.

4.5 Aquatic Resources

Potential direct effects of the project on the habitat value of borrow areas were evaluated by Killgore *et al.* (Appendix 8). The objective of the study was to quantify changes in fish habitat for borrow areas associated with each project alternative using HEP (USFWS 1980). Borrow areas riverside of the levee would incorporate aquatic design features. In addition, quantitative comparisons of the fish community were made between riverside and landside borrow areas to rank the relative habitat value among borrow areas. Results are briefly presented in this section and can be found in their entirety in Appendix 8.

Multivariate regression models were used to predict fish abundance from habitat variables specific to each alternative (Table 4-11). Models were developed from an existing data base for five evaluation taxa: buffalo, silversides, channel catfish, largemouth bass, and warmouth. Fish abundance was correlated with five different physical variables: mean depth and shoreline length of pits, annual days flooded, turbidity, and conductivity. For each taxon and each alternative, a HSI was calculated as a ratio: predicted fish abundance / maximum observed fish abundance.

Table 4-11.

Summary Statistics for Evaluation Species Based on 1981 Rotenone Collections in Mississippi River Borrow Pits (Cobb *et al.* 1984).

Species	Variable	N	Mean	Std. Dev.	Min	Max
Buffalo	No/acre	22	68.5	73.4	0	255
	Lbs/acre	22	116.5	130.7	0	440
Silversides	No/acre	19	200.7	279.9	0	990
	Lbs/acre	19	0.2	0.3	0	1.4
Channel catfish	No/acre	22	73.9	66.0	0	245
	Lbs/acre	22	14.8	10.4	0	38
Largemouth bass	No/acre	22	27.8	26.5	1	95
	Lbs/acre	22	5.8	4.7	0.1	15
Warmouth	No/acre	19	140.3	224.6	0	949
	Lbs/acre	19	0.9	0.9	0	3.4

Source: USACE 1998a.

HUs, the product of HSI and acres of borrow areas, increased for Plans 3 and 4, indicating that the proposed action would improve habitat for aquatic species (Table 4-12). Multiple regression models indicated that most riverine fishes would benefit from borrow areas that are relatively deep (>5ft) and frequently flooded. Exceptions include the warmouth, a wetland fish often found in shallow backwaters. Turbidity and conductivity may influence habitat quality for certain species, but the majority of existing borrow areas have suitable water quality to support a diverse assemblage of fish. Plan 4 would provide greater habitat value per acre of borrow area for most exploitable and forage species (buffalo, largemouth bass, silversides) than Plan 3 because deep borrow areas with irregular shorelines, islands, and possible plantings of riparian vegetation will be incorporated. Conversely, Plan 3 does not include aquatic design features.

Creation of permanent borrow areas riverside of the levee would result in HU gains ranging from 55 to 30,656 depending on USACE District. HUs were annualized over the project life to incorporate changes in borrow area acreage during construction (USFWS 1980). It was assumed that borrow area acreage would increase linearly during the period of construction, and would remain the same for the life of the project.

Based on these assumptions and using HSI values cumulative for all evaluation species (Table 4-12), AAHUs gained in the lower Mississippi River for Plan 3 were 30,499, and 27,381 for Plan 4 (Table 4-13). In the Vicksburg District, Plan 3 would create more borrow areas and have a larger gain in AAHUs than Plan 4. However, the habitat value per acre is greater for Plan 4 in all Districts. Implementation of the no-action alternative would prevent the creation of approximately 6,700 acres of high quality fisheries habitat.

Table 4-12.
HSI Values and HUs for Aquatic Evaluation Species by Plan and District.
(HUs for Plans 3 and 4 are in Addition to that of No Action)

Evaluation Species	Alternative								
	No Action			Plan 3: Traditional			Plan 4: Avoid and Minimize		
	HSI	Acres	HU	HSI	Acres	HU	HSI	Acres	HU
New Orleans District									
Buffalo	0.71	2939	2087	0.96	16.6	16	0.96	16.6	16
Silversides	0.56	2939	1646	0.43	16.6	7	0.43	16.6	7
Channel catfish	0.80	2939	2351	0.73	16.6	12	0.73	16.6	12
Largemouth bass	0.90	2939	2645	1.00	16.6	17	1.00	16.6	17
Warmouth	0.80	2939	2351	0.29	16.6	5	0.29	16.6	5
Cumulative for species	3.77	2939	11080	3.48	16.6	55	3.48	16.6	55
Vicksburg District									
Buffalo	0.52	5794	3013	0.52	11800	6136	0.97	6650	6450
Silversides	0.46	5794	2665	0.46	11800	5428	0.70	6650	4655
Channel catfish	0.70	5794	4056	0.70	11800	8260	0.94	6650	6251
Largemouth bass	0.62	5794	3592	0.62	11800	7316	1.00	6650	6650
Warmouth	0.62	5794	3592	0.62	11800	7316	1.00	6650	6650
Cumulative for species	2.92	5794	16918	2.92	11800	34456	4.61	6650	30656
Memphis District									
Buffalo	0.46	1340	616	0.46	0	0	1.0	60	60
Silversides	0.51	1340	684	0.51	0	0	0.41	60	25
Channel catfish	0.76	1340	1018	0.76	0	0	0.66	60	40
Largemouth bass	0.51	1340	684	0.51	0	0	1.0	60	60
Warmouth	0.81	1340	1085	0.81	0	0	0.47	60	28
Cumulative for species	3.05	1340	4087	3.05	0	0	3.54	60	213

Source: USACE 1998a.

Table 4-13. Summary of Aquatic Impacts for Plans 3 and 4.		
District	Gain in Average Annual Habitat Units	
	Traditional: Plan 3	Avoid and Minimize: Plan 4
New Orleans	55	55
Vicksburg	30,494	27,131
Memphis	0	195
Total	**30,549**	**27,381**

Source: USACE 1998a.

4.6 Threatened and Endangered Species

Implementation of the proposed construction would not directly, indirectly, or cumulatively impact populations of the pallid sturgeon, fat pocketbook pearly mussel, interior least tern, bald eagle, wood stork or black bear. This conclusion was based on review of appropriate literature and scientific data for each of the species and the inclusion, as appropriate, of specific environmental design measures to ensure that proposed construction would not adversely impact any of the species. The USFWS concurred with the "no affect" determination (see Appendix 2). The following paragraphs summarize the potential effects to the pallid sturgeon, fat pocketbook pearly mussel, interior least tern, bald eagle, or wood stork that were evaluated. For more information, refer to the appropriate sections in the BA (Appendix 11).

4.6.1 Pallid Sturgeon

Project related direct, indirect, or cumulative impacts to the pallid sturgeon are not anticipated. The project area is not in locations known for frequent occurrences and presumably high densities of pallid sturgeon (Dryer and Sandvol 1993). Dredging would take place during low water at some work item locations, which is outside the pallid sturgeon spawning period. Adult pallid sturgeon are not believed to be impacted by dredging (Constant *et al.* 1997). Sediment removed from near-shore areas or shallower waters offshore are unlikely to affect pallid sturgeon inhabiting deep water in the main channel.

4.6.2 Fat Pocketbook Pearly Mussel

The proposed action would not require any work within habitat suitable for the fat pocketbook pearly mussel, nor would the work impact such habitat. Therefore, the fat pocketbook pearly mussel would not be directly, indirectly, or cumulatively impacted.

4.6.3 Interior Least Tern

All potential borrow within the Memphis and New Orleans Districts would be obtained from sites which are away from the Mississippi River. No borrow material would be dredged from any sandbars or open river within the New Orleans and Memphis Districts. Thus, least tern habitat would not be directly, indirectly, or cumulatively impacted within these Districts.

Within the Vicksburg District, sand borrow material is currently proposed to be dredged from four open water sites and one sandbar in the Mississippi River. All Lower Mississippi River least tern surveys conducted by the USACE were researched for locations of nesting colonies or resting sandbars. No open water dredging sites are located near least tern nesting and foraging sites.

One sandbar located at RM-490-L is a proposed borrow area. This sandbar has never been used by least terns, and its configuration is such that is highly unlikely it would ever be used as a least tern nesting site. Thus, no adverse impacts are expected if this sandbar is used for borrow material. Overall, the proposed project would not directly, indirectly, or cumulatively have adverse impacts on the interior least tern population on the Mississippi River.

4.6.4 Bald Eagle

No direct, indirect, or cumulative adverse impacts to the bald eagle would be expected from the proposed project. Construction would not occur within 0.5 mile of any eagle nests during the time of egg-laying, incubation, and the first month after hatching (1 October to 15 May). The "no-construction" period could be shortened for specific items of proposed construction if it is determined, in consultation with the USFWS, that such construction would not directly, indirectly, or cumulatively have adverse impacts on the bald eagle.

4.6.5 Wood Stork

The avoid-and-minimize environmental measures that are integral to the recommended plan would significantly reduce the possibility of loss of suitable habitat for the wood stork. The existing hydrology within the proposed project area would not be impacted by the project construction. Overall, the proposed project would not adversely impact the wood stork, directly, indirectly, or cumulatively.

4.7 Cultural Resources

Approximately 70 archeological sites, four cultural resources sites with standing structures, and six cemeteries dating to historic times are located at or very near the proposed work items (USACE 1998o). Additional cultural resources identification, evaluation, and mitigation efforts would be required as specific work item areas are finalized. The identification studies would include field surveys to update the existing records searched. Evaluation typically includes additional field research or other actions aimed at determining a final status of a cultural resources site's eligibility for listing in the National Register of Historic Places. Mitigation treatment of significant cultural resources would consist of avoidance, where possible, and data recovery or other actions as determined under consultation procedures of the National Historic Preservation Act and other pertinent laws and regulations.

4.8 Water Quality

4.8.1 Mississippi River

Construction of the Mississippi River levees and its associated features may have some short-term direct impacts on water quality which would be localized within 1-2 miles downstream of proposed work items. However, implementation of Best Management Practices (BMPs) would assure that there are no adverse short- or long-term impacts to the water quality of the Mississippi River (USACE 1998q). Although the project may induce some sediment and nutrient retention, this retention would be small in scale and would not affect the hypoxia zone in the Gulf of Mexico.

4.8.2 Borrow Areas

Water quality in the Mississippi River is basically good and consequently, water quality within riverside borrow areas is within acceptable ranges most of the time. New borrow areas, depending on their location, are expected to have good water quality after a few years. Landside borrow areas have the potential to trap high levels of chlorinated pesticides, which could threaten the health of fish populations and their potential consumers. Direct and indirect impacts associated with implementation of Plans 3 and 4 are briefly discussed below and are provided in detail in Appendix 17.

The major impact to water quality associated with Plan 3 would be localized increases in turbidity and suspended solids, and would be greatest in immediate construction areas. In instances where borrow material would be obtained riverside of the levees, no work would be performed during high water periods. Because borrow material is easier to handle when dry, most riverside borrow areas would be dry during the construction period and direct impacts to water quality would be minimized. Turbidity increases would be likely during rain events that occur during the construction period but these impacts would be lessened by the application of best management practices (BMPs) for nonpoint pollution at construction sites.

Indirect impacts to water quality associated with Plan 3 are few. Borrow areas act as sinks for nutrients and sediments and perform many of the functions of wetlands such as nutrient retention and cycling, trapping pollutants, and organic carbon processing. They do not export organic carbon, but trap it in their sediments. With the possible exception of mercury, riverside borrow areas do not exhibit high levels of either organic or inorganic pollutants in the sediments or water. Although their small relative size and volume make it unlikely that they would have any measurable impact on the water quality of the Mississippi River, they are important aspects of the riverside habitat and would provide good habitat for fish and waterfowl and add diversity to the general environment.

Direct impacts associated with Plan 4 would also include localized increases in turbidity and suspended solids. These impacts have the potential of affecting somewhat larger areas due to longer haul distances, but reasonable efforts to reduce nonpoint pollution would be performed. Plan 4 includes construction of some berms with dredged material from the Mississippi River and would involve degrading existing berms and using the material to raise the levees. Sand would be dredged from sandbars in the river and placed in the excavated areas on the berms. Effluent water would be returned to the riverside of the levee. Because dredged material would consist primarily of sand, the effluent return would be fairly clean because sand generally drops out of suspension within 50 to 100 feet of the dredge pipe. Maximum anticipated suspended solids levels would be 2,000 mg/L based on samples with five percent silt and clay. The dredge effluent return would range between 25 and 50 cubic feet per second (cfs) and would eventually mix with the waters of the Mississippi River. The minimum observed flow in the Mississippi River at Vicksburg is approximately 100,000 cfs and consequently, the effluent would be diluted a minimum of 2,000 times. A short turbidity plume would likely be visible in the vicinity of the effluent return, but would mix within 1,000 feet of the point of return.

Plan 4 also includes the use of relief wells in some places to substitute for additional berms. The direct impact to water quality from the construction of relief wells would be minimal and may include slight increases in suspended solids and turbidity levels during storm events. Considering the high ambient levels of turbidity from other nonpoint sources landside of the levees, no observable effects would be expected.

Plan 4 would also include the use of slurry trench cutoffs in some places instead of berms to prevent seepage under levees. Construction of these trenches would involve right-of-way clearing, digging the trench with placement of the material to one side of the trench, and filling the trench with grout. The major impact to water quality would be elevated turbidity and suspended solids levels from site disturbance and the dredged material bank.

As with Plan 3, indirect impacts on water quality associated with Plan 4 are few. Plan 4 differs from Plan 3 in that some environmental features would be added to the borrow areas to improve the local environment. It is unlikely that reforested borrow areas would have a greater net impact on water quality than borrow areas that fill with water. Both would perform the wetland functions described under Plan 3. The forested areas may be net exporters of organic carbon instead of organic carbon sinks. Although borrow areas holding water may trap some organic carbon, the amount would not significantly alter organic carbon levels in the Mississippi River. Environmental features such as reforesting the areas around the borrow areas would enhance the localized value of the sites and improve such functions as sediment and nutrient retention, but due to their small total area and volume, it would not measurably change nutrient or suspended solids levels in the Mississippi River. Reforesting around the borrow areas would likely have a long-term impact on water temperature within the borrow areas and may reduce the suspended solids loads that the individual borrow areas receive.

4.9 Air Quality

Air quality in the majority of the project area is not expected to be significantly impacted by implementation of the proposed project. Most of the project area is classified as "in attainment" for air pollutants. Therefore, equipment used, which is classified as mobile source, is exempt from permitting requirements. Air quality for each USACE District is discussed below. No direct or cumulative adverse impact to air quality are expected.

4.9.1 Memphis District

After review of air quality regulations and permitting requirements from the states where the projects occur, and after conversations with officials from those states, it has been determined that 30 of the 31 work items would comply with SIPs in the various states (USACE 1998f), and the equipment used can be classified as mobile source and would be exempt from permitting unless asphalt batch plants or stone/concrete crushers are used.

However, the Drinkwater Pump Station Expansion project, near Levee Milepost 25 at Drinkwater Blue Hole, Missouri can be classified as either (1) modification of an existing, permitted facility, or (2) modification of an existing, exempt installation which currently emits less than the *de minimis* levels of any pollutant. This would require determination from the Missouri Department of Natural Resources, Air Pollution Control Permits Office.

4.9.2 Vicksburg District

Based on a review of the states of Arkansas, Louisiana, and Mississippi air quality regulations and permitting, it has been determined that all 85 work items would comply with SIPs in the various states. The equipment used can be classified as mobile emission sources and would be exempt from permitting requirements unless asphalt batch plants or stone/concrete crushers are used.

4.9.3 New Orleans District

An applicability determination based upon direct and indirect emissions was performed. Direct emissions included those resulting directly from construction of the proposed project. No other indirect Federal action, such as licensing or subsequent actions related to the construction would result from this action. Therefore, analysis was based upon total estimated hours required for construction and tonnage of woody biomass cleared that would be subject to open burning. Results of the analysis are shown in Appendix 6, Section 9. Based on this applicability determination, the emissions for this project are classified as *de minimus* and no further action is required.

4.10 Socioeconomic Impacts

4.10.1 Plan 3 - Traditional Method

Plan 3 would require significant expenditure of additional tax dollars but would reduce the impacts from flood events. Assuming that the levee failures would be avoided, the plan would reduce the negative impacts - flood damages, loss of life, reduced economic activity, out-migration - from a PDF event. These impacts would be long term and would be likely to sustain the socioeconomic vitality of the project area.

As noted below in 4.9.3, results of damage analyses indicate levee crevasses could potentially cause $4.6 billion in direct flood damages--$1.6 billion in the areas along the east bank of the Mississippi River and $3.0 billion on the west bank. Secondary and tertiary impacts could increase the total effect on the local economy to almost $10 billion. Plan 3 is expected to prevent these damages.

The construction of the recommended plan could also have short-term positive impacts on the local economy from increased business activity. The areas where construction occurred could experience temporary increases in employment, income and tax revenues and, potentially, short-term increases in population. The direct impacts from construction would also have secondary and tertiary economic impacts through economic multiplier affects, e.g., increased income leads to more retail spending in the area. The construction could in some cases, particularly in rural areas, have short-term impacts on provision of government services that might be overwhelmed by increased levels of economic activity.

4.10.2 Plan 4 - Avoid and Minimize

Socioeconomic impacts of Plan 4 - Avoid and Minimize would be similar to the impacts resulting from Plan 3 - Traditional Method. Differences in construction costs of the plans would affect the level of economic stimulus to the project area.

4.10.3 No Action Alternative

The no action alternative could directly and indirectly affect socioeconomic resources through increased flooding potential within the area. Potential impacts could occur to employment, income, population (migration), and government revenues and expenses. Impacts on waterway transportation and water supply are unlikely and therefore, the analysis of the no action alternative focuses on flood control impacts.

No systematic analyses have been completed to estimate the impact of a PDF (project design flood) event within the region of analysis. A small case study was completed by the Vicksburg District to determine the expected damages from crevasses in the Mississippi River levee at Mayersville, Mississippi, and Lake Providence, Louisiana (USACE 1998g). Although limited, this study provides an indication of the level of impacts from a levee failure that might occur under the No Action alternative.

Crevasses caused by floodwaters overtopping the levees near the small towns of Mayersville and Lake Providence could directly affect approximately 114,000 people, 40,000 residences, and 1,600 businesses in 12 counties and parishes along the Mississippi River. Results of damage analyses indicate levee crevasses could potentially cause $4.6 billion in direct flood damages--$1.6 billion in the areas along the east bank of the Mississippi River and $3.0 billion on the west bank. Secondary and tertiary impacts could increase the total effect on the local economy to almost $10 billion. Both agricultural and industrial interests would be adversely affected and would require a significant amount of time to recover. Traffic corridors such as Interstate Highway 20; U.S. Highways 61, 65, and 84; and other corridors, including railroads, could be closed for extended periods.

Additional impacts could occur that do not have direct dollar values or were not estimated within the case study. These impacts may include loss of life and devastation to families and communities as well as costs from state and Federal government spending on disaster relief and loss of local, state, and Federal government revenues from reduced economic activity. The impact of such an event would be likely to cause out-migration and long term reductions in population and economic activity.

Representing approximately 14 percent of the project area economic base area, results of this study indicate levee failures at other locations would cause significant damages and impacts regionwide. Based on extrapolation of data from the case study, estimated damages to the entire project area could approach $300 billion (USACE 1998g).

The no action alternative would, of course, require less spending of tax dollars for completion of the authorized project. The short term reduction in government expenditures and, as a result, government taxation, might in the long term lead to higher government costs from increased flood disaster assistance and reduced tax revenues from reduced economic activity from flood affected areas if levee failures or other disasters occurred.

4.11 Prime and Unique Farmlands

Requests were made to the NRCS Area or State Soil Scientist within each of the seven states of the project area to quantify the amount of important farmland potentially impacted by the proposed alternatives described in plans 3 and 4. Direct adverse impacts to farmlands associated with the proposed action would include (a) conversion to new levee or seepage control measure in areas where the levee is proposed to be enlarged or where berm construction is proposed, and (b) conversion to borrow areas. Farmland Conversion Impact Ratings (AD-1006 Forms) were received from Illinois, Tennessee, Missouri, and Louisiana. Table 4-14 summarizes the Farmland Conversion Impact Ratings received from those states.

Table 4-14
Summary of Farmland Conversion Impact Ratings for
Tennessee, Louisiana, Missouri, and Illinois

State	Plan 3	Plan 4
Tennessee		
Acres to be Converted	82	75
Acres of Prime Farmland	35	32
Louisiana		
Acres to be Converted	7185	6720
Acres of Prime Farmland	0	6720
Missouri		
Acres to be Converted	4263	2712
Acres of Prime Farmland	0	1990
Illinois		
Acres to be Converted	723	325
Acres of Prime Farmland	576	260
Total Prime Farmland Acres to be Converted	611	9002

4.12 Hazardous, Toxic, and Radioactive Wastes

The following paragraphs summarize the conclusions made during the Memphis, Vicksburg, and New Orleans District's HTRW site assessments. Significant findings of each assessment are contained within Section 9 of Appendix 6 (USACE 1998f).

4.12.1 Memphis District

The Memphis District HTRW site assessment revealed no evidence of recognized HTRW environmental conditions in connection with 27 of the proposed work items. The remaining four work items have potential HTRW concerns, and should be avoided if practicable. The work items with potential HTRW concerns are: (1) Commerce to Birds Point levee grade raise project, (2) Miston seepage berms project, (3) Butler seepage berms project, and (4) Blue Lake relief wells project. Project plan alternatives and HTRW response alternatives must be conducted for these four work items.

4.12.2 Vicksburg District

This Vicksburg District HTRW site assessment identified several HTRW sites adjacent to Vicksburg District work item sites. However, no information regarding any HTRWs was identified within work item site boundaries. Six proposed work item sites (Items 367-R, 368-R, 495-L, 526-L, 531-L, 543-L) were determined to have potential HTRW concerns.

A record review revealed 10 LUSTs within Greenville, Mississippi. The majority of the tanks listed have been removed and closed in accordance with MDEQ regulations. With the use of levee realignments and relief well construction, the risks associated with encountering HTRW resulting from these LUSTs was determined to be low.

Based on the analysis of these sites and data reviewed during this assessment, it was concluded that the overall risk of encountering HTRW on any of the 85 work items within the Vicksburg District study area is low.

4.12.3 New Orleans District

Based on land-use history, agency coordination, and field inspection, the risk of encountering HTRW throughout the New Orleans District study area was determined to be low. The Old Inger Superfund site associated with the Carville to Marchand levee work is under remediation and its contaminant impacts are confined to the land side of the levee. Vegetation of the levee embankment and batture exhibit no visible signs of chemical spills or runoff, burns, or aerial deposition of pollutants, so levee soils were determined to be unlikely to contain contaminants. The proposed alternative borrow pit site for the Carville-Marchand project was a subject of concern because of its location between two major industrial chemical plants; however, extensive research has failed to uncover any HTRW problems.

It was determined in the HTRW report that no other potential problems are expected within the proposed project sites and no further HTRW investigations would be required within the New Orleans District study area. Should the construction methods change the HTRW risk would require reevaluation.

4.13 Recreation and Esthetics

4.13.1 Recreation Impacts

4.13.1.1 Plan 3 - Traditional Method

Due to the magnitude of Plan 3, some temporary negative impacts to recreational opportunities would occur. As borrow areas are excavated, some woodlands and grasslands would be eliminated. In addition, sites and areas would be disrupted by the construction work.

Plan 3 would also generate direct positive impacts for recreation. Borrow areas would provide fishing habitat though there are no borrow area environmental enhancements under this plan.

Borrow areas would provide recreational fishing activities as the river inundates and replenishes the borrow areas. Proposed levee berms would also provide feeding habitat for wildlife. Overall impacts to recreation would be minimal under this plan.

4.13.1.2 Plan 4 - Avoid and Minimize

Like Plan 3, the magnitude of Plan 4 would create some temporary negative impacts to recreational opportunities. Impacts to woodlands and grasslands would occur and some sites and areas would be disrupted by construction. Also dredging operations would occur during construction.

Plan 4 would generate many direct positive impacts for recreation. Open areas would be reforested which would provide additional wildlife habitat. Some of the proposed borrow areas would be designed for aquatic resources and environmental enhancements. These borrow areas would provide fishing habitat as well as scenic qualities. Borrow areas would provide recreational fishing activities as the river inundates and replenishes the borrow areas. Proposed levee berms would also provide feeding habitat for wildlife.

Even though some fishery and wildlife habitat would be lost due to construction, the avoid-and-minimize plan allows for creation of additional in-kind habitats. The proposed borrow areas, berms, and reforestation would eventually create more recreation opportunities. This plan would substantially offset losses in recreational opportunities and have long-term benefits to meet the recreational needs along the project. Overall impacts are expected to be relatively minor.

4.13.2 Esthetics Impacts

4.13.2.1 Plan 3 - Traditional Method

Plan 3 would use traditional borrow area methods and produce a net loss of 11,584 acres of BLH. Borrow areas would not include environmental or esthetic enhancements. Because less than 1 percent of the project area would be affected, the net effect to the esthetics from Plan 3 would be insignificant.

4.13.2.2 Plan 4 - Avoid and Minimize

Current land use within the study area consists of the following lands: cropland, forest, herbaceous, levee, marsh, open water, pasture/old field, scrub shrub, tree plantation, and urban. Approximate total acreage within the study area without this project is 2,645,844. With Plan 4, an estimated 19,900 acres of land would have minor visual impacts. To help minimize the direct impact to esthetics of the project, some reforestation of BLH would occur. Also, borrow areas would be designed and constructed in a way as to blend them into the surrounding area; thus, minimizing any visual impacts. No direct or cumulative impacts are expected to esthetics.

This project would involve raising levees along portions of the Mississippi River. As a result of this work, borrow areas would be developed to supply fill material. Previously, traditional borrow areas were excavated in a rectangular shape with no esthetic concerns. Currently, maintaining the esthetic and habitat quality along the river is a high priority. To achieve this, the borrow areas would be designed to be a positive environmental feature of this work. Three types of borrow areas are proposed. Type A is one to 10 acres in size, Type B is 10 to 30 acres in size, and Type C is over 30 acres in size.

In most cases, Type A borrow areas would be located in forested areas. Type B borrow areas would consist of an irregular-shaped shoreline with hardwood trees and other natural vegetative plantings. This type area would be suitable for recreational fishing. Type C borrow areas would consist of an irregular-shaped shoreline with hardwood trees and other natural vegetative plantings. These areas would have islands, peninsulas, loafing sites, and native grasses, providing wildlife habitat.

All three types of borrow areas could be used for deep or shallow borrow areas as well as landside or riverside borrow areas. Visually, these borrow areas would be scenic and have good wildlife and fishery habitat. Specific design guidelines for these borrow areas are found in "*Environmental Design Considerations for Main Stem Levee Borrow Areas Along the Lower Mississippi River, Lower Mississippi River Environmental Program, Report 4, April 1986.*" This report was prepared by the USACE, MRC. Design of the borrow areas would be in accordance with this guidance, where practical.

In addition, some seepage berms would be constructed on the main levee's landside. These berms would be planted with grasses that would be suitable for wildlife forage. No trees would be planted on the seepage berms in order to maintain their structural integrity.

Less than one percent of the project area acres would be impacted. Based on this small percentage, the net effect to the esthetics in constructing this project is insignificant.

4.14 Cumulative Impacts

4.14.1 Early Settlement Activity

Agricultural development by early settlers began along the banks of the Mississippi River during Colonial times and as early as 1790, a few American farmers in the northern end of the valley were clearing forested areas to cultivate corn, cotton, wheat, tobacco, flax, and hemp. From Cairo, Illinois, to Memphis, Tennessee, these forests contained cottonwood, willow, sycamore, ash, hackberry, and a variety of oaks and other species (USACE 1976). From Memphis to Natchez, Mississippi, the composition was the same, but sycamore was more scarce and cypress, ash, and gum were more common. Below Natchez, magnolia and sweet bay became more common. Cottonwood and willow were almost universally found on the immediate bank of the river, on the islands, and on all new land formations. Early settlers met the challenge of too much water coming too often and staying too long on these newly settled lands by instituting levee building programs.

The first levees were constructed near New Orleans, Louisiana, and by 1844, the levee system was practically continuous on the west bank from below New Orleans northward to the mouth of the Arkansas River (Lower Mississippi Region Comprehensive Study Steering Committee, 1974). East bank levees extended from below New Orleans to Baton Rouge, Louisiana, and at several locations between Vicksburg and Memphis. Through the Swamp Land Acts of 1849 and 1850, the states gained possession of all unsold swamp and overflow lands bordering the Mississippi River. The Act provided that proceeds from the sale of the lands by the states would be used to construct levees and drainage ditches.

4.14.2 The 1900's

Based on land use included on survey maps from 1913 -1915 (MRC 1915), it appears agriculture played an important role on the lands along the Mississippi River, although forested areas still dominated land use. Similar to early reports on species composition along the banks of the Mississippi River, a large portion of the forested areas contained willow, cottonwood, and sycamore.

In 1917, Congress authorized Federal participation in the levee building program. This, in conjunction with the Swamp Land Acts, combined to provide further impetus to levee building activities. Following the devastating 1927 flood, the MR&T Project was initiated with the passage of the 1928 Flood Control Act. At that time, the existing system of local interest levees had defined an area between the levees of approximately 1.5 million acres in the Vicksburg District alone (Banks 1996). Construction on the Mississippi River mainline levees by the Federal Government has been continuous since the passage of the Flood Control Act of 1928.

The relative amounts of forested, open and water lands between the levees remained basically stable from the 1950's to the 1980's (Garnett *et al.* 1991). Based on transect data, Garnett *et al.* (1991) concluded there was a six to eight percent decrease in forest lands, a two to three percent increase in open land, and a four to five percent increase in open water over the four decades (Table 4-15).

Table 4-15.

Land Use Along the Mississippi River, River Mile 0 to 950

Land Use	1950's	1980's
Forested	55%	49%
Open	26%	29%
Water	19%	23%

Source: USACE 1998

Garnett *et al.* (1991) also reported that forested lands were dominated by three species associations--cottonwood/black willow, hackberry/green ash/American elm, and sycamore/sweetgum/American elm. Depending on the location along the river, these three community types account for between 73 and 89 percent of total forest cover.

Although they used different classification schemes and inventory techniques, most studies indicate a rapid rate of wetland loss in the United States, at least prior to the mid-1970's (Giudice and Ratti 1995). Federal flood control projects, agricultural economics, and climatic conditions within the broader Lower Mississippi Alluvial Plain (Delta) have influenced bottom-land hardwood conversion outside the immediate study area (U.S. Department of Interior 1988). The Delta originally contained 24 million acres of bottom-land hardwoods; however, by 1937, only 11.8 million remained. By 1988, only 5.2 million acres remained--20 percent of the original acreage. The greatest wetland losses are occurring in the Lower Mississippi Alluvial Plain and the prairie pothole region (Mitsch and Gosselink 1986). It is estimated the losses will continue at a rate of 2 percent per year (U.S. Department of Interior 1988). The importance of forested wetlands in the Lower Mississippi Alluvial Plain was stressed in a report to Congress by the Secretary of the Interior (U. S. Department of Interior 1988):

> These bottomland hardwoods are among the Nation's most important wetlands. They are prime overwintering grounds for many North American waterfowl, including 2.5 million of the 3 million mallards of the Mississippi Flyway, nearly 4 million wood ducks and many other migratory birds. Numerous finfishes depend on the flooded hardwoods for

spawning and nursery grounds. These wetlands support many other wildlife species of wildlife, including deer, squirrel, raccoon, mink, beaver, fox and rabbit. They also play a vital role in reducing flooding problems by temporarily storing large quantities of water and by slowing the velocity of flood waters. In the process, these wetlands remove chemicals such as fertilizers and pesticide from the water, trap soil eroding from nearby farmlands, and recharge ground water supplies.

In addition to being one of the most important wetland resources in the U.S., the Delta is also one of the most seriously depleted and threatened. While nationwide losses have reached the order of 50 percent, in the bottomland hardwood region of the lower Mississippi some 80 percent of the original wetlands have been lost.

In addition to the widely recognized fish and wildlife values associated with wetlands, they also possess functions that distinguish them from terrestrial and aquatic ecosystems (Giudice and Ratti 1995). These functions include flood mitigation, storm abatement, aquifer recharge, erosion control, water quality improvement, nutrient retention, removal and transformation, recreation and aesthetics (U.S. Department of Interior 1984; Mitsch and Gosselink 1986; Smith 1993).

Mitsch and Gooselink (1986) identified four common alterations which directly or indirectly alter wetlands: (1) draining, dredging and filling of wetlands, (2) modification of the hydrologic regime, (3) mining and mineral extraction, and (4) water pollution. Wetland values can be reduced without the actual conversion of bottom-land hardwoods to another land use. Therefore, not only have the wildlife and functional wetland values been eliminated or reduced on the 24 million acres previously cleared in the Lower Mississippi Alluvial Plain, but it is likely that the remaining fragmented bottom-land hardwoods have been altered to the point where there original functions have been modified. Clearly, wildlife habitat (and their associated wildlife populations) and the functional values of wetlands have been severely reduced as a result of human activity in the Lower Mississippi Alluvial Plain. In the absence of mitigative measures, additional losses could be considered significant given the cumulative losses of this resource. However, in recognition of the significance of bottom-land hardwood wetlands and the degree to which the resource has been depleted, legislative, regulatory and policy changes have been implemented in recent years to address this concern.

Legislative authorities and Executive Orders have addressed the issue of wetland protection and restoration in recent years. Section 404 of the Clean Water Act requires permits for the discharge of dredged or fill material into waters of the U.S. The Food Security Act of 1985 (referred to as "Swampbuster") removed some incentives for wetland development by eliminating agricultural subsidies to parties that produce commodities on wetlands converted after enactment.

The Wetlands Reserve Program is a voluntary program to restore wetlands. Participating landowners can establish conservation easements of either permanent or 30-year duration or can enter into restoration cost-share agreements where no easement is involved. E.O. 11990 directs Federal agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands if a practical alternative exist. E.O. 11988 directs Federal agencies to reduce flood loss risk; minimize impacts on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by floodplains. If the only practical alternative requires action in the floodplain, agencies must design or modify their action to minimize adverse impacts. These authorities and orders have and will continue to protect and restore wetlands in the study area and the Delta. In fact, in some areas of the Delta, the trend of clearing has stopped and, through restoration activities, the amount of forested land is increasing.

Currently, there is a variety of proposed water resource projects (flood control and environmental restoration) in the Delta. Studies are being conducted to evaluate the direction and magnitude of environmental change associated with these proposed projects. However, these projects are being designed to avoid and minimize environmental impacts to the extent practicable, and where appropriate, compensation provided to fully offset unavoidable impacts.

The proposed action includes levee enlargement and seepage control measures designed to protect against the project flood. The project would not change the hydrology associated with the Mississippi River; additionally, it would not result in additional hydrologic modification on the landside of the levee (except to prevent the Project Design Flood). After extensive avoid-and-minimize measures, the proposed action would impact 4,834 acres of BLH and 1,104 acres of tree plantations (mostly cottonwood). An estimated 2,760 acres of the BLH and 498 acres of the tree plantations are classified as wetlands.

The mitigation plan to offset unavoidable losses includes the acquisition and reforestation of 5,863 acres of frequently flooded agricultural lands (see Appendix 1). The mitigation lands would be managed by an appropriate Federal or state agency, ensuring the long-term stability of these lands. The mitigation plan provides a minimum of 100 percent compensation within each District for each resource category (Table 4-16). Two of the three resource categories in each District (except New Orleans District) would receive substantial net increases in resource value as a result of the mitigation plan.

Table 4-16.
Relative Compensation by District

Resource	Percent Compensated[a]		
	Vicksburg District	Memphis District	New Orleans District
Terrestrial (AAHU)	269	162	1,775
Wetlands (AAFCU)	100	100	100
Waterfowl[b] (DUD)	613	111	0

[a] Based on resource units (i.e., AAHUs, AAFCUs and DUDs).
[b] New Orleans District had no waterfowl impacts.

Source: USACE 1998.

In addition to the gains from the mitigation plan, environmental design features of the recommended plan include 6,727 acres of borrow area specifically designed to provide high-quality fisheries habitat and the reforestation of approximately 3,041 acres of borrow areas. The aquatic borrow areas would provide a 67 percent increase in borrow area fisheries habitat and an 85 percent increase in borrow area fisheries resource value (based on habitat units), The 3,041 acres of borrow area reforestation would provide an additional 7,998 terrestrial AAHUs, 12,985 wetland AAFCUs, and 158,132 waterfowl DUDs.

The mitigation plan and borrow area reforestation would result in a net gain of 4070 acres of BLH (excluding impacts to tree plantations). In addition, the quality of the reforested lands (large component of red oaks) would be considerably greater than the natural stands impacted (approximately six percent oaks).

The incremental impact of the proposed action, when added to former, present, and foreseeable future actions, results in a net gain in nationally significant habitat and environmental values in the study area. The proposed action would not improve or worsen any cumulative effects associated with the existing Mississippi River levees and other activities in the Lower Mississippi River Valley. Although the project may induce some sediment and nutrient retention, this retention would be small in scale and would not affect the hypoxia zone in the Gulf of Mexico. The environmental design and compensation features net an increase in terrestrial, wetland, waterfowl, and aquatic resource values such that no significant cumulative environmental impact results on an ecosystem, landscape, or regional scale when the proposed action is considered in conjunction with other activities. This net gain in environmental values is achieved while still accomplishing the construction objective.

4.15 Relationship Between Local Short-term Uses of Society's Environment and the Maintenance and Enhancement of Long-term Environmental Productivity

Flood control benefits and adverse environmental impacts represent trade-offs between the local short-term use and the long-term stability and productivity of society's environment. The project would reduce flooding to rural and developed properties and the associated financial and psychological hardships. Flood protection would improve the ability of local governments to provide and maintain public services, including education, police protection, various county social welfare services, and road and bridge maintenance. The stability of the project area is based on the continuation of an agricultural economy. Protection from catastrophic floods would aid the continued existence of the agricultural economy and reduce the fragmentation and duress on individuals, families, and communities. These benefits, however, would produce adverse impacts to natural resources that could not be avoided or minimized. These impacts would be mitigated as detailed in Chapter 5 and the Mitigation Plan (Appendix 1).

The recommended plan would convert 3,691 acres of forested wetland habitat (includes BLH, tree plantations, scrub/shrub, herbaceous, and marsh wetland cover types) and 3,637 acres of farmed wetlands (includes cropland, pasture, and urban wetland cover types). The forested and farmed wetland conversions would have long-term adverse impacts to terrestrial wildlife and wetland functional values. However, these impacts would be compensated concurrently with project construction. Because the reforested lands are dedicated to the project life and because an ecosystem approach to mitigation was used, compensation measures would contribute to the long-term stability and productivity of wildlife resources and society's environment. Compensation measures combined with environmental design features would produce a net gain in terrestrial, wetland, waterfowl, and aquatic resources.

4.16 Any Irreversible and Irretrievable Commitments of Resources Involved in Implementation of the Proposed Action

The proposed action would cause the permanent removal or consumption of renewable resources. Project implementation would irreversibly and irretrievably commit 19,900 acres of lands and resources for the project life to levee enlargement, seepage control measures, borrow areas, and other project features. Approximately 5,900 acres of land would be committed to compensatory mitigation. It also commits fuel, labor, building material, planning, technical expertise, and monetary resources.

5.0 MITIGATION MEASURES

This chapter presents mitigation features that would be incorporated into the recommended plan. The mitigation measures include environmental design features and measures to compensate significant unavoidable impacts. A mitigation plan (Appendix 1) has been prepared that summarizes environmental impacts, evaluates potential mitigation alternatives to compensate for impacts, and presents the recommended mitigation alternative.

5.1 Avoid and Minimize and Environmental Design Features

Various considerations have been incorporated into the project design of the recommended plan and would be implemented during detailed design and construction. The primary environmental design objective was the avoidance and minimization of impacts to BLH.

Two environmental design features would be incorporated into borrow area construction. Approximately 6,727 acres of borrow areas would be designed to include varying depths, irregular shorelines and islands. These areas would provide high quality aquatic habitat. In addition, 3,041 acres of borrow areas would be reforested. Both features would provide benefits to the environment (Table 5-1).

Table 5-1
Borrow Area Design Benefits

Resource	Value/Acre	Benefits
Terrestrial (AAHU's)	2.63	+ 7,998
Wetlands (AAFCU's)	4.27	+ 12,985
Waterfowl (DUD's)	52.00	+ 158,132
Aquatic (AAHU's)	4.07	+ 27,381

As an additional environmental design feature, revegetation measures would be implemented as soon as practical after construction, to control erosion. The construction areas would be seeded with ground cover mixtures (e.g., *Lespedeza*, clover, rye grass and Bermuda grass) at appropriate rates. This environmental design feature would eliminate or reduce erosion and the potential for secondary adverse impacts on water quality of adjacent waterbodies.

5.2 Waterfowl Resources

Reforestation is the USFWS's recommended mitigation technique for several reasons: (1) it constitutes an ecosystem approach to replacing the waterfowl values, (2) it would provide a stable, low maintenance, high reliability mitigation feature, (3) the chance of successful waterfowl habitat value replacement is highest with reforestation, (4) reforestation offsets terrestrial and wetland losses, and (5) reforestation of marginal agricultural or other cleared lands is easily accomplished.

The waterfowl benefit for reforested lands varies from 124 to 294 annual DUD/acre, depending on oak composition of reforested lands (Table 5-2). The USFWS recommends reforestation with 70 percent red oaks to produce a value of 235 DUD. At 70 percent red oak reforestation, compensation acreage for Plan 4 would be 574 acres and 849 acres for the Memphis and Vicksburg Districts, respectively.

Table 5-2 Duck-Use-Days/acre Benefit in Winter Various Habitats	
Habitat	Duck-Use-Days
Moist Soil	1,037
Corn	970
Rice	580
Soybean	253
Bottomland Hardwoods	
30% red oaks	124
50% red oaks	176
70% red oaks[a]	235
90% red oaks	294

[a] 235 DUD/acre was used to determine acres required to mitigate for impacts.

Source: USACE 1998i.

5.3 Terrestrial Resources

Forest establishment on cleared lands by natural succession or artificial regeneration would be necessary to compensate for terrestrial habitat losses, since few opportunities exist to improve habitat quality in the remaining forested lands. AAHUs that could be gained by reestablishing BLH forest on 100 acres of cleared land under various management plans (MP) range from 201 to 336 AAHUs (see Table 1-4, Appendix 1). Benefits with MP's in place were estimated for selected target years over the life of the project using models developed by consensus of the HEP team.

Implementing Plan 4 would result in the loss of 1,163 AAHUs for the Memphis District, 5,694 AAHUs for the Vicksburg District, and four AAHUs for the New Orleans District (total loss of 6,861 terrestrial AAHUs [see Table 10-3, Appendix 10]). Compensation was estimated by dividing total AAHU losses by the potential AAHU benefits of MP 7 (see Table 1-4, Appendix 1) and multiplying by 100. Complete compensation for Plan 4 would be 2,325 acres (Table 5-3). A summary of the mitigation by District to compensate for terrestrial habitat impacts of Plan 4 is given in Table 5-3.

Table 5-3 Terrestrial Mitigation for Plan 4	
District	Acres
Memphis District	394
Vicksburg District	1,930
New Orleans District	1
Total	**2,325**

5.4 Wetland Resources

Unavoidable wetland losses are identified in Appendix 13. Plan 4 would result in conversion impacts on 3,691 acres of forested wetlands and 3,637 acres of farmed wetlands. This would represent a wetland resources loss of 25,035 AAFCUs with implementation of the project. This total was reduced from those of Plan 3 by 29,040 AAFCUs through environmental design features.

Compensation for unavoidable impacts described in Section 4.3 can be accomplished through reforestation of frequently flooded agricultural lands (FFAL). The benefit in FCUs for this Plan is 4.27 AAFCUs per acre. This benefit was derived by taking the sum of the FCI reforestation values for each of the seven wetland functions evaluated (Table 5-4). The FCI's represent the net gain in functional value of reforesting frequently flooded agricultural lands assuming a linear recovery of full functional capacity over 20 years, annualized over the project life (100 years). Compensation was determined by dividing AAFCU losses by the AAFCU benefit per acre for reforestation of frequently flooded agricultural lands. Approximately 5,863 acres of reforestation would be necessary to compensate wetland impacts of Plan 4, including 5,200 acres in the Vicksburg District, 639 acres in the Memphis District, and 24 acres in the New Orleans District.

Table 5-4
FCI Values for Reforestation of Frequently Flooded Agricultural Lands.

Wetland Function	FCI Value
Short-term water storage	0.45
Long-term water storage	0.68
Water velocity reduction	0.64
Sediment detention	0.77
Onsite erosion control	0.58
Nutrient and dissolved substance removal	0.55
Organic carbon export	0.60
Total	**4.27**

Source: USACE 1998a.

5.5 Aquatic Resources

The recommended plan would provide aquatic benefits within the project area. Plan 4 would result in 6,727 acres of additional aquatic habitat including 17 acres in the New Orleans District, 6,650 acres in the Vicksburg District, and 60 acres in the Memphis District. These areas would range in size from about 10 to 200 acres with an average size of approximately 100 acres. Resulting habitat gains would be 55 AAHUs for the New Orleans District, 27,131 AAHUs for the Vicksburg

Table 5-5
Total Aquatic Habitat Gains by District.

District	Aquatic Resources (AAHUs)
Vicksburg	27,131
Memphis	195
New Orleans	55
Total	**27,381**

Source: USACE 1998a and Geo-Marine, Inc.

5.6 Cultural Resources

All sites eligible for or listed on the NRHP would be avoided, where practical. Appropriate mitigation measures for unavoidable impacts to significant cultural sites would be taken on a case by case basis under provisions of the National Historic Preservation Act.

5.7 Water Quality

With implementation of BMPs, no significant impacts on water quality are expected and therefore, no mitigation measures would be required. The general revegetation BMPs would be implemented as soon as practical after construction and would eliminate or reduce erosion and the potential for secondary adverse impacts on water quality of adjacent waterbodies.

5.8 Air Quality

Significant impacts on air quality are not expected; therefore, mitigation, other than incorporating BMPs and monitoring construction processes to ensure air quality standards are not violated, would not be required. Good engineering practices, such as wetting access roads and stockpiles would be implemented throughout the construction project in order to minimize air pollution. All construction practices conducted within the project area as part of this project would be required to comply with current Federal and state air quality regulations and standards. The applicability determination for the New Orleans District showed that emissions for the entire group of construction items are classified as *de minimis* and no further action, other than those described above, would be required.

5.9 Recommended Mitigation

Reforesting 5,863 acres of frequently flooded agricultural land is recommended to compensate for wetland, terrestrial, and waterfowl resource impacts (Table 5-6). A mixture of BLH species comprised of 70 percent red oaks would be planted on tracts acquired within each District. The successful reestablishment of BLH would benefit target resources and serve to improve the overall habitat value of lands within the project area. Monitoring of the mitigation lands would be conducted to determine the effectiveness of the compensation. The estimated first costs and annual cost for implementing the recommended mitigation alternative are given in Table 1-9 of Appendix 1. First costs would be $7.8 million, $986,000, and $58,000 for Vicksburg, Memphis, and New Orleans Districts, respectively. Annual costs including operation and maintenance would be $606,000, $75,400, and $4,400, respectively. The mitigation lands would be managed by an appropriate Federal or state agency, ensuring the long-term stability of these lands. The mitigation plan provides a minimum of 100 percent compensation within each District for each resource category. The compensation measures combined with the environmental design features would provide a net gain in terrestrial, wetland, waterfowl and aquatic resource value in the project area (Table 5-7).

Table 5-6 Mitigation Percentage and Cost Per Habitat Unit for the Recommended Plan												
Resource Category	Vicksburg District (5,200 acres)				Memphis District (639 acres)				New Orleans District (24 acres)			
	Units Impacted	Units Gained	Percent Mitigated	Cost Per Unit ($)	Units Impacted	Units Gained	Percent Mitigated	Cost Per Unit ($)	Units Impacted	Units Gained	Percent Mitigated	Cost Per Unit ($)
Terrestrial (AAHU's)	-5,694	15,340	269	1,375	-1,163	1,885	162	832	-4	71	1,775	14,500
Wetlands (AAFCU's)	-22,206	22,206	100	353	-2,728	2,728	100	355	-101	101	100	575
Waterfowl (DUD's)	-199,440	1,222,000	613	39	-134,992	150,165	111	7	0	5,640	N/A	N/A
Aquatics [a] (AAHU's)	N/A	27,131	N/A	N/A	N/A	195	N/A	N/A	N/A	55	N/A	N/A

[a]Aquatic habitat gains from aquatic borrow areas are shown here.

Table 5-7 Net Effect on Resources				
Resource	Impact	Compensation	Design	Net Change
Terrestrial (AAHU's)	(6,861)	+17,296	+7,998	+18,433
Wetlands (AAFCU's)	(25,035)	+25,035	+12,985	+12,985
Waterfowl (DUD's)	(334,432)	+1,377,805	+158,132	+1,201,505
Aquatic (AAHU's)	0	0	+27,381	+27,381

6.0 PUBLIC INVOLVEMENT

6.1 Public Involvement Program

The USACE public involvement program included a public scoping as well as appropriate agency review and coordination. The Public Involvement Program assisted the Planning Division of the Vicksburg, Memphis, and New Orleans Districts in maintaining effective two-way communication with the affected publics in the project area; ensured early agency and public participation be planned and incorporated; identified and developed solutions for the public involvement needs; established a proactive philosophy to guide the USACE in aggressively and systematically managing its public involvement future; identified all specific publics impacted by the project and establish information interchange systems; and fully informed the publics of the modern USACE capabilities and expertise and promote the USACE as an environmentally sensitive, preferred leader in those areas.

6.1.1 Public Scoping

A Notice of Intent (NOI) to prepare a SEIS for this project was published in the *Federal Register* on 4 April 1997. During the period of 20-29 May 1997, six scoping meetings were held at various locations along the Lower Mississippi River from Cape Girardeau, Missouri, to Head of Passes, Louisiana, to outline study procedures and receive public input concerning the study process and problems of the area. The minutes from the scoping meetings are on file with the USACE, Vicksburg District.

Appendix 5 contains a summary of coordination activities of the Memphis, Vicksburg, and New Orleans Districts during the conduct of these investigations. Technical team meetings occurred frequently throughout the study process and three additional public information meetings were held in October 1997.

Significant concerns identified by the public at preliminary scoping meetings which were common to each of those meetings included:

a. Flood control is needed to protect people and environmental resources.
b. The SEIS process and the project should be completed as quickly as possible.
c. Landside "borrow," or soil, for levee construction, is unaffordable and would remove productive farmlands.
d. Riverside borrow is affordable and appropriate for the legally designated use of the land.
e. Avoid damages to bottomland hardwoods and other fish and wildlife habitat as much as possible.
f. Avoid, minimize, and/or compensate for all adverse impacts, including erosion, sedimentation of adjacent water bodies, and fragmentation and loss of forested wetlands and nonwetland forests.
g. Compensate for loss of bottomland hardwood forests by establishment of large, contiguous blocks of woodlands.
h. Keep the public informed throughout the SEIS and period of project construction.
I. Provide protection for homes and farmlands.
j. Do not leave humans out of the equation when studying impacts on wildlife and bottomland hardwoods.

A site-by-site summary of a cross-section of issues that were presented by the public during the scoping meetings was presented in the July 1997 newsletter for the SEIS. As of the date of publication of the final SEIS, 4 newsletters detailing the progress of the SEIS and the public involvement program were mailed out to interested publics. Copies of the newsletters are on file with the USACE, Vicksburg District.

After the release of the draft SEIS, public meetings were held in Cape Girardeau, Missouri; Blytheville, Arkansas; Greenville, Mississippi; Lake Providence, Louisiana; Natchez, Mississippi, and Baton Rouge, Louisiana in March 1998. The purpose of the meetings was to receive comments on the draft SEIS and Sections 404 and 401 analyses prepared in accordance with the Clean Water Act.

6.2 Cooperating Agencies

Intense coordination has been maintained between the Vicksburg, Memphis, and New Orleans Districts and the Mississippi River Commission, various state and Federal agencies, including but not limited to, the USFWS, EPA, and NRCS. Responsibilities for the various agencies have included aiding in the development and preparation of the SEIS, environmental analyses, and resource documentation. Other contributions made by the cooperating agencies included scoping process participation, study direction and technical analyses, meeting and field work participation, and document and technical appendices review.

6.3 Public Review and Coordination

Coordination activities performed during the development of this study included public meetings (scoping and update meetings), newsletters, and fact sheets. The Project Report, draft SEIS, and associated appendices were circulated to appropriate agencies and interested organizations, groups, and private individuals for a minimum of 45 days for review and comment. All public involvement materials, including a list of recipients of the SEIS, are on file with the USACE, Vicksburg District.

All public comments received on the Draft SEIS as well as USACE responses are contained in Appendix 5. The USFWS Planning Aid Report is contained within Appendix 2. The following are responses to recommendations in the USFWS Planning Aid Report.

Recommendation 1. Borrow material should be obtained from cleared lands, particularly landside of the levee, to the extent possible.

Response. Borrow material will be obtained from cleared lands to the maximum extent practicable. Landside borrow is included on 12 work items.

Recommendation 2. Borrow pits should be environmentally designed as described in the SEIS to provide maximum benefits to fish and wildlife, and should also include:

a. Tree plantings around the perimeter.
b. Native grass plantings along the banks of the borrow areas.
c. Brush piles should be constructed with tree limbs from project clearing in the borrow sites.

Response. Approximately 6,700 acres of borrow areas will be designed to provide high value aquatic habitat. This design will also provide limited waterfowl foraging habitat. The specific design features in items a, b, and c will be included where appropriate and feasible.

Recommendation 3. Whenever possible, shallow borrow areas should be constructed, drained, and replanted in bottomland hardwoods to partially mitigate terrestrial losses.

Response. Reforestation of approximately 3,000 acres of borrow areas has been included as environmental design. This habitat is in addition to the terrestrial value provided by the mitigation plan.

Recommendation 4. All forested losses should be mitigated "in-kind" through fee title acquisition. BLH mitigation should primarily focus on reforestation of large blocks of cleared lands within or adjacent to the bird conservation areas.

Response. The preferred method of compensation is through fee title acquisition and reforestation of frequently flooded agricultural lands. The size of the potential mitigation tract and its relationship to forest bird conservation zone will be two of several factors considered when prioritizing and selecting mitigation lands.

Recommendation 5. Compensation lands do not need to be acquired concurrently with each work item, but, mitigation should be completed in each Corps' District prior to the end of the construction period (i.e. Memphis District - the year 2013).

Response. Acquisition and reforestation of mitigation lands will be phased-in across the construction period as suitable tracts are identified. These actions will likely not be associated with individual work items, but rather a group of work items.

Recommendation 6. Compensation for waterfowl foraging habitat, as described in our Waterfowl Analysis should be by reforestation of degraded wetlands and the restoration of the flooding regime.

Response. Waterfowl mitigation will be accomplished by the acquisition and reforestation of frequently flooded agricultural lands. These lands will be selected in part because of the existing flooding regime. Restoration of the flooding regime is not required.

Recommendation 7. The Service should be involved in any detailed design and engineering for the levee enlargement project, and all mitigation plans should be reviewed by the Service.

Response. The USFWS will be provided plans and specifications for each work item for review. Mitigation activities will be conducted with all appropriate Federal and state agencies.

7.0 LIST OF PREPARERS

The following people were involved with preparation of this Supplemental Environmental Impact Statement (SEIS) or supporting appendixes.

Name	Discipline/ Expertise	Experience	Role in Preparing SEIS or Supporting Appendixes
Martha Andrys	B.S./M.S.	20 years, real estate appraisal experience	Prepared Real Estate Cost Estimates
Larry Banks, P.E.	B.S., Engineering	27 years, hydrologic engineering and hydraulics; currently, Chief, Hydraulics Branch, U.S. Army Corps of Engineers, Vicksburg District	Hydraulics and Hydrology Team Leader; Wetland Delineation and Avoid and Minimize Determination
Chris Beacham	M.S., Economics B.A., Economics	7 years economic studies, Geo-Marine, Inc.; 3 years economic studies, Gulf Engineers and Consultants; 4 years economic studies, Gulf South Research Institute	Recreation/Esthetics and Socioeconomic SEIS sections
Richard Bergez	B.S. Mechanical Engineering MBA	31 years including 27 years, New Orleans; 9 years Project Management, 13 years Programs Management, 3 years Operations Division, and 2 years Engineering Division	Public Involvement, Coordination, and Mitigation
John Bivona	B.S., Engineering	24 years, U.S. Army Corps of Engineers, New Orleans District; 15 years college instructor/lecturer	Cost Engineering
Michael Brennan	B.S., Engineering	5 years, U. S. Army Corps of Engineers, New Orleans District, Engineering and Design, flood control projects	Engineering/Design
Eddie Brooks, P.E.	M.S., Engineering B.S., Engineering	24 years, hydrologic engineering, hydraulics, and project management	Hydraulics and Hydrology Team Member; Wetlands Delineation
Jon Christopher Brown	B.S., Biology M.S., Botany	1.5 years, environmental planning, U.S. Army Corps of Engineers, New Orleans District	Hazardous, Toxic, and Radiological Waste
Gene Buglewicz	M.S., Limnology	30 years, U.S. Army Corps of Engineers	SEIS Preparation, Public Involvement, and Coordination
Stoney Burke	M.S., Agricultural Economics	20 years, U.S. Army Corps of Engineers, Vicksburg District; currently, Chief, Economic and Social Analysis Branch, Vicksburg District	Economics Team Leader
Robert Campos	B. S., Civil Engineering Cert Engr Mgmt	27 years, U.S. Army Corps of Engineers, New Orleans District; General Engineering, Design Services, and Engineering and Project Management	SEIS Public Involvement, Coordination, and Mitigation Team Member
Marvin Cannon	B.S., Biology	22 years, U.S. Army Corps of Engineers, Vicksburg District	Contract Manager, Terrestrial and Waterfowl Team Leader, Bat Appendix, SEIS Review and Coordination, and Mitigation

Name	Discipline/ Expertise	Experience	Role in Preparing SEIS or Supporting Appendixes
Dave Carney	B. S., Wildlife Biology M.S., Wildlife Biology	20 years, environmental planning, U.S. Army Corps of Engineers, New England and New Orleans Districts	SEIS Preparation, Public Involvement, Coordination, and Mitigation Team Member
Randy Clark	B.S., Biology M.S., Biology	14 years, U.S. Army Corps of Engineers in water resources planning, wetlands permitting, and delineation	Wetland Delineation, Section 404(b)(1), and Wetland Analysis
Darrell Coad	Cartographic Technician	22 years cartography experience, U.S. Army Corps of Engineers	Geographic Information System mapping
Steve Cobb	M.S., Aquatic Biology	23 years, U.S. Army Corps of Engineers	Geographic Information System
Joe Coulon	B.S., Landscape Architecture	23 years experience with U.S. Army Corps of Engineers	Recreation/Esthetics Team Leader
Moody Culpepper, P.E.	B.S., Engineering	4 years aquatic plant research, 6 years soils research, 4 years construction, 20 years Planning Division Team Leader	Study Team Manager, Mitigation and Public Involvement
James Darnell	B.S. Civil Engineering	2 years, Bridge Design, Arkansas Highway Department; 4 years, Bridge Division, Mississippi Highway Department; 20 years, U.S. Army Corps of Engineers	Alternative and baseline estimates
Missy David	B.S., Biology M.S., Biology	5 years water quality surveillance, inspection, and analysis, LA Department of Environmental Quality; 5 years National Environmental Policy Act and natural resources studies, Geo-Marine, Inc.	Aquatic Resources, Wetlands, Water Quality, and Air Quality SEIS sections
Ronnie Dunn, P.E.	B.S., Civil Engineering M.S., Civil Engineering	33 years, U.S. Army Corps of Engineers, engineering and design/project management; currently, Acting Chief, Engineering Division, Memphis District	Engineering/Design Coordination
Billy Dycus, P.E.	B.S., Civil Engineering	18 years, U.S. Army Corps of Engineers, study manager and project manager, Memphis District	SEIS Public Involvement, Coordination, and Mitigation Team Member
Paul Eagles, P.E.	B.S., Civil Engineering	11 years study management, U.S. Army Corps of Engineers, Vicksburg District; 9 years structures research at U.S. Army Engineer Waterways Experiment Station	Mitigation
Dave Elmore	B.S., Engineering	1 year, Civil Engineering A/E; 4 years Study Manager, 1.5 years Hydrologic Engineer, U.S. Army Corps of Engineers, New Orleans District	Hydraulics and Hydrology
Stephen F. Finnegan	B.L.A., Landscape Architecture	20 years, recreation planning /esthetics studies, U.S. Army Corps of Engineers, New Orleans District	Recreation/Esthetics

Name	Discipline/ Expertise	Experience	Role in Preparing SEIS or Supporting Appendixes
Bobby Fleming, P.E.	B.S., Engineering M.S., Engineering	30 years, U.S. Army Corps of Engineers in engineering and design, with speciality in Geotechnical Engineering. Currently serving as Chief, Design Branch.	Geographic Information System Team Leader and Engineering/ Design Team Leader
Andy Gaines	B.S., Civil Engineering M.S., Hydraulic Engineering	12 years, U.S. Army Corps of Engineers, Hydraulics and Hydrology; 1 year experience in remote sensing and Geographic Information System applications	Hydraulics and Hydrology Satellite Imagery and Wetland and Waterfowl Analysis
Daniel Gregg	B.S., Fisheries	6 years, U.S. Fish and Wildlife Service	HEP Team
Beth Guynes	B.S., Biology	20 years, U.S. Army Corps of Engineers, Regulatory Branch; currently Chief, Regulatory Branch	Section 404(b)(1) Team
Larry Harper	B.S., Agriculture	Certified wetland scientist. 20 years experience in wetland delineation. Lead instructor for nine Federal Wetland Delineation Training Courses. Team leader for interagency test of Federal Wetland Delineation manuals.	Wetland Delineation Team Leader
Danny Harrison	B.S., Civil Engineering	28 years, U.S. Army Corps of Engineers, Design and Construction; currently, Chief, Flood Control Section	Design Coordination Team member
Larry Hartzog	M.S., Fisheries Biology	7 years, research limnology, Florida G&FFC; 20 years, environmental planning, U.S. Army Corps of Engineers, New Orleans District	Endangered Species, Aquatic
Phil Hegwood	B. S., Engineering	23 years, U.S. Army Corps of Engineers, Vicksburg District	Cost Engineering
Jan Hoover	Ph.D., Ichthyology	8 years, EIS Studies, U.S. Army Engineer Waterways Experiment Station	Aquatic Analysis, Endangered Species
Richard Hurst	B.S., Civil Engineering	9 years experience cost engineering; 10 years general engineering	Cost Engineering
Chris Ingram	Biology/Ecology	8 years SEIS studies, Geo-Marine, Inc.; 2 years SEIS studies, Gulf Engineers and Consultants; 7 years SEIS studies, Gulf South Research Institute; 2 years SEIS studies, Sunbelt Research Corporation	SEIS Review
Curtis James	B.S., Fish and Wildlife Biology	26 years environmental studies, U.S. Fish and Wildlife Service	Neotropical Migrants, Waterfowl Appendix, Planning Aid Report
Tracy James	B.S., Civil Engineering	16 years, U.S. Army Corps of Engineers, water quality and hydraulics	Coordination of water quality sampling with U.S. Army Engineer Waterways Experiment Station
David Jenkins	B.S., Civil Engineering	4 years as a cost estimator in Engineering Division, U.S. Army Corps of Engineers, Vicksburg District	Prepared alternatives and baseline estimates

Name	Discipline/ Expertise	Experience	Role in Preparing SEIS or Supporting Appendixes
Wanda C. Jennings	B.S., Civil Engineering B.S., Math	14 years, U.S. Army Corps of Engineers, Vicksburg District, Engineering Division	Engineering Appendix
Dan Johnson	B.S., Civil Engineering	24 years, U.S. Army Corps of Engineers; currently, Chief, Plan Formulation Branch	Supervision of overall document development; Coordination Appendix
Dave Johnson	M.S., Engineering	20 years, water quality, remote sensing, Geographic Information System	Water and Air Quality Team Leader, Section 404(b)(1), Wetlands Delineation, Geographic Information System Team Member
Ken Jones, P.E., P.G.	B.S., Geological Engineering M.S., Geological Engineering M.S., Civil Engineering	21 years, U.S. Army Corps of Engineers, Vicksburg District, Geological design	Geological
Jack Killgore, Ph.D.	Ph. D., Aquatic Ecology	12 years, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station	Aquatic Analysis Team Leader, Endangered Species
Wendell King	B.S., Biology M.S., Biology	18 years with U.S. Army Corps of Engineers, Planning Division, Environmental Resources Branch; 3 years with U.S. Fish and Wildlife Service; 3 years Mississippi Department of Environmental Quality	Section 404(b)(1) Team Leader, Endangered Species Team Leader
Daphlyn Koester	B.S., Mechanical Engineering M.S., Engineering Management	7 years in engineering, 3 years technical management	Engineering/Design
Edward P. Lambert	Wildlife Biology/Ecology M.S., Biology	8 years, U.S. Army Corps of Engineers, Environmental Branch; 3 years with Tennessee Wildlife Resources	Public Involvement, Terrestrial, Waterfowl, Mitigation, and EIS Coordination and Review
Bobby Learned	M.S., Agriculture Economics	17 years, U.S. Army Corps of Engineers, Economic Analysis	Mitigation, Economics, Recreation/Esthetics
Edwin E. Lyon II	Ph.D., History, Archeology	3 years, historian, U.S. Army Corps of Engineers, New Orleans District; 12 years, cultural resource studies, New Orleans District	Cultural Resources Appendix
Cindy Lyons	B.S., Economic	19 years, planning studies, U.S. Army Corps of Engineers, Vicksburg District	Economics
Rodney Mach	B.S., Civil Engineering	21 years, U.S. Army Corps of Engineers, New Orleans District	Hydraulics and Hydrology, Water and Air Quality
Stuart McLean	B.S., Fisheries M.S., Fisheries	4 years, U.S. Army Corps of Engineers, Planning Division, Environmental Resources Branch	Neotropical Migrants Team Leader
Jim McNeil	B.A., Archaeology M.A., Archaeology	12 years private and college experience in archeology; 18 years, U.S. Army Corps of Engineers, archeology	Cultural Resources Appendix

Name	Discipline/ Expertise	Experience	Role in Preparing SEIS or Supporting Appendixes
Danny McPhearson	B.S. Civil Engineering	7 years, inspection and evaluation of complete works, 11 years cost estimating, U.S. Army Corps of Engineers. Corps certified cost consultant.	Prepared alternate and baseline estimates.
Don Meador	Civil Engineering Technician	31 years, U.S. Army Corps of Engineers	Identified and cost public utilities
Charles Mendrop, P.E.	B.E.T., Construction Engineering B.S., Civil Engineering M.C.E., Civil Engineering	1 year, Mississippi Power and Light Company; 20 years, U.S. Army Corps of Engineers, Vicksburg District, Geotechnical design; currently serving as Chief, Analytical Section, Geotechnical Branch	Geotechnical
James Merritt	J.D. B.A., Biology	12 years, U.S. Army Corps of Engineers; 3 years, private sector	Legal Review
Eddie Miller	B.S., Engineering	13 years, U.S. Army Corps of Engineers, Vicksburg District	Engineering/Design
Chris Mills	B.S., Biology M.S., Biology	5 years, Army Chemical Corps Officer and Biology Instructor; 1 year, U.S. Army Corps of Engineers	Bat Appendix; Hazardous, Toxic, and Radiological Waste Appendix Review
Allan Mueller	Fish and Wildlife Biologist	24 years, U.S. Fish and Wildlife Service, Field Supervisor	Neotropical Migrants, Waterfowl Analysis, Planning Aid Report
Wayne Naquin	B.S., Civil Engineering M.S., Civil Engineering	24 years, U.S. Army Corps of Engineers, New Orleans District, Design of Flood Protection and Drainage	Engineering/Design
Darrell Normand	B.S., Civil Engineering	13 years, U.S. Army Corps of Engineers, New Orleans District, Cost Engineering	Cost Engineering
Frank Palmer, P.E.	B.S., Civil Engineering	30 years, U.S. Army Corps of Engineers, New Orleans and Vicksburg Districts	Engineering/Design
Kent Parrish, P.E.	B.S., Agricultural Engineering S., Business Administration	7 years, Assistant Project Engineer, Soil Conservation Service; 12 years, Study Manager, Planning Division, U.S. Army Corps of Engineers, Vicksburg District; 2 years, Project Manager, Mississippi River Levees, Vicksburg District	Agency Coordination Team Leader
Fred Pinkard, P.E.	M. S., Engineering	20 years hydraulics and water quality	Water Quality Analysis
Nancy Purvis, P.E.	B.S., Civil Engineering M.C.E., Civil Engineering	3 years, South Central Bell; 14 years, U.S. Army Corps of Engineers, Vicksburg District, Geotechnical design	Geotechnical
Jay Ratcliff	B.S., Civil Engineering M.S., Civil Engineering	10 years, U.S. Army Corps of Engineers, New Orleans District, Geographic Information System Experience	Geographic Information System
Steve Reed	Biologist	23 years, U.S. Army Corps of Engineers, Planning Division, Environmental Resources Branch	Supervisory Biologist, National Environmental Policy Act Compliance, and EIS Coordination

Name	Discipline/ Expertise	Experience	Role in Preparing SEIS or Supporting Appendixes
Virginia Rettig	M.S., Wildlife Biology	3 years, regulatory/environmental studies, U.S. Fish and Wildlife Service	Terrestrial Habitat Evaluation
Rick Robertson	B. S., Engineering	23 years experience in hydraulics and hydrologic engineering	Hydraulics and Hydrology Team Member
Erwin Roemer	B. A., Geography M.A., Anthropology	7 years, archeology, U.S. Army Corps of Engineers; 16 years, archeology, other agencies and firms	Cultural Resources Team Leader
Ben G. Ruff, Jr., P.E.	B.S., Engineering	20 years planning studies, U.S. Army Corps of Engineers, Vicksburg District	Technical Review Coordinator
John Rumancik	B.S., Zoology M.S., Fisheries Biology	18 years experience with U.S. Army Corps of Engineers	Endangered Species, Neotropical Migrants
Rome Rushing	Associate Degree, Engineering Design	20 years, U.S. Army Corps of Engineers, Levee and Drainage Section	Design
Robert P. Russell	M.A., Wildlife Biology	1 year, Ireland Bird Observatory; 1 year, Everglades National Park; 9 years, geographer, Defense Mapping Agency; 5 years, environmental planning, U.S. Army Corps of Engineers, New Orleans District	Neotropical Migrants
Robert C. Simrall, P.E.	B.S., Civil Engineering	14 years, project management, hydrology and hydraulics, U.S. Army Corps of Engineers	SEIS preparation and coordination
Jack Smith	2 years college (technical)	15 years experience topographic, cadastral and photogrammetric mapping, 10 years experience in digital mapping, 8 years experience in CADD/GIS system administration. Currently serving as CADD system administrator and REEGIS coordinator for CEMVK.	Engineering/Mapping/GIS Analysis; Wetland Delineation and GIS Team Leader
Steve Smith	B.S., Wildlife Management	3 years National Environmental Policy Act and natural resource studies, Geo-Marine, Inc.	Wetland and Prime Farmland SEIS sections
Barry Sullivan, P.E.	B.S., Engineering	10 years hydraulics, water quality	Geographic Information System Mapping, Water Quality
Brent Tebbets	M.S., Economics B.S., Economics	4 years economic studies, Geo-Marine, Inc.	Socioeconomics
Dwayne Templet	B.S., Forest Management	8 years National Environmental Policy Act and natural resource studies, Geo-Marine, Inc.	Project Manager, SEIS Preparation
Jeff Thommes	B.S., Zoology M.S., Zoology	3 years National Environmental Policy Act and natural resource studies, Geo-Marine, Inc.	Waterfowl and Threatened and Endangered Species SEIS sections
Loc Tran	B.S., Electrical Engineering M.S., Electrical Engineering	5 years, U.S. Army Corps of Engineers, New Orleans District; Computer Networks; 3 years, U.S. Army Corps of Engineers, New Orleans District, GIS	Geographic Information System

Name	Discipline/ Expertise	Experience	Role in Preparing SEIS or Supporting Appendixes
Richard Turner	B.S., Civil Engineering	3 years as Co-Op Student and 1 year as Civil Engineer with U.S. Army Corps of Engineers	Geographic Information System Mapping and Design Team
David Vigh	Ph.D., Biology	13 years, environmental planning (wetland ecology and Hazardous, Toxic, and Radiological Waste emphasis), U.S. Army Corps of Engineers, New Orleans District	Hazardous, Toxic, and Radiological Waste
Gary Walker	B.S., Agricultural Economics M.S., Agricultural Economics	11 years economic analysis; 11 years study management, U.S. Army Corps of Engineers, Vicksburg District	Project Document
Dave Wallace	B.S., Civil Engineering M.S., Civil Engineering	8 years experience in Environmental Engineering	Hazardous, Toxic, and Radiological Waste Team Leader, Section 404(b)(1)
John Watkins	B.S., Forestry	20 years, U.S. Army Corps of Engineers, Geographic Information System, wetlands, and waterfowl analysis	Geographic Information System, Water Quality, Wetlands Delineation, Waterfowl Analysis
Ken White	B.S., Business M.B.A., Business	26 years, U.S. Army Corps of Engineers; currently, Chief, Appraisal Branch	Real Estate Cost Estimate
Greg Williams	B.S., Fisheries	7 years experience in fisheries research; 6 years environmental engineering experience	Hazardous, Toxic, and Radiological Waste; Aquatic; Water and Air Quality
William C. Wilson	M.S., Wildlife Biology	6 years, wildlife biology, GA DNR; 19 years, environmental planning, U.S. Army Corps of Engineers, New Orleans District	Public Involvement, Terrestrial, Water and Air Quality, Wetlands, Section 404(b)(1), Waterfowl, and Mitigation
Robert Wood	B.S. Finance and Real Estate	12 years, U.S. Army Corps of Engineers	Real Estate cost estimate
Gary Young	B.S., Forestry/Wildlife Management M.S., Forestry	6 years, U.S. Army Corps of Engineering, Vicksburg District, Planning Division, Environmental Resources Branch	Wetland Analysis Team Leader, SEIS Review and Coordination, and Mitigation
Doug Young	B.B.A., B.S.E., M.A.T., M.A., Economics	15 years, U.S. Army Corps of Engineers, Economics; 10 years EIS experience	Recreation/Esthetics/Real Estate
Furcy Zerinque	B. S., Forestry M. S., Wildlife Management.	1 year, U.S. Forest Service; 1 year, Environmental Construction; 8 years, LSU Forestry and Wildlife Reserve; U.S. Army Corps of Engineers, Memphis District, 1 year, Environmental Analysis Branch, 6 years, Regulatory. Functions. Branch; New Orleans District, 3 years, Regulatory Functions Branch	Wetland Delineation

8.0 REFERENCES

Aggus, L. R., and G. R. Ploskey. 1986. "Environmental Design Considerations for Main Stem Levee Borrow its Along the Lower Mississippi River". Lower Mississippi River Environmental Program Report 4, Mississippi River Commission, Vicksburg, Miss

Baker, J.A., K.J. Killgore, and R.L. Kasul. 1991. Aquatic Habitats and Fish Communities in the Lower Mississippi River. Reviews in Aquatic Sciences 3: 313-356.

Banks, L. 1996. Beneficial Impacts of Corps of Engineers Projects on the Natural Resources of the Delta Region in the Corps Vicksburg District. In: The DELTA: Connecting Points of View for Sustainable Natural Resources. 17pp

Buglewicz, E. G., W. A. Mitchell, J. E. Scott, M. Smith, and W. L. King, 1988. "A Physical Description of Main Stem Levee Borrow Pits Along the Lower Mississippi River". Lower Mississippi River Environmental Program Report 2, Mississippi River Commission, Vicksburg, MS.

Cites. 1997. What you need to know and sturgeon and CITES. USFWS, Office of Management Authority Fact Sheet, Arlington, VA, 5 pp.

Clark, J. R. and Benforado 1981. Proceedings: Wetlands of Bottomland Hardwood Forests.

Cobb, S.P., C.H. Pennington, J.A. Baker, and J.E. Scott. 1984. Fishery and Ecological Investigations of Main Stem Levee Borrow Pits along the Lower Mississippi River. Lower Mississippi River Environmental Program, Report 1. US Army Corps of Engineers, Mississippi River Commission, Vicksburg, MS.

Constant, G. C., W. E. Kelso, D. A. Rutherford, and C. F. Bryan. 1997. "Habitat, Movement, and Reproductive Status of Pallid Sturgeon (*Scaphirhunchus albus*) in the Mississippi and Atchafalaya Rivers." Report prepared for the U.S. Army Corps of Engineers, New Orleans District, 78 pp.

Dahl, T. E. and Johnson, C. E. 1991. Status and Trends of Wetlands in the Conterminous United States, Mid-1970's to Mid-1980's. Department of Interior.

Dryer, M. P. and A. J. Sandvol. 1993. "Recovery Plan for the Pallid Sturgeon (*Scaphirhynchus albus*)." U.S. Fish and Wildlife Service, Denver, Colorado, 55 pp.

EPA. 1982. AP42. from "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines" (found in EPA publication AP42).

EPA. 1988. National Water Quality Inventory. 1988 Report to Congress.

Garnett, L. W.; F. W. Miller; and J. D. Hodges. 1991. Land Cover Analysis of the Leveed Floodplain of the Lower Mississippi River. Mississippi Remote Sensing Center, Department of Forestry, Mississippi State University. 174 pp. + Appendixes.

Gosselink, J. G., et al. 1990. Bottomland Hardwood Wetland Ecosystems.

Giudice and Ratti. 1995. "Interior Wetlands of the United States: a Review of Wetland Status, General Ecology, Biodiversity, and Management, " Technical Report WRP-SM-9, U.S. Army Engineer Waterway Experiment Station, Vicksburg, MS.

James, C.B. 1997. Waterfowl Technical Appendix for the Mississippi River Mainline Levee Enlargement Project, Draft. U.S. Fish and Wildlife Service, Vicksburg, MS. December 1997.

Jester, D.B., A.A. Echelle, W.J. Matthews, J. Pigg, C.M. Scott, and K.D. Collins. 1992. The Fishes of Oklahoma, Their Gross Habitats, and Their Tolerance of Degradation in Water Quality and Habitat. Proc. Okla. Acad. Sci. 72: 7-20.

LDEQ. 1998. Personal communication between Mr. Raymond Guillaume, Louisiana Department of Environmental Quality, Air Quality Division, Baton Rouge, Louisiana, and Ms. Mary H. David, Geo-Marine, Inc., Baton Rouge, Louisiana. 11 February.

LMRCSCC. 1974. Lower Mississippi Region Comprehensive Study Steering Committee, Lower Mississippi Region Comprehensive Study, Appendix F. 212pp.

Mississippi River Commission. 1915. Mississippi River Commission, Survey of the Mississippi River.

Mississippi River Commission, 1986. "Bird and Mammal Use of Main Stem Levee Borrow Pits Along the Lower Mississippi River". Lower Mississippi River Environmental Program Report 3, Mississippi River Commission, Vicksburg, MS.

Mitsch, W. J. and Gosselink, J. G. 1993. Wetlands (2d edition). Van Nostrand Reinhold, New York. 722 pp.

Mueller, A. J., et al. 1996. Draft Development of Management Objectives for Breeding Birds in the Mississippi Alluvial Valley. U.S. Fish and Wildlife Service, Vicksburg, Mississippi.

Noss, R.; M. Scott; and E. T. LaRae. 1995. Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation. Biological Report 28, February 1995. National Biological Service. 58 pp.

Sabo, M.T., and W.E. Kelso. 1991. Relationship Between Morphometry of Excavated Floodplain Ponds along the Mississippi River and Their Use as Fish Nurseries. Transactions of the American Fisheries Society 120: 552-561.

Smith. R. D., Amman, A., Bartoldus, C. and Garrett, P. 1993. "A Procedure for Assessing the Functional Capacity of Wetlands," Technical Report , U.S. Army Engineer Waterway Experiment Station, Vicksburg, MS.

U.S. Department of Interior. 1988. The Impact of Federal Programs on Wetlands. Volume I: The Lower Mississippi Alluvial Plain and the Prairie Pothole Region. A Report to Congress by the Secretary of the Interior. Washington, DC. 417 pp.

USACE. 1861. Report of the Mississippi River, Professional Paper of the Corps of Engineers, U.S. Army, No. 13, Captain A. A. Humphreys and Lieutenant H. L. Abbott.

USACE. 1973. Environmental Inventory for the Mississippi River, Cairo, Illinois to Venice, Louisiana (Volumes I - IV). Prepared by Gulf South Research Institute for the U.S. Army Corps of Engineers, Vicksburg District.

USACE. 1976. Final Environmental Impact Statement, Mississippi River and Tributaries, Mississippi River Levees and Channel Improvement. Prepared by the U.S. Army Corps of Engineers, Vicksburg District, dated February 1976.

USACE. 1995. Floodplain Management Assessment of the Upper Mississippi River and Lower Missouri Rivers and Tributaries. Headquarters, U.S. Army Corps of Engineers, Washington, DC.

USACE. 1998q. Project Report, Mississippi River and Tributaries--Mississippi River Mainline Levees Enlargement and Berm Construction Project. Prepared by the U.S. Army Corps of Engineers, Vicksburg District, dated March 1998.

USACE. 1998a. Appendix 1, Mitigation. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998b. Appendix 2, U.S. Fish & Wildlife Service Planning Report. Prepared by the USFWS for the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998c. Appendix 3, 404(b)(1) Evaluation. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998d. Appendix 4, Plates. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998e. Appendix 5, Public Involvement. Prepared by Gulf South Research Corporation for the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998f. Appendix 6, Engineering. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998g. Appendix 7, Socioeconomic Analysis. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998h. Appendix 8, Aquatic Resources. Prepared by K. Jack Killgore, Jan Jeffrey Hoover, and James P. Kirk, for the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998i. Appendix 9, Waterfowl. Prepared by James B. Curtis, USFWS Vicksburg Field Office, Vicksburg, Mississippi, for the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998j. Appendix 10, Terrestrial Resources. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998k. Appendix 11, Endangered Species. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998l. Appendix 12, Neotropical Migrants. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998m. Appendix 13, Wetland Functional Analysis. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998n. Appendix 14, Bats. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998o. Appendix 15, Cultural Resources. Prepared by R. Christopher Goodwin & Associates, Inc., New Orleans, Louisiana, for the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998p. Appendix 16, Recreation/Esthetics. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USACE. 1998q. Appendix 17, Water Quality. Prepared by the Memphis, Vicksburg, and New Orleans Districts, U.S. Army Corps of Engineers.

USFWS. 1980. Habitat Evaluation Procedure. ESM 102, U.S. Fish and Wildlife Service, Washington, D.C.

USFWS. 1987. "Migratory Nongame Birds of Management Concern in the United States." U.S. Department of Interior, U.S. Fish and Wildlife Service, Washington, DC.

USFWS. 1991. "Endangered and Threatened Wildlife and Plants." 50 CFR 17.11 and 17.12 U.S. Department of Interior, U.S. Fish and Wildlife Service, Washington, DC.

USFWS. 1995. Recovery Plan. Louisiana Black Bear (*Ursus americanus luteolus*). U.S. Fish and Wildlife Service, Southeast Region, Atlanta, Georgia. 52 pp.

USGS. 1996. Contaminants in the Mississippi River, 1987-1992. U.S. Geological Survey Circular 1133, Robert H. Meade, editor.

9.0 INDEX

10.0 ACRONYMS

AAFCU	Average Annual Functional Capacity Unit (wetland)
AAHU	Average Annual Habitat Unit
AQCR	Air Quality Control Region
BA	Biological Assessment
BLH	bottomland hardwood
BMP	best management practice
CAA	Clean Air Act
CO	carbon monoxide
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CITES	Committee on International Trade in Endangered Species
DUD	duck-use-days
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
FCI	functional capacity index value
FCU	functional capacity unit
FFAL	frequently flooded agricultural lands
Ft	feet
FWC	freshwater chronic criteria
FY	fiscal year
GIS	Geographic Information system
HD	House document
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic, and Radioactive Waste
HU	habitat unit
L	liter
LAC	Louisiana Administrative Code
LDEQ	Louisiana Department of Environmental Quality
LUST	Leaking Underground Storage Tank
MDEQ	Mississippi Department of Environmental Quality
mg	milligram
MR&T	Mississippi River and Tributaries
MRC	Mississippi River Commission
MRL	Mississippi River Levee
MSA	mean statistical area
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NO_2	nitrogen dioxide
NPL	National Priority List
NRCS	Natural Resources Conservation Service
O_3	ozone
Pb	lead
PCI	per capita income
PDF	Project Design Flood
PI	personal income

PM_{10}	particulate matter less than 10 microns in diameter
ppm	parts per million
pptr	parts per trillion
RCRA	Resource Conservation and Recovery Act
SEIS	Supplemental Environmental Impact Statement
SIP	State Implementation Plan
spp.	species
SO_2	sulfur dioxide
TKN	Total Kjeldahl Nitrogen
TSD	Treatment, Storage, and Disposal
U.S.	United States
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
VOC	Volatile Organic Compounds

APPENDIX 1
MITIGATION

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 1
MITIGATION

Table of Contents

Table of Contents (Cont)

Table of Contents (Cont)

LIST OF TABLES

Table of Contents (Cont)

LIST OF TABLES

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 1
MITIGATION

INTRODUCTION

1. Following disastrous floods in 1927, Congress authorized the Mississippi River and Tributaries (MR&T) Project in the Flood Control Act of 1928. Construction of the Mississippi River mainline levees began shortly thereafter and has continued ever since. The U.S. Army Corps of Engineers is committed to the need to conserve and enhance nationally significant environmental resources in this region. This is reflected in the design and construction of the Mississippi River Levees.

2. An Environmental Impact Statement (EIS) for the MR&T Project Mississippi River Levees and Channel Improvement was filed with the Council on Environmental Quality in April 1976. The decision was made in April 1997 to supplement the 1976 EIS to cover all remaining mainline levee construction. This Supplemental EIS (SEIS) presents project background information, defines significant resources of concern, evaluates proposed flood damage reduction alternatives and associated impacts to resources, and addresses compensation to offset unavoidable project impacts. Terrestrial, wetland, endangered species, neotropical migrants, bats, water quality, aquatic, and waterfowl technical appendixes support the SEIS. The SEIS and appendixes should be referred to for specific methodologies and other detailed information. This document serves as a comprehensive mitigation plan to reduce and offset adverse biological impacts associated with implementing the remaining features of the Mississippi River Levees project.

AUTHORIZATION

3. Section 906(b)(1) of the Water Resources Development Act of 1986 provides statutory authority for compensatory mitigation for the remaining work on the Mississippi River Levees. Section 906(c) of the Water Resources Development Act of 1986 defines cost-sharing requirements for mitigation and specifies that it shall be consistent with the basic authority for the project. Section 2 of the Flood Control Act of 1928 recognized the national significance of the comprehensive MR&T project and noted the substantial non-Federal contribution already made at the time of enactment. It states " . . . no local contribution to the project herein adopted is required." Section 3(c) further specified that local interest ". . . provide without cost to the United States all rights-of-way for levee foundations and levees on the main stem . . . " Acquisition of lands and all costs for compensatory mitigation are a Federal responsibility.

SIGNIFICANT RESOURCES

4. The project area contains 2,127,758 acres of land. This includes 1,021,710 acres of bottom-land hardwoods, 636,254 of which are wetlands. The total wetland area is 1,022,357 acres, approximately one-half of the project area. Land use is shown in Table 1-1. Project area land is used primarily for timber production and farming with about one-third of the project area in crops. The forests are composed of various successional stages and are subject to periodic harvest. Many project area lands are also intensively managed for wildlife and sustain high value leases for the seasonal hunting and fishing opportunities.

TABLE 1-1
PROJECT AREA LAND USE ACREAGE

Land Use	Nonwetland	Wetland	Total
Forested	385,456	636,254	1,021,710
Cropland	537,704	231,556	769,260
Urban/Industrial	71,570	4,594	76,164
Scrub/Shrub	23,939	43,440	67,379
Tree Plantations	27,887	22,584	50,471
Sandbar	3,790	45,600 a/	49,390
Pasture	22,854	19,536	42,390
Levee	26,990		26,990
Herbaceous	3,469	11,043	14,512
Marsh		5,925	5,925
Bare Soil	1,742	1,825	3,567
Subtotal	1,105,401	1,022,357	2,127,758
Open Water			518,086
Total			2,645,844

a/ Jurisdictional (regulated) waters of the United States, but may not be vegetated due to river currents, recent formation, lack of nutrients, etc.

5. Significant resources are described in the SEIS. Specific evaluations of project impacts, beneficial and adverse, on waterfowl, terrestrial, wetland, and aquatic resources are contained in their respective appendixes. These evaluations were used to determine compensation for the selected plan.

6. The U.S. Fish and Wildlife Service (FWS) classifies bottom-land hardwood habitat as Resource Category 2 defined as follows: "Habitat to be impacted is of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section. The mitigation goal for habitat placed in this category is that there should be no net loss of in-kind habitat value."

7. Significant nonmonetary values have been institutionally ascribed by society at the national and international levels to preservation of bottom-land hardwood wetlands such as those within the Mississippi River flood plain. The Administration has a goal of no-net loss of wetlands. In addition, Executive Order 11990 states that Federal agencies shall avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands.

8. Waterfowl is considered a significant resource because the loss and degradation of breeding and wintering habitats are major waterfowl management problems in North America. The North American Waterfowl Management Plan states clearly that "in all waterfowl management decisions and actions, first priority should be given to perpetuate waterfowl populations and their supporting habitats."

9. Aquatic resources are significant throughout the project area. The rise and fall of the Mississippi River produce spawning and rearing habitat for a variety of species throughout the alluvial flood plain. Oxbow lakes, borrow areas, and other permanent waterbodies benefit from this seasonal fluctuation and are replenished annually, providing some of the best fisheries habitat in the continental United States.

PROJECT ALTERNATIVES

NO ACTION

10. The no-action plan includes no new construction. Existing levees, berms, and floodways would maintain current levels of flood protection. Levee failures in the Vicksburg District could begin at a discharge of approximately 2.2 million cubic feet per second (cfs) on the Vicksburg gage. The Project Design Flood discharge is approximately 2.7 million cfs at Vicksburg and 3.0 million cfs at Red River Landing. Catastrophic failure of the levees would most likely result in loss of life and property in unprecedented proportions. Repairs would be made at crevasse sites to return the levees to conditions existing prior to any failures. The economic base of this region is built on agricultural and industrial infrastructure put in place with the understanding that Mississippi River flooding would be confined within the mainline levees. A reversal of this assumption would encourage cutbacks by existing industries and avoidance by new industry looking for a place to operate. It would place a severe economic burden on the resident population that depend on local business and industry for their livelihood.

PLAN 1

11. Plan 1 represents a nonstructural option to structural flood damage reduction. This plan involves the purchase of flowage easements on thousands of acres of land. Unlike the no-action plan, levees would not be repaired after failure since flood flowage easements would have been purchased. Consequently, areas would flood more frequently than before due to a decreased level of protection where levee failures occur. This plan would render the alluvial plain uninhabitable. Faced with annual flooding, industry would shut down. Cities would cease to exist without an economic base and protection from flooding. Public utilities and transportation arteries would fall into disrepair. The alluvial plain would be abandoned to return to a more natural state.

PLAN 2

12. This plan includes continuing project construction; however, it requires that all borrow material be obtained from landside of the levees. Borrow areas would be used for aquatic habitat or reforested for terrestrial benefits. Three landside borrow schemes were investigated. Each one included taking borrow from a band of real estate 2,000 to 3,000 feet from the landside toe of the levee. This prevents underseepage problems while limiting haul distances for borrow material. The first option included traditional rectangular borrow areas 8 to 10 feet deep. The second option was for 8-foot-deep borrow areas surrounded by forested buffer zones approximately equal in size to the borrow areas. A berm around the buffer zone would isolate the borrow areas from local drainage containing pesticides and other contaminants. The third option included shallow borrow areas (about 3 feet deep) connected to local drainage and reforested.

PLAN 3

13. This is the traditional plan or the conventional method of construction with borrow areas selected from the closest engineeringly feasible location. Features of Plan 3 in the Memphis District include the construction of levee enlargement, berms, and some wave protection. The Vicksburg District portion of the project includes earthen berms, relief wells, and levee enlargement. Construction items in New Orleans District include levee enlargement and slope paving. Even with no enhancements, most traditional borrow areas hold water which is periodically flushed by high river stages resulting in prime aquatic and waterfowl habitat. The traditional plan was carried into the final array with Plan 4 and evaluated in detail to determine the recommended plan.

PLAN 4

14. Plan 4 includes the structural features in Plan 3 with environmental design measures to avoid and minimize damages to riverside bottom-land hardwoods and wetlands. Three measures designed to minimize impacts include (a) relocation of borrow areas to less environmentally sensitive areas, (b) levee enlargement using existing berm material with new berms constructed of dredged material from the river, and (c) relief wells or slurry trench cutoffs to control seepage instead of berms. Environmental features such as irregular shorelines and varying depths are incorporated into borrow areas design. Additionally, 3,041 acres of newly created borrow areas will be reforested to restore terrestrial and wetland values. These areas will provide excellent spawning habitat for aquatic species since they will be open to the river. As with Plan 3, riverside borrow areas would also be replenished by normal river fluctuations.

15. Plan 4 was selected as the recommended plan for which compensation was determined in this analysis.

ENVIRONMENTAL IMPACTS

GENERAL

16. Environmental impacts for terrestrial resources were determined using Habitat Evaluation Procedures (HEP) developed by FWS (Appendix 10). HEP teams were composed of professional biologists from the Corps of Engineers, FWS, and state wildlife agencies representing the affected states. These teams sampled project lands to determine habitat quality based on habitat suitability index (HSI) models developed for evaluation species. Impacts were measured in average annual habitat units (AAHU's) which were used to determine compensation requirements.

17. A semiquantitative method developed by the Wetland Evaluation Work Unit of the Wetland Research Program at the U.S. Army Engineer Waterways Experiment Station was used to evaluate functional impacts to forested and farmed wetlands (Appendix 13). Wetland functions evaluated were short-term water storage, long-term water storage, water velocity reduction, sediment detention, onsite erosion control, nutrient and dissolved substance removal, and organic carbon export. Wetland functional impacts were expressed as functional capacity units, which reflect both the quantity and quality of wetland functional values. Functional capacity units were determined by multiplying the functional capacity index value of each function and the acreage affected. Forested and farmed wetland functional index values ranged from 0 to 1, with 1 representing optimal wetland value.

18. The waterfowl analysis was conducted by FWS based on the caloric value of foraging habitat available to migratory waterfowl during the fall and winter months (Appendix 9). Impacts were measured in duck use days (DUD) lost due to land use changes. Compensation was based on duck use days.

19. An HEP team was formed to guide the evaluation of aquatic resources impacts and was composed of members from seven state fish and wildlife agencies, FWS, and the Corps of Engineers (Appendix 8). The aquatic analysis was conducted by the U.S. Army Engineer Waterways Experiment Station. As in the terrestrial evaluation, HSI models were developed for evaluation species to determine changes in habitat value, with impacts measured in AAHU'S.

20. The resource impacts described in this section are shown by Corps District in Table 1-2. This table should be referred to as impacts are described.

PLAN 3 IMPACTS

Terrestrial Resources

21. A total of 19,565 terrestrial AAHU's (0.8 percent) will be lost with implementation of Plan 3. This includes 7,045, 12,516, and 4 AAHU's lost for Memphis, Vicksburg, and New Orleans Districts, respectively. Habitat for mink increased due to the net gain in permanent water provided by borrow areas bordered by woodlands.

TABLE 1-2
PROJECT IMPACTS
PLAN 3 AND PLAN 4

Resource Category	Units	Existing Conditions			Plan 3 Impacts			Plan 4 Impacts		
		Memphis	Vicksburg	New Orleans	Memphis	Vicksburg	New Orleans	Memphis	Vicksburg	New Orleans
Terrestrial	Acres	381,258	552,351	138,572	3,078	9,126	17	514	5,407	17
	AAHU's	1,002,216	1,211,298	183,285	7,045	12,516	4	1,163	5,694	4
Wetlands	Acres	440,933	464,538	116,886	3,227	8,410	17	1,340	5,971	17
	AAFCU's	1,792,587	2,367,691	714,094	14,247	39,727	101	2,728	22,206	101
Waterfowl	Acres	100,307	64,942	30,663	406	612	0	302	833	0
	DUD's	17,887,601	10,058,221	1,795,510	215,580	323,539	0	134,992	199,440	0
Aquatics a/	Acres	1,340	5,794	2,939	0	(11,800)	(17)	(60)	(6,650)	(17)
	AAHU's	4,087	16,918	11,080	0	(30,494)	(55)	(195)	(27,131)	(55)

a/ Project results in aquatic habitat gains which are shown in parenthesis. Includes only borrow areas.

Wetland Resources

22. Wetland acres impacted by Plan 3 represent approximately 1.1 percent of the total wetlands in the project area with 8,995 acres of forested wetlands and 2,659 acres of farmed wetlands impacted by this plan. Approximately 6 percent of the forested wetlands is scrub/shrub, tree plantation, herbaceous, and marsh cover types. One percent of the farmed wetlands is in the urban cover type. Approximately 75 percent and 25 percent of the forested wetlands impacted occur in the Vicksburg and Memphis Districts, respectively. About two-thirds of the impacted farmed wetlands occur in the Vicksburg District with the remainder in the Memphis District. A loss of 54,075 AAFCU's results from implementation of this plan.

Waterfowl Resources

23. Under existing conditions, 195,912 acres of foraging habitat are available to waterfowl within the project area during the fall and winter migration period; 100,307 acres are in the Memphis District, 64,942 acres are in the Vicksburg District, and 30,663 acres are in the New Orleans District. Project impacts from Plan 3 affect 406 acres and 612 acres in the Memphis and Vicksburg Districts, respectively, or 0.5 percent of the available foraging habitat. This represents 215,580 and 323,539 DUD's lost in Memphis and Vicksburg District, respectively. No significant waterfowl impacts are expected for New Orleans District.

Aquatic Resources

24. Borrow areas created with Plan 3 provide additional aquatic habitat, increasing the aquatic AAHU'S for New Orleans and Vicksburg Districts. There were no changes in aquatic habitat for the Memphis District with this plan. Increases in AAHU'S for New Orleans and Vicksburg Districts were 55 and 30,494, respectively.

RECOMMENDED PLAN (PLAN 4) IMPACTS

Terrestrial Resources

25. Terrestrial losses decrease to 6,861 AAHU's with Plan 4, a reduction of 12,704 AAHU's from Plan 3 and 0.3 percent of existing AAHU's. Approximately 83 percent of the losses occur in the Vicksburg District and 17 percent in the Memphis District. New Orleans District had a 4 AAHU decrease.

Wetland Resources

26. Plan 4 impacts approximately 3,691 acres of forested wetlands and 3,637 acres of farmed wetlands or 0.7 percent of the total project area wetlands. Approximately 93 percent of the forested wetlands acres and 70 percent of the farmed wetlands acres impacted occur in the Vicksburg District. The remaining impacted acres are located in the Memphis District except for 17 acres of forested wetlands occurring in the New Orleans District. Wetlands impacted by Plan 4 generally occur in the same states as Plan 3. Plan 4 results in the loss of 25,035 AAFCU's, a reduction in wetland impacts of 29,040 AAFCU's compared to Plan 3.

Waterfowl Resources

27. Plan 4 impacts 302 and 833 acres of foraging habitat, with losses of 136,282 and 343,275 DUD's for the Memphis and Vicksburg Districts, respectively. DUD's lost in Memphis District were reduced by 1,290 DUD's because of 2 acres of fringe waterfowl foraging habitat created through aquatic borrow area design. DUD's lost for the Vicksburg District were reduced by 143,835 DUD's due to 223 acres of fringe waterfowl foraging habitat created through aquatic borrow area design. This resulted in total losses of 134,992 DUD's for Memphis District and 199,440 DUD's for Vicksburg District for a total project loss of 334,432 DUD's. No significant waterfowl impacts are anticipated for New Orleans District.

Aquatic Resources

28. Plan 4 includes 6,727 acres of additional aquatic habitat including 17 acres in New Orleans District, 6,650 acres in Vicksburg District, and 60 acres in Memphis District. These areas range in size from about 10 to 200 acres with average size approximately 100 acres. Resulting habitat gains were 55 AAHU'S; 27,131 AAHU'S; and 195 AAHU'S for New Orleans, Vicksburg, and Memphis Districts, respectively.

29. Total habitat losses (gains) for terrestrial, wetland, waterfowl, and aquatic resources are shown in Table 1-3 by Corps District.

TABLE 1-3
LOSSES (GAINS) BY CORPS DISTRICT

Corps District	Terrestrial Resources (AAHU'S)	Wetland Resources (AAFCU'S)	Waterfowl Resources (DUD'S)	Aquatic Resources (AAHU'S)
Vicksburg	5,694	22,206	199,440	(27,131)
Memphis	1,163	2,728	134,992	(195)
New Orleans	4	101	0	(55)
Total	6,861	25,035	334,432	(27,381)

MITIGATION PLANNING

GENERAL

30. The lands between the Mississippi River Levees are noted for high value fish and wildlife resources and naturally flooded wetlands. This area serves as an integral part of the economic and social life of local residents and sportsmen from around the Nation.

31. Losses to terrestrial, wetland, and waterfowl resources were reduced significantly by incorporating environmental design features into the recommended plan. Significant increases in aquatic habitat will also occur with this plan. The recommended plan incorporated the process of avoiding, then minimizing impacts through project design prior to developing compensatory measures for unavoidable impacts. The mitigation process and resulting recommendations are described below.

PLANNING OBJECTIVES

32. An evaluation of the recommended plan has identified unavoidable impacts to terrestrial, wetland, and waterfowl resources. Specific planning objectives have been developed to guide the formulation of alternative measures to compensate these unavoidable losses. The planning objectives were:

a. To formulate measures to offset 100 percent in-kind 6,861 terrestrial AAHU's lost.

b. To formulate measures to offset 100 percent in-kind 25,035 wetland AAFCU's lost.

c. To formulate measures to offset 100 percent in-kind 334,432 waterfowl DUD's lost.

d. To formulate measures which compensate for as many resource categories as possible on the same real estate.

PLAN FORMULATION

33. This section describes the criteria used to screen potential mitigation measures and the methodology guiding the evaluation of mitigation alternatives. This process is outlined in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, effective 8 July 1983.

Formulation Criteria

34. The objectives and criteria used in developing this mitigation plan are based on pertinent statutes, U.S. Army Corps of Engineers regulations, and coordination with project sponsors, wildlife agencies, and environmental groups. Criteria adopted for use in the development and selection of a mitigation plan are as follows:

a. Memorandum of Agreement between the Environmental Protection Agency and the Department of the Army which states that mitigation utilize a sequence of avoidance, minimization, and then compensation to reconcile project impacts.

b. Environmental design measures should be evaluated during planning to eliminate or reduce the need for compensation.

c. Project lands and lands with easements held by project sponsors should be utilized for compensation as much as possible.

d. Regionally significant unavoidable habitat losses (i.e., bottom-land hardwoods) should be compensated in-kind.

e. Land acquisition for compensation must be from willing sellers and should be confined to the vicinity of the project area. The feasibility of onsite mitigation will be balanced with the goal of acquiring lands adjacent to large contiguous tracts of bottom-land hardwoods. However, if sufficiently large tracts are not available from willing sellers within the project area, then tracts elsewhere in the alluvial valley of the Mississippi River should be considered.

f. Land acquisition for compensation should be fee title; however, easements will be considered on a case-by-case basis in consultation with levee boards and state and Federal agencies. Acquisition will primarily be directed toward frequently flooded agricultural lands.

g. Mitigation priority should be given to large tracts and tracts adjacent to forested areas.

h. Land acquisition for compensation should be proportioned to the extent possible among the Corps Districts where the losses occur.

Formulation Methodology

35. Numerous measures are possible to mitigate the impacts resulting from the remaining work on the Mississippi River Levees enlargement project. Alternative mitigation measures may be classified into the following basic categories:

a. Implement measures to reduce environmental resource losses through project design.

b. Implement management measures on existing Corps project lands.

c. Increase the level of management on other public lands.

d. Acquire additional land and implement management measures.

These categories form a logical progression and should be considered in the order they are listed; i.e. acquisition of additional land should be considered only when all options are exhausted for the other three categories. The first category has been satisfied through the selection of the recommended plan which includes environmental design measures to reduce project-related impacts to significant resources. Each remaining category must be evaluated with respect to the overall benefits to terrestrial, wetland, and waterfowl resources. Mitigation alternatives were identified and screened based on the criteria discussed herein and their implementability. The ideal mitigation plan would offset impacts for each resource category without overcompensating.

COMPENSATION ANALYSIS

36. The following paragraphs present compensation analyses to offset unavoidable adverse impacts associated with the recommended plan. Compensation was developed separately for each Corps District based on the resource impacts within that District.

TERRESTRIAL RESOURCES

37. The recommended plan will result in the loss of 6,861 terrestrial AAHU's. Forest establishment on cleared lands by natural succession or reforestation will be necessary to compensate for these losses, since few opportunities exist to improve habitat quality in the remaining forested lands. AAHU's that could be gained by reestablishing bottom-land hardwood forest on 100 acres of cleared land under various management plans are given in Table 1-4 and range from 201 to 336 AAHU's. Benefits with management plans in place were estimated for selected target years over the life of the project using models developed by consensus of the HEP team.

38. Management Plans MP1 and MP2 assume that selected borrow areas created during construction would be drained to the Mississippi River and allowed to revert to woodlands naturally (MP1), or be reforested using seedlings (MP2). Substantial benefits result for all evaluation species except mink. Management Plans MP3 through MP8 apply to reforested flood plain lands, with MP3, MP4, and MP5 representing natural succession and MP6, MP7, and MP8 representing active reforestation. MP3 and MP6 apply to cleared sites within the Mississippi River flood plain without permanent water or long-duration flooding. This would exclude benefits to mink and wood duck habitat. MP4 and MP7 apply to sites with permanent water in the same proportion as the project area. Significant benefits result for all evaluation species except mink. MP5 and MP8 apply to cleared lands within 328 feet of a lake or stream with surface water present 9 or more months per year. These plans provide significant benefits to all evaluation species.

WETLAND RESOURCES

39. The recommended plan will result in conversion impacts on 3,691 acres of forested wetlands and 3,637 acres of farmed wetlands. This represents a wetland resources loss of 25,035 AAFCU's with implementation of the project. Compared to Plan 3, this total was reduced by 29,040 AAFCU's (54 percent).

40. Compensation for these unavoidable impacts can be accomplished through reforestation of frequently flooded agricultural lands. The benefit in functional capacity units for this alternative is 4.27 AAFCU's per acre. This benefit was derived by taking the sum of the functional capacity index (FCI) reforestation values for each of the seven wetland functions evaluated (Table 1-5). The FCI's represent the net gain in functional value of reforesting frequently flooded agricultural lands assuming a linear recovery of full functional capacity over 20 years (annualized over the project life of 100 years). Compensation can thus be determined by dividing AAFCU losses by the AAFCU benefit per acre for reforestation of frequently flooded agricultural lands.

TABLE 1-4
ESTIMATED BENEFITS OF ESTABLISHMENT OF BOTTOM-LAND FORESTS
UNDER VARIOUS MANAGEMENT PLANS
(Increase in AAHU's per 100 Acres Management)

Plan	Barred Owl	Fox Squirrel	Carolina Chickadee	Pileated Woodpecker	Mink	Wood Duck	Total
Natural Succession							
MP1	43.25	29.05	41.74	41.55	0.0	48.60	204.19
Active Reforestation							
MP2	50.25	58.04	51.84	51.20	0.0	52.07	263.40
Reforested Flood Plain							
Natural Succession							
MP3	60.00	37.65	48.00	55.65	0.00	0.00	201.30
MP4	60.00	37.65	48.00	55.65	0.00	10.58	211.88
MP5	60.00	37.65	48.00	55.65	41.58	10.58	253.40
Active Reforestation							
MP6	60.00	65.35	48.00	55.65	0.00	0.00	228.90
MP7	60.00	65.25	48.00	55.65	0.00	65.70	294.60
MP8	60.00	65.25	48.00	55.65	41.58	65.70	336.18

MP1 and MP2 - These management plans are calculated for reforesting drained borrow areas in the study area. MP1 reveals the AAHU's per 100 acres that allow such lands to revert to woods naturally. MP2 reveals the AAHU's gained per 100 acres of land that would result from actively reforesting drained borrow areas. No benefits accrue to mink unless the site is within 328 feet of a lake or stream.
MP3 and MP6 - These plans apply to sites on a flood plain that do not have any significant amounts of permanent water or seasonal flooding.
MP4 and MP7 - These plans apply to sites on the flood plain that have similar amounts of permanent water as the study area.
MP5 and MP8 - These plans apply to sites within 328 feet of a lake or stream containing surface water equal to or greater than 9 months per year. Abundant shoreline cover is expected to be present.

TABLE 1-5
FCI VALUES FOR REFORESTATION OF
FREQUENTLY FLOODED AGRICULTURAL LANDS

Wetland Function	FCI Value
Short-term water storage	0.45
Long-term water storage	0.68
Water velocity reduction	0.64
Sediment detention	0.77
Onsite erosion control	0.58
Nutrient and dissolved substance removal	0.55
Organic carbon export	0.60
Total	4.27

WATERFOWL RESOURCES

41. A total of 1,135 acres of waterfowl foraging habitat will be impacted by the recommended plan, resulting in the loss of 479,557 DUD's. Borrow area construction for the recommended plan creates 225 acres of fringe waterfowl habitat which provides 145,125 DUD's in benefits. The net result is a loss of 334,432 DUD's for the recommended plan.

42. Compensation for these unavoidable impacts can be achieved through land use conversion resulting in a net increase in waterfowl forage value. Forage values for various land uses are shown in Table 1-6. Reforesting these tracts with 70 percent red oaks will change the value to 235 DUD's/acre. Waterfowl compensation will be integrated with wetland and terrestrial compensation.

TABLE 1-6
COMPENSATION VALUES FOR WATERFOWL MITIGATION

Land Use	DUD/Acre
Moist soil	1,037
Corn	970
Rice	580
Soybean	~~257~~ *253*
Bottom-land hardwoods a/ @ 30 % Red Oak	124
@ 50% Red Oaks	176
@ 70% Red Oaks	235
@ 90% Red Oaks	294

a/ Annualized values assuming no acorn production until year 20 and 52 DUD/acre for moisture/fallow (first 5 years @ 1,037 DUD/acre (5,185)/100 years = 52 DUD/acre).

IDENTIFICATION AND SCREENING OF ALTERNATIVES

AVOID AND MINIMIZE FISH AND WILDLIFE LOSSES THROUGH PROJECT DESIGN

43. One of the alternatives available to reduce environmental impacts is to avoid and minimize fish and wildlife losses through project design. Avoid-and-minimize considerations to reduce environmental impacts were (a) increase depth in borrow areas to reduce the surface area, (b) drain borrow areas and reforest if possible, (c) relocate borrow area to less environmentally sensitive areas, (d) use existing berm material for levee enlargement, replacing it with dredge material, if suitable, and (e) use relief wells or slurry trench cutoffs instead of seepage berms where feasible.

44. Plan 4 is an environmental design which incorporates measures to avoid and minimize environmental damages to bottom-land hardwoods and wetlands. To develop the layout of the plan, interdisciplinary teams of state and Federal agencies representatives, local sponsors, and Corps staff were formed. They initially focused on relocating the construction borrow areas using the following placement prioritization criteria as a guide.

a. Landside cropland from willing sellers.

b. Landside cropland when riverside locations were unavailable.

c. Riverside prior-converted cropland.

d. Riverside tree plantations.

e. Riverside farmed wetlands (cropland).

f. Riverside farmed wetlands (pasture).

g. Riverside herbaceous wetlands.

h. Riverside forested nonwetlands.

i. Riverside forested wetlands.

j. Landside and riverside bottom-land hardwoods with black bear presence.

k. Landside cropland condemnation.

45. However, as various methods of construction were evaluated for each work item, it became apparent that the prioritization criteria could not be strictly and consistently applied to the entire Mississippi River Levees study area. For example, in the New Orleans District, the area between the top bank of the river and the levee is relatively narrow and often developed, whereas in the Vicksburg District these areas are relatively wide and undeveloped. Riverside land use in the Vicksburg District is split between cropland and forested, but in the Memphis District the riverside land use becomes predominantly cropland. Rather than apply the prioritization scheme mechanically, the study team evaluated each individual item, and applied the avoid-and-minimize techniques as was most reasonable, considering the environmental, economic, and engineering solutions available for that item.

46. Criteria for determining borrow areas that could be reforested include:

a. Borrow areas greater than 125 acres for the Vicksburg District and borrow areas greater than 60 acres for the Memphis District.

b. Channel work for drainage $\leq$ 2,000 feet directly connected to the Mississippi River.

c. Drainage channel avoids impacting significant forested acreage.

Based on these criteria, 3,041 acres of borrow were identified for reforestation. Potential benefits for borrow area design are shown in the following tabulation. These benefits will not be considered in the compensation analysis because the success of this technique has not been documented and borrow areas would be under an easement.

BORROW AREA DESIGN BENEFITS

Resource	Value/Acre	Benefits
Terrestrial (AAHU's)	2.63	+7,998
Wetlands (AAFCU's)	4.27	+12,985
Waterfowl (DUD's)	52.00	+158,132
Aquatic (AAHU's)	4.07	+27,381

47. Other design considerations include the use of riverside levee enlargement which generally requires the least amount of fill material and selection of underseepage control methods designed to reduce impacts to environmentally sensitive areas. As additional design data become available, every effort will be made to reduce impacts further.

IMPLEMENTATION OF MANAGEMENT MEASURES ON EXISTING CORPS PROJECT LANDS

48. Lands acquired for the Mississippi River Levees enlargement project will be used for excavation of borrow material and construction of levees, seepage control measures, and other features. The avoid- and-minimize features will maximize the opportunities to reduce terrestrial, wetland, and waterfowl impacts through project rights-of-way. Other Corps lands include property acquired for other projects or for mitigation of other projects. Existing mitigation tracts such as the Twin Oaks, Mahannah, Lake George, and Big Twist properties in the Mississippi Delta are being fully utilized to offset impacts of other projects. Project funds are being used to reforest these tracts to the appropriate level.

49. Other project lands may have potential for development. To be considered, they must be cleared and should meet the formulation criterion of being in the "vicinity" of the project area. Each Corps District must evaluate project lands available to determine if they meet this criterion. Potential restoration areas could include cleared lands acquired in excess of those required to fulfill the public access feature of the Atchafalaya Basin Multipurpose Plan, or cleared lands near the Old River Control Structure, depending on why those lands were acquired. Cleared lands adjacent to Corps lakes are not characteristic of the lands in the Mississippi River alluvial plain and should not be considered as being in the "vicinity" of the project area. Other project lands will be considered on a case-by-case basis as construction proceeds.

MITIGATION BY DEVELOPMENT OF OTHER PUBLIC LANDS

50. The possibility of development and management of other public lands within the project area was considered during the preparation of this mitigation plan. Many public areas managed for wildlife resources by state and other Federal agencies exist throughout the project area. These agencies were contacted with regard to lands available for implementation of management measures. Responses had no mention of possible activities to enhance resources on lands within their jurisdiction. In the past, these agencies have responded that the frequently flooded cleared agricultural lands under their control will be reforested in the future or that additional management/development of public lands is not necessary. The states, through the levee boards, currently have easements on project area lands. The possibility exists to upgrade these easements to fee title if sufficient lands are available. This type of compensation will be considered on a case-by-case basis in consultation with the levee boards and various state and Federal agencies.

MITIGATION BY ACQUISITION AND MANAGEMENT OF SEPARABLE LANDS

Fee Title Acquisition and Management of Bottom-land Hardwoods

51. This alternative, considered in previous studies, is based on providing additional habitat quality through management of existing bottom-land hardwoods. Project-induced losses are assumed to be offset through management of existing bottom-land hardwoods by increasing the HU value of the land. Only the incremental increase in habitat value can be used to offset AAHU losses; therefore, vast amounts of land are required. In addition, the net gain from management is difficult to measure; therefore, monitoring of this alternative to ensure increases in habitat values are occurring and offsetting impacts is impractical. Reforestation of cleared lands is a more practical approach and results in much less property under Federal control. Based on this information, acquisition and management of privately owned bottom-land hardwoods to offset project losses have been eliminated from further study.

Perpetual Land Use Easement Acquisition of Bottom-land Hardwoods

52. This alternative is designed to prevent any change in existing land use for bottom-land hardwoods by securing a perpetual land use easement. This alternative preserves bottom-land hardwoods but does not offset project impacts. Therefore, this alternative will receive no additional consideration.

Easement Acquisition of Cleared Agricultural Lands with Reforestation

53. The Wetland Reserve Program is an example of this type of plan. Farmers are allowed to bid their land into the program for a certain price. If accepted by the government, the lands are removed from production and allowed to revegetate naturally or reforested with naturally occurring hardwood species. In order to utilize easements on this project, a landowner would have to demonstrate how the mitigation lands would be preserved and managed for the life of the project. The Corps would pay for the appropriate easement, reforestation, and other management requirements. The Corps would evaluate this type of compensation on a case-by-case basis if opportunities for this alternative occur.

Fee Title Acquisition of Cleared Agricultural Land With Reforestation

54. This alternative would reestablish a functional bottom-land hardwood wetland forest community on low-lying, frequently flooded agricultural lands. This is accomplished by establishing desirable tree species which occur in a later successional forest and are valuable to wildlife. These lands thus become suitable and appropriate to use for compensation of project-induced terrestrial, waterfowl, and wetland losses and to provide additional aquatic benefits. The restoration of frequently flooded agricultural land to increase wetland functional value is also consistent with the national goal of no-net wetland loss.

55. Planting species to provide ecological productivity is the primary objective of the reforestation effort. Additional diversification will come from volunteer species expected for a given site. Plantings and natural regeneration of species such as willow, water, Nuttall, and overcup oaks; bitter pecan; green ash; persimmon; elm; willow; sugarberry; and other native understory plants will provide diversity to recreate a forest environment ideal for supporting a wide range of wildlife populations.

56. Reforestation can be accomplished through natural succession or artificial regeneration. These reforestation methods are discussed below.

a. Natural succession. This method of reforestation should only be considered where available acorn or other seed sources exist at or near the site to be reforested. The increase in AAHU's associated with natural succession presented in Table 1-1 assume that reliable mast-producing seed sources exist near or within the mitigation site. Available mitigation lands are typically cultivated on a large scale for crops with little or no adjacent trees for mast sources. Natural regeneration on these types of areas would most likely result in undesirable light seeded, wind-distributed species with few hard mast-producing trees such as oaks and pecans. Although this alternative is economical, quality reforestation and desired mitigation results are site dependent.

b. Artificial regeneration. Recent experience in the establishment of bottom-land hardwoods on mitigation tracts indicates that containerized seedlings tend to survive in much greater proportions than bare root seedlings or trees established through direct seeding. These and other considerations will be taken into account prior to choosing a method of reforestation for selected mitigation tracts. Seedling survivability depends to a great extent on the amount of flooding or drought that occurs during the first few growing seasons. All reasonable techniques will be employed to ensure the survival of seedlings through this critical period.

57. Reforestation measures on lands acquired in fee title have the potential to offset project impacts for terrestrial, wetland, and waterfowl resource categories and to increase aquatic habitat. They also fit the formulation criteria mentioned previously and will be evaluated further to determine the best plan for mitigating project losses.

EVALUATION OF THE FINAL ARRAY OF ALTERNATIVES

SUMMARY OF MITIGATION ALTERNATIVES

58. Conceptual mitigation alternatives still under consideration at this stage of planning are shown in Table 1-7. These alternatives were evaluated for each Corps District to determine the recommended plan.

TABLE 1-7
CONCEPTUAL MITIGATION ALTERNATIVES

Alternative	Mitigation Alternative Description	Habitat Value		
		Terrestrial (AAHU's/Acre)	Wetlands (AAFCU's/ Acre)	Waterfowl (DUD's/Acre)
1	Forest reestablishment by natural succession on frequently flooded agricultural lands	2.12	4.27	52
2	Forest reestablishment by planting seedlings on frequently flooded agricultural lands	2.95	4.27	235

59. Alternative 1 is designed to allow mitigation lands to reforest naturally. Few oak trees will be established with this alternative due to the lack of a seed source and/or insufficient project life (100 years) for the natural establishment of an oak component that would provide necessary mitigation value. Terrestrial habitat value is 2.12 AAHU's per acre as shown for MP4 in Table 1-4 (i.e., 211.88 AAHU per 100 acres). Wetland value is 4.27 AAFCU's per acre (Table 1-5). Bottom-land hardwoods established through natural succession have little waterfowl foraging value because of the absence of red oaks. The only waterfowl credit with this alternative is for moist soil/fallow field habitat assumed to exist during the first 5 years after conversion, yielding 52 DUD's per acre/year (see footnote a/ in Table 1-6).

60. Alternative 2 is based on reforestation of frequently flooded agricultural lands with 70 percent red oak seedlings. Terrestrial values associated with this plan are higher than that for natural succession at 2.95 AAHU's per acre (Table 1-4). Wetland value is again 4.27 AAFCU's per acre, the same as Alternative 1. Because of the presence of red oaks, waterfowl value is significantly higher at 235 DUD's per acre (including 52 DUD's per acre as shown in Table 1-6 due to moist soil/fallow conditions present during first 5 years after conversion as in Alternative 1) than for natural succession.

EVALUATION OF ALTERNATIVES BY CORPS DISTRICT

61. Since mitigation lands will be purchased by Corps District, an analysis is necessary to determine the amount of land required from each District to mitigate project losses. The controlling resource loss was used to determine compensation acreage for each District. Acreage for each resource category was determined by dividing resource losses by the value of mitigation lands displayed in Table 1-7 (e.g., 5,694 AAHU's/2.95 AAHU's/acre = 1,930 acres). Table 1-8 displays losses and compensation by resource category for Alternatives 1 and 2 within each District.

62. Alternative 2 is the most effective plan to compensate for unavoidable losses within each District. Compensation acreage is driven by wetlands impacts. Approximately 5,200 acres are necessary to compensate wetland losses in the Vicksburg District with terrestrial and waterfowl compensation at 1,930 and 849 acres, respectively. Approximately 639 acres are needed to compensate wetland losses in the Memphis District with terrestrial and waterfowl compensation at 394 and 574 acres, respectively. Twenty-four acres are needed for New Orleans District to compensate wetland losses.

63. Alternative 1 would result in 1,957 additional acres for Memphis District to compensate waterfowl losses. Although acreage requirements are the same for Alternatives 1 and 2 in Vicksburg and New Orleans Districts, for all Corps Districts to maintain consistency throughout the project area, Alternative 2 is carried forward as the recommended plan.

64. The total compensation acreage for all Corps Districts is 5,863 acres. Included in this total is the compensation for Fiscal Years 1997 and 1998 construction items. The recommended plan and measures to implement this plan are described below.

RECOMMENDED MITIGATION PLAN

65. Alternative 2 is selected as the recommended mitigation plan for each Corps District. This plan will result in reforestation of 5,863 acres of frequently flooded agricultural lands. A mixture of bottom-land hardwood species comprised of 70 percent red oaks will be planted on tracts purchased within each District. The successful reestablishment of bottom-land hardwoods will benefit target resources and serve to improve the overall habitat value of lands within the project area. First costs for the recommended plan are shown in Table 1-9. First costs are $7.8 million, $968,000, and $58,000 for Vicksburg, Memphis, and New Orleans Districts, respectively. Annual costs including operation and maintenance are $606,200, $75,400, and $4,400, respectively.

66. The mitigation percentage for each resource category is shown in Table 1-10 by District. This table also displays the total habitat units provided and the cost per required habitat unit for each resource category. Although some categories exceed minimum in-kind replacement within each District, the recommended plan achieves the formulation goal of fully offsetting unavoidable impacts for each resource category.

TABLE 1-8
MITIGATION REQUIREMENTS BY CORPS DISTRICT

Resource Category	Vicksburg District			Memphis District			New Orleans District		
	Loss	Acres Required		Loss	Acres Required		Loss	Acres Required	
		Alternative 1	Alternative 2		Alternative 1	Alternative 2		Alternative 1	Alternative 2
Terrestrial (AAHU's)	5,694	2,686	1,930	1,163	549	394	4	2	1
Wetlands (AAFCU's)	22,206	5,200	5,200 a/	2,728	639	639 a/	101	24	24 a/
Waterfow (DUD's)	199,440	3,835	849	134,992	2,596	574	0	0	0
Aquatics b/ (AAHU's)	(27,131)	N/A	N/A	(195)	N/A	N/A	(55)	N/A	N/A

a/ Controlling resource category for the best alternative.
b/ Aquatic habitat gains from project implementation are shown in parenthesis and include benefits from creation of 6,700 acres of aquatic borrow area.

TABLE 1-9
MITIGATION COSTS
RECOMMENDED PLAN

Item	Unit	Quantity	Cost/Unit ($)	Costs ($)	O&M ($)
Vicksburg District					
First Costs					
Lands and Damages	acres	5,200	750	3,900,000	
Contingencies (25%)				975,000	
Acquisition Costs	tract	6	18,000	108,000	
Temporary Permits				13,200	
Public Law 91-646				86,000	
Contingencies (25%)				51,800	
Total Real Estate				5,134,000	
Development					
Reforestation	acres	5,200	200	1,040,000	
Wood Duck Boxes	each	265	60	15,900	
Road Construction	miles	11.6	40,000	463,000	
Survey	miles	21.5	1,000	21,500	
Contingencies (25%)				385,100	
Total Development				1,925,500	
Engineering and Design (30%)				577,700	
Construction Management (10%)				192,600	
Total First Costs				7,829,800	
Annual Costs					
Interest Rate (0.07125)				557,900	
Sinking Fund (0.00236)				18,500	
Wood Duck Boxes	each	264.5	10	2,600	2,600
Road Maintenance	miles	11.6	400	4,600	4,600
Boundary Maintenance	miles	21.5	100	2,100	2,100
Vegetation Maintenance	acres	5,200	1	5,200	5,200
Timber Management	acres	5,200	2	10,400	10,400
Project Administration				4,900	4,900
Total Annual Costs				606,200	29,800

TABLE 1-9 (Cont)

Item	Unit	Quantity	Cost/Unit ($)	Costs ($)	O&M ($)
Memphis District					
First Costs					
Lands and Damages	acres	639	750	479,300	
Contingencies (25%)				119,800	
Acquisition Costs	tract	1	18,000	18,000	
Temporary Permits				1,600	
Public Law 91-646				10,600	
Contingencies (25%)				7,550	
Total Real Estate				636,850	
Development					
Reforestation	acres	639	200	127,800	
Wood Duck Boxes	each	30	60	1,800	
Road Construction	miles	1.4	40,000	56,900	
Survey	miles	2.6	1,000	2,600	
Contingencies (25%)				47,275	
Total Development				236,375	
Engineering and Design (30%)				70,900	
Construction Management (10%)				23,600	
Total First Costs				967,725	
Annual Costs					
Interest Rate (0.07125)				69,000	
Sinking Fund (0.00236)				2,300	
Wood Duck Boxes	each	30	10	300	300
Road Maintenance	miles	1.4	400	600	600
Boundary Maintenance	miles	2.6	100	300	300
Vegetation Maintenance	acres	639	1	600	600
Timber Management	acres	639	2	1,300	1,300
Project Administration				1,000	1,000
Total Annual Costs				75,400	4,100

TABLE 1-9 (Cont)

Item	Unit	Quantity	Cost/Unit ($)	Costs ($)	O&M ($)
New Orleans District					
First Costs					
Lands and Damages	acres	24	750	18,000	
Contingencies (25%)				4,500	
Acquisition Costs	tract	1	18,000	18,000	
Temporary Permits				100	
Public Law 91-646				400	
Contingencies (25%)				4,625	
Total Real Estate				45,625	
Development					
Reforestation	acres	24	200	4,800	
Wood Duck Boxes	each	1	60	100	
Road Construction	miles	0.1	40,000	2,100	
Survey	miles	0.1	1,000	100	
Contingencies (25%)				1,775	
Total Development				8,875	
Engineering and Design (30%)				2,700	
Construction Management (10%)				900	
Total First Costs				58,100	
Annual Costs					
Interest Rate (0.07125)				4,100	
Sinking Fund (0.00236)				100	
Wood Duck Boxes	each	1	10	10	10
Road Maintenance	miles	0.1	400	20	20
Boundary Maintenance	miles	0.1	100	10	10
Vegetation Maintenance	acres	24	1	20	20
Timber Management	acres	24	2	50	50
Project Administration				40	40
Total Annual Costs				4,350	150

TABLE 1-10
MITIGATION PERCENTAGE AND COST PER HABITAT UNIT FOR RECOMMENDED PLAN

Resource Category	Vicksburg District (5,200 acres)				Memphis District (639 acres)				New Orleans District (24 acres)			
	Units Impacted	Units Gained	Percent Mitigated	Cost Per Unit ($)	Units Impacted	Units Gained	Percent Mitigated	Cost Per Unit ($)	Units Impacted	Units Gained	Percent Mitigated	Cost Per Unit ($)
Terrestrial (AAHU's)	-5,694	15,340	269	1,375	-1,163	1,885	162	832	-4	71	1,775	14,500
Wetlands (AAFCU's)	-22,206	22,206	100	353	-2,728	2,728	100	355	-101	101	100	575
Waterfowl (DUD's)	-199,440	1,222,000	613	39	-134,992	150,165	111	7	0	5,640	N/A	N/A
Aquatics a/ (AAHU's)	27,131	N/A	N/A	N/A	195	N/A	N/A	N/A	55	N/A	N/A	N/A

a/ Aquatic habitat gains from project implementation are shown here and include benefits from creation of 6,700 acres of aquatic borrow area.

IMPLEMENTATION OF MITIGATION MEASURES

67. Mitigation will be accomplished concurrent with construction of project features; therefore, tracts are anticipated to be purchased as part of this process. State and Federal agencies along with environmental groups have expressed interest in securing mitigation tracts of suitable size to be managed efficiently. To achieve this, losses for several items of work should be combined and a tract purchased to offset these losses. Three Corps Districts are involved in this project. Each District will have construction and mitigation responsibilities. Each District will seek and purchase separate mitigation lands unless joint purchases are determined by prior agreement to be more appropriate. All attempts will be made to purchase lands in the approximate vicinity of project impacts and within the state and/or levee district in which the losses occur. However, the feasibility of onsite mitigation will have to be balanced with the goal of acquiring tracts of suitable size contiguous with large tracts of bottom-land hardwoods.

MANAGEMENT RESPONSIBILITIES

68. The Corps of Engineers will be responsible for acquisition and reforestation of 5,863 acres of privately owned cleared agricultural land to mitigate project losses. The preferred method of acquisition would be by fee title; however, other methods such as use of public lands and easements on private lands, etc., would be considered on a case-by-case basis in coordination with other Federal, state, and local agencies. Upon identification of the particular tract(s) of land to be acquired and the mitigation value of the habitat to be established, all appropriate Federal and state agencies will be contacted to determine their desire to manage these lands. A selection will be made of the agency to manage each particular tract based on management cost proposals, proximity of the tract to existing agency holdings, and other factors deemed appropriate. To ensure success as much as possible on these mitigation tracts, annual operation and maintenance funds will be provided to the agency for management responsibilities, subject to the availability of Federal appropriations for this purpose.

69. Once a tract of land has been identified, evaluated, and purchased by the Corps, a reforestation plan will be developed that will evaluate the species of trees most suitable for this tract. The evaluation will include a review of the frequency and duration of flooding, soil types, tree species common to the area, planting dates, and other factors which may affect the mortality of the trees. The spacing and number of trees per acre will be based on the species recommended and current planting practices. After planting, the tract will be monitored to ensure a sufficient survival rate of trees. If sufficient trees do not survive, the tract will be replanted until sufficient survival rates do exist to ensure a satisfactory forest stand. As the forest matures, sufficient monitoring will be conducted to assure mitigation credits are gained as predicted in the analysis. If the forest fails to achieve the gains as predicted, the mitigation requirements will be reconsidered. The forest will be managed using normal silvicultural and wildlife management practices to achieve the terrestrial, wetland, and waterfowl habitats.

POTENTIAL MITIGATION LANDS

70. Potential mitigation lands will not be identified at this point. As the project progresses, Corps project managers and real estate staff will initiate activities to locate and acquire lands based on the criteria set forth herein. Serious consideration will be given to any lands offered for this purpose. Selection of tracts to purchase will be strictly based on the potential to offset project losses and will be coordinated with project sponsors and appropriate state and Federal agencies prior to purchase.

APPENDIX 2
FISH AND WILDLIFE PLANNING AID REPORT

A Planning Aid Report

on the

Mississippi River Mainline Levee Enlargement and Seepage Control Project

Prepared by
Curtis B. James
U.S. Fish and Wildlife Service
Vicksburg Field Office
Vicksburg, Mississippi

June 1998

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

This is the U.S. Fish and Wildlife Service's (Service) planning aid report on the Mississippi River Mainline Levee Enlargement project. This report describes fish and wildlife resources, describes problems and planning objectives, evaluates alternative plans, and discusses potential conservation measures. It has been prepared with the assistance of the Arkansas Game and Fish Commission; the Louisiana Department of Wildlife and Fisheries; the Mississippi Department of Wildlife, Fisheries and Parks; and the Missouri Department of Conservation and their letters are enclosed . Our report is submitted in accordance with the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-667e) and the Endangered Species Act (87 Stat. 884, as amended U.S.C. 1531 et seq.). However, this report does not constitute the final report of the Secretary of the Interior as required by Section 2b of the act.

PRIOR WORKS AND AUTHORIZATION

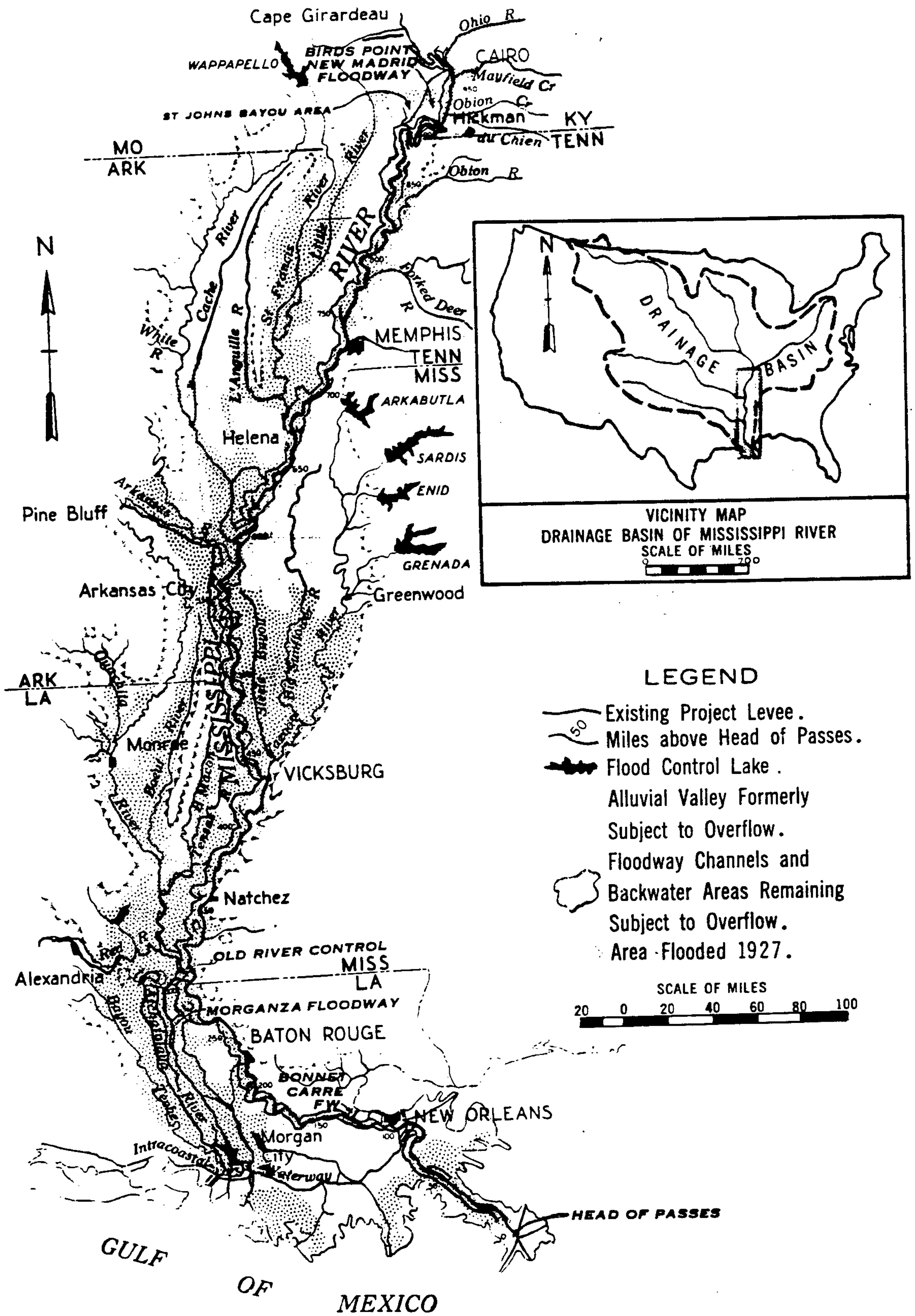
Prompted by major floods in the early 1900's and especially the disastrous flood of 1927, the flood of record, Congress passed the Flood Control Act of 1928 (FCA), authorizing the Mississippi River and Tributaries project (MR&T). The passage of this act initiated a direct federal role in flood control in the Delta of the Lower Mississippi River. Subsequent flood control acts (1936, 1941, 1944, 1948, 1950, 1960) provided for flood control and improvement of specific tributaries of the Mississippi River.

In response to a June 12, 1954, Senate resolution, the Chief of Engineers, U.S. Army, Corps of Engineers (Corps) prepared a Comprehensive Review Report of the MR&T project. The report, which was released in December 1964, constituted an extensive review of the adequacy and feasibility of the plan for flood control of the lower Mississippi River and its tributaries within the alluvial valley. The report recommended modification of the MR&T project to provide for authorization of additional improvements, including raising the height of the mainstem levees to suitable grade. As a result of this report, Congress passed the FCA of 1965 authorizing additional work on specific tributaries of the Mississippi River as well as upgrading the mainstem levees.

DESCRIPTION OF THE STUDY AREA AND THE PROPOSED PROJECT

The mainline levees cover more than 2,000 miles within the Lower Mississippi River Basin and extend from Cape Girardeau, Missouri, to the Head of Passes, Louisiana (Figure 1). The lower Mississippi River valley floodplain has about 35,000 square miles of alluvial lands bordering the river. The study area includes all lands riverside of the mainline levees, and an area 3,000 feet landside of the levee toe on both sides. According to the Corps, there are approximately 1,022,357 acres of wetlands, 1,105,401 acres of nonwetlands, and 518,086 acres of open water for a total of 2,645,844 acres included in the levee enlargement project (Corps 1998).

Following a major flood in 1973, the Corps determined that the existing mainline levee system was insufficient to contain a "project flood." A project flood would result from heavy rains in the upper Mississippi and Ohio River valleys at the same time for a long duration. This hypothetical flood would be 11 percent greater than the 1927 flood at the mouth of the Arkansas River and 29 percent greater, or 3,030,000 cubic feet per second, at the Red River Landing, about 60 miles



ALLUVIAL VALLEY OF THE MISSISSIPPI RIVER
Corps of Engineers 1998

Figure 1

below Natchez (Corps 1976). Based on data from flood events in 1973, 1974, and 1975, a new project design flowline was established. As a result of this new flowline, the Corps reevaluated the existing levees, identified deficiencies, and initiated design and construction of improvements for the deficient levees. Approximately 83 miles of levees have been raised since 1973.

The proposed work consists of 128 work items-31 items in the Memphis District, 85 in the Vicksburg District, and 12 in the New Orleans District. Work in the Memphis District includes 31.8 miles of levee enlargement and 74.3 miles of berm construction; within the Vicksburg District, 216.8 miles of levee enlargement and approximately 57.4 miles of intermittent berms; and in the New Orleans District, the improvements consist of 14.2 miles of levee enlargement and 0.1 miles of berm construction. Usually, berm construction consists of fill material, however, relief wells and slurry cutoff trenches will be used in lieu of berms where engineeringly feasible to minimize environmental impacts. To complete the work items in the Memphis District would require 15 years and 23 years in the Vicksburg District. If sufficiently funded, the entire project could be completed in the year 2020.

FISH AND WILDLIFE RESOURCES

Fishery Resources

Fishery habitat of special concern within the study area consists of the Mississippi River and its tributaries, the adjoining floodplain, borrow pits, and oxbow lakes. Approximately one hundred fourteen freshwater fish species have been identified in the project area (Corps 1976). The slack water areas and floodplain are especially important aquatic resources and are used by numerous fish species as spawning areas during annual spring flooding. Beneficial nutrient input to the aquatic ecosystem combined with the low erosion and run-off characteristics of these bottomland hardwood forested wetlands are factors which in the past resulted in excellent water quality and a highly productive fisheries. Slackwater areas outside the main channel are frequently slow moving and shallow, providing important spawning and nursery sites for fishes and abundant food in the form of benthos and plankton. These slackwaters are valuable for both commercial and sport fishing.

The bottomland hardwoods growing in the batture lands are especially important to various fish species during annual flooding. Fish are especially dependent upon these forested overflow areas for food production, feeding, spawning, and rearing of young. Spring flooding allows fish such as blue, channel, and flathead catfish; largemouth bass; bluegill and other sunfish; white crappie; and buffalo to spawn in the forested wetlands. Lambou (1990) found that of the 95 species of finfish known to occur in the leveed Atchafalaya Basin, Louisiana, 54 percent use overflow wooded areas for spawning and/or rearing of young, while 56 percent use these areas for feeding. Finfishes moved in and out of the overflow areas in the Atchafalaya Basin in response to the rising or falling of the water level. Others (Welcomme 1979, Welcomme 1985, Holder 1970, Walker 1985, Guillory 1979) have also documented the use of forested overflow areas by fishes.

The lakes and borrow areas also support productive fisheries within the project area. The total of eighty fish species now known from borrow areas suggests an ichthyofauna second in diversity only to the lower reaches of tributary streams. Riverside borrow area communities include several uncommon and imperiled wetland species once characteristic of floodplain ponds (e.g., pugnose minnow, tailight shiner) and oxbow lakes (e.g., paddlefish, alligator gar) (Corps 1998). These relatively stable water bodies have large aquatic populations of plants and animals. The higher plants around these water bodies are important primary producers in that a significant amount of leaf litter, branches, and other organic matter wash into these lakes and borrow areas during high water conditions, becoming a source of detritus. Flooding recharges and relieves periodic overpopulation and crowding of the oxbow lakes and borrow areas and results in a net export of fish to Mississippi River channel habitats.

The total standing stock of fish averages approximately 600 pounds per acre in borrow pits within the project area, indicating high fishery production. Populations of benthic macroinvertebrates in the borrow pits are also comparatively high. Since many benthic organisms are used by various fish species as food, the abundance of benthic organisms is additional evidence of the value of borrow pits as fish habitat. The length of time that borrow pits are flooded annually is the single most important factor that influences population densities, standing stock, and diversity of borrow pit fishes and benthic macroinvertebrates. The greater the average annual days flooded, the more productive the borrow pits (Cobb et al. 1984).

Wildlife Resources

Bottomland hardwoods are one of the most productive habitat types in the U.S. (Clark and Benforado 1981), and are being lost at an alarming rate over most of their range (MacDonald et al. 1979). At one time the Mississippi Alluvial Valley (MAV) contained 24 million acres of bottomland hardwood forested wetlands. Today only five million acres of forested wetlands remain (U.S. Fish and Wildlife Service 1988). With the exception of a few public areas, the only large remaining contiguous blocks of forested wetlands are found riverside of the mainline levee.

Historically, most of the MAV was subject to periodic flooding by the Mississippi River and its tributaries. However, hydrologic relationships in the MAV have been altered by federally funded water resource developments for flood control and agricultural enhancement (Reinecke et al. 1988). In western Mississippi, for example, the two year flood originally inundated more than 4.5 million acres. Construction of the mainstem Mississippi River levees reduced the two year flood to approximately one million acres (Galloway 1980). Thus, in western Mississippi alone, the cumulative impacts of the mainline levees have reduced the two year flood by about 88 percent (Reinecke et al. 1989). Additionally, the confining effect of the mainline levee system has caused progressively higher flood stages throughout much of the Mississippi River corridor (Tuttle and Pinner 1982).

The MR&T mainline levee project has been responsible for the loss of millions of acres of forested wetlands within the MAV. The prevailing opinion of most experts on the Delta and the lower MAV is that: 1) the natural topography alone does not provide much flood protection and 2) in the absence of the mainline levee system forest clearing and sustained cultivation of the lower MAV is impossible (U.S. Fish and Wildlife Service 1988). Galloway (1980) contends that in the absence of the federal program initiated in 1928 to rebuild and expand the mainline levees, clearing would have abated and the dominating hydrologic influence of the Mississippi River would have led to the ultimate reversion of most of the Delta to bottomland hardwood forest.

Forested wetlands are highly integrated, open systems with continuous inflow and outflow of energy, sediments, nutrients, and species between aquatic and terrestrial environments (Moulton 1990). Furthermore, bottomland hardwoods are extremely important as a component in the life cycle of many wildlife species (Glasglow and Noble 1971). One measure of the bottomland forests productivity is their abundant wildlife. At the time of European and African settlement, the dynamic water regime and high diversity of these forests supported large numbers of resident, wintering, breeding, and migrating animals, including some species that have since been regionally extirpated or become extinct (Fredrickson 1978).

Southern bottomland forests can support two to five times as many game animals as nearby mixed pine and hardwood forest (Harris et al. 1984). Squirrels reach their highest densities in the ideal habitat provided by mature mast trees. Furbearers such as mink (*Mustela vison*), river otter (*Lutra canadensis*), raccoon (*Procyon lotor*), opossum (*Didelphis marsupialis*), beaver (*Castor canadensis*), bobcat (*Lynx rufus*), and gray fox (*Urocyon cinereoargenteus*) are found in bottomland hardwoods, swamps, and riparian areas. Many nongame species such as small mammals, neotropical migrant birds, owls, and raptors find ideal habitat in the wooded wetlands of the area. These forested areas also provide important travel corridors for numerous wildlife species as well as feeding and dening sites for the federally listed threatened Louisiana black bear (*Ursus americanus luteolus*).

The importance of bottomland hardwoods to waterfowl and other birds cannot be overemphasized as over nine-tenths of all the bird species of eastern North America use bottomlands at one time or another (Harris et al. 1984). Large areas of bottomland hardwood forests are critical to meet the needs of neotropical migratory birds many of which are declining (Hunter et al. 1993). Fragmentation, resulting in small, isolated forest patches, has been found to be related to declines of some interior forest birds and local extinctions of others (Finch 1991). The refuge provided by bottomland forests is vital to these birds.

The bottomland hardwoods that remain along the Mississippi River are among the nation's most important wetlands. These forested wetlands fulfill special waterfowl habitat requirements not provided by open lands. Wooded habitats produce nutritious foods for waterfowl and provide secure roosting areas, cover during inclement weather, loafing sites, protection from predators, and isolation for pair formation. Eight species of waterfowl regularly use bottomland hardwood forests, including the 2.8 million mallards of the Mississippi Flyway, nearly all of the 1.7 million wood ducks, and many other migratory birds (Bellrose and Holm 1994).

Additionally, these forested areas are inseparably linked to the surrounding floodplain and have other enormous but often unrecognized values. They provide space for the dispersal and temporary storage of flood waters until the natural drainage can carry them away. This natural function can reduce potential damages from floods. One acre of a forested floodplain can store about 325,000 gallons of water if flooded to a depth of only one foot (Natural Hazards Research and Applications Information Center 1992). Forested wetlands also contribute to water quality by reducing sediment loads, filtering out chemical and organic wastes, and reducing nutrients, thereby protecting the physical, biological, and chemical integrity of water. They also facilitate recharge of underground aquifers and reduce erosion by binding the soil with root systems.

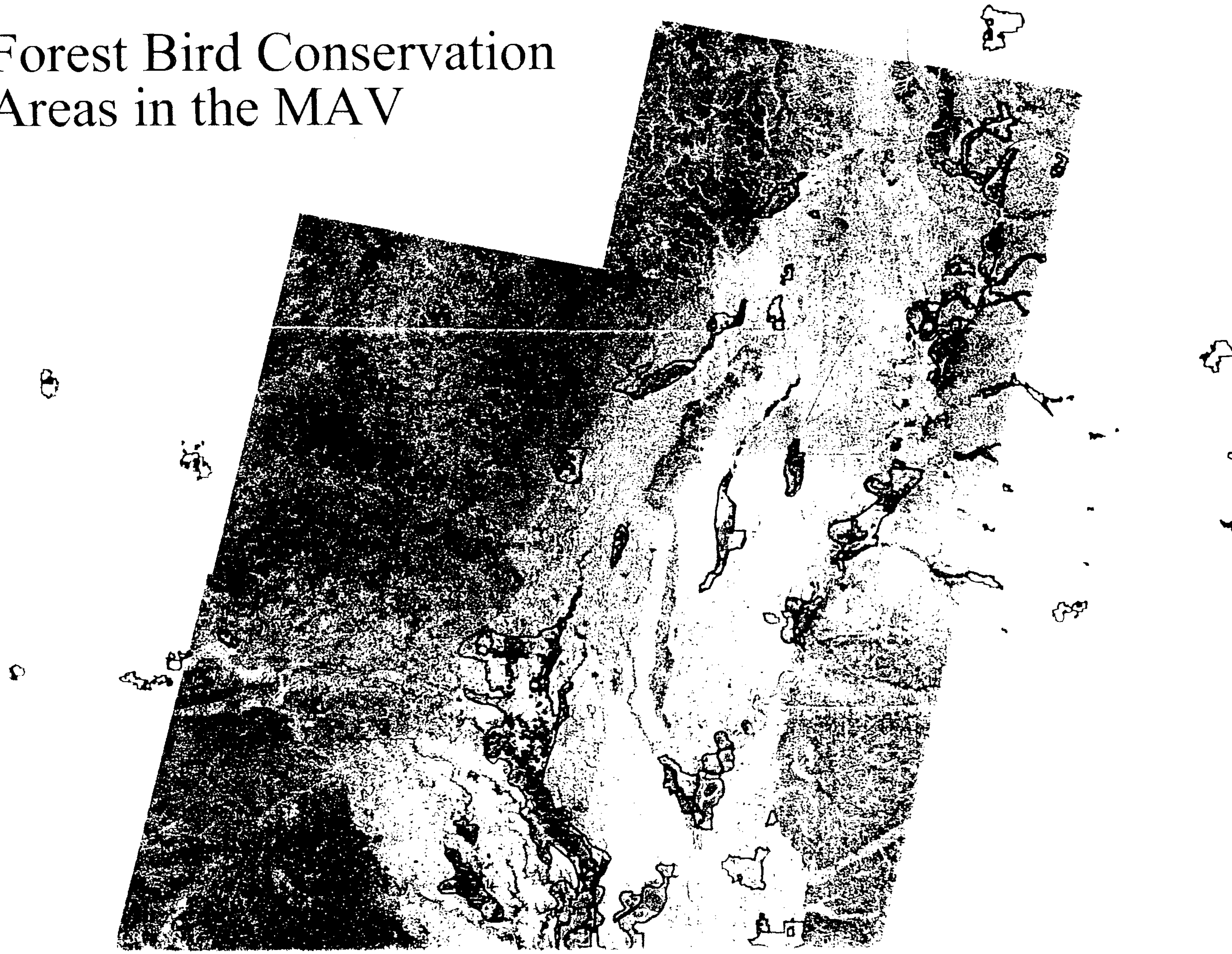
The Water Resources Development Act of 1986 recognizes the importance of bottomland hardwoods by directing that losses of bottomland hardwoods due to water resource development projects are to be mitigated in kind to the extent possible. Because of their overall scarcity and importance, the Service considers the bottomland hardwoods and wintering waterfowl habitat of the project area to be a Resource Category 2 as defined in the Service's Mitigation Policy (Service 1981). Resource Category 2 habitat is of "high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section." The mitigation goal for habitat in Resource Category 2 is "no net loss of in-kind value" and the Service is mandated to recommend measures to avoid losses of this habitat, or if unavoidable losses do occur, to recommend measures to replace habitat value so that no net loss of habitat value is sustained.

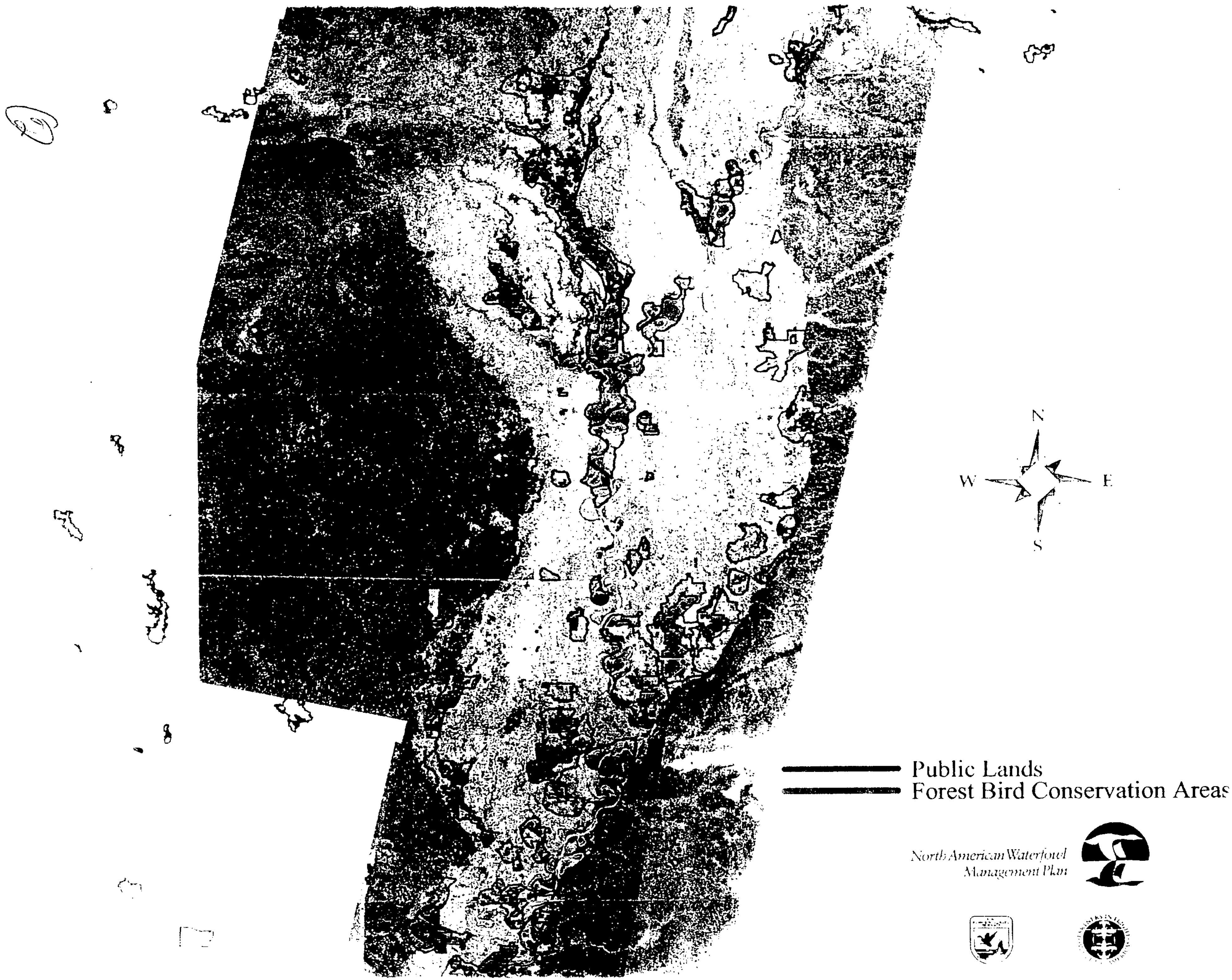
All of the forested lands within the project area are of special concern to the Service, not just those designated as jurisdictional wetlands. The Service, with other federal and state agencies and the private sector, is developing management objectives to protect forest breeding birds and their habitat in the MAV. One of the top priorities of this effort is to identify "bird conservation areas" (forest patches 10,000 acres or greater to support long term, self-sustaining populations of forest breeding birds) which contain cleared areas that need to be reforested (Figure 2, Mueller et al In press). Therefore, the Service is concerned about how potential adverse project impacts to bottomland hardwoods, primarily in the batture lands, could interfere with the overall goal to maintain and support forest breeding birds within the project area.

ENDANGERED SPECIES

The Endangered Species Act requires that an official list of endangered and threatened species be requested for any federal construction project. The Corps requested a list of endangered or threatened species that may be in the project area in an August 21, 1997 letter. In a letter dated August 28, 1997, the Service responded that the following federally listed species may occur in the project area: pallid sturgeon (*Scaphirynchus albus*), fat pocketbook pearly mussel (*Potamilus capax*), interior least tern (*Sterna antillarum*), and wood stork (*Mycteria americana*). The Corps' March 1998 Biological Assessment (BA) concluded that the proposed levee enlargement work items would have "no affect" on the endangered pallid sturgeon, fat pocketbook pearly mussel, interior least tern, and wood stork. The Service concurs with the Corps' determination that the proposed levee enlargement work items would not adversely affect the above mentioned species. The Service previously concurred (in a letter dated November 30,

Forest Bird Conservation Areas in the MAV




N
W
E
S
Public Lands
Forest Bird Conservation Areas
North American Waterfowl
Management Plan

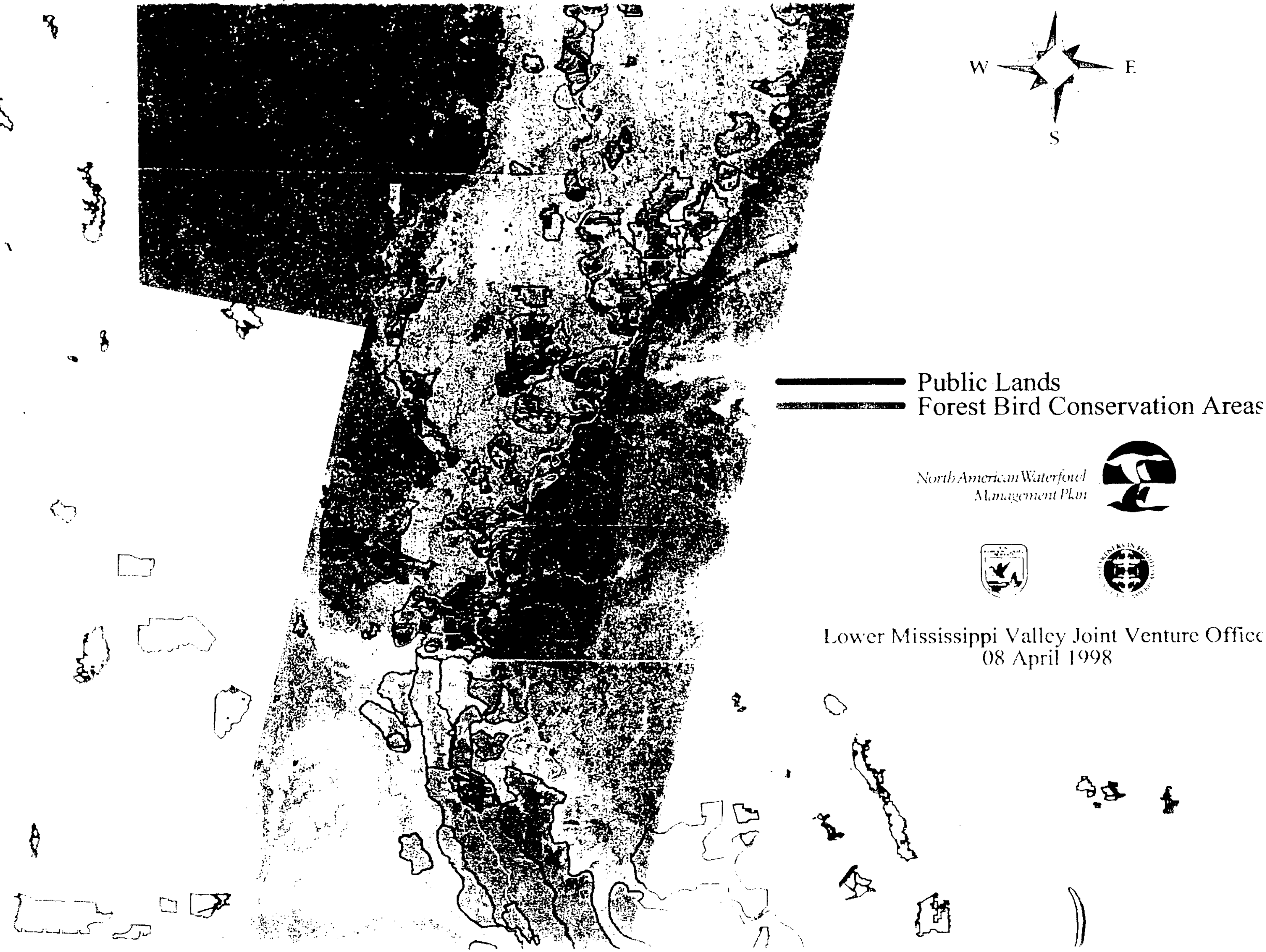

W
E
S
Public Lands
Forest Bird Conservation Areas
North American Waterfowl
Management Plan
Lower Mississippi Valley Joint Venture Office
08 April 1998

FIGURE 2

3

1995) with the Corps' generic BA which stated that the project would not adversely impact the Louisiana black bear as long as specific conservation measures were incorporated during project construction. These measures included: avoiding den trees (to the extent possible), using dredge material from the Mississippi River for berm construction to further reduce loss of forested losses in the batture lands, and replanting borrow areas or allowing the borrow areas to revegetate naturally.

FISH AND WILDLIFE RESOURCE PROBLEMS, OPPORTUNITIES, AND PLANNING OBJECTIVES

The Service acknowledges the need to maintain the integrity of the mainline levees, but it should be done in an environmentally sensitive manner. Bottomland hardwoods constitute the most biologically productive habitat and support the most diverse wildlife populations of any of the habitat types within the study area. Due to the previous loss of bottomland hardwoods in the lower Mississippi River valley, the forested acreages in the project area are an extremely important resource. This forested corridor is an important component in the continued survival and recovery of the federally threatened Louisiana black bear as well as providing food, cover, and resting areas for overwintering waterfowl and numerous other wildlife species. In view of the resource concerns expressed previously, the Service has developed the following planning objectives to be incorporated into the mainline levees enlargement project:

1. Preserve bottomland forests, including jurisdictional and non-jurisdictional wetlands, within the study area.

2. Maintain existing forested corridors within the project area.

3. Maintain and enlarge existing forest patches.

4. Improve recreational opportunities and the public use of fish and wildlife resources.

DESCRIPTION OF ALTERNATIVES

The Corps proposes to raise 263 miles of mainline levee and construct approximately 131.5 miles of seepage control (berms, relief wells, and slurry trench cutoffs). Four plans were described in detail in the SEIS:

Plan 1- Nonstructural Alternative

Because flowage easements would not provide the prescribed level of flood protection, the prohibitive costs for easements on millions of acres of land subject to flooding, and public unacceptableness; the Corps determined that the nonstructural plan would not be implementable.

Plan 2- Landside Borrow

Levee raising and seepage control would be constructed and all borrow would be obtained landside of the levees. Three schemes were investigated. Plan 2A would be traditional rectangular borrow pits eight to 10 feet in depth. Plan 2B would also be the traditional borrow areas with a forested buffer zone approximately equal in area to the borrow, with a protective berm around the outside of the buffer to prevent agricultural chemicals from entering the borrow pit. Plan 2C would be shallow landside borrow pits approximately three feet deep and designed to drain so that these areas can be reforested.

Landside borrow plans were rejected because of increased land costs, landowner resistance to borrow areas on their cropland, local sponsors resistance since levee boards have lands specified for borrow purposes, and the poor water quality documented in existing landside borrow pits.

Plan 3- Traditional Method

This is the historical method to construct levee enlargements and berms. Borrow areas are normally located riverside as close to the construction site as engineeringly feasible. This plan requires no special configuration or location of borrow areas except for engineering purposes. Bottomland hardwoods are not specifically avoided. No provisions are made for drainage or environmental enhancement of the borrow pits. This plan and the following plan (the avoid and minimize plan) were analyzed in detail in the SEIS.

Plan 4- Environmental Design (Avoid-and-Minimize)

This plan incorporates measures to avoid and minimize adverse impacts to bottomland hardwoods and wetlands. Interdisciplinary teams of state and federal agency representatives, local sponsors, and the Corps initially focused on relocating borrow areas out of sensitive riverside areas including farmed wetlands, emergent wetlands, riverside upland forests, and bottomland hardwood wetlands. All relocated borrow areas would include environmental features such as varying depths, irregular shorelines, islands, and forested buffers. The teams also came up with other design approaches to reduce impacts to bottomland hardwoods and other wetlands. When feasible, existing berm material would be used to enlarge the levee and the excavated berm would be replaced with material dredged from the river. The only environmental loss resulting from the use of river material is the relatively narrow path to lay the dredge pipe from the river to the berm site. The use of less environmentally damaging relief wells or cutoff trenches to control seepage instead of berms would be used when engineeringly and environmentally feasible.

Plan 4, the avoid and minimize alternative, was selected as the recommended plan. Although Plan 4 is 4.6 percent more costly than the traditional construction plan, the avoid and minimize design will greatly reduce environmental impacts.

By using innovative approaches to levee, berm, and borrow pit construction and using cleared riverside areas for some of the borrow area, forest losses would be substantially reduced. One approach will be the use of a hydraulic dredge to construct the berms from material dredged from the Mississippi River. Some levee sections will be raised by using the existing landside seepage berm to obtain suitable material. Another environmental design the Corps will use is to dig deeper borrow pits to reduce the area required for borrow material and to provide better aquatic habitat. In the past, borrow areas were excavated to an average eight foot depth. To reduce the size of the borrow area, the average depth could be increased to ten feet, provided the increased depth does not adversely affect the levee from a seepage standpoint. Another measure would be borrow pit reforestation, which could replace some of the bottomland hardwoods destroyed by the project. Approximately 3,041 acres of shallow borrow pits will be provided drainage and reforested. This technique is experimental, so the Corps did not include shallow borrow reforestation as mitigation and considers it an environmental feature.

DESCRIPTION OF POTENTIAL IMPACTS

Direct impacts associated with the construction of levees and seepage berms include conversion of forested areas to borrow pits, including disruption of ground cover and the associated changes in habitat values. Indirect impacts include increased erosion and increased sediment and turbidity in the adjacent water bodies. Converting bottomland hardwood forests to borrow areas would result in significant loss of fish and wildlife habitat and other wetland functional values. These losses would occur on project lands directly converted for project purposes. The selected alternative, Plan 4, would result in the loss of 4,834 acres of bottomland hardwoods of which 2,038 acres are needed for the levee footprints. The Corps determined that 2,761 acres of the hardwoods impacted are jurisdictional wetlands pursuant to the methodology used for the Clean Water Act.

The Corps, in cooperation with the Service and the state fish and wildlife agencies of Arkansas, Louisiana, and Mississippi, conducted field investigations to document project induced impacts to aquatic and terrestrial resources using the Habitat Evaluation Procedures (HEP) analysis (U.S. Fish and Wildlife Service 1980). HEP is a habitat based evaluation system that quantifies current and future habitat conditions, compares project alternatives, and devises mitigation strategies, all without the need for direct sampling of animal populations. The objectives of the HEP studies are (1) to determine pre-project (baseline) habitat suitability for selected aquatic and wildlife species in the project area, (2) to estimate potential impacts to each species from project work, (3) aid in the development of avoid-and-minimize construction techniques, and (4) determine mitigation requirements for unavoidable losses.

The project area consists largely of bottomland hardwood forests interspersed with oxbow lakes and numerous borrow pits. However, some large tracts of bottomland hardwoods have been converted to monoculture cottonwood plantations. Since the bottomland forests, scrub/shrub habitat, and to some extent the cottonwood plantations are the significant terrestrial resource in the project area, these were the habitats that were sampled.

With consensus of the HEP team members, species were selected for the terrestrial and aquatic evaluations. The combined habitat requirements of these species reflect the important fish and wildlife values of the terrestrial and aquatic habitat in the project area. The following species were selected for the terrestrial HEP evaluation: barred owl (*Strix varia*), fox squirrel (*Sciurus niger*), Carolina chickadee (*Parus carolinensis*), pileated woodpecker (*Dryocopus pileatus*), wood duck (*Aix sponsa*), and mink (*Mustela vison*). The quality of habitat for each species was determined by measuring specific habitat variables (canopy cover, tree height, size and abundance of snags) on sample plots and entering these data into Habitat Suitability Index (HSI) models for each species. Impacts of each plan were determined by calculating the net change in average annual habitat units (AAHUs) between without-project and with-project plans for each evaluation species. Adverse impacts of Plan 3 were estimated at -19,565 AAHUs for all species combined and -6,861 AAHUs for the avoid and minimize alternative, Plan 4.

Adequate compensation for project induced habitat losses would require between 2,000 and 3,530 acres of reforestation, depending upon the time of reforestation, the proximity and permance of water at the reforestation site, and the method of reforestation.

The aquatic HEP analysis evaluated impacts to existing borrow areas in the project area. Existing habitat parameters measured in some pits were the same as those measured in earlier studies and included geomorphic (surface area, depth, shoreline length, and number of days flooded) and water quality variables (temperature, conductivity, pH, dissolved oxygen, and turbidity). The Lower Mississippi River Environmental Program (LMREP) physical and biological habitat data collected in 1981 and 1982 in borrow pits in the Vicksburg District and multiple regression models of fish-habitat relationships were used to quantify project impacts, aid environmental planning, and identify any unavoidable losses (Corps 1986 and 1998).

The following species selected for the aquatic HEP evaluation represent the predominant fish species or species guilds in the borrow pits: largemouth bass (*Micropterus salmoides*), silversides (*Menidia beryllina* and *Labidesthes sicculus*), warmouth (*Lepomis gulosus*), buffalo (*Ictiobus* spp.), carp (*Cyprinus carpio*), and channel catfish (*Ictalurus punctatus*). All evaluation species are numerically abundant in borrow pits and represent important commercial, recreational, and forage fishes of the lower Mississippi River system. These species provide a broad representation of habitat preferences (surface and demersal, littoral and pelagic), reproductive biology (early and late spawners, egg broadcasters, and nesting species), and trophic levels (planktivores, benthivores, and piscivores) (Corps 1998).

Habitat Units, the product of HSI and acres of borrow areas, increased for Plans 3 and 4, indicating that the levee project would improve aquatic habitat. The avoid/minimize plan would provide higher habitat value per acre than that of the traditional construction plan (Plan 3) because relatively deep borrow areas with irregular shorelines, islands, and possible plantings of riparian vegetation will be constructed instead of rectangular shallow borrow pits of less aquatic value. Although the habitat values were higher for Plan 4, the lower AAHUs gained, +27,381, than the traditional plan, +30,549, are a reflection of the lower acreages of borrow pits created for levee enlargement.

We recommend that trees be planted around the perimeter of borrow areas to moderate summertime water temperatures and provide cover and aquatic nutrients. The Service also recommends that native wetland grasses be planted along the bank of borrow areas to control erosion, serve as a sediment filter, add nutrients, and enhance fish spowning habitat. Cover is also an important part of an aquatic system and should be included in the design of borrow areas. We recommend that brush piles, constructed with tree limbs from timber clearing, be constructed at various depths in the borrow sites.

The Corps has completed jurisdictional wetland determinations within the project area using Geographic Information Service (GIS) data bases, as well as other available data bases, to characterize hydrology and vegetation. Only those areas which indicate positive signatures of wetland criteria for all three parameters (vegetation, soils, and hydrology) were considered jurisdictional wetlands. The Corps considers the upper limit of jurisdictional areas meeting wetland hydrology to be those areas which are flooded, ponded, or saturated for five percent of the growing season in most years. Elevations correlating to this criterion were calculated from existing gauge data and applied to topographic maps.

The Service, as part of an interagency review team, participated in a field review of preliminary jurisdictional wetland maps prepared for this project during February 12-16, 1996. The purpose of the field review was to verify the accuracy of the offsite jurisdictional wetland determination and validate assumptions used to prepare the preliminary maps. The field review confirmed the overall accuracy of the offsite jurisdictional maps for planning and analysis of environmental impacts. Field sites intentionally focused on controversial areas and the team found that minor adjustments were needed (and were made) at some locations to account for wetland areas with hydrology derived from saturation and not necessarily from flooding or ponding occurring at or below the five percent duration. Follow up actions were completed prior to finalizing the jurisdictional maps.

The Service has completed a Waterfowl Technical Appendix for the SEIS (Appendix 9) which quantifies the impacts of the project to wintering waterfowl carrying capacity and foraging habitat in the project area. Using with and without hydrology modifications and land use data supplied by the Corps, the impact methodology was based on food as an index of wintering waterfowl carrying capacity expressed in terms of number of duck-use-days (DUD). Project impacts in terms of losses of average seasonal acres flooded during the 120 day wintering period from November 1 to February 28, were identified. Losses would occur as a result of direct impacts to waterfowl foraging habitat being converted to borrow pits and berms. Annual waterfowl habitat carrying capacity would be reduced by 598,640 DUD with the traditional methods of levee construction (Plan 3) and 535,213 DUD with implementation of the avoid and minimize plan (Plan 4). Compensation by the reforestation of degraded wetlands with 70 percent mast producing trees and restoration of the flooding regime would require 2,293 acres for Plan 3 and 1,429 acres for Plan 4.

A semiquantitative wetland functional analysis developed by the U.S. Army Engineer Waterways Experiment Station was used by the Corps to evaluate impacts to forested and farmed wetlands (Appendix 13, SIES, Corps 1998). Several wetland functions including short-term water storage, sediment detention, nutrient and dissolved substance removal, and organic carbon export were evaluated. As with other quantitative analysis, such as the Service's HEP, a value between 0.0 and 1.0, the Functional Capacity Index (FCI), was used to quantify each wetland type and function (e.g., short-term water storage on forested wetland). The functional capacity units (FCUs) were a product of the FCI and the wetland acreage. Similar to HEP, the FCUs are a function of the quality and quantity of a wetland function.

As currently presented there is little explanation of how the FCI values for each wetland function (ie. 1.0 for short-term water storage in forested wetlands and 0.50 for the same function in farmed wetlands) were determined. Whereas the HEP interagency team determined species values based on published models, there is little basis provided for the determination of FCIs in the wetland analysis. Therefore, the Service cannot provide our views on the compensation acreages for the Corps' wetland functional analysis, since no rational for FCI values is given.

FISH AND WILDLIFE CONSERVATION MEASURES

The Fish and Wildlife Service's Mitigation Policy establishes an approach towards mitigation which coincides with the Council on Environmental Quality's mitigation definition. This includes five means of mitigation: (1) avoiding, (2) minimizing, (3) rectifying, (4) reducing, or as a last resort, (5) compensating for unavoidable adverse impacts. The Service is concerned about the loss of bottomland hardwoods in the project area to borrow areas and berm construction. The most severe environmentally damaging effects could be avoided by using borrow material from cleared agricultural land including landside of the levee to the extent possible. However, the Corps has indicated that some of the borrow material will be obtained from forested areas, instead of agricultural land, which in turn will have adverse impacts on terrestrial habitat. Therefore, since there will be unavoidable losses of wildlife resources associated with the project, habitat compensation is appropriate.

Mitigation is a process designed to off-set, as much as possible, the negative effects of a proposed project on fish and wildlife resources. Mitigation is defined in the Mitigation Policy as: "the replacement of project-induced losses to fish and wildlife resources, provided such full replacement has been judged by the Service to be consistent with the appropriate mitigation planning goal." The phrase "project-induced losses to fish and wildlife resources" indicates that wildlife resource losses can be assigned directly, indirectly, or cumulatively to a project or series of projects, and that the losses can be documented and quantified. "Full replacement" means that replacement with values less than 100 percent is not considered compensation by this definition, and "...judged by the Service to be consistent with the appropriate mitigation planning goal" refers to resource category 2 habitat as applied to this particular project.

The Service has determined that the only acceptable compensation for adverse impacts to forest resources in the project area is "in-kind" compensation. Habitat or species losses must be replaced with the same habitat or species and at the same level as the losses. Since the Service has identified the bottomland hardwoods in the project area as resource category 2 type habitat, we recommend that the Corps primarily focus on purchasing agricultural land, preferably within or adjacent to bird conservation areas (Figure 2) and replanting the mitigation lands with bottomland hardwoods to compensate for unavoidable habitat losses.

The Corps has determined that 5,863 of cleared lands need to be purchased to compensate for unavoidable impacts resulting from the construction of the selected alternative, Plan 4. There are numerous cleared areas within and adjacent to the bird conservation areas that need to be reforested to create contiguous bottomland hardwood forests for interior forest wildlife species and other bottomland hardwood species. The compensation lands should be purchased in approximate proportion to the impacts that occur in each state affected. Acquisition of mitigation lands does not need to be concurrent with each work item, but rather reforestation should be completed as cleared tracts in the bird conservation areas become available. Mitigation purchases and reforestation should be completed in each Corps District prior to the end of the project construction period (i. e. Memphis District- complete before the year 2013).

CONCLUSIONS AND RECOMMENDATIONS

Federally constructed flood control projects, such as the Mississippi River mainline levees project, provide protection and reduce damages from flood events. They cannot, however, guarantee protection against all future flood events. As the Midwest Flood of 1993 has shown, people and property remain at risk, not only in the floodplain of the upper Mississippi River Basin, but also throughout the nation. Many of those at risk do not fully understand the nature and the potential consequences of that risk nor do they share fully in the fiscal implications of bearing that risk. For example, over the last thirty years, in the United States average annual flood damages have exceeded $2 billion. Over the last ten, average annual damages have been over $3 billion. Between 1988 and 1992 the Federal Emergency Management Agency (FEMA) expended nearly $200 million each year in flood recovery activities (Corps 1993, FEMA 1994). The federal government receives far more requests for assistance from local governments and individuals than can be accommodated given current funding constraints. The inability to provide assistance in some situations can lead to inappropriate floodplain development decisions (permitting new development, not requiring flood proofing of structures in flood prone areas, and failure to safeguard new water and sewage lines) and, therefore, increased long term costs. Constructing flood control projects without requiring a commitment to educate the public on the values of wetlands and the realistic flood control benefits to be expected is not in the best interests of the local citizens or the nation.

Finally, risk exists in all areas within a floodplain including those areas protected by channel modifications, dams, or levees. Levees (such as those proposed within the project area) built to provide a 500 year level of protection, or greater, modify the natural overflow boundary of the floodplain. Even though areas protected by levees are considered safe, the potential for catastrophic loss still exists. If floodwaters overtop a levee, flooding in the protected area could reach depths equaling or exceeding the levee height. Higher levees reduce risk but could increase potential damage (Interagency Floodplain Management Review Committee 1994).

The U.S. Fish and Wildlife Service has determined that the proposed Mississippi River mainline levee enlargement and berm construction project would have significant adverse environmental impacts on wildlife resources. The completion of the 263 miles of levee enlargement with the avoid and minimize alternative (Plan 4) would result in the loss of approximately 4,834 acres of bottomland hardwoods in the MAV, an area that has already lost thousands of acres of forested wetlands.

The Service has recommended that the major goal of the Corps' Mississippi River levee enlargement project should be to protect fish and wildlife resources while providing flood damage reduction. Therefore, the Service recommends that the following measures be implemented to avoid and compensate for fish and wildlife resource damages incurred as a result of the levee enlargement project:

1. Borrow material should be obtained from cleared lands, particulary landside of the levee, to the extent possible.

2. Borrow pits should be environmentally designed as described in the SEIS to provide maximum benefits to fish and wildlife, and should also include:

    a. Tree plantings around the perimeter.
    b. Native grass plantings along the banks of the borrow areas.
    c. Brush piles, constructed with tree limbs from project clearing, in the borrow sites.

3. Whenever possible, shallow borrow areas should be constructed, drained, and replanted in bottomland hardwoods to partially mitigate terrestrial losses.

4. All forested losses should be mitigated "in-kind" through fee title acquisition. Bottomland hardwood mitigation should primarily focus on reforestation of large blocks of cleared lands within or adjacent to the bird conservation areas.

5. Compensation lands do not need to be acquired concurrently with each work item, but mitigation should be completed in each Corps' District <u>prior</u> to the end of the construction period (i.e. Memphis District- the year 2013).

6. Compensation for waterfowl foraging habitat, as described in our Waterfowl Analysis should be by reforestation of degraded wetlands and the restoration of the flooding regime.

7. The Service should be involved in any detailed design and engineering for the levee enlargement project, and all mitigation plans should be reviewed by the Service.

SUMMARY OF FINDINGS AND SERVICE POSITION

The Service recognizes that the mainline levee enlargement project is necessary, and we support the concept of maintaining the integrity of the mainline levees. We have worked closely with the Corps, the local sponsors, and other interests to avoid damages to bottomland hardwood forests and other fish and wildlife habitats and to develop compensation for unavoidable damages to forested wetlands, as well as nonwetland forests. Service planning objectives, recommendations, and mitigation have been incorporated into features of the proposed project. The Corps has modified the original plans, Plan 3, and through avoidance measures reduced adverse impacts to hardwood forests from approximately 11,582 acres to 4,834 acres. Those avoidance measures include relocation of borrow areas, use of existing berm material, relief wells, slurry trenches, and others.

The Corps has also developed compensation measures for the unavoidable impacts to forested wetlands, other wetlands, and waterfowl foraging habitat. Approximately 5,863 acres will be purchased and reforested by the Corps. The avoid and minimize plan, Plan 4, also contains other environmental design features including 6,727 acres of borrow areas designed with shallow and deep areas, irregular shorelines, and constructed islands to provide high quality habitat. Another environmental feature is the reforestation of approximately 3,041 of shallow designed borrow areas with drainage to encourage the successful establishment of oak species.

In summary, the Service commends the Corps for selecting Plan 4, the avoid and minimize plan, which significantly reduces bottomland hardwood losses and compensates for unavoidable adverse impacts and incorporates several environmental design features. We appreciate the opportunity to work with the Corps of Engineers' staff during the planning for the levee enlargement project. The Service looks also forward to our participation in the planning and implementation of the mitigation plan for this project.

LITERATURE CITED

Bellrose, F.C. and D. J. Holm. 1994. Ecology and management of the wood duck. Stackpole Books, Mechanicsburg, PA. 598pp.

Clark, J.R. and J. Benforado. 1981. Wetlands of bottomland hardwood forests; proceedings of a workshop on bottomland hardwood forest wetlands of the southwestern United States. Lake Lanier, GA. Elsevier Sci. Publ. Co., New York.

Cobb, S.P., C.H. Pennington, J.A. Baker, J.E. Scott. 1984. Fishery and ecological investigations of main stem levee borrow pits along the lower Mississippi River. Lower Mississippi River Environmental Program, Report 1. U.S. Army Corps of Engineers, Mississippi River Commission, Vicksburg, MS.

Federal Emergency Management Agency. 1994. Disaster payment report. Washington, D.C.

Finch, D.M. 1991. Population ecology, habitat requirements, and conservation of neotropical migratory birds. USDA Forest Service, Rocky Mountain Forest and Experiment Station, Fort Collins, CO. GTR-RM-205.

Fredrickson, L.H. 1978. Lowland hardwood wetlands: current status and habitat values for wildlife. Pp. 296-306 In: Greeson, P.E., J.R. Clark, and J.E. Clark. (eds.). Wetland functions and values: the state of our understanding. Am. Water Resour. Assoc., Tech. Publ. 79-2.

Galloway, G.E. 1980. Ex post evaluation of regional water resources development: the case of the Yazoo-Mississippi delta. Institute for Water Resources, U.S. Army Corps of Engineers, Ft. Belvoir, Virginia.

Glasglow, L.L. and R.E. Noble. 1971. The importance of bottomland hardwoods to wildlife. Pages 30-43 In: Proc. Symp. on southeastern hardwoods. Southeastern area, state and private forestry, Forest Service, U.S. Dept. Of Agric.

Guillory, V. 1979. Utilization of an inundated floodplain by Mississippi River fishes. Florida Scientist 42:222-228.

Harris, L.D., R. Sullivan, and L. Badger. 1984. Bottomland hardwoods: valuable, vanishing, and vulnerable. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL.

Holder, D.R. 1970. A study of fish movements from the Okefenokee Swamp into the Suwannee River. Proceedings Southeast Fish and Wildlife Agencies 24:591-608.

Hunter, W.C., D.N. Pashley, and R.E.F. Escano. 1993. Neotropical migratory landbird species and their habitats of special concern within the southeast region. Pages 159-171, In: Finch, D.M. and P.W. Stangel (eds.). Status and Management of Neotropical Migratory Birds. U.S.D.A. For. Serv. Gen. Tech. Rep. RM-229. 422pp.

Interagency Floodplain Management Review Committee. 1994. Sharing the challenge: floodplain management into the 21st century. A report to the Administration Floodplain Management Task Force. Washington, D.C. 191pp w/append.

Lambou, V.S. 1990. Importance of bottomland hardwood-forest zones to fishes and fisheries: the Atchafalaya Basin, a case history. In: Gosselink, J.G. and S. Hamilton (eds.). Ecological processes and cumulative impacts, as illustrated by bottomland hardwood wetland ecosystems. Lewis Publisher, Inc.

MacDonald, P.O., W.E. Frayer, and J.K. Clauser. 1979. Documentation, chronology, and future projections of bottomland hardwood habitat loss in the lower Mississippi Alluvial Plain. Vol. 1, Basic Report, U.S. Fish and Wild. Serv., Vicksburg, MS. 133pp.

Moulton, D.W. 1990. Texas waterfowl habitat: status and needs. Texas Parks and Wildlife Department, Austin, TX. Special staff report

Mueller, A.J., C.R. Loesch, and D.J. Twedt. In press. Development of management objectives for breeding birds in the Mississippi Alluvial Valley. Proceedings of the International Partners in Flight meeting, Cape May, N.J.

Natural Hazards Research and Applications Information Center. 1992. Floodplain management in the United States: An assessment report Vol 1. Prepared for the Federal Interagency Floodplain Management Task Force. University of Colorado at Boulder (Contract No. TV-72105A. 69pp.

Reinecke, K.J., R.C. Barkley, and C.K. Baxter. 1988. Potential effects of changing water conditions on mallards wintering in the Mississippi Alluvial Valley. Pages 325-337 In: Weller, M.W. (ed.). Waterfowl In Winter. Univ. Minn. Press, Minneapolis.

Reinecke, K.J., J.D. Moorhead, J.D. Hodges, and J.R. Nasser. 1989. Mississippi Alluvial Valley. Pages 203-247 In: Smith, L.M., R.L. Pederson, and R.M. Kaminski (eds.). Habitat management for migrating and wintering waterfowl in North America. Texas Tech Univ. Press, Lubbock. 560pp.

Tuttle, J.R. and W. Pinner. 1982. Analysis of major parameters affecting the behavior of the Mississippi River. U.S. Army Engineer, Lower Mississippi Valley Division, Potamology Program report 4, Vicksburg. MS.

U.S. Army Corps of Engineers. 1976. Final environmental impact statement, Mississippi River and Tributaries, Mississippi River Levees and Channel Improvement. Vicksburg, MS. 289pp.

______. 1986. Environmental design considerations for main stem levee borrow areas along the lower Mississippi River. Lower Mississippi River Environmental Program report 4. Vicksburg, MS. 28pp.

______. 1993. Annual flood damage report to Congress for fiscal year 1993. Prepared by the USACE Engineering Division in cooperation with the National Weather Service, Office of Hydrology, Washington, D.C.

______. 1998. Supplement No. 1 to the Final Environmental Impact Statement. Mississippi River Mainline Levees Enlargement And Seepage Control. Vicksburg, MS.

U.S. Fish and Wildlife Service. 1980. Habitat evaluation procedures. 102 ESM, U.S. Fish and Wildlife Service, Washington, D.C.

______. 1981. U.S. Fish and Wildlife Service mitigation policy. Federal Register 46(15): 7644-7663.

______. 1988. The impact of federal programs on wetlands. Volume 1: The lower Mississippi Alluvial Plain and the Prairie Pothole Region. A report to Congress by the Secretary of the Interior. Washington, D.C. 417pp.

Walker, M.D. 1985. Fish utilization of an inundated swamp-stream floodplain. EPA-600/3-85-046.

Welcomme, R.L. 1979. Fisheries ecology of floodplain rivers; as cited in V.W. Lambou. Pages 123-131 In: Proceedings of the international wetland symposium on wetlands and river corridor management, Charleston, S.C. Omnipress, Madison, WI.

Welcomme, R.L. 1985. River fisheries. FAO Fisheries Technical Paper 262.

MISSOURI DEPARTMENT OF CONSERVATION

Headquarters
2901 West Truman Boulevard, P.O. Box 180, Jefferson City, Missouri 65102-0180
Telephone: 573/751-4115 ◆ Missouri Relay Center: 1-800-735-2966 (TDD)

JERRY M. CONLEY, Director

RECEIVED
JUN 01 1998
U.S. FISH & WILDLIFE SERVICE
VICKSBURG, MS

May 26, 1998

Mr. Curtis James
U.S. Fish and Wildlife Service
Vicksburg Field Office
2524 South Frontage Road, Suite B
Vicksburg, Mississippi 39180-5269

Dear Mr. James:

Thank you for providing an opportunity for comment on the Service's Planning Aid Report on the Vicksburg District's Mississippi River Mainline Levee Enlargement and Berm Construction Project. Missouri Department of Conservation staff have reviewed the planning aid document and have the following additions to include in the report's Conclusions and Recommendations section:

> Maintain, as appropriate, wooded riparian corridors around the perimeter of borrow areas to moderate summertime water temperatures and to provide cover and organic nutrients for invertebrates.
>
> Plant native wetland grasses along the bankline of the borrow area to control erosion, serve as a sediment filter, add nutrients and enhance spawning habitat for fish. (Specific plant species may be recommended on an on-site basis to enhance habitats for selected species.)
>
> Maintain 5 to 10% of a borrow area in water 3 to 4 feet deep.
>
> Maintain at least 1 to 2% of the borrow area in water deeper than 6 feet for overwintering resident brood fishes and to allow a permanent fishery.
>
> Borrow areas should be designed to avoid fish entrapment in shallow water. Sinuous borrow areas with islands and excavated deep-water areas increase aquatic edge and diversity.
>
> Borrow areas should be constructed to allow a "hydraulic connection" during a receding hydrograph to allow fish passage from the borrow area to the river.
>
> Cover is an important part of an aquatic system and should be included in the design of borrow areas. We suggest that brush piles, constructed with tree limbs, etc. from timber clearing, be constructed at various depths in the borrow sites.

Again, thank you for providing an opportunity for input, and if you have questions pertaining to our comments, please feel free to contact me at the above address and at 573/751-4115 extension 353.

Sincerely,

Gordon B. Farabee

GORDON B. FARABEE
POLICY SPECIALIST

GBF:vch

c: Joe Garvey, Stan Michaelson, Mark Haas, Mark Boone, Harriet Weger

RECEIVED
JUN 01 1998
U.S. FISH & WILDLIFE SERVICE
VICKSBURG, MS

State of Louisiana

James H. Jenkins, Jr.
Secretary

Department of Wildlife and Fisheries
Post Office Box 98000
Baton Rouge, LA 70898-9000
(504)765-2800

M.J. "Mike" Foster, Jr.
Governor

May 21, 1998

U.S. Fish & Wildlife Service
Vicksburg Field Office
Attn: Curtis James
2524 South Frontage Rd., Ste. B
Vicksburg, MS 39180-5269

Dear Mr James:

Personnel of our technical staff have reviewed the planning aid report on the Mississippi River mainline levee enlargement project prepared by Curtis James in May 1998. The Louisiana Department of Wildlife and Fisheries concurs with the service on this project.

We appreciate the opportunity to review and comment on this project.

Sincerely,

James H. Jenkins, Jr.,
Secretary

JHJ:JD:cgd

APPENDIX 3
SECTION 404(b)(1) EVALUATION

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 3
SECTION 404(b)(1) EVALUATION

Table of Contents

Table of Contents (Cont)

Table of Contents (Cont)

LIST OF TABLES

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX 3
SECTION 404(b)(1) EVALUATION

INTRODUCTION

1. As required by Section 404(b)(1) of the Clean Water Act, this evaluation assesses the short- and long-term impacts associated with the discharge of dredged and fill materials into the waters of the United States resulting from this project.

PROJECT DESCRIPTION

LOCATION

2. The project is within the lower Mississippi River Valley and extends from the Head of Passes on the lower extremity of the Mississippi River to Cape Girardeau, Missouri.

GENERAL DESCRIPTION (PLAN 4)

3. Plan 4 for this project would integrate environmental design measures in the proposed project which would avoid and minimize adverse impacts to wetlands and forested areas. Where practicable, existing landside berms would be rehabilitated using borrow material obtained from dredging sand bars from the Mississippi River. New berms would be constructed using material from riverside and landside borrow areas resulting in the filling of some wetland areas. In some areas, relief well installation would be incorporated to reduce the amount of wetland acres being filled due to berm construction. Levee enlargements would be constructed from materials excavated from existing landside berms requiring rehabilitation and from riverside and landside borrow areas. Proper selection of dredge and borrow sites would be used in the construction of project features minimizing the discharge of these materials into wetlands and into the Mississippi River.

4. Plan 4 is an environmental design which incorporates measures to avoid and minimize environmental damages to bottom-land hardwoods and wetlands. To develop the layout of the plan, interdisciplinary teams of state and Federal agencies representatives, local sponsors, and Corps staff were formed. They initially focused on relocating the construction borrow areas using the following placement prioritization criteria as a guide.

a. Landside cropland from willing sellers.

b. Landside cropland when riverside locations were unavailable.

c. Riverside prior-converted cropland.

d. Riverside tree plantations.

e. Riverside farmed wetlands (cropland).

f. Riverside farmed wetlands (pasture).

g. Riverside herbaceous wetlands.

h. Riverside forested nonwetland.

i. Riverside forested wetland.

j. Landside and riverside bottom-land hardwoods with black bear presence.

k. Landside cropland condemnation.

5. However, as various methods of construction were evaluated for each work item, it became apparent that the prioritization criteria could not be strictly and consistently applied to the entire MRL study area. For example, in the New Orleans District, the area between the top bank of the river and the levee is relatively narrow and often developed, whereas in the Vicksburg District, these areas are relatively wide and undeveloped. Riverside land use in the Vicksburg District is split between cropland and forested, but in the Memphis District, the riverside land use becomes predominantly cropland. Rather than apply the prioritization scheme mechanically, the study team evaluated each individual item and applied the avoid-and-minimize techniques as was most reasonable, considering the environmental, economic, and engineering solutions available for that item.

6. Typical drawings of proposed project features are displayed on plates contained in Appendix 4. Features of the recommended plan subject to the Clean Water Act and addressed in this evaluation are construction activities involving the discharge of dredged or fill material into waters of the United States including forested and farmed wetlands, open water, and sandbars.

PURPOSE AND AUTHORITY

7. Proposed levee enlargement and berm construction features are necessary to maintain the integrity of the Mississippi River levee system. Project authority is the Flood Control Act of 1928. Other applicable Flood Control Acts were passed in 1936, 1938, 1941, 1946, 1950, 1954, 1962, 1965, and 1968.

GENERAL DESCRIPTION OF
DREDGED OR FILL MATERIAL

General Characteristics of Material

8. Fill material used in levee enlargement and berm construction would predominantly consist of clays from borrow areas interbedded with layers of silts and sands and sand from proposed dredge sites within the Mississippi River.

Quantity of Material

9. The total estimated quantity of dredged and fill material that would be deposited into waters (and wetlands) of the United States regulated by Section 404 guidelines is approximately 21,980,000 cubic yards. Table 3-1 presents an estimated quantity of this material by state.

TABLE 3-1
ESTIMATED QUANTITY OF MATERIAL

State	Material (cubic yards)
Arkansas	1,300,000
Illinois	--
Kentucky	--
Louisiana	6,800,000
Mississippi	10,500,000
Missouri	3,300,000
Tennessee	80,000
Total	21,980,000

Source of Material

10. Fill material would be obtained from landside and riverside borrow areas, old setback levees, open water sites, and, where feasible, from sandbars in the Mississippi River.

DESCRIPTION OF THE
PROPOSED DISCHARGE SITES

Location

11. The discharge of fill and dredged material would be at levee enlargement and berm construction sites. Locations of the various project features are displayed in Appendix 4.

Size

12. Wetland acreages impacted by proposed project construction would total approximately 7,328 acres. Tables 3-2 and 3-3 display impacted wetland acreage sandbar and open water by state and U.S. Army Corps of Engineers District, respectively.

TABLE 3-2
WETLAND ACREAGE SANDBAR AND OPEN WATER IMPACTED
BY STATE

State	Forested a/	Farmed b/	Sandbar	Open Water	Total
Arkansas	166	411	0	0	577
Illinois	29	42	0	0	71
Kentucky	0	0	0	0	0
Louisiana	1,816	1,378	0	0	3,194
Mississippi	1,493	925	13	723	3,154
Missouri	187	853	0	0	1,040
Tennessee	0	28	0	0	28
TOTAL	3,691	3,637	13	723	8,064

a/ Includes forested, forested tree plantations, scrub/shrub, herbaceous, and marsh cover types.
b/ Includes cropland, pasture, and urban cover types.

TABLE 3-3
WETLAND ACREAGE IMPACTED
BY CORPS DISTRICT

Corps District	Forested	Farmed	Sandbar	Open Water	Total
Vicksburg	3,428	2,543	13	723	6,707
Memphis	246	1,094	0	0	1,340
New Orleans	17	0	0	0	17
TOTAL	3,691	3,637	13	723	8,064

Types of Sites

13. Sites are located on both cleared and uncleared acreages. Discharge sites include the footprints of levees and berms as well as borrow areas. Where these sites occur in waters of the United States at the time of impact, some areas will be vegetated and some will be disturbed; e.g., farmland.

Types of Habitat

14. Habitat types predominantly include forested and agricultural lands.

Timing and Duration of Discharge

15. Discharge timing would depend on preconstruction planning and construction activities. Presently, construction is scheduled to begin in 1998, and the capability exists to complete construction in 2020. With specific discharges at a discrete site, in most cases no open water discharges would occur for levee or berm construction. Some minimal discharge may occur in open water if any existing borrow areas are used.

DESCRIPTION OF DISPOSAL METHOD

16. The majority of borrow material would be utilized in levee enlargement and berm construction. Minimal discharges into riverside wetlands are anticipated. To the extent practicable, efforts would be made to avoid and minimize adverse impacts to forested wetland areas. Clean fill material would be transported by land-based equipment and dredge. Excess water from dredging operations would be discharged back into the Mississippi River .

FACTUAL DETERMINATIONS

PHYSICAL SUBSTRATE DETERMINATIONS

Substrate Elevation and Slope

17. The mainline flood control levees in the lower Mississippi Valley are founded on the Quaternary alluvium of the Mississippi River system. The flood plain has a typical downstream slope of 0.6 foot per mile. Relief is generally less than 10 feet. The greatest relief is associated with natural levees and point bar ridges. Ground slope ranges from 300 feet, National Geodetic Vertical Datum (NGVD), in the northern part of the valley to sea level on the delta. No significant effects to these existing slopes are anticipated to result from the proposed project.

Sediment Type

18. Soils located within borrow areas are comprised of primarily clay, silt and sand materials. Sediments located on sandbars within the Mississippi River are 95 percent sand.

Dredged/Fill Material Movement

19. Any movement of dredged or fill material would be insignificant. Disturbed areas would be revegetated as soon as possible following construction. No open water discharges which would be subject to current or wave action are expected.

Physical Effects on Benthos

20. Deposition of dredged or fill material into wetland areas would occur during the excavation and placement of borrow material during levee enlargement and berm construction. Benthic organisms adjacent to these sites will be affected by construction operations. However, these

organisms would be expected to recolonize after borrow operations have been completed. In addition, benthic organisms would establish in the newly constructed borrow areas that would be created by this project.

Actions Taken to Minimize Impacts

21. Disturbed areas would be revegetated as soon as practical. Materials to be discharged are similar to the substrate at discharge sites. Open water discharge would be avoided to the extent possible. Wetlands and other waters would be avoided to the extent practicable in the design and construction of each item of work.

WATER CIRCULATION, FLUCTUATION,
CHEMICAL, AND PHYSICAL DETERMINATIONS

Water

22. Water quality impacts resulting from project construction would primarily be short term and localized. Dredging operations conducted in the Mississippi River would result in localized increases in turbidity and suspended solids within the vicinity of the dredge. Increased turbidity and suspended solids levels would be expected to return to preconstruction levels soon after dredging operations are completed. The impacts to water quality at discharge sites are expected to be insignificant since most work will occur in the dry.

23. Excavation at borrow areas would result in localized increases in turbidity and suspended solids adjacent to excavation operations. Increased turbidity levels and suspended solids would be expected to return to preconstruction levels upon completion of excavation operations.

24. Water quality within newly constructed borrow areas would be affected by the soil concentrations of the surrounding area and from flushing the effects from seasonal high-water fluctuations on the Mississippi River. Landside borrow sites are located primarily in agricultural areas and would be affected by residual soil nutrient and pesticide loadings. Landside borrow areas would not experience flushing effects from seasonal high-water fluctuations on the Mississippi River.

a. Salinity. No impacts to existing salinity conditions are anticipated.

b. Water chemistry. As reported in the Water Quality Analysis (Appendix 17), water quality within the Mississippi River and existing riverside borrow areas is of good quality. Dredge and fill operations associated with this project are not anticipated to significantly affect the water chemistry of either the Mississippi River or the existing borrow areas. Newly constructed borrow areas would be affected by the surrounding soil conditions. After new borrow areas become established and an equilibrium condition is reached, the water quality of the newly constructed riverside borrow areas is anticipated to be similar to those of the existing borrow areas.

c. Clarity. Increased turbidity and suspended solids levels would reduce surface water clarity during placement of dredged and fill material. This would be a temporary and localized condition. Clarity would return to pre-existing conditions shortly after proposed construction activities.

d. Color. Any changes in water color would be temporary and minor.

e. Odor. Construction operations would result in the release of odors otherwise contained. However, this condition is not expected to be hazardous and would be localized and short-lived.

f. Taste. No potable water intakes are known to exist in the immediate vicinity of the proposed discharge sites.

g. Dissolved gas levels. As reported in the Water Quality Analysis (Appendix 17), water quality within the Mississippi River and existing riverside borrow pits is considered good. Impacts to dissolved oxygen levels are anticipated at the cutterhead of the dredge. This would result in decreases in dissolved oxygen as a direct response to increases in suspended solids and turbidities. Based on previous dredging operations on the Mississippi River, decreases in dissolved oxygen levels should not fall below the recommended minimum criteria of 5.0 mg/l. Dissolved oxygen levels would return to preconstruction levels following completion of proposed dredging activities.

h. Nutrients. The surface waters and sediments within the borrow areas are rich in nutrients, especially nitrogen and phosphorous. Sediment disturbance during construction would cause temporary increases in nutrient levels. However, such increases would be of short duration and nutrient levels would return to preconstruction levels following completion of proposed construction activities.

i. Eutrophication. Some short-term and localized increases in turbidity, sedimentation, and nutrient levels would occur during the discharge of dredged and fill materials. However, surface waters and sediments within borrow areas and at discharge sites are presently nutrient-rich (especially in nitrogen and phosphorous). Therefore, no net increases or decreases in nutrient loadings are anticipated due to project construction. No significant changes in the eutrophic state are anticipated.

j. Current pattern and circulation. No significant impacts to existing river current or water circulation patterns in adjacent waters are anticipated.

k. Velocity. No changes in velocities within the Mississippi River are anticipated resulting from proposed dredging operations. Water velocities within borrow areas would not be impacted.

l. Stratification. Only borrow areas which are increased in size are likely to be impacted with regards to stratification. Short-term increases in turbidity are likely to occur during excavation and filling operations. This may affect water temperatures near construction areas. Since stratification is primarily dependent on temperature, short-term impacts in stratification are likely to occur during excavation and filling operations. Any impacts resulting in a change in stratification processes would be minor and temporary.

m. Hydrologic regime. The hydrologic regime would not be significantly impacted as a result of project construction. The addition of new borrow areas and/or increasing existing borrow areas would provide for additional water storage. Berm construction would result in the filling of some wetland areas which would result in a reduction of water storage. No changes in existing drainage patterns which would result in a change in the hydrologic regime of the project area are anticipated.

n. Normal water level fluctuation. Normal water level fluctuations are influenced primarily by stages on the Mississippi River. Since project construction would not affect river stages, no impacts to normal water level fluctuations are anticipated, except where wetlands are filled for berm/levee construction.

o. Salinity gradients. Not applicable.

Actions That Will Be
Taken to Minimize Impacts

25. The adverse impacts to water quality associated with removal of vegetation would be minimized by seeding disturbed areas after construction. The Corps will implement stormwater runoff measures in accordance with appropriate state laws and regulations.

SUSPENDED PARTICULATE/
TURBIDITY DETERMINATIONS

26. The temporary effects of clearing, filling, and/or dredging associated with the proposed project construction would be increases in soil erosion and/or turbidity. Eroded material from areas excavated for borrow may be transported into nearby drainage ways. Additionally, Mississippi River areas subject to dredging would experience short-term and localized increases in suspended particulates and turbidity levels.

a. Light penetration. Short-term reductions in light penetration are likely to occur during the excavation of borrow areas, construction of berms in wetland areas, and within the Mississippi River during dredging operations. These reductions in light penetration are anticipated to be short term and localized to the area adjacent to construction operations. Light penetration levels should return to preconstruction levels soon after construction is completed.

b. Dissolved oxygen (DO). As stated earlier, impacts to dissolved oxygen resulting from increases in suspended particulate matter are anticipated in the vicinity of the cutter head of the dredge and adjacent to excavation and filling operations. Presently, DO levels within existing borrow areas and the Mississippi River meet standards. It is anticipated that excavation within borrow areas and the construction of berms within wetland areas would be conducted along borrow area perimeters. Increases in suspended solids and turbidity will occur adjacent to these sites resulting in short term and localized reductions in dissolved oxygen. The decreases in DO will only occur during construction operations and are not anticipated to fall below state minimum standards of 5.0 mg/l.

c. Toxic metals and organisms. As reported in the Water Quality Analysis (Appendix 17), trace metals were evaluated within the project area. Results of the metal analysis of sediment samples collected within existing borrow areas indicated elevated levels of arsenic, cadmium, mercury and nickel were in surface sediments. No water samples evidenced elevated levels of these metals. Fish tissue analysis indicated mercury levels in fish taken from riverside borrow areas are generally low. Of over 100 fish tested, only two fish had mercury levels above 0.5 mg/kg. None of the fish samples reported any mercury concentrations above the Food and Drug Administration action level of 1.0 mg/kg. Fish tissue data reported in Appendix 17 indicate that the fisheries within borrow areas are not impacted by any of these trace metals.

d. Pathogens. While coliform and enterococci bacteria may be present in project waters, project construction would not affect this condition.

e. Esthetics. For dredging in the Mississippi River, given the nature of the material to be dredged (sand), any turbidity plumes created would be intermittent and localized to a short distance downstream of the dredge. If plumes are created by the effluent return from contained areas, they would not likely exceed 1,000 feet from the point of return. Material utilized for levee and berm construction would be seeded with grasses. Approximately 3,041 acres of borrow areas would be reforested. The remaining borrow areas would stabilize in a relatively short period of time. Adverse impacts to esthetics would be temporary and minor since the construction and borrow areas would resemble the surrounding levee, berms, and forested wetlands in time.

f. Pesticides. Pesticide analysis conducted on water samples from 17 existing borrow areas did not detect any pesticides above trace amounts in any borrow area. Trace amounts of three pesticides (G-BHC, endosulfan sulfate and heptachlor epoxide) were detected in three borrow areas. Detection of pesticides in sediment samples was also infrequent. Trace amounts of pesticides were detected in 17 of 29 samples taken from 24 sites. Trace amounts of aldrin, delta-BHC, ppDDD, ppDDT, heptachlor, dieldrin, endrin aldehyde and heptachlor epoxide were detected within at least one borrow site indicating the persistence of these pesticides. The primary source of these pesticides is from nonpoint sources of runoff from agricultural practices in the lower Mississippi Valley. Based on the levels of ppDDE reported in the landside borrow area, it is likely that some moderate biological effects may occur as a result of this pesticide present in the sediment.

g. Effects on biota. Periodic reduction in light transmissions as a result of erosion associated with construction would reduce photosynthesis and primary production to a minor degree in portions of aquatic areas; i.e., construction within existing borrow areas and portions of the Mississippi River. It is anticipated that new borrow areas created during this project will develop similarly to those present within the project area.

h. Suspension/filter feeders. Larval and juvenile forms of suspension and filter feeding organisms would be adversely affected on a localized basis. Adult filter feeders are capable of withstanding temporary increases in suspended particulates and can recover from minor amounts of new sediment deposits (U.S. Army Engineer Waterways Experiment Station, Dredged Material Research Program).

i. Sight feeders. No significant effects. These organisms are generally highly mobile and would avoid or escape any areas of high turbidity.

j. Actions taken to minimize impacts. Disturbed areas would be revegetated as soon as possible following construction. Discharges will take place in the dry as much as possible.

CONTAMINATION DETERMINATIONS

27. Based on the analysis performed and documented in Appendix 17 and within this evaluation, the risk of contamination of waters resulting from the placement of dredged material and borrow material into waters located within the project area is low. As reported earlier, the water quality within the Mississippi River and existing riverside borrow pits is of good quality and meets current water quality standards. Dredging and filling operations associated with this project are not anticipated to significantly affect the water chemistry of the Mississippi River, existing borrow areas, or wetlands affected by placement of dredged or fill material.

28. Fish tissue analysis indicated that mercury levels reported from fish taken from riverside borrow areas are generally low. Of over 100 fish tested, only two fish reported mercury levels above 0.5 mg/kg. None of the fish samples reported any mercury concentrations above the FDA action level of 1.0 mg/kg. Pesticides were not detected above trace amounts in any of the water samples collected except for one sample collected in a landside borrow site. Only pesticides; e.g., ppDDE which was reported in a landside borrow area, are likely to cause fishery problems in riverside borrow areas.

AQUATIC ECOSYSTEM AND
ORGANISM DETERMINATIONS

Effects on Plankton

29. Any existing plankton in the immediate area of dredging and discharge of dredged and fill material would be adversely impacted due to elevated turbidity levels. However, these impacts would be localized and short-term. Those waters and wetlands to be filled by levee enlargement and berm construction would, unavoidably, no longer be available for use by plankton.

Effects on Benthos

30. Some benthic organisms would be adversely impacted by deposition of fill material. Those waters and wetlands to be filled by levee enlargement and berm construction would, unavoidably, no longer be available for use by benthic organisms.

Effects on Nekton

31. No direct impacts are expected on free-swimming animals. Those waters and wetlands to be filled by levee enlargement and berm construction would, unavoidably, no longer be available for use by nekton.

Effects on Aquatic Food Web

32. The aquatic food web would, unavoidably, be adversely impacted due to the loss of 3,691 acres of forested wetlands, 3,637 acres of farmed wetlands, and 13 acres of sandbar and the proposed project's short-term impact on 723 acres of open water.

Effects on Special Aquatic Sites

33. The Mississippi River from Cairo, Illinois, to Head of Passes, Louisiana, along with associated oxbow lakes and borrow areas, comprises a major aquatic resource in the project area. Any project-induced impacts; e.g., increased erosion during construction, would be minor and temporary.

a. Wetlands. Approximately 3,691 acres of forested wetlands and 3,637 farmed wetlands would be impacted by the project. Wetland acreage impacted by state is depicted in Table 3-2.

b. Mudflats. Not applicable.

c. Vegetated shallows. Not applicable.

d. Coral reefs. Not applicable.

e. Riffle and pool complexes. Not applicable.

f. Threatened and endangered species. The U.S. Fish and Wildlife Service advised by letter, 28 August 1997, that their records indicate the following Federally listed species may occur in the project area--the pallid sturgeon (Scaphirynchus albus), flat pocketbook pearly mussel (Potamilus capax), interior least tern (Sterna antillarum), bald eagle (Haliaeetus leucocephalus), woodstork (Mysteria americana), and Louisiana black bear (Ursus americanus lutealus). The Corps prepared an Endangered Species Biological Assessment (BA) (Appendix 11) that evaluated the potential effects of the proposed project on these species. The BA concluded that the project would not likely impact the species in question. The U.S. Fish and Wildlife Service has concurred with the "no effect" determination.

g. Other wildlife. Wildlife wetland habitat and associated wildlife would experience unavoidable adverse impacts due to loss of this habitat. Because of environmental design of borrow areas and planned mitigation, although this habitat will be altered and temporarily reduced, similar habitat will replace it.

h. Actions to minimize impacts. Environmental design features have been incorporated in the proposed project design. These features include the following:

(1) Riverside borrow areas. Some of these borrow areas would be drained and reforested. This would reduce the loss of forested wetlands in the project area. Table 3-4 depicts the reforestation of borrow area acreages by state.

TABLE 3-4
REFORESTATION OF BORROW AREA
BY STATE

State	Acres to Reforest (Plan 4)
Arkansas	228
Illinois	0
Kentucky	0
Louisiana	643
Mississippi	1,572
Missouri	598
Tennessee	0
TOTAL	3,041

(2) Landside borrow areas. Create borrow areas that are deep and that have steep sides. This avoids terrestrial habitat and the riverside wetlands and minimizes impacts to forested areas.

(3) Utilize dredge at some locations to provide fill material. Sand fill material obtained from the Mississippi River (dredge sites indicated in Table 3-5) would be utilized for berm construction at selected sites. This would minimize impacts to terrestrial habitat and forested wetlands.

TABLE 3-5
SAND BORROW MATERIAL DREDGE SITES

State	River Mile	Open Water Acres	Sand Acres
Mississippi	486-L	161	
	490-L	125	13
	493-L a/	103	
	495-L, 497-L, and 498-L a/	334	

a/ Items 493-L and 498-L have been combined with Items 495-L and 497-L and renamed 496-L.

(4) Utilize relief wells where possible. In lieu of constructing earthen berms, relief wells would be utilized, where possible. This would significantly reduce the areas of terrestrial habitat impacted.

34. As indicated in Table 3-2, wetland acreage that would be impacted is 3,691 acres of forested wetlands; 3,637 acres of farmed wetlands; 13 acres of sandbar; and 723 acres of open water. Reforestation of 5,863 acres of agricultural lands would be necessary to achieve a no net loss wetland functional value. The preferred method of acquisition would be by fee title; however, other methods such as use of public lands and easements on private lands, etc., would be considered on a case-by-case basis in coordination with other Federal, state, and local agencies.

PROPOSED DISPOSAL
SITE DETERMINATIONS

Mixing Zone Determinations

35. Mixing zones will be less than 1,000 feet. No water quality criteria should be exceeded by the discharges. Return effluent from material dredged for berm construction will be returned to the Mississippi River using existing drainage ditches.

Determinations of Compliance with
Applicable Water Quality Standards

36. Changes to water quality conditions as a result of this project are not anticipated to cause long-term changes in the existing water quality within the project area. The water quality within the project area is in compliance with current water quality standards. Only temporary, short-term impacts to water quality are anticipated as a direct result of project construction. These impacts include temporary increases in suspended solids and increases in turbidity levels which would occur only during and adjacent to construction operations.

Potential Effects on Human
Use Characteristics

37. Municipal and private water supply. No significant effects.

38. Recreational and commercial fisheries. Approximately 6,727 acres of aquatic habitat would be created (predominantly on private lands). This would provide limited additional opportunities for fishing.

39. Water-related recreation. Recreational activities would be temporarily curtailed in the vicinity of the proposed discharge sites during project construction. Temporary increases in turbidity and suspended sediments during dredging and construction activities would adversely impact recreational fishing downstream of discharge sites. These impacts would be localized and occur only during actual construction.

Determination of Cumulative
Effects on the Aquatic Ecosystem

40. The requirement for deposition of fill material during construction would add a relatively minimal amount of pollutants to the proposed project area's ecosystem. Pollutants would primarily be in the form of temporarily increased sediment loads that would result in minor

increases in both suspended solids and turbidity. The proposed construction would impact 7,341 acres of wetlands, create 6,727 acres of fishery habitat, and result in the reforestation of 5,863 acres of agricultural land.

Determination of Secondary
Effects on the Aquatic Ecosystem

41. Secondary impacts on the aquatic ecosystem would be minimal.

FINDING OF COMPLIANCE FOR FLOOD CONTROL

42. No significant adaptations of the Section 404(b)(1) guidelines were made relative to this evaluation.

43. Deposition of fill material associated with construction requirements for the Mississippi River and Tributaries Project, Mississippi River Mainline Levee Enlargement and Berm Construction Project, would adversely impact 3,691 acres of forested wetlands and 3,637 acres of farmed wetlands. Additionally, fill material dredged from the Mississippi River would impact an estimated 723 acres of open water and 13 acres of sandbar. The proposed project features were designed to avoid to the extent practicable, wetlands and waters of the United States. Incorporated into the project's design were avoid, minimize, and environmental design measures that will lessen adverse impacts to wetlands. Project-induced adverse impacts to important wetlands would be fully compensated.

44. The planned deposition of fill material would not violate any applicable State Water Quality Standards. Further, the planned fill action would not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

45. No endangered species or their critical habitat will be adversely impacted by the planned action (refer to section describing Endangered Species Act compliance).

46. The proposed deposition of fill material would not result in unacceptable adverse effects on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. Further, the proposed discharges would not result in unacceptable adverse effects on the life stages of aquatic or semiaquatic organisms, the aquatic ecosystem, diversity, productivity, stability, recreation and esthetic resources, and economic values.

47. Appropriate steps to minimize potential adverse impacts of the fill action on aquatic systems include cessation of fill activities during extreme flood events and avoidance of discharges into open water where possible.

48. On the basis of the Section 404(b)(1) guidelines, the proposed sites for the deposition of dredged and fill material are specified as complying with the requirements of these guidelines.

APPENDIX 4
PLATES

MISSISSIPPI RIVER AND TRIBUTARIES PROJECT
MISSISSIPPI RIVER MAINLINE LEVEES
ENLARGEMENT AND SEEPAGE CONTROL
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

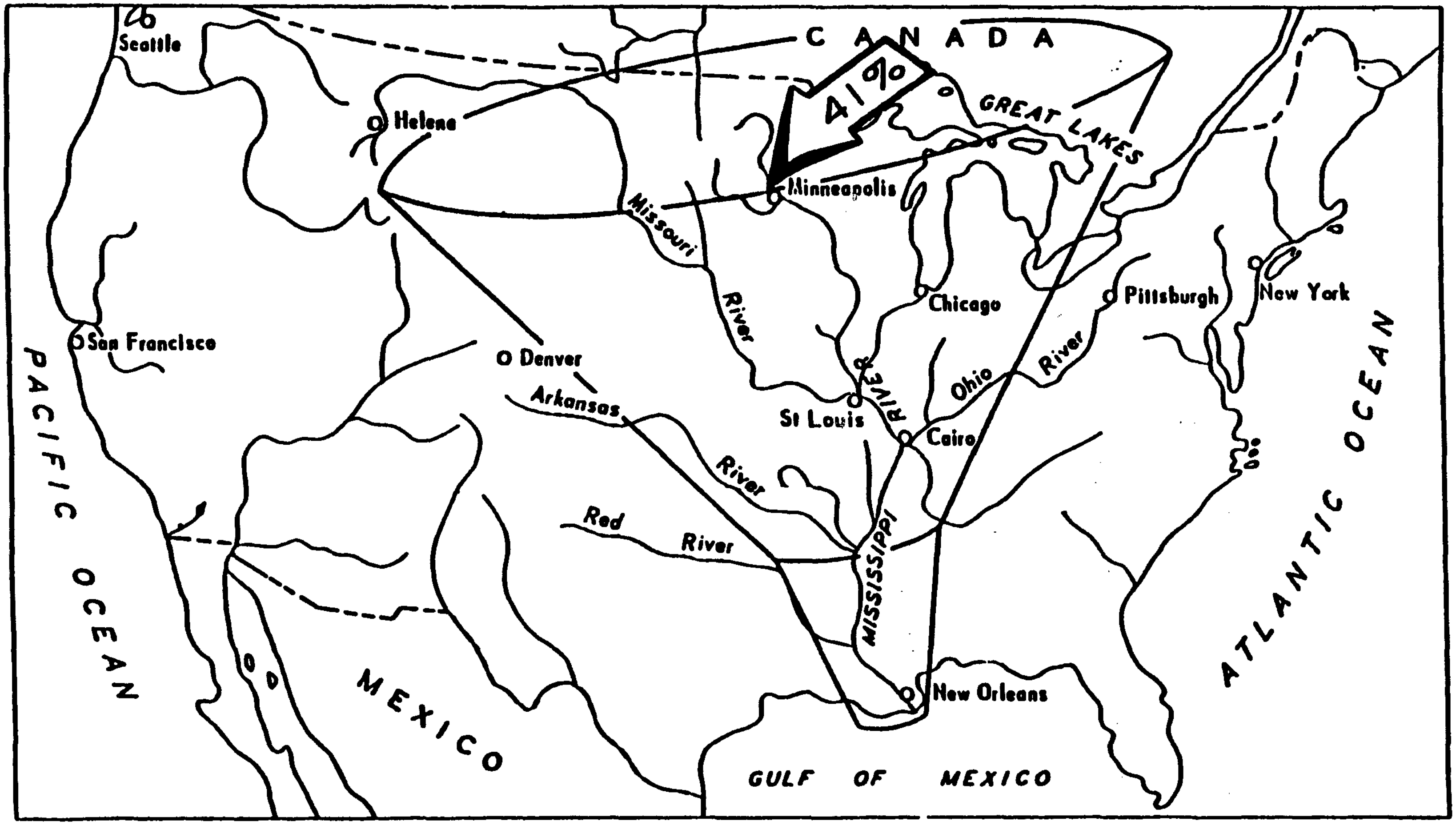
APPENDIX 4
PLATES

Table of Contents

LIST OF PLATES

Table of Contents (Cont)

LIST OF PLATES (Cont)



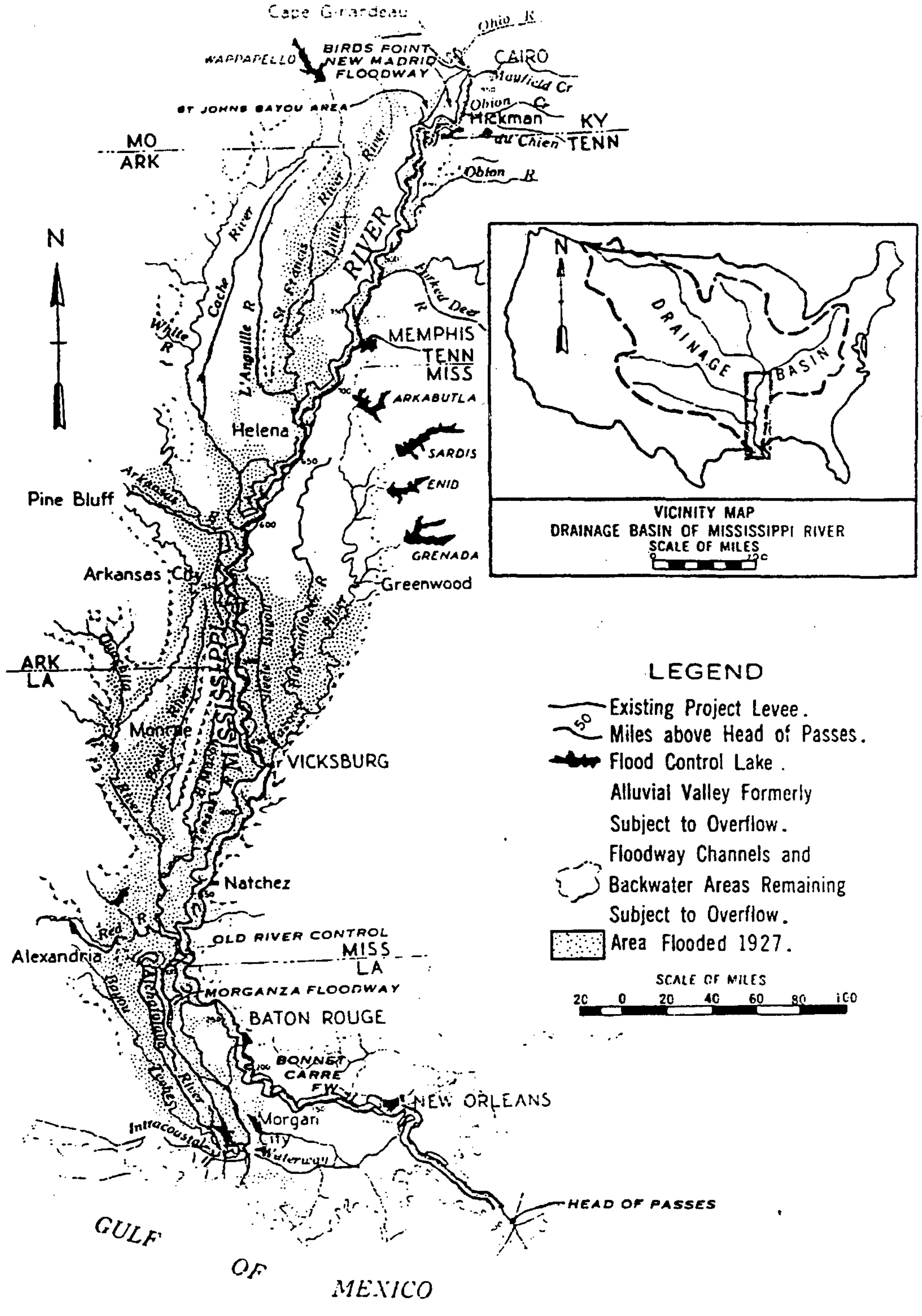
THE MISSISSIPPI RIVER CARRIES WATER FROM 41 PERCENT OF THE 48 CONTIGUOUS STATES OF THE UNITED STATES

MISSISSIPPI RIVER LEVEE PROJECT

Mississippi River Drainage Basin

Vicksburg District
Corps of Engineers

Plate 1

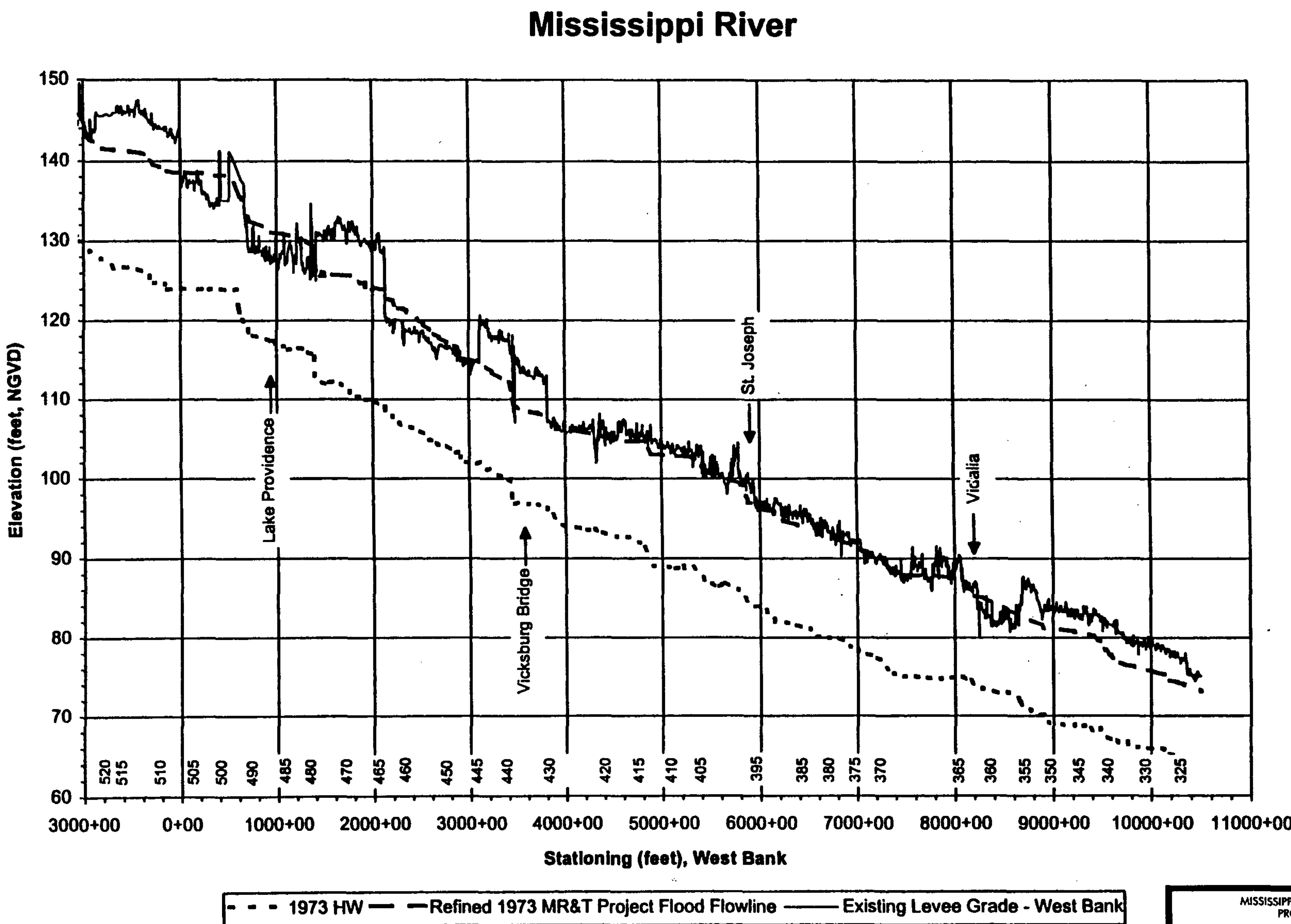


ALLUVIAL VALLEY OF THE MISSISSIPPI RIVER

MISSISSIPPI RIVER LEVEE PROJECT

Location and Vicinity Map
Mississippi River and Tributaries Project

Corps of Engineers



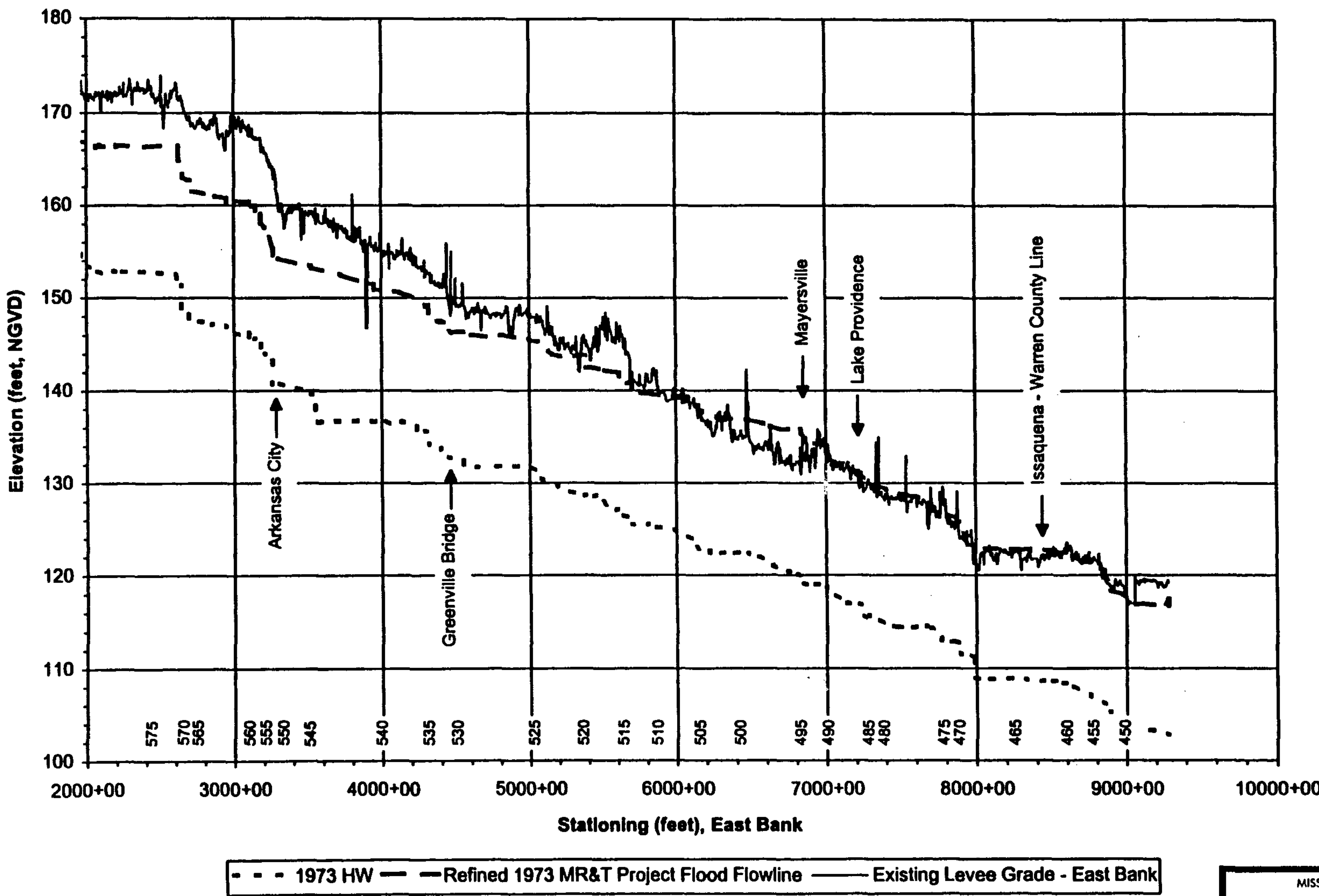
MISSISSIPPI RIVER LEVEE PROJECT

Water Surface and Levee Profiles West Bank

Vicksburg District Corps of Engineers

Plate 5a

Mississippi River



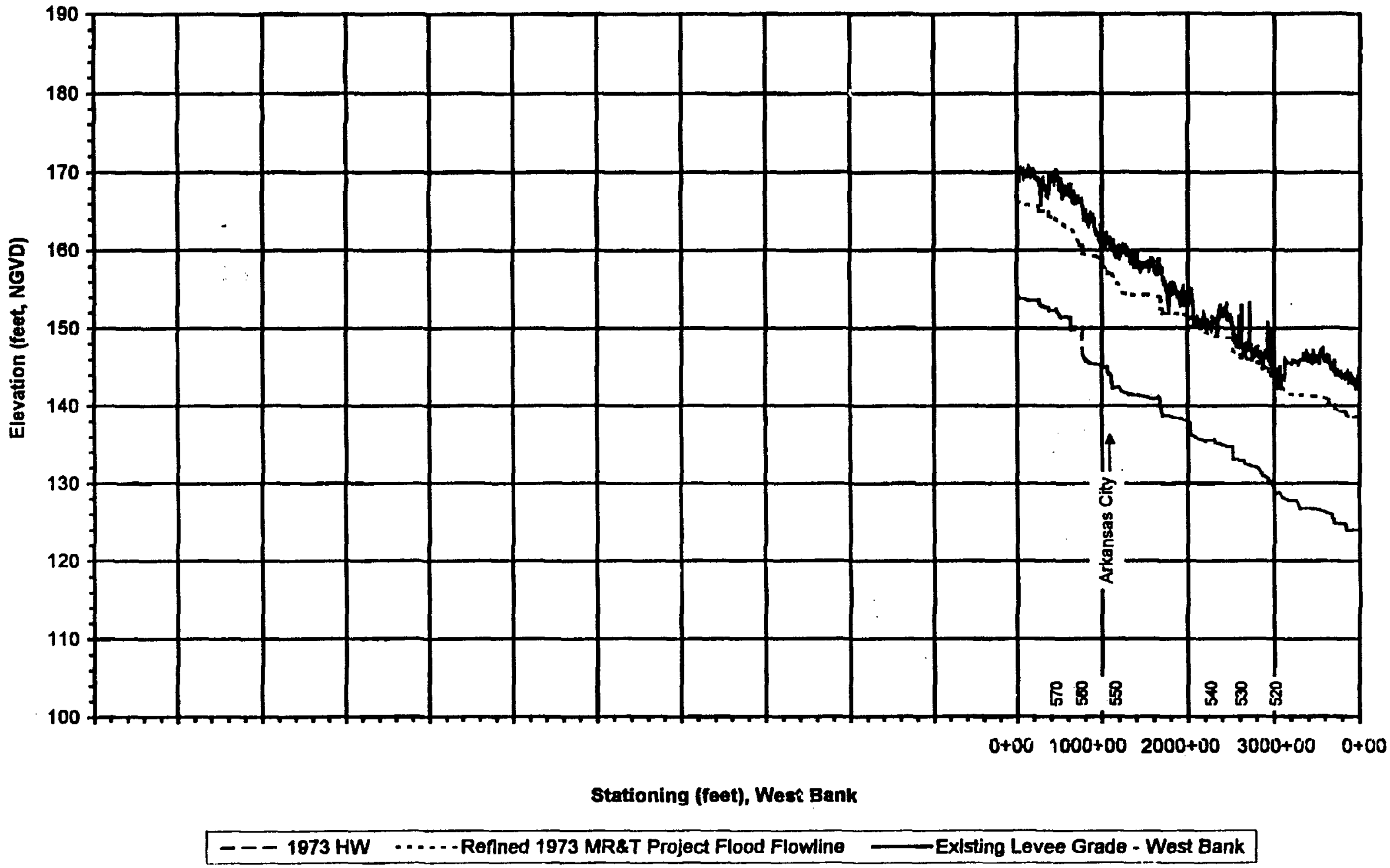
MISSISSIPPI RIVER LEVEE PROJECT

Water Surface and Levee Profiles East Bank

Vicksburg District Corps of Engineers

Plate 3b

Mississippi River

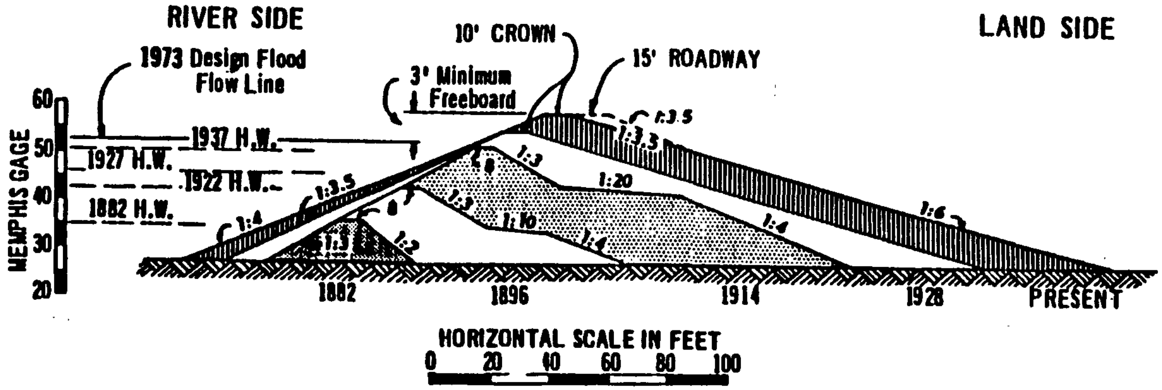


MISSISSIPPI RIVER LEVEE PROJECT

Water Surface and Levee Profiles West Bank

Vicksburg District
Corps of Engineers

Plate 3c



DIMENSIONS OF CROSS SECTIONS

YEAR	HEIGHT FEET	BASE WIDTH FEET	AREA SQ. FEET
1882	9.0	53.0	274
1896	15.5	120.5	951
1914	24.0	200.0	2455
1928	27.0	260.0	3645
PRESENT	30.5	315.0	4956

SCHEMATIC SHOWING INCREASE IN SIZE OF LEVEE FROM 1882 TO PRESENT

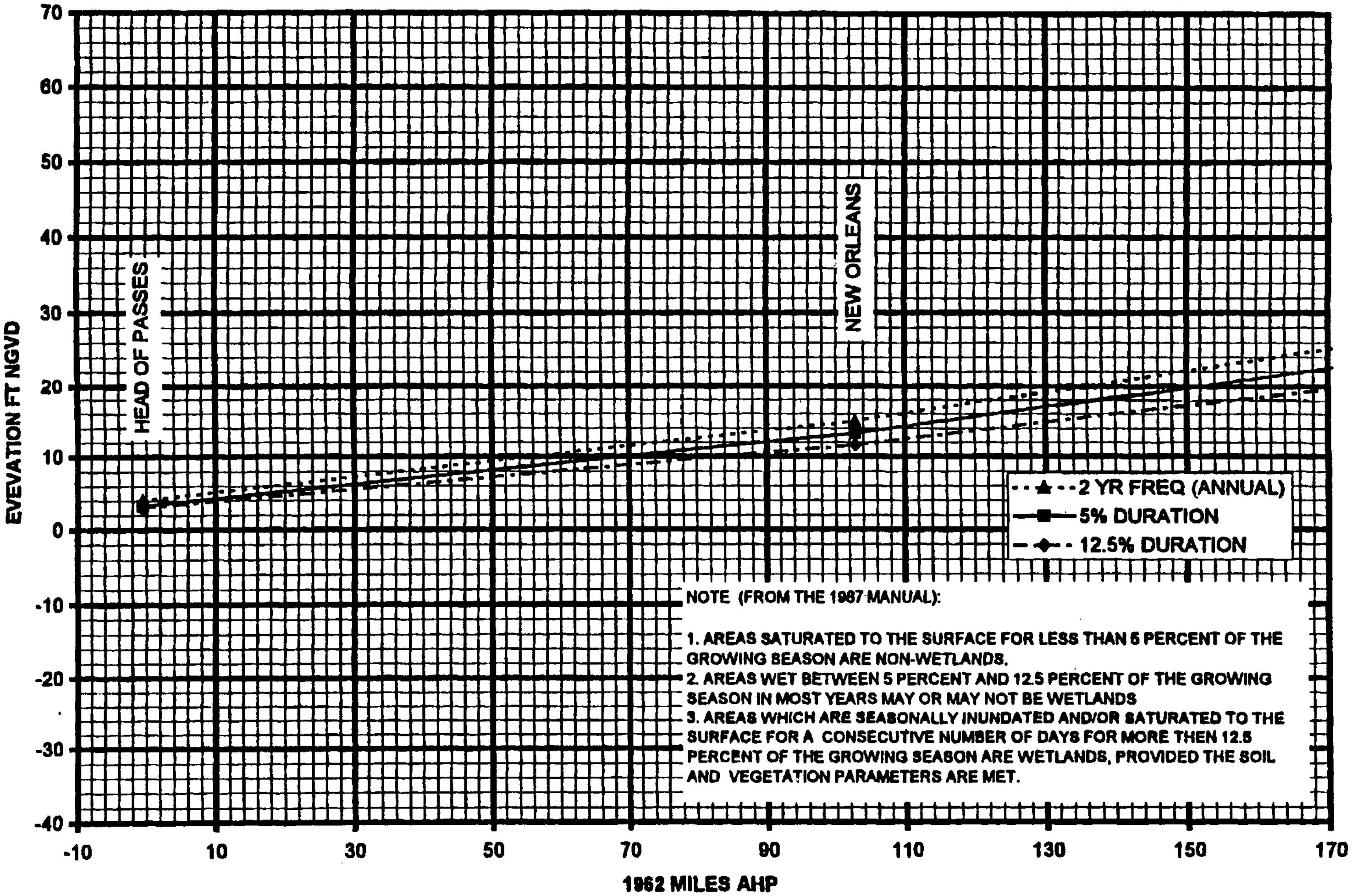
MISSISSIPPI RIVER LEVEE PROJECT

Levee Enlargement History

Vicksburg District
Corps of Engineers

Plate 4

MISSISSIPPI RIVER PROFILES



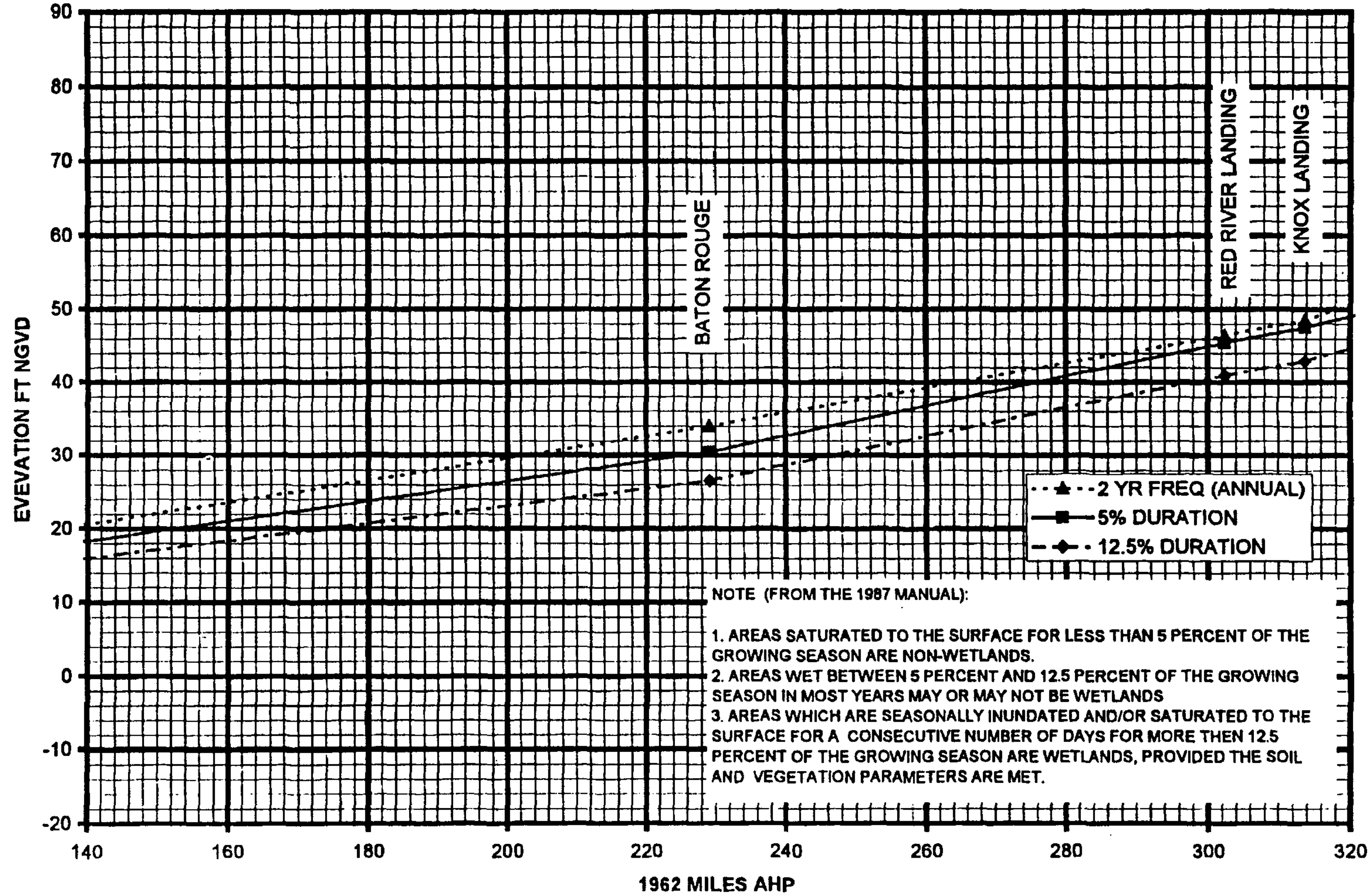
MISSISSIPPI RIVER LEVEE PROJECT

Limits of Wetlands,
5% and 12.5% Duration
(Growing Season) Profiles

Vicksburg District
Corps of Engineers

Plate 5a

MISSISSIPPI RIVER PROFILES



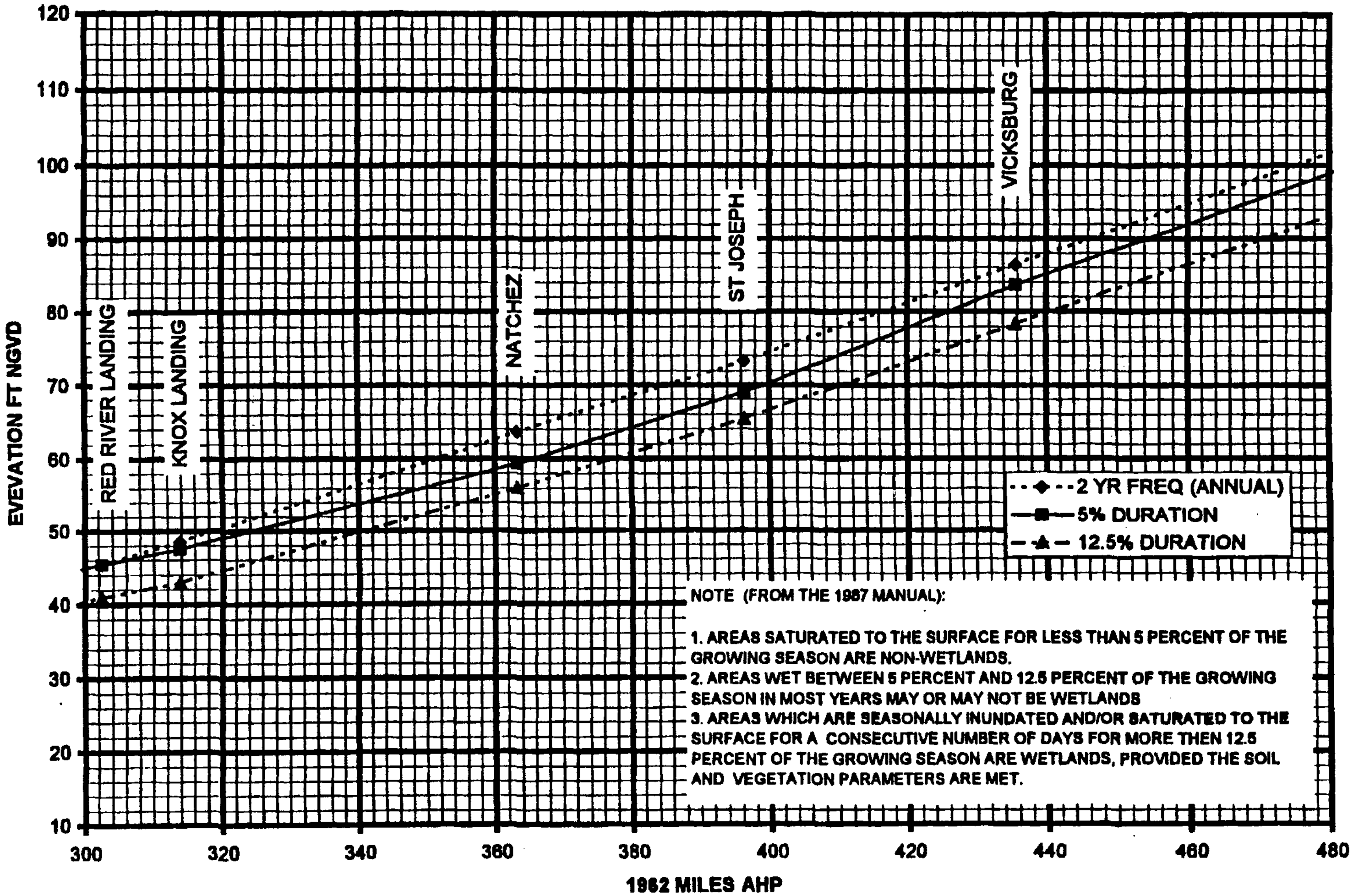
MISSISSIPPI RIVER LEVEE PROJECT

Limits of Wetlands, 5% and 12.5% Duration (Growing Season) Profiles

Vicksburg District
Corps of Engineers

Plate 5b

MISSISSIPPI RIVER PROFILES



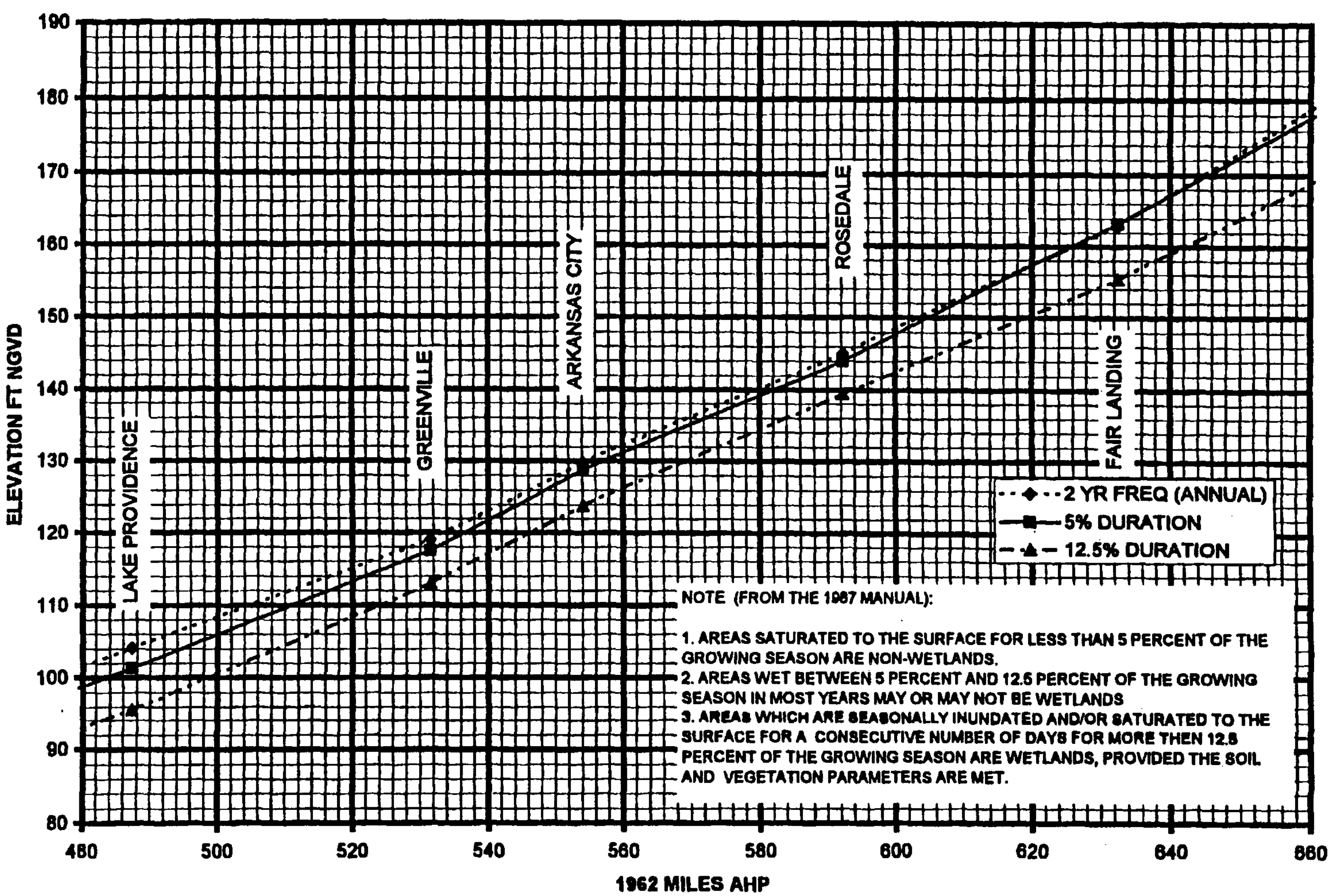
MISSISSIPPI RIVER LEVEE PROJECT

2 Year Frequency, 5% and 12.5% Duration (Growing Season) Profiles

Vicksburg District
Corps of Engineers

Plate 6c

MISSISSIPPI RIVER PROFILES



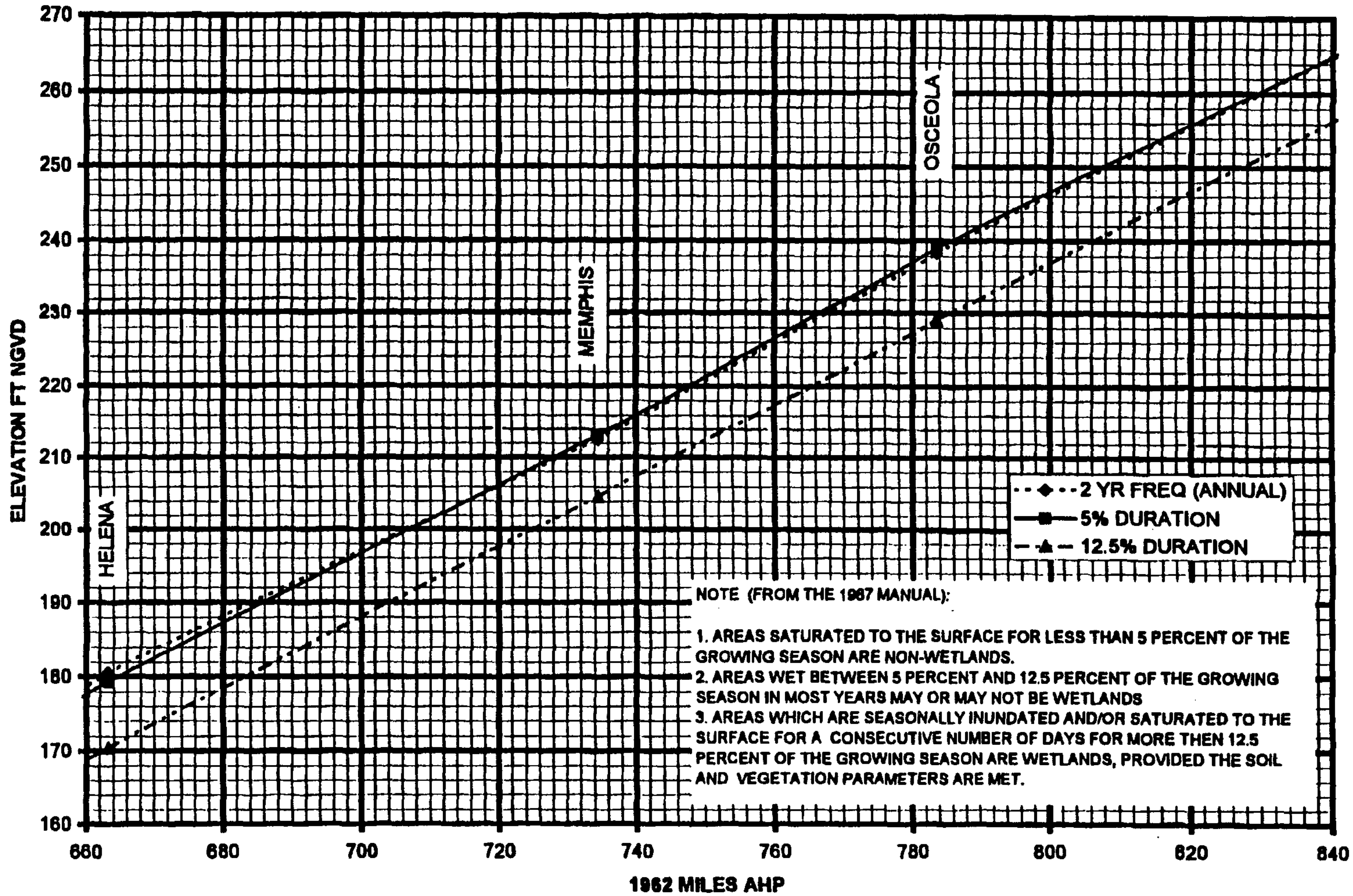
MISSISSIPPI RIVER LEVEE PROJECT

2 Year Frequency, 5% and 12.5% Duration (Growing Season) Profiles

Vicksburg District
Corps of Engineers

Plate 5d

MISSISSIPPI RIVER PROFILES



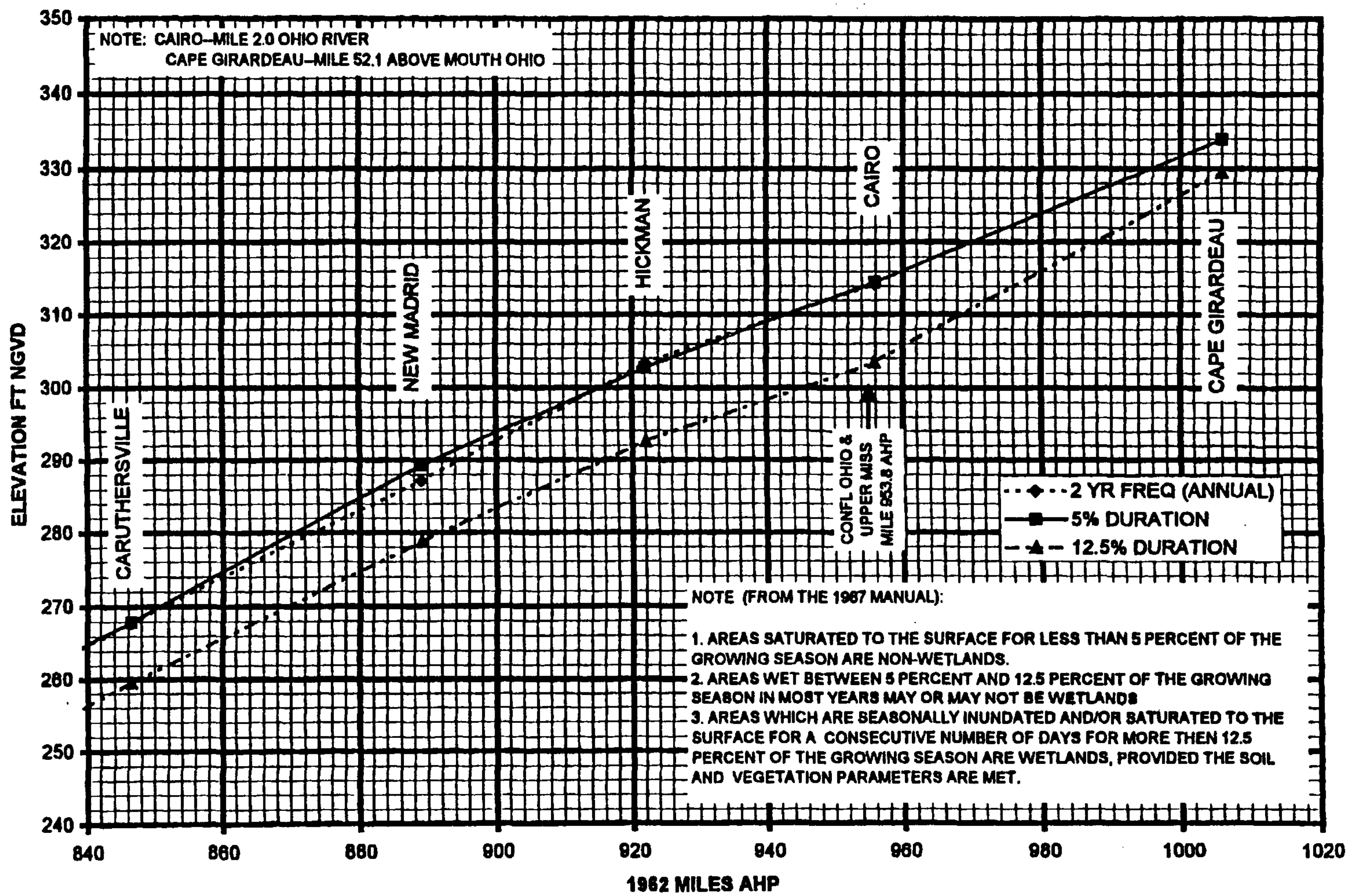
MISSISSIPPI RIVER LEVEE PROJECT

2 Year Frequency, 5% and 12.5% Duration (Growing Season) Profiles

Vicksburg District
Corps of Engineers

Plate 6e

MISSISSIPPI RIVER PROFILES



NOTE (FROM THE 1987 MANUAL):

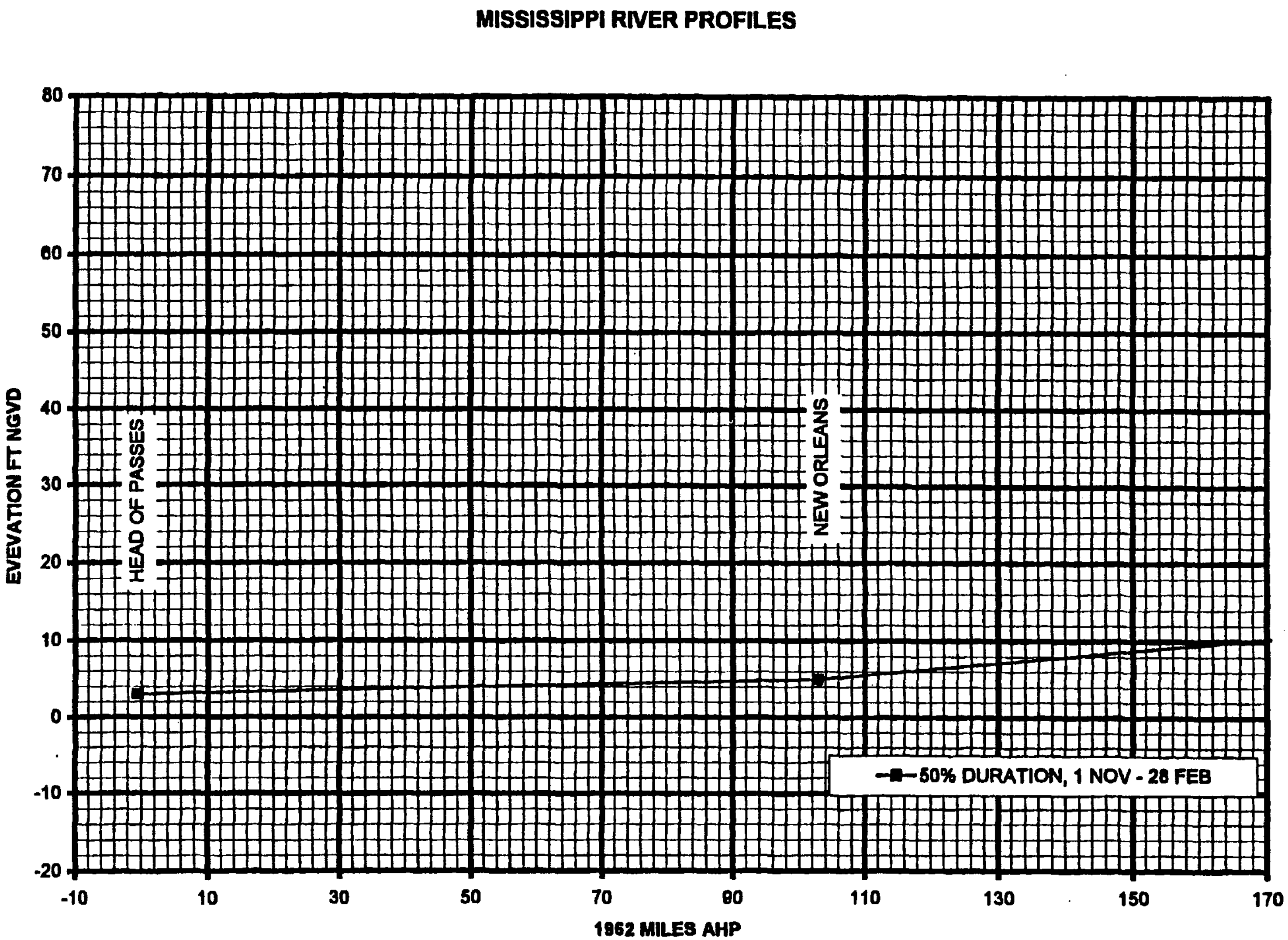
1. AREAS SATURATED TO THE SURFACE FOR LESS THAN 5 PERCENT OF THE GROWING SEASON ARE NON-WETLANDS.
2. AREAS WET BETWEEN 5 PERCENT AND 12.5 PERCENT OF THE GROWING SEASON IN MOST YEARS MAY OR MAY NOT BE WETLANDS
3. AREAS WHICH ARE SEASONALLY INUNDATED AND/OR SATURATED TO THE SURFACE FOR A CONSECUTIVE NUMBER OF DAYS FOR MORE THEN 12.5 PERCENT OF THE GROWING SEASON ARE WETLANDS, PROVIDED THE SOIL AND VEGETATION PARAMETERS ARE MET.

MISSISSIPPI RIVER LEVEE PROJECT

2 Year Frequency, 5% and 12.5% Duration (Growing Season) Profiles

Vicksburg District
Corps of Engineers

Plate 6



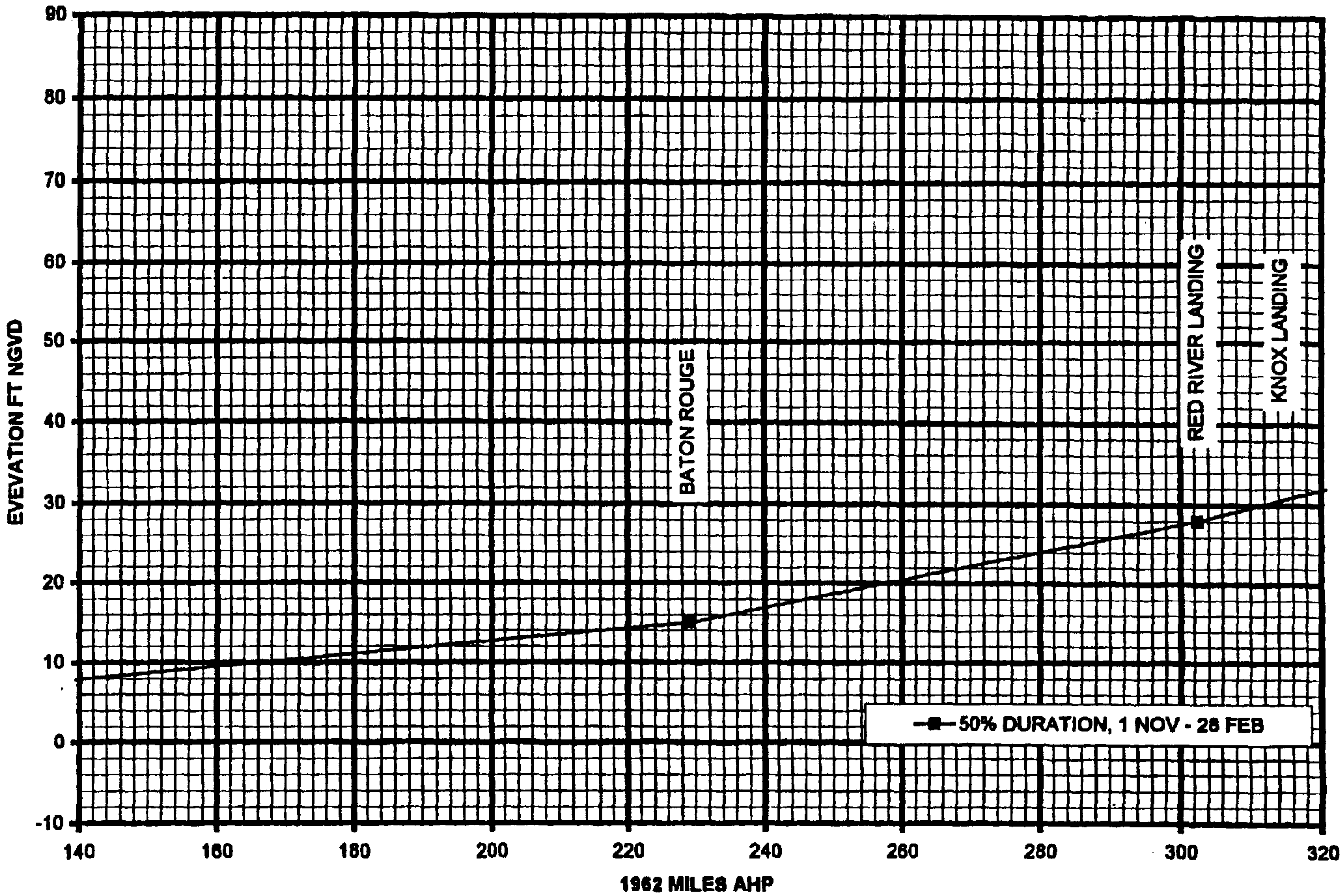
MISSISSIPPI RIVER LEVEE PROJECT

50 % Duration (November--February) Profile

Vicksburg District
Corps of Engineers

Plate 6a

MISSISSIPPI RIVER PROFILES



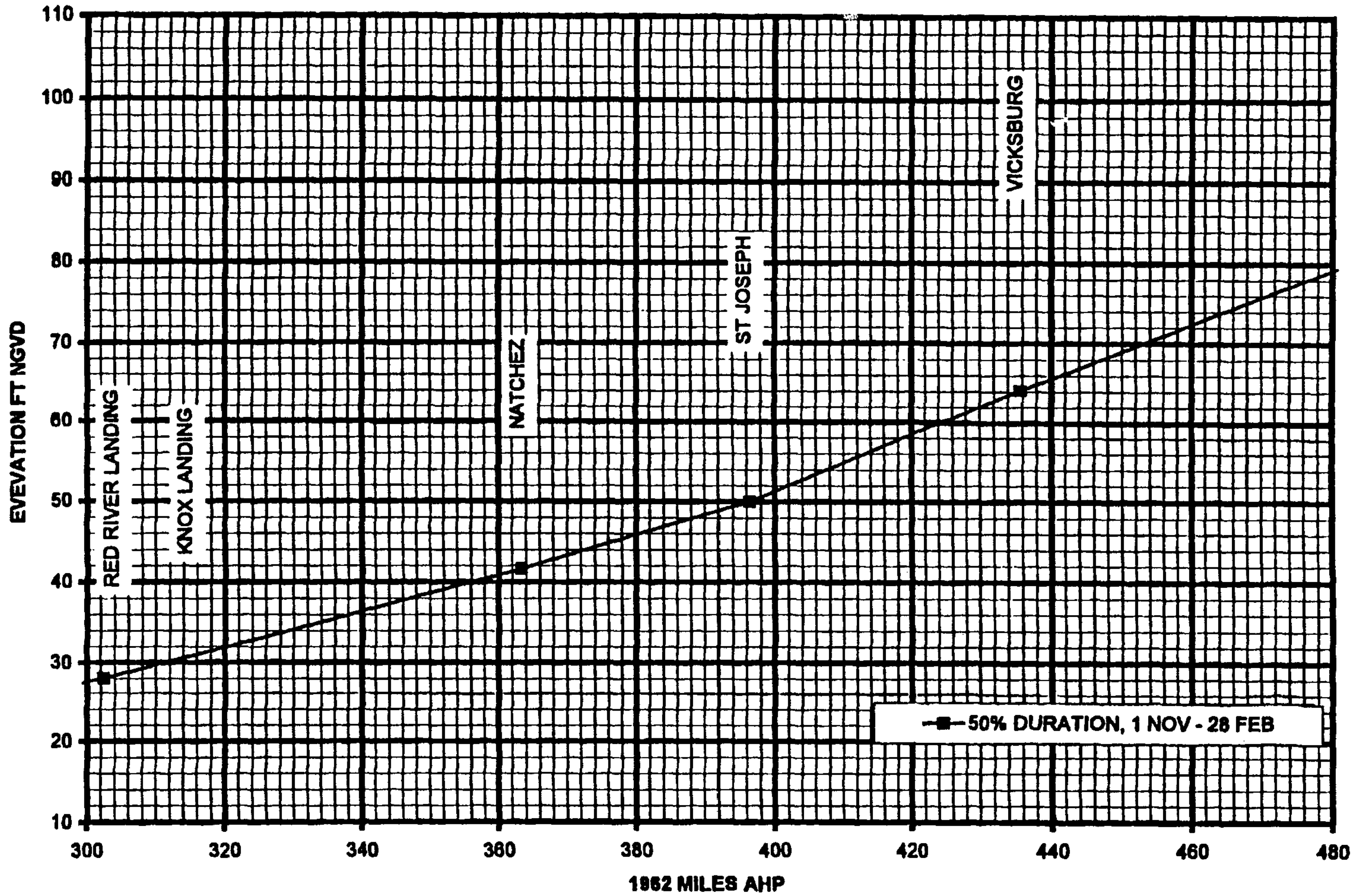
MISSISSIPPI RIVER LEVEE PROJECT

50 % Duration (November–February) Profile

Vicksburg District
Corps of Engineers

Plate 6b

MISSISSIPPI RIVER PROFILES



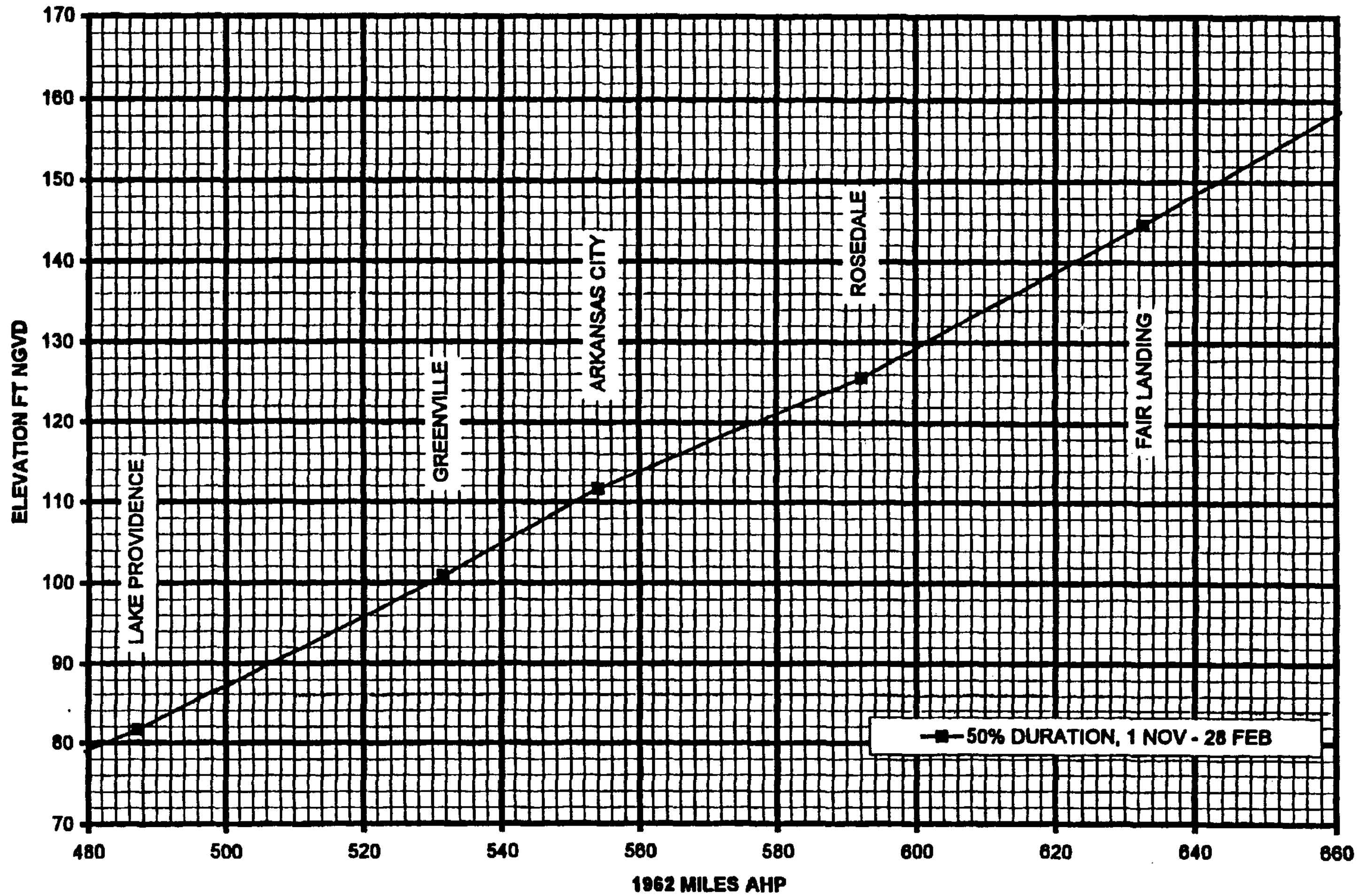
MISSISSIPPI RIVER LEVEE PROJECT

50 % Duration
(November–February) Profile

Vicksburg District
Corps of Engineers

Plate 6c

MISSISSIPPI RIVER PROFILES



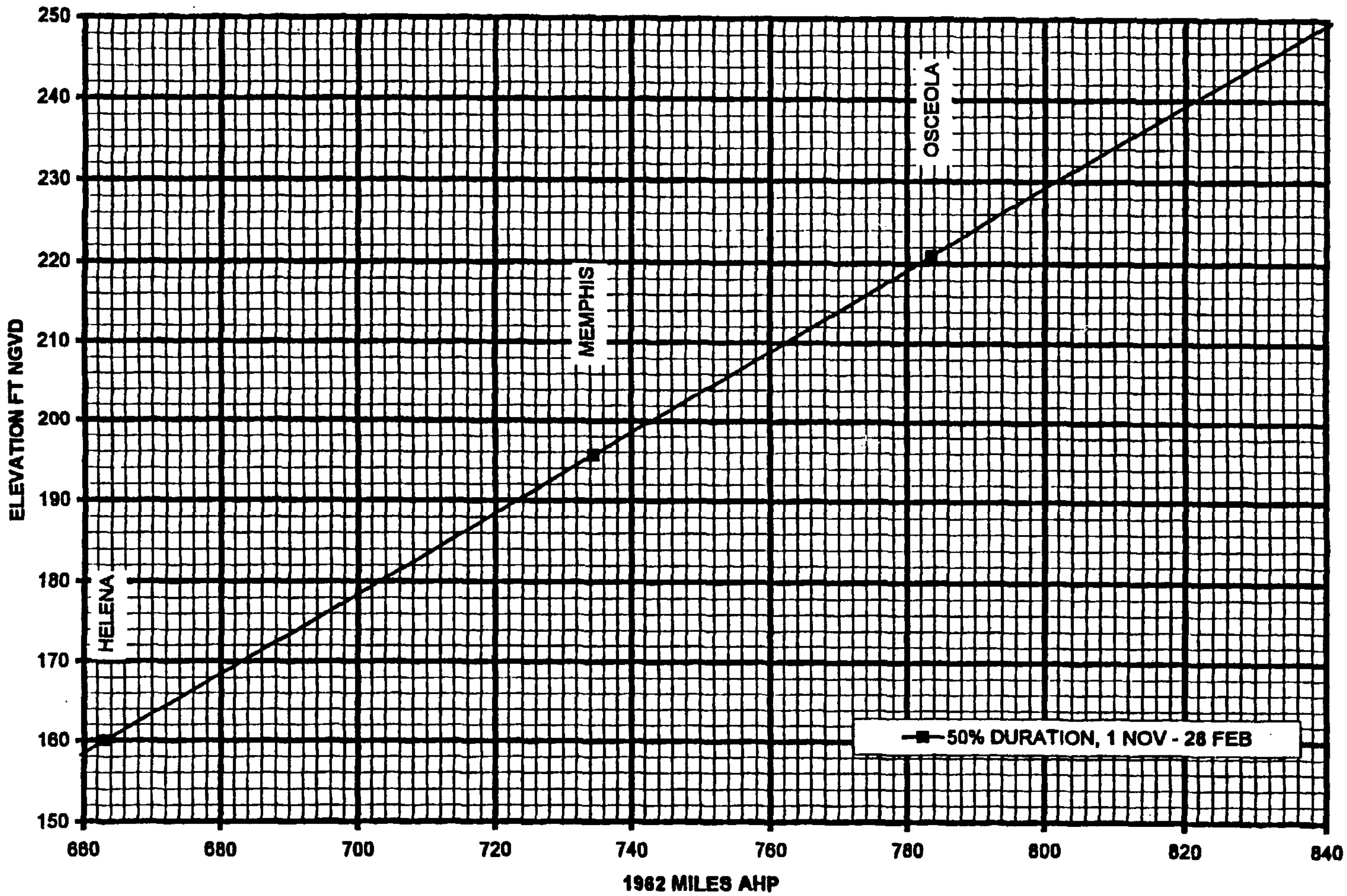
MISSISSIPPI RIVER LEVEE PROJECT

50 % Duration
(November–February) Profile

Vicksburg District
Corps of Engineers

Plate 64

MISSISSIPPI RIVER PROFILES

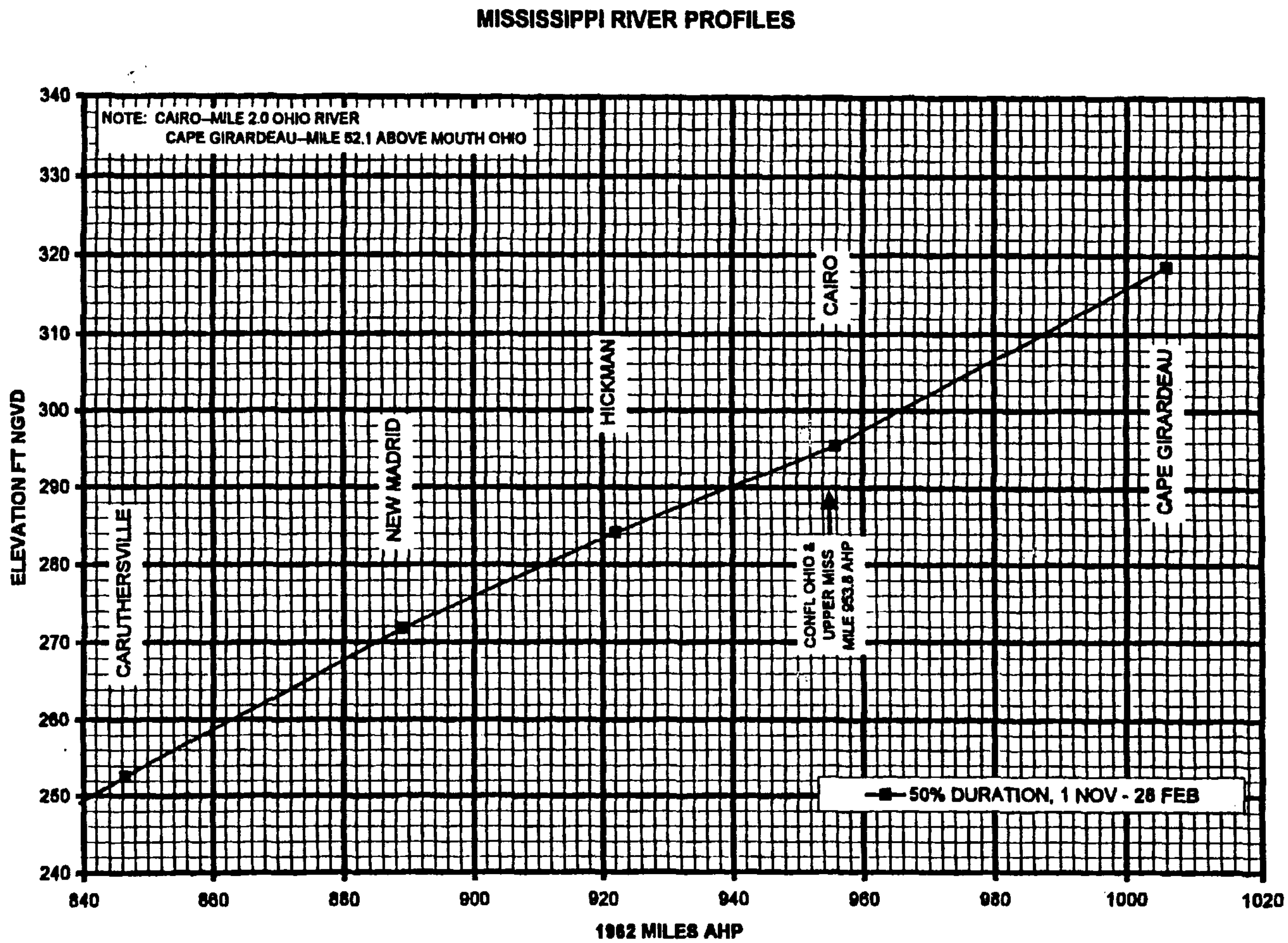


MISSISSIPPI RIVER LEVEE PROJECT

50 % Duration (November–February) Profile

Vicksburg District
Corps of Engineers

Plate 8a

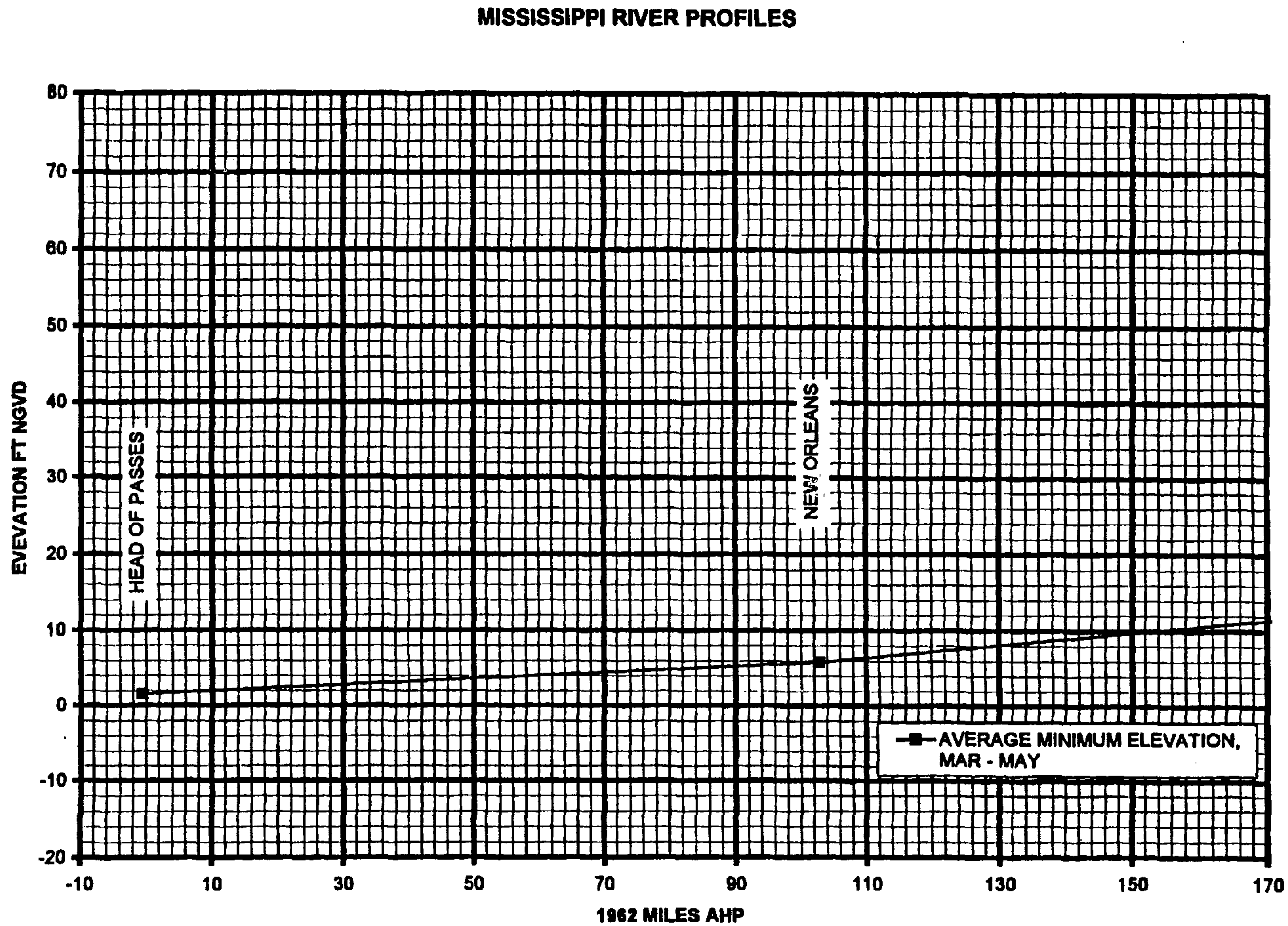


MISSISSIPPI RIVER LEVEE PROJECT

50 % Duration (November–February) Profile

Vicksburg District
Corps of Engineers

Plate 6

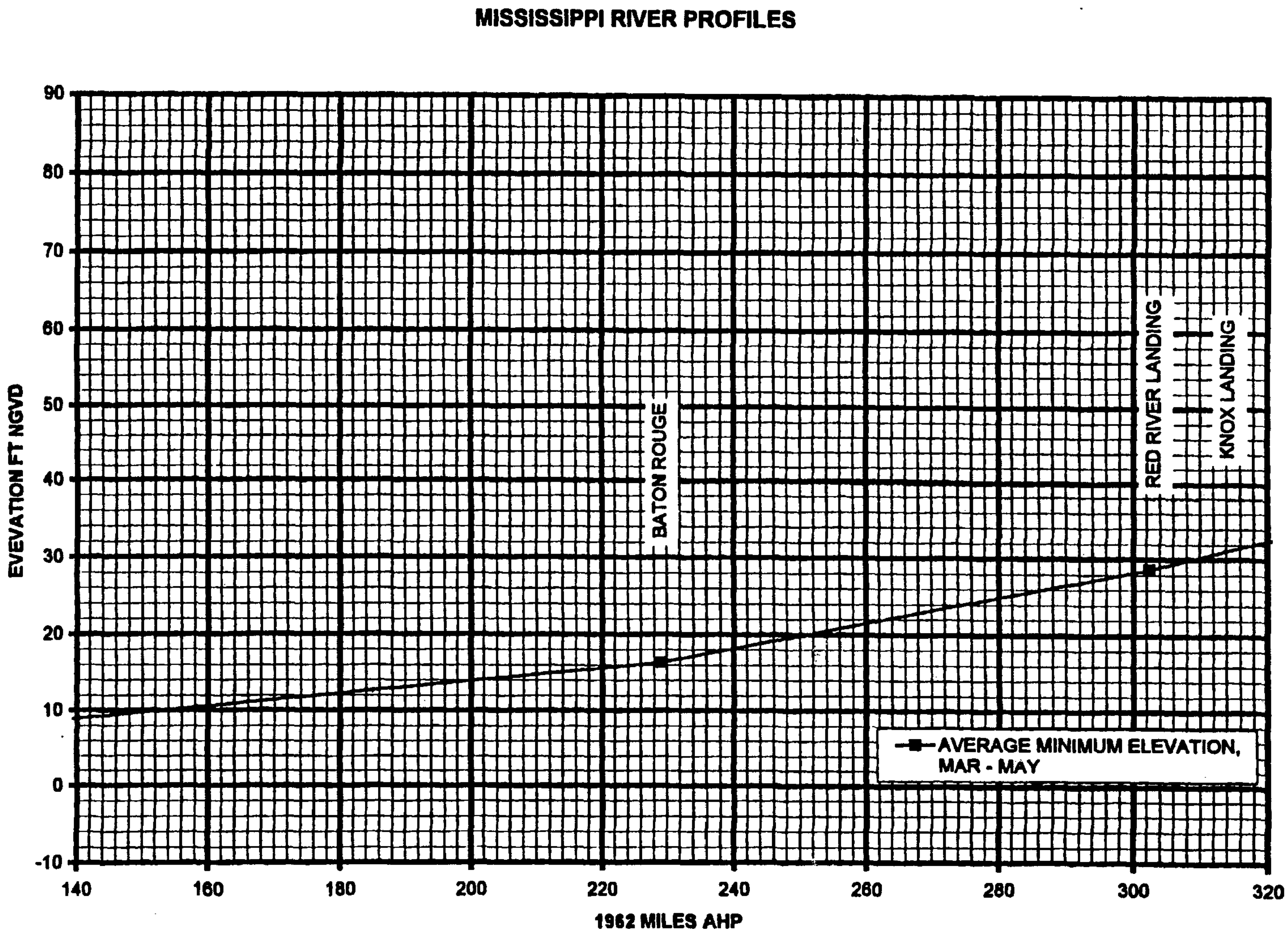


MISSISSIPPI RIVER LEVEE PROJECT

Average Minimum Elevation (March–May) Profile

Vicksburg District
Corps of Engineers

Plate 7a



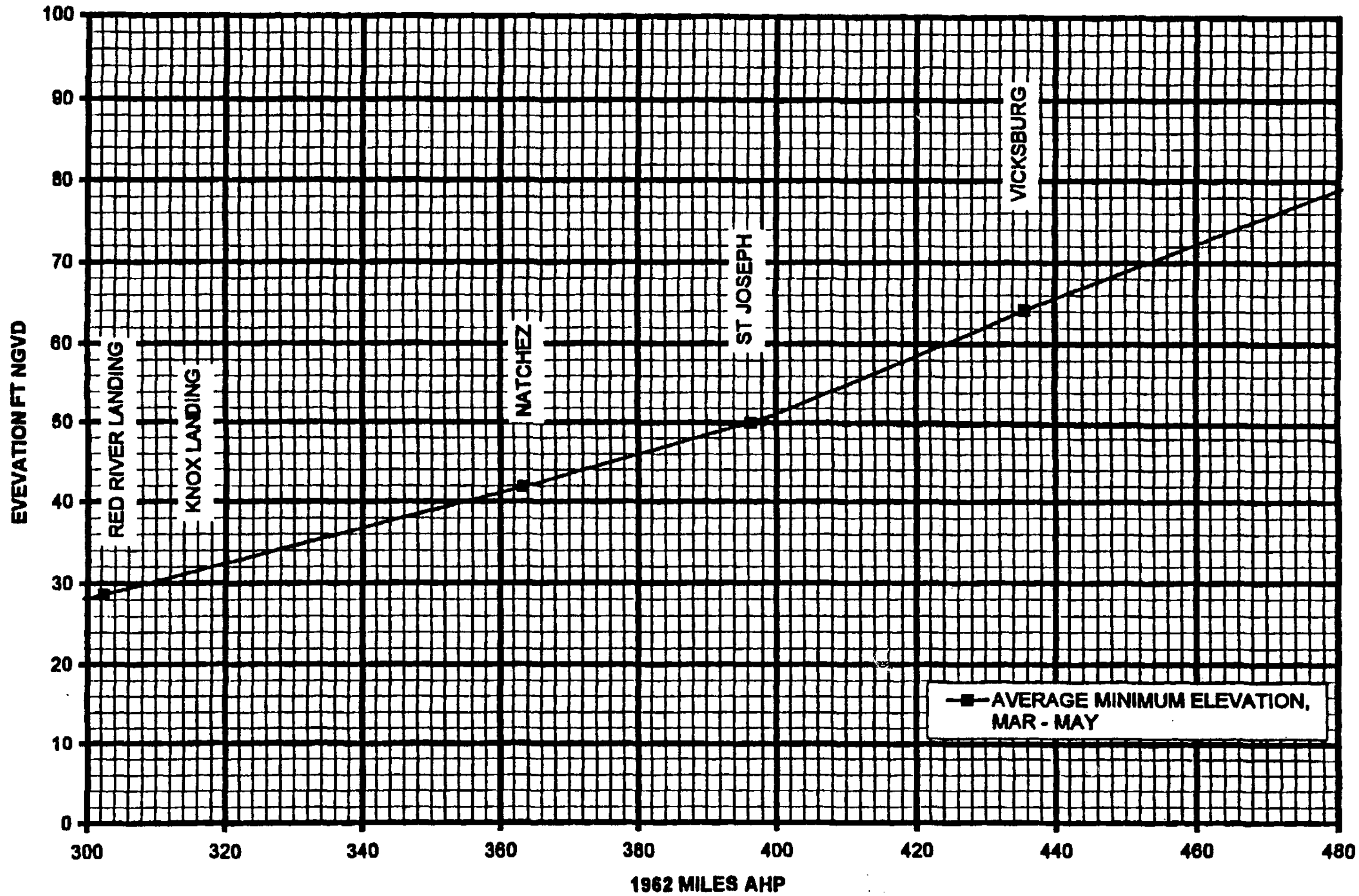
MISSISSIPPI RIVER LEVEE PROJECT

Average Minimum Elevation (March–May) Profile

Vicksburg District
Corps of Engineers

Plate 7b

MISSISSIPPI RIVER PROFILES



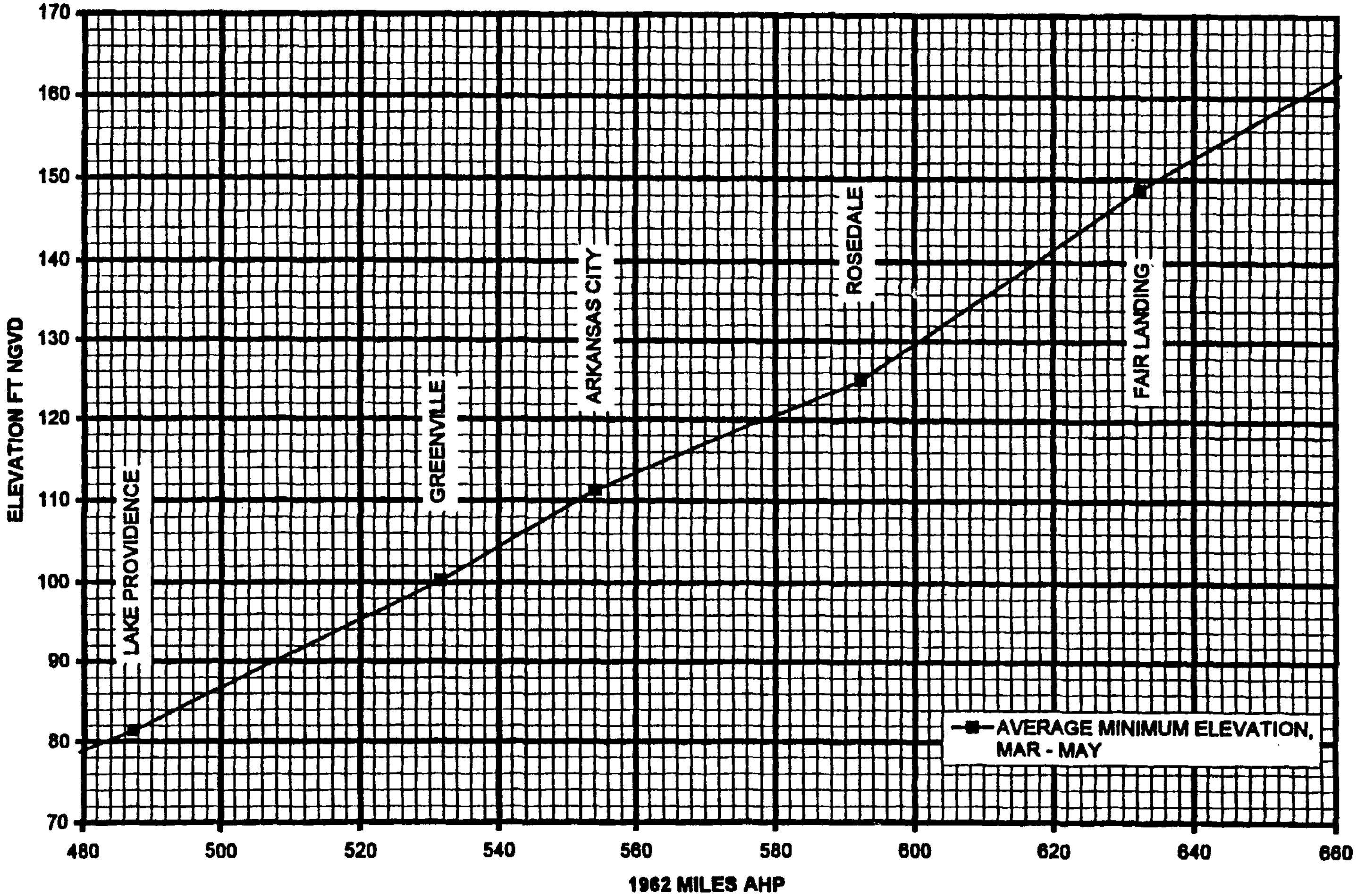
MISSISSIPPI RIVER LEVEE PROJECT

Average Minimum Elevation (March–May) Profile

Vicksburg District
Corps of Engineers

Plate 7c

MISSISSIPPI RIVER PROFILES



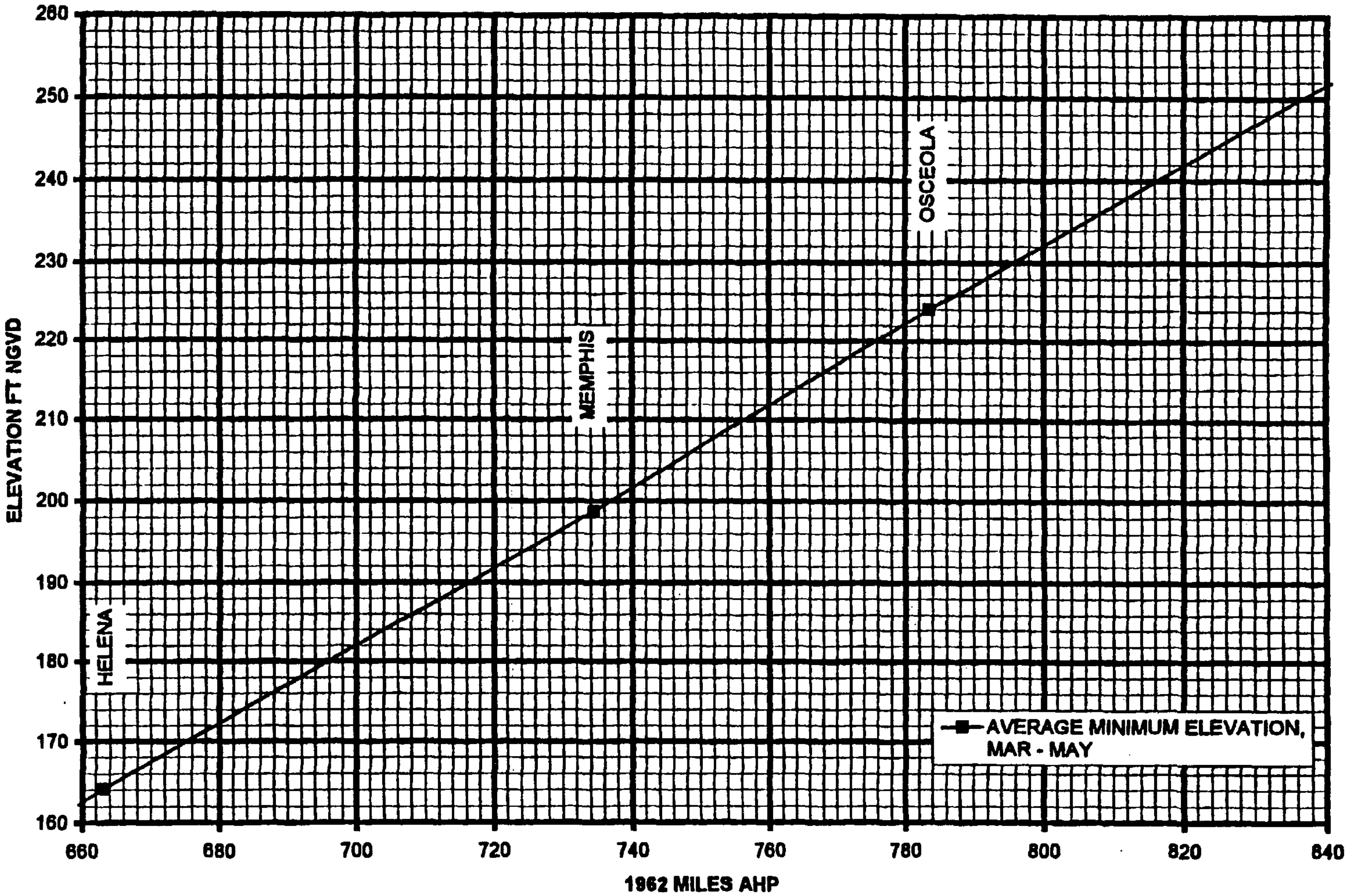
MISSISSIPPI RIVER LEVEE PROJECT

Average Minimum Elevation (March–May) Profile

Vicksburg District
Corps of Engineers

Plate 74

MISSISSIPPI RIVER PROFILES



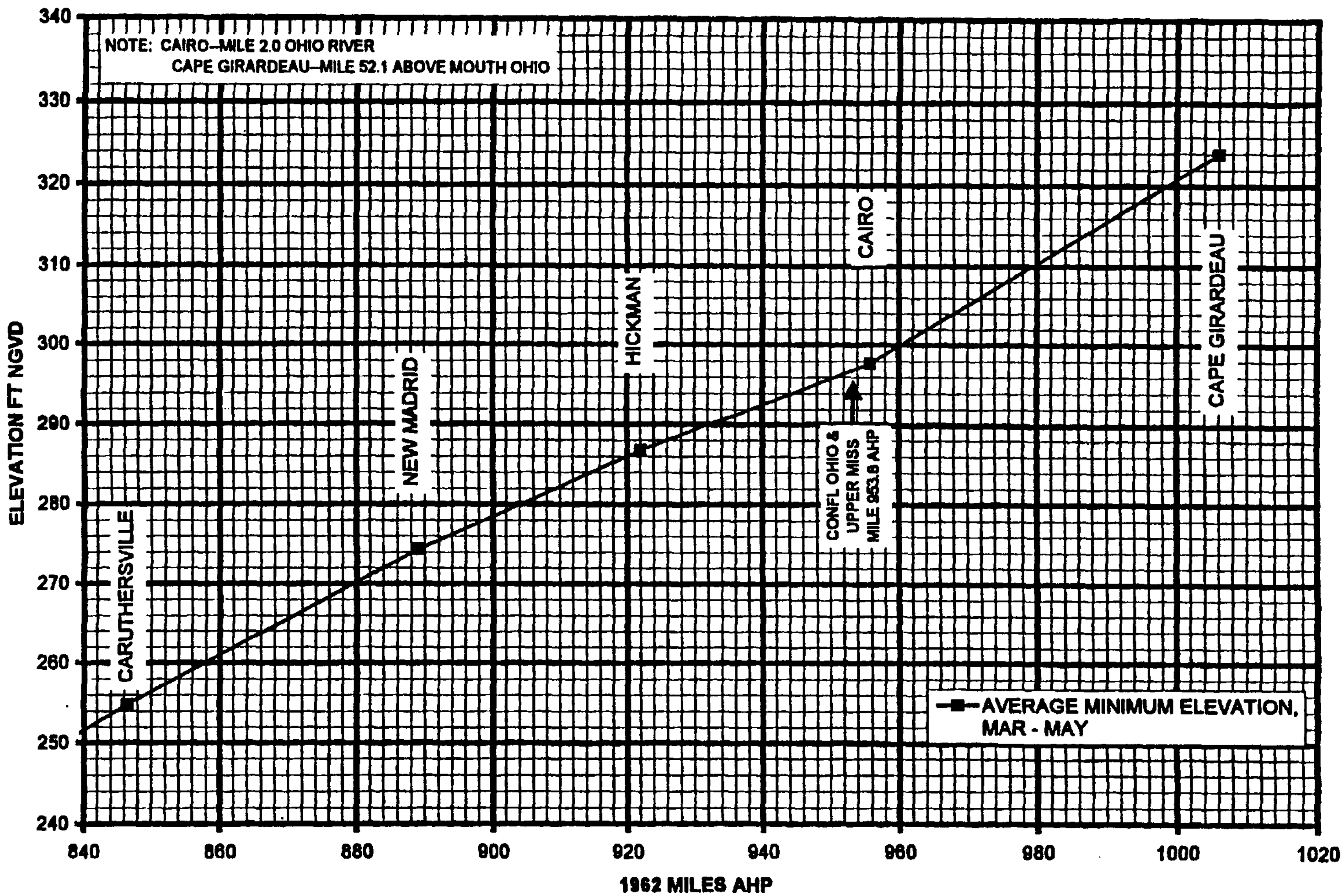
MISSISSIPPI RIVER LEVEE PROJECT

Average Minimum Elevation (March–May) Profile

Vicksburg District
Corps of Engineers

Plate 7a

MISSISSIPPI RIVER PROFILES

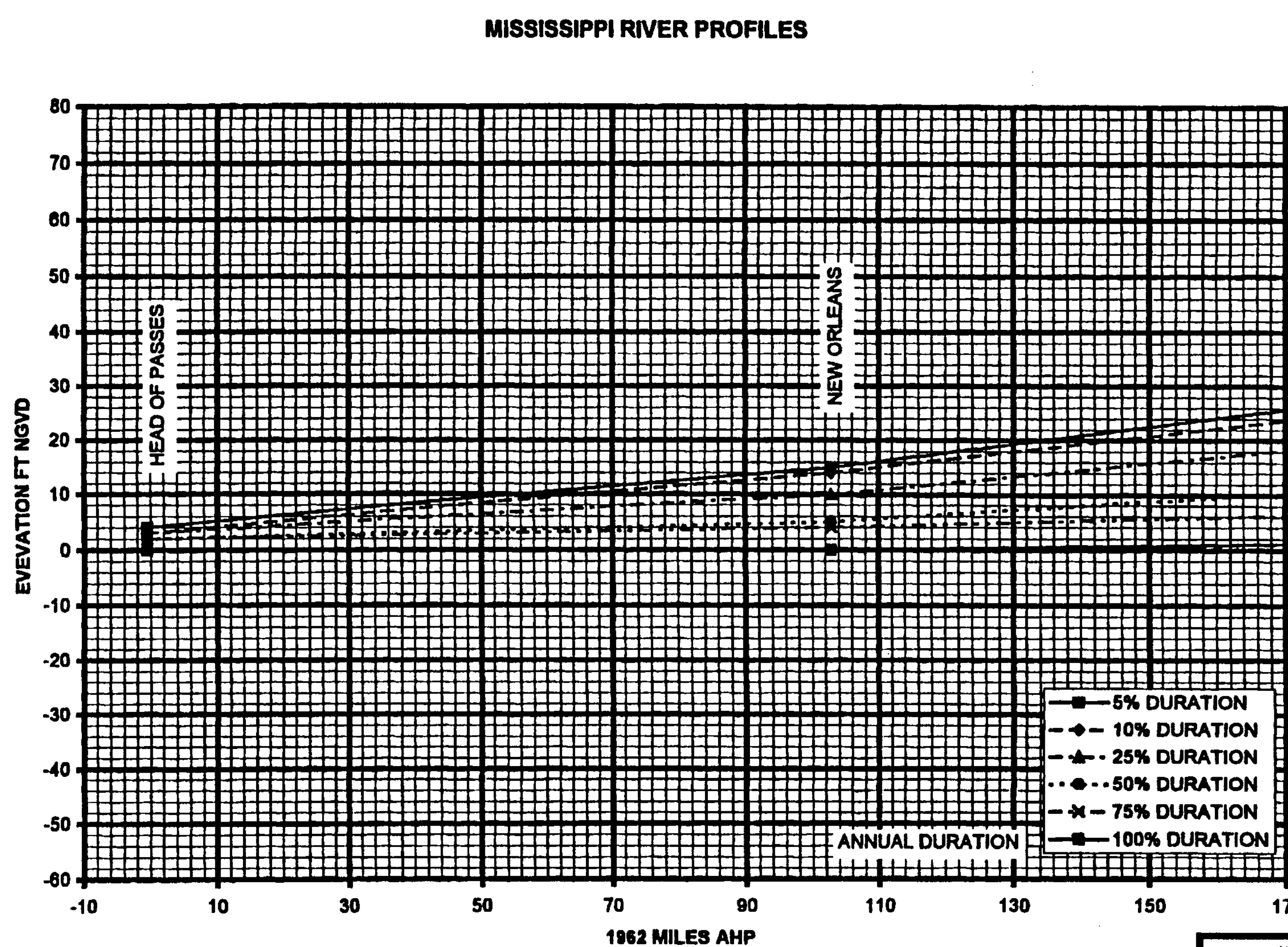


MISSISSIPPI RIVER LEVEE PROJECT

Average Minimum Elevation (March–May) Profile

Vicksburg District
Corps of Engineers

Plate 7f

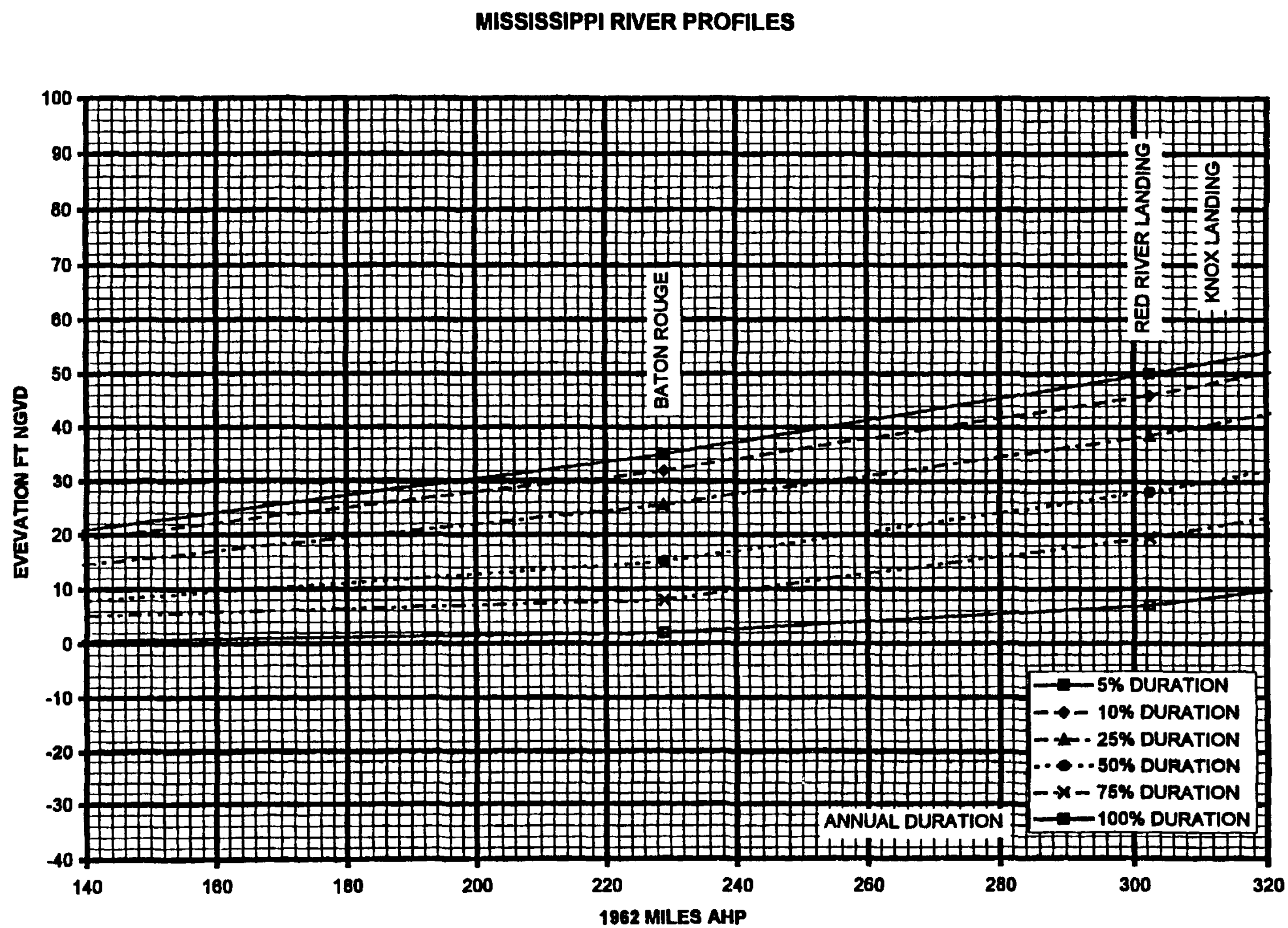


MISSISSIPPI RIVER LEVEE PROJECT

Annual Duration Profiles

Vicksburg District
Corps of Engineers

Plate 8a

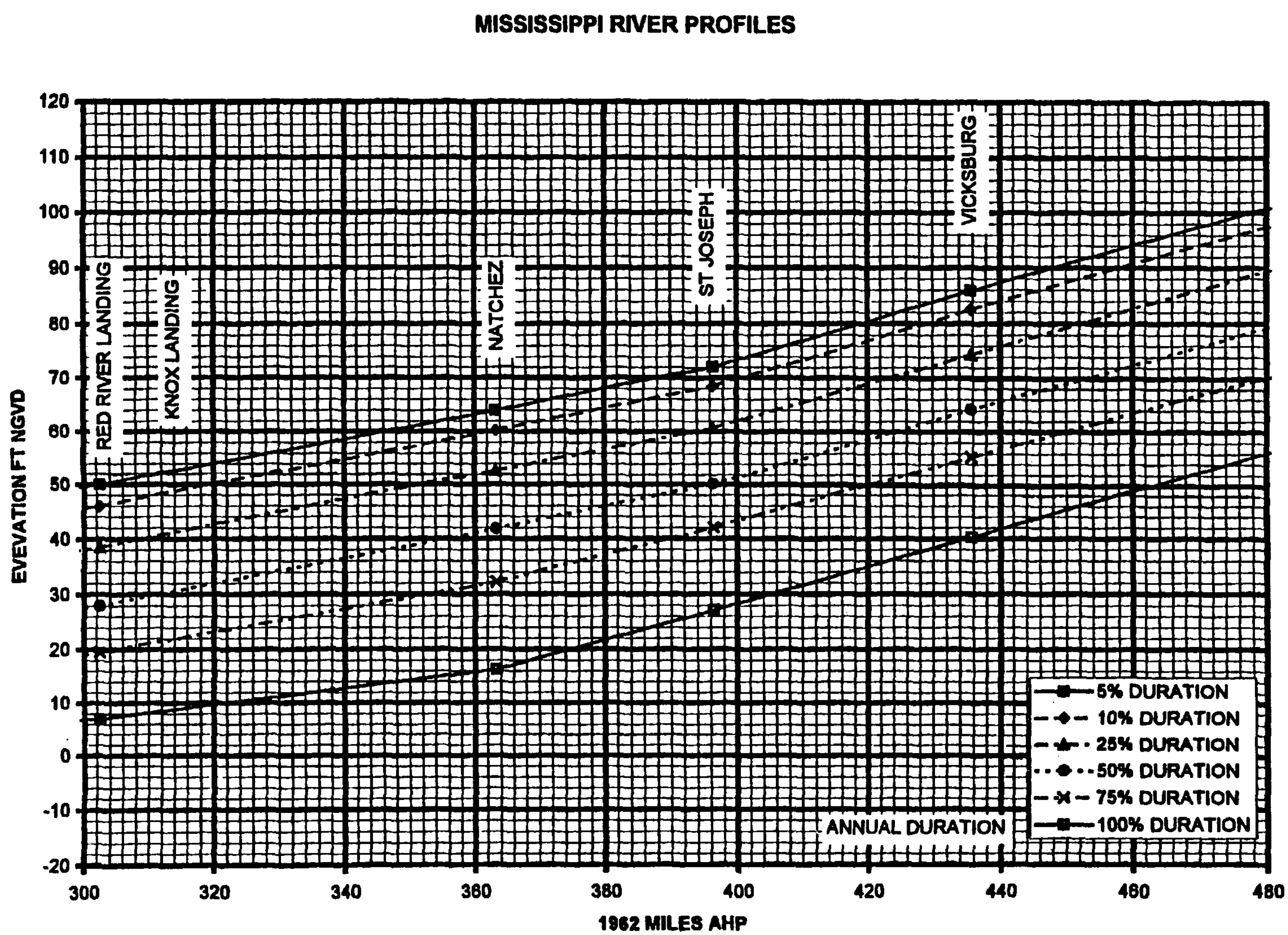


MISSISSIPPI RIVER LEVEE PROJECT

Annual Duration Profiles

Vicksburg District
Corps of Engineers

Plate 8b



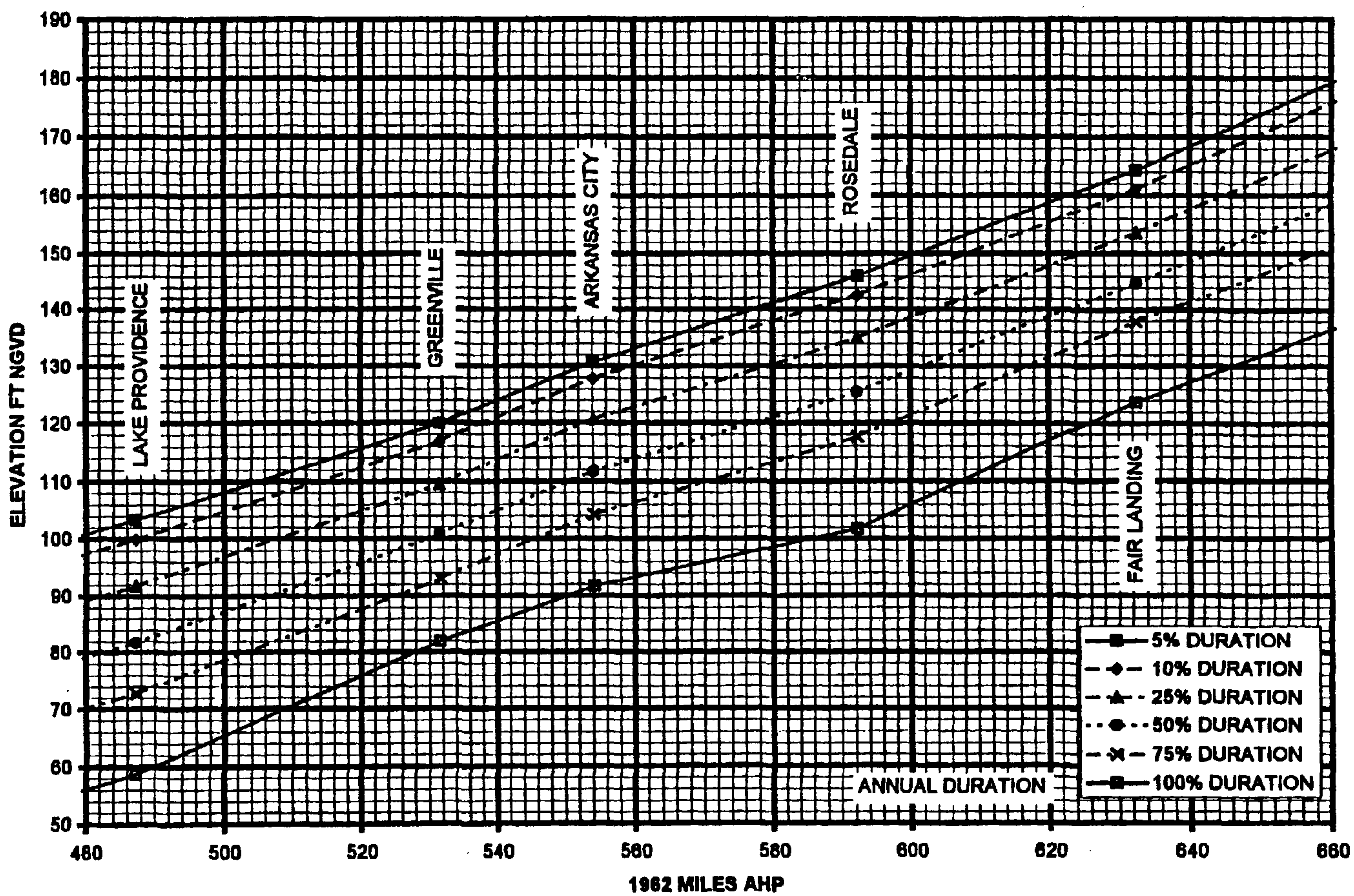
MISSISSIPPI RIVER LEVEE PROJECT

Annual Duration Profiles

Vicksburg District
Corps of Engineers

Plate 8c

MISSISSIPPI RIVER PROFILES

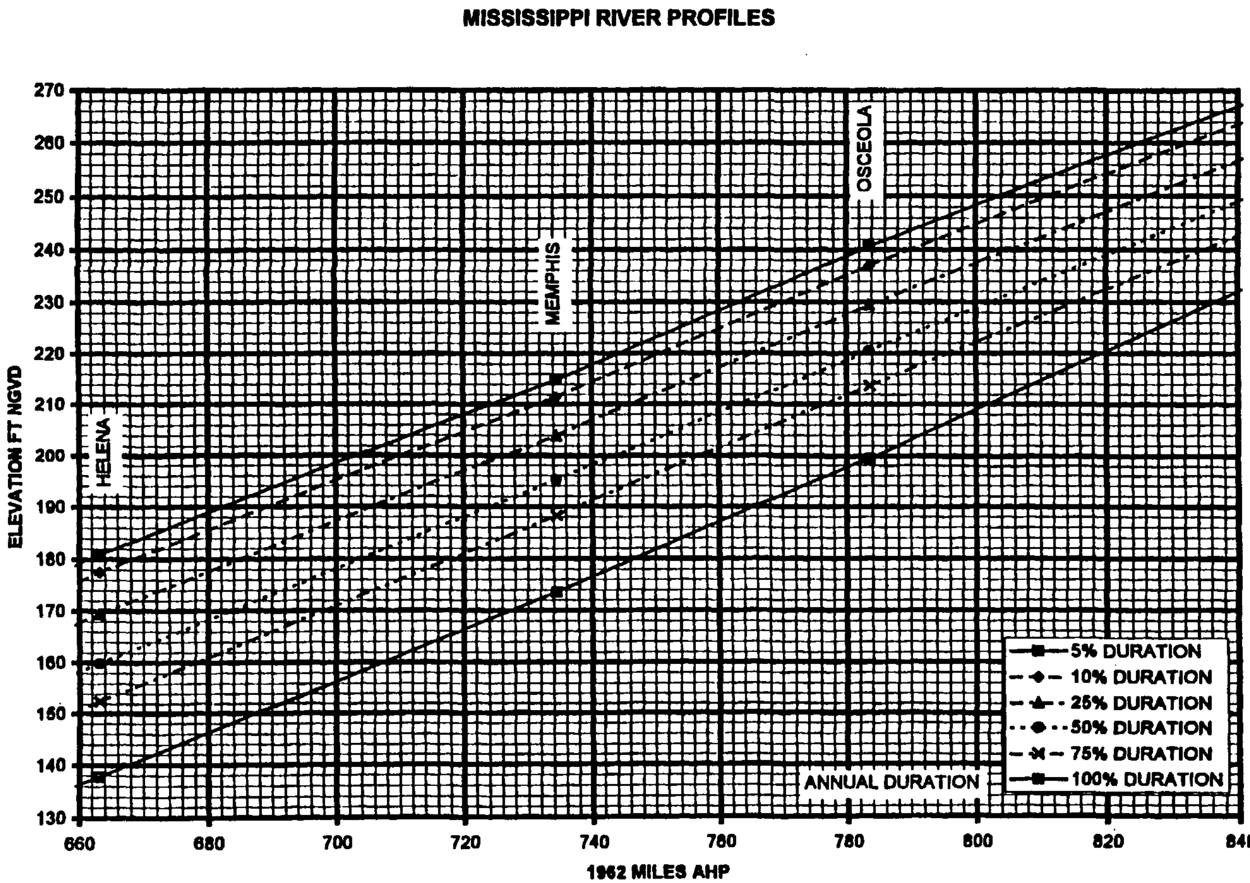


MISSISSIPPI RIVER LEVEE PROJECT

Annual Duration Profiles

Vicksburg District
Corps of Engineers

Plate 84



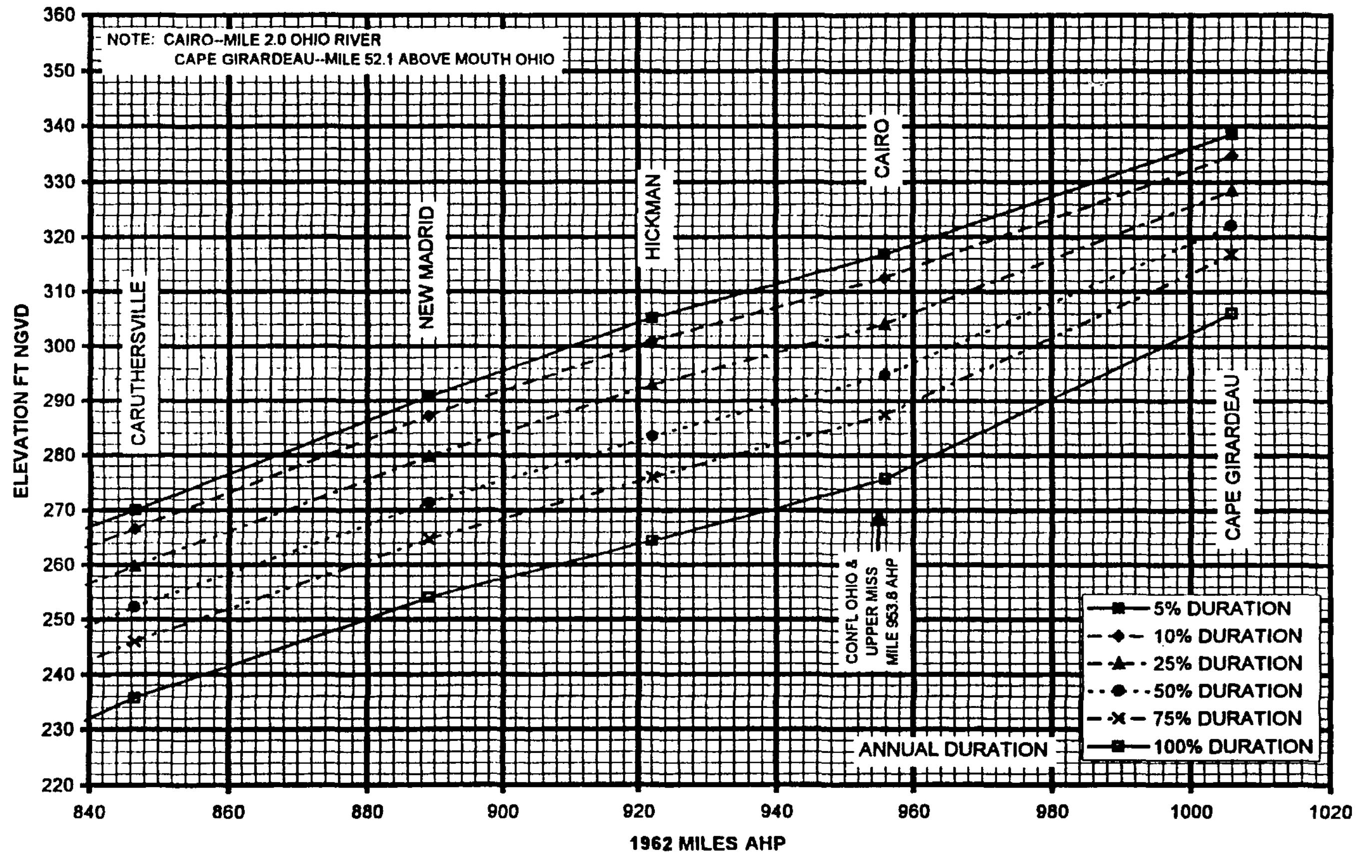
MISSISSIPPI RIVER LEVEE PROJECT

Annual Duration Profiles

Vicksburg District
Corps of Engineers

Plate 8e

MISSISSIPPI RIVER PROFILES



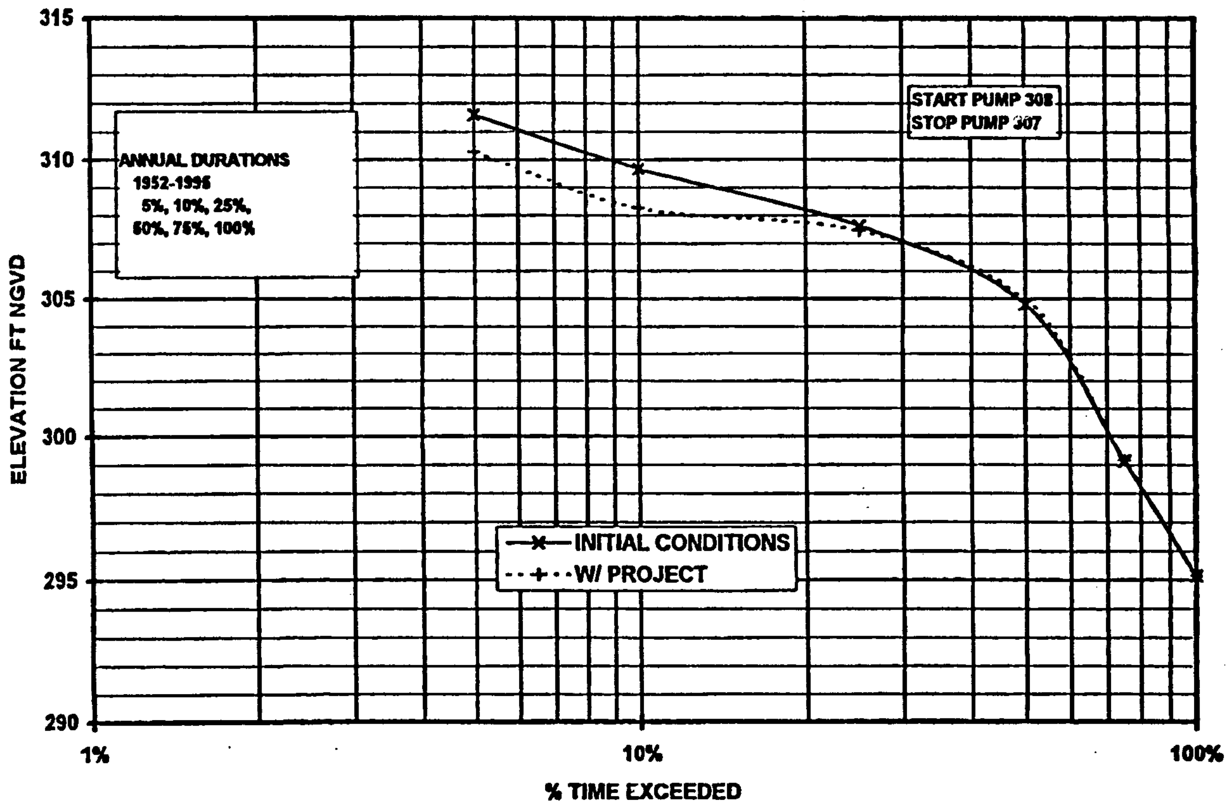
MISSISSIPPI RIVER LEVEE PROJECT

Annual Duration Profiles

Vicksburg District
Corps of Engineers

Plate 8f

DRINKWATER PUMPING PLANT POOL ELEVATION
EXCEEDANCE DURATION
TERRESTRIAL & AQUATIC EVALUATION

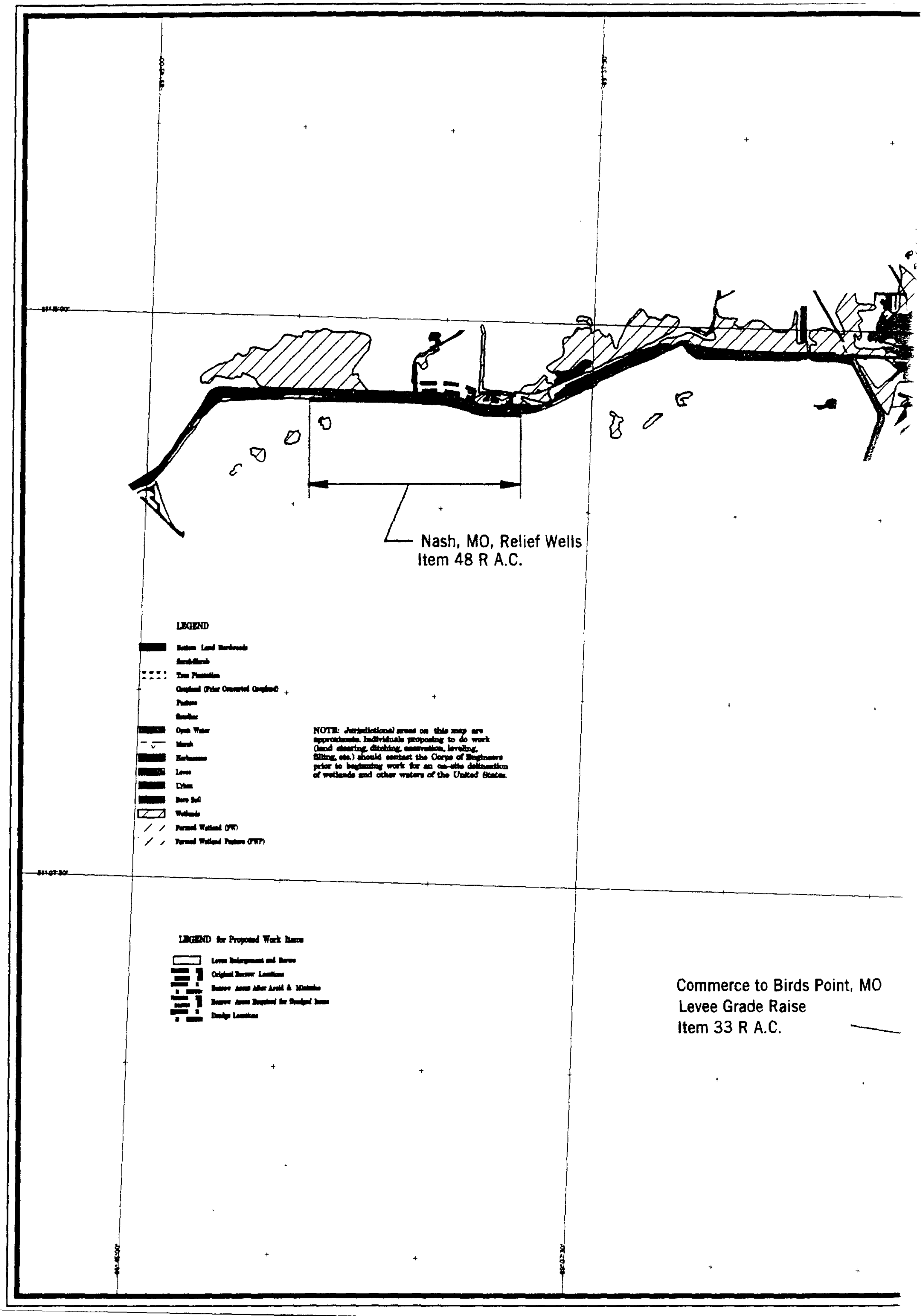


MISSISSIPPI RIVER LEVEE PROJECT

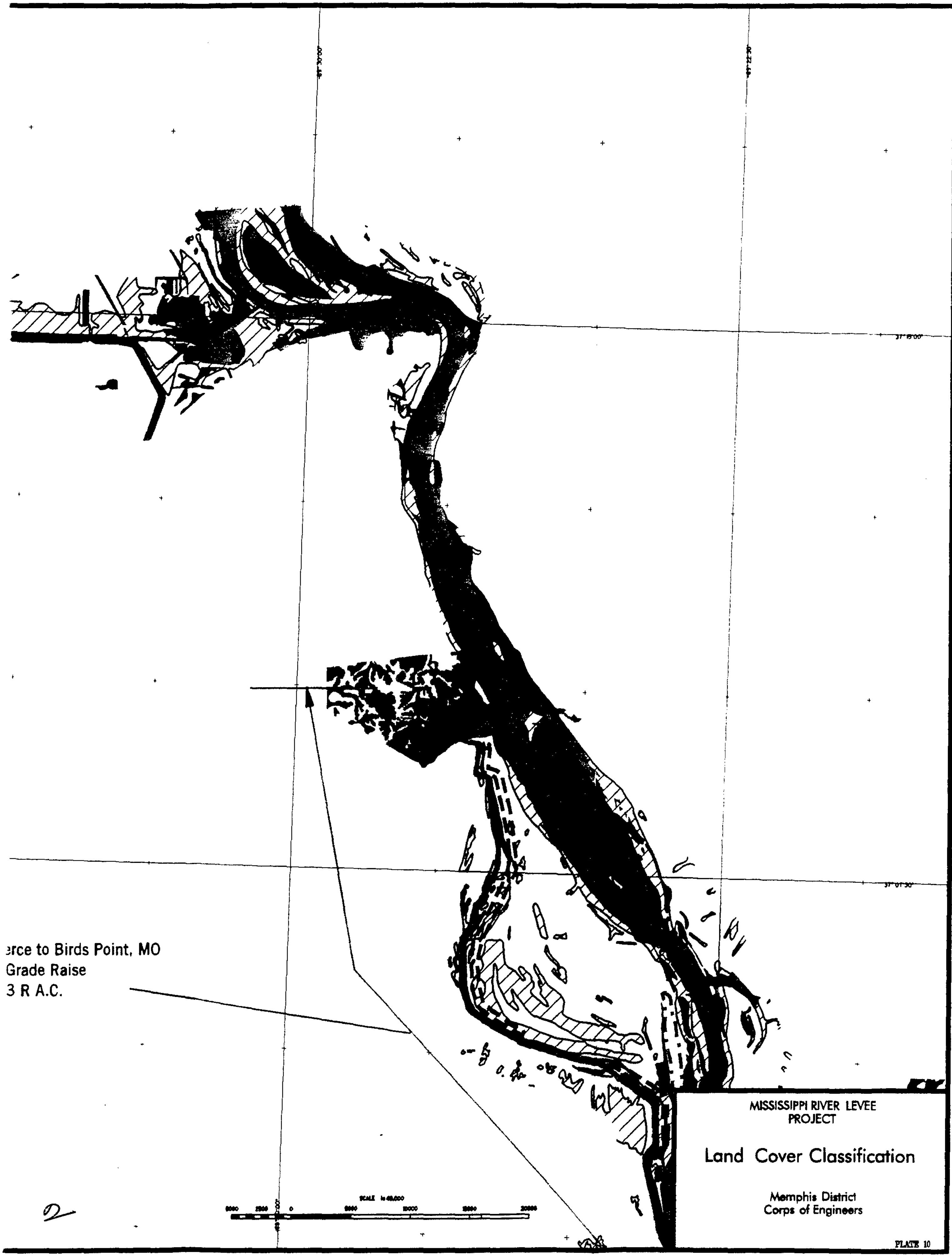
Drinkwater Pumping Plant Pool Elevation Exceedance Duration

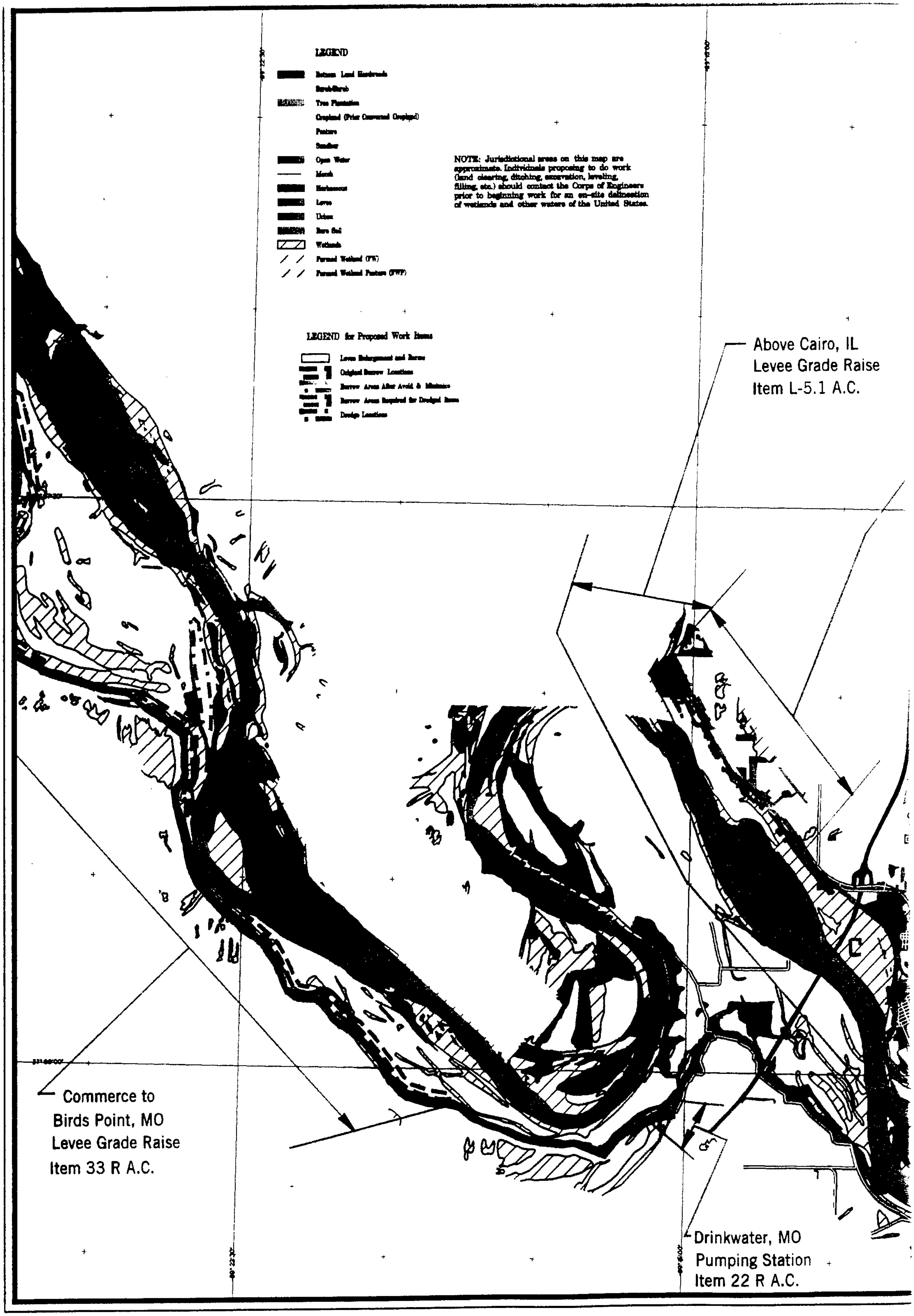
Vicksburg District
Corps of Engineers

Plate 9

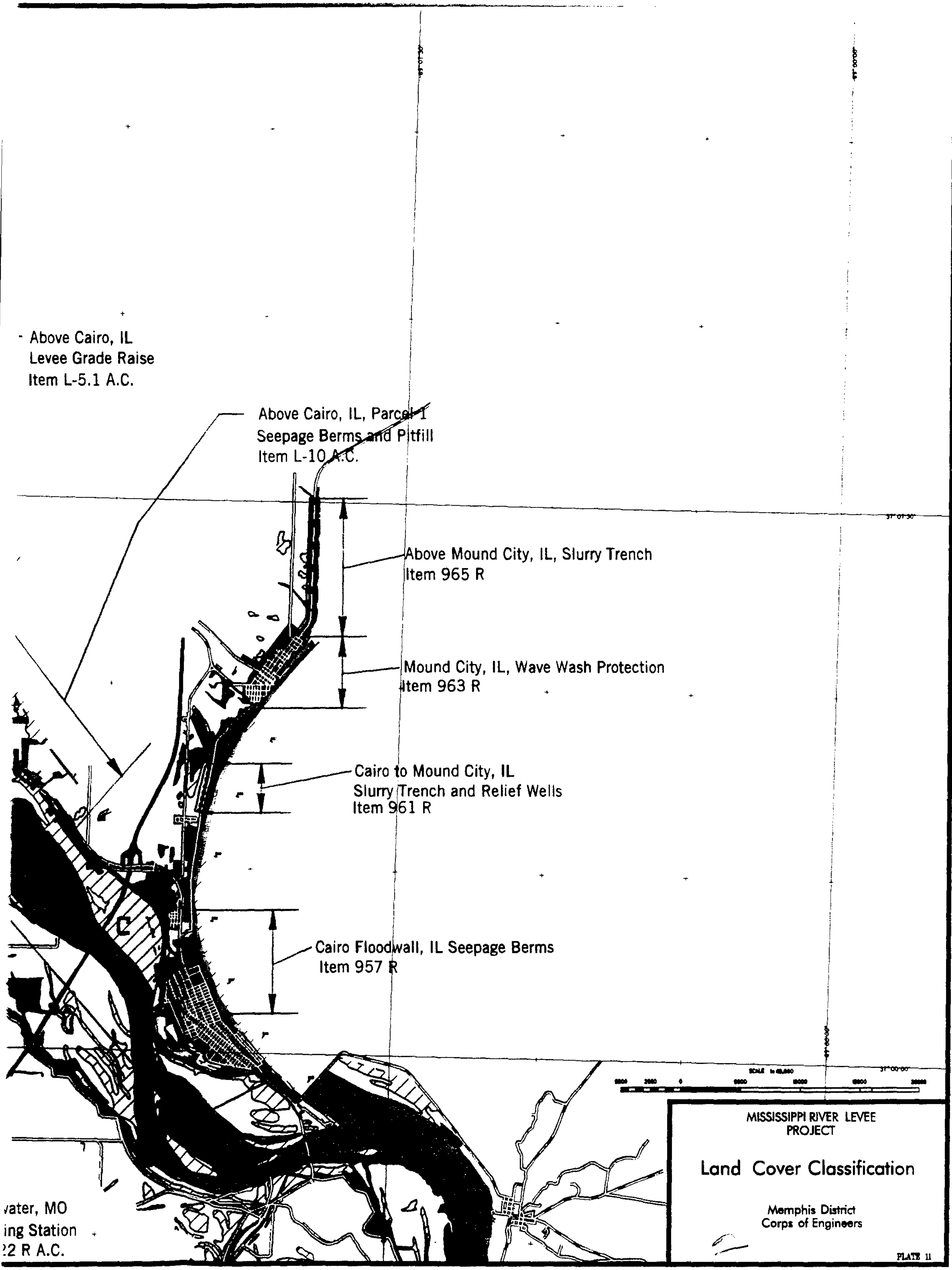

Nash, MO, Relief Wells
Item 48 R A.C.
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Designed Items
Dredge Locations
Commerce to Birds Point, MO
Levee Grade Raise
Item 33 R A.C.

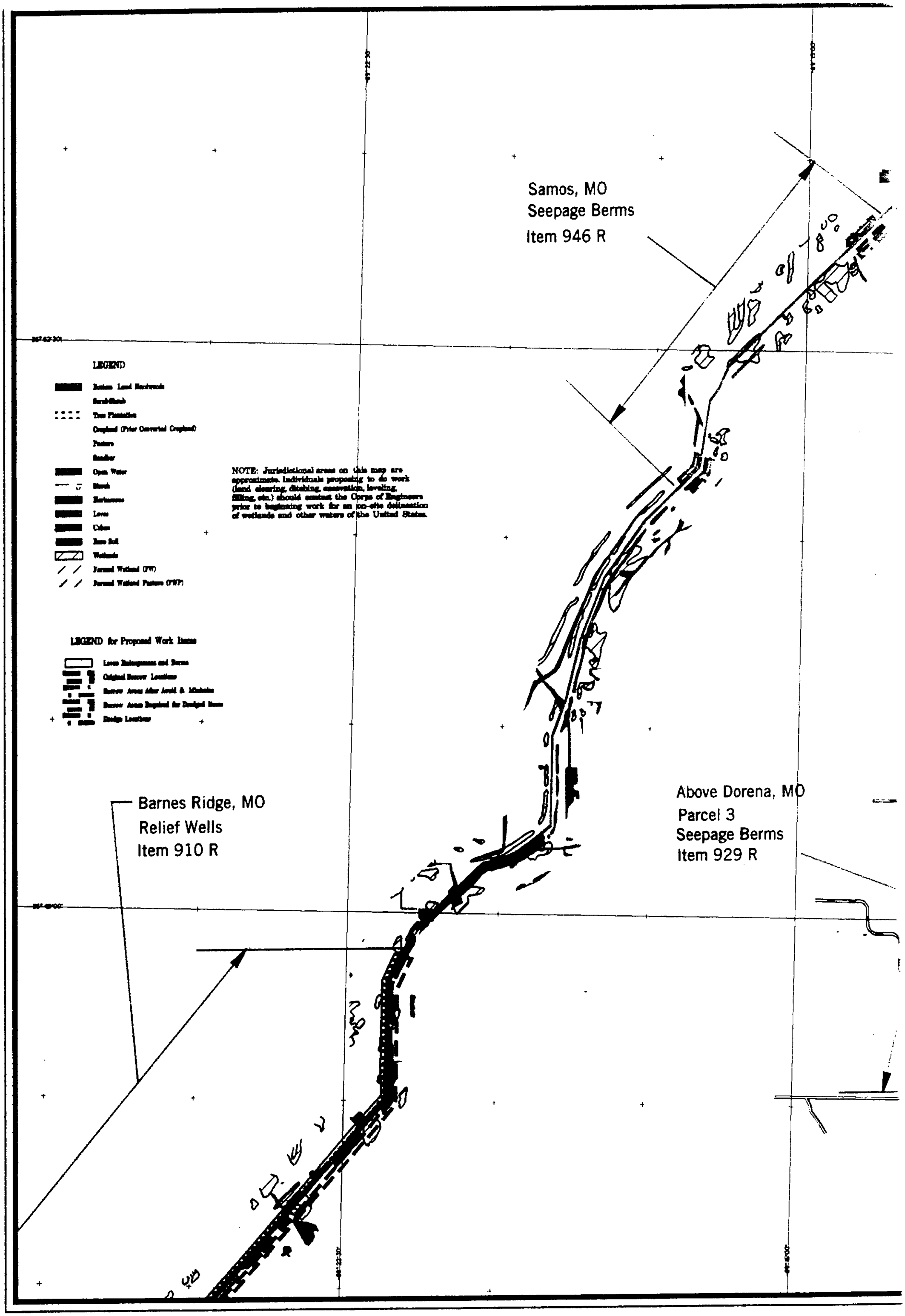
1

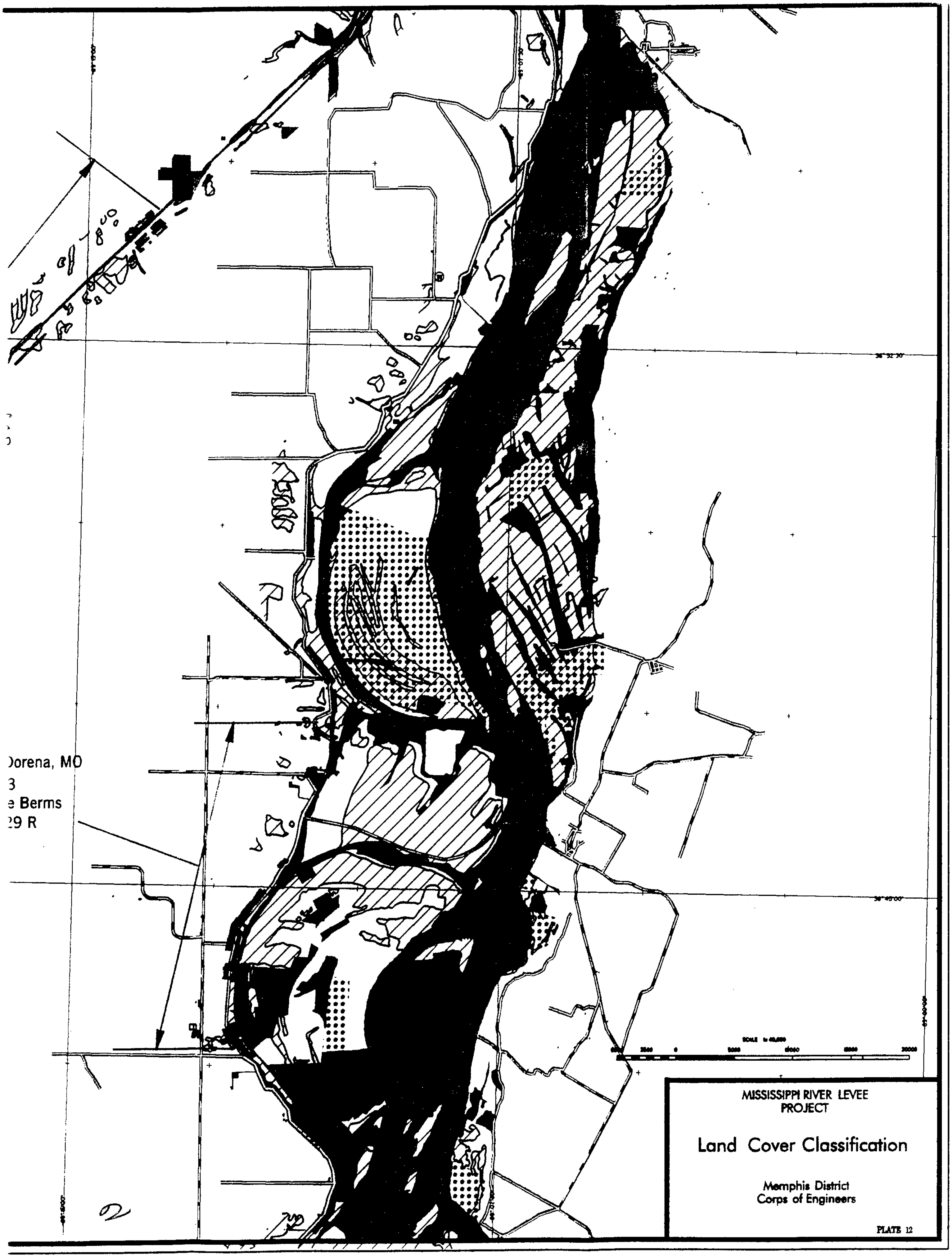

rce to Birds Point, MO
Grade Raise
3 R A.C.
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 10

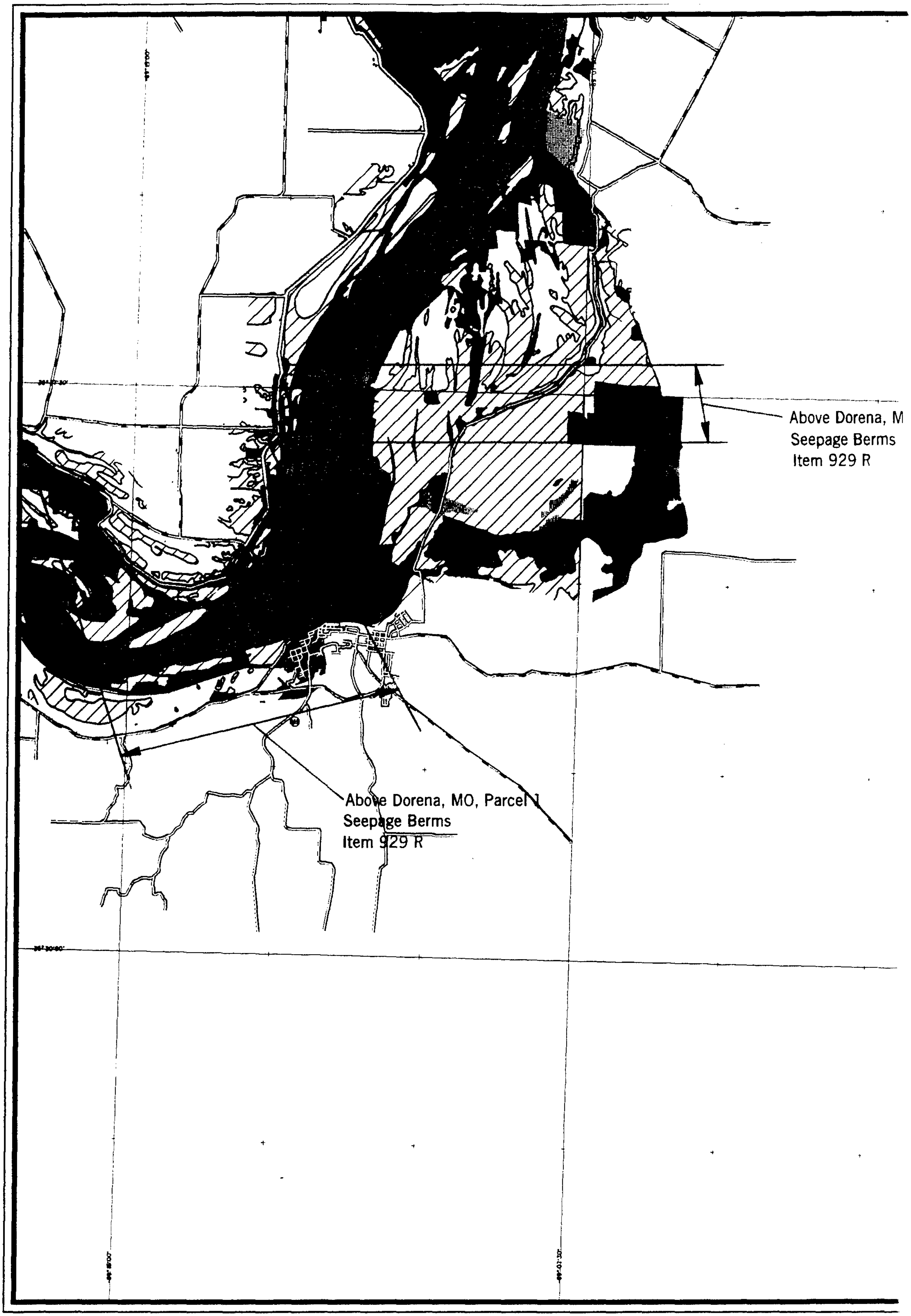

LEGEND
Open Water
Levee
Urban
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Above Cairo, IL
Levee Grade Raise
Item L-5.1 A.C.
Commerce to
Birds Point, MO
Levee Grade Raise
Item 33 R A.C.
Drinkwater, MO
Pumping Station
Item 22 R A.C.

1

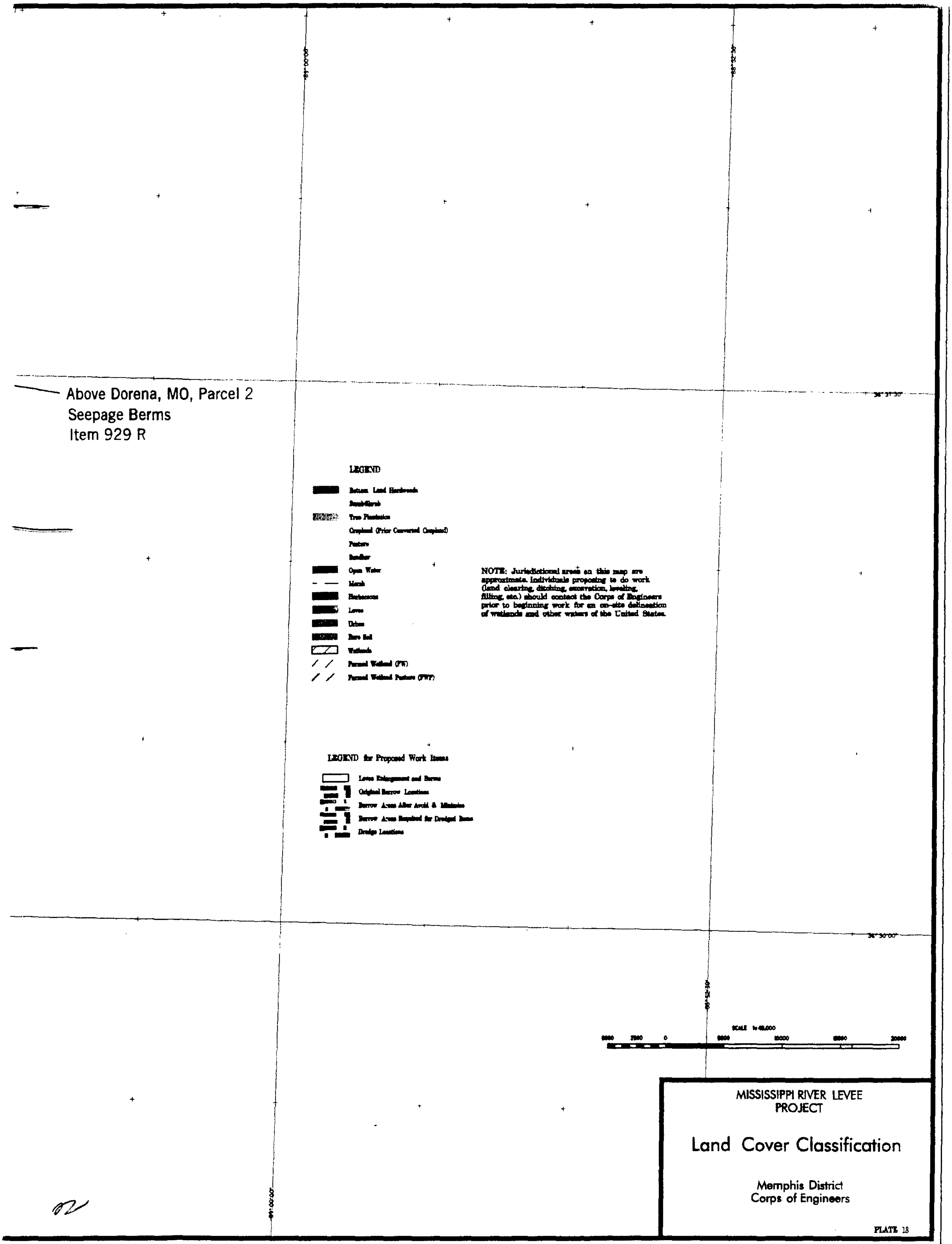

Above Cairo, IL
Levee Grade Raise
Item L-5.1 A.C.
Above Cairo, IL, Parcel 1
Seepage Berms and Pitfill
Item L-10 A.C.
Above Mound City, IL, Slurry Trench
Item 965 R
Mound City, IL, Wave Wash Protection
Item 963 R
Cairo to Mound City, IL
Slurry Trench and Relief Wells
Item 961 R
Cairo Floodwall, IL Seepage Berms
Item 957 R
vater, MO
ing Station
22 R A.C.
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 11

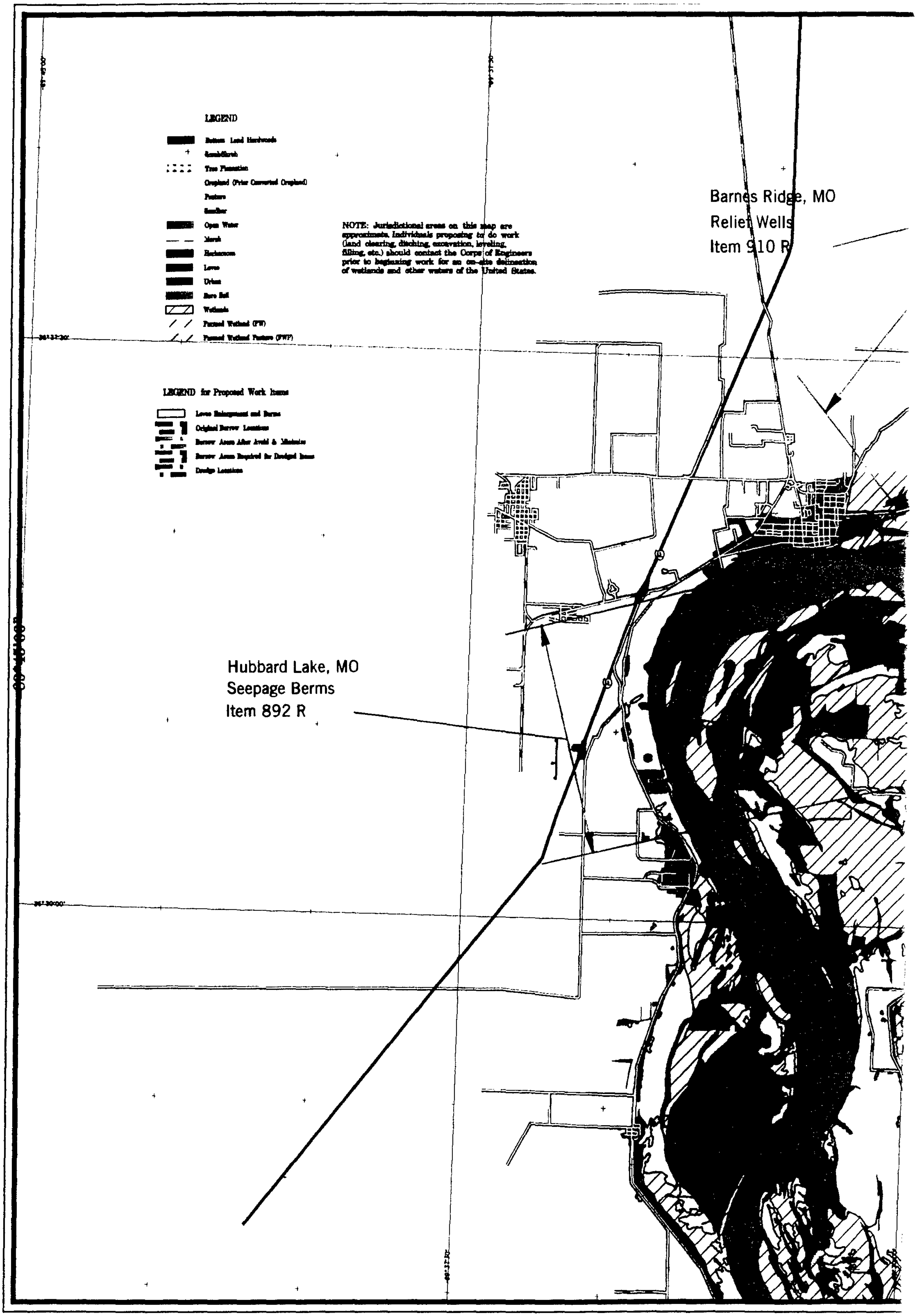

Samos, MO
Seepage Berms
Item 946 R
LEGEND
Open Water
Marsh
Wetlands
Farmed Wetland (FW)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Dredge Locations
Barnes Ridge, MO
Relief Wells
Item 910 R
Above Dorena, MO
Parcel 3
Seepage Berms
Item 929 R


)orena, MO
3
e Berms
!9 R
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 12

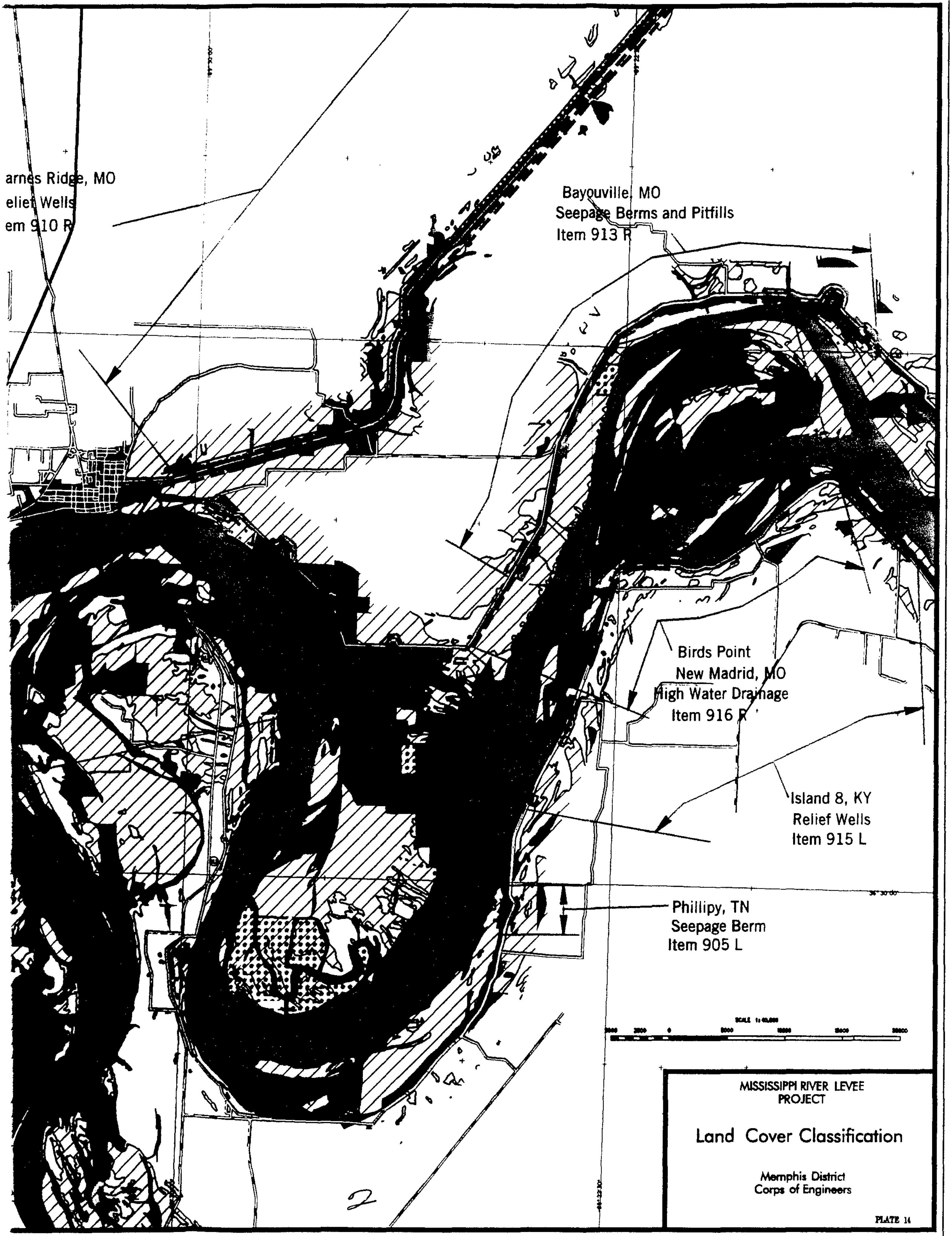

Above Dorena, M
Seepage Berms
Item 929 R
Above Dorena, MO, Parcel 1
Seepage Berms
Item 929 R

0

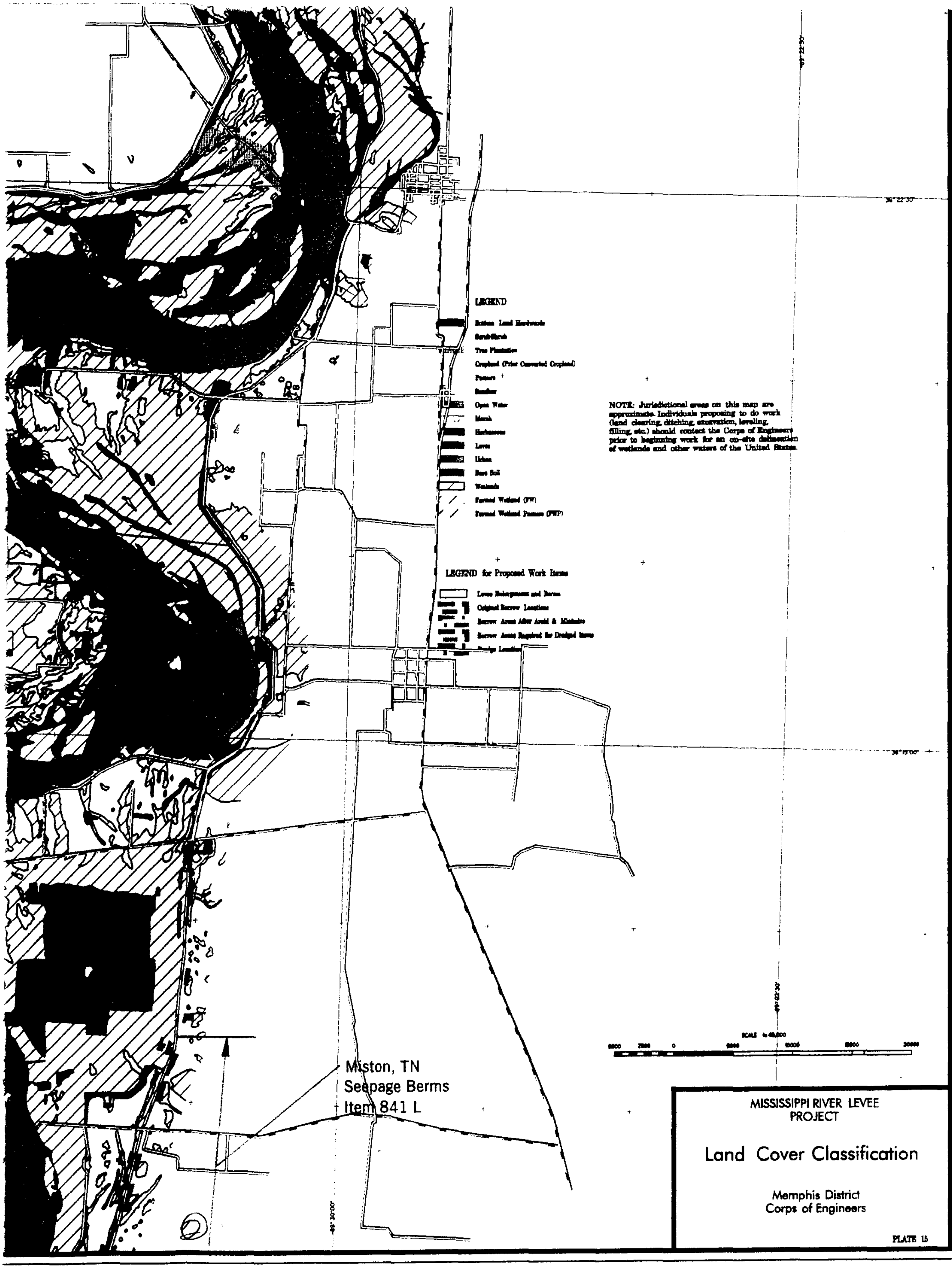

Above Dorena, MO, Parcel 2
Seepage Berms
Item 929 R
89° 00' 00"
88° 52' 30"
36° 31' 30"
36° 30' 00"
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations
SCALE 1:48,000
2500
0
10000
20000
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 18


LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Designed Items
Dredge Locations
Barnes Ridge, MO
Relief Wells
Item 910 R
Hubbard Lake, MO
Seepage Berms
Item 892 R

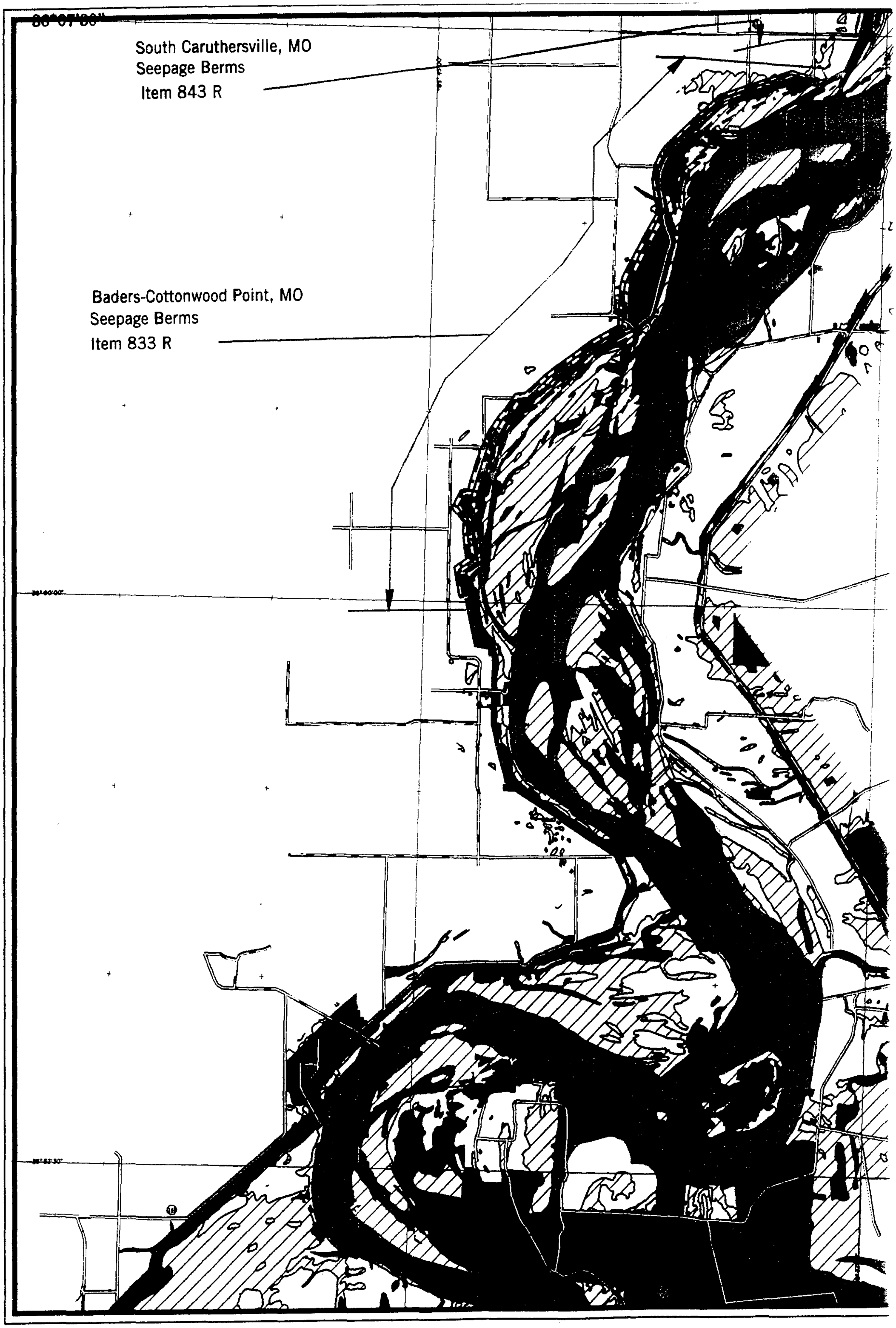
(1)

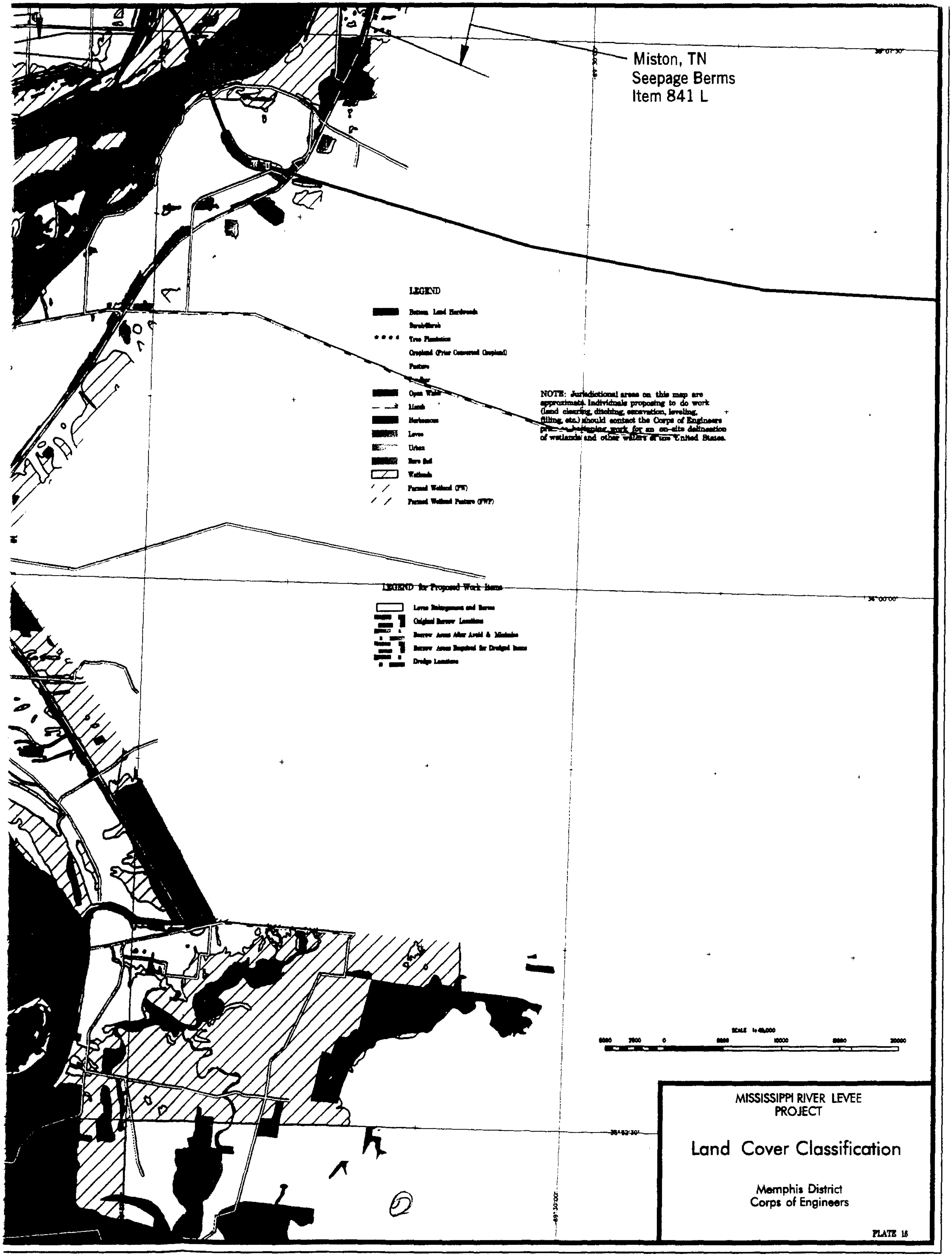

arnes Ridge, MO
elief Wells
em 910 R
Bayouville, MO
Seepage Berms and Pitfills
Item 913 R
Birds Point
New Madrid, MO
High Water Drainage
Item 916 R
Island 8, KY
Relief Wells
Item 915 L
Phillipy, TN
Seepage Berm
Item 905 L
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 14
2

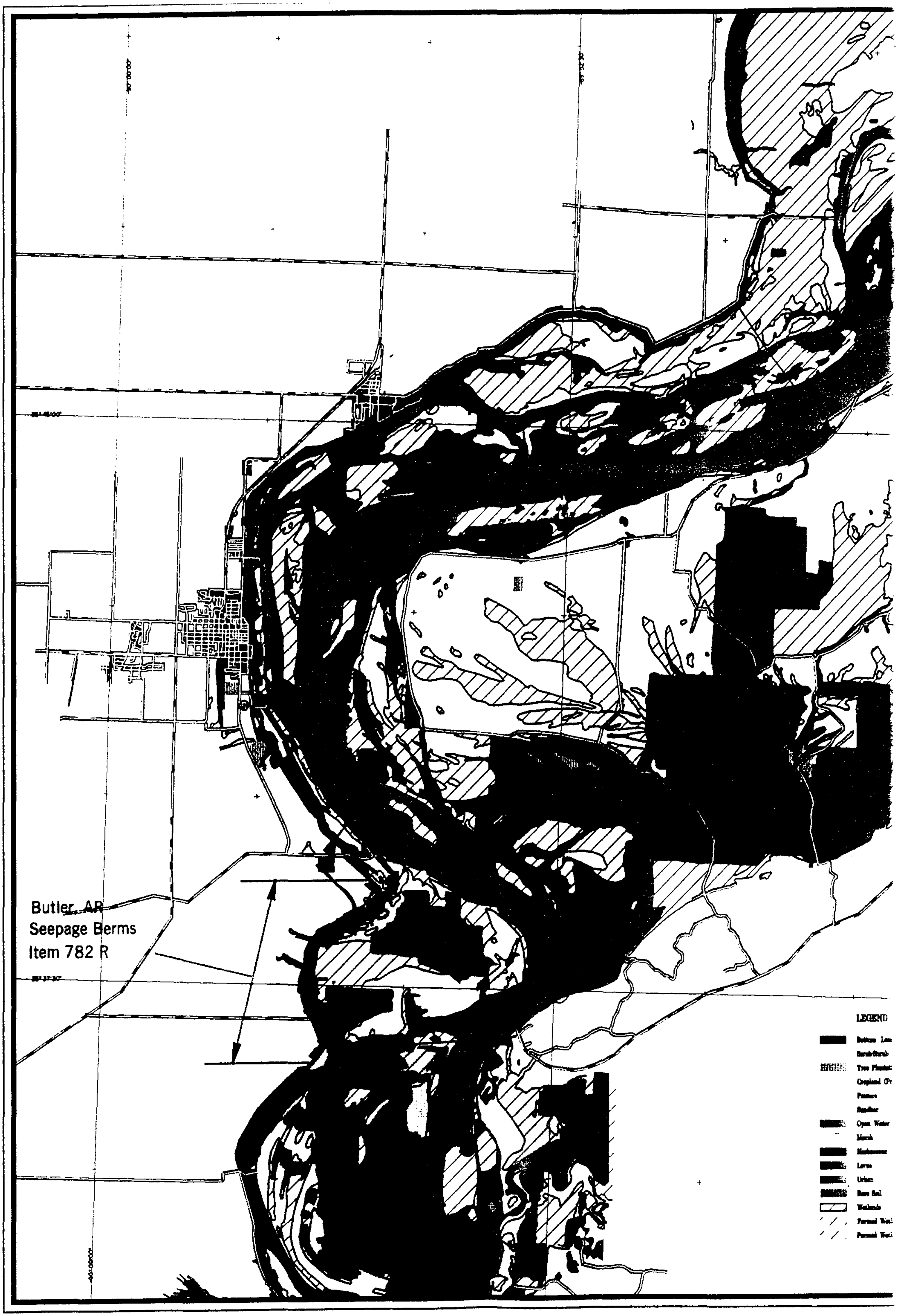

South Caruthersville, MO
Seepage Berms
Item 843 R



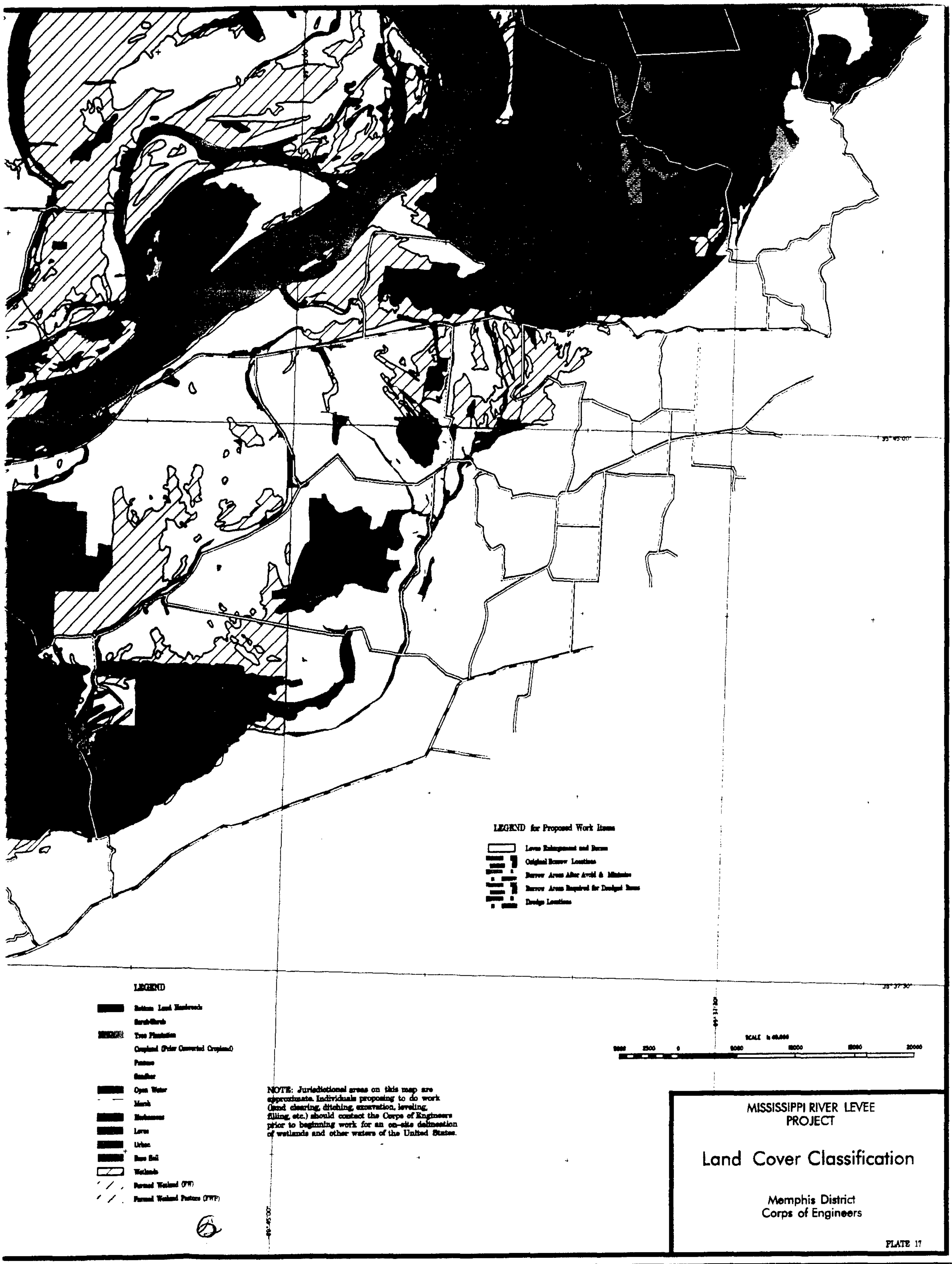
LEGEND
Tree Plantation
Cropland (Prior Converted Cropland)
Open Water
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Miston, TN
Seepage Berms
Item 841 L
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 15

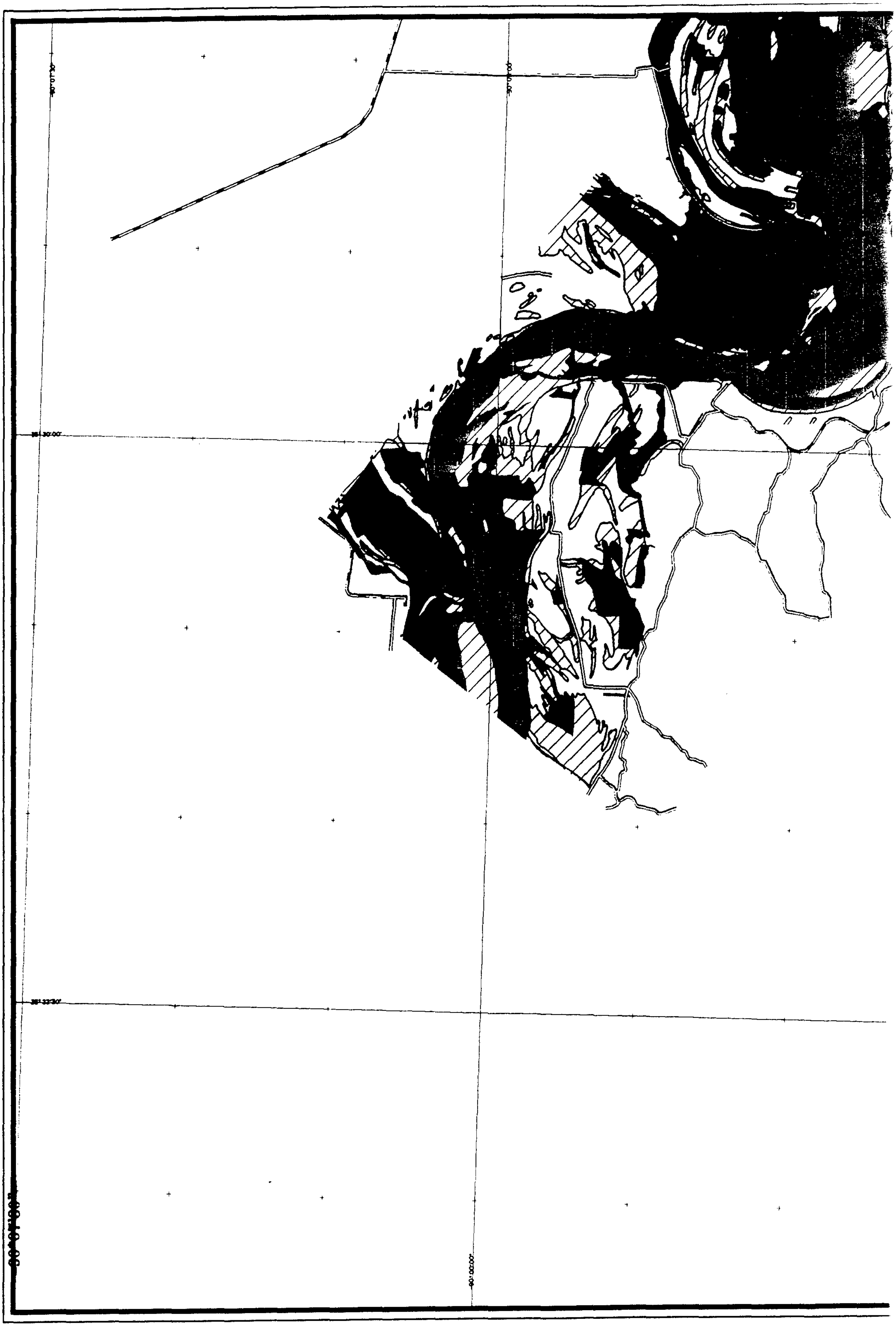

South Caruthersville, MO
Seepage Berms
Item 843 R
Baders-Cottonwood Point, MO
Seepage Berms
Item 833 R

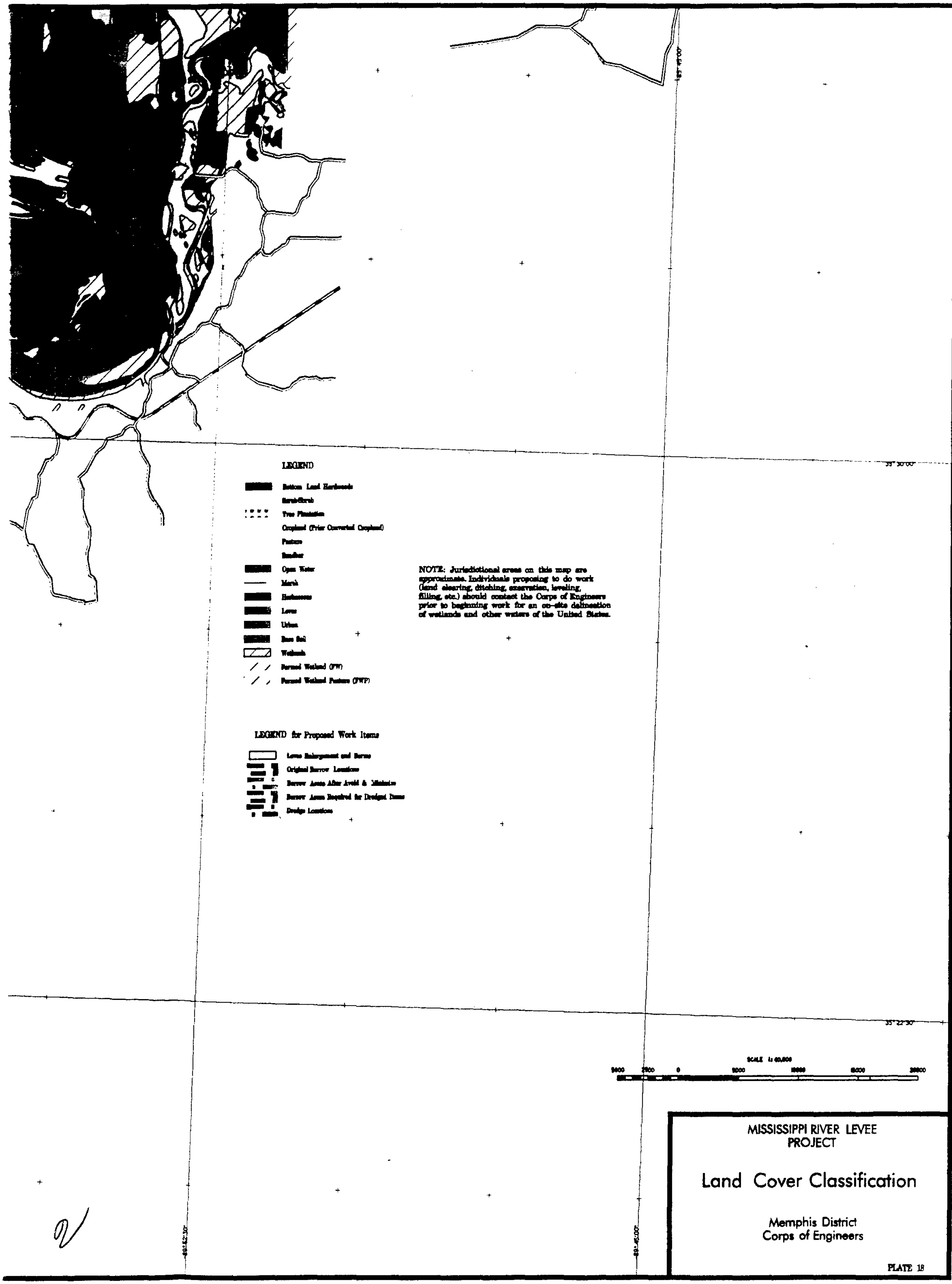

Miston, TN
Seepage Berms
Item 841 L
LEGEND
Open Water
Marsh
Herbaceous
Levee
Urban
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Borrow Areas After Avoid & Minimize
Dredge Locations
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 18


Butler, AR
Seepage Berms
Item 782 R
LEGEND
Open Water
Marsh
Levee
Urban
Bare Soil
Wetlands

(1)


LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Dredge Locations
LEGEND
Bottom Land Hardwoods
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Open Water
Marsh
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 17



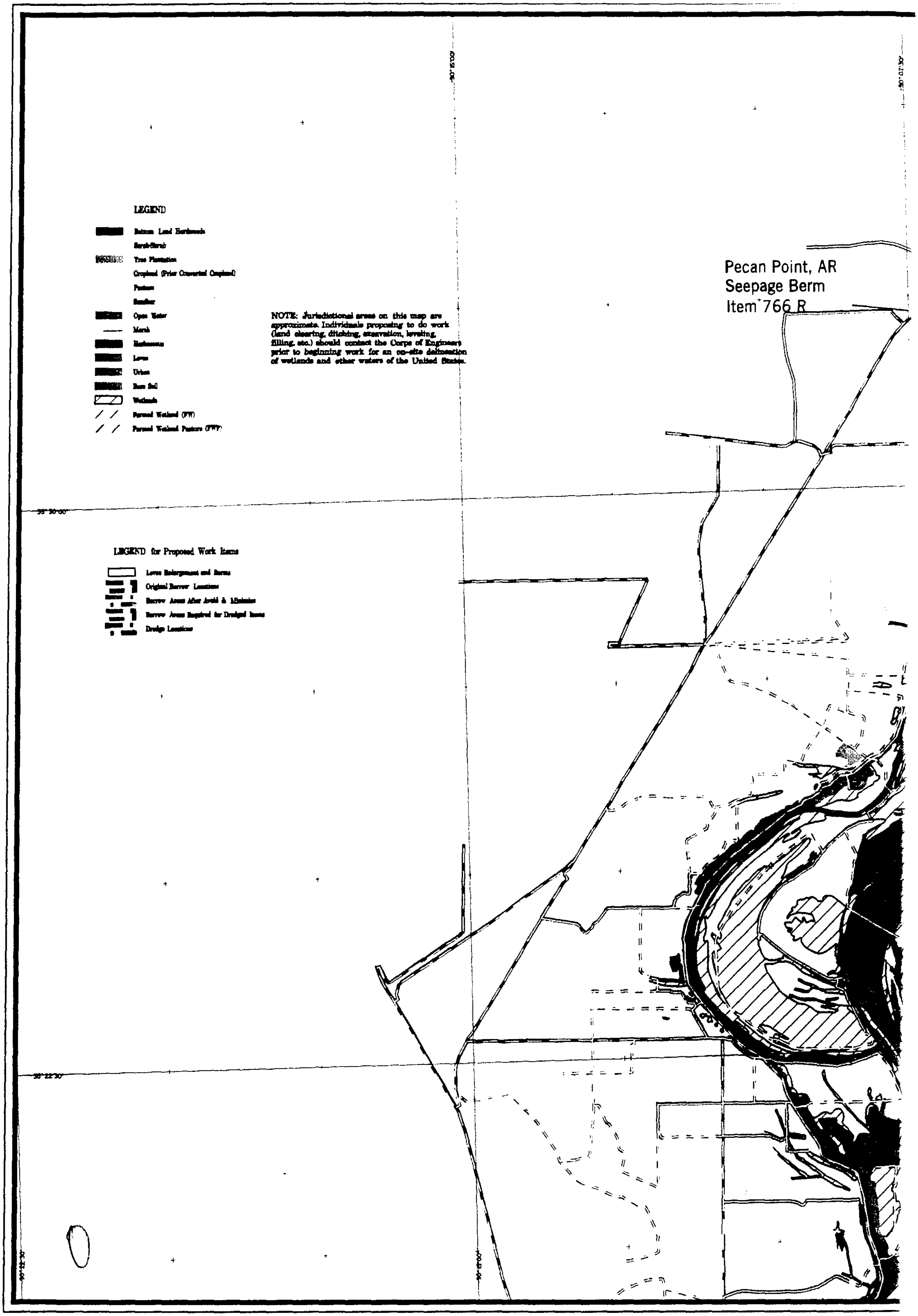


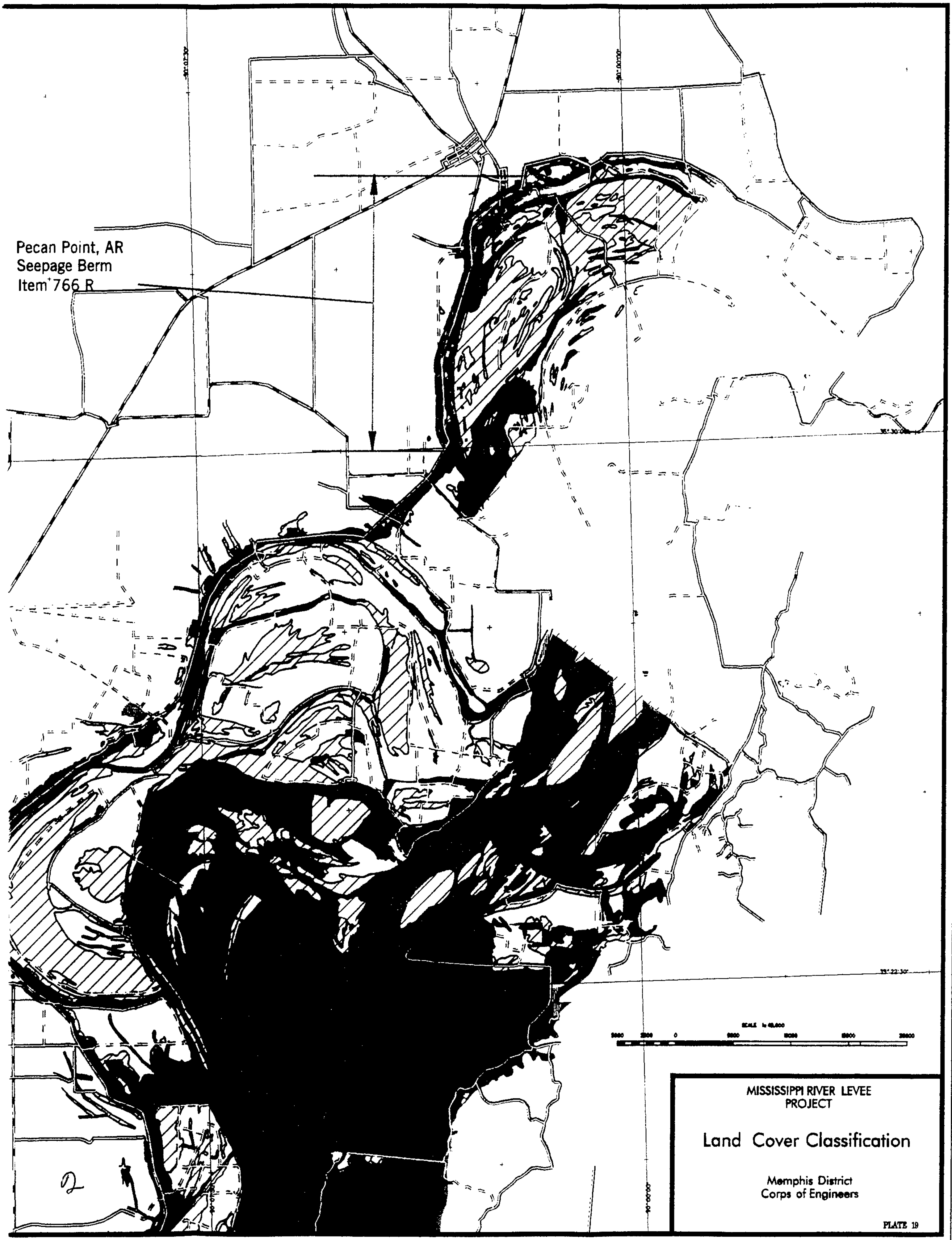
MISSISSIPPI RIVER LEVEE PROJECT

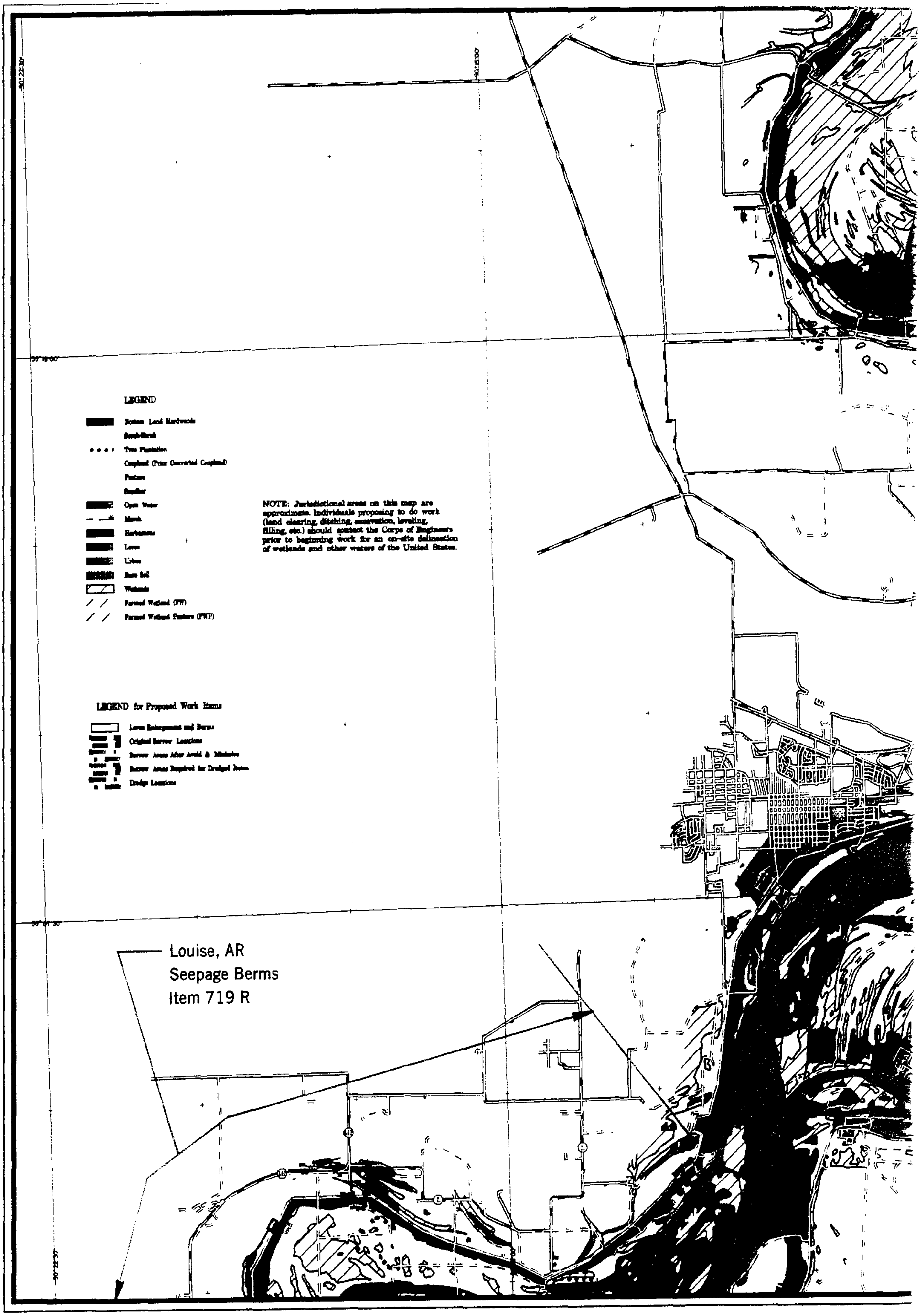
Land Cover Classification

Memphis District
Corps of Engineers

PLATE 18


Pecan Point, AR
Seepage Berm
Item 766 R
LEGEND
Tree Plantation
Cropland (Prior Converted Cropland)
Open Water
Marsh
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations


Pecan Point, AR
Seepage Berm
Item 766 R
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 19

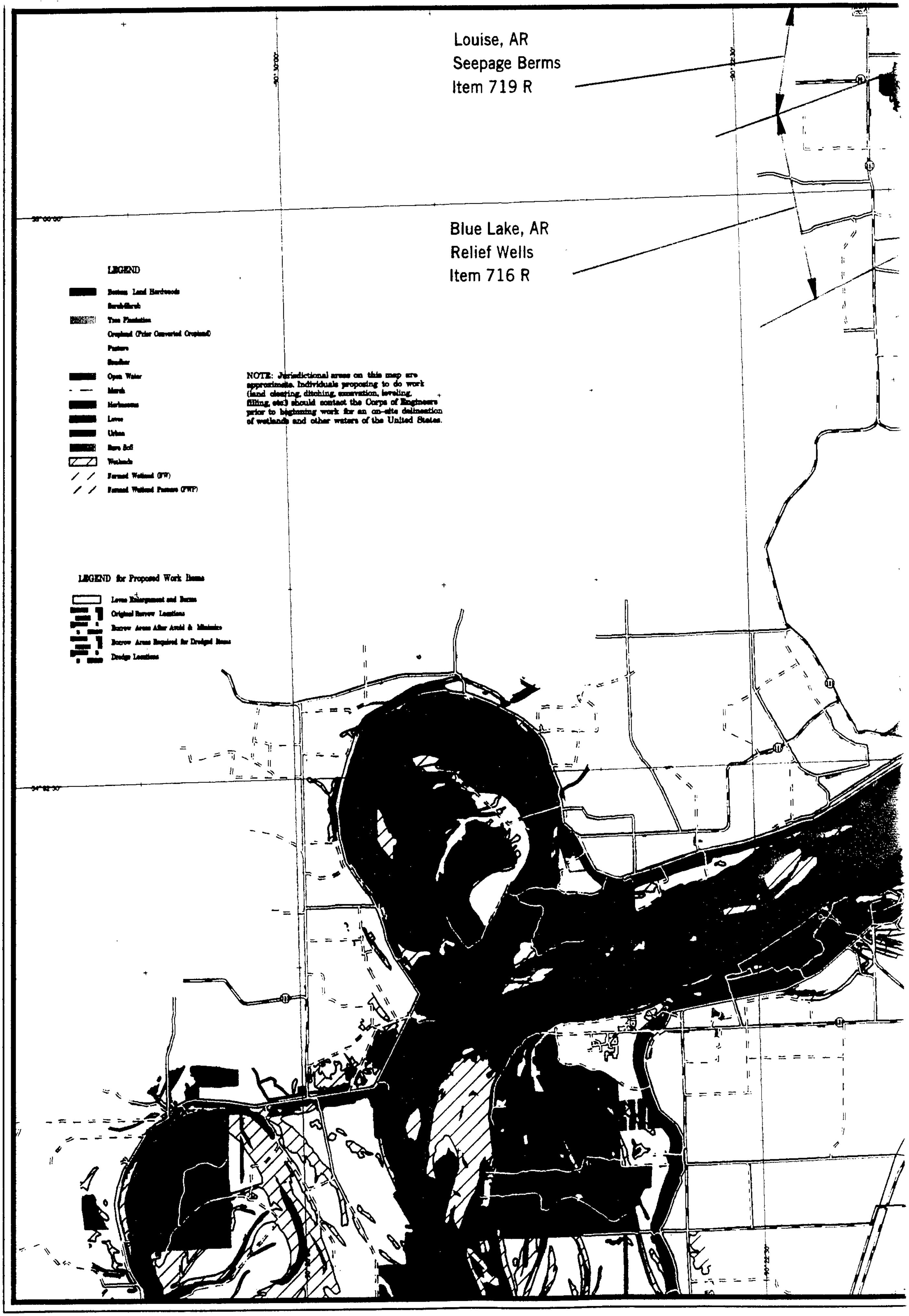

LEGEND
Bottom Land Hardwoods
Scrub-Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations
Louise, AR
Seepage Berms
Item 719 R

MISSISSIPPI RIVER LEVEE
PROJECT

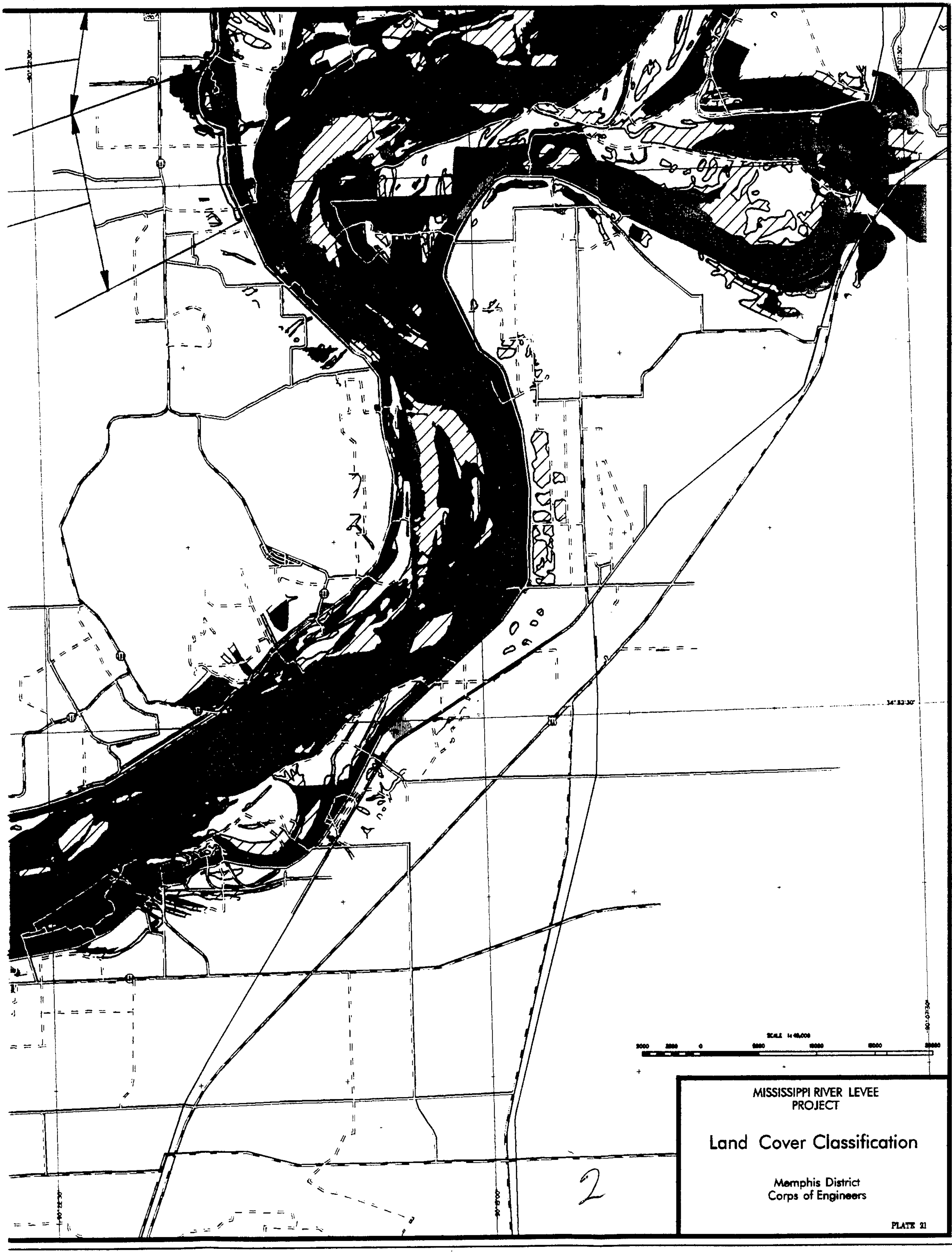
Land Cover Classification

Memphis District
Corps of Engineers

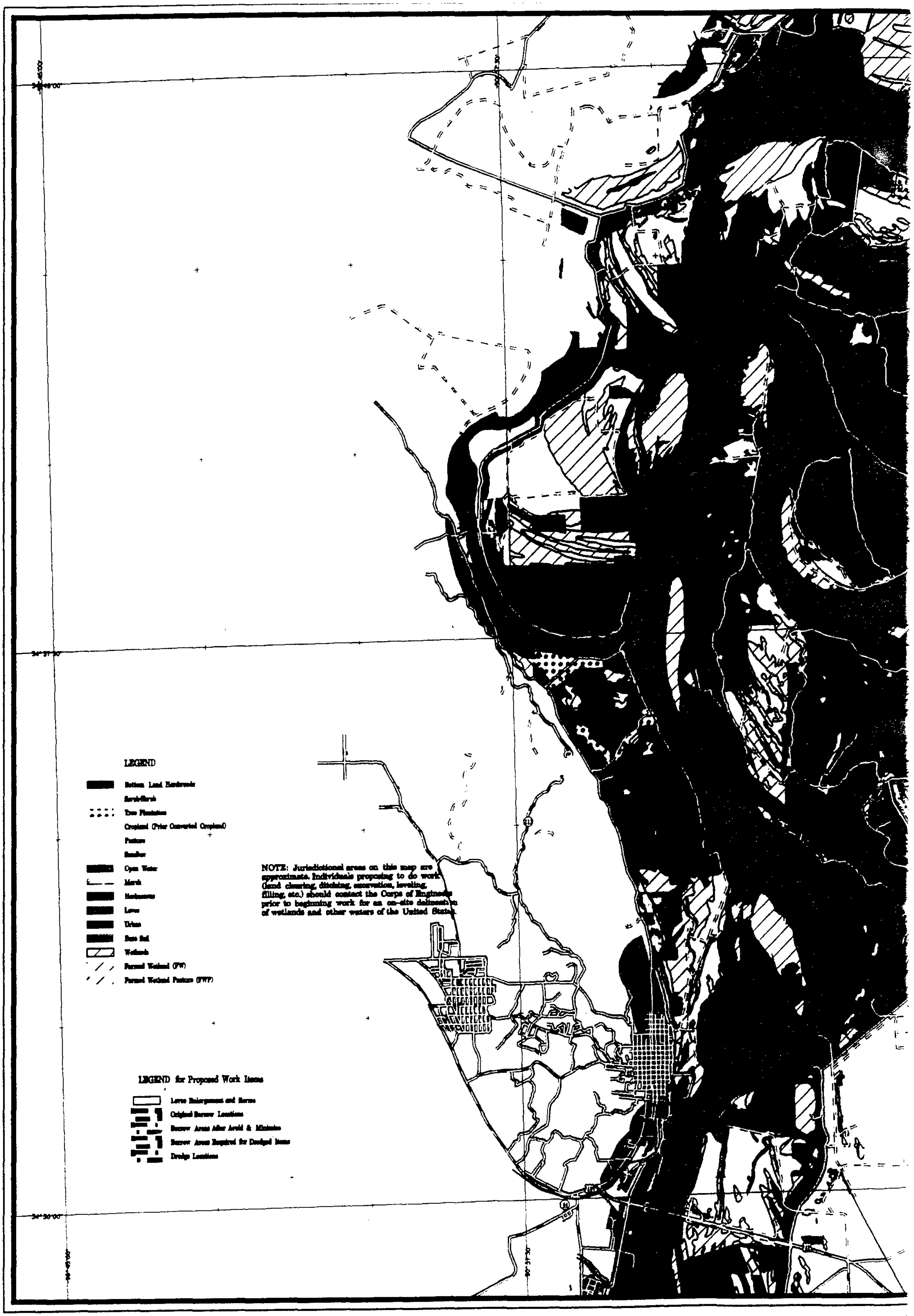
PLATE 30



Louise, AR
Seepage Berms
Item 719 R
Blue Lake, AR
Relief Wells
Item 716 R
LEGEND
Bottom Land Hardwoods
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Open Water
Marsh
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations

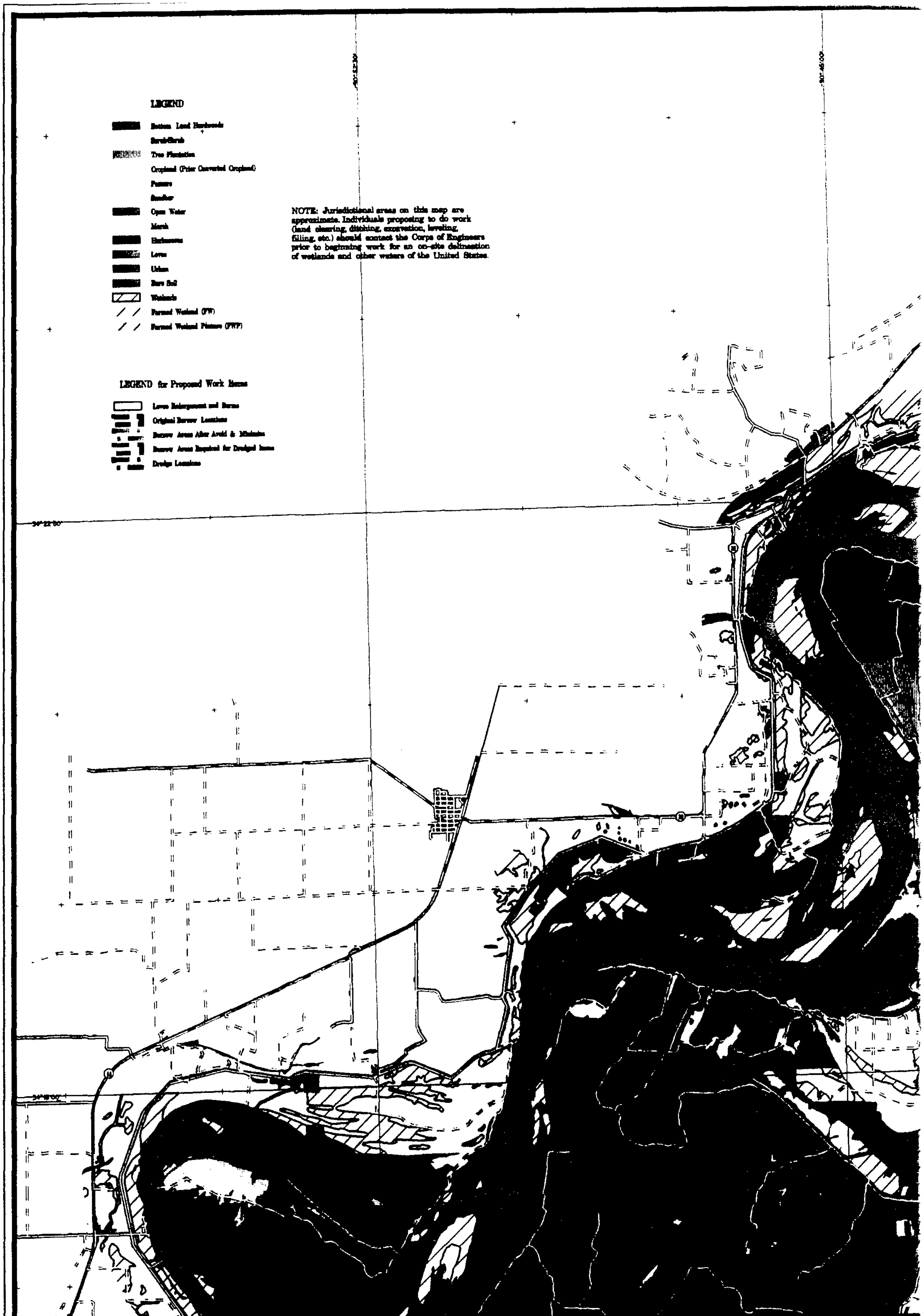


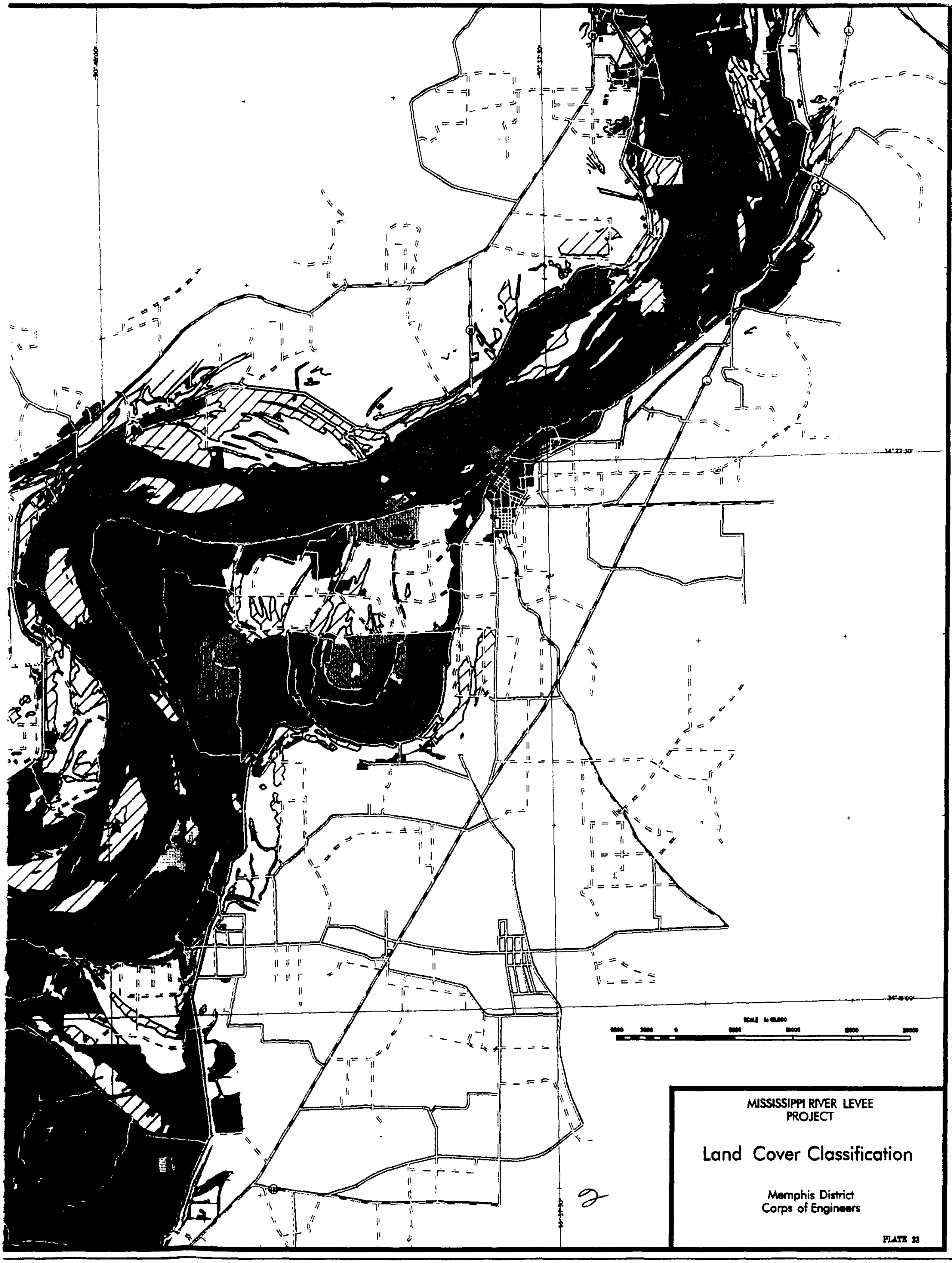
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 21
2

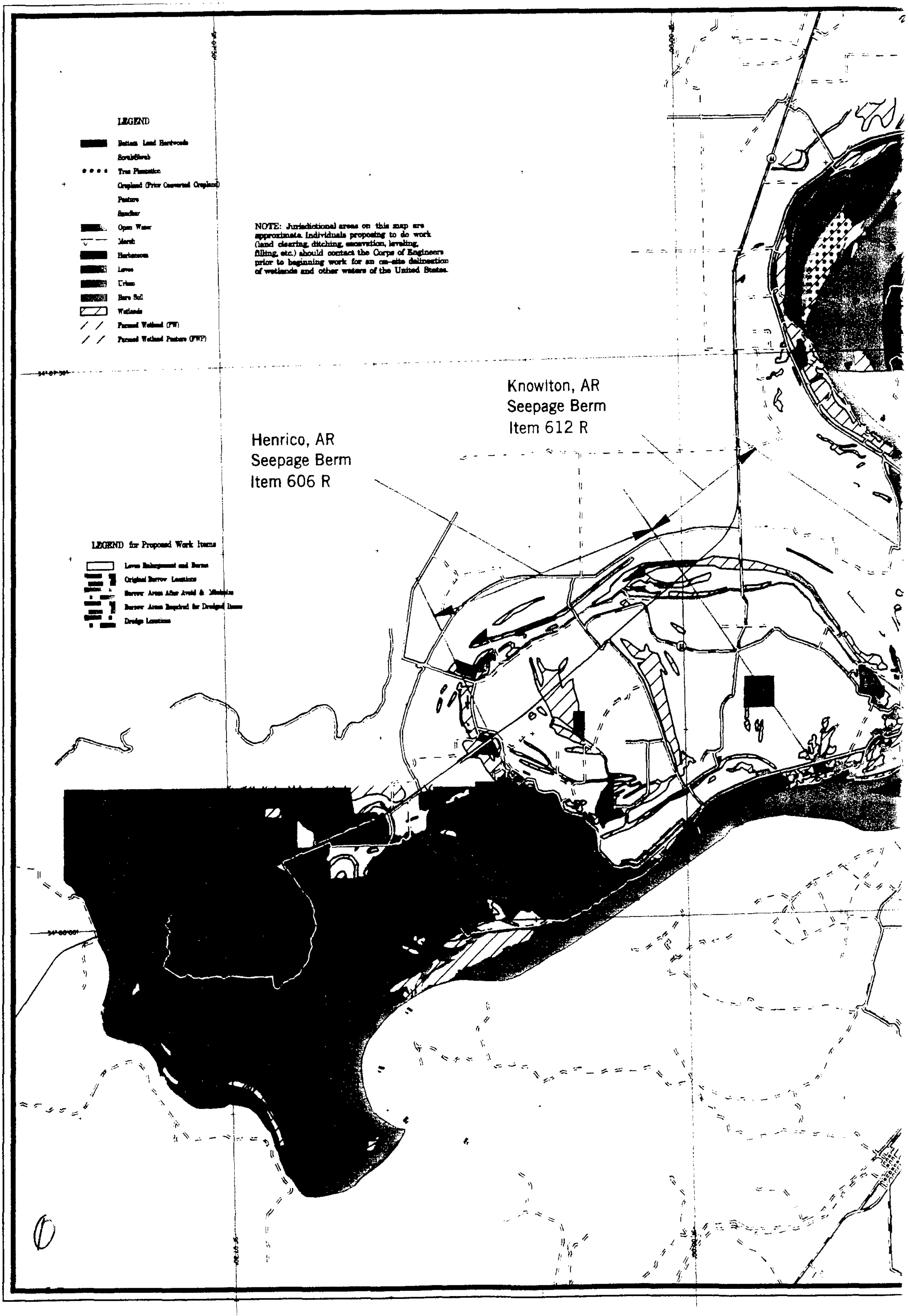

LEGEND
Bottom Land Hardwoods
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Open Water
Marsh
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations

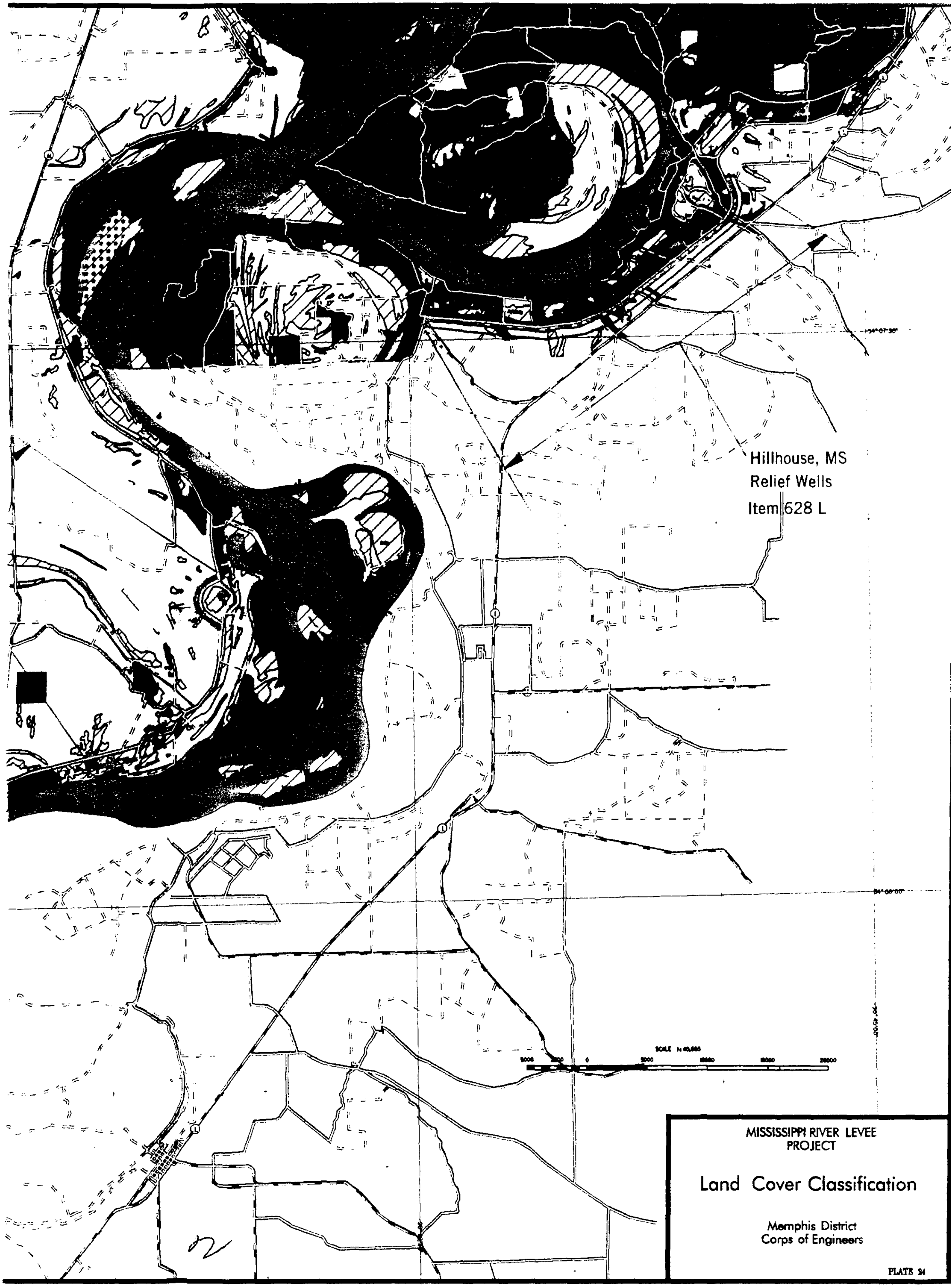
1


Austin, MS
Relief Wells
Item 675 L
Trotters, MS
Seepage Berm
Item 670 L
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 22


LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations


MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Memphis District
Corps of Engineers
PLATE 23


LEGEND
Tree Plantation
Pasture
Open Water
Marsh
Levee
Urban
Bare Soil
Wetlands
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
Knowlton, AR
Seepage Berm
Item 612 R
Henrico, AR
Seepage Berm
Item 606 R
LEGEND for Proposed Work Items
Original Borrow Locations
Dredge Locations

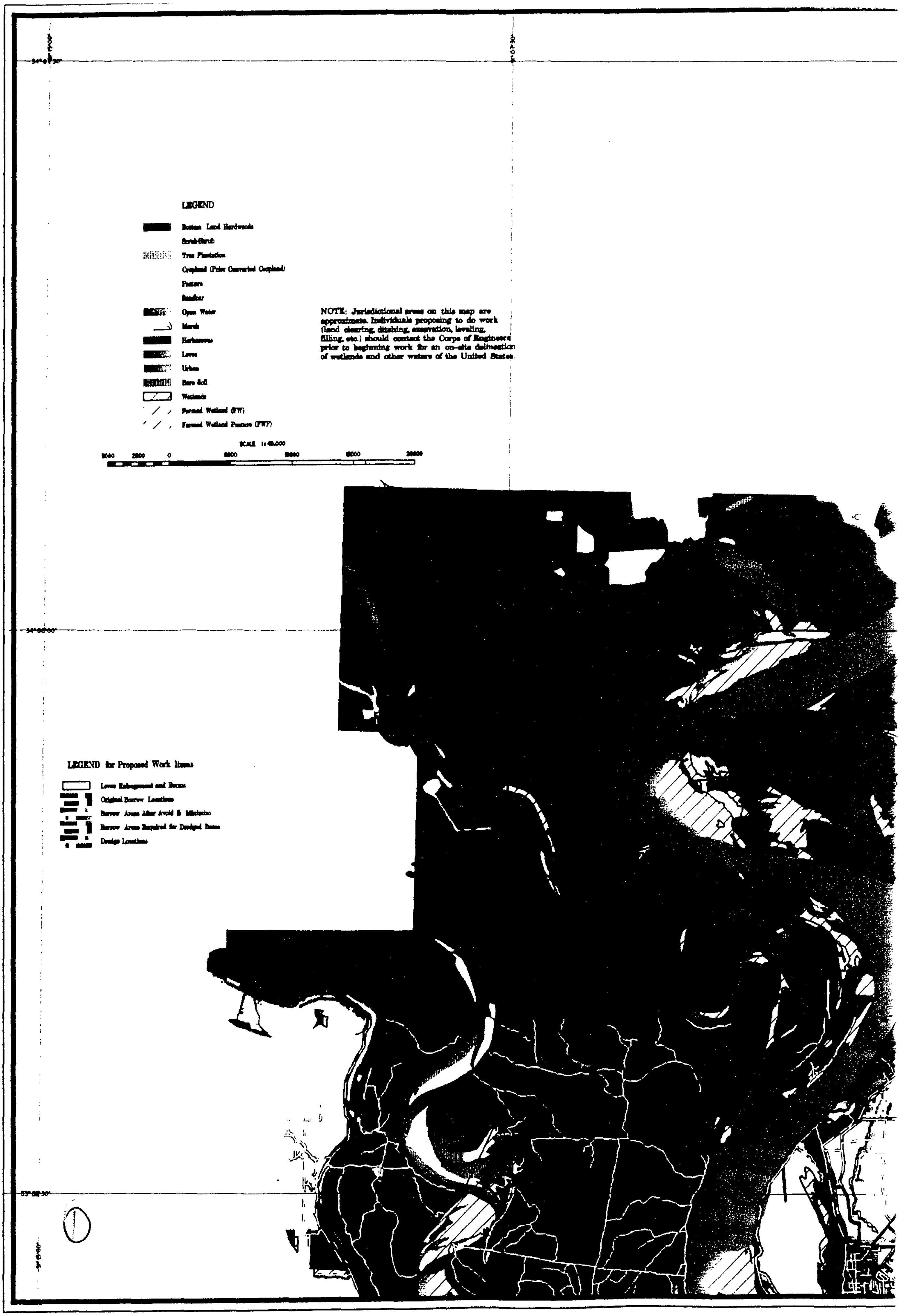


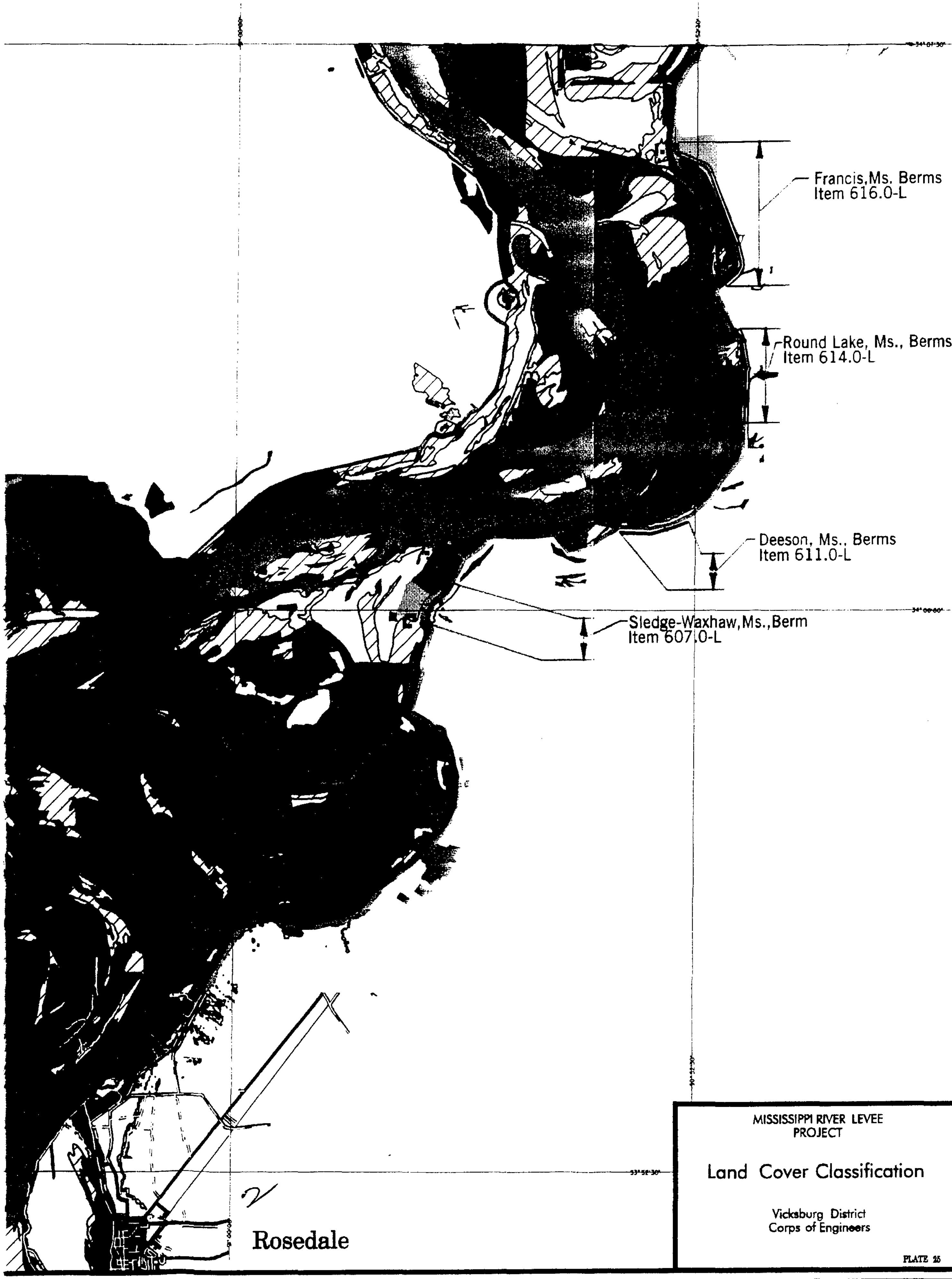
MISSISSIPPI RIVER LEVEE PROJECT

Land Cover Classification

Memphis District
Corps of Engineers

PLATE 24

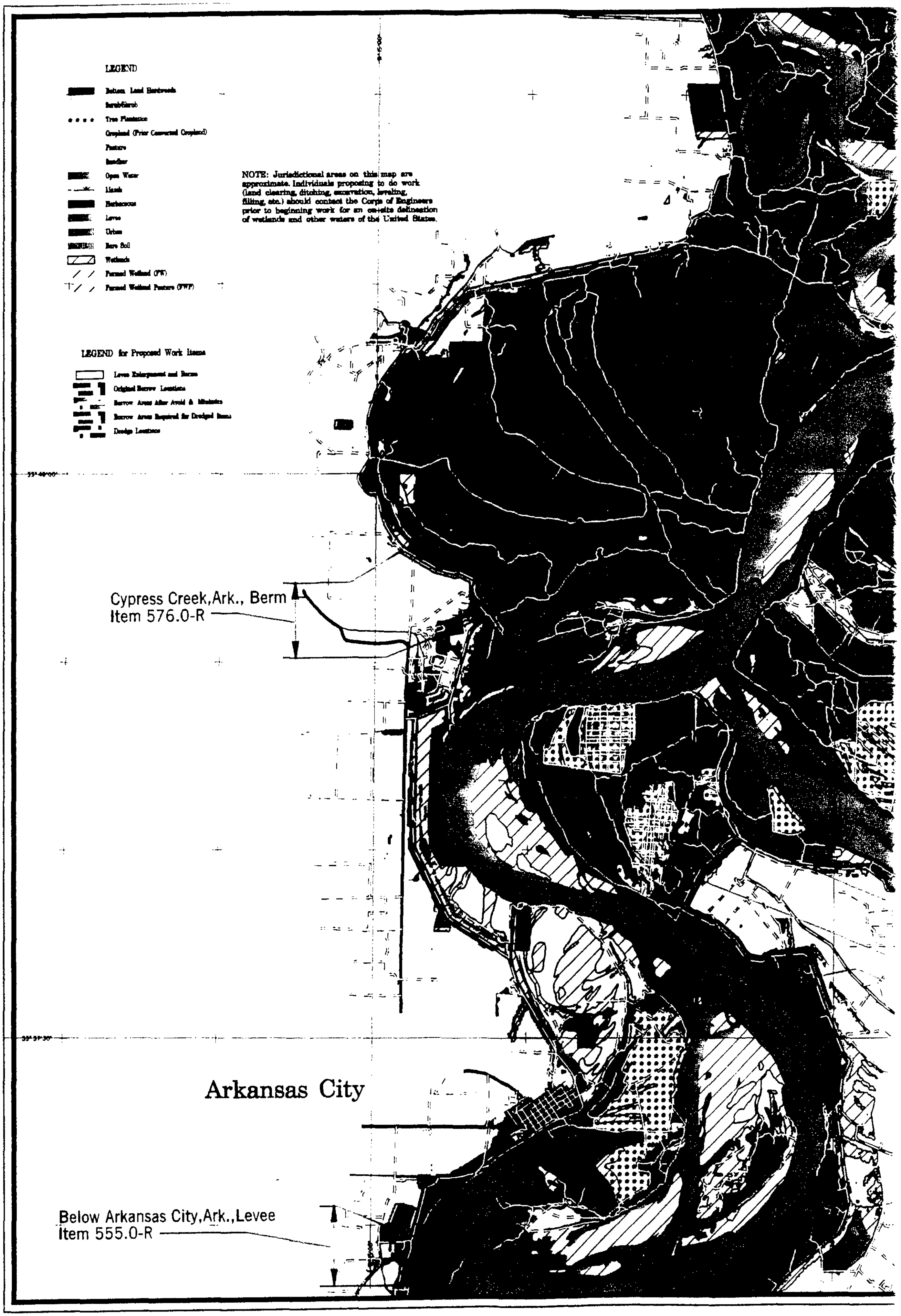

LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
SCALE 1:40,000
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Designed Berms
Dredge Locations



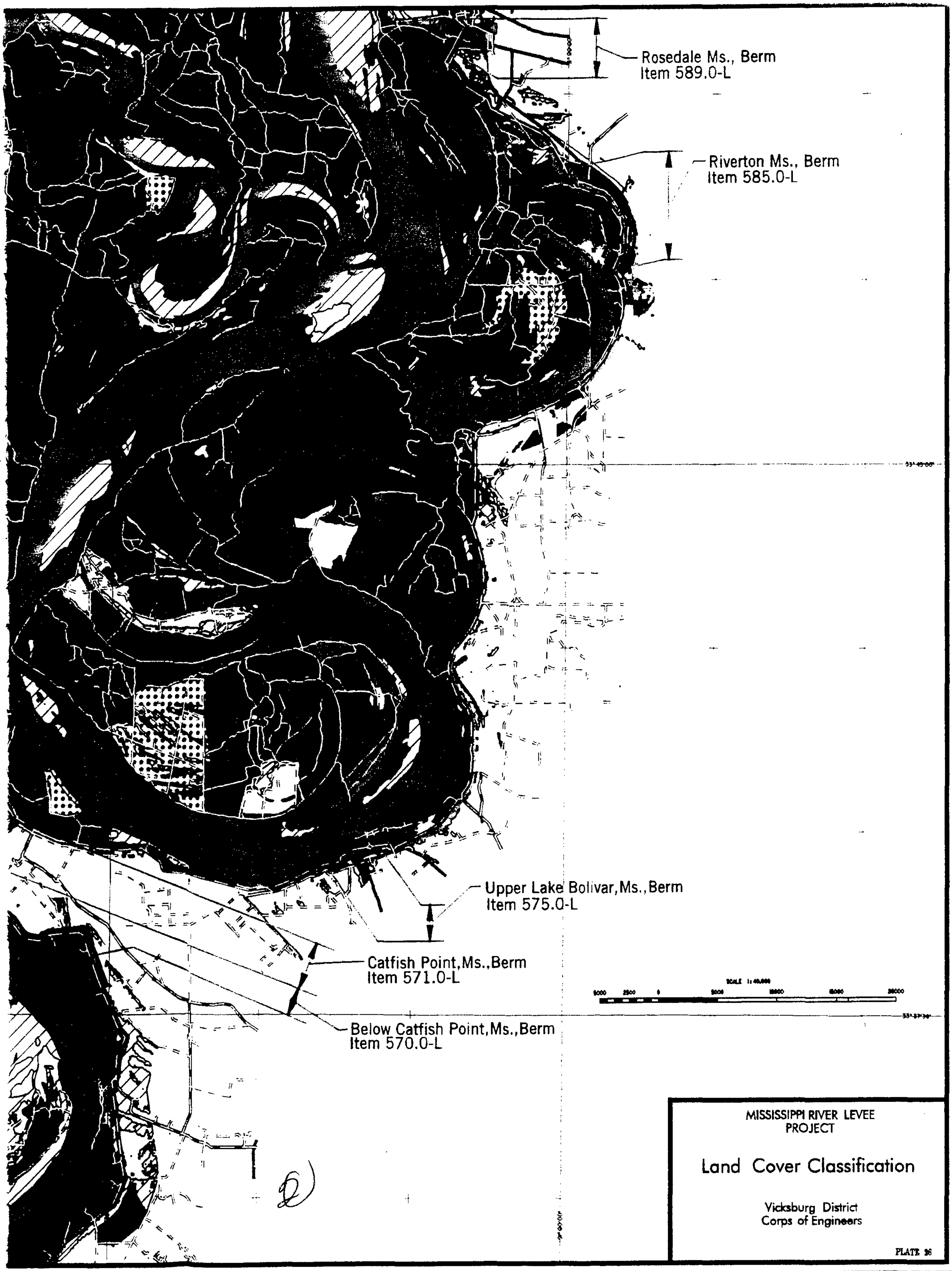
MISSISSIPPI RIVER LEVEE
PROJECT

Land Cover Classification

Vicksburg District
Corps of Engineers


LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations
Cypress Creek, Ark., Berm
Item 576.0-R
Arkansas City
Below Arkansas City, Ark., Levee
Item 555.0-R

1

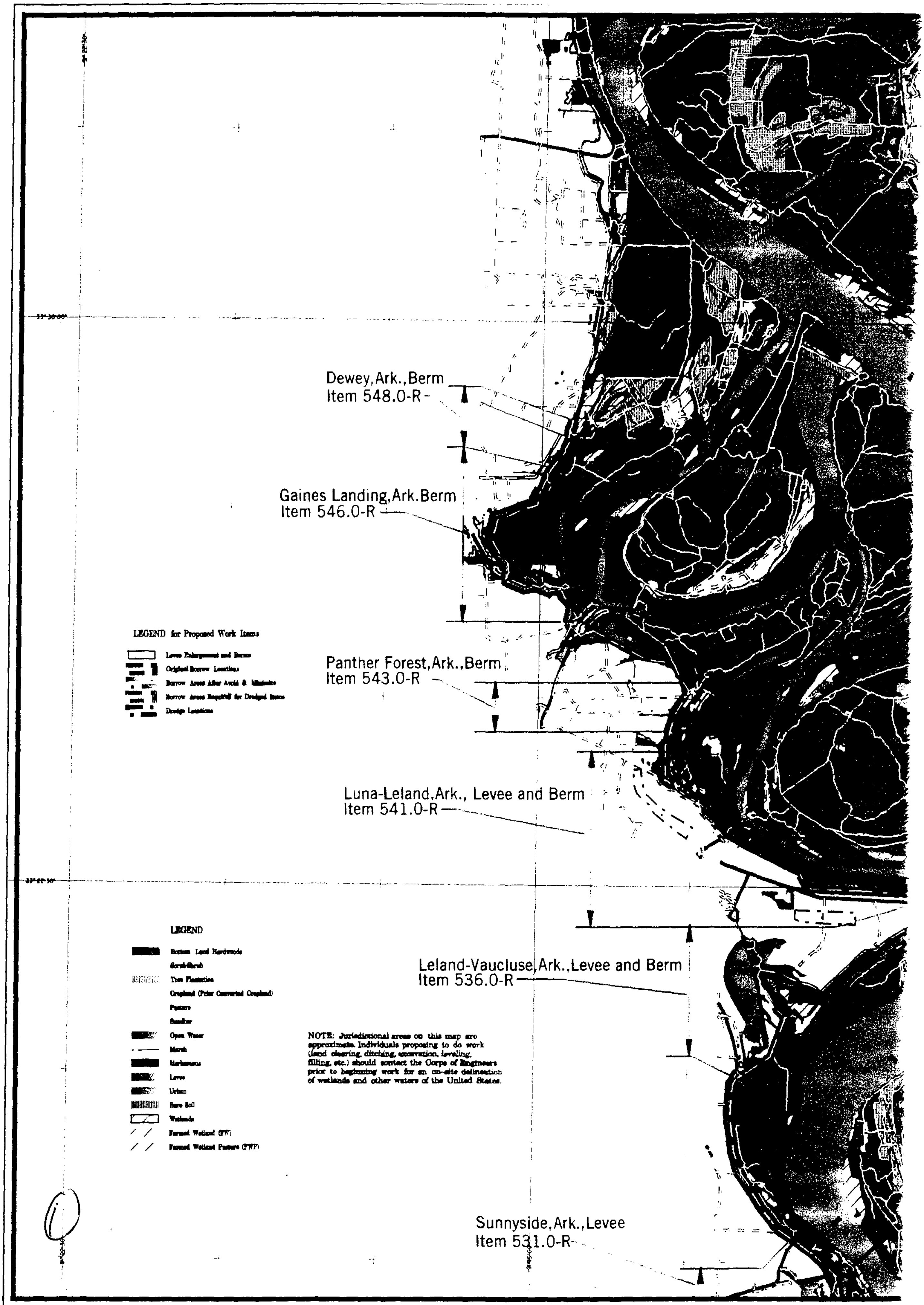


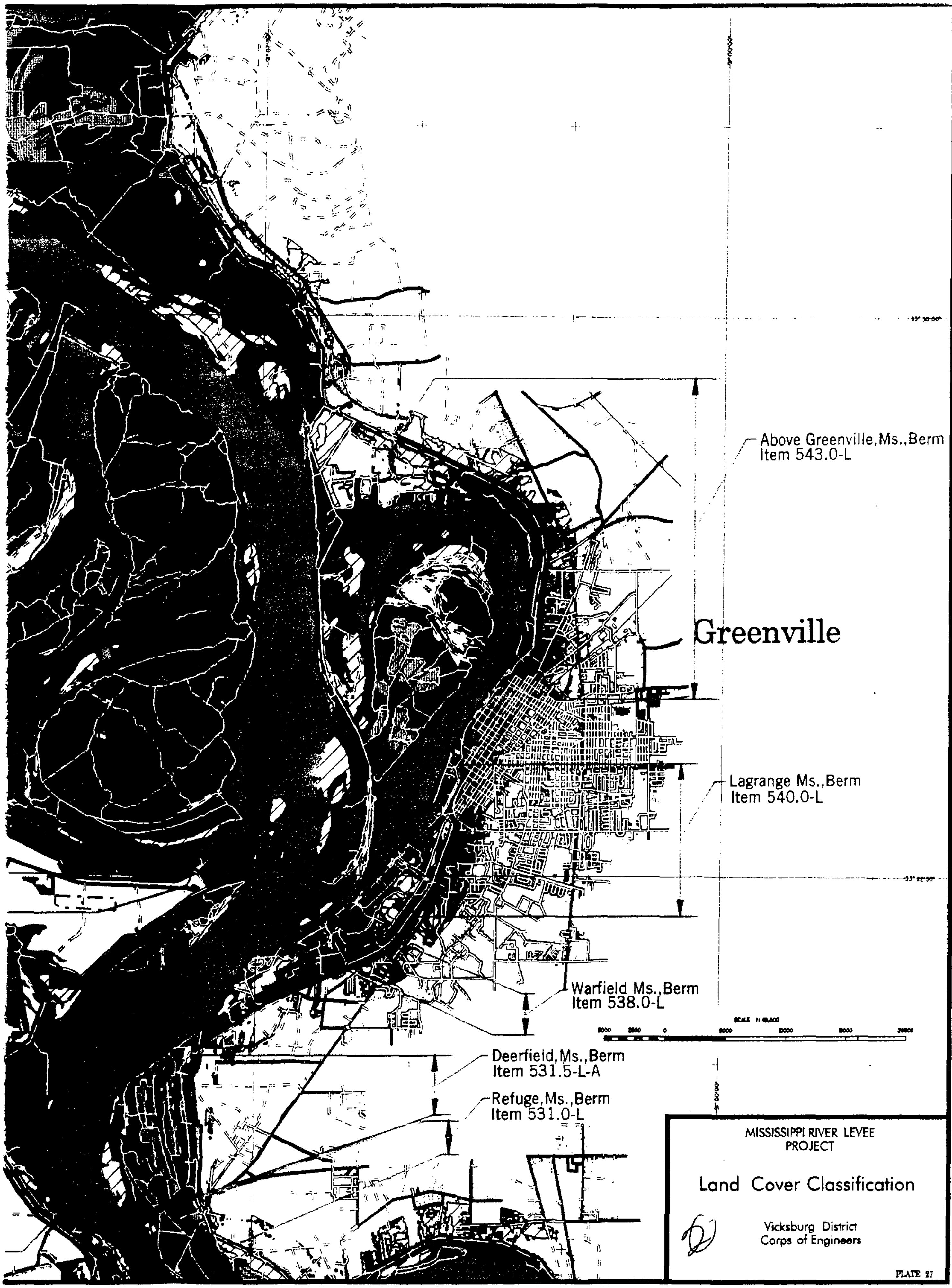
MISSISSIPPI RIVER LEVEE PROJECT

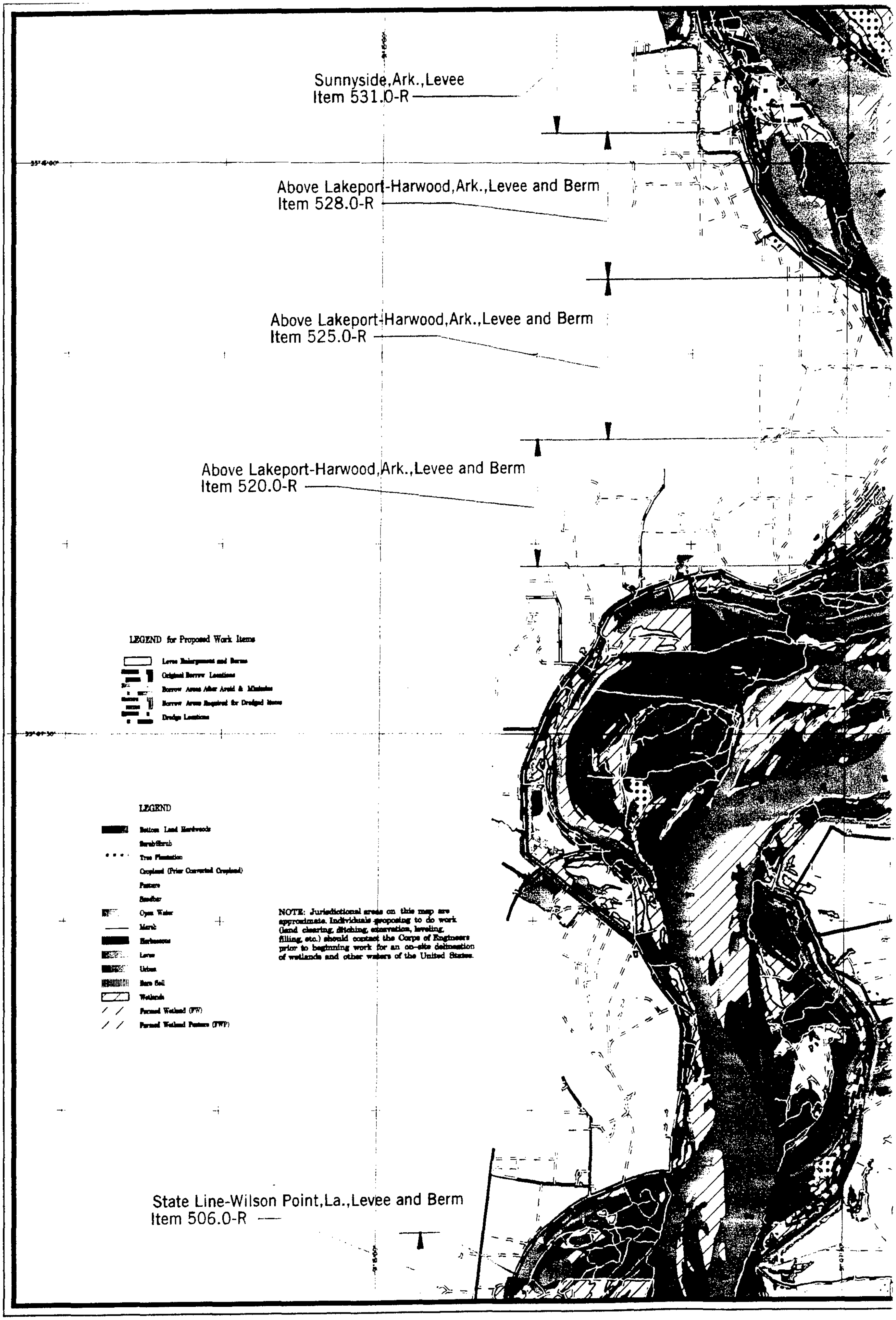
Land Cover Classification

Vicksburg District
Corps of Engineers

PLATE 26

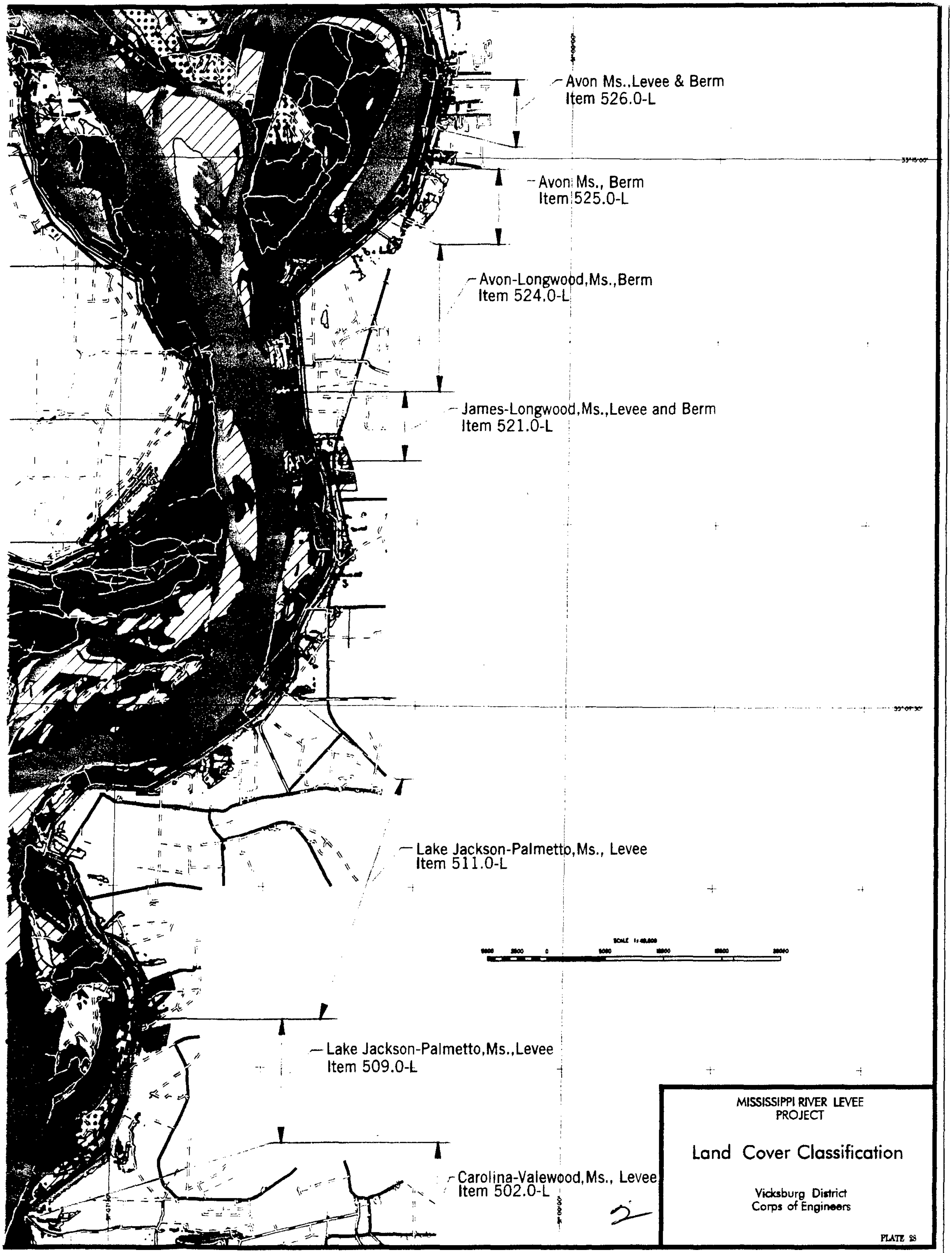

Dewey, Ark., Berm
Item 548.0-R
Gaines Landing, Ark. Berm
Item 546.0-R
Panther Forest, Ark., Berm
Item 543.0-R
Luna-Leland, Ark., Levee and Berm
Item 541.0-R
Leland-Vaucluse, Ark., Levee and Berm
Item 536.0-R
Sunnyside, Ark., Levee
Item 531.0-R
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Dredge Locations
LEGEND
Bottom Land Hardwoods
Scrub-Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.

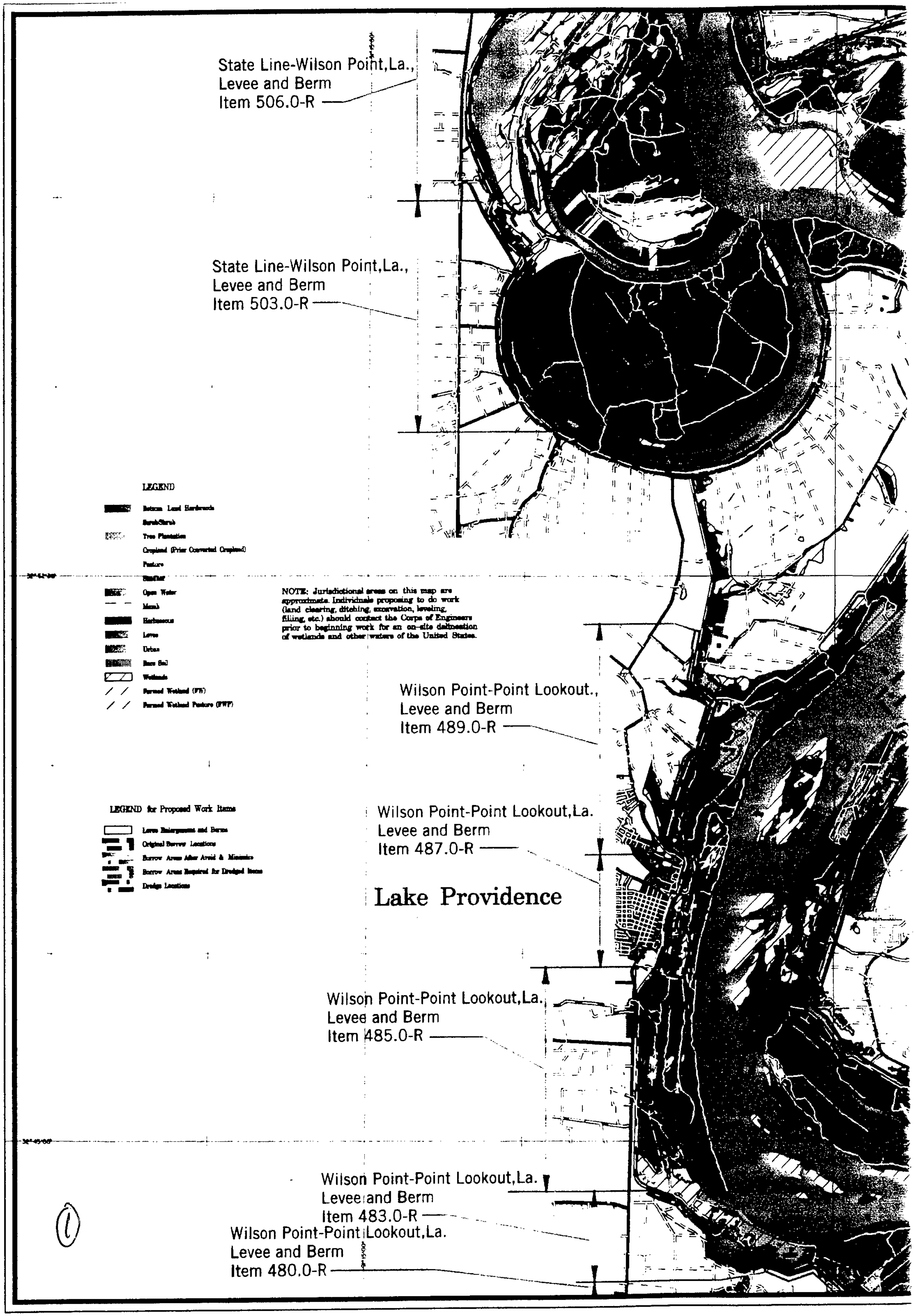

Above Greenville,Ms.,Berm
Item 543.0-L
Greenville
Lagrange Ms.,Berm
Item 540.0-L
Warfield Ms.,Berm
Item 538.0-L
Deerfield,Ms.,Berm
Item 531.5-L-A
Refuge,Ms.,Berm
Item 531.0-L
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Vicksburg District
Corps of Engineers
PLATE 27

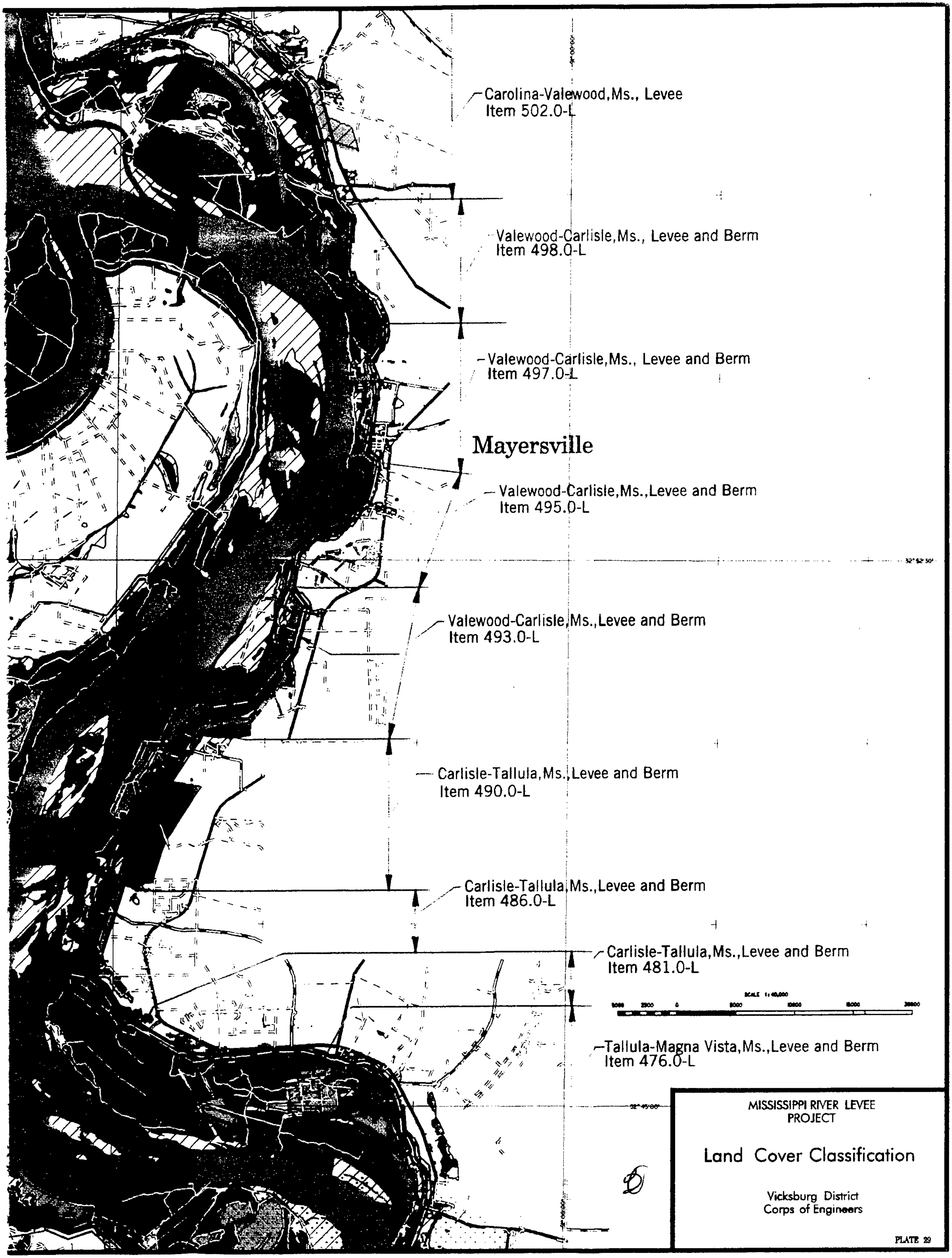


Sunnyside, Ark., Levee
Item 531.0-R
Above Lakeport-Harwood, Ark., Levee and Berm
Item 528.0-R
Above Lakeport-Harwood, Ark., Levee and Berm
Item 525.0-R
Above Lakeport-Harwood, Ark., Levee and Berm
Item 520.0-R
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
State Line-Wilson Point, La., Levee and Berm
Item 506.0-R

1


Avon Ms.,Levee & Berm
Item 526.0-L
Avon Ms., Berm
Item 525.0-L
Avon-Longwood,Ms.,Berm
Item 524.0-L
James-Longwood,Ms.,Levee and Berm
Item 521.0-L
Lake Jackson-Palmetto,Ms., Levee
Item 511.0-L
Lake Jackson-Palmetto,Ms.,Levee
Item 509.0-L
Carolina-Valewood,Ms., Levee
Item 502.0-L
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Vicksburg District
Corps of Engineers
PLATE 28


State Line-Wilson Point,La.,
Levee and Berm
Item 506.0-R
State Line-Wilson Point,La.,
Levee and Berm
Item 503.0-R
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
Wilson Point-Point Lookout.,
Levee and Berm
Item 489.0-R
LEGEND for Proposed Work Items
Levee Enlargements and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations
Wilson Point-Point Lookout,La.
Levee and Berm
Item 487.0-R
Lake Providence
Wilson Point-Point Lookout,La.
Levee and Berm
Item 485.0-R
Wilson Point-Point Lookout,La.
Levee and Berm
Item 483.0-R
Wilson Point-Point Lookout,La.
Levee and Berm
Item 480.0-R
(l)

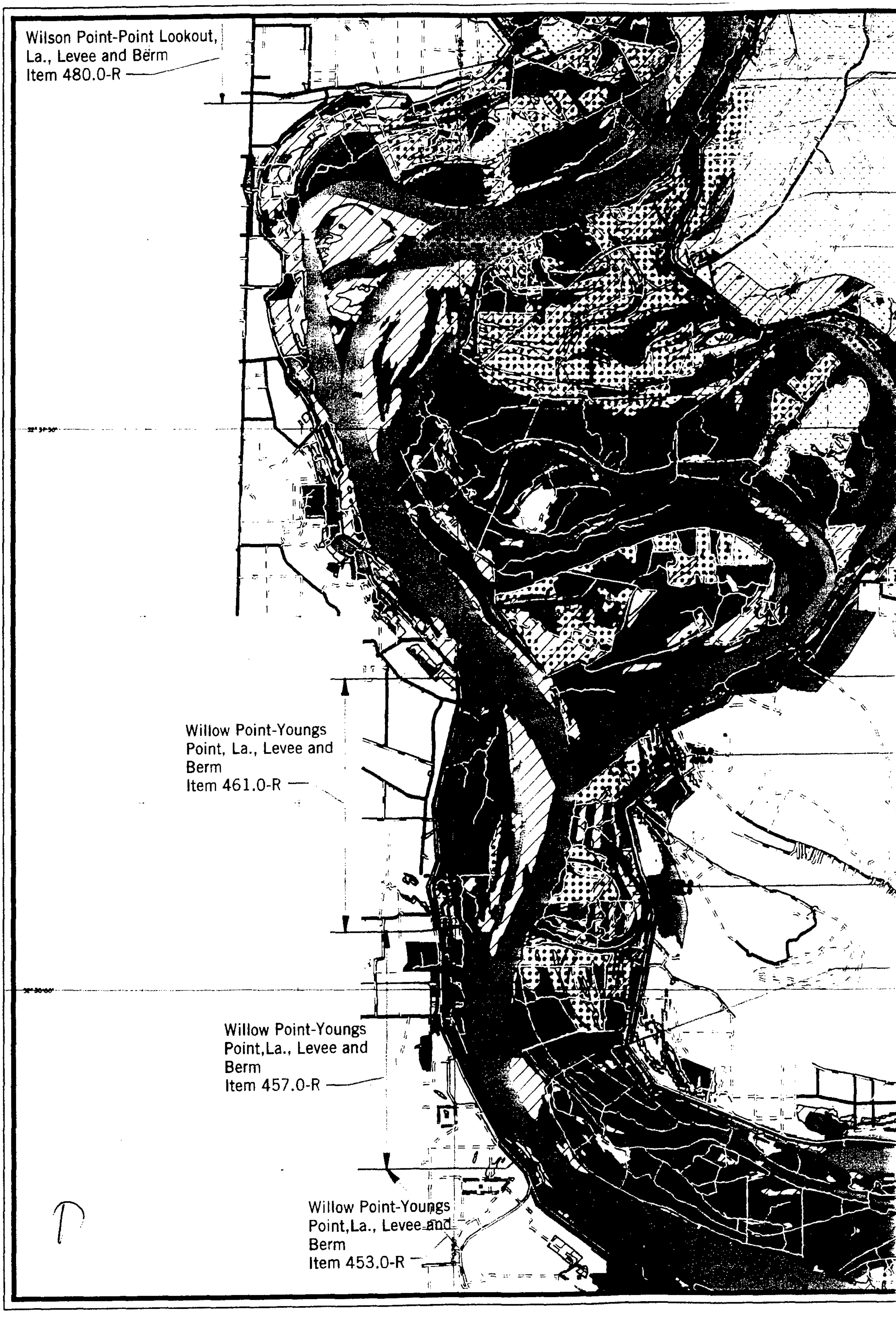


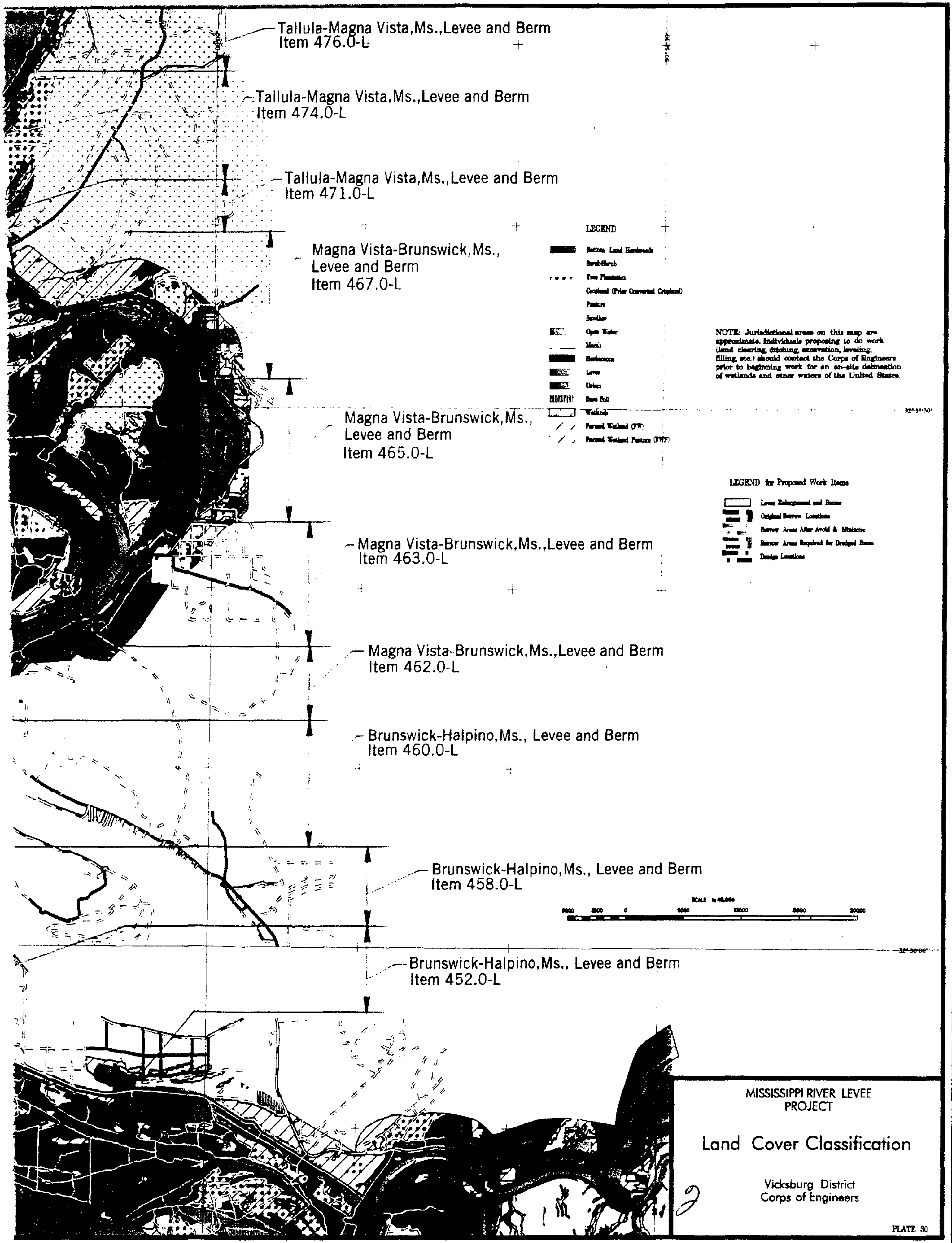
MISSISSIPPI RIVER LEVEE PROJECT

Land Cover Classification

Vicksburg District
Corps of Engineers

PLATE 29


Wilson Point-Point Lookout, La., Levee and Berm Item 480.0-R
Willow Point-Youngs Point, La., Levee and Berm Item 461.0-R
Willow Point-Youngs Point,La., Levee and Berm Item 457.0-R
Willow Point-Youngs Point,La., Levee and Berm Item 453.0-R

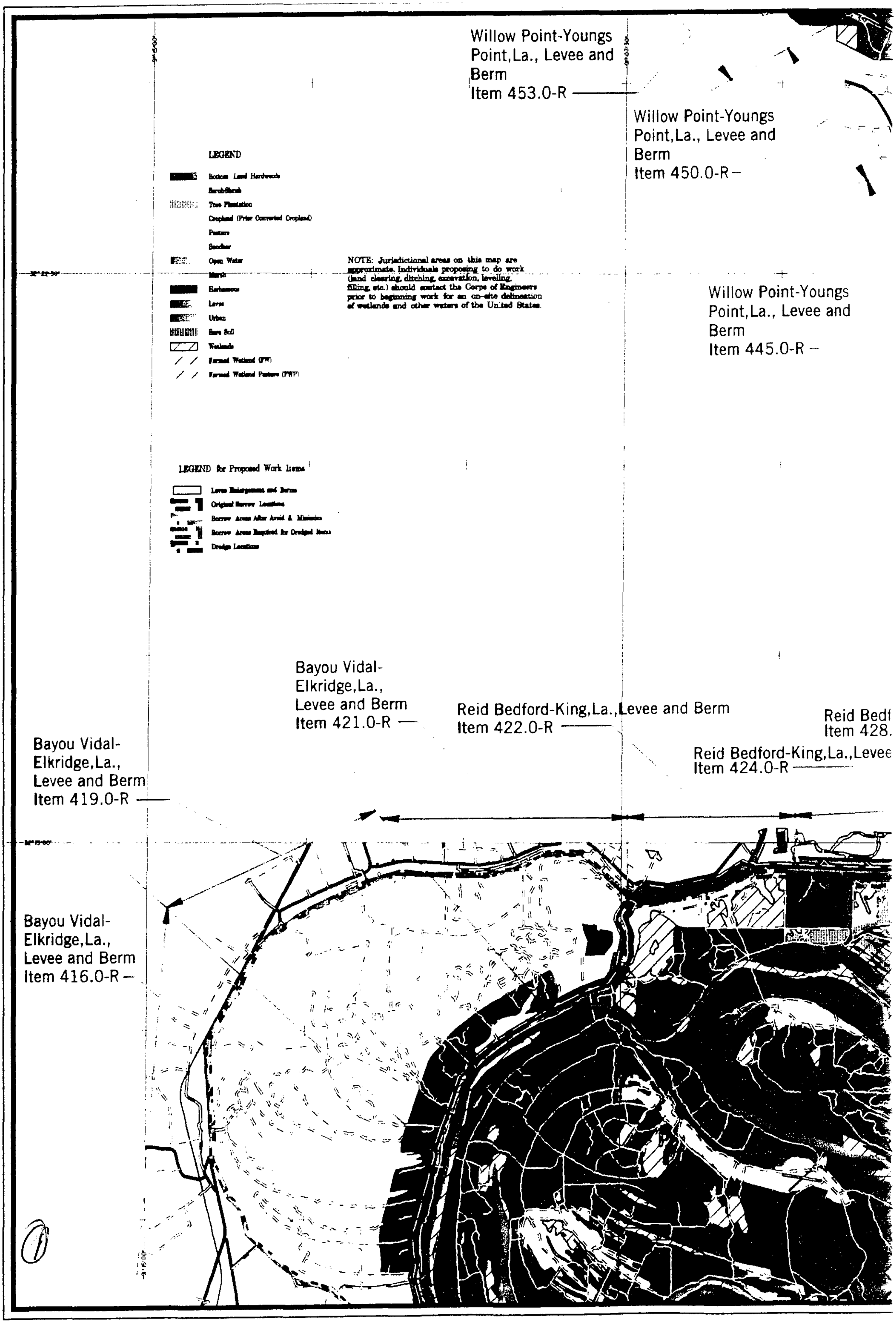


MISSISSIPPI RIVER LEVEE PROJECT

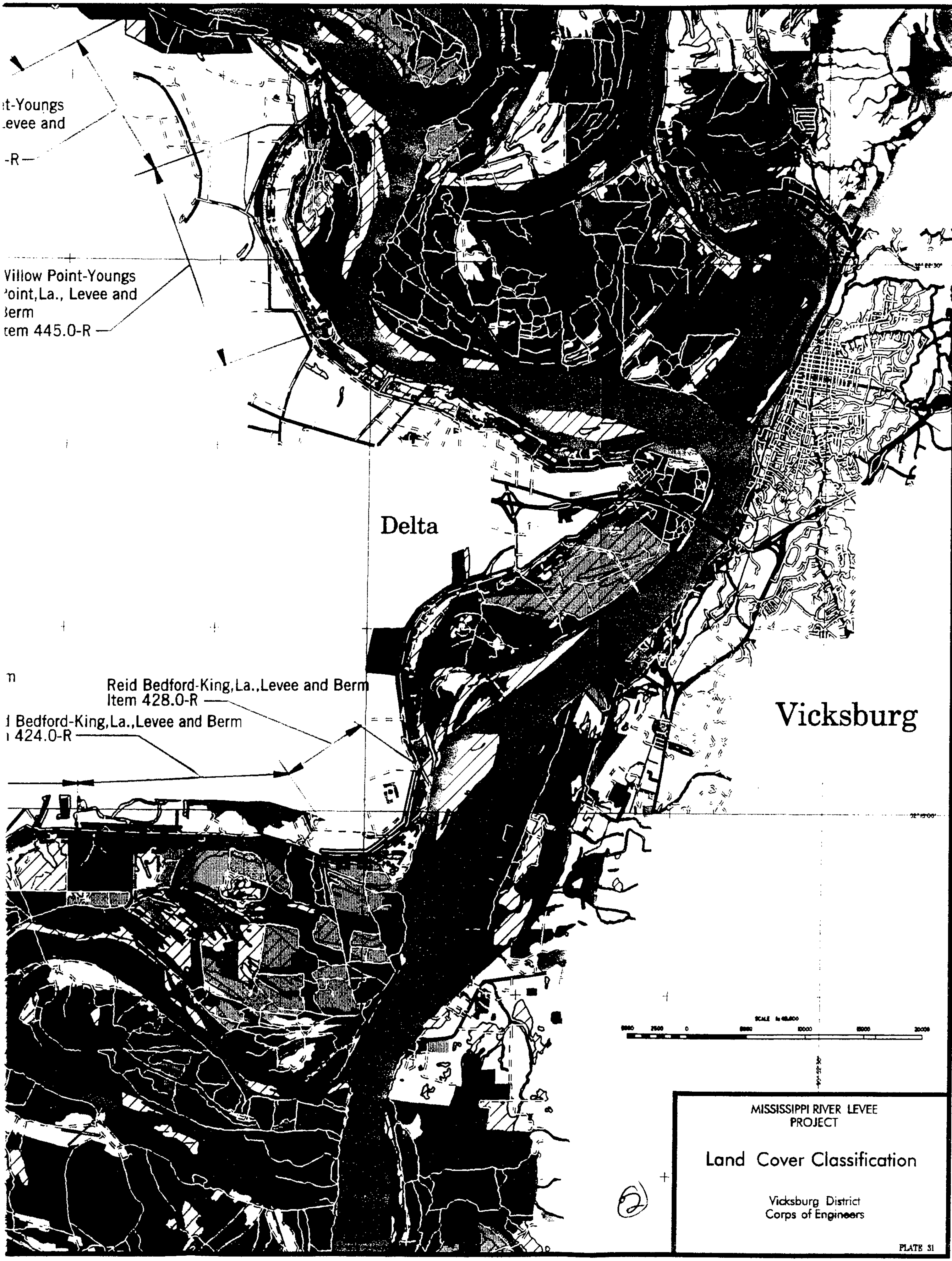
Land Cover Classification

Vicksburg District
Corps of Engineers

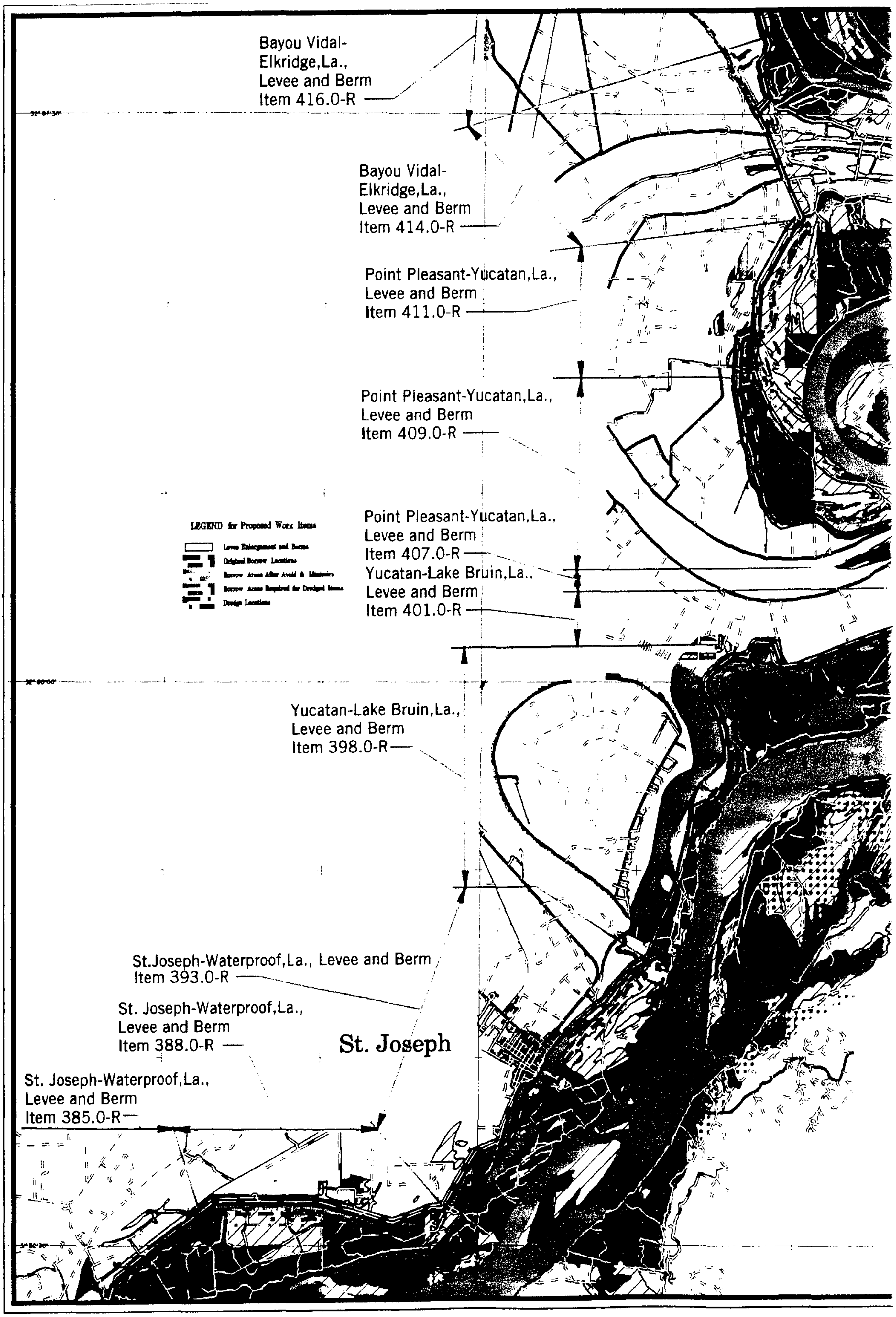
PLATE 30



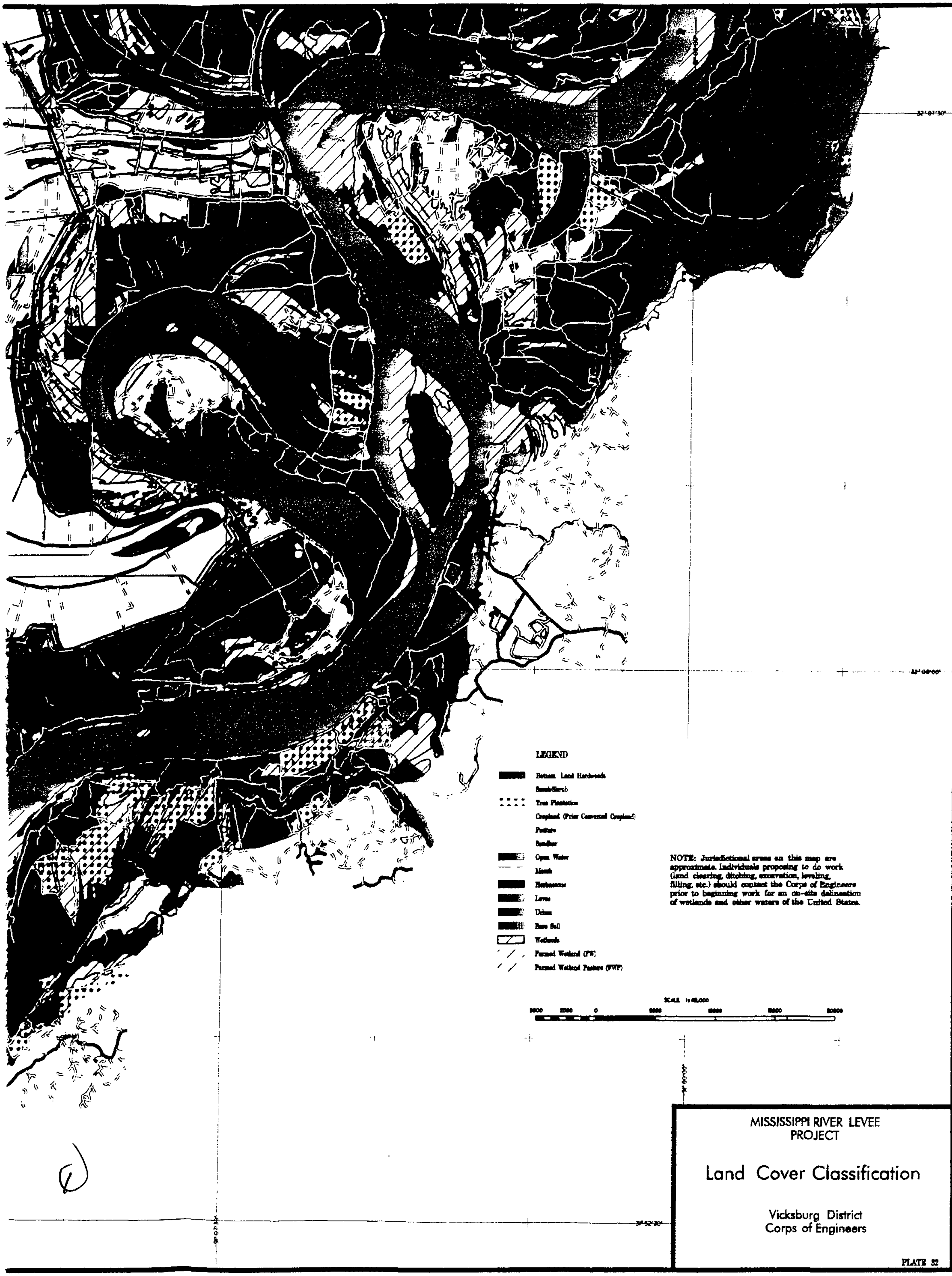
Willow Point-Youngs Point,La., Levee and Berm
Item 453.0-R
Willow Point-Youngs Point,La., Levee and Berm
Item 450.0-R
Willow Point-Youngs Point,La., Levee and Berm
Item 445.0-R
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
LEGEND for Proposed Work Items
Levee Enlargements and Berms
Original Borrow Locations
Dredge Locations
Bayou Vidal-Elkridge,La., Levee and Berm
Item 421.0-R
Reid Bedford-King,La.,Levee and Berm
Item 422.0-R
Reid Bedf
Item 428.
Reid Bedford-King,La.,Levee
Item 424.0-R
Bayou Vidal-Elkridge,La., Levee and Berm
Item 419.0-R
Bayou Vidal-Elkridge,La., Levee and Berm
Item 416.0-R



t-Youngs
.evee and
-R
Villow Point-Youngs
'oint,La., Levee and
Berm
tem 445.0-R
Delta
Vicksburg
n
Reid Bedford-King,La.,Levee and Berm
Item 428.0-R
d Bedford-King,La.,Levee and Berm
1 424.0-R
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
Vicksburg District
Corps of Engineers
PLATE 31



Bayou Vidal-Elkridge,La., Levee and Berm Item 416.0-R
Bayou Vidal-Elkridge,La., Levee and Berm Item 414.0-R
Point Pleasant-Yucatan,La., Levee and Berm Item 411.0-R
Point Pleasant-Yucatan,La., Levee and Berm Item 409.0-R
LEGEND for Proposed Work Items
Original Borrow Locations
Dredge Locations
Point Pleasant-Yucatan,La., Levee and Berm Item 407.0-R
Yucatan-Lake Bruin,La., Levee and Berm Item 401.0-R
Yucatan-Lake Bruin,La., Levee and Berm Item 398.0-R
St.Joseph-Waterproof,La., Levee and Berm Item 393.0-R
St. Joseph-Waterproof,La., Levee and Berm Item 388.0-R
St. Joseph
St. Joseph-Waterproof,La., Levee and Berm Item 385.0-R

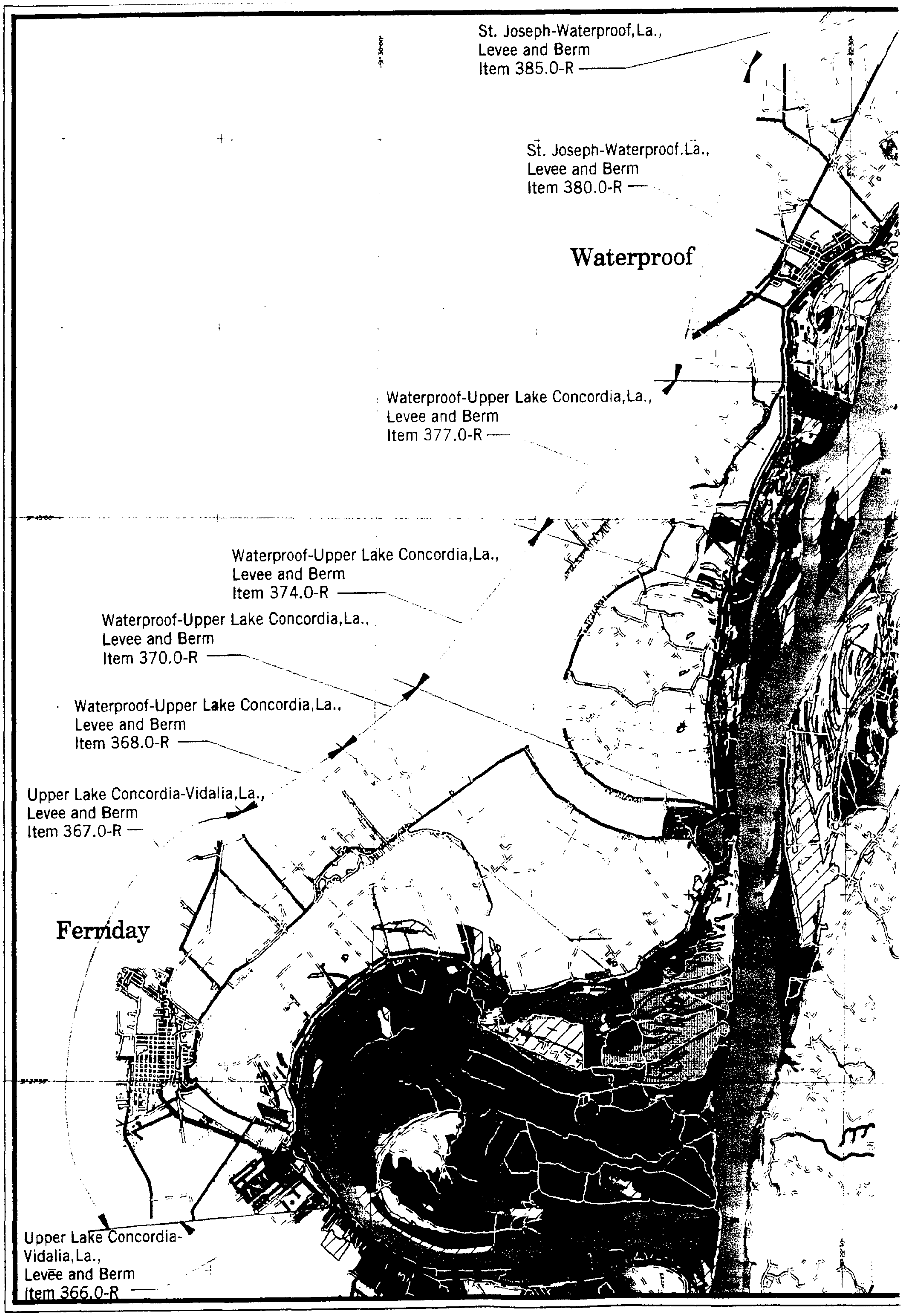


MISSISSIPPI RIVER LEVEE PROJECT

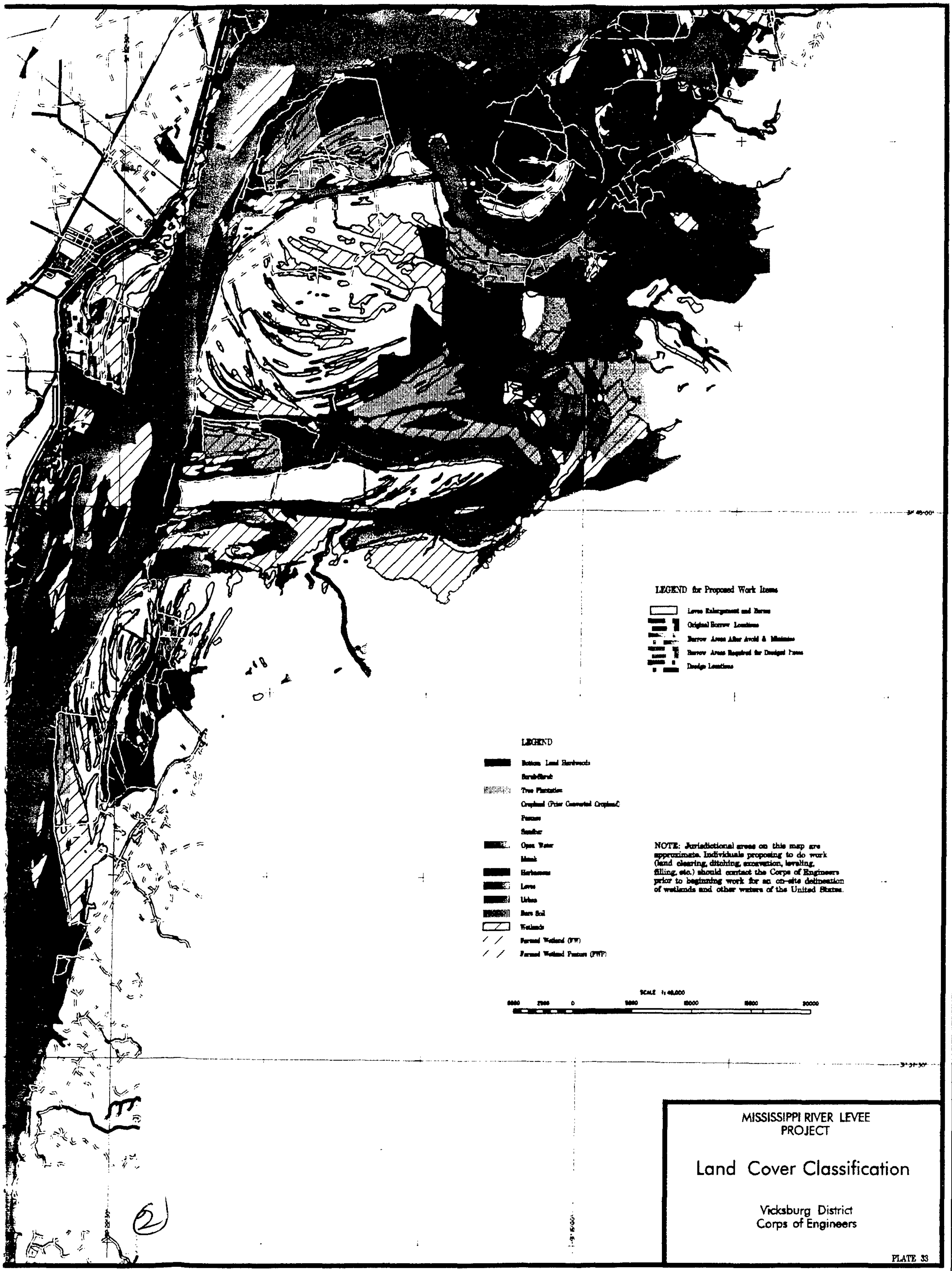
Land Cover Classification

Vicksburg District
Corps of Engineers

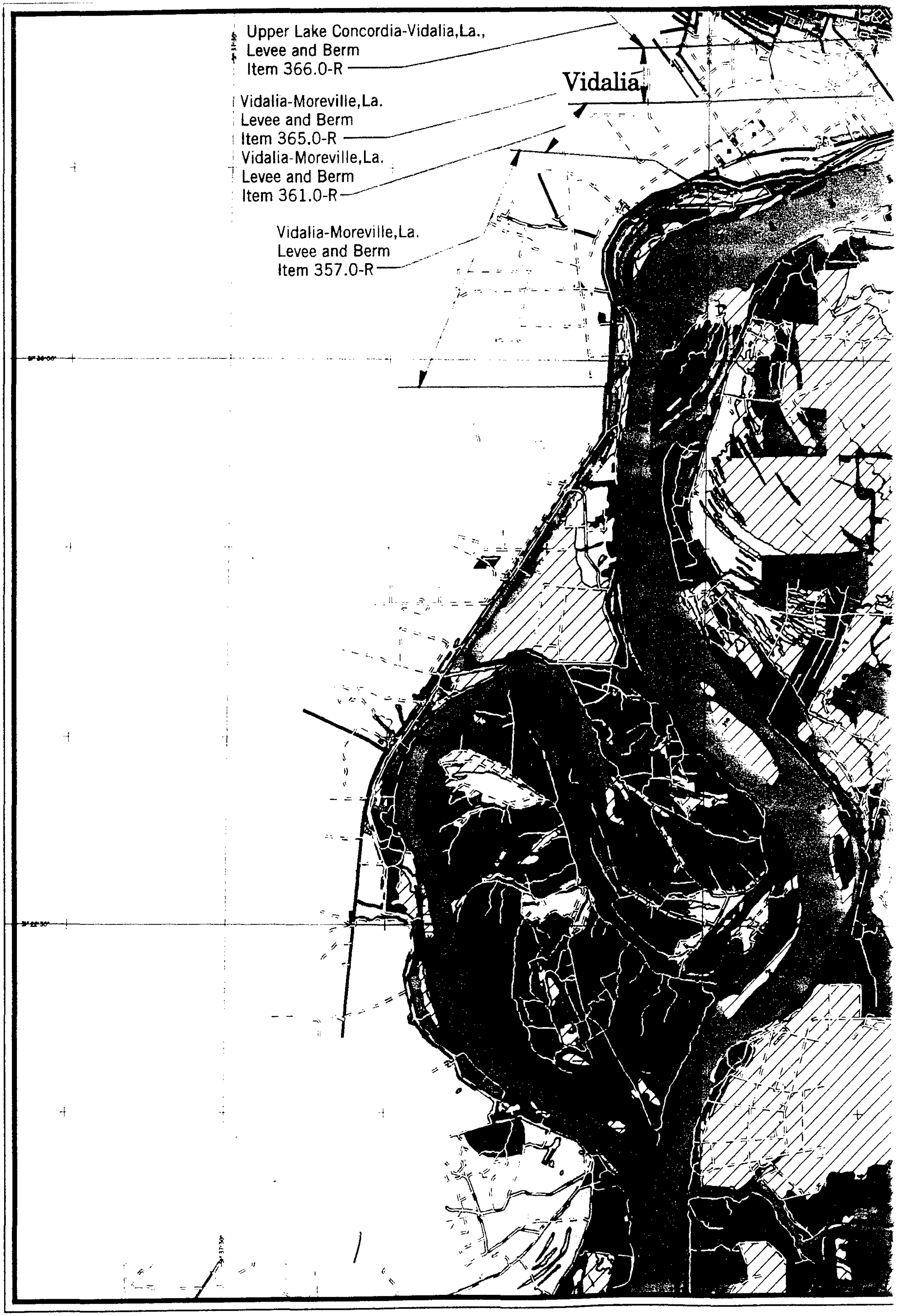
PLATE 32



St. Joseph-Waterproof,La.,
Levee and Berm
Item 385.0-R
St. Joseph-Waterproof.La.,
Levee and Berm
Item 380.0-R
Waterproof
Waterproof-Upper Lake Concordia,La.,
Levee and Berm
Item 377.0-R
Waterproof-Upper Lake Concordia,La.,
Levee and Berm
Item 374.0-R
Waterproof-Upper Lake Concordia,La.,
Levee and Berm
Item 370.0-R
Waterproof-Upper Lake Concordia,La.,
Levee and Berm
Item 368.0-R
Upper Lake Concordia-Vidalia,La.,
Levee and Berm
Item 367.0-R
Ferriday
Upper Lake Concordia-
Vidalia,La.,
Levee and Berm
Item 366.0-R

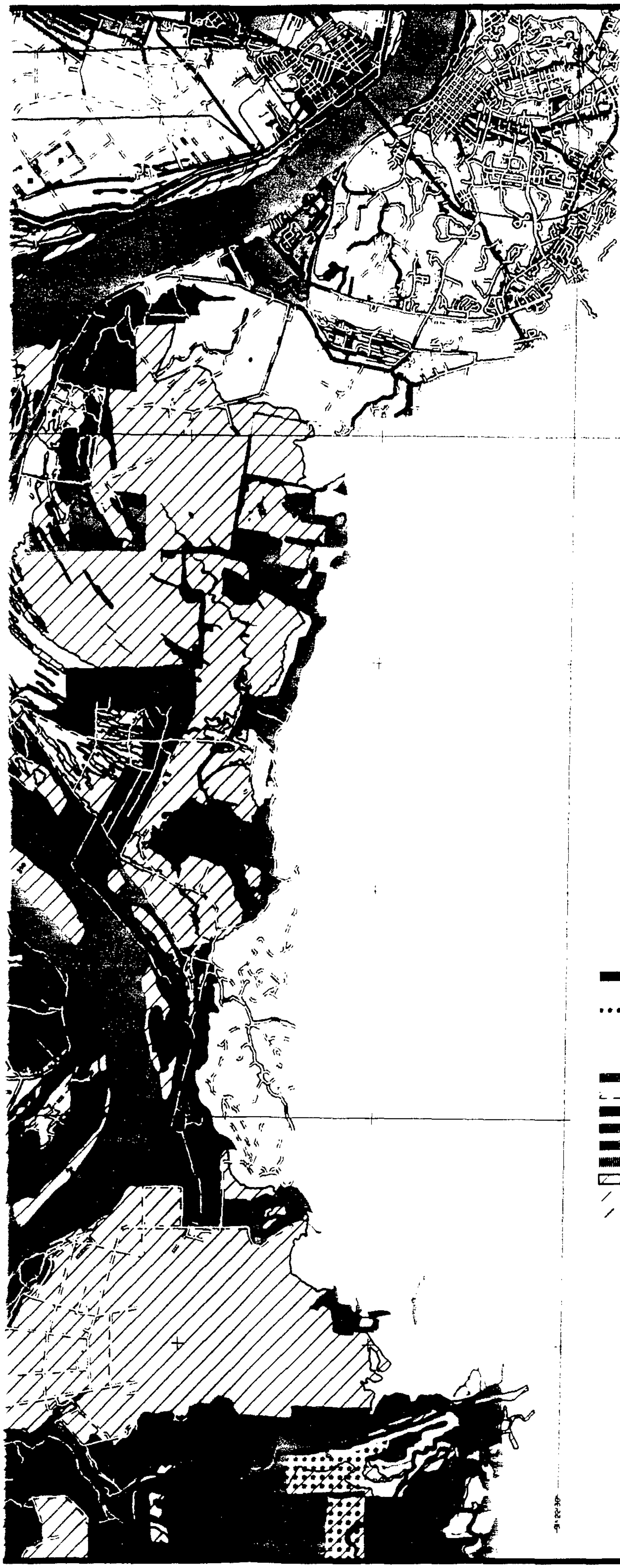

LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Designed Fuses
Dredge Locations
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Herbaceous
Levee
Urban
Bare Soil
Wetlands
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
SCALE 1:48,000
0
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
Vicksburg District
Corps of Engineers
PLATE 33

2



Upper Lake Concordia-Vidalia,La.,
Levee and Berm
Item 366.0-R
Vidalia
Vidalia-Moreville,La.
Levee and Berm
Item 365.0-R
Vidalia-Moreville,La.
Levee and Berm
Item 361.0-R
Vidalia-Moreville,La.
Levee and Berm
Item 357.0-R

Natchez



LEGEND for Proposed Work Items

- Levee Enlargement and Berms
- Original Borrow Locations
- Borrow Areas After Avoid & Minimize
- Borrow Areas Required for Dredged Berms
- Dredge Locations

LEGEND

- Bottom Land Hardwoods
- Scrub/Shrub
- Tree Plantation
- Cropland (Prior Converted Cropland)
- Pasture
- Sandbar
- Open Water
- Marsh
- Herbaceous
- Levee
- Urban
- Bare Soil
- Wetlands
- Farmed Wetland (FW)
- Farmed Wetland Pasture (FWP)

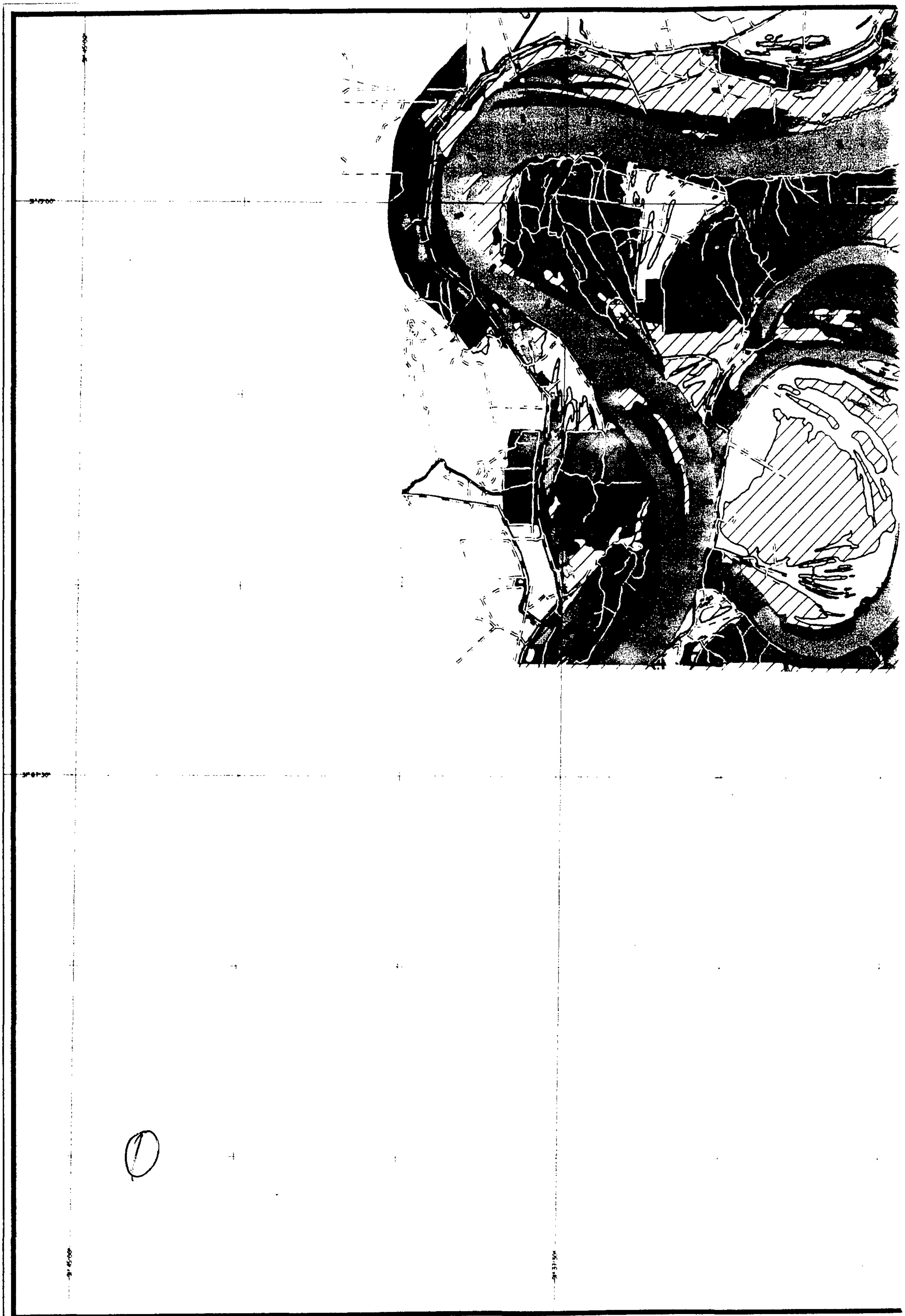
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.

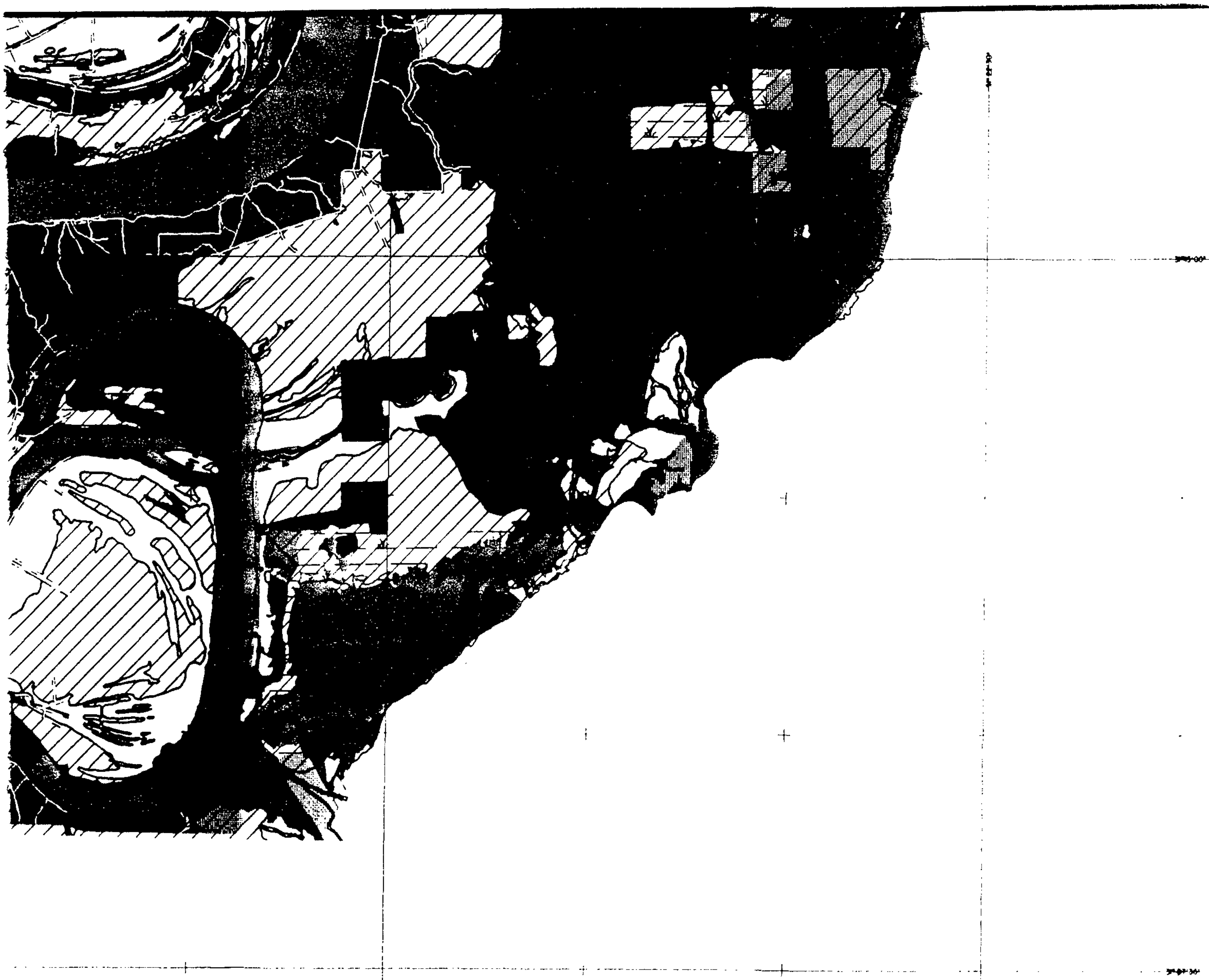
MISSISSIPPI RIVER LEVEE PROJECT

Land Cover Classification

Vicksburg District
Corps of Engineers

PLATE 34





LEGEND

- Bottom Land Hardwoods
- Scrub/Shrub
- Tree Plantation
- Cropland (Prior Converted Cropland)
- Pasture
- Sandbar
- Open Water
- Marsh
- Herbaceous
- Levee
- Urban
- Bare Soil
- Wetlands
- Farmed Wetland (FW)
- Farmed Wetland Pasture (FWP)

NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other Waters of the United States.

SCALE 1:40,000

5000 2500 0 5000 10000 15000 20000

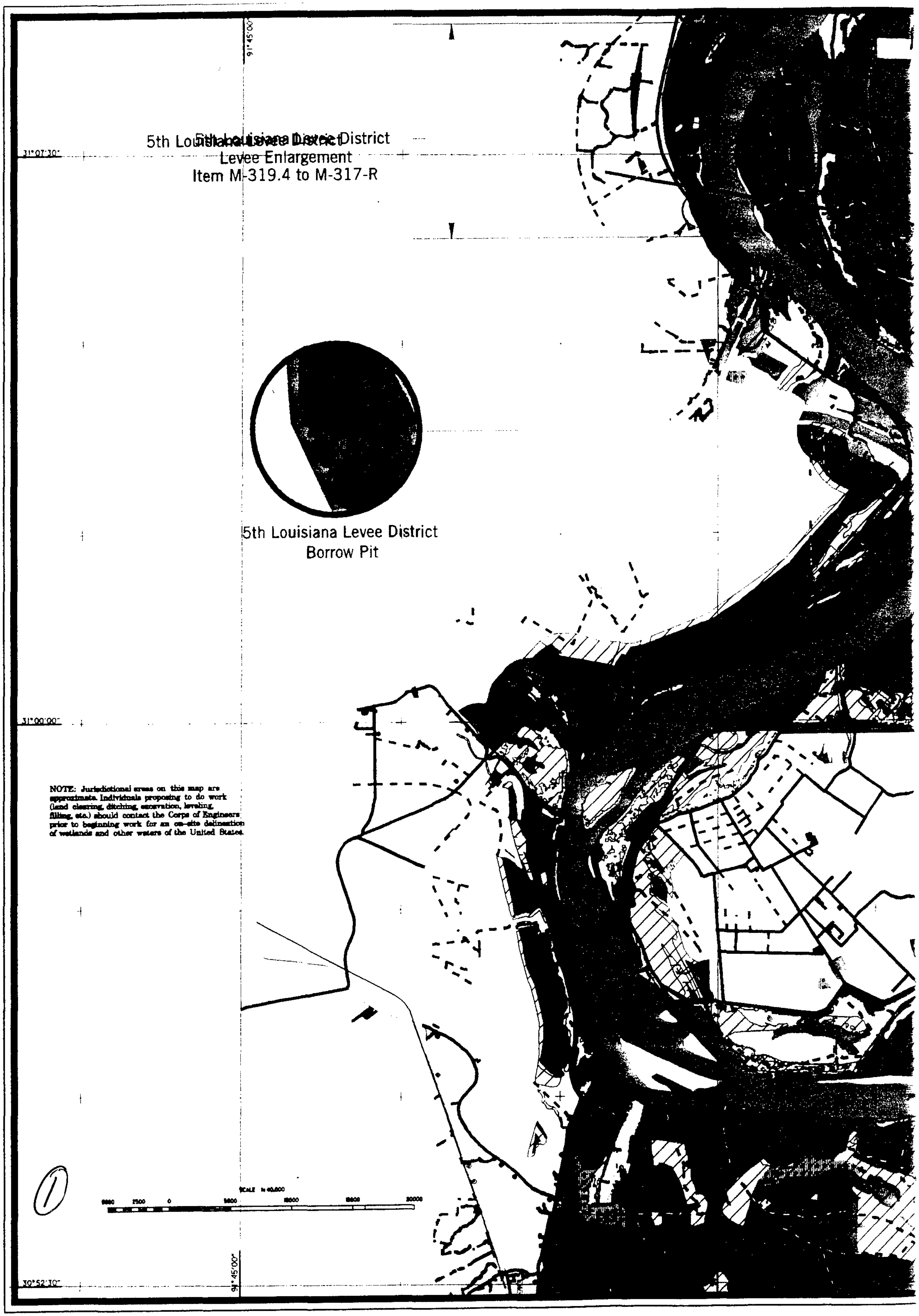
(2)

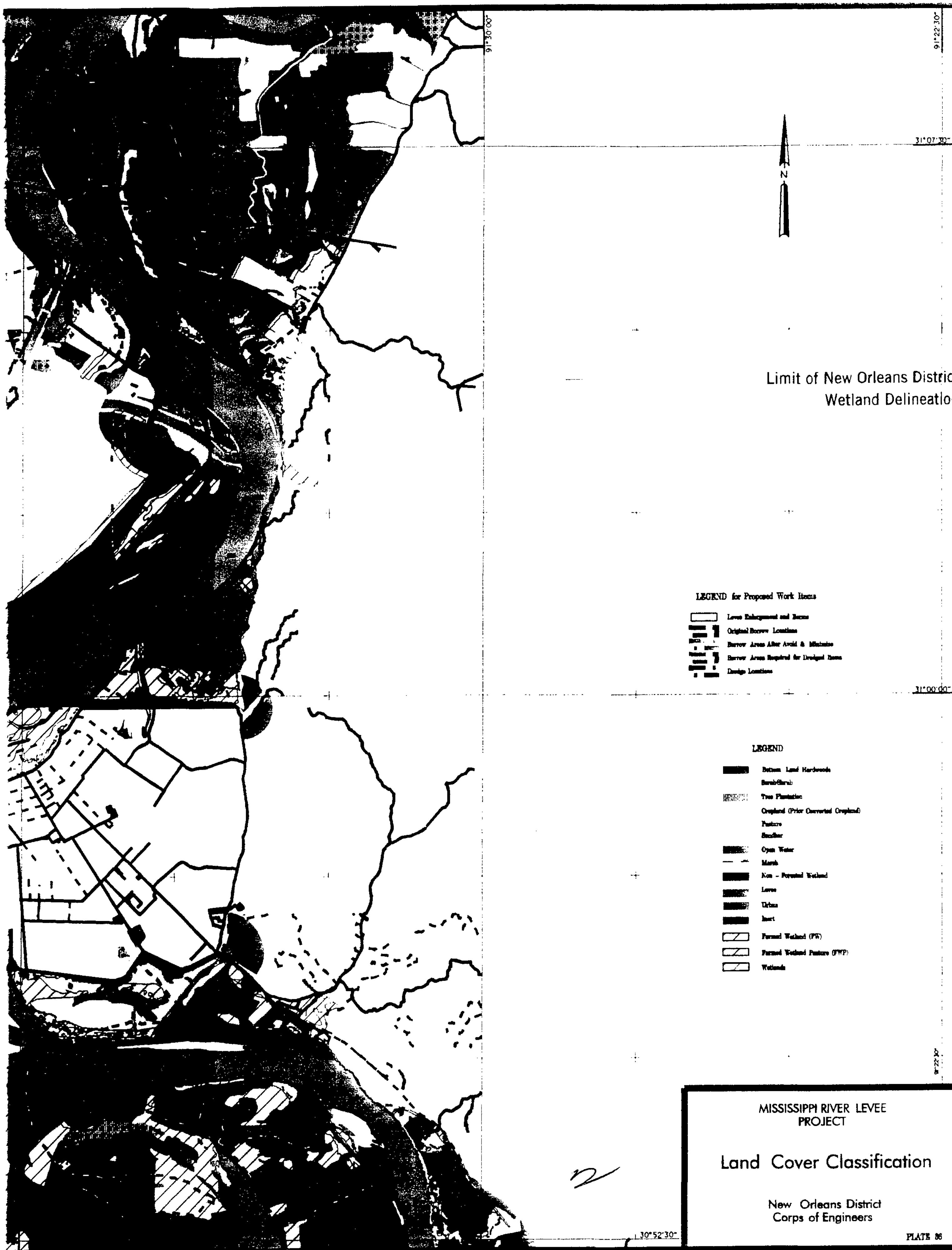
MISSISSIPPI RIVER LEVEE PROJECT

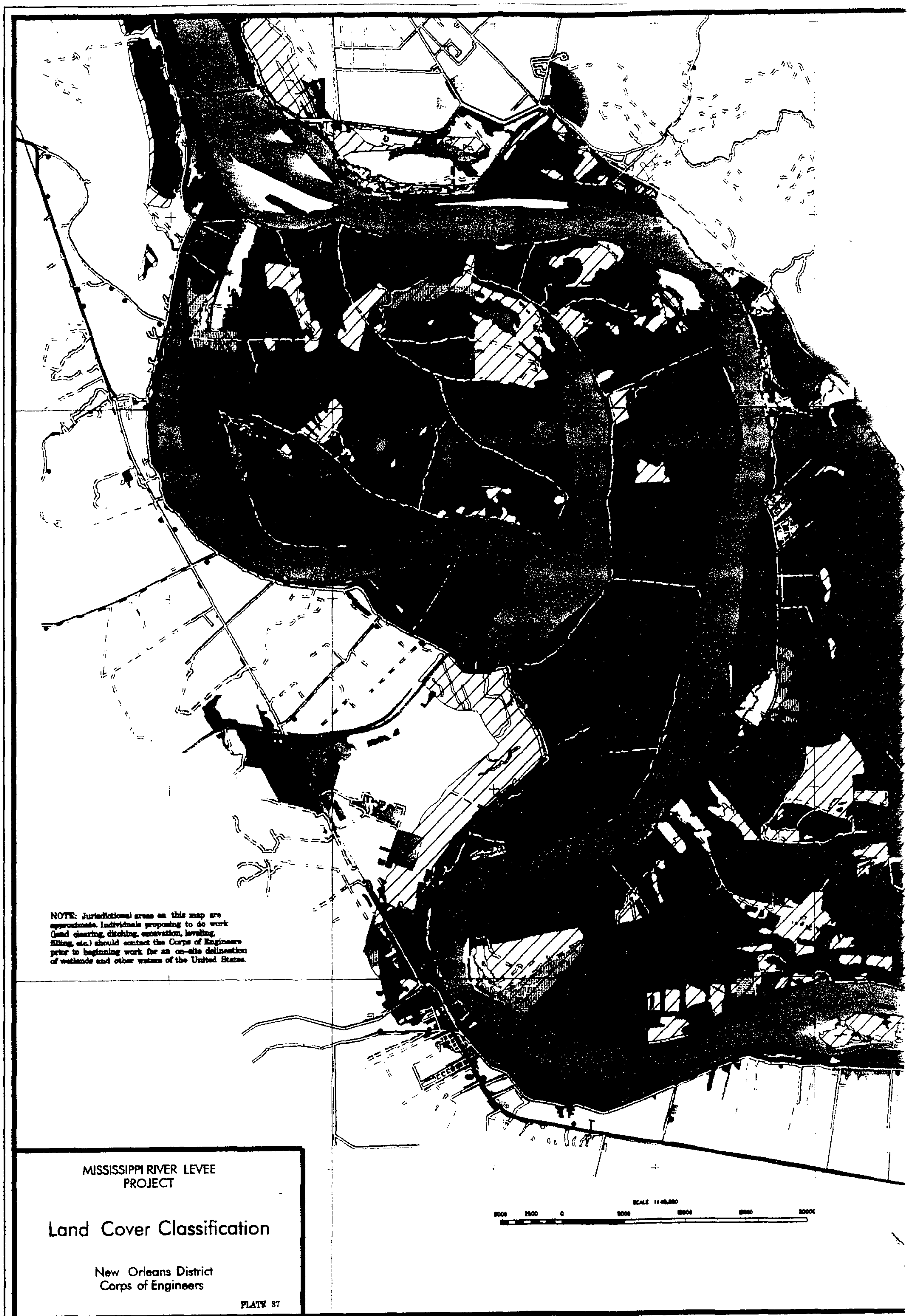
Land Cover Classification

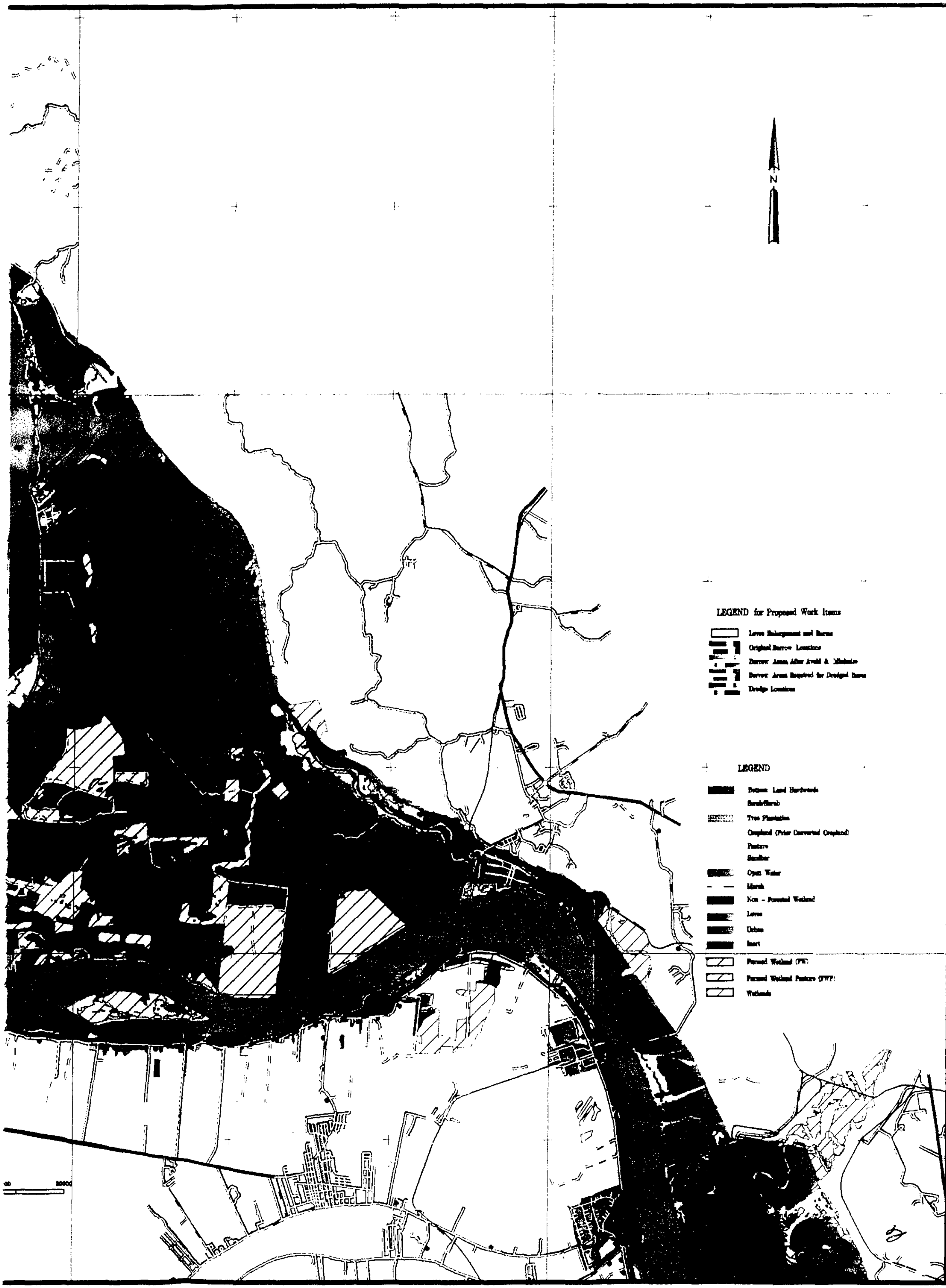
Vicksburg District
Corps of Engineers

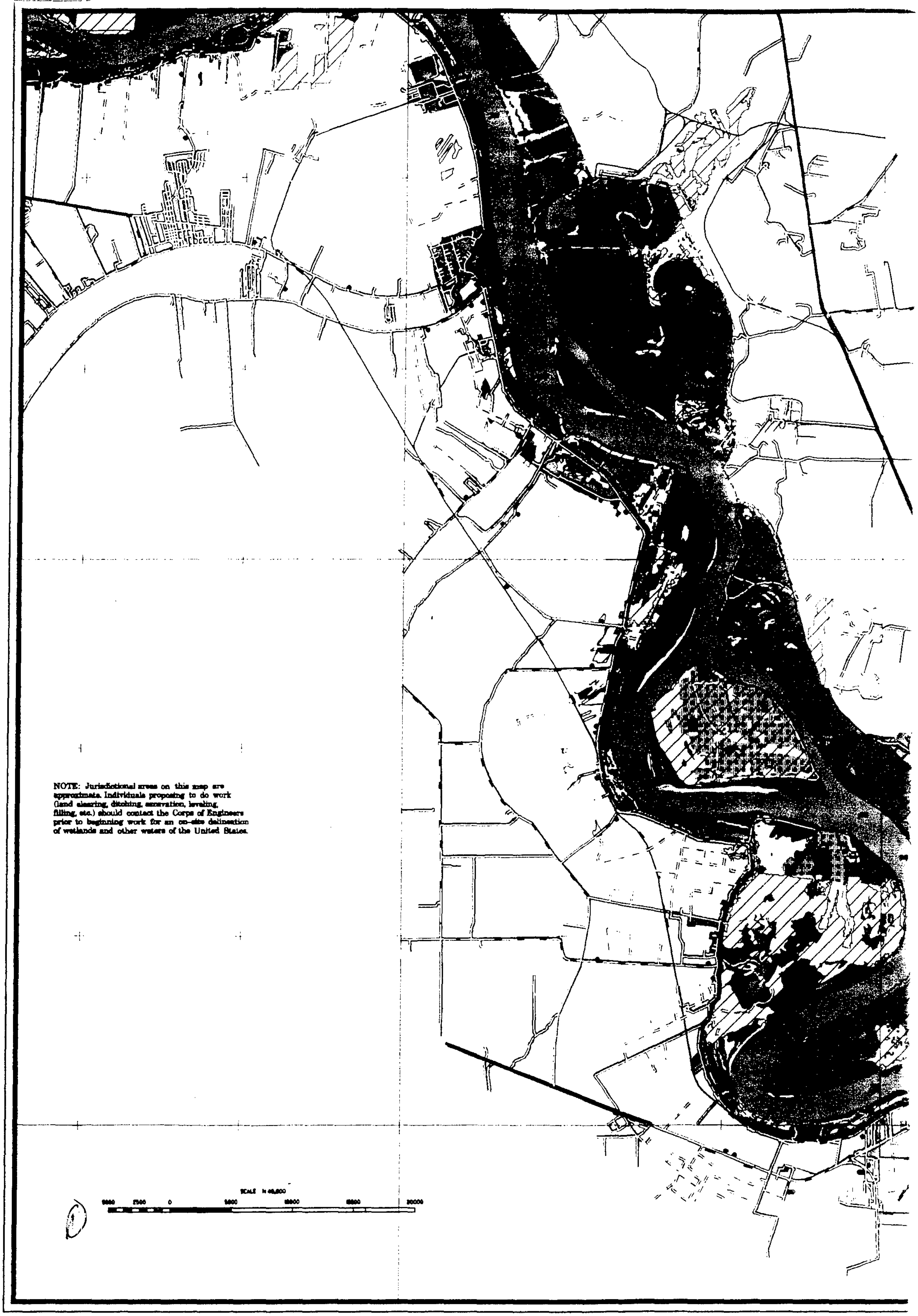
PLATE 35

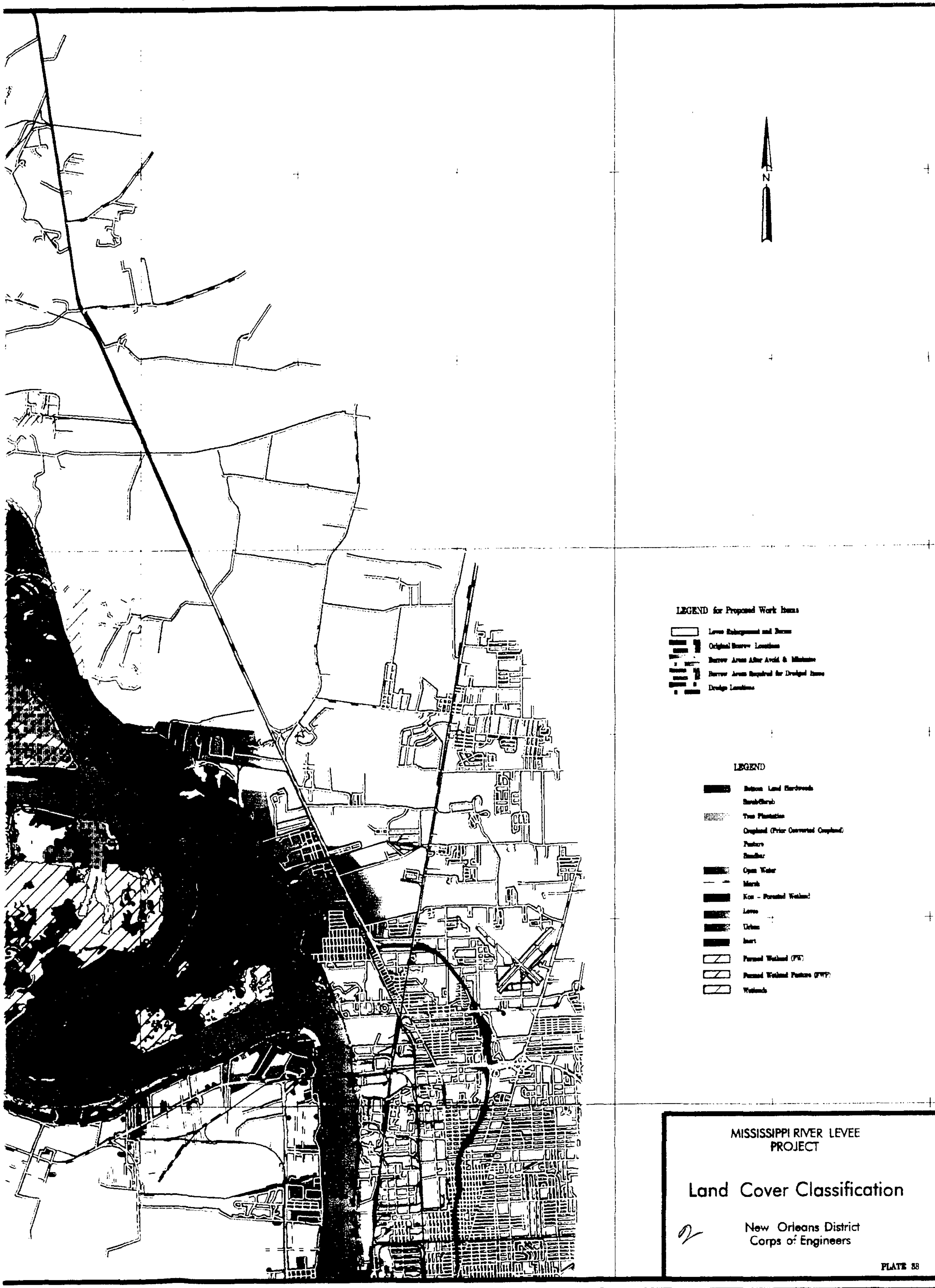

5th Louisiana Levee District
Levee Enlargement
Item M-319.4 to M-317-R
5th Louisiana Levee District
Borrow Pit
31°07'30"
31°00'00"
30°52'30"
91°45'00"
91°45'00"
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
2500
0
20000
1


91°30'00"
91°22'30"
31°07'30"
N
Limit of New Orleans District
Wetland Delineation
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations
31°00'00"
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Non - Forested Wetland
Levee
Urban
Insert
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
Wetlands
30°52'30"
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
New Orleans District
Corps of Engineers
PLATE 86


NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
SCALE
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
New Orleans District
Corps of Engineers
PLATE 37


N
LEGEND for Proposed Work Items
Original Borrow Locations
Dredge Locations
LEGEND
Bottom Land Hardwoods
Tree Plantation
Pasture
Open Water
Marsh
Non - Forested Wetland
Levee
Urban
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
Wetlands


NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
0
20000



LEGEND for Proposed Work Items

- Levee Enlargement and Berms
- Original Borrow Locations
- Borrow Areas After Avoid & Minimize
- Borrow Areas Required for Dredged Items
- Dredge Locations

LEGEND

- Bottom Land Hardwoods
- Scrub/Shrub
- Tree Plantation
- Cropland (Prior Converted Cropland)
- Pasture
- Sandbar
- Open Water
- Marsh
- Non - Forested Wetland
- Levee
- Urban
- Inert
- Farmed Wetland (FW)
- Farmed Wetland Pasture (FWP)
- Wetlands

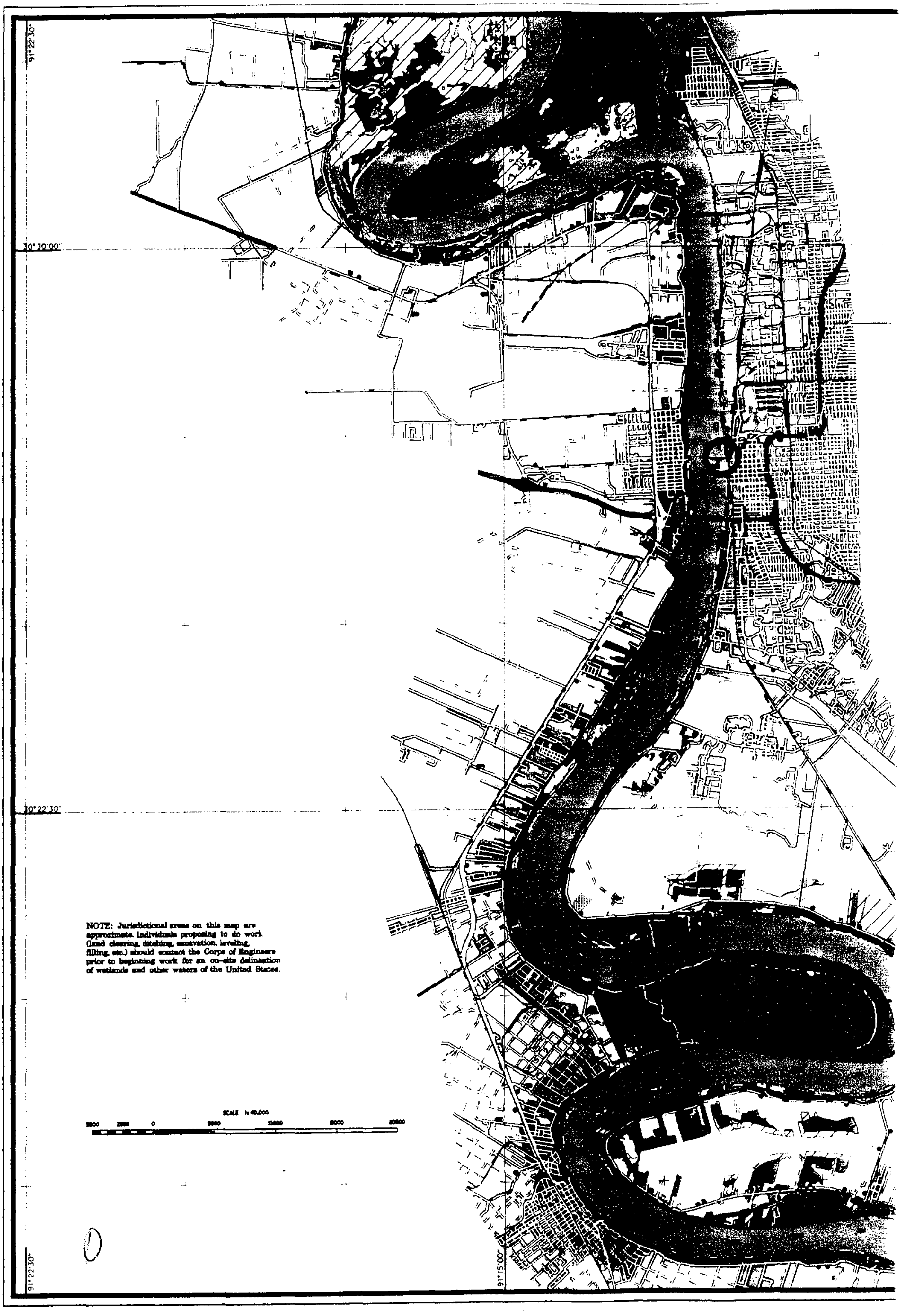
MISSISSIPPI RIVER LEVEE PROJECT

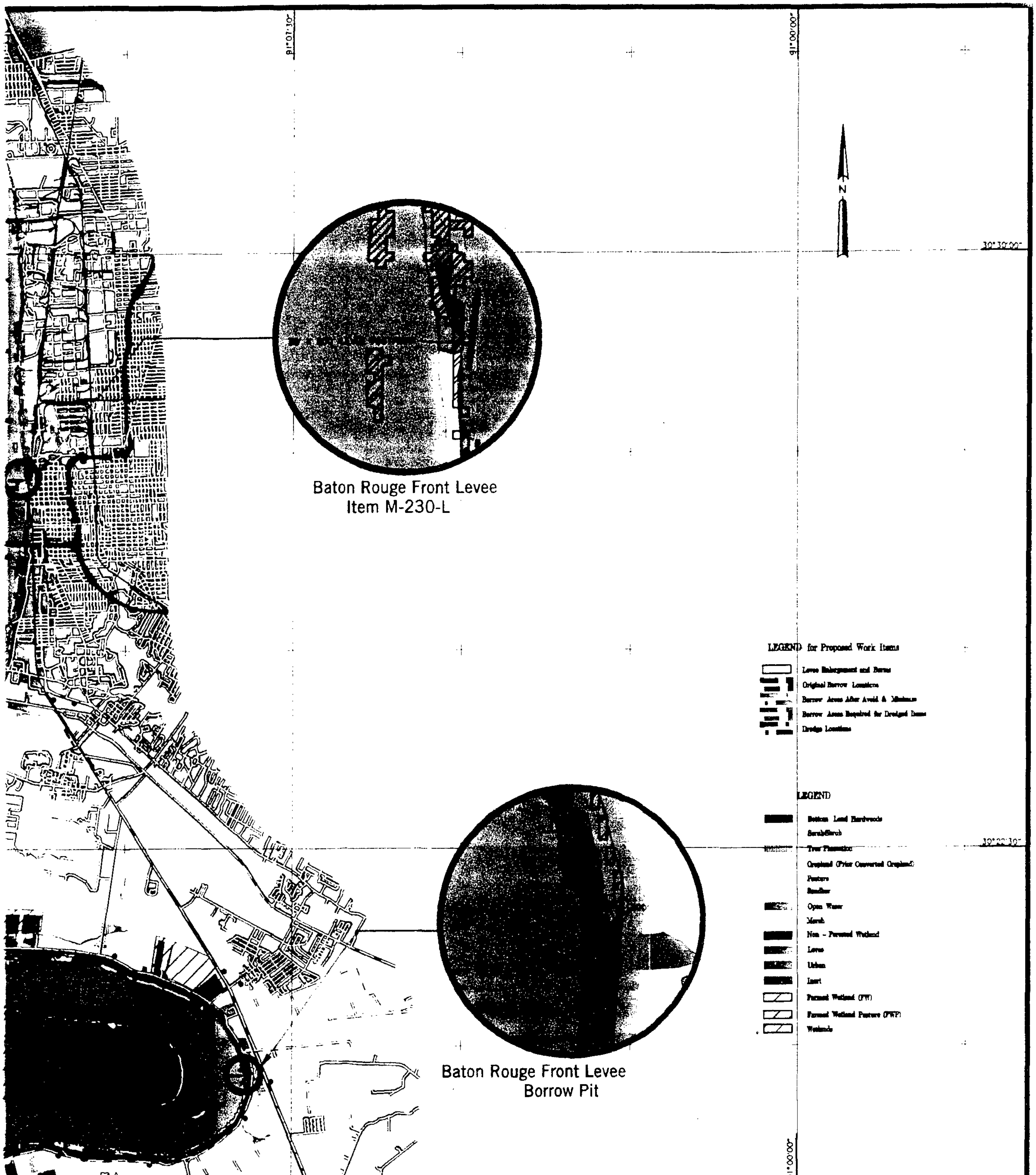
Land Cover Classification

2

New Orleans District
Corps of Engineers

PLATE 38


91°22'30"
30°30'00"
30°22'30"
91°15'00"
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
SCALE 1:40,000

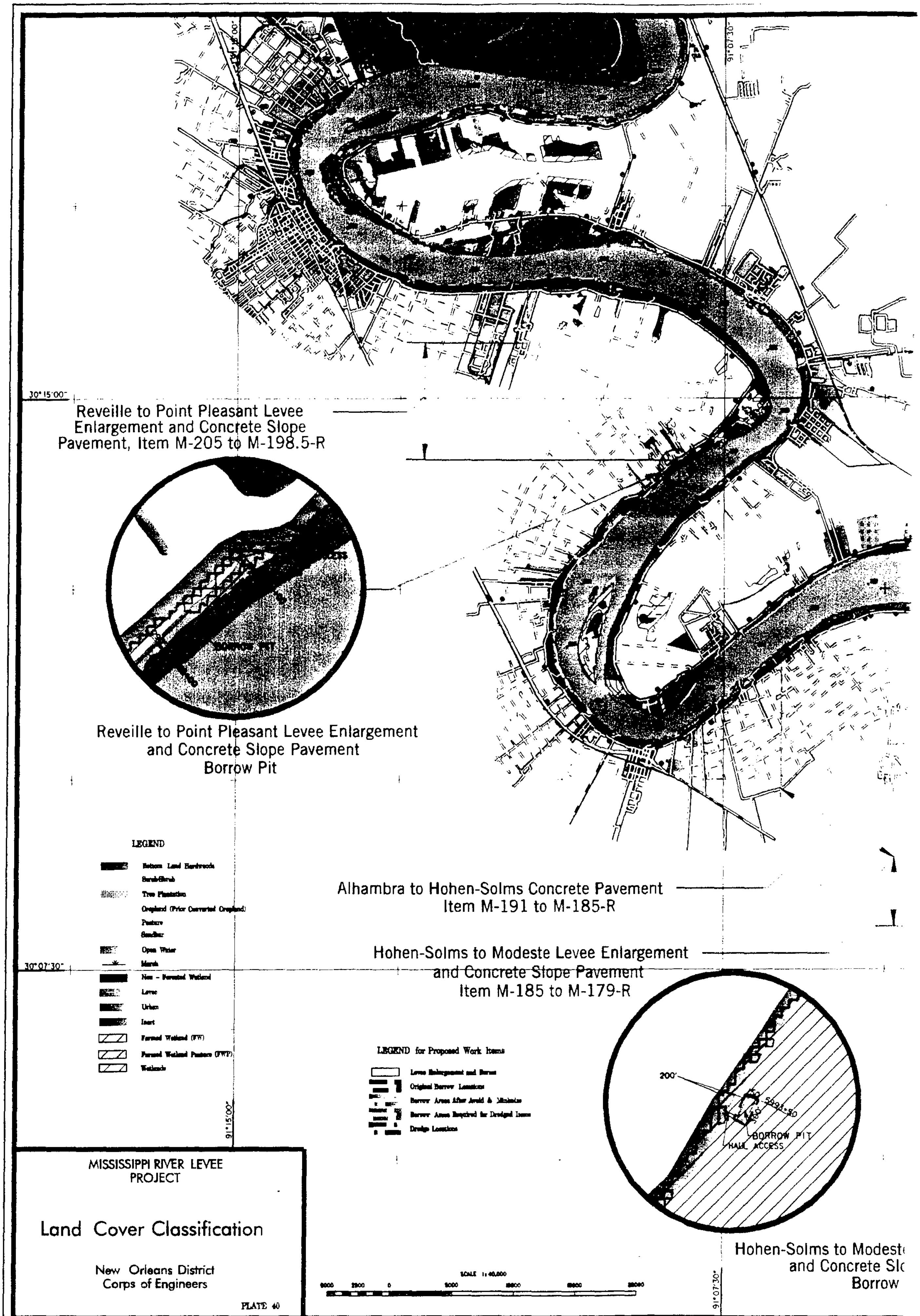


MISSISSIPPI RIVER LEVEE PROJECT

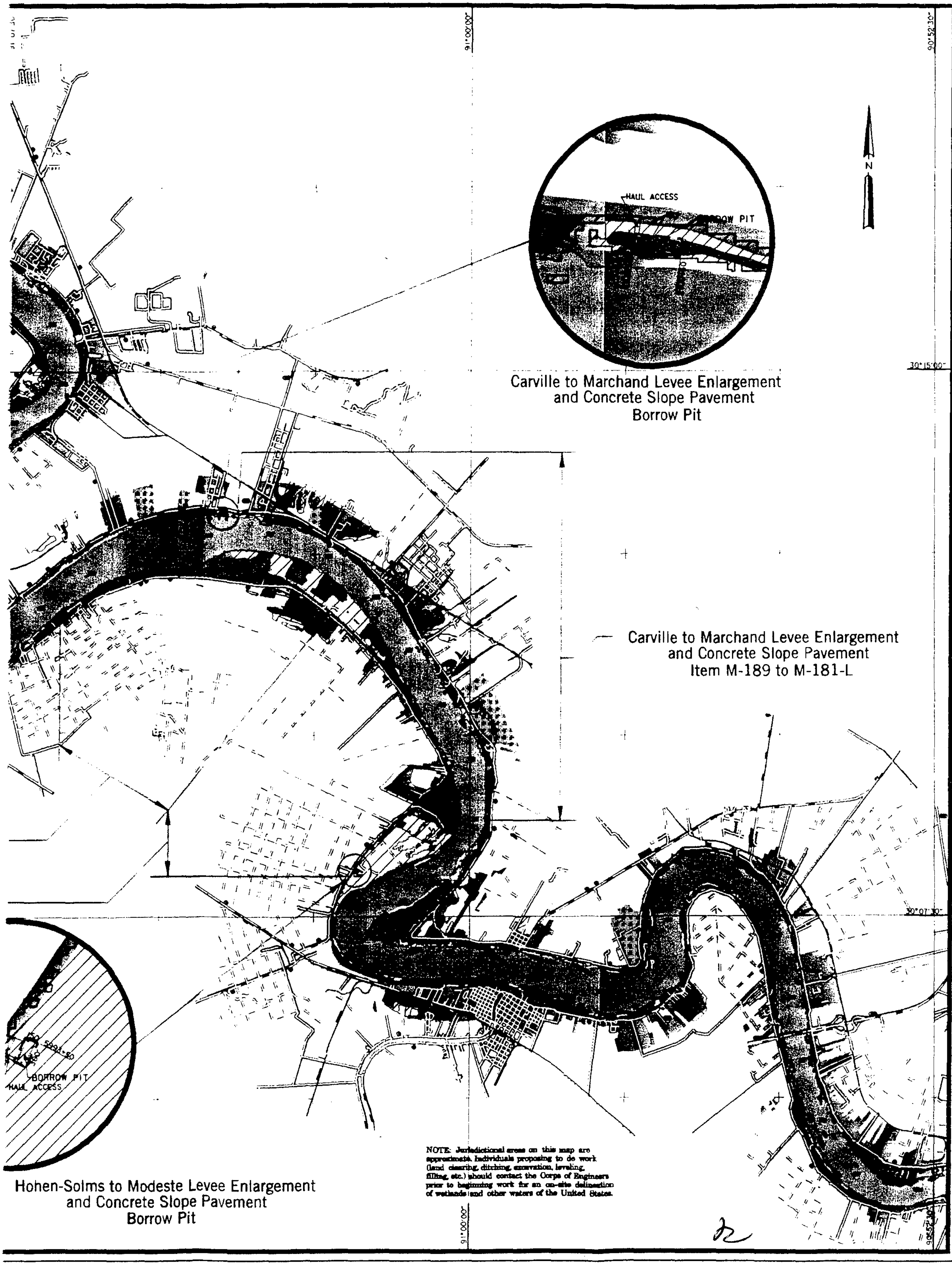
Land Cover Classification

New Orleans District
Corps of Engineers

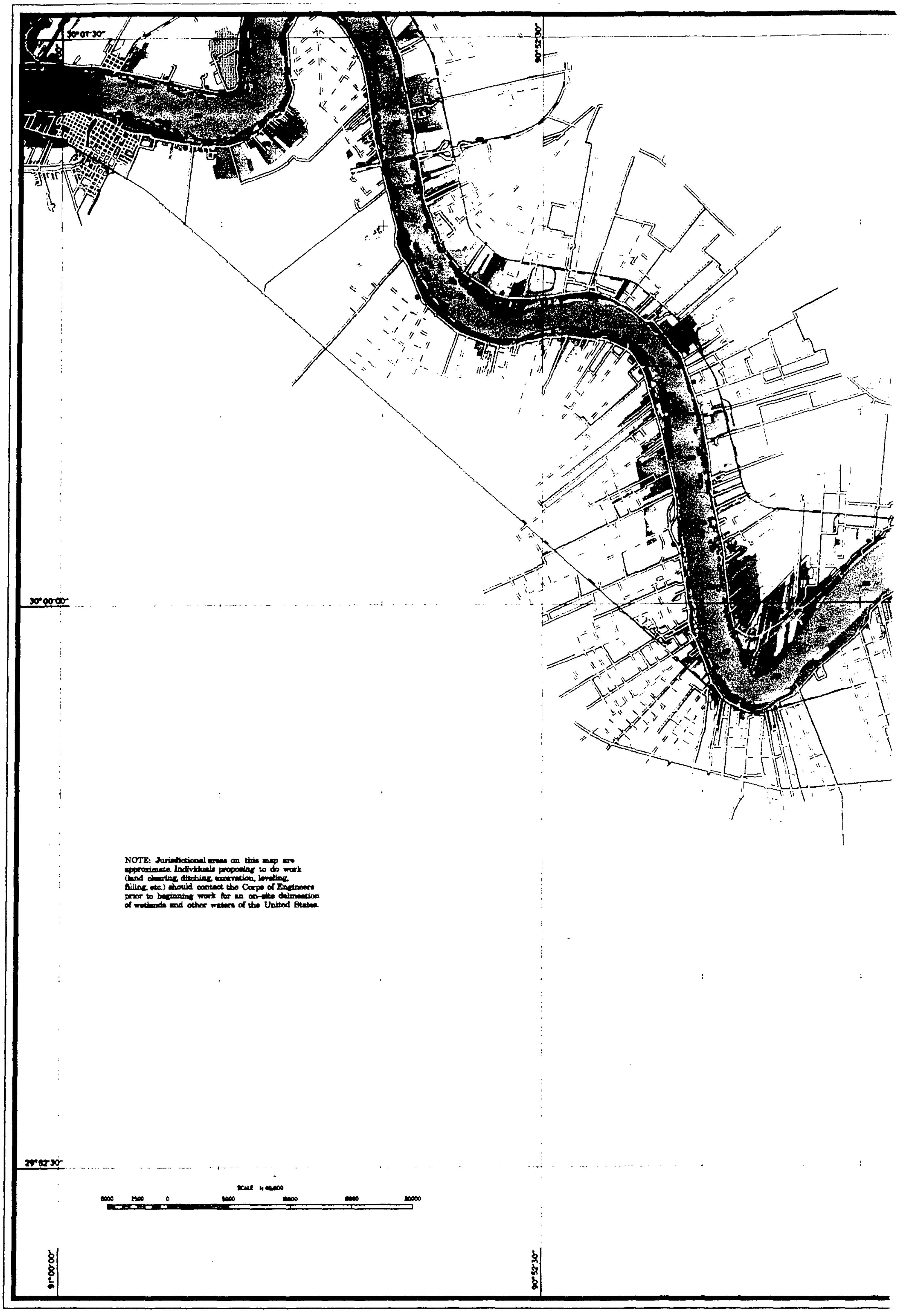
PLATE 89

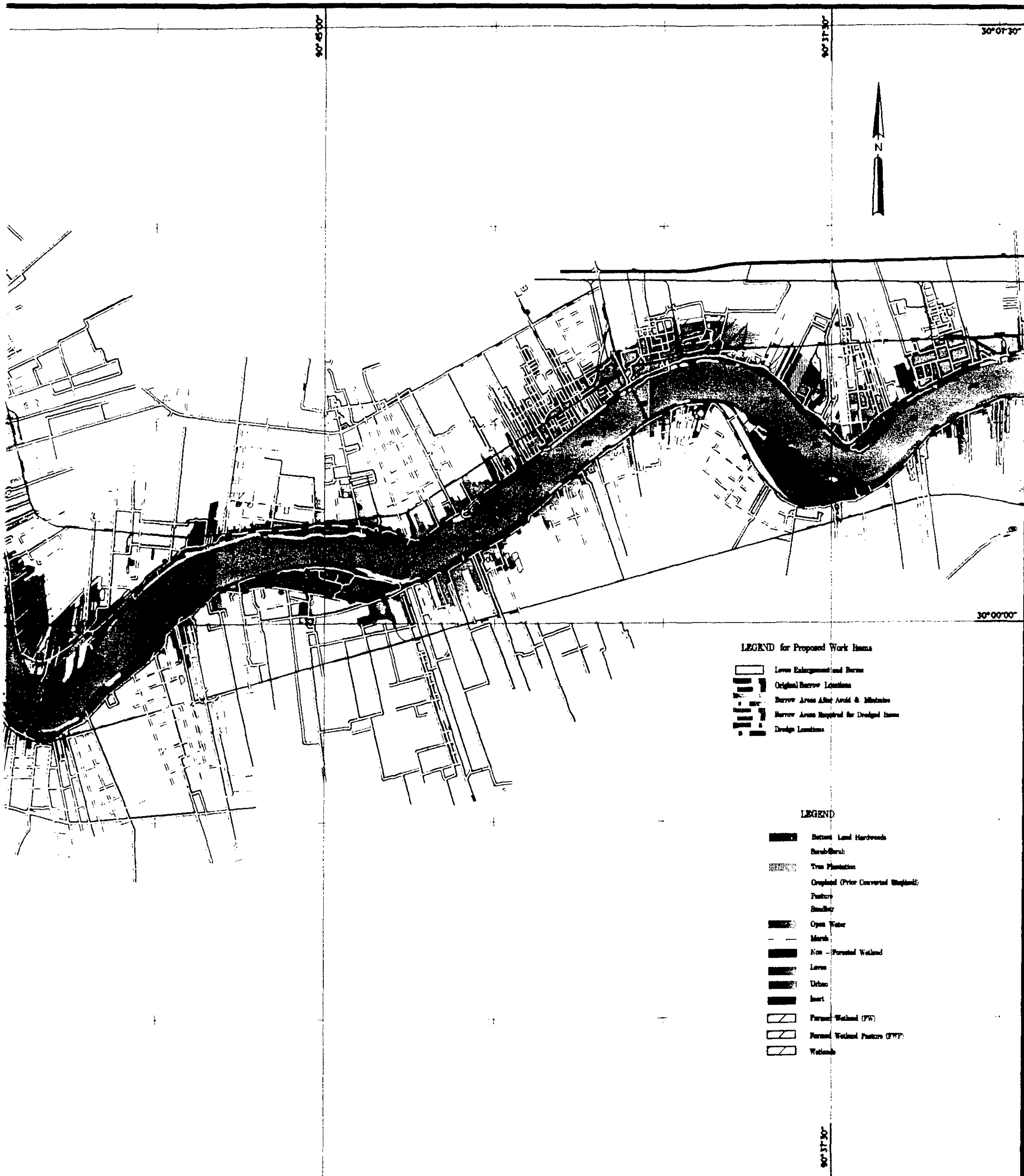


30°15'00"
91°15'00"
91°07'30"
Reveille to Point Pleasant Levee Enlargement and Concrete Slope Pavement, Item M-205 to M-198.5-R
Reveille to Point Pleasant Levee Enlargement and Concrete Slope Pavement Borrow Pit
Alhambra to Hohen-Solms Concrete Pavement Item M-191 to M-185-R
Hohen-Solms to Modeste Levee Enlargement and Concrete Slope Pavement Item M-185 to M-179-R
200'
BORROW PIT
HAUL ACCESS
Hohen-Solms to Modeste
and Concrete Sl
Borrow
30°07'30"
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Non - Forested Wetland
Levee
Urban
Inert
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
Wetlands
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
New Orleans District Corps of Engineers
PLATE 40



N
91°00'00"
90°52'30"
30°15'00"
30°07'30"
HAUL ACCESS
Carville to Marchand Levee Enlargement
and Concrete Slope Pavement
Borrow Pit
Carville to Marchand Levee Enlargement
and Concrete Slope Pavement
Item M-189 to M-181-L
BORROW PIT
HAUL ACCESS
Hohen-Solms to Modeste Levee Enlargement
and Concrete Slope Pavement
Borrow Pit
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.


30°07'30"
90°52'30"
30°00'00"
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
29°52'30"
SCALE
91°00'00"
90°52'30"

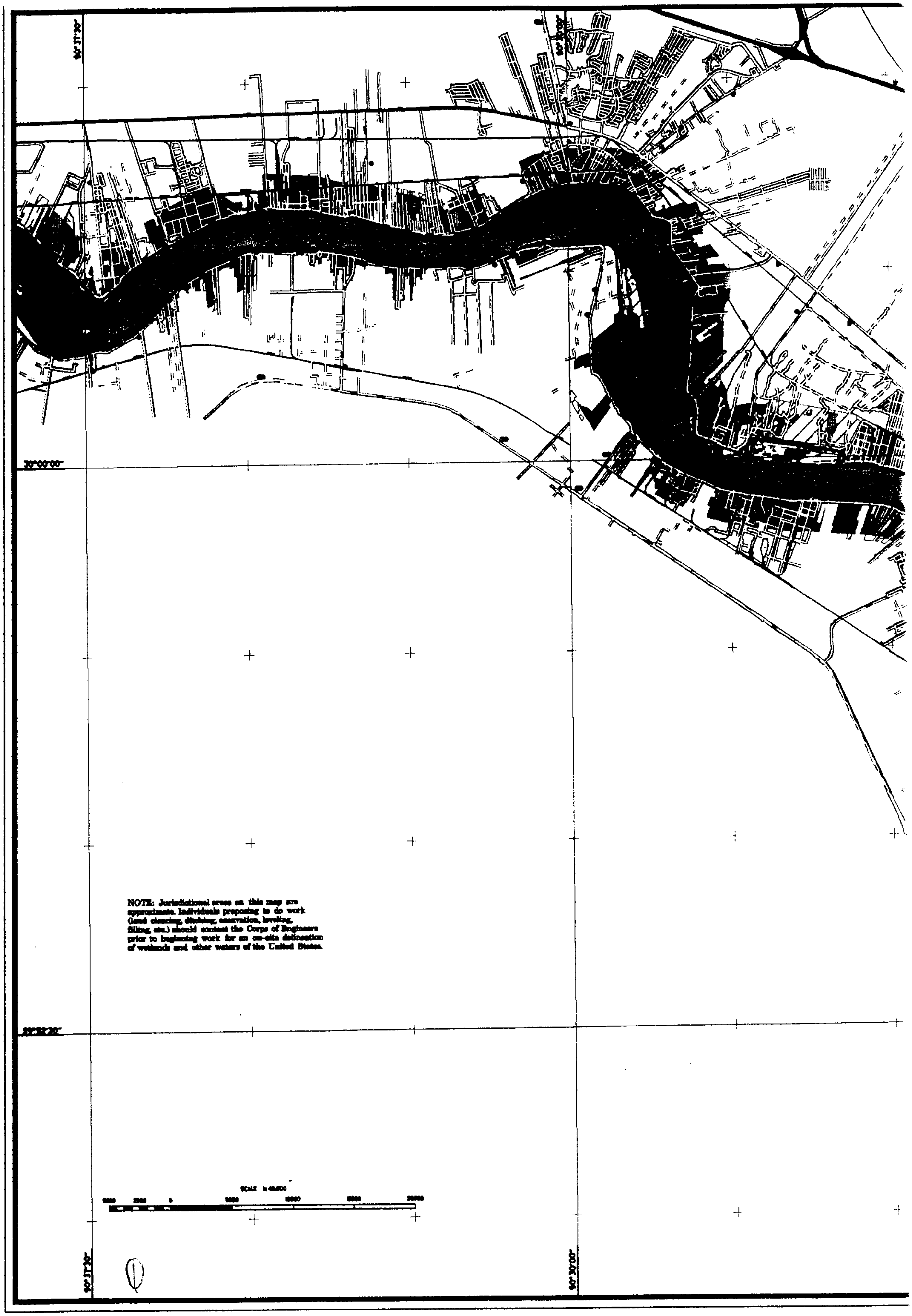


MISSISSIPPI RIVER LEVEE PROJECT

Land Cover Classification

New Orleans District
Corps of Engineers

PLATE 41

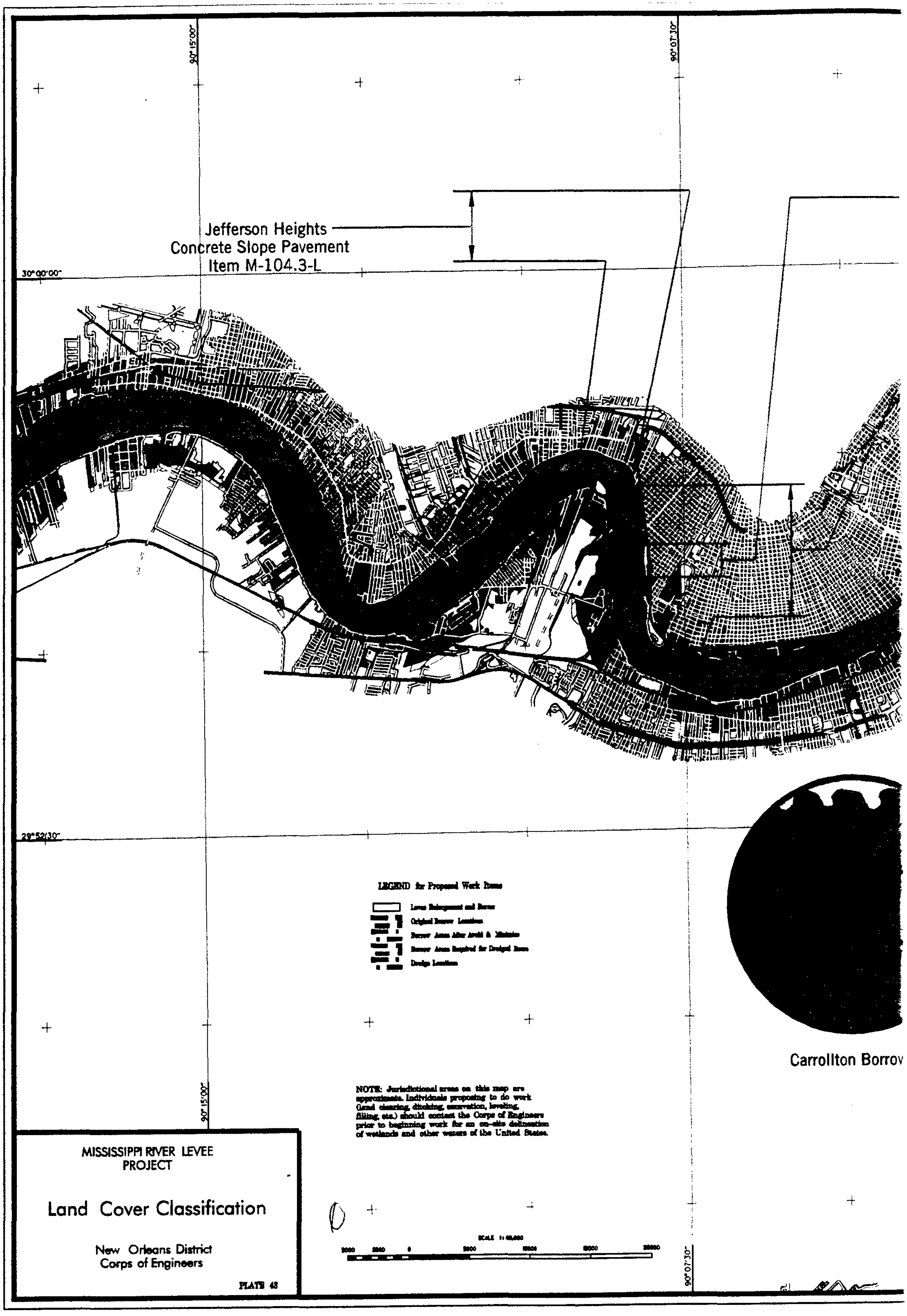

90°37'30"
90°30'00"
30°00'00"
29°52'30"
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
0
10000
20000
90°37'30"
1
90°30'00"

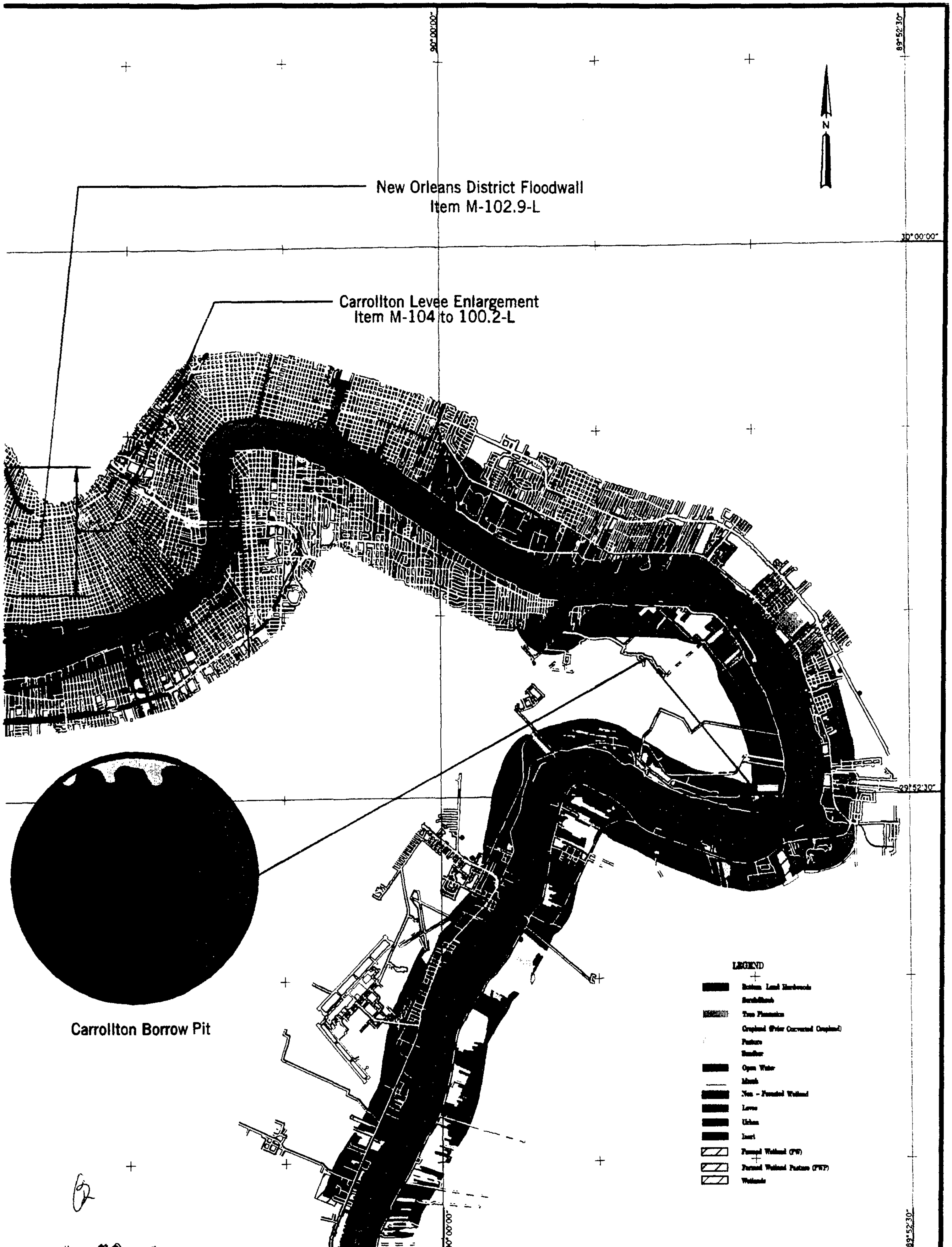
MISSISSIPPI RIVER LEVEE PROJECT

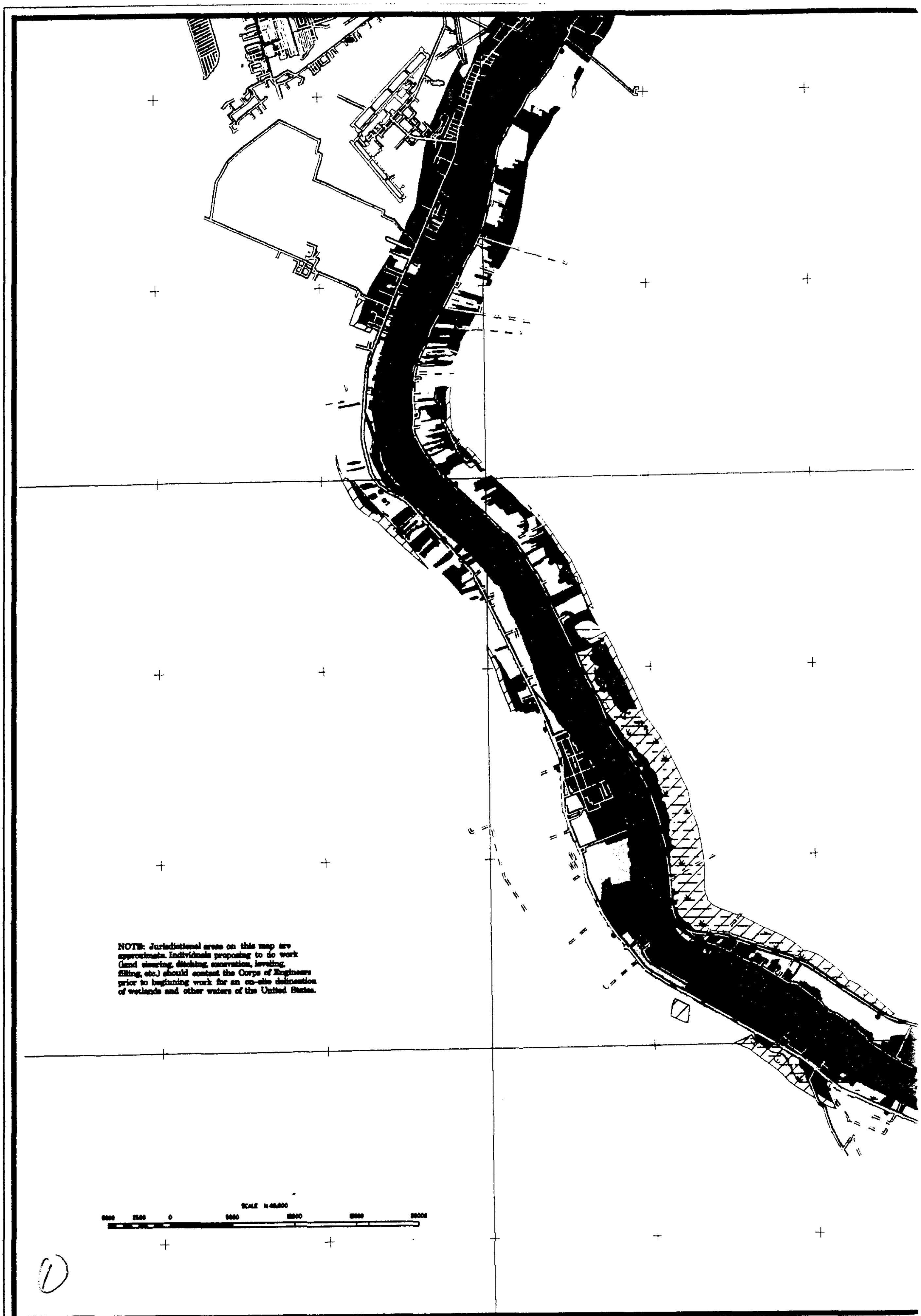
Land Cover Classification

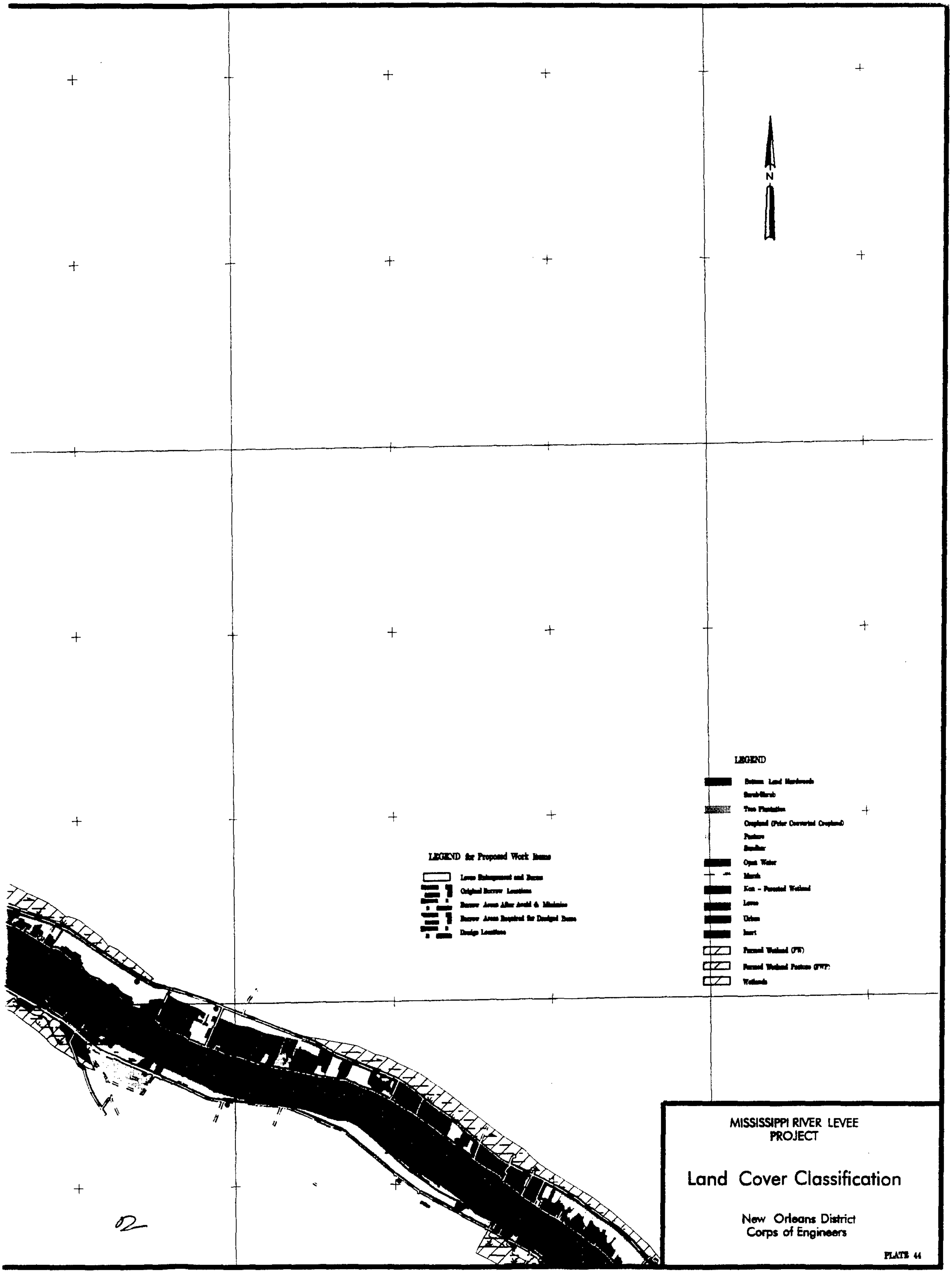
New Orleans District
Corps of Engineers

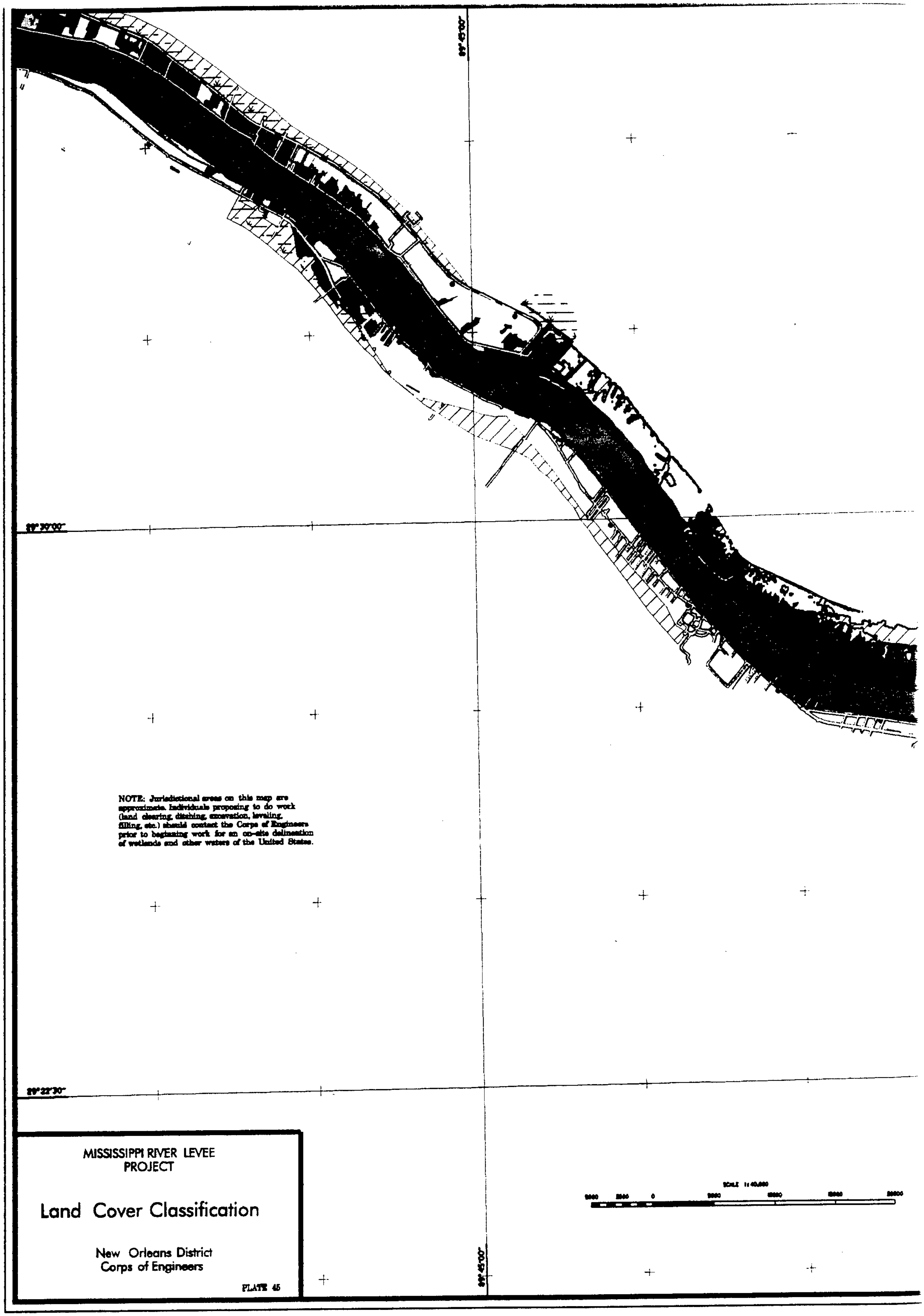
PLATE 41


90°15'00"
90°07'30"
Jefferson Heights
Concrete Slope Pavement
Item M-104.3-L
30°00'00"
29°52'30"
LEGEND for Proposed Work Items
Original Borrow Locations
Dredge Locations
Carrollton Borrov
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
90°15'00"
MISSISSIPPI RIVER LEVEE
PROJECT
Land Cover Classification
New Orleans District
Corps of Engineers
PLATE 43
90°07'30"


90°00'00"
89°52'30"
30°00'00"
29°52'30"
N
New Orleans District Floodwall
Item M-102.9-L
Carrollton Levee Enlargement
Item M-104 to 100.2-L
Carrollton Borrow Pit
LEGEND


NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
SCALE


N
LEGEND for Proposed Work Items
Original Borrow Locations
LEGEND
Tree Plantation
Pasture
Open Water
Marsh
Levee
Urban
Wetlands
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
New Orleans District
Corps of Engineers
PLATE 44

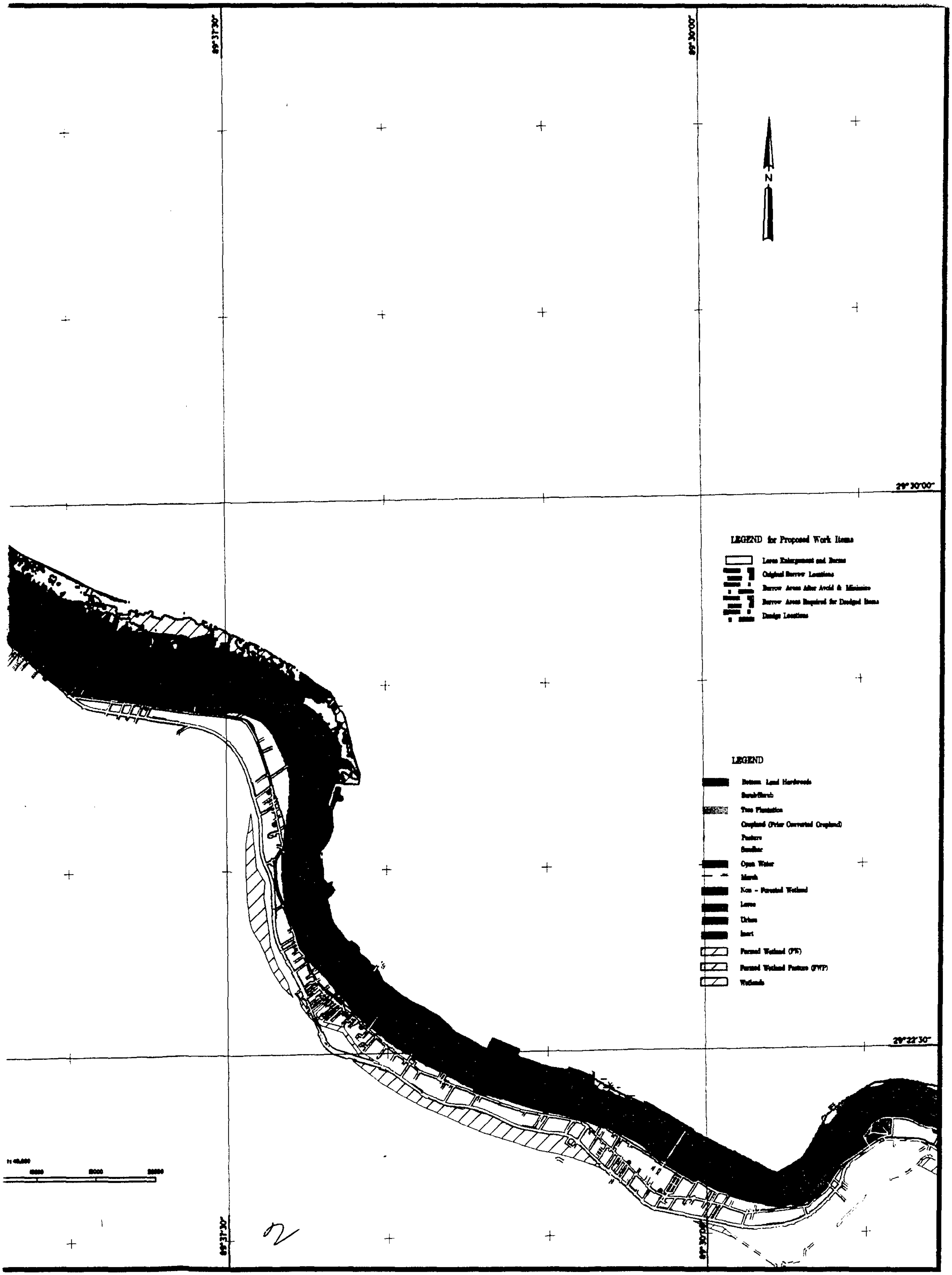


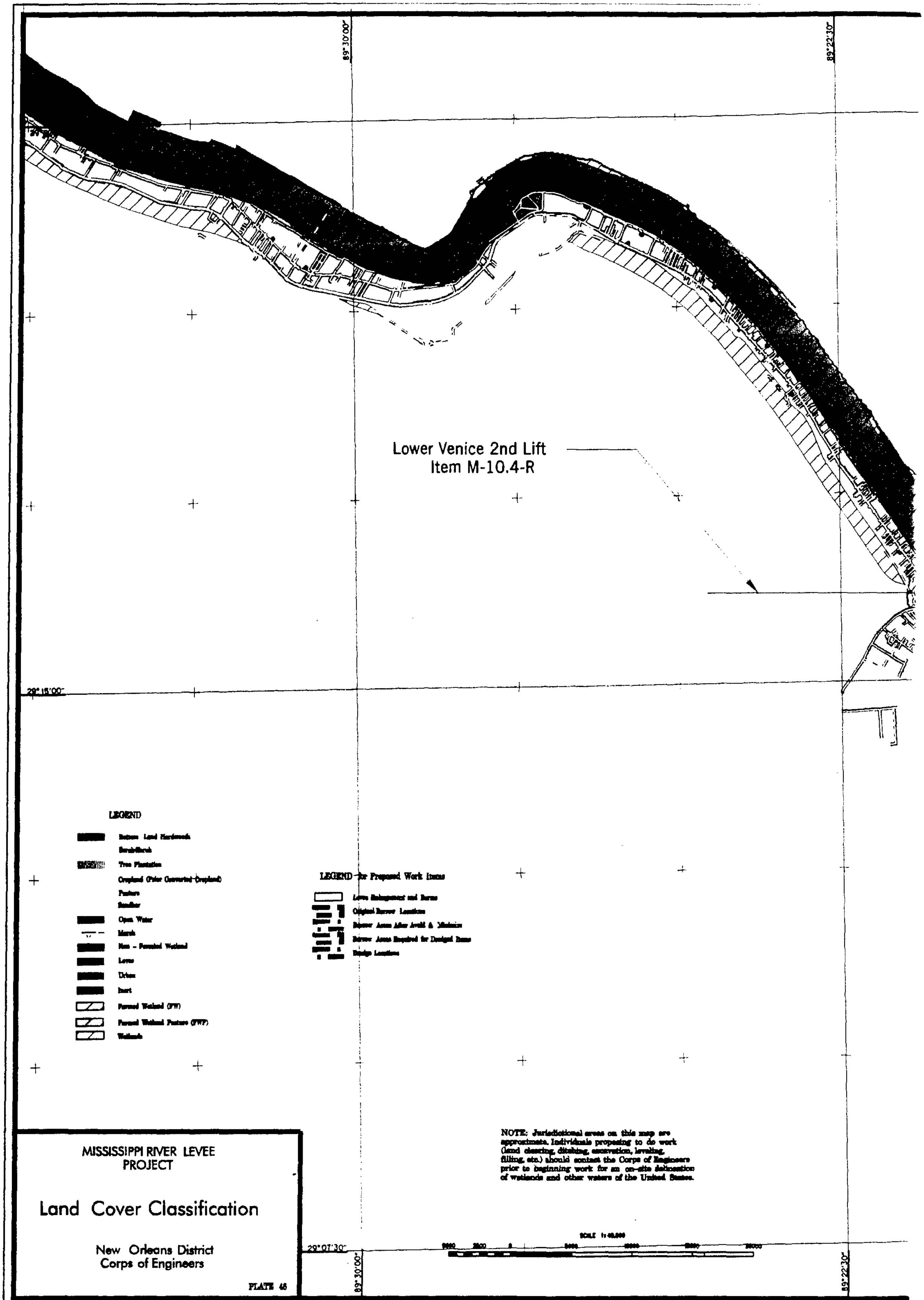
MISSISSIPPI RIVER LEVEE PROJECT

Land Cover Classification

New Orleans District
Corps of Engineers

PLATE 45

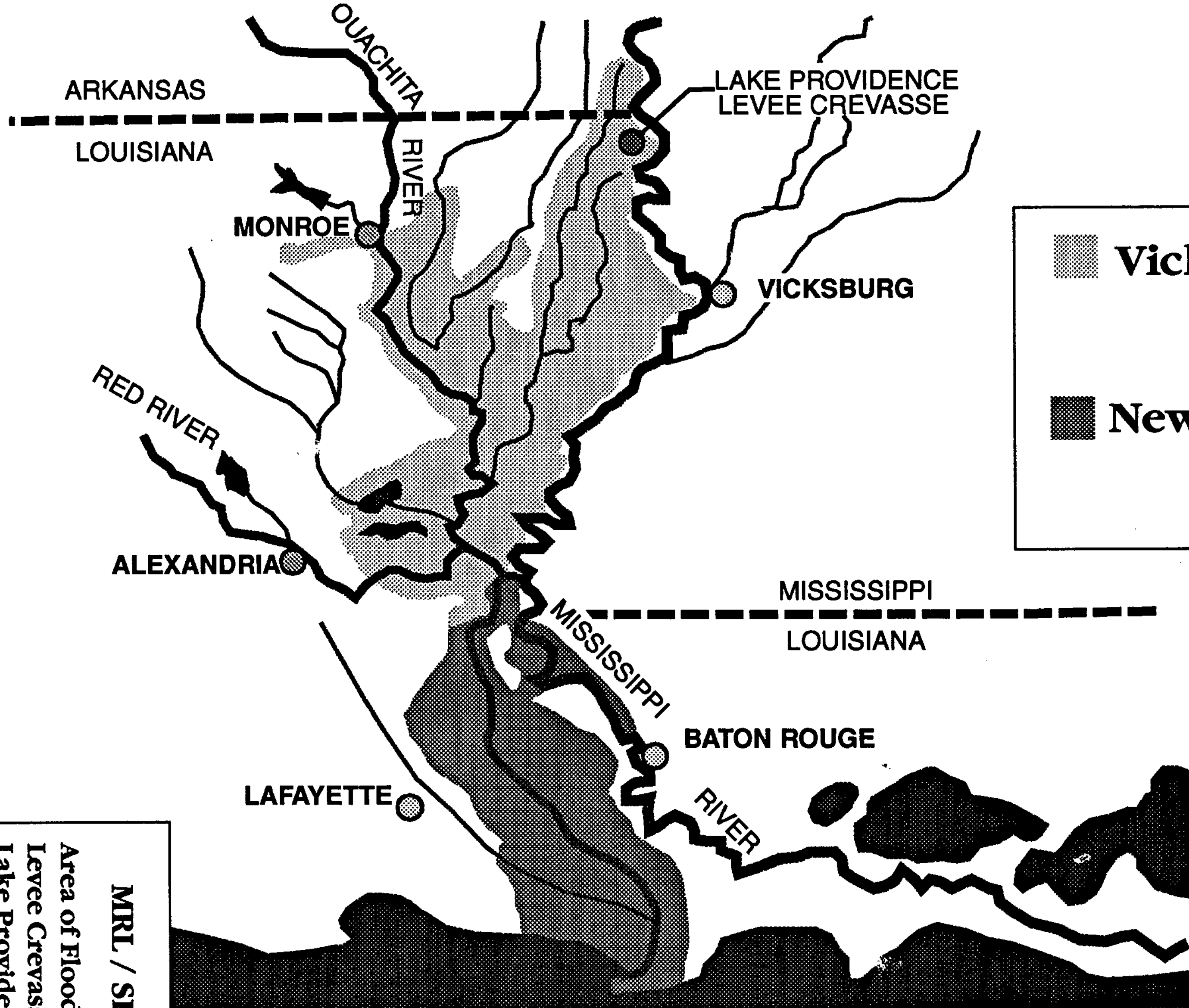

89°37'30"
89°30'00"
N
29°30'00"
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Dredged Items
Dredge Locations
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Non - Forested Wetland
Levee
Urban
Inert
Farmed Wetland (FW)
Farmed Wetland Pasture (FWP)
Wetlands
29°22'30"
89°37'30"
89°30'00"
2



89°30'00"
89°22'30"
Lower Venice 2nd Lift
Item M-10.4-R
29°15'00"
LEGEND
Bottom Land Hardwoods
Scrub/Shrub
Tree Plantation
Cropland (Prior Converted Cropland)
Pasture
Sandbar
Open Water
Marsh
Non - Forested Wetland
Levee
Urban
Inert
Forested Wetland (FW)
Forested Wetland Pasture (FWP)
Wetlands
LEGEND for Proposed Work Items
Levee Enlargement and Berms
Original Borrow Locations
Borrow Areas After Avoid & Minimize
Borrow Areas Required for Designed Items
Bridge Locations
NOTE: Jurisdictional areas on this map are approximate. Individuals proposing to do work (land clearing, ditching, excavation, leveling, filling, etc.) should contact the Corps of Engineers prior to beginning work for an on-site delineation of wetlands and other waters of the United States.
MISSISSIPPI RIVER LEVEE PROJECT
Land Cover Classification
New Orleans District
Corps of Engineers
PLATE 46
29°07'30"
89°30'00"
89°22'30"

89°22'30"
89°15'00"
29°22'30"
N
29°15'00"
29°07'30"

MISSISSIPPI RIVER PROJECT DESIGN FLOOD



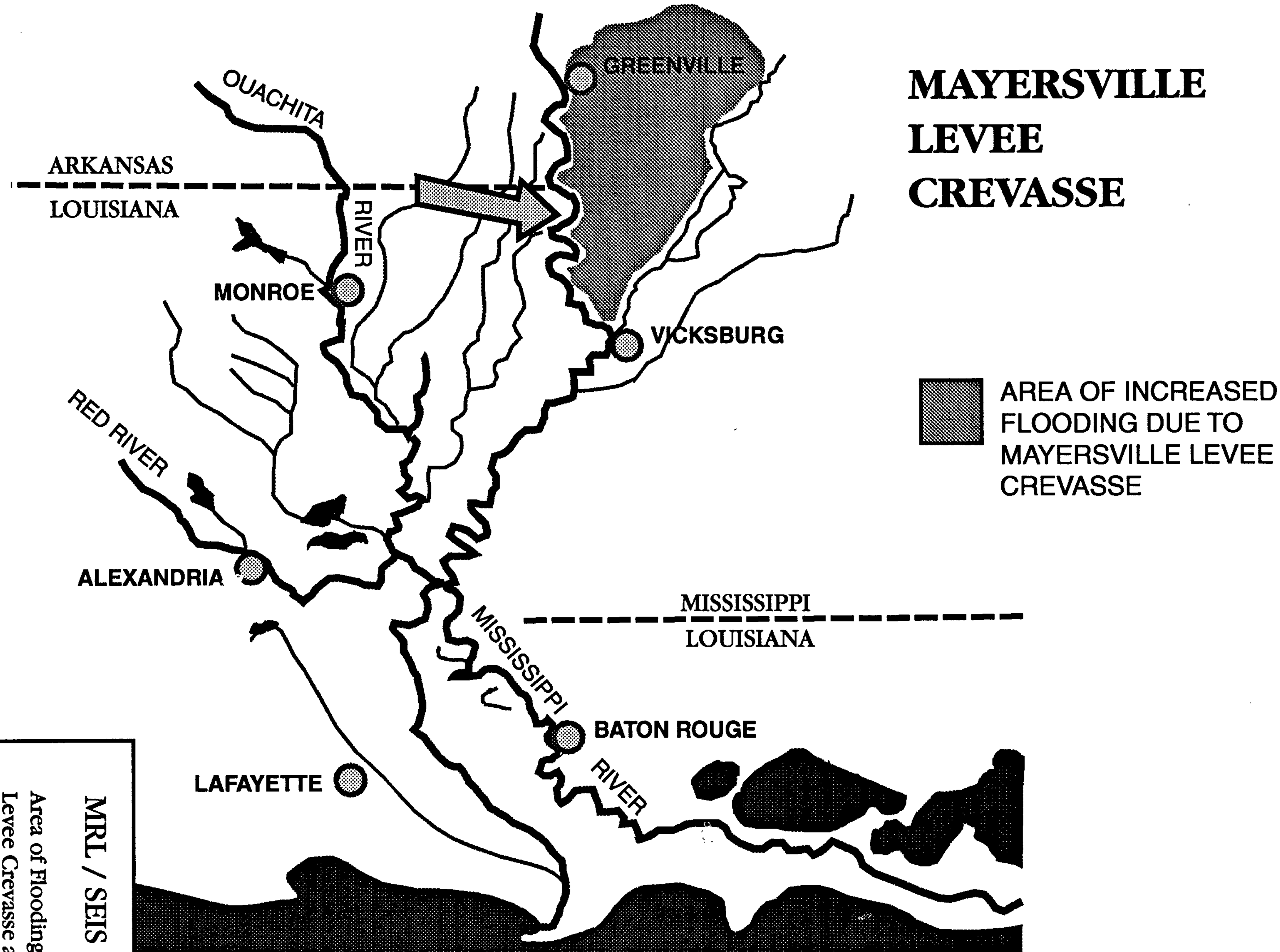
Vicksburg District

Area of increased flooding due to Lake Providence levee crevasse

New Orleans District

Project Design Flood with or without Lake Providence levee crevasse

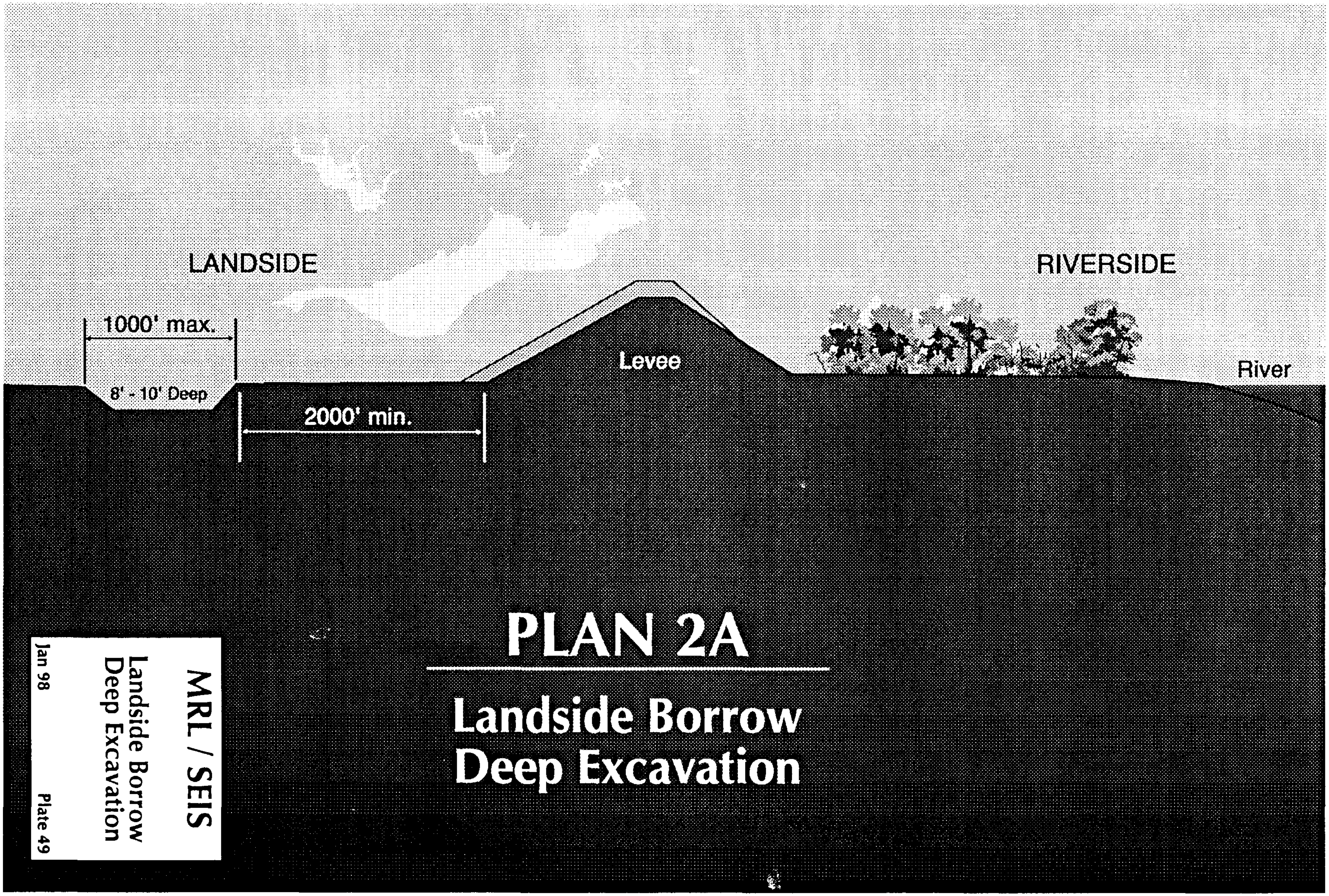
MRL / SEIS
Area of Flooding
Levee Crevasse at
Lake Providence, LA
Dec 97 Plate 47

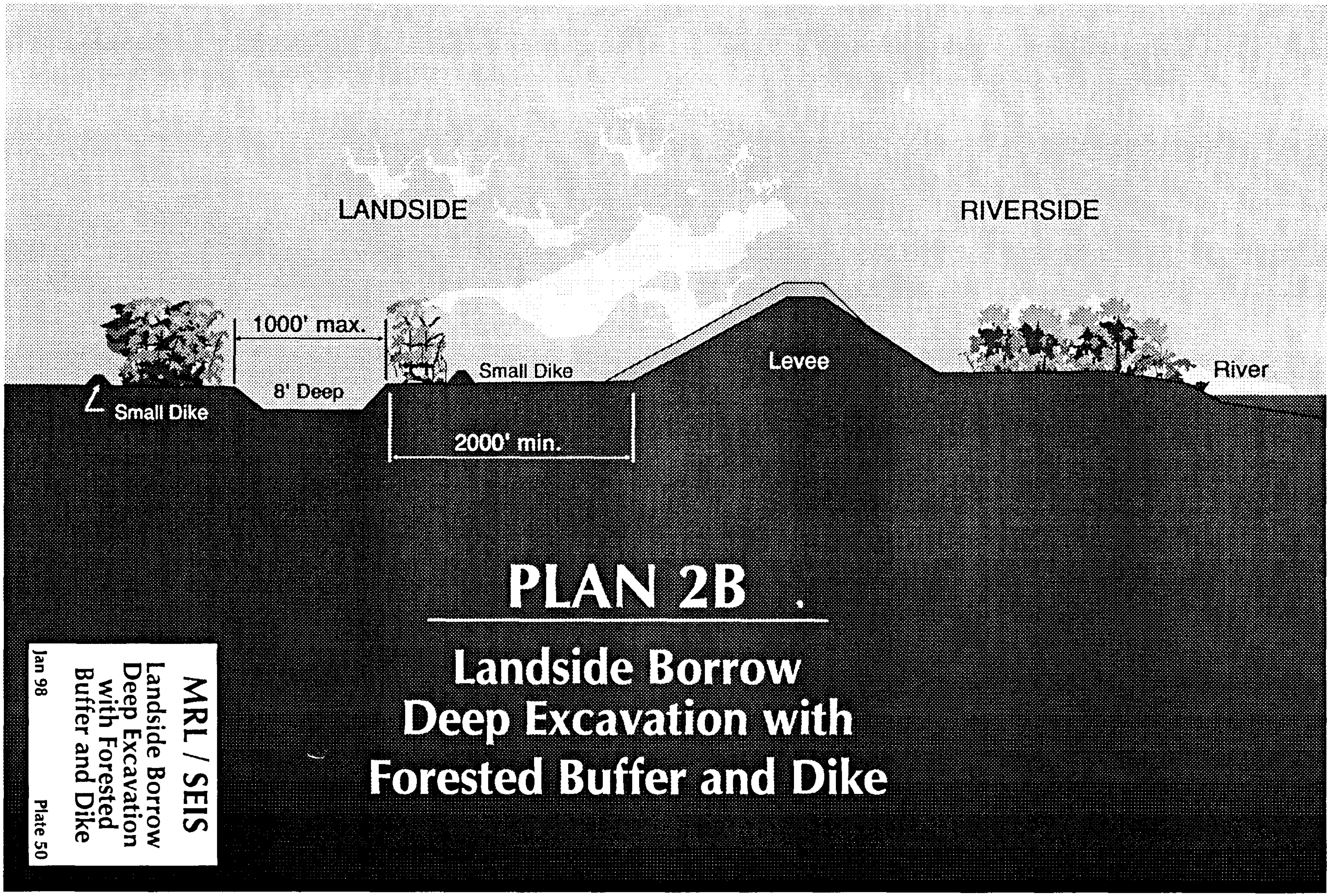


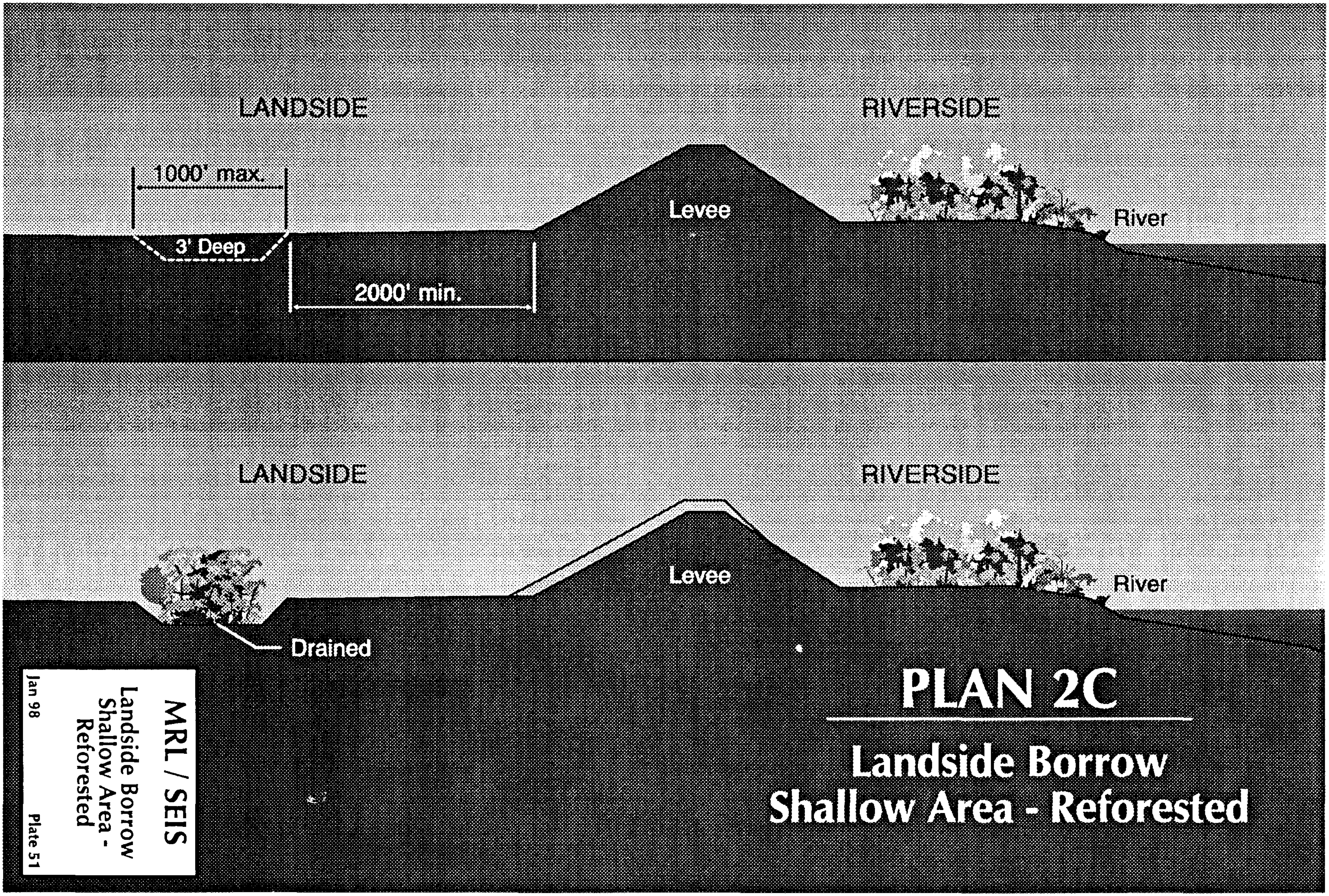
MRL / SEIS

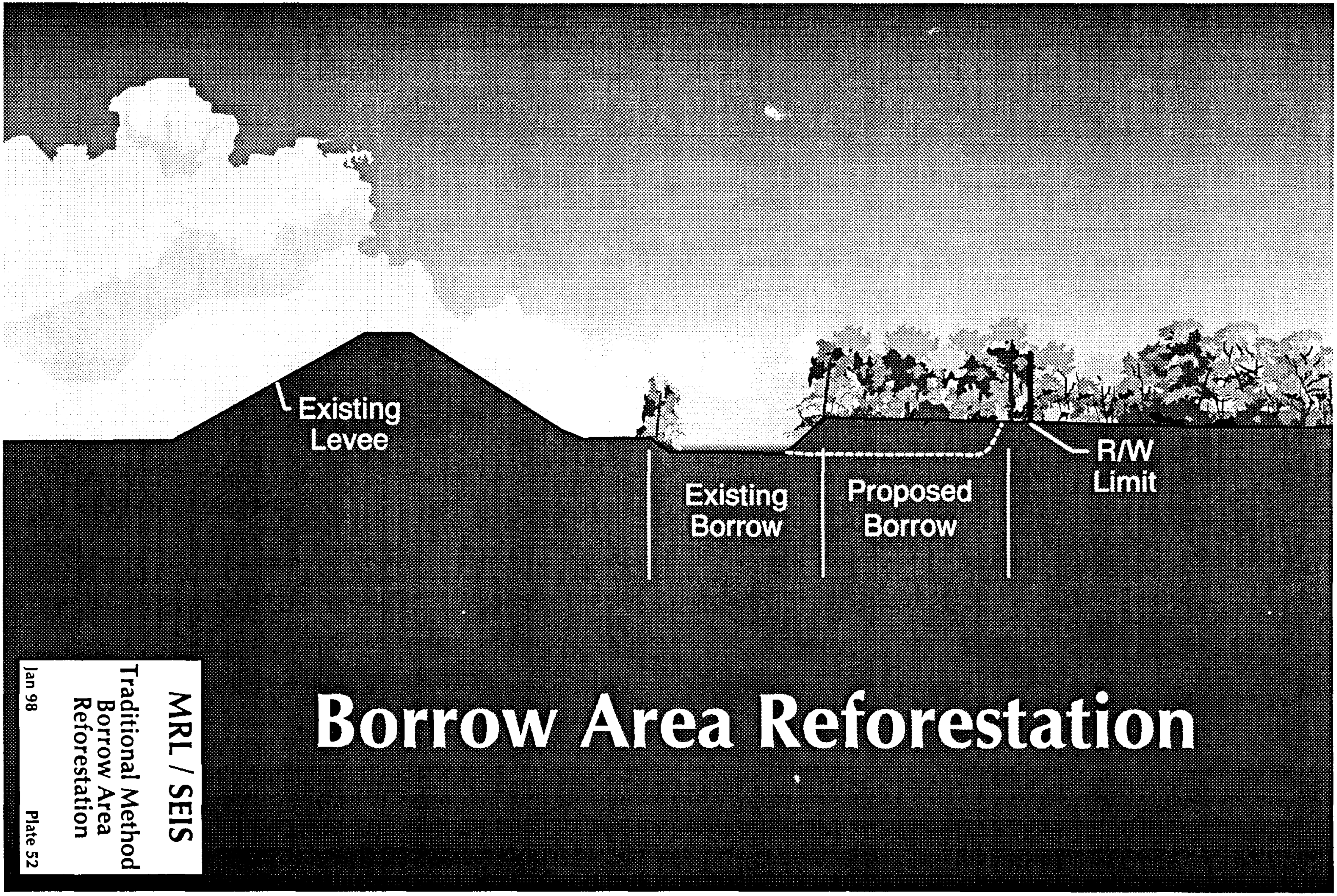
Area of Flooding
Levee Crevasse at
Mayersville, MS

Dec 97 Plate 48


LANDSIDE
RIVERSIDE
1000' max.
8' - 10' Deep
2000' min.
Levee
River
PLAN 2A
Landside Borrow
Deep Excavation
MRL / SEIS
Landside Borrow
Deep Excavation
Jan 98
Plate 49


LANDSIDE
RIVERSIDE
1000' max.
8' Deep
Small Dike
Small Dike
2000' min.
Levee
River
PLAN 2B
Landside Borrow
Deep Excavation with
Forested Buffer and Dike
MRL / SEIS
Landside Borrow
Deep Excavation
with Forested
Buffer and Dike
Jan 98
Plate 50

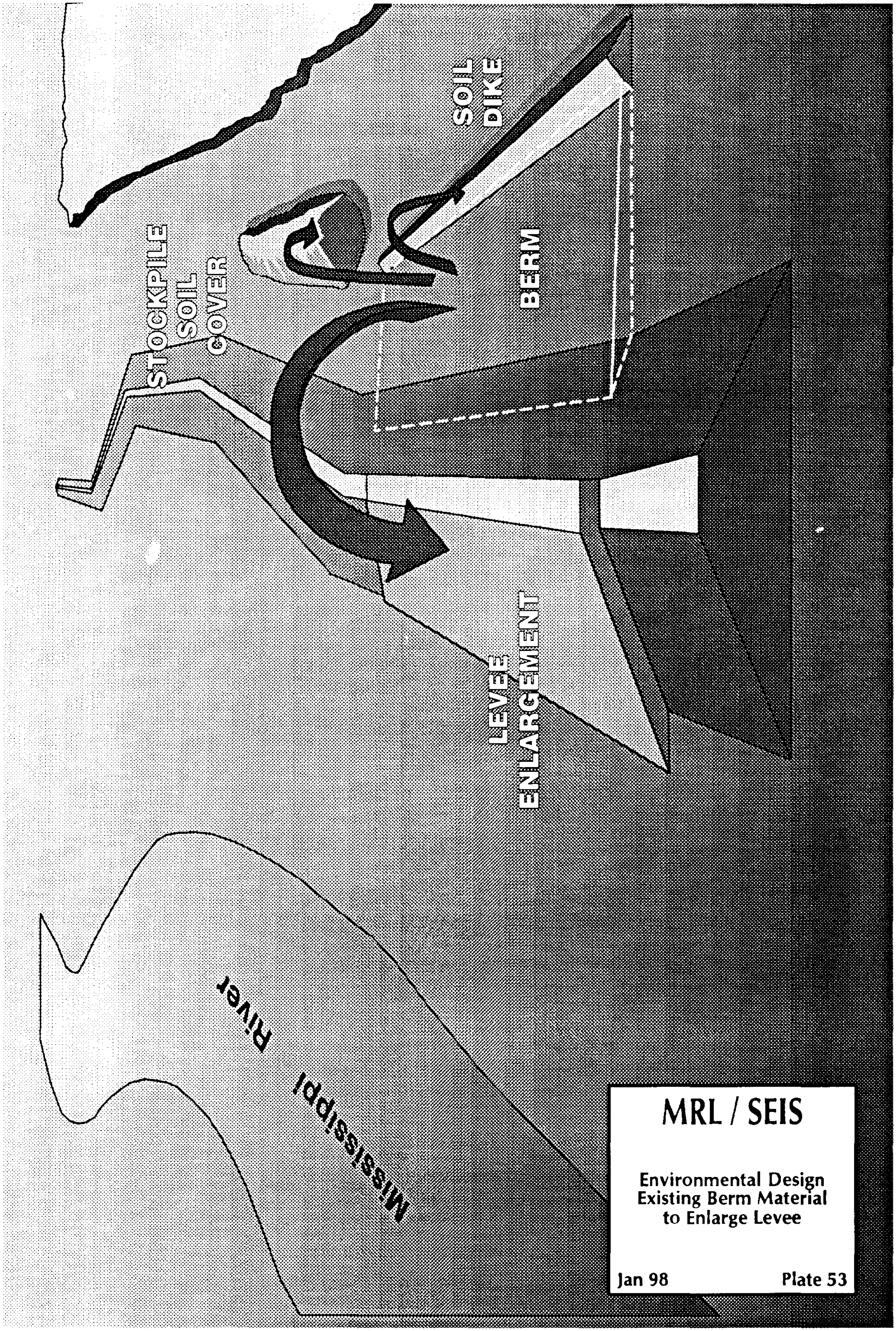

LANDSIDE
RIVERSIDE
1000' max.
3' Deep
2000' min.
Levee
River
LANDSIDE
RIVERSIDE
Levee
River
Drained
PLAN 2C
Landside Borrow
Shallow Area - Reforested
MRL / SEIS
Landside Borrow
Shallow Area -
Reforested
Jan 98
Plate 51



MRL / SEIS

Traditional Method Borrow Area Reforestation

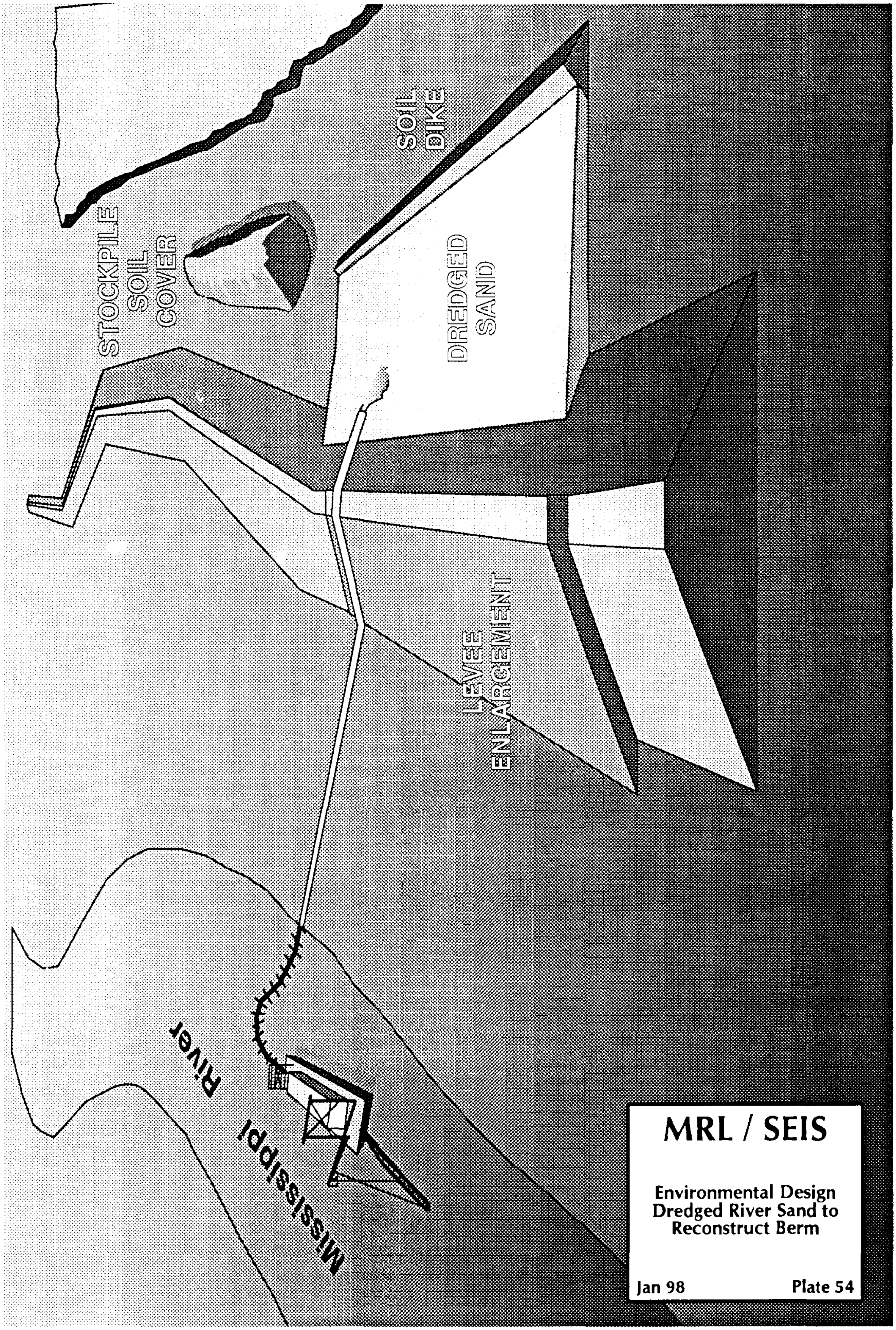
Jan 98 Plate 52



MRL / SEIS

**Environmental Design
Existing Berm Material
to Enlarge Levee**

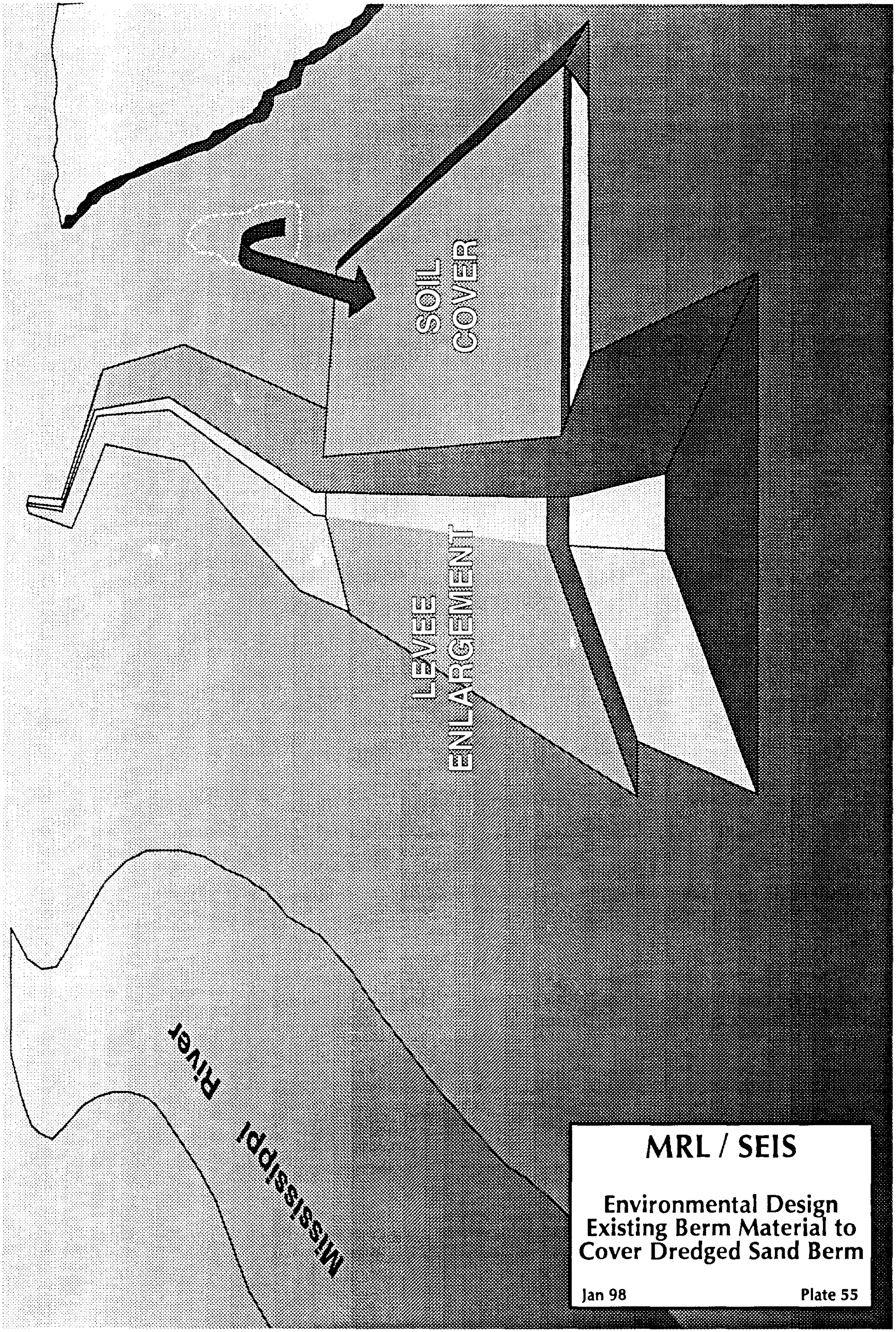
Jan 98 Plate 53



MRL / SEIS

Environmental Design
Dredged River Sand to
Reconstruct Berm

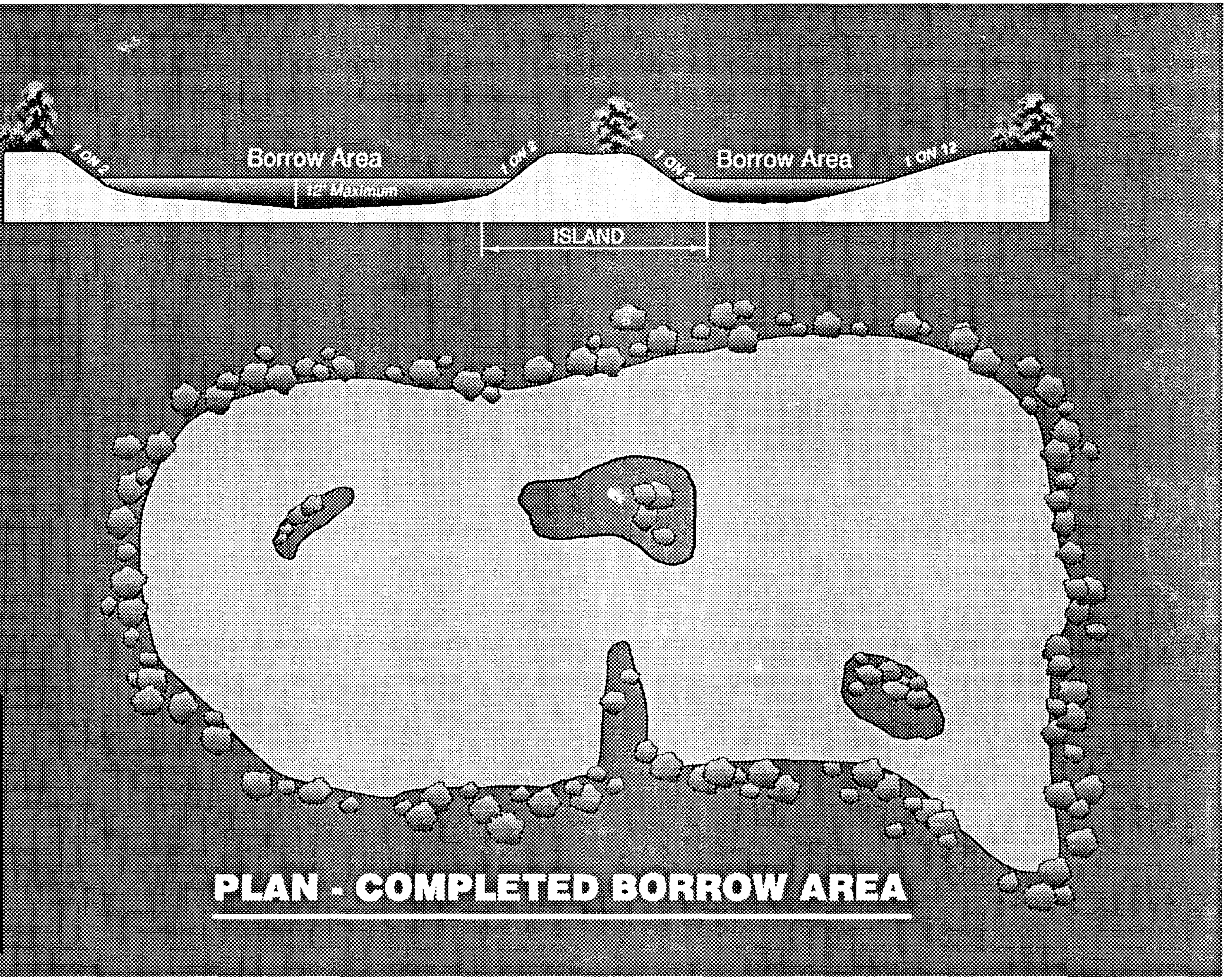
Jan 98 Plate 54



MRL / SEIS

Environmental Design
Existing Berm Material to
Cover Dredged Sand Berm

Jan 98 Plate 55



MRL / SEIS

Environmental Design
Relocated Borrow Areas

Jan 98

Plate 56