YAZOO AREA PUMP PROJECT
REEVALUATION REPORT

VOLUME 2
TECHNICAL REPORT
JULY 1982

INTRODUCTION

This volume presents the technical data and aspects of the reevaluation studies. Volume 1 contains the Main Report, which summarizes the data presented in the Technical Report, and the Environmental Impact Statement.

The information in this Technical Report is grouped into 11 appendixes:

-- Appendix A contains detailed technical descriptions and data regarding problem identification.

-- Appendix B describes formulation, assessment, and evaluation of alternative plans considered and the plan selection process.

-- Appendix C presents technical data pertaining to hydrologic and hydraulic investigations.

-- Appendix D presents technical data pertaining to geology and soils investigations.

-- Appendix E contains design and cost estimates for the plans investigated.

-- Appendix F contains the results of economic analysis of all plans investigated.

-- Appendix G contains the results of the environmental analysis of all plans investigated.

-- Appendix H contains the institutional analysis, describes the public involvement program, and presents the comments received during public review of draft report.

-- Appendix I contains the Final Fish and Wildlife Coordination Act Report and Vicksburg District responses to issues raised by the U. S. Fish and Wildlife Service.

-- Appendix J contains the Section 404(b)(1) Evaluation.

-- Appendix K contains plates which are pertinent to the entire report.

YAZOO PUMP PROJECT
YAZOO BACKWATER AREA
MISSISSIPPI

APPENDIX A

REEVALUATION REPORT

PERTINENT DATA AND PROBLEM IDENTIFICATION

PREPARED BY
THE UNITED STATES ARMY
VICKSBURG DISTRICT, CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

REEVALUATION REPORT
YAZOO AREA PUMP PROJECT
YAZOO BACKWATER AREA, MISSISSIPPI

APPENDIX A

PERTINENT DATA AND PROBLEM IDENTIFICATION

Table of Contents

Table of Contents (Cont)

Table of Contents (Cont)

Table of Contents (Cont)

LIST OF TABLES

LIST OF FIGURES

REEVALUATION REPORT
YAZOO AREA PUMP PROJECT
YAZOO BACKWATER AREA, MISSISSIPPI

APPENDIX A

PERTINENT DATA AND PROBLEM IDENTIFICATION

PROJECT AUTHORIZATION DATA

1. Flood protection for the Yazoo Backwater Area was authorized by Section 3 of the Flood Control Act of 18 August 1941, which states in part:

> (b) The project for flood control of the Yazoo River shall be as authorized by the Flood Control Act approved June 15, 1936, as amended, by Section 2 of the Act approved June 28, 1938, except that the Chief of Engineers may, in his discretion, from time to time, substitute therefor combinations of reservoirs, levees, and channel improvements; and except that the extension of the authorized project and improvements contemplated in Plan C of the report of March 7, 1941, of the Mississippi River Commission as authorized, including the extension of the levee on the east of the Mississippi River generally along the west bank of the Yazoo River to a connection in the vicinity of Yazoo City with the Yazoo River levee, authorized by the existing project for protection against headwater floods of the Yazoo River system and the adjustment in the discretion of the Chief of Engineers of the grades of the existing levees in the backwater area or the east bank of the Yazoo River below Yazoo City, all at an estimated additional cost of $11,982,000; Provided, That the Chief of Engineers shall fix the grade of the extension levees along the Yazoo River, with higher levees in his discretion, so that their construction will give the maximum practical protection without jeopardizing the safety and integrity of the main Mississippi River levees: And provided further, That prior to the beginning of construction local authorities shall furnish satisfactory assurances that they will (1) maintain the levees in accordance

> with the provisions of Section 3 of the Act of 15 May 1928, and will (2) not raise the levees in the backwater above the limiting elevations established therefor by the Chief of Engineers.

2. The portion of the 7 March 1941 report by the Mississippi River Commission which described Plan C reads in part as follows:

> . . . protecting Yazoo Backwater . . . with headwater plan in operation, Sunflower River dammed by backwater levees and all drainage pumped.

PRIOR STUDIES AND REPORTS

3. Review Report on the Project for Flood Control of the Mississippi River in its Alluvial Valley, dated 7 March 1941. This report proposed three plans for protection against backwater flooding. Each plan included levees, with all drainage pumped. The Flood Control Act of 18 August 1941 authorized the project. World War II occurred during the time work normally would have been accomplished, and no construction was begun.

4. Consolidated Report on the Yazoo Basin Backwater Protection Plan, dated 10 November 1947. This report recommended that the Yazoo Backwater plan be modified to include general provisions for the development of fish and wildlife resources of the area. This report was deferred by letter of the President of the Mississippi River Commission dated 8 July 1949.

5. Comprehensive Review of the Mississippi River and its Tributaries, dated 6 April 1962. As a result of the review of the Mississippi River and Tributaries Project completed on 6 April 1962, published in House Document No. 308, 88th Congress, 2nd Session, the Chief of Engineers modified the authorized plan to include a connecting channel between Sunflower River and Steele Bayou, with all interior drainage evacuated through the Little Sunflower and Steele Bayou drainage structures. The Chief of Engineers' report in House Document 308 reads, in part, as follows:

> . . . I believe that, at some future time, protection of some areas in the Yazoo Backwater by pumping may be warranted. Since the new plan developed by the Mississippi River Commission is proposed for construction under existing project authorization, selection of this plan does not affect those authorizations, which I consider sufficiently broad to permit selection of location and capacities of pumping plants, or a combination of gravity and pumped drainage, as future developments dictate. The selection would be made after study, within present authorization to determine economic justification, and with such modification as in the discretion of the Chief of Engineers may be advisable.

EXISTING CONDITIONS

PROJECT AREA

6. The part of the Yazoo Backwater project known as the Yazoo Area is located in west-central Mississippi between the east bank Mississippi River levee and the Will M. Whittington Auxiliary Channel. The Yazoo Area comprises approximately 900,000 acres, approximately 80 percent of which is cleared and in agricultural production (see Figure A-1).

7. The project area is that part of the Yazoo Area inundated by the 100-year flood and includes 539,000 acres in parts of Humphreys, Issaquena, Sharkey, Warren, Washington, and Yazoo Counties, Mississippi, and part of Madison Parish, Louisiana. Big Sunflower and Little Sunflower Rivers, Deer Creek, and Steele Bayou flow through the area. The high ground along Deer Creek forms a natural divide between the Steele Bayou and Sunflower River basins. A connecting channel has been constructed from the Big Sunflower River to the Little Sunflower River and from there to Steele Bayou, thus connecting the Sunflower River and the Steele Bayou interior ponding areas.

PRIOR WORK

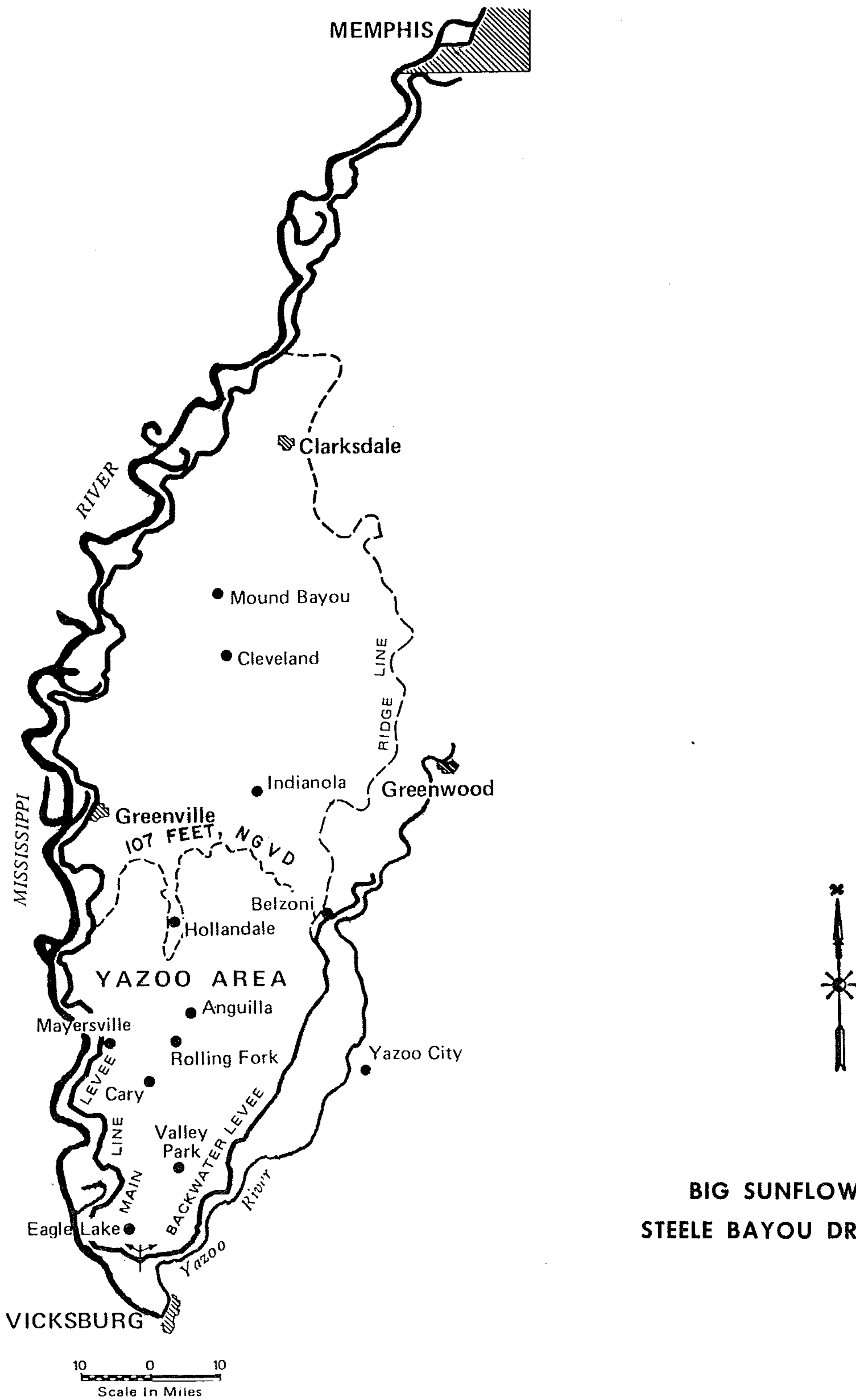
8. Completed flood control works for the Yazoo Area of the Backwater Project include a levee system approximately 27 miles in length, extending from the end of the east bank Mississippi River levee generally along the west bank of the Yazoo River to a connection with the west levee of the Will M. Whittington Auxiliary Channel. This levee system is complete to an interim grade of 107 feet, NGVD, and includes two drainage structures (one with 19,000-cfs design capacity at the mouth of Steele Bayou and one with 8,000-cfs design capacity at the mouth of the Little Sunflower River) and 27.7 miles of connecting channels from the Big Sunflower River to the Little Sunflower River, and from there to Steele Bayou. The Muddy Bayou Structure controls the water level of Eagle Lake.

TOPOGRAPHY

9. The project area is within the Yazoo alluvial physiographic area. The Yazoo alluvium or delta area is in the alluvial valley of the Mississippi River. The topography is characterized by relatively flat, poorly drained lands with slopes of 0.3 to 0.9 foot per mile. Elevations range from 100 feet, NGVD, in the upper end of the area to 70 feet, NGVD, in the lower end.

CLIMATE

10. The climate of the project area is mild and humid and is generally considered subtropical. Summers are characteristically long and hot with relative humidities averaging 75 percent; winters are usually short and moderate



SOURCE: U.S. Army Corps of Engineers Vicksburg District, 1979.

BIG SUNFLOWER RIVER-
STEELE BAYOU DRAINAGE BASIN

Figure A-1

although high humidity and winds often result in chill factors much lower than indicated by actual temperatures. Temperatures of 90 degrees F. or greater are expected 80 days of the year, with only 33 days expected to be below 32 degrees F. Precipitation over the area averages about 51 inches yearly; the average monthly rainfall varies from a low of 2.5 inches in October to a high of 5.6 inches in March. Prevailing winds are from the southeast or southwest approximately 40 percent of the time. The average growing season is about 230 days.

NATURAL RESOURCES

Water

11. Groundwater in the project area is seasonally variable, and the quantity depends upon local climatic and geological conditions. The aquifers of the area include the Mississippi River Valley aquifer, the Cockfield Formation, and the Sparta Formation. The latter two aquifers have the potential to supply sufficient quantities of potable water for domestic and many industrial purposes. Water quality in the Mississippi River Valley aquifer is usually poor because of low pH and excessive iron and carbon dioxide content.

12. Principal streams within the project area include the Little and Big Sunflower Rivers, Steele Bayou, Deer Creek, and the connecting channels. The Little Sunflower River begins in the northern part of the project area and meanders south to a junction with the Yazoo River. The Big Sunflower River flows through the project area from northeast to south, eventually intercepting the Yazoo River; Steele Bayou and Deer Creek flow through the project area from north to south. Two connecting channels have been constructed within the project area. One of these channels connects the Big and Little Sunflower Rivers; the other parallels the Yazoo River levee from the structure on the Little Sunflower River to the structure on Steele Bayou.

13. In addition to the streams and rivers, the project area contains a large oxbow lake (Eagle Lake) and numerous wetland and backwater areas. Eagle Lake was formed more than 100 years ago by a natural cutoff of the Mississippi River and has a minimum surface area of approximately 3,000 acres. The old river channel occupied by the lake continues to be the boundary between the states of Mississippi and Louisiana. Historically, these lakes and wetland areas have provided excellent fishing, waterfowl hunting, and other recreational opportunities.

Forest

14. The forests of the project area are primarily bottom-land hardwoods and vary considerably in composition and density. Conditions of the forested areas depend primarily on ownership, past and present silvicultural practices, and local site quality. Sweetgum, for example, is usually found in association with water oaks. The older soil formations or terraces are characterized by cherrybark oak, swamp chestnut oak, hickory, white oak, blackgum, and

winged elm. Cypress is the only softwood of importance in the bottom lands. Stands of tupelo and cypress occur in the swamps and on other fertile but very heavy "buckshot" soils of low, wet flats and deep sloughs. Areas between these low flats and the somewhat higher elevations consist of green ash, Nuttall oak, boxelder, hackberry, overcup oak, bitter pecan, and various intergradations of species that occur above and below these elevations.

Soils

15. Soils of the project area have fertility and water management limitations which may be relatively easily overcome. Under the prevailing growing season, normal rainfall, and adequate flood control, major soils are considered to be prime farmland and are used extensively for crop production. Distinguishing soil characteristics include: gently to nearly level slope, which are of prime importance in erosion control; soils favorably supplied with plant nutrients; and soils highly retensive of moisture. Soils in the project area include numerous series and types which have been grouped into 14 associations. These groupings can be further combined to formulate four basic associations.

a. Commerce-Robinsonville-Crevasse. Soils in this association occupy broad, nearly level, recent natural levees along lakes and streams and were formed from medium- to coarse-textured recent alluvium. As distance from streams increases, soils become finer-textured and more poorly drained. Natural fertility is high, and soil reaction is neutral to mildly alkaline. The principal crops grown are cotton, soybeans, small grains, and corn.

b. Sharkey-Dowling-Bowdre-Tunica-Moon. This association is in wide, level and nearly level, slack-water positions. Some sloping soils are located along narrow depressions scattered throughout the area. These soils are fine-textured, dark grayish-brown clays formed by Mississippi River alluvium. Internal drainage is poor. Natural fertility is high, and soil reaction is slightly acid to mildly alkaline. The principal crops are soybeans, cotton, and small grains.

c. Alligator-Forestdale-Dowling. This association occupies broad, nearly level, poorly drained slack-water areas. These soils developed in fine-textured alluvium from the Mississippi River and tributary streams. Medium-textured soils may be encountered along narrow depressions and shallow streams that dissect that area. Soils are generally light grayish-brown clays, medium in fertility and strongly acid. Crops grown on this association include soybeans, small grains, and cotton.

d. Forestdale-Dundee-Dubbs-Dowling. The soils of this association occur on broad, nearly level, old natural levees. These soils were developed in Mississippi River alluvium with medium surface textures and clay subsoils. Internal drainage varies from well drained to poorly drained, with the more poorly drained conditions occupying positions farthest from lakes and streams. Natural fertility is moderate and soil reaction ranges from medium to very strongly acid. Most of this area is cleared and is used for the production of cotton, soybeans, small grains, and corn.

LAND USE

Current Land Use

16. The project area (the area flooded by the 100-year flood) includes approximately 539,000 acres of land. Of this total, about 74 percent is cleared and used for row crops, livestock production, and miscellaneous and idle uses. An estimated 26 percent is in woodlands. Of the total woodland area, approximately 80,200 acres are located within the Delta National Forest, the Panther Swamp National Wildlife Refuge, the Yazoo National Wildlife Refuge, and Delta Wildlife and Forestry, Inc. (a privately owned corporation operated with the primary objective of providing hunting for its stockholders).

Area	Area Subject to Flooding Cleared (acres)	Wooded (acres)	Total (acres)
Lower Ponding Area	148,000	52,000 a/	200,000
Upper Ponding Area	249,500	89,500 b/	339,000
TOTAL	397,500	141,500	539,000

a/ Includes 3,630 woodland acres within Yazoo National Wildlife Refuge.
b/ Includes 76,589 woodland acres within Delta National Forest, Delta Wildlife and Forestry, Inc., and Panther Swamp National Wildlife Refuge.

General Land Use Patterns

17. The majority of the project area is located within Issaquena and Sharkey Counties. Land use development patterns within these two counties are representative of development patterns throughout the project area. Issaquena and Sharkey Counties comprise a total of 850 square miles. Of this total, 472 square miles are in agricultural uses, while 290 square miles are in forests. Water bodies comprise 59 square miles, and other uses, including marshes and swamps, comprise 20 square miles. Five square miles are in residential use, while 3.3 square miles are used for transportation and utilities. Commercial, industrial, institutional, and recreational uses each comprise less than 0.1 percent of the total land area. Land use distribution data for Issaquena and Sharkey Counties are shown in Table A-1.

RECREATIONAL SETTING

18. Leisure and recreational activities in the project area are limited primarily to hiking, sightseeing, boating, hunting, and fishing. Other activities such as golf and tennis are provided by towns and private clubs. The natural lakes, wetlands, and bottom lands of the area provide fishing, hunting, water sports, and general recreation. Public hunting areas and a large number of private hunting clubs are located throughout the area. Agricultural land use characteristics of the study area restrict the potential of many of the natural land and water bodies since it is difficult for intense cultivation and recreational areas to coexist because of their conflicting demands. Extensive land clearing activities have also altered the ecosystem of many water areas by increasing runoff, thus increasing the siltation in streams and lakes.

ARCHEOLOGICAL, CULTURAL, AND HISTORICAL SETTING

19. A literature search and records review were accomplished to determine what resources are known to be located in the project area. One archeological site, 22IS522, is located in the general vicinity; however, the site is not in the direct impact area. No sites eligible for listing in the National Register of Historic Places are located within the study area. A preliminary field assessment of the pump station and approach channel did not reveal any cultural resources.

TRANSPORTATION

Highways

20. A number of Federal, state, and county roads provide access to the project area. North-south access is provided by U. S. Highways 61 and 49 and State Highway 3. East-west service is provided by state roads 1, 14, 16, and 433.

Rail

21. Rail transportation is provided by the Illinois-Central Gulf Railroad which runs north and south through the project area.

Waterways

22. Water access to the area is provided via the navigation channels of the Mississippi and Yazoo Rivers. The main stem Mississippi River channel is open during the entire year and is the main navigational artery for the Lower Mississippi Region's network of navigation feeder channels. It is maintained at a low-water depth of 9 feet and a width of 300 feet from Cairo, Illinois, to Baton Rouge, Louisiana, a distance of 720 miles. From Baton Rouge to the Gulf of Mexico, the Mississippi River is maintained as a deep-water ship channel (40-foot controlling depth).

23. The existing Yazoo River navigation channel, extending from Greenwood, Mississippi, to Vicksburg, Mississippi, varies from a depth of 4 to 9 feet, with 9-foot depth available 46 percent of the time. Improvements to the existing channel have been authorized and will provide 9-foot depth 97 percent of the time.

Pipelines

24. Natural gas and crude oil pipelines cross the area from the southwest to the northeast and east. Origins of these lines are in east Texas and coastal areas of Louisiana.

SOCIOECONOMIC SETTING

Social Aspects

25. Population.

a. Past trends. The population of the area increased until about 1940 and then began a decline which has continued through the present time (see tabulation below). These population totals include the built-up areas of Anguilla, Belzoni, Cary, Holly Bluff, Mayersville, and Rolling Fork.

Year	Population
1930	45,200
1940	88,200
1950	76,700
1960	65,100
1970	53,600
1978	52,500

Source: U. S. Census of Population, Bureau of the Census, U. S. Department of Commerce.

b. Density. In 1978, density of the population for the project area was 24 persons per square mile. As shown in the following tabulation, the density of the project area ranged from a low of 6 persons per square mile in Issaquena County to 34 persons per square mile in Humphreys County. These figures are based on land areas for the four counties (Humphreys, Issaquena, Sharkey, and Yazoo) of 421, 414, 436, and 938 square miles, respectively.

Year	Population Per Square Mile			
	Humphreys	Issaquena	Sharkey	Yazoo
1930	61	14	33	41
1940	62	14	35	43
1950	53	12	30	38
1960	45	9	25	34
1970	35	7	20	29
1978	34	6	20	29

Source: Number of Inhabitants, Bureau of the Census, U. S. Department of Commerce.

26. Migration and mobility. The project area experienced a net outmigration of 33.8 percent between 1960 and 1970 and 11.3 percent between 1970 and 1977. The highest net outmigration for 1960-1970 (40.1 percent) was reported in Humphreys County. The lowest net outmigration for 1960-1970 (26 percent) occurred in Yazoo County, possibly reflecting the employment opportunities afforded by Yazoo City, the largest urban area in the project area. Of the 47,680 inhabitants 5 years of age or over in the project area in 1970, only 28,468 occupied the same house as in 1965, while 17,297 lived in a different house. Approximately 73.5 percent of the inhabitants 5 years of age and over who lived in a different house lived in the same county, while 26.5 percent lived in a different county within Mississippi. A total of 2,095 of the inhabitants 5 years of age and over either lived abroad or had moved and did not report a 1965 residence. The apparent mobility of the project area inhabitants reflects the mechanization and technological improvements taking place in a predominantly agriculture-oriented economy.

27. Housing. Within the general area, there were 16,222 housing units in 1970. Of this total, 90 percent (14,605) were occupied. Of the occupied housing units, 52 percent (7,600) were owner-occupied, whereas 48 percent were occupied by renters. Units lacking all or some plumbing facilities constituted 45 percent (6,613) of all occupied units compared with 27 percent for Mississippi. Based on a 1970 population of 53,600, an average of 3.3 persons resided in each occupied household. Median size of occupied units in each county ranged from 4.5 to 4.7 rooms per household. Owner-occupied homes had a median value of $11,300. Median rent of renter-occupied homes was $30.

Economic Aspects

28. Income.

a. Personal income. Total personal income, the principal component of gross national product, is the best available indicator of economic activity of the project area. Total personal income refers to income of individuals received through wages, salaries, profits, property income, or transfer payments. The 1970 total personal income of the project area was $136.6 million, reflecting an average annual increase of 2.7 percent over the $80.4 million income of 1950. The total personal and per capita incomes are shown in the following tabulation.

Year	Income: Total Personal ($000) a/	Income: Per Capita ($) b/
1950	80,356	1,048
1959	92,653	1,397
1970	136,583	2,548
1972	162,242	3,090
1976	195,400	3,900
1978	209,300	4,000

a/ Source: Economic Base Study, Yazoo River Basin, Mississippi, for Vicksburg District, Corps of Engineers.
b/ Based on total personal income (center column) and population (see para 25a).

b. Family income. Of the 11,981 families residing in the project area in 1970, 40 percent had incomes less than $3,000 in 1969 (Table A-2). Median income of families ranged from $3,331 in Humphreys County to $4,648 in Yazoo County. Based on U. S. Census of Population data, poverty status was evidenced by the fact that 5,526 families, 46 percent of all families, had incomes below poverty levels. These levels are based on an index providing a range of poverty income cutoffs adjusted by such factors as family size, sex of the family head, number of children under the age of 18, and farm and nonfarm residence. Mean income of families having incomes below poverty levels ranged from $1,720 in Yazoo County to $1,989 in Sharkey County. Mean family income deficits ranged from $2,010 in Sharkey County to $2,185 in Humphreys County. Of the 5,526 families below poverty levels, 37.2 percent received public assistance. This percentage ranged from a low of 29.9 percent in Humphreys County to a high of 41.3 percent in Issaquena County. Only 53 percent of all families had incomes equal to or greater than 125 percent of poverty levels. Families with incomes greater than $10,000 accounted for 19 percent of all families. As of October 1978, all project area counties were designated as redevelopment areas due to low median family incomes as provided under Title IV of the Public Works and Economic Development Act of 1965.

29. Employment and labor force.

a. In 1970, 15,431 persons 16 years of age and over were employed in the four-county area (Table A-3). Major industries within the project area comprised 82 percent of the total employment in 1970: (a) services 4,099;

(b) agriculture, forestry, and fisheries 3,954; (c) manufacturing 2,436; and (d) retail trade 2,168 (Table A-3). Other significant industries were construction; transportation, communication, and public utilities; and public administration (accounting for 13 percent of the 1970 project area employment).

b. Of the total civilian labor force, 935 or 5.7 percent were unemployed (Table A-4). Of the total unemployed, 887 were experienced unemployed (Table A-5). The leading occupation of experienced unemployed was farmworkers with 259. Other occupations contributing significantly to unemployment were craftsmen, foremen, and kindred workers (189); laborers, except farm (116); and service workers (112). Unemployment was more common among females as evidenced by the fact that 8.5 percent of the female labor force as compared to 4.1 percent of the male labor force was unemployed (Table A-4). Male unemployment was concentrated in the farmworker occupation, while female unemployment centered in the craftsman, farmworker, service worker, and laborer categories. All four counties in the project area are currently designated as redevelopment areas due to substantial unemployment as covered under Title IV of the Public Works and Economic Development Act of 1965.

30. Other economic indicators.

a. Value added by manufacture can be defined as the value of shipments and other receipts less the total cost of materials, adjusted to reflect the net change in finished products and work-in-process inventories between the beginning and end of the year. Value added by manufacturing is a valuable means to measure the contribution of productive effort by industrial classification and locality. Within the project area, value added by manufacture was estimated at $77.7 million in 1978, an increase of 20 percent since 1972. The average annual rate of increase from 1972 to 1978 was 3.1 percent.

Year	Value Added by Manufacturer a/ ($000)
1958	17,000 b/
1963	36,400 b/
1967	85,100 b/
1972	64,600
1976	72,300
1978	77,700

a/ Source: Economic Base Study, Yazoo River Basin, Mississippi, for Vicksburg District, Corps of Engineers.
b/ Data are incomplete due to disclosure restrictions.

b. Bank deposits include the total of time and demand deposits in commercial banks. Bank deposits increased from \$46.5 million in 1964 to \$74.8 million in 1975, an increase of 61 percent.

31. Agribusiness.

a. General. The study area is located in the Mississippi Delta, the most productive agricultural area in Mississippi, and one of the most productive in the nation. The agricultural industry is highly developed, employing the latest technological and production techniques. It is basically crop production-oriented with the major crops being cotton, soybeans, and small grains.

b. Agricultural characteristics. Trends of various farm characteristics in the project area are presented in Table A-6. The number of farms decreased from 1,224 in 1969 to 1,131 in 1974, or 8 percent. While the land area in farms increased from 922,972 acres in 1969 to 931,302 acres in 1974, average farm size increased from 754 to 823 acres, an increase of 9 percent. In 1974, the value of land and buildings per acre was \$310, approximately 1 percent greater than the 1969 value of \$306 per acre. Value of all farm products sold increased significantly through 1964, at which time the total value of farm products sold was estimated at \$81.8 million (Table A-7). Data presented for census years 1969 and 1974 reflect major decreases in value of farm products sold. These decreases are due to several factors: (1) the 1969 and 1974 censuses being taken by mail rather than the direct interview process used in previous years; (2) extremely adverse climatic conditions; and (3) a major change in the definitions of farming operations between the 1969 and 1974 censuses.

ENVIRONMENTAL SETTING

32. The project area is typified by flat, nearly level land characteristic of the Mississippi River alluvial valley. Local relief is provided by natural levees and alluvium from river meanders. The project area was once heavily forested with extensive bottom-land hardwoods, wetlands, swamps, and lakes. Land clearing for agricultural uses has reduced the original forested area by almost 74 percent.

33. Alluvial soils and abundance of water are the area's most valuable natural resources. Because the area is in the Mississippi River alluvial valley, flooding has always been a critical environmental component. The bottom-land forest and wetland ecosystems adapted through time to the historic flood regime.

34. Man's efforts to develop and live in the project area have resulted in a number of environmental impacts--some beneficial, some adverse, some not yet known--all of which comprise the array of trade-offs for the present status quo within the project area. The intensive flood control program throughout the Yazoo Delta has changed considerably the original delta environment, from

an extensive wooded swamp and hardwood forest system to an intensively managed agricultural system. A more detailed description of the environmental setting is contained in Appendix G.

FUTURE WITHOUT-PROJECT CONDITIONS

LAND USE

35. An analysis of future conditions indicates that land requirements for residential, commercial, and recreational uses and roads, railroads, etc., will remain essentially unchanged. However, favorable markets for agricultural commodities have increased economies of scale associated with agricultural enterprises and are expected to result in a continuation of land clearing within the project area.

36. Woodlands within the Delta National Forest, Panther Swamp National Wildlife Refuge, Delta Wildlife and Forestry, Inc., and the Yazoo National Wildlife Refuge comprise approximately 80,200 acres of dedicated forestry areas for which no clearing is expected. However, 48,400 wooded acres within the lower ponding area and 12,900 wooded acres within the upper ponding area were considered undedicated and potential acreages for clearing under existing (without-project) conditions and with-project conditions. Existing and projected future without-project cleared and woodland relationships are presented in Table A-8. Projected clearing rates are based on the land use study for the Yazoo Basin, as described in the Lower Mississippi Region Comprehensive Study, Plan Formulation Appendix T, 1974.

POPULATION

37. Population projections were taken from Economic Base Study, Yazoo River Basin, Mississippi, Vicksburg District, Corps of Engineers, conducted by Weston. The projections were determined using the "Cohort Survival Migration" model for projecting population. This method incorporates three primary parameters--fertility, mortality or survival, and net migration.

38. Results of this procedure indicate that population will experience a slight decreasing trend to the year 2030 and then begin to increase. A 7 percent decrease is projected over the period 1978 to 2030. Projections indicate the project area density will be 22 persons per square mile from 1990 to 2039.

Year	Project Area Population	Project Area Density Per Square Mile
1978	52,500 a/	24
1990	49,100 b/	22
2000	49,100 b/	22
2010	48,900 b/	22
2020	48,900 b/	22
2030	48,800 b/	22
2039	48,900 b/	22

a/ Source: U. S. Census of Population, and Number of Inhabitants, Bureau of the Census, U. S. Department of Commerce.
b/ Source: Economic Base Study, Yazoo River Basin, Mississippi for the Vicksburg District, Corps of Engineers.

ECONOMY

Income

39. Projections indicate total personal incomes of $209.3 million, $332.2 million, and $1,187.2 million for 1978, 1990, and 2039, respectively. Based on these values, along with population projections, the per capita income is projected to be $24,300 by 2039, reflecting an average annual rate of increase of approximately 2.7 percent over 1978.

Year	Income	
	Total Personal ($000) a/	Per Capita ($)
1978	209,300	4,000
1990	332,200	6,800
2000	465,100	9,500
2010	619,600	12,700
2020	793,800	16,200
2030	990,500	20,300
2039	1,187,200	24,300

a/ Source: Economic Base Study, Yazoo River Basin, Mississippi, for Vicksburg District, Corps of Engineers.

Manufacture

40. Value added by manufacture is projected to increase to $105.8 and $119.3 million in 1990 and 2000, respectively, and thereafter to decline to $111.9 million by 2039.

Year	Value Added by Manufacturer [a/] ($000)
1978	77,700
1990	105,800
2000	119,300
2010	111,600
2020	111,700
2030	111,800
2039	111,900

a/ Source: Economic Base Study, Yazoo River Basin, Mississippi, for Vicksburg District, Corps of Engineers.

Agriculture

41. Projected data indicate that under prevailing conditions, farm product sales will continue to increase to approximately $127.0, $167.0, and $330.0 million in 1978, 1990, and 2039, respectively. Projected data were derived by use of linear regression analysis (see tabulation below).

Year	Value of Farm Products Sold [a/] ($000)	Ratio of Increase Over Previous Value
1978	126,699.9	
		1.3154
1990	166,655.4	
		1.1998
2000	199,951.7	
		1.1665
2010	233,248.0	
		1.1428
2020	266,544.3	
		1.1249
2030	299,840.6	
		1.0999
2039	329,807.2	

a/ Based on linear regression analysis excluding 1969 and 1974 historical data.

ENVIRONMENT

Forest Resource

42. Between 1967 and 1973, forested areas decreased from 56 to 55 percent of the total land area within the state. From 1957 to 1967, 22 percent of the commercial forest in the Delta was cleared. From 1967 to 1973, 14 percent of the Delta forest was cleared and planted, primarily in soybeans and cotton. The Delta unit, which is associated primarily with the alluvial plain of the Mississippi River, contains some of the state's most productive land. If widespread clearing continues, as predicted, the impact on the hardwood resource will become even more severe within the next decade.

43. Wooded swamps provide valuable habitat for furbearers, resident and wintering waterfowl, songbirds, shorebirds, wading birds, and various other wildlife species including deer, turkey, and swamp rabbit. These swamps are highly desirable nesting and roosting habitat for wood ducks. Important furbearing animals which use wooded swamps include raccoon, mink, nutria, river otter, muskrat, and beaver.

44. Seasonally flooded basins and flats are the predominant wetland type found throughout the project area. The vegetation found in this type wetland is influenced by the soils and the duration, frequency, depth, and season of flooding. The flooded flats within the area attract high concentrations of mallards and wood ducks and provide food and cover for a number of game and nongame animals and furbearers.

45. Future land use in the project area is expected to parallel present conditions of intensive agricultural development. Land use in the area will depend to a large degree on future market demands for agricultural production. It is expected that these future demands will result in continued deterioration in both the size and quality of remaining wetland and bottomland hardwood forests, regardless of further flood control improvements.

Fish and Wildlife

46. The current farming practices of straight-row cropping, cultivation to the edges of streams and lakes, large-field monoculture, and other "clean farming" practices allow little habitat for wildlife. In addition, the widespread use of agricultural chemicals, together with heavy suspended sediment loads washed into area streams and lakes from agricultural areas, has contributed greatly to the loss and degradation of aquatic and terrestrial wildlife habitat in the Delta.

47. Frequent winter and early spring flooding of woodlands and low-lying farmlands provides habitat for wintering waterfowl. The amount of waterfowl habitat is expected to decline with the clearing of the woodlands and reduction of flooding.

Water Quality

48. The use of agricultural chemicals in the Delta has had considerable impact on the biological environment of the project area. Pesticide residues have been found in tissue, water, and mud samples. In many cases, pesticide levels in lakes and rivers evaluated have been high enough to be suspected of interfering with the productivity of biota in the area, particularly animals high in the aquatic food chain such as largemouth bass and herons. In high enough concentrations, pesticides may also reduce the numbers of aquatic food organisms, and at sublethal levels, may adversely affect growth, reproduction, and behavior of higher animals which ingest pesticide contaminated organisms.

49. During more recent years, the levels of toxaphene and DDT have begun to decline. As new pesticides are marketed, these chemicals begin to appear in aquatic samples above the allowable limits. Pesticide contamination of the aquatic environment within the project area will likely continue until such time as safe pesticides are formulated.

50. High levels of turbidity occur in nearly all streams and lakes, with the associated problems of reduced light penetration and primary productivity, interference with respiration of aquatic organisms, damage to sensitive tissue, silting over of nesting sites, smothering of eggs, and alteration of habitat for benthic flora and fauna.

PROBLEMS AND NEEDS

PROBLEMS

Flooding

51. Flooding and poor drainage are the principal problems in the project area. Major problems which have resulted from frequent flooding include flood damage to agricultural crops, noncrop items, rural residential property, and public roads and bridges, and a reluctance on the part of farm operators to apply improved production inputs and techniques. Three important factors which affect flood losses to agricultural lands are time of year, duration, and frequency of flooding. Frequent or intermittent floods can occur any time of year; however, flood records indicate that the majority of floods occur during the land preparation and spring planting months (January through June). Average flood duration is in excess of 30 days, and the frequency of occurrence is approximately 1.5 times annually.

52. The alluvial lands of the Yazoo Area have always been subject to flooding by the Mississippi River. From 1897 through 1937, massive floods inundated the region regularly. Then, for a 35-year period less severe flooding occurred, causing many to dismiss massive floods as things of the past. But in 1973, a severe flood again devastated the area. Other destructive floods

followed in rapid succession in 1974, 1975, and 1979. Hundreds of persons were forced from their homes, crops and buildings were damaged or lost, and wildlife was destroyed.

53. During 108 years of recordkeeping, the Yazoo Area has flooded to some extent every year except 1954. More than 50,000 acres were flooded at least once a year for 86 of the 108 years. Flooding of more than 100,000 acres has occurred in 64 years and flooding of 400,000 to 820,000 acres has occurred 13 times. Twelve of these thirteen floods were between 1897 and 1937, averaging 3-1/3 years between floods.

54. Following 35 years of mostly moderate flooding, severe flooding began again in the 1970's. No year in the 1970 decade was flood free. Small floods in 1970, 1971, 1972, and 1978 were accompanied by massive floods in 1973, 1974, 1975, and 1979. Very small floods occurred in 1976 and 1977.

55. The most severe flood of the 1970's (1973) created a body of water 60 miles long (almost as large as the Great Salt Lake), with financial losses amounting to over $65 million and personal trauma immeasurable in dollars. The flood stage lasted almost 9 months.

56. Area flooded. The total area subject to flooding by the 100-year frequency flood under existing conditions is 539,000 acres, of which 74 percent is cleared land. The remaining 26 percent is in woodlands. The classification of floods and number of occurrences in the Yazoo Area for the period 1872 through 1979 are shown in the tabulation below.

Acres Flooded	Classification a/	Number of Years Occurring
820,000 - 400,001	Massive	13 b/
400,000 - 200,001	Major	28
200,000 - 100,001	Medium	23
100,000 - 50,001	Small	22
Less than 50,000	Very Small	21

a/ SOURCE: Classification provided by Mississippi Research and Development Center, 1979.

b/ These massive floods occurred in 1897, 1903, 1907, 1912, 1913, 1916, 1920, 1922, 1927, 1929, 1932, 1937, and 1973.

57. Plates presented in Appendix K illustrate flooding under existing and with-project conditions for the various flood frequencies: the 1-year frequency flood (Plate 5); the 3-year frequency flood (Plate 6); the 5-year frequency flood (Plate 7); the 25-year frequency flood (Plate 8); the 50-year frequency flood (Plate 9); the 100-year frequency flood (Plate 10); and the Mississippi River Project Design Flood (Plate 11). The Mississippi River Project Design Flood was considered a flood of magnitude approximately equal to the Standard Project Flood (see Appendix C).

58. Major backwater floods. Major floods which have occurred in the Yazoo Backwater Area during the 1970's (described briefly in the following paragraphs) typify the kind of flooding to which this study is addressed. The 1973, 1974, and 1975 floods occurred prior to completion of the backwater levee and gravity structures, whereas the 1979 flood occurred after they were completed.

a. Flood of 1973. Beginning in late September 1972 and continuing through the spring of 1973, unusual meteorological and hydrological events persisted with a relentless variety of phenomena over areas and basins in the Vicksburg District. Severe weather in the forms of intense thunderstorms, tornadoes, high winds, and rain were observed at frequent and recurring intervals, inflicting widespread flooding and extensive property damage. Storm cells pelted some areas with measured precipitation which exceeded amounts expected to occur on an average of only once in 100 years. Flooding in the Yazoo Backwater Area was the worst recorded since the 1937 flood. The resulting damage to prime delta farmlands and properties was the highest ever experienced because of extensive developments over the past years. Other losses to farmers occurred as a result of the long duration of flooding which was prohibitive to the planting of cotton.

b. Flood of 1974. The 1973-1974 highwater season began in November 1973 and continued through May 1974. Continuing rains kept streams above damage levels. The situation was worsened when backwater flooding from the rising Mississippi River was added to headwater flood runoff. Families in portions of Sharkey, Issaquena, and Warren Counties, many of whom had only recently returned to their homes from the 1973 flood, were forced to evacuate. At the height of backwater flooding, approximately 301,000 acres were inundated.

c. Flood of 1975. The third consecutive year of significant flooding throughout the Yazoo Backwater Area began during December 1974. About 90 percent of Sharkey and Issaquena Counties was inundated, and between 700 and 800 families were evacuated from the flooded area.

d. Flood of 1979. This flood occurred after the backwater levee was completed and began as the Mississippi River started to rise early in 1979. By 1 March, due to a combination of rainfall in the Yazoo Area and high Mississippi River stages, Steele Bayou began to rise above elevation 80, the elevation at which flood damages begin to occur. On 4 March, as water reached elevation 82.5, the Steele Bayou gates were closed to prevent the Mississippi and Yazoo Rivers from flowing into the Yazoo Area. The Little Sunflower River Structure was closed on 5 March as water reached 85.05 feet. On both the river and land sides of the backwater levees, the water continued to rise, with the river side reaching peak elevations of 97.2 and 97.6 feet on 28 April at the Steele Bayou and Little Sunflower River Structures, respectively. Due to the large amount of rainfall in the Yazoo Area, the land side did not reach its peak of 96.6 at the Little Sunflower River Structure until 5 May. The Mississippi and Yazoo Rivers, which had begun their fall several days before, fell low enough for the gates to be opened at Steele Bayou on 4 May at elevation 96.3 and Little Sunflower River on 5 May at elevation 96.6. This decline continued until water fell below the damage elevation in the Steele Bayou area on 14 June and the Little Sunflower area on 15 June 1979, ending a flood which had lasted 104 days and flooded a maximum of 350,400 acres. Without the levees and drainage structures, approximately 400,000 acres would have been flooded.

59. Flood ranking. A ranking of the Yazoo Area floods occurring during the 1970's, by area flooded, financial losses, classification, and effect, is given below.

Flood Ranking	Year	Area Flooded (acres - sq mi)		Financial Losses (millions of dollars)	Classification a/ and Effect of Floods
1	1973	595,000	930	65.5	Massive hardship and devastation
2	1975	370,000	578	21.5	Major concern and economic dislocation
3	1979	350,400	552	15.3	
4	1974	285,000	352	12.9	
5	1970	75,500	118	b/	Small impact and minor concern
6	1971	54,000	84	b/	
7	1972	51,600	81	b/	
8	1978	50,000	78	2.1	
9	1977	15,000	23	b/	Very small impact and generally ignored
10	1976	10,000	16	b/	

a/ SOURCE: Mississippi Research and Development Center, November 1979.
b/ Of the six lesser floods of the 1970's, estimates of damages are available for only 1978, which totaled $2.1 million. Floods in 1970, 1971, and 1972 covered more acres than in 1978, but damages were probably lower due to less land in cultivation and less inflated values in those earlier years. The total for all 10 years is estimated at $120 million. It is estimated that combined losses for the years footnoted would not exceed $3 million.

Social

60. The primary social impacts in the project area are associated with the flooding of rural residential structures. There are approximately 16,000 residences in the general area. The estimated numbers of buildings in the project area subject to flooding by the 100-year frequency flood under without-project conditions are shown below.

Property Type	Number of Buildings Subject to Flooding
Residential	
Brick homes	144
Frame homes	479
Trailer homes	127
Subtotal	750
Commercial	37
Industrial	4
Recreational	244
Public	4
Semipublic	15
Total	1,054

61. The 750 rural residential structures which are subject to flooding without the project are generally permanent homes. Most of the 244 recreational structures are occupied on a seasonal or weekend basis. Many of these families returned to their homes after the floods of the 1970's to find their homes and furnishings ruined or damaged. As a result, these families experienced much undue hardship and mental anguish.

Water Quality

62. Water quality in the project area is of poor quality but is presently sufficient to support fish life and other aquatic organisms. Pesticide contamination has become a serious problem to water areas throughout the delta. Based on average observed levels of physical, chemical, and pesticide parameters, many water bodies in the Delta appear to be near threshold

conditions for life support on aquatic biota. Levels of dissolved oxygen, turbidity, and pesticides are particularly critical.

Fish and Wildlife Habitat

63. The continuing decline of fish, wildlife, and forest habitat is another significant problem. The project area has lost a large portion of its original forest lands, a loss which is expected to continue. The intensive agricultural efforts within the area, with the associated herbicides, insecticides, and land clearing, have contributed to an overall decline in water quality and fishery resources in the area.

CURRENT NEEDS

Flood Control

64. About 74 percent of the project area flood plain is cleared and used primarily for agricultural production. Most of the agricultural land is used for row crops, primarily cotton and soybeans. Floods in the area occur on the average of one to two times annually and are of long duration. Reduction of both frequency and duration of flooding is needed to permit optimum agricultural development.

Water Quality

65. Water quality throughout the project area is affected by two major pollution sources--soil erosion and associated agricultural chemicals. Other sources of pollution exist but are nominal. Water quality degradation has adversely affected biotic production in lakes and streams within the project area. The major need is to reduce the sediment and agricultural pesticides entering the lakes and streams in the project area.

Fish and Wildlife

66. As recently as 1960, the project area was over 58 percent forested in bottom-land hardwoods. However, land clearing for agricultural production has greatly reduced this bottom-land hardwood forest. The major needs for fish and wildlife are to retain the remaining bottom-land hardwood forest in the area, retain some flooding during the winter for wintering and resident waterfowl, and improve the quality of water in the lakes and streams for fishery production.

Recreation

67. Major recreational activities in the project area are hunting and fishing, with associated use of lakes and streams. Limited public use facilities exist for camping and boating. The clearing of vast acreages of woodlands and poor water quality have reduced the environmental diversity necessary for outdoor recreational activity.

68. The Delta National Forest is located in the project area and provides public use areas for hunting, fishing, and wildlife-oriented recreation. Current recreation needs include improved public access to available areas and development of additional recreational areas with facilities for parking, access, etc.

PLANNING OBJECTIVES

69. Planning objectives stem from the national, state, and local water and related land resources management needs specific to the Yazoo Area of the Yazoo Backwater Project. These objectives have been developed through problem analysis and an intensive public involvement program and have provided the basis for formulation of alternatives, impact assessment, evaluation, and selection of a recommended plan. The planning objectives are as follows:

a. Reduce flood damages to agricultural lands in the project area resulting from prolonged high stages on the Mississippi River.

b. Reduce flood damages to rural residents, churches, and public buildings.

c. Preserve or improve any project-related recreational opportunities in the study area, particularly those of waterfowl and deer hunting.

d. Minimize destruction of wetlands and significant tracts of bottomland hardwoods or improve remaining acreages of these resources.

e. Minimize degradation of water quality in the study area during construction; preserve or improve significant aquatic resources of the area such as Eagle Lake.

f. Preserve or improve related wildlife resources in the area.

PLANNING CONSTRAINTS

70. Alternative methods for reduction of flood damages in the Yazoo Area were limited by the existing flood control works and the type of flooding now occurring.

71. Energy conservation has recently become an important factor in planning and designing water resource projects. High-capacity pumps, with pumping initiated at low elevations, provide the greatest NED benefits yet also consume large amounts of energy.

TABLE A-1
LAND USE DISTRIBUTION
(Issaquena and Sharkey Counties, Mississippi)

Land Use	Sharkey		Issaquena		Total	Percent of
	Square Miles	Percent of Total	Square Miles	Percent of Total	Square Miles	Two-County Total
Residential	2.9	0.66	2.1	0.50	5.0	0.59
Commercial	0.3	0.06	0.4	0.10	0.7	0.08
Industrial	0.1	0.02	0.4	0.10	0.5	0.06
Transportation and Utilities	2.0	0.48	1.3	0.30	3.3	0.39
Institutional	0.2	0.05	0.4	0.10	0.6	0.07
Recreational	0.1	0.01	0.4	0.10	0.5	55.49
Agricultural	275.9	63.29	195.8	47.30	471.7	34.05
Forest	120.5	27.64	168.9	40.80	289.4	6.89
Water	14.7	3.37	43.9	10.60	58.6	2.32
Other	19.3	4.42	0.4	0.10	19.7	0.06
Total Land Area	436.0		414.0		850.0	

Source: Economic Base Study, Yazoo River Basin, Mississippi, Vicksburg District, Corps of Engineers.

TABLE A-2
FAMILY INCOME
1969
(Current Dollars)

Income	County				Total
	Humphreys	Issaquena	Sharkey	Yazoo	
All families (no.)	3,166	576	1,831	6,408	11,981
Less than $ 3,000	1,464	210	750	2,367	4,791
$ 3,000 - $ 4,999	609	104	315	976	2,004
$ 5,000 - $ 6,999	343	87	191	757	1,378
$ 7,000 - $ 9,999	376	54	194	965	1,589
$10,000 - $14,999	217	78	239	924	1,458
$15,000 - $24,999	93	31	115	302	541
$25,000 and over	64	12	27	117	220
Median family income ($)	3,331	4,409	3,770	4,648	4,040
Families below (no.)					
Poverty income level	1,704	242	864	2,716	5,526
Percent of all families	53.8	42.0	47.2	42.4	46.4
Mean family income ($)	1,739	1,825	1,989	1,720	1,818
Mean family deficit ($)	2,185	2,097	2,010	2,048	2,084
Percent receiving public assistance	29.9	41.3	39.4	38.3	37.2
125 percent of poverty income level	1,931	306	1,011	3,115	6,363

Source: U. S. Census of Population, Bureau of the Census, U. S. Department of Commerce.

TABLE A-3
EMPLOYMENT BY INDUSTRY
1970

Industry	County				Total
	Humphreys	Issaquena	Sharkey	Yazoo	Project Area
Total, 16 and over	3,951	749	2,432	8,299	15,431
Services	1,051	105	732	2,211	4,099
Agriculture, forestry, and fisheries	1,328	396	756	1,474	3,954
Manufacturing	398	68	260	1,710	2,436
Retail trade	571	75	344	1,178	2,168
Construction	239	20	107	412	778
Transportation, communication, and public utilities	132	32	48	494	706
Wholesale trade	55	0	25	187	267
Public administration	91	48	116	277	532
Finance, insurance, and real estate	72	5	34	184	295
Mining	14	0	10	172	196

Source: U. S. Census of Population, Bureau of the Census, U. S. Department of Commerce.

TABLE A-4
LABOR FORCE AND EMPLOYMENT

Category	County				Total
	Humphreys	Issaquena	Sharkey	Yazoo	
Male, 16 and over	4,022	825	2,451	8,077	15,375
Labor Force	2,617	561	1,693	5,457	10,328
Percent of Total	65.1	68.0	69.1	67.6	67.2
Civilian Labor Force	2,614	561	1,693	5,457	10,325
Employed	2,483	545	1,560	5,313	9,901
Unemployed	131	16	133	144	424
Percent of Unemployed	5.0	2.9	7.9	2.6	4.1
Female, 16 and over	4,764	858	2,783	9,290	17,695
Labor Force	1,529	228	1,076	3,208	6,041
Percent of Total	32.1	26.6	38.7	34.5	34.1
Civilian Labor Force	1,529	228	1,076	3,208	6,041
Employed	1,468	204	872	2,986	5,530
Unemployed	61	24	204	222	511
Percent of Unemployed	4.0	10.5	19.0	6.9	8.5
Total, 16 and over	8,786	1,683	5,234	17,367	33,070
Labor Force	4,146	789	2,769	8,665	16,369
Percent of Total	47.2	46.9	53.9	49.9	49.5
Civilian Labor Force	4,143	789	2,769	8,665	16,366
Employed	3,951	749	2,432	8,299	15,431
Unemployed	192	40	337	366	935
Percent of Unemployed	4.6	5.1	12.2	4.2	5.7

Source: U. S. Census of Population, Bureau of the Census, U. S. Department of Commerce.

TABLE A-5
EXPERIENCED UNEMPLOYED BY OCCUPATION
1970

Occupation	Male, 16 and Over					Female, 16 and Over					Total, 16 and Over				
	Humphreys	Issaquena	Sharkey	Yazoo	Total	Humphreys	Issaquena	Sharkey	Yazoo	Total	Humphreys	Issaquena	Sharkey	Yazoo	Total
Total	131	16	133	136	416	57	24	198	192	471	188	40	331	328	887
Professional, technical, and managerial	--	--	5	16	21	--	--	17	4	21	--	--	22	20	42
Salesworkers	5	--	--	6	11	--	--	4	--	4	5	--	4	6	15
Clerical and kindred	--	--	6	6	12	7	5	37	17	66	7	5	43	23	78
Craftsmen, foremen, and kindred	45	6	9	33	93	10	9	49	28	96	55	15	58	61	189
Operatives, including transport	14	--	14	16	44	3	--	5	14	22	17	--	19	30	66
Laborers, except farm	8	5	11	20	44	15	--	51	6	72	23	5	62	26	116
Farmworkers	59	5	83	19	166	13	5	26	49	93	72	10	109	68	259
Service workers, including private households	--	--	5	15	20	9	5	9	69	92	9	5	14	84	112

Source: U. S. Census of Population, Bureau of the Census, U. S. Department of Commerce.

TABLE A-6
COMPARISON OF FARM CHARACTERISTICS
1969 AND 1974

Item	1969	1974
Number of farms	1,224	1,131
Land area, approximate (acres)	1,413,568	1,413,568
Land in farms (acres)	922,972	931,302
Average size of farms (acres)	754	823
Value of land and buildings (000 1972 dollars)	282,466	288,653
Average per farm (1972 $)	230,773	255,219
Average per acre (1972 $)	306	310

Source: U. S. Census of Agriculture, Bureau of the Census, U. S. Department of Commerce. Based on farms with sales of $2,500 and over.

TABLE A-7
VALUE OF FARM PRODUCTS SOLD
1949-1978
(Thousands of 1972 Dollars)

Year	Value of Farm Products Sold	Ratio of Increase Over Previous Value
1949[a/]	29,907.3	
		1.6362
1954[a/]	48,933.9	
		1.2230
1959[a/]	59,846.2	
		1.3662
1964[a/]	81,763.7	
		-0.3578
1969[a/]	52,506.8	
		1.3825
1974[a/]	72,581.0	
		1.7456
1978[b/]	126,699.8	

a/ Source: U. S. Census of Agriculture, Bureau of the Census, U. S. Department of Commerce.
b/ Based on linear regression analysis excluding 1969 and 1974 historical data.

TABLE A-8
EXISTING AND PROJECTED FUTURE
WITHOUT-PROJECT LAND USE

Year	Lower Ponding Area (acre)			Upper Ponding Area (acre)			Total Project Area (acre)		
	Cleared Land	Woods[a/]	Total	Cleared Land	Woods[b/]	Total	Cleared Land	Woods[c/]	Total
1978	148,000	52,000	200,000	249,500	89,500	339,000	397,500	141,500	539,000
1990	159,600	40,400	200,000	252,500	86,500	339,000	412,100	126,900	539,000
2000	165,000	35,000	200,000	254,000	85,000	339,000	419,000	120,000	539,000
2010	166,200	33,800	200,000	254,300	84,700	339,000	420,500	118,500	539,000
2020	167,400	32,600	200,000	254,600	84,400	339,000	422,000	117,000	539,000
2030	168,500	31,500	200,000	254,900	84,100	339,000	423,400	115,600	539,000
2039	169,500	30,500	200,000	255,200	83,800	339,000	424,700	114,300	539,000

a/ Includes 3,600 acres of dedicated woods in Yazoo National Wildlife Refuge.
b/ Includes 76,600 acres of dedicated woods in Delta National Forest, Panther Swamp, and Delta Wildlife and Forestry, Inc.
c/ Includes 80,200 acres of dedicated woods.

YAZOO PUMP PROJECT
YAZOO BACKWATER AREA
MISSISSIPPI

REEVALUATION REPORT

APPENDIX B

FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS

PREPARED BY
THE UNITED STATES ARMY
VICKSBURG DISTRICT, CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

REEVALUATION REPORT
YAZOO AREA PUMP PROJECT
YAZOO BACKWATER AREA, MISSISSIPPI

APPENDIX B

FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS

Table of Contents

Table of Contents (Cont)

Table of Contents (Cont)

Table of Contents (Cont)

LIST OF TABLES

Table of Contents (Cont)

LIST OF TABLES (Cont)

REEVALUATION REPORT
YAZOO AREA PUMP PROJECT
YAZOO BACKWATER AREA, MISSISSIPPI

APPENDIX B

FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS

FORMULATING THE PLANS

1. Summarized in this section is the plan formulation analysis conducted to select, from viable alternatives, a plan to resolve the problems and fulfill the needs in the study area. The following paragraphs present the evaluation criteria used in formulating a plan, alternative solutions considered, and the procedure used in eliminating alternatives to arrive at the recommended plan.

FORMULATION AND EVALUATION CRITERIA

2. Alternative plans were formulated and evaluated 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 economically feasible solution.

3. Federal policy on multiobjective planning, derived from both legislative and executive authorities, establishes and defines the national objectives for water resource 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 benefits and costs, both tangible and intangible, and effects on the environment and social well-being of the community.

4. Plan formulation criteria include published regulations and principles adopted by WRC, and implementing regulations developed by the Corps of Engineers. A listing of pertinent laws, regulations, and guidance applied in this study is presented below.

a. Water Resources Development Act of 1974 (Public Law 93-251).

b. Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500).

c. Section 122 of the River and Harbor and Flood Control Act of 1970 (Public Law 91-611).

d. Section 102(2)(c), National Environmental Policy Act of 1969 (Public Law 91-190) and implementing instructions contained in ER 1105-2-507, "Preparation and Coordination of Environmental Statements."

e. Flood Disaster Protection Act of 1973 (Public Law 93-234) and implementing guidelines contained in ER 1105-2-351, "Evaluation of Beneficial Contributions to National Economic Development for Flood Plain Management Plans."

f. Other specific engineering regulations pertaining to planning of flood control and related water resource problems.

TECHNICAL CRITERIA

5. The following technical data and criteria were adopted in developing the plans:

a. The existing Backwater levee, plus the Steele Bayou and Little Sunflower drainage structures, will continue to function under future conditions.

b. During the nonflood season, the Muddy Bayou Control Structure will continue to be operated to provide the water levels in Eagle Lake established in cooperation with the Mississippi Department of Wildlife Conservation.

c. The elevation of flooding will be maintained, if possible, below elevation 95.0 feet, National Geodetic Vertical Datum (NGVD), so as to alleviate the need for opening the gates on the Muddy Bayou Control Structure and allowing Eagle Lake to flood. This would prevent the overtopping of Highway 465 and the inundation of 213 buildings (homes, businesses, recreation structures, etc.) at Eagle Lake. In addition, more than 700 additional buildings and numerous roads and bridges in the project area would be protected.

d. Plans developed should be consistent with provisions of the National Flood Insurance Program (NFIP).

e. Provide adequate flood control while minimizing energy consumption.

f. The useful life of the project should be as long as possible, considering constraints of physical practicality and economic feasibility.

ECONOMIC CRITERIA

6. Economic criteria for formulation of the plans are summarized as follows:

a. The benefits and costs should be expressed in comparable terms as fully as possible. All evaluations of alternatives should be based on October 1980 prices, an interest rate of 2-1/2 percent (the interest rate used when the project was authorized), and a 50-year project life for flood control alternatives.

b. Each alternative considered in detail must be "justified" in the sense that total beneficial effects (monetary and nonmonetary) associated with the objectives are equal to or exceed the total adverse effects (monetary and nonmonetary) associated with the objectives.

c. The alternative plans must have net national economic benefits unless the deficiency in net benefits incurred is associated with attaining environmental quality objectives.

d. The maximization of net benefits should be determined in sizing a project; however, environmental quality and intangible considerations could dictate a project larger or smaller in size which would forego some of the net tangible benefits.

e. Project benefits should be based on analysis of conditions without and with a project, using methodology described in Corps regulations.

ENVIRONMENTAL CRITERIA

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

a. Plans should be formulated to the extent practicable to preserve and enhance the quality of the natural environment, specifically including fish and wildlife, vegetation, land, air, water, and scenic and esthetic values.

b. Detrimental environmental effects should be avoided where possible, and feasible mitigation for unavoidable effects should be included.

c. The relationship of the proposed action to land use plans should be considered, and the environmental impact of any proposed action should be evaluated. Any adverse environmental effects which could not be avoided, if a proposal were implemented, should be delineated; alternatives to such proposed action should be identified; the relationship between local short-term uses and the maintenance or enhancement of long-term productivity should be determined; and any irreversible and irretrievable commitments of resources involved if a proposed action were implemented should be identified.

SOCIOECONOMIC CRITERIA

8. The following socioeconomic criteria are applicable in 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. Displacement of people by the floods and/or the project should be minimized to the extent practicable.

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

e. Effects of a project on regional development, including income, employment, business and industrial activity, population distribution, and desirable community growth, should be considered.

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

g. The plans should be implementable considering the present and potential constraints of the local sponsoring agency in regard to its structure, function, relationships, and associations in the study area.

DESCRIPTION OF PLANS CONSIDERED IN PRELIMINARY PLANNING (STAGES 1 AND 2)

NO-ACTION

9. The no-action alternative is considered as an alternative to structural flood control measures (levees and pumps) and provides without-project

conditions for evaluation of structural measures. The no-action alternative does not provide flood control or flood protection works in the project area.

10. Flooding in the Yazoo Area is historic and will continue as long as pumps are not constructed to complete the flood control system for the area. The flooding will continue to damage crops, homes, roads, and other improvements in the project area. Current average annual damages in the project area are estimated at $3.9 million. The no-action alternative must consider as acceptable all damages which occur in the absence of a project. It must also consider that present trends of development could continue, thereby increasing the current level of flood damages.

11. Even with a no-action alternative, more extensive agricultural development is expected. Large tracts of land in the Yazoo Area were cleared and converted to row crop agriculture in the late 1960's and 1970's. Most of these tracts flood more frequently than once every 3 years, indicating that landowners are willing to risk occasional flooding to gain the benefits of cultivation. The land clearing trend in the area is expected to continue, with an estimated 27,200 acres of bottom-land hardwoods in the project area being cleared during the life of the project.

12. The effect of the no-action alternative on water quality trends would be one of continued deterioration. Turbid, pesticide-laden rainfall is a by-product of agriculture. This runoff, following natural drainage patterns, will enter the several streams and lakes in the project area in increased amounts and will lower water quality. Conservation means implemented by state and local interests could be used to preserve select lakes and bayous; however, there are no assurances that such measures will be implemented.

NONSTRUCTURAL ALTERNATIVES

13. All practicable nonstructural measures to reduce flood damages were given consideration in the early screening of alternatives. While some were eliminated during early formulation of alternatives, others were carried through detailed evaluation to determine if a combination of structural and nonstructural measures would, in fact, comprise the best solution for the overall project area.

14. Basically, there are two types of nonstructural measures for flood protection, those which reduce existing damages and those which reimburse for existing damages and reduce future damage potential. Those nonstructural measures which reduce damages and were investigated to varying degrees in this study included the following:

a. Floodproofing.

(1) Waterproofing of walls and openings in structures.

(2) Raising structures in place.

(3) Constructing walls or levees around structures.

b. Permanent evacuation of flood plain.

(1) Relocate structures and contents to flood-free area.

(2) Relocate contents and demolish structures. Provide replacement housing.

(3) Flood forecasting and warning systems with temporary evacuation.

15. Nonstructural measures which compensate or reimburse for existing damages and/or reduce future damages include:

a. Acquisition of easement to flood property.

b. Flood plain regulation by zoning ordinances, regulations, and building codes.

c. Flood insurance.

STRUCTURAL ALTERNATIVES ELIMINATED AFTER PRELIMINARY ANALYSIS

16. Several alternatives were eliminated after only preliminary analysis and will not be discussed in detail in this design memorandum. These alternatives and reasoning for elimination are discussed below.

Sunflower River Levees

17. A levee system along both sides of the Sunflower River from the Yazoo River to near the junction of Bogue Phalia was considered. This system would allow floodflows from the Big Sunflower River to enter the Yazoo River without ponding in the Backwater area. Such a levee system would require extensive lands for construction and would require about 40 drainage structures and pumps at several locations to provide improved flood protection for the large intercepted drainage area. A pumping station would still be required near Steele Bayou to provide protection from frequent floods in the lower ponding area.

Pumping Stations of Less Than 10,000-cfs Capacity

18. Pumping stations with a total capacity of less than 10,000 cfs were eliminated since the total drainage area providing inflows requires greater capacity to significantly affect the interior ponding stages.

Combinations of More Than Two Pumping Stations

19. Systems including more than two pumping stations, such as considered in previous studies, were eliminated since the connecting channel between the

upper and lower ponding areas allows transfer of flows between the ponding areas and from Deer Creek to the lower ponding area. Economies of scale also favor fewer and larger pumping stations.

STRUCTURAL ALTERNATIVES CONSIDERED IN DETAIL

20. The authorized plan and nine other pump plans with 10,000-cfs and larger pump capacities were evaluated during Stage 2 planning efforts. A description of the plans and a comparison of pertinent data are presented in Table B-1. Eight of the plans formulated feature a single pumping station located immediately southwest of the Steele Bayou drainage structure. These plans differ in the elevation at which pumping is initiated as well as various operational schemes. Various pump capacities ranging from 10,000 to 30,000 cubic feet per second were considered with most of the plans. Each of the plans requires an inlet channel from Steele Bayou and an outlet channel to the Yazoo River. The inlet channel from Steele Bayou to the pumping station (for a 17,500-cubic-foot-per-second-pump) would be about 4,000 feet long and would vary in bottom width from 355 feet at Steele Bayou to 765 feet at the pumping station. The outlet channel would be about 6,000 feet long and would vary in bottom width from 765 feet at the pumping station to 300 feet at the Yazoo River. The ninth plan formulated (Plan B) features pumping stations near both the Steele Bayou and Little Sunflower drainage structures. This plan would require similar inlet and outlet channels to both pump stations; however, the channels widths would vary with pump sizes.

21. Electrical motors, with electric power to be supplied by the local utility company, were selected for analysis of each plan in the Reevaluation Report. However, numerous energy sources other than electricity were considered:

a. Fusion, coal liquefaction, and wind power. These energy sources are experimental and are not considered viable alternatives to other more practical energy sources.

b. Nuclear. Electric power derived from nuclear sources is an economically feasible source of energy when supplied by local utility. It does not appear economically justified for the Corps of Engineers to build, operate, and maintain its own nuclear generating plant.

c. Diesel fuel. A March 1976 detailed analysis for pumping stations in the Vicksburg District (Lake Chicot) showed that electricity is less expensive and more reliable than diesel fuel. Also, there is a continuing effort to reduce the use of petroleum products to be consistent with the Corps of Engineers Energy Plan, January 1980. However, if utility rates increase, diesel fuel and other energy sources used to fuel internal combustion engines may be cost-competitive.

TABLE B-1
DESCRIPTION OF PLANS
COMPARISON OF PERTINENT DATA
YAZOO AREA PUMP STUDY

Plan	Elevation Pumping Initiated	Pump Capacities Lower Sump	Pump Capacities Upper Sump	Environmental Features	Minimum Inlet Channel Bottom Width	Minimum Outlet Channel Bottom Width	Excavation
	(feet, NGVD)	(cfs)	(cfs)		(feet)	(feet)	(cu yd)
Plan A							
	80	10,000	--	None.	200	185	2,138,000
		15,000[a]	--		305	260	3,025,000
		17,500	--		355	300	3,394,000
		20,000	--		405	335	4,012,000
		25,000	--		500	390	5,179,000
		30,000	--		585	455	6,348,000
Plan B							
	80	15,000	10,000	None.	305(L) 200(U)	260(L) 185(U)	6,513,000
		10,000	15,000		200(L) 305(U)	185(L) 260(U)	6,984,000
		7,000	18,000		125(L) 390(U)	125(L) 310(U)	7,464,000
Plan C							
	80	10,000	--	Pumping initiated at 85 feet, 1 December - 1 March.	200	185	2,138,000
		15,000	--		305	260	3,025,000
		17,500	--		355	300	3,394,000
		20,000	--		405	335	4,012,000
		25,000	--		500	390	5,179,000
		30,000	--		585	455	6,348,000
Plan D							
	80	25,000	--	Pumping initiated at 85 feet, 1 December - 15 March. Interior ponding held at 85 feet, 1 January - 15 March; 80 feet, 15 March - 15 April.	500	390	5,179,000
Plan E							
	80	25,000	--	Pumping initiated at 85 feet 1 December - 15 March. Interior ponding held at 80 feet, 1 January - 15 April.	500	390	5,179,000

TABLE B-1 (Cont)

Plan	Elevation Pumping Initiated	Pump Capacities		Environmental Features	Minimum Inlet Channel Bottom Width	Minimum Outlet Channel Bottom Width	Excavation
		Lower Sump	Upper Sump				
	(feet, NGVD)	(cfs)	(cfs)		(feet)	(feet)	(cu yd)
Plan F							
	83	10,000	--	Pumping initiated at 85 feet, 1 December - 1 March.	160	130	1,874,000
		15,000	--		260	210	2,761,000
		17,500	--		300	240	3,087,000
		20,000	--		360	280	3,620,000
		25,000	--		460	350	5,044,000
		30,000	--		550	410	6,220,000
Plan G							
	85	10,000	--	None.	125	100	1,671,000
		15,000	--		225	170	2,585,000
		17,500	--		265	200	2,879,000
		20,000	--		325	245	3,360,000
		25,000	--		425	320	4,954,000
Plan H							
	85	15,000	--	Acquisition of 30,000 acres of hardwoods.	225	170	2,585,000
Plan I							
	90	10,000	--	None.	80	50	1,423,000
		15,000	--		160	105	2,294,000
		20,000	--		245	160	3,361,000

a/ Approximates authorized plan.

d. Natural gas, propane, coal gasification. These energy sources could be used to fuel internal combustion engines to operate the pumps in lieu of electric pumps. Because of increasing electric rates, these energy sources may be a competitive alternative. Detailed analyses will be required before economic feasibility can be determined.

e. Solar. This source of energy is not considered practical since the pumping station will have to operate 24 hours per day with peak power requirements in excess of 17 megawatts.

f. Coal-fired steam boiler. Steam could be used with either a reciprocating engine or turbine-type engine to drive the pumps. This energy source may be cost-competitive.

22. Electricity, natural gas, coal gasification, and coal-fired steam are considered to be viable alternative sources of energy. However, detailed analysis of energy alternatives and detailed cost estimates will be included in Phase II studies. The most recent studies of energy sources for large pumping stations in the Vicksburg District showed that electricity was the least costly and most reliable source of energy.

Authorized Project

23. The initial authorized project for the Yazoo Backwater area, based on Plan C of the report of the Mississippi River Commission dated 7 March 1941, contemplated the construction of 54 miles of backwater levee across the mouths of Steele Bayou and Big Sunflower River with the impounded drainage being pumped over the levee when gravity drainage was not possible by reason of high stages on the Mississippi or Yazoo River. A pumping capacity of 14,000 cubic feet per second would be provided, which, together with the impounded drainage, would limit the ponding elevation to about 90 feet, NGVD, for a frequency of not more than an average of once in 5 years. This plan contemplated closing the drainage structures and operating the pumps when the Yazoo River rose to the 80-foot level.

24. The authorized project was later modified to include a more direct connecting channel between the two ponding areas. This connecting channel, in combination with the Yazoo River levees and drainage structures, has been constructed. If a 14,000-cubic-foot-per-second pumping station were added to the system, the ponding elevations associated with the 5-year frequency event would be reduced to about elevation 90.0 and 89.5 feet, NGVD, in the upper and lower ponding areas, respectively.

25. The backwater project has been further modified to include the Muddy Bayou Control Structure, which has been constructed and provides flood control and environmental benefits to Eagle Lake and the surrounding area until flood stages in the backwater area reach or exceed elevation 95.0 feet, NGVD, in the lower ponding area.

26. At the time of the initial study, the project area contained only 2,650 acres of cleared land below elevation 90 feet. As a result, Plan C of

the MRC report dated 7 March 1941, referenced by the 1941 Flood Control Act, was not intended to protect lands below elevation 90 feet from the 5-year frequency flood. Now there are some 59,000 cleared acres. The 1941 Flood Control Act did not authorize Plan C, but "the extension of the authorized project and improvement contemplated in Plan C . . . ." It is apparent that the MRC report contemplated the extension and improvements to protect the project area. The Chief's views contained in H.D. 308, which was the basis for the authorizations contained in the 1965 Flood Control Act, include his statement that he considered the previous authorization "sufficiently broad to permit selection of locations and capacities of pumping plants . . . as future development dictates." Present conditions dictate a greater pumping capacity.

Pump Plan A

27. The major feature of this plan is a pumping station located in the lower ponding area just west of the Steele Bayou drainage structure. Pumping would begin when interior ponding reaches an elevation of 80 feet, NGVD. The minimum practical pumping level was considered to be 80 feet, NGVD. Between elevation 75 and 80, the storage in the lower ponding area is sufficient to provide only one-third to one day of pumping for the range of plant capacities tested. Pumping below elevation 80 would require a more costly pumping plant and more frequent operation of pumps, and would result in no significant additional reduction in peak stage. Flooding conditions on the 2,000 cleared acres and 5,000 wooded acres below elevation 80 feet, NGVD, would remain unchanged.

28. Pumping capacities of 10,000, 15,000, 17,500, 20,000, 25,000, and 30,000 cubic feet per second were evaluated in detail as a part of this plan. All pump sizes considered have benefits that exceed their cost, with the maximum benefits over cost occurring with the 25,000-cubic-foot-per-second pump.

Pump Plan B

29. This plan consists of two pumping stations, one in each of the interior ponding areas. One station would be located just west of the Steele Bayou drainage structure and the other southwest of the Little Sunflower drainage structure. Pumping for both of the stations would begin when interior ponding stages reach 80 feet, NGVD. Only combinations of the structures to provide 25,000 cubic feet per second of pumping capacity were evaluated in detail for this alternative. Combinations evaluated are as follows: 15,000 cubic feet per second, lower area and 10,000 cubic feet per second, upper area; 10,000 cubic feet per second lower area and 15,000 cubic feet per second upper area; and 7,000 cubic feet per second lower area and 18,000 cubic feet per second upper area.

30. Pump Plan B resulted in the greatest reduction of interior ponding of any plan studied; however, it produced the greatest fish and wildlife losses. The

routings also showed that significant increases in Yazoo River stages would result from a large pumping plant located in the upper ponding area.

Pump Plan C

31. Structurally, this plan is the same as Plan A. However, it includes an operational modification that would allow flooding to continue during the winter and early spring on approximately 41,000 acres that presently flood on an average of once every year. Pumping would be initiated at 80 feet, NGVD, except during the period 1 December-1 March when pumping would be initiated at 85 feet, NGVD, to reduce the impact on waterfowl and other fish and wildlife species. This time frame was chosen since it coincides with the period of the heaviest concentration of waterfowl in the area and the waterfowl hunting season. This modification greatly reduces the fish and wildlife losses while the economic benefits remain high. Pumping capacities of 10,000, 15,000, 17,500, 20,000, 25,000, and 30,000 cubic feet per second were evaluated in detail in the analysis of this alternative.

Pump Plan D
(Induced Ponding Plan)

32. Pump Plan D and Pump Plan E, which are discussed in the following section, were both formulated in an attempt to meet the EQ objectives while satisfying the flood control needs.

33. Pump Plan D consists of a 25,000-cubic-foot-per-second pumping plant near the Steele Bayou structure with pumping initiated when interior ponding reaches elevation 80 feet, NGVD, except between 1 December and 15 March when pumping would not be initiated until the ponding level reaches 85 feet, NGVD. On 1 January, the drainage structures could be closed and the ponding level raised to 85 feet, NGVD, as water is available. The 85-foot, NGVD, elevation would be held until 15 March, when the water would be lowered to 80 feet, NGVD, and held until 15 April. This modification would provide feeding and nesting areas for waterfowl during the hunting and migratory season. During June, July, and August, the sump level would be held at 75 feet, NGVD (approximately the level of Eagle Lake). During all other periods, pumping would begin when the interior ponding elevation reaches 80 feet, NGVD. The existing stilling basins and outlet channel protection would not withstand such an operating condition, and replacement or considerable modification would be required.

Pump Plan E
(Induced Ponding Plan)

34. Plan E is the same as Plan D except that induced flooding would be to elevation 80 during the entire 1 January to 15 April period.

Pump Plan F

35. Plan F consists of a pumping station located in the lower ponding area just west of the Steele Bayou drainage structure, with pumping initiated when interior ponding reaches an elevation of 83 feet, NGVD, except during the

period 1 December through 1 March, when pumping would be initiated when water rises above elevation 85 feet, NGVD, to further reduce fish and wildlife losses. Pumping capacities of 10,000, 15,000, 17,500, 20,000, and 25,000, and 30,000 cubic feet per second were evaluated as a part of this plan.

Pump Plan G

36. The major feature of Plan G is a pumping station located in the lower ponding area just west of the Steele Bayou drainage structure, with pumping initiated when interior ponding reaches an elevation of 85 feet, NGVD. Pumping capacities of 10,000, 15,000, 17,500, 20,000, and 25,000 cubic feet per second were evaluated. Flooding on the approximately 41,000 acres below elevation 85 feet, NGVD, would not be changed by this plan.

Pump Plan H

37. This plan includes a 15,000-cubic-foot-per-second capacity pumping station in the lower ponding area. Pumping would be initiated when interior ponding reaches elevation 85 feet, NGVD, as with Plan G, and would provide the same reductions in peak stages and duration as Plan G, 15,000-cfs.

38. Plan H was formulated as the third attempt to find a candidate EQ plan. As mentioned earlier, Plans D and E were formulated to address the planning objectives while emphasizing esthetic, ecological, and environmental contributions. After detailed analysis, it was determined that neither of these plans was a candidate EQ plan since neither made net positive contributions to the components of the EQ account.

39. After studying input from the public sector, recommendations of the Fish and Wildlife Service (FWS) and the Mississippi Department of Wildlife Conservation, and the planning objectives, the interdisciplinary planning team decided the ponding of water and the purchase, development, and management of woodlands provided the greatest benefits to the EQ account.

40. Meetings were held with U. S. Forest Service, FWS, and the Mississippi Department of Wildlife Conservation to identify sites for water control structures on land in the project area already owned or under lease by a government agency. The only feasible site found was that area below elevation 75.0 feet that could be inundated by operation of the Steele Bayou Structure identified in Plans D and E. After obtaining survey information and on-site investigations, it was found that holding water to elevation 75 at this site would kill bottom-land hardwoods, thereby inducing more terrestrial losses than the value of fishery resources gained; therefore, this feature was eliminated from further consideration.

41. It was agreed after consultation with state and Federal agencies and interested groups that if any woodlands were to be purchased, developed, and managed, then all woodlands in manageable contiguous tracts remaining in the

project area by 1990 (base year) should be purchased. It is estimated that by 1990 only 30,000 acres will remain in manageable contiguous tracts, all of which will be purchased, developed, and managed as a feature of this alternative for the purpose of preserving bottom-land hardwoods and improving fish and wildlife benefits.

Pump Plan I

42. This plan includes one pumping station, with pumping of interior ponding beginning at 90 feet, NGVD. Pumping capacities of 10,000, 15,000, and 20,000 cubic feet per second were evaluated in detail.

SCREENING OF ALTERNATIVES

43. In order to thoroughly evaluate the alternatives carried into the final array, it was necessary to eliminate those plans which were insufficient in meeting planning objectives and plan formulation criteria.

NONSTRUCTURAL ALTERNATIVES

44. Prevalent construction in the flood plain is slab-on-grade for residential as well as commercial and public buildings. Such structures are impractical to raise through normal jacking procedures; therefore, two of the previously identified measures, raising structures in place and relocating structures outside the flood plain, were screened from further consideration. The remaining nonstructural measures were evaluated for the units within the project area to determine which, if any, appreciably minimize the flood hazard or enhance the value of the flood plain at a reasonable cost. These also were then screened from further consideration, primarily because over 81 percent of the damages occurring are attributable to agricultural operations.

STRUCTURAL ALTERNATIVES

Elimination Criteria

45. In order to screen the various structural alternatives, the nine basic plan groups were screened based upon the parameters presented in Table B-2 and described below.

46. First costs. In light of the current attempt to curtail government spending and balance the national budget, the total first cost of the project was determined to be a key parameter in the screening of alternatives. First costs differ with the various pump sizes considered for each plan.

TABLE B-2
COMPARISON OF PLANS
YAZOO AREA PUMP STUDY
(2-1/2 Percent Interest Rate)

Plan (Elevation and Flow)	First Costs[a/]	Excess Benefits	Benefit-Cost Ratio	Reduction in Damages	Energy Use	Induced Clearing[b/]	Net Fish and Wild-life Losses
	($000)	($000)		(%)	(Million kWh)	(acres)	($000)
Plan A (80.0 feet)							
10,000 cfs	86,800	10,454	3.7	45	7.2	2,300	63
15,000 cfs	126,200	14,101	3.4	62	14.1	3,700	123
17,500 cfs	147,400	16,038	3.4	68	17.0	4,200	146
20,000 cfs	175,400	17,398	3.2	77	19.4	4,800	172
25,000 cfs	212,900	18,671	2.9	86	22.6	5,400	199
30,000 cfs	250,600	18,270	2.6	89	23.9	5,600	202
Plan B (80.0 feet)							
15 (L) - 10,000 (U) cfs	238,000	18,670	2.7	89	27.0	5,700	215
10 (L) - 15,000 (U) cfs	239,600	18,437	2.7	90	30.3	5,900	218
7-18,000 cfs	240,900	18,196	2.6	90	32.8	5,900	219
Plan C (80.0 feet Modified) [c/]							
10,000 cfs	85,800	10,347	3.8	45	6.3	2,200	58
15,000 cfs	125,500	13,627	3.4	60	12.0	3,200	83
17,500 cfs	147,200	15,441	3.3	68	14.9	3,700	95
20,000 cfs	172,600	16,970	3.2	76	16.5	4,300	107
25,000 cfs	210,900	18,661	3.0	86	19.7	4,800	120
30,000 cfs	250,200	18,214	2.7	89	21.4	5,100	128
Plan D (HOLD 85.0 feet)							
25,000 cfs	251,100	14,017	2.3	75		3,800	74

TABLE B-2 (Cont)

Plan (Elevation and Flow)	First Costs[a/]	Excess Benefits	Benefit-Cost Ratio	Reduction in Damages	Energy Use	Induced Clearing[b/]	Net Fish and Wild-life Losses
	($000)	($000)		(%)	(Million kWh)	(acres)	($000)
Plan E (HOLD 80.0 feet)							
25,000 cfs	220,100	15,931	2.7	77		4,700	108
Plan F (83.0 feet) c/							
10,000 cfs	85,200	5,640	2.6	29	3.4	1,400	35
15,000 cfs	124,900	8,279	2.6	41	6.4	2,200	58
17,500 cfs	145,900	9,360	2.5	46	5.6	2,600	67
20,000 cfs	171,000	10,126	2.4	52	8.7	3,000	78
25,000 cfs	205,000	11,959	2.4	62	9.7	3,600	90
30,000 cfs	241,200	11,392	2.1	65	10.6	3,700	92
Plan G (85.0 feet)							
10,000 cfs	83,900	3,021	1.9	20	2.6	900	25
15,000 cfs	117,100	6,291	2.3	35	4.7	1,700	46
17,500 cfs	144,100	6,849	2.2	38	5.6	2,000	56
20,000 cfs	168,100	7,589	2.1	44	6.3	2,500	67
25,000 cfs	202,300	9,175	2.1	54	7.1	3,000	79
Plan H (85.0 feet)							
15,000 cfs	162,800	4,662	1.8	35	4.7	700	-253
Plan I (90.0 feet)							
10,000 cfs	81,500	623	1.2	12	0.9	400	8
15,000 cfs	114,200	1,311	1.3	18	1.7	700	13
20,000 cfs	164,700	663	1.1	22	2.3	800	17

NOTE: (L) = Lower site; (U) = Upper site.

a/ Does not include mitigation costs, but tentative mitigation costs increase this figure by less than 10 percent.

b/ Includes right-of-way.

c/ Pumping initiated at 85 feet, 1 December - 1 March.

47. Excess benefits. Excess benefits over cost was also selected as a parameter for screening of alternatives. National economic development (NED) is considered the paramount project objective. Excess benefits over cost provides a direct indication of the plan's contribution to the NED account.

48. Benefit-cost ratio. The benefit-cost ratio denotes the economic efficiency of the alternatives. The plan with the highest benefit-cost ratio is the plan which provides the maximum rate of return for every dollar invested.

49. Reduction in damages. The percent reduction in flood damages was selected as a parameter for screening of the alternatives since it gives a direct indication of the overall effectiveness of the plans being considered. The percent reduction in damages varied among the various pump sizes considered with each plan from a low of 12 percent with Plan I to 90 percent with Plan B.

50. Energy consumption. Since the conservation of energy has become an item of national concern, energy consumption was selected as a parameter by which to screen the various alternatives. As would be expected, the higher capacity pumps consume greater amounts of energy.

51. Induced clearing. One of the key planning objectives in the formulation of alternatives for this study was to minimize the destruction of bottom-land hardwoods in the study area. This parameter provides an indication of the impact of each of the various alternatives on the environment.

52. Net annual fish and wildlife losses. Another planning objective was to preserve or improve the aquatic and wildlife resources of the area. Net annual fish and wildlife losses give a direct indication of how each of the alternatives meets this objective. These losses were compacted by the man-day user analysis and do not include mitigation benefits.

PLANS ELIMINATED

Plan A

53. When considering comparative pump sizes, Plan A provided the greatest net benefits of all of the plans. However, the excess benefits for Plan A are only about 1 percent higher than Plan C. In addition, Plan C has essentially the same damage reduction effectiveness as Plan A but consumes about 13 percent less energy and results in approximately 10 percent less clearing of hardwoods and 35 percent fewer fish and wildlife losses. For these reasons, Plan A was not carried into the final array of alternatives.

Plan B

54. Plan B resulted in the greatest reduction of interior ponding of any plan studied; however, it produced the greatest fish and wildlife losses.

55. The hydraulic routings for Plan B also showed that significant increases in Yazoo River stages would result from a large pumping plant located in the upper ponding area. The 15,000-cfs lower and 10,000-cfs upper pump plan provided the greatest net benefits, lowest energy consumption, and lowest fish and wildlife losses of the three pump schemes considered under Plan B. This pump scheme has approximately the same excess benefits as the 25,000-cfs pump under Plan C ($18,670,000 versus $18,532,000). However, it costs $27.1 million more, consumes 7.3 million more kilowatt hours (kWh) of annual energy, and results in the induced clearing of 900 more acres and an additional $95,000 in annual fish and wildlife losses. Plan B was eliminated from the final array of alternatives.

Plan D

56. Plan D is the first of the two induced ponding plans. It included a feature to hold water behind the floodgates to as high as 85 feet during the winter and early spring. In order to obtain this operation, extensive modifications would have to be made and 21 families would have to be relocated. When compared to the equivalent pump size in Plan C (25,000-cfs), this plan would result in spending over $40 million to save some $46,000 in net fish and wildlife losses. These losses could be compensated for through the purchase of woodlands at a far lower cost. In addition, Plan D would provide 25 percent fewer excess benefits and would result in approximately 11 percent higher average annual damages. For these reasons, Plan D was eliminated from the final array of plans.

Plan E

57. Plan E is the other induced ponding plan with a feature to hold the ponding elevation at 80 feet during the winter and early spring. Since this plan ponds water to an elevation 5 feet lower than Plan D, it is not as costly. Still, when compared to the equivalent pump size in Plan C (25,000-cfs), it would result in spending $9.3 million to save $12,000 in annual fish and wildlife losses and prevent only 100 acres of project-induced clearing. In addition, approximately $2.7 million in excess benefits would be forfeited and average annual damages would be 9 percent lower. Plan E was also eliminated from the final array of plans.

Plan F

58. Plan F evaluated the same pump sizes as Plans A and C initiating pumping at elevation 83 rather than 80. This operation reduced excess benefits by approximately 30 percent over Plan Groups A and C with average annual damages approximately 20 percent higher. Benefits were affected more by initiating pumping at the higher elevation than was pump cost, thus causing the benefit-cost ratio to be lower for Plan F. Plan F did reduce fish and wildlife losses as well as energy consumption, however, not to the extent to justify carrying this plan into the final array of alternatives.

Plan G

59. Relative to the previous plans considered, Plan Group G was a much weaker flood control plan. Only five pump sizes were evaluated with Plan C. With the exception of the 25,000-cfs pump size, none of the pump sizes reduced average annual damages by more than 45 percent. When compared to the equivalent pump sizes with Plan C, Plan G reduced excess benefits by 66 percent while reducing fish and wildlife losses by only 41 percent. For these reasons, Plan C was not carried into the final array of alternatives.

Plan I

60. As shown in Table B-2, compared to the other plans, pump sizes evaluated with Plan I were ineffective relative in providing flood protection. Therefore, Plan I was not carried into the final array of alternatives.

PLANS CONSIDERED IN DETAIL

Plan C

61. Structurally, Plan C is the same as Plan A. However, it includes an operational modification that would allow flooding to continue during the winter and early spring on approximately 41,000 acres that presently flood on an average of once a year. This feature greatly reduces the waterfowl losses associated with Plan A. This plan provides essentially the same benefits as Plan A, which provided the maximum, while reducing impacts to the environment by approximately 35 percent. Plan C provided the best overall operational scheme when considering both flood control and waterfowl impacts and was retained for detail analysis in the final array of plans.

Plan H

62. Plan H consisted of the 15,000-cfs pump plan of Plan G in combination with a woodlands acquisition feature. Although this plan had the same economic weaknesses as several of the plans which have been eliminated, Plan H was the only plan which provided a net positive benefit to the environment. For this reason, Plan H was carried into the final array of alternatives.

SENSITIVITY ANALYSIS

63. The above plans were formulated and evaluated based on benefit-cost data computed with a 2-1/2 percent interest rate. This is the interest rate in effect at the time the project was authorized. As a sensitivity analysis, benefit-cost data was also computed using the current interest rate (7-5/8 percent). As can be seen in Table B-3, several of the alternatives are no longer economically justified. All of these plans were eliminated from the final

TABLE B-3
BENEFIT-COST DATA AT 7-5/8 PERCENT INTEREST RATE

Plan	First Cost	Annual Cost	Annual Benefits	Benefit-Cost Ratio	Excess Benefits Over Costs
	($000)	($000)	($000)		($000)
A - 80 feet					
10,000	86,800	8,684	12,666	1.5	3,982
15,000	126,200	12,828	17,594	1.4	4,766
17,500	147,400	14,994	20,143	1.3	5,149
20,000	175,400	17,715	22,368	1.3	4,653
25,000	212,900	21,493	24,989	1.2	3,496
30,000	250,600	25,095	25,957	1.0	862
B - 80-foot					
15,000 - 10,000	238,000	24,034	26,002	1.1	1,968
10,000 - 15,000	239,600	24,437	26,076	1.1	1,639
7,000 - 18,000	240,900	24,700	26,032	1.1	1,332
C - 80-foot modification					
10,000	85,800	8,537	12,489	1.5	3,952
15,000	125,500	12,608	17,048	1.4	4,440
17,500	147,200	14,827	19,516	1.3	4,689
20,000	172,600	17,301	21,789	1.3	4,488
25,000	210,900	21,083	24,736	1.2	3,653
30,000	250,200	24,857	25,728	1.0	871
D - Hold 85 feet					
25,000	251,100	23,979	21,588	0.9	-2,391

TABLE B-3 (Cont)

Plan	First Cost ($000)	Annual Cost ($000)	Annual Benefits ($000)	Benefit-Cost Ratio	Excess Benefits Over Costs ($000)
E - Hold 80 feet					
25,000	220,100	21,550	22,349	1.0	799
F - 83 feet					
10,000	85,200	7,894	8,145	1.0	251
15,000	124,900	12,204	11,988	1.0	-216
17,500	145,900	14,270	13,713	1.0	-557
20,000	171,000	16,679	15,301	0.9	-1,378
25,000	205,000	19,927	18,108	0.9	-1,819
30,000	241,200	23,369	18,864	0.8	-4,505
G - 85 feet					
10,000	83,900	8,099	5,759	0.7	-2,340
15,000	117,100	11,368	9,886	0.9	-1,482
17,500	144,100	13,935	11,304	0.8	-2,631
20,000	168,100	16,208	12,798	0.8	-3,410
25,000	202,300	19,515	15,431	0.8	-4,084
H - 15,000	162,800	14,874	9,696	0.7	-5,178
I - 90 feet					
10,000	81,500	7,761	3,434	0.4	-4,327
15,000	114,200	10,916	5,230	0.5	-5,686
20,000	164,700	15,692	6,399	0.4	-9,293

array of alternatives with the exception of Plan H. Plan H was retained since it was the only alternative which met the requirements of an EQ plan. Plan C is still economically justified and, based on the evaluation parameters, still represents the best plan group.

ASSESSMENT AND EVALUATION OF PLANS IN FINAL ARRAY

64. Prior to detailed assessment and evaluation of the plans in the final array, a further screening of the various pump plans resulted in the elimination of the 30,000-cfs pump from further consideration. The reason for its elimination is that when compared to the 25,000-cfs pump plan, it is obvious that the 30,000-cfs pump plan is inferior and should not be considered in any type of trade-off analysis. Not only does the 30,000-cfs pump use more energy, cause more fish and wildlife losses and induced clearing, but it also has fewer excess benefits than the 25,000-cfs pump plan. In addition, when evaluated at 7-5/8 percent, as shown in Table B-3, the 30,000-cfs pump size is only marginally economically justified. For these reasons, it was obvious that the 30,000-cfs pump plan should be eliminated from further study.

FEATURES COMMON TO ALL PLANS

65. The plans in the final array of alternatives (Plans C-10,000, C-15,000, C-17,500, C-20,000, C-25,000 and Plan H-15,000) are very similar. Consequently, the discussion presented in this section includes general statements which are valid for all plans.

66. The pumping plant for all three would all be located southwest of the Steele Bayou drainage structure and would include a pumping plant powered by electricity. The plans would all require an inlet channel about 4,000 feet long from Steele Bayou to the pumping plant, with the minimum bottom width varying from 500 feet for Plan C - 25,000 cfs, to 225 feet for Plan H, to 200 feet for Plan C - 10,000 cfs. The outlet channel required for each of the plans would be about 6,000 feet long and would have a minimum bottom width varying from 390 feet for Plan C - 25,000 cfs to 170 feet for Plan H. Reevaluation studies provide for generalized location and design of the pumping station, inlet and outlet channels, and appurtenant structures. Adjustments may be necessary during detailed design and preparation of plans and specifications.

67. Of critical importance when designing the pumping plant and appurtenant structures are the size, location, and elevation of the interior ponding area. The present damage elevation for the Yazoo Area is considered to be 80.0 feet, NGVD, since only minor flooding occurs below this elevation. Lower woodland areas are usually the most desirable ponding areas because they flood frequently and the land usage is compatible with flooding. In Plan C, the ponding area would be restricted to 13,000 acres of low-lying lands, most of which (8,500 acres) are wooded and/or in bayous and streams. The ponding area for Plan H contains 44,100 acres. Ponding areas can be held to a minimum size

only if pumping is initiated at low elevations and the pumping plant is of large capacity. The most economical pumping design capacity will maximize the economics of pump cost versus ponding area.

68. Based on knowledge of conditions in the area, suitable construction material should be available in the immediate construction area. Further soils investigation will be included in detailed design.

IMPACT ASSESSMENT

69. The various pump sizes considered with Plans C and H each provide to some degree a solution to the flood problems within the project area; however, plan selection must be based on an analysis of the significant economic, social, and environmental impacts of each plan. Also, since each of the alternative plans in the final array included flood reduction measures that would consume large amounts of energy, energy conservation was included as a parameter by which project impacts could be evaluated. These impacts are determined by comparing the existing and future effects of implementing each plan with those of doing nothing, that is, the "without-project condition." In addition, the future conditions of doing nothing must be compared with the base conditions to determine the impacts of a "no-action" plan. This section identifies and describes the impacts which are pertinent to final plan selection.

ECONOMIC DEVELOPMENT

70. Quantification of costs and benefits for the plans under consideration is the measure of economic impacts. Table B-4 presents a comparison of first costs, annual benefits, annual costs, excess benefits over costs, and benefit-cost ratios.

71. First cost for the various pump sizes ranged from $85.8 million to $210.9 million. Costs for Plan C pump plans varied according to pump size and included only the cost associated with meeting the flood control objective. Plan H cost included $45.7 million for the purchase and development of 30,000 acres of bottom-land hardwoods.

72. Annual costs shown in Table B-5 include amortization, operation and maintenance costs, and net annual fish and wildlife losses. Annual costs ranged from $3.8 million with Plan C - 10,000 to $9.3 million with Plan C - 25,000. There would be no first costs or average annual charges for the "no-action" plan.

73. Flood damage reduction is the primary objective addressed by this investigation, and primary benefits are those derived from providing flood protection. All plans have benefits that exceed costs, with Plan C - 25,000 having the highest excess benefits. Plan H - 15,000 provides the lowest

TABLE B-4
BENEFIT-COST DATA
PLANS IN FINAL ARRAY
(2-1/2 Percent Interest Rate)

Plan	First Cost	Annual Benefits a/	Annual Cost	Excess Benefits Over Costs b/	Benefit-Cost Ratio c/
	($000)	($000)	($000)	($000)	
C - 10,000	85,800	14,107	3,760	10,347	3.8
C - 15,000	125,500	19,247	5,620	13,627	3.4
C - 17,500	147,200	22,072	6,631	15,441	3.3
C - 20,000	172,600	24,661	7,691	16,970	3.2
C - 25,000	210,900	28,001	9,340	18,661	3.0
H - 15,000	162,800	10,859	6,197	4,662	1.8

a/ Includes inundation and intensification benefits.
b/ Excess benefits over costs calculation excludes redevelopment benefits (primary benefits minus annual cost).
c/ Benefit-cost ratio calculated using annual benefits and annual costs.

TABLE B-5

FIRST COSTS AND ANNUAL COSTS [a/]

(2-1/2 Percent Interest Rate, 50-Year Project Life)

Item	C-10,000 ($000)	C-15,000 ($000)	C-17,500 ($000)	C-20,000 ($000)	C-25,000 ($000)	H-15,000 ($000)
First Costs						
First Cost	85,800	125,500	147,200	172,600	210,900	162,800 [b/]
Interest During Construction (5 years)	5,363	7,844	9,200	10,788	13,181	8,317
Net Investment	91,163	133,344	156,400	183,388	224,081	171,117
Annual Costs						
Interest (.025)	2,279	3,334	3,910	4,585	5,602	4,278
Sinking Fund (.01026)	935	1,368	1,605	1,882	2,299	1,756
Operation and Maintenance	488	835	1,021	1,117	1,319	416
Fish and Wildlife Loss	58	83	95	107	120	-253
Total	3,760	5,620	6,631	7,691	9,340	6,197

a/ All cost data based on October 1980 price levels.

b/ Includes $29,735,000 cost of fish and wildlife lands.

excess benefits with a benefit-cost ratio of 1.8. Flood damages would actually increase for the no-action plan because flood plain development will continue.

OTHER SOCIAL EFFECTS

74. The primary social impacts of flood control works in the project area are associated with the reduced flooding of rural residential structures. There are approximately 16,000 residential, commercial, industrial, recreational, and public and semipublic structures in the general area. The estimated number of structures in the project area subject to flooding by the 100-year frequency flood under without- and with-project conditions is shown in Table B-6. The number of structures subject to flooding is not expected to increase during the project life due to a projected negative population growth and the development constraints pursuant to the Flood Disaster Protection Act of 1973.

TABLE B-6
STRUCTURES SUBJECT TO FLOODING
BY 100-YEAR FLOOD

Property Type	Number of Structures Subject to Flooding						
	Without- Project	With-Project					
		C-10,000	C-15,000	C-17,500	C-20,000	C-25,000	H-15,000
Residential							
Brick homes	144	108	93	68	38	14	92
Frame homes	479	333	174	103	69	31	180
Trailer homes	127	46	25	24	15	7	24
Subtotal	750	487	292	195	122	52	296
Commercial	37	12	5	1	2	1	5
Industrial	4	1	1	-	-	-	1
Recreational	244	118	56	35	39	11	62
Public	4	-	-	-	-	-	-
Semipublic	15	6	2	1	1	1	2
Total	1,054	624	356	232	164	65	366

75. The 750 rural residential structures which are subject to flooding without the project are generally permanent homes. Most of the 244 recreational structures are occupied on a seasonal or weekend basis. The flood of 1973 inundated the entire project area, with additional damages being incurred from

the inundations of 1974, 1975, and 1979. Families returned to their homes after these inundations to find their homes and furnishings ruined or damaged. As a result, these families experienced much undue hardship and mental anguish.

76. As shown in Table B-6, the proposed plans will eliminate damage to most structures located within the project area, resulting in a healthier and safer place to live. Much of the area to be protected is agricultural land upon which many area residents depend for their livelihood. Thus, flood protection will greatly reduce one of the many uncertainties associated with farming enterprises, which will in turn have a stabilizing effect on the area income.

77. Of the social parameters examined, those evaluated as receiving no effect were population, displacement of people, and community growth. Social parameters identified as possibly receiving potentially adverse effects include community cohesion, noise, and esthetic values. The possible adverse effect on community cohesion stems from the fact that persons located below elevation 85 feet, NGVD, will be left unprotected all year with Plan H and for 3 months with Plan C, and thus will be subject to frequent inundation. However, their neighbors above elevation 85 feet, NGVD, will be provided flood protection.

78. Health problems caused by flooded wells and septic tanks would be greatly reduced by all three plans. With better flood protection, the residents in the area may take more pride in property ownership. These problems would still exist under the no-action alternative.

79. Project construction for each of the plans would be accomplished in a fairly unpopulated area where the noise associated with construction would be of little significance. Traffic flow on Highway 465 would be temporarily disrupted due to the construction of a new bridge across the outlet channel. There would be temporary impairment of the normal esthetic nature of the project site and the leisure and recreational opportunities associated with the forest environment.

ENVIRONMENTAL EFFECTS

80. The primary environmental impacts associated with the various plans are directly linked with the impacts to bottom-land hardwoods and wooded and shrub swamp. Depending on the plan selected, installation of the project would result in the loss of 600 to 4,400 acres of bottom-land hardwoods and 100 to 400 acres of wooded and shrub swamp. Project-related land requirements for each plan considered in the final array are shown in Table B-7.

TABLE B-7
PROJECT-RELATED LAND REQUIREMENTS

Plan	Project-Induced Land Clearing a/		
	Woods	Wooded and Shrub Swamp	Total
	(acres)	(acres)	(acres)
C-10,000	2,000	200	2,200
C-15,000	2,950	250	3,200
C-17,500	3,400	300	3,700
C-20,000	3,950	350	4,300
C-25,000	4,400	400	4,800
H-15,000	600	100	700

a/ Includes rights-of-way.

81. Coincident with the removal of vegetation would be some reduction and disturbance of wildlife. Wildlife dependent on woodland habitat would be directly impacted. Permanent reductions will occur in those species of wildlife dependent upon the areas where vegetation will be permanently removed. Wildlife in adjacent areas would be temporarily disturbed as a result of construction noises and activity and many would emigrate. Many species would reestablish after the disturbance has stopped. Wildlife reduction in areas that have the potential for regrowth would be temporary with reutilization being commensurate with vegetation development.

82. Wetlands are even more scarce than bottom-land hardwoods. Reduction and/or elimination of the annual flood cycle will tend to reduce the quality of the existing seasonal wetlands with regard to the overall ecology of the community. Lowering the flooding frequency will promote the potential for clearing or "edging" of these areas. The inlet channel for the various plans will convert up to 12 acres of wooded swamp to standing water wetlands. The operation of the 25,000-cfs pumps will reduce the frequency of flooding by 72 percent on about 2,300 acres of wooded swamp, approximately 3,300 acres of wooded wetlands, and 11,800 acres of forested land presently flooding annually. With a 17,500-cfs pump, approximately 2,600 acres of wooded wetlands and 1,900 acres of wooded swamp now flooding on a 1-year frequency would be flooded on a 1.5- to 2-year frequency.

83. Since Plan C pump plans incorporate an operational feature to initiate pumping at elevation 85 feet, NGVD, from 1 December to 1 March, waterfowl impacts were significantly reduced over those of a straight 80 plan. The American alligator is the only endangered animal species likely to exist in the project area. Project impacts would be secondary in nature, resulting from project-associated noise and disturbance and should not affect this species.

84. By initiating pumping at 85 feet, NGVD, all year, the impacts associated with Plan H are not as great as those associated with the Plan C pump plans.

the 1973 and 1975 floods were introduced and stage hydrographs were recorded at stations on the Lower Yazoo and Mississippi Rivers for various conditions including preproject (no backwater levees), existing (levees and floodgates only), and the recommended plan. The tests indicated an increase of about 0.4 foot in all stages above bankfull at the Vicksburg (Canal) gage for both 1973 and 1975. Since these increases resulted at a time when the pumping plant would have been operating at maximum capacity for a prolonged period, it may be assumed that these differences represent the maximum increase which could be anticipated for floods of similar magnitude. With the recommended 17,500-cubic-foot-per-second pumping plant, the increase would be proportionally smaller. The effect was found to decrease downstream of Vicksburg and no measureable increase was indicated at stations below St. Joseph, Louisiana (mile 396.4 Above Head of Passes).

LOWER YAZOO RIVER

70. As stated previously, the routings did not show a significant increase in slope over the mouth of Steele Bayou to the Vicksburg Canal gage reach, indicating that the increase in stage in this area would be essentially the same as the increase in the Mississippi River stage at Vicksburg. The maximum possible increase in stage in this area would be about 0.7 foot and would occur below flood stage. From the routing results and rating curves, it is estimated that the maximum increase in peak stages on farmland in this area would be about 0.3 foot. The Vicksburg-Yazoo Area, which includes the Long Lake, Ford's, and Chickasaw Communities, is located within the flood plain in this reach. The effect would decrease upstream of the pumping plant location.

OTHER LEVEED AREAS OF THE
YAZOO BACKWATER PROJECT
(SATARTIA AND ROCKY BAYOU AREAS)

71. Any increase in interior flooding in these areas (shown on Plate C-2) would result from an increase in stages on the Yazoo River at their respective outlets. Such stage increases can safely be considered negligible at these locations.

YAZOO BACKWATER PROJECT
STRUCTURAL MITIGATION FEATURES

72. Operation of the Muddy Bayou control structure and existing and proposed greentree reservoirs and slough control structures would not be adversely affected by the recommended plan. In addition, flood damages to these structures should be reduced.

YAZOO RIVER NAVIGATION

73. The recommended plan would not reduce the discharge in the Yazoo River for river stages below 80.0 feet, NGVD. Therefore, navigation depth under low-flow conditions would not be adversely impacted. The pump outlet channel would be aligned to minimize crosscurrents in the navigation channel, and the necessity of training dikes or other features to further reduce the impact on existing and proposed navigation would be investigated in the detailed design.

SEDIMENTATION

74. Sediments transported by streams in the Yazoo Area consist primarily of fine silt and clay particles which are carried in suspension. Identifying the effects of the recommended plan on sediment transport and deposition in the area would require extensive and complex analysis which is beyond the scope of this study; however, because of the nature of the sediment load and past experience in the area, no sediment related problems are anticipated.

CHANNEL STABILITY

75. With the recommended plan, the water surface slope in the existing connecting channel is increased markedly over existing conditions. However, for the most severe condition indicated by the period-of-record routings, the mean channel velocity would be less that 4 feet per second, and no significant channel stability problems are anticipated. The necessity of providing erosion control measures in critical areas such as highway and railroad bridges will be addressed during detailed design.

In addition, the acquisition and development of 30,000 acres of bottom-land hardwoods as part of this plan would provide significant benefits to the fish and wildlife resources of the area.

85. The no-action plan would allow the species associated with the bottom-land hardwood environment to remain unaltered by construction and to follow a normal course of biological and physical processes. A no-action plan would induce no adverse effects on the environmental quality, but the trend of clearing of bottom-land hardwoods is expected to continue. A no-action plan would offer no guarantee that the environmental and recreational potential of the area would not be destroyed.

ENERGY CONSERVATION

86. Table B-8 shows the average annual energy consumption for the various alternatives as well as the estimated energy cost for present and future conditions. Average annual energy use ranged from 4.7 million kWh with Plan H - 15,000 to 19.7 million kWh with Plan C - 25,000. Based on current energy rates in the project area, annual energy costs would be $367,000 and $1,227,000 for these plans. Anticipated rate increases would increase these costs by over 300 percent over the next 10 years. The no-action plan would have no impact on energy consumption.

TABLE B-8
ENERGY COSTS
PLANS IN FINAL ARRAY

Plan	Average Annual Energy Use (million kWh)	Annual Energy Cost Present Conditions ($000)	Annual Energy Cost[a/] 1990 Conditions ($000)
C-10,000	6.3	432	1,420
C-15,000	12.0	764	2,510
C-17,500	14.9	944	3,099
C-20,000	16.5	1,035	3,399
C-25,000	19.7	1,227	4,028
H-15,000	4.7	367	1,206

a/ Estimate based on data obtained from Mississippi Power and Light Company.

EVALUATION

87. The purpose of this section is to evaluate the various alternative plans including the authorized plan, and the no-action alternative so that they may be compared with one another. Specific items of comparison include the accomplishment of the planning objectives identified in Appendix A, net economic benefits, beneficial and adverse social and environmental impacts,

implementability of the plans, and acceptability of the plans by the public. This comparison may lead to trade-offs between plans or other modifications to achieve the most objectives at the least cost and still maintain the support of the people. Contributions to the national economic development, environmental quality, other social effects, and regional development by each of the plans are displayed in the system of accounts at the end of this section.

AUTHORIZED PROJECT

88. The initial authorized project for the Yazoo Backwater area, based on Plan C of the report of the Mississippi River Commission dated 7 March 1941, contemplated the construction of 54 miles of backwater levee across the mouths of Steele Bayou and Big Sunflower River with the impounded drainage being pumped over the levee when gravity drainage was not possible by reason of high stages on the Mississippi or Yazoo River. A pumping capacity of 14,000 cubic feet per second would be provided, which, together with the impounded drainage, would limit the ponding elevation to about 90 feet, NGVD, for a frequency of not more than an average of once in 5 years. This plan contemplated closing the drainage structures and operating the pumps when the Yazoo River rose to the 80-foot level.

89. At the time of the initial study, the project area contained only 2,650 acres of cleared land below elevation 90. As a result, Plan C of the MRC report dated 7 March 1941, referenced by the 1941 Flood Control Act, was not intended to protect lands below elevation 90 from the 5-year frequency flood. Now there are some 59,000 cleared acres. The 1941 Flood Control Act did not authorize Plan C, but "the extension of the authorized project and improvements contemplated in Plan C . . . ." It is apparent that the MRC report contemplated the extension and improvements to protect the project area. The Chief's views contained in H.D. 308, which was the basis for the authorizations contained in the 1965 Flood Control Act, include his statement that he considered the previous authorization "sufficiently broad to permit selection of locations and capacities of pumping plants . . . as future development dictates." Present conditions dictate a greater pumping capacity.

DESIGNATION OF NED PLAN

90. Economic efficiency as embodied in the NED objective is essentially the basis upon which water resources development decisions have been made for many years. The objective seeks a net increase in the national income by investing in order to derive what economists call "efficiency" benefits.

91. Measurement of these benefits is in terms of the value of increased output of goods and services. In practice, the benefits are measured by normal public investment techniques for counting benefits. The following investment principles are used to identify the NED objectives:

a. Produce net economic returns so as to maximize the amount by which benefits exceed costs.

b. Goods and services to be produced by a project have value only to the extent that there will be a need and demand for the product.

c. The project as well as any separable segment or increment selected to accomplish a given purpose should be more economical than any other actual or potential available means, public or private, of accomplishing that specific purpose.

92. The alternative plans were ranked according to the above parameters. Plan C with 25,000-cubic-foot-per-second pumps achieves the greatest excess benefits (benefit minus cost), best enhances the national economic development, and is designated the NED plan. Total annual benefits from Plan C-25,000 would amount to $28,001,000 with excess benefits over cost of $18,661,000 annually. Plan C has a benefit-cost ratio of 3.0.

DESIGNATION OF EQ PLAN

93. Determination of Environmental Quality (EQ) benefits involves subjective analysis, which requires extensive interdisciplinary planning and public input to evaluate the environmental contributions of the plans. Designating an EQ plan involves measuring the environmental changes related to different plans, considering public input, and selecting the plan which contributes to or is most harmonious with environmental objectives. At a minimum, an alternative plan must make net positive contributions to the EQ account in order to be designated the EQ plan.

94. The objectives of the EQ plan that has been developed are to preserve the bottom-land hardwood resources or improve the associated fish and wildlife habitat, maintain some seasonal flooding for the benefit of fish and wildlife in general and waterfowl in particular, and maintain an adequate amount of water during the spring and summer months to improve the dwindling fishery resource.

95. Plan H, 15,000 cubic feet per second, is considered the best plan from an environmental standpoint. This plan includes the purchase of approximately 30,000 acres of bottom-land hardwoods in tracts of 100 acres and larger to be developed for the purpose of preserving bottom-land hardwoods and improving fish and wildlife resources. Initially, the feature from Plans D and E to hold the ponding level at 75 feet, NGVD, during May, June, July, and August to benefit the fishery resource was included in this plan. However, after

detailed stage 3 studies, this feature was deleted since it was found that ponding water to this elevation for 4 months induced terrestrial losses which exceeded the benefits to the fishery resource. Plan H would make a net positive annual contribution of 554,722 habitat units to the environment and is designated the EQ plan. Plan H also provides $252,700 in net fish and wildlife benefits.

TRADE-OFFS

96. Many factors had to be considered in determining the recommended plan. Negative factors considered included the following: reduction of forested lands with attendant losses in forestry income and wildlife values, reduction in fisheries, reduction in frequency and duration of flooding to wooded swamps and wooded wetlands, natural scenic appeal, and energy consumption. On the positive side, the items beneficially affected are: agricultural productivity; net farm income; rural residential flood damages; displacement of people, livestock, and wildlife; property values; regional growth; business activity; public facilities and services; and total area employment.

97. A reduction in seasonal flooding is part of all structural plans and allows for more effective utilization of agricultural lands. Conversely, the reduction in flooding adversely affects the waterfowl and aquatic habitats of the project area. The waterfowl season in the project area, December through February, is the most desirable time to have parts of the area flooded. The harvesting of crops is usually completed by early December, although inclement weather could delay harvest. Some flooding could be tolerated inside the leveed area from mid-December through mid-February without a major effect on agriculture. As a benefit to waterfowl, the sump area can be allowed to flood to elevation 85.0 feet, NGVD, from 1 December through 1 March, when sufficient runoff occurs to produce such flooding. This procedure would allow the flooding of up to 41,000 acres annually, as under present conditions.

98. The environmental quality of the Yazoo Area is declining under no-action conditions and will continue to decline in the future, even with the no-action alternative. Structural or nonstructural plans will not reverse the deterioration of the natural environment. Although there will be continued deterioration of the natural environment, mitigation features will be added to the recommended plan to mitigate many of those losses that can be directly attributed to the project.

99. Table B-9 shows a comparison of pertinent data for the various plans considered in the final array.

TABLE B-9
COMPARISON OF PLANS IN FINAL ARRAY
(2-1/2 Percent Interest Rate)

Plans/ Parameters	First Costs ($000)	Excess Benefits ($000)	Benefit-Cost Ratio	Reduction in Damages (%)	Area Protected from 100-Year Flood (acres)	Structures Protected from 100-Year Flood	Energy Consumption (Million kWh)	Induced Clearing (acres)	Net Fish and Wildlife Losses ($000)
C - 10,000	85,800	10,347	3.8	45	148,600	430	6.3	2,200	58
C - 15,000	125,500	13,627	3.4	60	204,070	698	12.0	3,200	83
C - 17,500	147,200	15,441	3.3	68	241,300	822	14.9	3,700	95
C - 20,000	172,600	16,970	3.2	76	263,470	890	16.5	4,300	107
C - 25,000 a/	210,900	18,661	3.0	86	348,240	989	19.7	4,800	120
H - 15,000 b/	162,800	4,662	1.8	89	205,590	688	4.7	700	-253

a/ NED Plan.
b/ EQ Plan.

DESIGNATION OF
RECOMMENDED PLAN

100. Selection of the recommended plan was based on a trade-off of beneficial impacts toward economic, environmental, and energy resources. Plan C - 17,500 was designated the recommended plan since it proved to be the best effort toward meeting this trade-off. As shown in Table B-9, Plan C - 17,500 provides a balance between the NED plan and the EQ plan in every category. The difference in excess benefits between Plan C - 17,500 and C - 25,000 are sufficiently offset by the reduced energy consumption, project-induced clearing, and fish and wildlife losses.

101. Based on the flood control needs of the residents of the Yazoo Area as well as environmental and energy considerations, Plan C-17,500 and appropriate mitigation measures offers the best balance of economic, environmental, social, regional, and engineering factors and is designated as the recommended plan. The mitigation features included with this plan include the acquisition of 6,500 acres of bottom-land hardwoods in land use easements, the purchase and development of 6,000 acres of bottom-land hardwoods in fee title, or some combination of the two. The total project cost is $150,000,000 which includes $2,859,000 for mitigation measures (easement approach). The estimated average annual benefits total $21,346,000.

102. In addition to being evaluated at the 2-1/2 percent interest rate, each of the alternatives presented in the final array were also evaluated at the current 7-5/8 percent interest rate. As shown in Table B-10, the plan which provides the highest excess benefits is now the Plan C - 17,500. Excess benefits for the recommended plan are $4,077,000 at the current interest rate producing a benefit-cost ratio of 1.3. Plan H - 15,000 is not economically justified when evaluated at a 7-5/8 percent interest rate.

DIVISION OF PLAN RESPONSIBILITIES

103. The purpose of this section is to present pertinent information concerning the Federal and non-Federal responsibilities regarding cost apportionment and the division of responsibilities for construction and subsequent operation and maintenance of the proposed project. Such cost apportionment is based on Federal legislation and administrative policies.

TABLE B-10
BENEFIT-COST DATA FOR FINAL PLANS

Plan	First Cost ($000)	Annual Benefits ($000)	Annual Cost ($000)	Excess Benefits Over Costs ($000)	Benefit-Cost Ratio
		2-1/2 Percent Interest Rate			
C - 10,000	85,800	14,107	3,760	10,347	3.8
C - 15,000	125,500	19,247	5,620	13,627	3.4
C - 17,500	147,200	22,072	6,631	15,441	3.3
C - 17,500 a/ (with mitigation)	150,000 b/	21,346	6,633	14,713	3.2
C - 20,000	172,600	24,661	7,691	16,970	3.2
C - 25,000 c/	210,900	28,001	9,340	18,661	3.0
H - 15,000 d/	162,800	10,589	6,197	4,662	1.8
		7-5/8 Percent Interest Rate			
C - 10,000	85,800	12,489	8,537	3,952	1.5
C - 15,000	125,500	17,048	12,608	4,440	1.4
C - 17,500	147,200	19,516	14,827	4,689	1.3
C - 17,500 a/ (with mitigation)	150,000 b/	19,027	14,950	4,077	1.3
C - 20,000	172,600	21,789	17,301	4,488	1.3
C - 25,000 c/	210,900	24,736	21,083	3,653	1.2
H - 15,000 d/	162,800	9,696	14,874	- 5,178	0.7

a/ Recommended Plan.
b/ Easement approach to mitigation was assumed for the purpose of estimating cost.
c/ NED Plan.
d/ EQ Plan.

FEDERAL RESPONSIBILITIES

104. Under existing legislation for the Yazoo Backwater project, construction, operation and maintenance costs for the authorized pump plan would be borne by the Federal Government, except for minor maintenance of the inlet and outlet channels. If a plan is selected which exceeds the scope of the authorized plan to the extent that it is no longer within the Chief of Engineers' discretionary authority, it would then have to be authorized by Congress. Presently, all projects going to Congress for authorization will include cost sharing based on requirements now being developed by the current Administration.

105. The Federal Government would design, prepare detailed plans and specifications, and construct the project. This would be accomplished after Congressional funding, and after the non-Federal items required prior to construction have been provided. The Federal Government would also be responsible for the relocation and modification of bridges. The Federal Government would assume responsibility for its contractors during construction.

NON-FEDERAL RESPONSIBILITIES

106. The local sponsoring agencies are required to perform minor maintenance of the inlet and outlet channel for the recommended plan. A listing of the sponsors and their functions is provided in Appendix H.

SYSTEM OF ACCOUNTS

107. Consistent with the requirements of the National Environmental Policy Act of 1969, and other related policies, Tables B-11, B-12 and B-13 present the project details and impacts under the various categories of the system of accounts for the recommended plan, the NED plan, and the EQ plan. These tables display the breadth and detail of the assessment and evaluation of final alternative plans. All significant impacts of and trade-offs between plans are presented.

TABLE B-11
SYSTEM OF ACCOUNTS
RECOMMENDED PLAN (PLAN C--17,500-CUBIC-FOOT-PER-SECOND PUMP WITH MITIGATION) a/

Account/ Parameter	Location of Impacts		Total (Net) National Impact
	Project Area	Rest of Nation	
1. National Economic Development (NED)			
a. Beneficial impacts ($000)			
(1) Flood control	4,562 3/6/9/	0	4,562 3/6/9/
(2) Intensification	16,784 3/6/9/	0	16,784 3/6/9/
(3) Total beneficial impacts	21,346	0	21,346
b. Adverse impacts ($000)			
(1) Value of resources for project construction and operation and maintenance	1,021 1/3/6/9/	5,512 1/3/6/9/	6,533 1/3/6/9/
(2) Mitigation	100 1/3/6/9/	0	100 1/3/6/9/
(3) Fish and wildlife	0	0	0
(4) Total adverse impacts	1,121	5,512	6,633
c. Net (NED) impacts ($000)	20,225 1/3/6/9/	-5,512 1/3/6/9/	14,713 1/3/6/9/
d. Benefit-cost ratio	--	--	3.2

TABLE B-11 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
2. Environmental Quality (EQ)			
a. Environmental quality enhanced			
*Manmade resources	No impacts on historical or current developments. 1/6/9/	No impact	No impacts on historical or current developments. 1/6/9/
b. Environmental quality degraded			
*(1) Manmade resources	No impact on historical or current developments. 1/6/9/	No impact	No impacts on historical or current developments. 1/6/9/
*(2) Natural resources	Results in 17 acres of cleared land and 23 acres of woodlands to be taken in fee title along with 256 acres of woodlands in easements for construction along with the conversion of 900 acres of bottom-land hardwoods to agricultural crop production. This reduction (with the reduction in wetlands due to flood protection) will result in loss of natural wildlife habitat and flooding areas. 1/6/9/	No impact	Reduced fish and wildlife habitat values on remaining wetlands, water areas, and woodlands. 17 acres of cleared land and 23 acres of woodlands will be taken in fee title along with 256 acres of woodlands in easements for construction. 900 acres of bottom-land hardwoods will be converted to agricultural crop production. 1/6/9/

TABLE B-11 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(3) Water quality	Reduced water quality of area streams and lakes. Directly affects wetlands and oxbow lakes by precluding flooding and flushing. Indirect effects will result from the clearing of woodlands and more intensified agricultural management practices. Magnitude of adverse impact will be proportionate to project-induced land clearing. 1/6/9/	No impact	Reduced water quality of area streams and lakes. Magnitude of adverse impacts will be proportionate to project-induced land clearing. 1/6/9/
*(4) Air quality	Reduced air quality from additions to atmosphere residues from open air burning, dust and internal combustion engines during construction period. Modifications and land clearing may remove buffers against wind, increase summer air temperature, and evaporation rates. Long-term reduction of air quality due to intensified agricultural activities will degrade ambient air quality levels by additions of pesticides, dust, and other particulate matter. 1/3/6/9/	No impact	Intensified agricultural activities will result in minor degradation of ambient air quality levels by additions of pesticides, dust and other particulate matter. 1/3/6/9/

TABLE B-11 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
c. Environmental quality destroyed			
*(1) Natural resources	Ecological habitat destroyed on 300 wooded acres required for project.1/6/9/	No impact	Ecological habitat destroyed on 300 wooded acres required for project.1/6/9/
*(2) Water resources	Reduction of aquatic (fish) habitat in area streams and lakes.1/6/9/	No impact	Reduction of aquatic (fish) habitat in area streams and lakes.1/6/9/
3. Other Social Effects (OSE)			
a. Beneficial impacts			
*(1) Community cohesion	Strengthened over the long-run due to the security and development potentials provided by the project.3/5/9/	No impact	Long-run strengthened by the project.3/5/9/
*(2) (Desirable) community growth	No impact	No impact	No impact

TABLE B-11 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
b. Adverse impacts			
*(1) Esthetics	Destruction of 300 acres of bottom-land hardwood forests from construction activities (excavation sites), permanent alteration of natural wetlands (caused from less frequent flooding), and project-induced land clearing of 900 acres will be adverse impacts. 1/3/6/9/	Insignificant	Loss of 1,200 wooded acres resulting from construction activities and project-induced land clearing and adverse effect of alteration of natural wetlands caused by less frequent flooding with project. 1/3/6/9/
*(2) Noise	Minor adverse impacts during construction and periods of operation and maintenance. 1/6/9/	No impact	Minor adverse impacts during construction and periods of operation and maintenance. 1/6/9/
*(3) Displacement of people	None	None	None
4. Regional Economic Development (RED)			
a. Beneficial impacts			
(1) Income			
Summary (NED) account ($000)	20,225 1/3/6/9/	-5,512 1/3/6/9/	14,713 1/3/6/9/

TABLE B-11 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(2) Employment			
(a) Project construction	Creates 150 supervisory, 113 skilled, 716 semi-skilled, and 99 unskilled jobs annually for 5 years. 1/6/8/9/	A significant number of the required labor and supervisory jobs will come from "rest of nation" causing some decrease in personnel from this area for the 5-year period. Construction material and equipment needs will also impact on industries in "rest of nation."	Creates 150 supervisory, 113 skilled, 716 semi-skilled, and 99 unskilled jobs annually for 5 years. 1/6/8/9/
(b) Project operation and maintenance	Creates 3 skilled and 1 unskilled jobs annually for 50 years. 3/6/9/	No impact	Creates 3 skilled and 1 unskilled jobs annually for 50 years. 3/6/9/
(c) All other regional employment impacts not evaluated	----------	----------	----------

TABLE B-11 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(3) Property values	Property values throughout the project area will be increased due to the flood protection provided or by knowledge of future protection, while property values on rights-of-way land would be reduced. Unquantifiable. 3/5/9/	No Impact	Increase in property values in affected area. 3/5/9/
*(4) Tax revenues	Induced land clearing, increased agricultural output and agri-business activities will generate additional tax revenues. 3/4/9/	Insignificant	Increase in tax revenues. 3/4/9/
*(5) Business and industrial activity	Beneficial impact on project area during construction and postconstruction period. 3/5/9/	Insignificant	Beneficial impact resulting primarily from increased agricultural activities. 3/5/9/
*(6) (Desirable) regional growth	Provides a stimulant to economic growth. 3/5/9/	Insignificant	Provides stimulus for economic growth. 3/5/9/

TABLE B-11 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
b. Adverse Impacts			
*(1) Displacement of farms	Seventeen acres of cleared land and 23 acres of woodlands will be taken in fee title. Easements will be required on 167 acres of woodlands. 1/3/6/9/	Insignificant	Loss of productivity on 17 acres of cleared land. 1/3/6/9/
*(2) Public facilities	No impact	No impact	No impact
*(3) Public services	No impact	No impact	No impact

* Parameters specifically required in Section 122 and ER 1105-2-240.
a/ For the purpose of evaluation, the acquisition of land use easements was used as the proposed means of mitigation.

Timing:
1/ Impact is expected to occur prior to or during implementation of the plan.
2/ Impact is expected within 15 years following plan implementation.
3/ Impact is expected in a longer time frame (15 or more years following implementation).

Uncertainty:
4/ The uncertainty associated with the impact is 50 percent of more
5/ The uncertainty is between 10 and 50 percent.
6/ The uncertainty is less than 10 percent.

Exclusivity:
7/ Overlapping entry; fully monetized in NED account.
8/ Overlapping entry; not fully monetized in NED account.

Actuality:
9/ Impact will occur with implementation.
10/ Impact will occur only when specific additional actions are carried out during implementation.
11/ Impact will not occur because necessary additional actions are lacking.

TABLE B-12
SYSTEM OF ACCOUNTS
NED PLAN (PLAN C--25,000-CUBIC-FOOT-PER-SECOND PUMP)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
1. National Economic Development (NED)			
a. Beneficial impacts ($000)			
(1) Flood control	5,730 3/6/9/	0	5,730 3/6/9/
(2) Intensification	22,271 3/6/9/	0	22,271 3/6/9/
(3) Total beneficial impacts	28,001	0	28,001
b. Adverse impacts ($000)			
(1) Value of resources for project construction and operation and maintenance	1,319 1/3/6/9/	7,901 1/3/6/9/	9,220 1/3/6/9/
(2) Fish and wildlife	120 1/3/6/9/	0	120 1/3/6/9/
(3) Total adverse impacts	1,439	7,901	9,340
c. Net (NED) impacts ($000)	26,562 1/3/6/9/	-7,901 1/3/6/9/	18,661 1/3/6/9/
d. Benefit-cost ratio	--	--	3.0

TABLE B-12 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
2. Environmental Quality (EQ)			
a. Environmental quality enhanced			
*Manmade resources	No impact on historical or current developments. 1/6/9/	No impact	No impacts on historical or current developments. 1/6/9/
b. Environmental quality degraded			
*(1) Manmade resources	No impact on historical or current developments. 1/6/9/	No impact	No impacts on historical or current developments. 1/6/9/
*(2) Natural resources	Results in 17 acres of cleared land and 23 acres of woodlands to be taken in fee title along with 354 acres of woodlands in easements for construction along with the conversion of 4,400 acres of bottom-land hardwoods to agricultural crop production. This reduction (with the reduction in wetlands due to flood protection) will result in loss of natural wildlife habitat and flooding areas. 1/6/9/	No impact.	Reduced fish and wildlife habitat values on remaining wetlands, water areas, and woodlands. Seventeen acres of cleared land and 23 acres of woodlands will be taken in fee title along with 354 acres of woodlands in easements for construction. 4,400 acres will be converted to agricultural crop production. 1/6/9/

TABLE B-12 (cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(3) Water quality	Reduced water quality of area streams and lakes. Directly affects wetlands and oxbow lakes by precluding flooding and flushing. Indirect effects will result from the clearing of woodlands and more intensified agricultural management practices. Magnitude of adverse impact will be proportionate to project-induced land clearing. 1/6/9/	No impact.	Reduced water quality of area streams and lakes. Magnitude of adverse impact will be proportionate to project-induced land clearing. 1/6/9/
*(4) Air quality	Reduced air quality from additions to atmosphere residues from open air burning, dust and internal combustion engines during construction period. Modifications and land clearing may remove buffers against wind, increase summer air temperature, and evaporation rates. Long-term reduction of air quality due to intensified agricultural activities will degrade ambient air quality levels by additions of pesticides, dust and other particulate matter. 1/3/6/9/	No impact.	Intensified agricultural activities will result in minor degradation of ambient air quality levels by additions of pesticides, dust and other particulate matter. 1/3/6/9/

TABLE B-12 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
c. Environmental quality destroyed			
*(1) Natural resources	Ecological habitat destroyed on 400 wooded acres required for project. 1/6/9/	No impact	Ecological habitat destroyed on 400 wooded acres required for project. 1/6/9/
*(2) Water resources	Reduction of aquatic (fish) habitat in area streams and lakes. 1/6/9/	No impact	Reduction of aquatic (fish) habitat in area streams and lakes. 1/6/9/
3. Other Social Effects (OSE)			
a. Beneficial impacts			
*(1) Community cohesion	Strengthened over long-run due to the security and development potentials provided by the project. 3/5/9/	No impact	Long-run strengthened by the project. 3/5/9/
*(2) (Desirable) community growth	No impact	No impact	No impact

TABLE B-12 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
b. Adverse Impacts			
*(1) Esthetics	Destruction of 400 acres of bottom-land hardwood forests from construction activities (excavation sites), permanent alteration of natural wetlands (caused from less frequent flooding), and project-induced land clearing of 4,400 acres will be adverse impacts. 1/3/6/9/	Insignificant	Loss of 4,800 wooded acres resulting from construction activities and project-induced land clearing, and adverse effect of alteration of natural wetlands caused by less frequent flooding with project. 1/3/6/9/
*(2) Noise	Minor adverse impact during construction and periods of operation and maintenance. 1/6/9/	No impact	Minor adverse impact during construction and periods of operation and maintenance. 1/6/9/
*(3) Displacement of people	None	None	None
4. Regional Economic Development (RED)			
a. Beneficial Impacts ($000)			
(1) Income			
Summary (NED) account	26,562 1/3/6/9/	-7,901 1/3/6/9/	18,661 1/3/6/9/

TABLE B-12 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(2) Employment			
(a) Project construction	Creates 150 supervisory, 113 skilled, 716 semi-skilled and 99 unskilled jobs annually for 5 years. 1/6/8/9/	A significant number of the required labor and supervisory jobs will come from "rest of nation" causing some decrease in personnel from this area for the 5-year period. Construction material and equipment needs will also impact on industries in "rest of nation."	Creates 150 supervisory 113 skilled, 716 semi-skilled and 99 unskilled jobs annually for 5 years. 1/6/8/9/
(b) Project operation and maintenance	Creates 3 skilled and 1 unskilled jobs annually for 50 years. 3/6/9/	No impact	Creates 3 skilled and 1 unskilled jobs annually for 50 years. 3/6/9/
(c) All other regional employment impacts not evaluated	----------	----------	----------
*(3) Property values	Property values throughout the project area will be increased due to the flood protection provided or by knowledge of future protection, while property values on rights-of-way land would be reduced. Unquantifiable. 3/5/9/	No impact	Increase in property values in affected area. 3/5/9/

TABLE B-12 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(4) Tax revenues	Induced land clearing creating increased agricultural output and agribusiness activities will generate additional tax revenues. 3/4/9/	Insignificant	Increase in tax revenues. 3/4/9/
*(5) Business and industrial activity	Beneficial impact on project area during construction and postconstruction period. 3/5/9/	Insigniciant	Beneficial impact resulting primarily from increased agricultural activities. 3/5/9/
*(6) (Desirable) regional growth	Provides a stimulant to economic growth. 3/5/9/	Insignificant	Provides stimulant for economic growth. 3/5/9/
b. Adverse Impacts			
*(1) Displacement of farms	Seventeen acres of cleared land and 23 acres of woodlands will be taken in fee title. Easements will be required on 354 acres of woodlands. 1/3/6/9/	Insignificant	Loss of productivity on 17 acres of cleared land. 1/3/6/9/

TABLE B-12 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(2) Public facilities	No impact	No impact	No impact
*(3) Public services	No impact	No impact	No impact

* Parameters specifically required in Section 122 and ER 1105-2-240.

Timing:
1/ Impact is expected to occur prior to or during implementation of the plan.
2/ Impact is expected within 15 years following plan implementation.
3/ Impact is expected in a longer time frame (15 or more years following implementation).

Uncertainty:
4/ The uncertainty associated with the impact is 50 percent of more
5/ The uncertainty is between 10 and 50 percent.
6/ The uncertainty is less than 10 percent.

Exclusivity:
7/ Overlapping entry; fully monetized in NED account.
8/ Overlapping entry; not fully monetized in NED account.

Actuality:
9/ Impact will occur with implementation.
10/ Impact will occur only when specific additional actions are carried out during implementation.
11/ Impact will not occur because necessary additional actions are lacking.

TABLE B-13
SYSTEM OF ACCOUNTS
EQ PLAN (PLAN H)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
1. National Economic Development (NED)			
a. Beneficial impacts ($000)			
(1) Flood control	2,523 3/6/9/	0	2,523 3/6/9/
(2) Intensification	8,336 3/6/9/	0	8,336 3/6/9/
(3) Fish and wildlife	253	0	253
(4) Total beneficial impacts	11,112	0	11,112
b. Adverse impacts ($000)			
(1) Value of resources for project construction and operation and maintenance	416 1/3/6/9/	6,034 1/3/6/9/	6,450 1/3/6/9/
(2) Fish and wildlife	0 1/3/6/9/	0	0 1/3/6/9/
(3) Total adverse impacts	416	6,034	6,450
c. Net (NED) impacts ($000)	10,696 1/3/6/9/	-6,034 1/3/6/9/	4,662 1/3/6/9/
d. Benefit-cost ratio	--	--	1.8

TABLE B-13 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
2. Environmental Quality (EQ)			
a. Environmental quality enhanced			
*(1) Manmade resources	No impacts on historical or current developments. 1/6/9/	No impact	No impacts on historical or current developments. 1/6/9/
*(2) Natural resources	30,000 acres of bottom-land hardwoods will be purchased for preservation for future generations. 1/3/6/9/	No impact	30,000 acres of bottom-land hardwoods will be preserved. 1/3/6/9/
b. Environmental quality degraded			
*(1) Manmade resources	No impact on historical or current development. 1/6/9/	No impact	No impacts on historical or current developments. 1/6/9/

TABLE B-13 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(2) Natural resources	Results in 17 acres of cleared land and 23 acres of woodlands to be taken in fee title along with 167 acres of woodlands in easements for construction. 700 acres of bottom-land hardwoods will be converted to agricultural crop production. This will result in a loss of wildlife habitat. 1/6/9/	No impact	Reduced fish and wildlife habitat values on remaining wetlands, water areas, and woodlands. 17 acres of cleared land and 23 acres of woodlands will be converted to agricultural crop production. 1/6/9/
*(3) Water quality	Reduced water quality of area streams and lakes. Directly affects wetlands and oxbow lakes by precluding flooding and flusing. Indirect effects will result from the clearing of woodlands and more intensified agricultural management practices. Magnitude of adverse impact will be proportionate to project-induced land clearing. 1/6/9/	No impact	Reduced water quality of area streams and lakes. Magnitude of adverse impacts will be proportionate to project-induced land clearing. 1/6/9/

TABLE B-13 (Cont)

Account/ Parameter	Location of Impacts		Total (Net) National Impact
	Project Area	Rest of Nation	
*(4) Air quality	Reduced air quality from additions to atmosphere residues from open air burning, dust and internal combustion engines during construction period. Modification of land clearing may remove buffers against wind, increase summer air temperature, and evaporation rates. Long-term reduction of air quality due to intensified agricultural activities will degrade ambient air quality levels by additions of pesticides, dust, and other particulate matter. 1/3/6/9/	No impact	Intensified agricultural activities will result in minor degradation of ambient air quality levels by additions of pesticides, dust and other particulate matter. 1/3/6/9/
c. Environmental quality destroyed			
*(1) Natural resources	Ecological habitat destroyed on 200 wooded acres required for project. 1/6/9/	No impact	Ecological habitat destroyed on 200 wooded acres required for project. 1/6/9/
*(2) Water resources	Reduction of aquatic (fish) habitat in area streams and lakes. 1/6/9/	No impact	Reduction of aquatic (fish) habitat in area streams and lakes. 1/6/9/

TABLE B-13 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
3. Other Social Effects (OSE)			
a. Beneficial Impacts			
*(1) Community cohesion	Strengthened over the long-run due to the security and development potentials provided by the project.3/5/9/	No impact	Long-run strengthened by the project.3/5/9/
*(2) (Desirable) community growth	No impact	No impact	No impact
b. Adverse Impacts			
*(1) Esthetics	Destruction of 200 acres of bottom-land hardwood forests from construction activities (excavated sites), permanent alteration of natural wetlands (caused from less frequent flooding), and project-induced land clearing of 500 acres will be adverse impacts.1/3/6/9/	Insignificant	Loss of 700 wooded acres resulting from construction activities and project-induced land clearing and adverse effect of alteration of natural wetlands caused by less frequent flooding with project.1/3/6/9/
*(2) Noise	Minor adverse impacts during construction and periods of operation and maintenance.1/6/9/	No impact	Minor adverse impacts during construction and periods of operation and maintenance.1/6/9/

TABLE B-13 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
*(3) Displacement of people	None	None	None
4. Regional Economic Development (RED)			
a. Beneficial impacts			
(1) Income			
Summary (NED) account ($000)	10,696 1/3/6/9/	-6,034 1/3/6/9/	4,662 1/3/6/9/
*(2) Employment			
(a) Project construction	Creates 150 supervisory, 113 skilled, 714 semi-skilled, and 99 unskilled jobs annually for 5 years. 1/6/8/9/	A significant number of the required labor and supervisory jobs will come from "rest of nation" causing some decrease in personnel from this area for this period. Construction material and equipment needs will also impact on industries in "rest of nation."	Creates 150 supervisory, 113 skilled, 714 semi-skilled, and 99 unskilled jobs annually for 5 years. 1/6/8/9/
(b) Project operation and maintenance	Creates 3 skilled and 1 unskilled jobs annually for 50 years. 3/6/9/	No impact	Creates 3 skilled and 1 unskilled jobs annually for 50 years. 3/6/9/

TABLE B-13 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
(c) All other regional employment impacts not evaluated	----------	----------	----------
*(3) Property values	Property values throughout the project area will be increased due to the flood protection provided or by knowledge of future protection, while property values on rights-of-way land would be reduced. Unquantifiable. 3/5/9/	No impact	Increase in property values in affected area. 3/5/9/
*(4) Tax revenues	Induced land clearing, creating increased agricultural output and agribusiness activities, will generate additional tax revenues. 3/4/9/	Insignificant	Increase in tax revenues. 3/4/9/
*(5) Business and industrial activity	Beneficial impact on project area during construction and postconstruction period. 3/5/9/	Insignificant	Beneficial impact resulting primarily from increased agricultural activities. 3/5/9/
*(6) (Desirable) regional growth	Provides stimulus for economic growth. 3/5/9/	Insignificant	Provides stimulus for economic growth. 3/5/9/

TABLE B-13 (Cont)

Account/ Parameter	Location of Impacts: Project Area	Location of Impacts: Rest of Nation	Total (Net) National Impact
b. Adverse Impacts			
*(1) Displacement of farms	Seventeen acres of cleared land and 23 acres of woodlands will be taken in fee title. Easements will be required on 167 acres of woodlands. 1/3/6/9/	Insignificant	Loss of productivity on 17 acres of cleared land. 1/3/6/9/
*(2) Public facilities	No impact	No impact	No impact
*(3) Public services	No impact	No impact	No impact

* Parameters specifically required in Section 122 and ER 1105-2-240.

Timing:
1/ Impact is expected to occur prior to or during implementation of the plan.
2/ Impact is expected within 15 years following plan implementation.
3/ Impact is expected in a longer time frame (15 or more years following implementation).

Uncertainty:
4/ The uncertainty associated with the impact is 50 percent of more
5/ The uncertainty is between 10 and 50 percent.
6/ The uncertainty is less than 10 percent.

Exclusivity:
7/ Overlapping entry; fully monetized in NED account.
8/ Overlapping entry; not fully monetized in NED account.

Actuality:
9/ Impact will occur with implementation.
10/ Impact will occur only when specific additional actions are carried out during implementation.
11/ Impact will not occur because necessary additional actions are lacking.

YAZOO PUMP PROJECT
YAZOO BACKWATER AREA
MISSISSIPPI

A P P E N D I X C

REEVALUATION REPORT

HYDRAULICS AND HYDROLOGY

PREPARED BY
THE UNITED STATES ARMY
VICKSBURG DISTRICT, CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

REEVALUATION REPORT
YAZOO AREA PUMP PROJECT
YAZOO BACKWATER AREA, MISSISSIPPI

APPENDIX C

HYDRAULICS AND HYDROLOGY

Table of Contents

Table of Contents (Cont)

Table of Contents (Cont)

LIST OF TABLES

Table of Contents (Cont)

LIST OF TABLES (Cont)

LIST OF PLATES

Table of Contents (Cont)

LIST OF PLATES (Cont)

REEVALUATION REPORT
YAZOO AREA PUMP PROJECT
YAZOO BACKWATER AREA, MISSISSIPPI

APPENDIX C

HYDRAULICS AND HYDROLOGY

PURPOSE OF HYDROLOGIC ANALYSIS

1. The purpose of the analysis described herein is to identify the existing hydrologic conditions in the Yazoo Area and to estimate the modifications to those conditions which would result from each of several alternative plans. Since virtually all of the economic and environmental impacts of these plans result directly from changes to the water resource, this analysis is essential to plan formulation and to the evaluation of environmental and socioeconomic effects.

2. This appendix presents the methodology utilized in the analysis, an explanation of the types of data developed, a summary of the results of the analysis, and discussion of the hydrologic effects of the various plans. In addition, the hydraulic effects of the recommended plan are explained in detail and pertinent hydraulic design considerations are presented. Applications of the developed data are discussed in Appendixes E, F, and G.

DESCRIPTION OF STUDY AREA

DRAINAGE AREAS

3. The Yazoo Area drainage area is comprised of the Little Sunflower River, Big Sunflower River, Deer Creek, and Steele Bayou Basins as shown on Plate C-1. The streams in these basins collectively drain 4,093 square miles of the alluvial valley east of the Mississippi River. The area has an average width of about 30 miles and extends from the confluence of the Yazoo River and Steele Bayou to the vicinity of Clarksdale, Mississippi, about 140 miles to the north. The alluvial plain is generally flat with slopes averaging 0.3 to

0.9 foot per mile. Location of the Yazoo Area is shown on Plate 1 of the main report. Drainage areas of the four basins are listed below.

Stream		Drainage Area (sq mi)
Big Sunflower River		2,832
Little Sunflower River		309
Deer Creek		200
Steele Bayou		752
	TOTAL	4,093

CLIMATE

4. The climate for the Big Sunflower, Little Sunflower, Deer Creek and Steele Bayou Basins is generally mild. The summers are long and hot; the winters are short and mild. The average annual temperature is about 64 degrees F. Average monthly temperatures range from 44 degrees F in January to 82 degrees F in July and extremes range from about -10 degrees F to 110 degrees F.

PRECIPITATION

5. The average annual rainfall over the Yazoo Area is about 51 inches. Normal monthly rainfalls at Stoneville, Miss. (near center of basin), vary from 5.6 inches in March to 2.5 inches in October. For the period 1918 to 1976, the annual rainfall at Stoneville has ranged from a minimum of 33.5 inches in 1943 to a maximum of 76.0 inches in 1923. During March 1973, observed rainfalls at several stations in the area exceeded the normal rainfall for that month by more than 11 inches. Snowfall occurs about once a year with an average amount of about 2 inches.

INFILTRATION AND RUNOFF

6. Runoff factors can vary from about 5 percent of the rainfall in the summer and fall to approximately 75 percent during the winter and spring, depending on antecedent conditions, rainfall distribution, and rainfall intensity. Observed data on the Big Sunflower River at Sunflower, Mississippi, show that annual runoff varies from about 6 to 28 inches and averages about 17.5 inches. Seasonal variations in runoff factors are indicated by the generalized values shown below:

Month	Runoff Percent
December, January, and February	60
March and April	70
May	60
June	40
July	25
August and September	10
October and November	25

EXISTING CONDITIONS

PROJECT FEATURES

7. Presently completed features of the Yazoo Area are shown on Plate C-2; levee and channel profiles are shown on Plate C-4. These features include:

a. Backwater levee extending from the end of the east bank main line Mississippi River levee to the downstream end of the west side Lower Auxiliary Channel levee.

b. Drainage structures at Steele Bayou and the Little Sunflower River. These structures allow interior runoff to be released when the ponding area stages are higher than the river stages and prevent backwater flooding from the Mississippi and Yazoo Rivers when the river is higher than the ponding areas.

c. A 200-foot bottom width connecting channel between the Big Sunflower and Little Sunflower Rivers and an enlarged Little Sunflower River channel between this connecting channel and the Little Sunflower drainage structure.

d. A 200-foot bottom width connecting channel between the Little Sunflower River and Steele Bayou, which also intercepts Deer Creek flow.

e. A gated structure in Muddy Bayou which controls Eagle Lake inflows and outflows for environmental purposes.

PONDING AREAS

8. Ponding of runoff from the Big Sunflower River, Little Sunflower River, Deer Creek, and Steele Bayou is provided by two ponding areas connected by a 200-foot bottom width channel. The lower ponding area, formerly referred to as the Lower or Steele Bayou sump, lies in the lower end of the Steele Bayou Basin while the upper ponding area, formerly called the Upper or Sunflower River sump, is located in the lower portion of the Little Sunflower River Basin.

EXISTING CONDITIONS
FLOODING

9. Under present conditions, flooding in the study area results primarily from interior ponding during high Mississippi River stages. As can be seen from the observed flood profiles presented on Plate C-4, the water surface profiles through the ponding areas are generally flat.

10. For all but the most extreme events, the water surface in the upper area is significantly higher than the water surface in the lower area. This difference is due primarily to slope through the connecting channel and head losses across bridges and overbank openings along Deer Creek ridge, the divide between the two areas. The area affected by interior ponding is rarely, if ever, affected by headwater flooding from rivers and streams in the Steele Bayou, Deer Creek, or Big Sunflower River Basins.

11. The Muddy Bayou control structure was constructed primarily as a means of controlling inflows to and discharge from Eagle Lake during nonflood conditions in order to enhance the water quality of the lake. However, due to the relatively high topography surrounding the lake, a degree of flood protection is also provided.

12. During flood conditions the Muddy Bayou structure is opened to allow water to pass from the lower ponding area into Eagle Lake only if it becomes apparent that this line of protection will be overtopped (about elevation 95).

13. Since the storage available in the lake is very large compared to the drainage area, essentially no flooding results from local rainfall in the Eagle Lake area alone. Similarly, two private levee systems (Floweree and Brunswick) provide protection to comparatively small areas.

ALTERNATIVES CONSIDERED

14. The plans evaluated are summarized in Table C-1. The recommended plan involves a 17,500-cubic-foot-per-second pumping plant located in the lower ponding area with a modified 80-foot, NGVD, minimum pumping level (85 minimum for December through February, and 80 minimum for March through November). Construction of a levee system on the Big Sunflower River was also considered; however, preliminary estimates indicated that this plan would not be economically feasible and further study could not be justified. The hydraulic effects of the various plans are discussed in the section entitled "Effects of Plans on Flooding in the Yazoo Area."

MATHEMATICAL MODEL
AND DATA BASE

15. A computer model was developed to simulate the hydraulic effects of the various alternatives on observed flood events. The mathematical model used is shown schematically on Plate C-3 and is essentially a coupled modified Puls hydrologic routing for the two ponding areas. The data base for this model included data of two forms: descriptive relationships including discharge rating curves, unit hydrographs and elevation-storage curves; and daily data such as river stages and discharges. The development and adjustment of these data, and the routing conditions and assumptions are described below.

DESCRIPTIVE RELATIONSHIPS

Elevation-Area and Storage Curves

16. Elevation-area curves were developed by planimetering the area enclosed by various contours on 1:24,000-scale topographic quadrangle maps with 5-foot contour intervals. These curves indicate total area including water areas such as lakes, streams, and sloughs. Elevation-storage curves were then derived by numerical integration of the elevation-area curves. As explained earlier, certain portions of the lower ponding area are separated by manmade structures, specifically Eagle Lake Road and Muddy Bayou Structure and the Floweree and Brunswick levees. Storage of these areas was assumed not to become available until overtopping of the line of protection of these areas occurred. Elevation-area and storage curves are shown on Plate C-6.

Unit Hydrographs

17. The development of inflow unit hydrographs for the two ponding areas is explained in "General Design Memorandum, Yazoo Backwater Project, DM No. 1," December 1959, Revised January 1962. The applicability of the lower ponding area unit hydrograph was verified by back-routing an observed flood event (March 1975). Inflow unit hydrographs are presented in Table C-2.

Discharge Rating Curves

18. Tailwater-discharge rating curves for the Yazoo River from the Vicksburg (Canal) gage to the mouth of Steele Bayou were based entirely on observed stages and measured discharges. When the Mississippi River at the canal gage is below elevation 80 feet, NGVD, the stage at the mouth of Steele Bayou is dependent on the canal gage elevation and the Yazoo River discharge. As the stage at the canal gage increases between 80 and 90 feet, NGVD, overbank flooding from the Mississippi moves progressively upstream from Vicksburg toward Steele Bayou. For this condition, stages at the mouth of Steele Bayou reflect a stage relation between the canal gage and the limit of overbank flooding, and a tailwater discharge rating between this point and the mouth of Steele Bayou. When the canal gage is above about 90 feet, NGVD, the entire reach is flooded by Mississippi River overbank flow and there is essentially a

direct stage relation between the canal gage and the mouth of Steele Bayou which is virtually independent of the Yazoo River discharge.

19. Rating curves for the Yazoo River from the mouth of Steele Bayou to the mouth of the Little Sunflower River indicating levee confining conditions were developed from backwater computations performed by use of the computer program "HEC-2, Water Surface Profiles." Cross-sectional data were obtained from hydrographic surveys made in 1975. Connecting channel ratings were also computed by HEC-2 with cross-section data taken from recent "as constructed" and "as specified" drawings. Since the channel has a flat bottom grade and fairly uniform geometry, it was assumed that these curves could be reversed when it was necessary to compute flow from the lower to the upper ponding area. Drainage structure rating curves were derived by the procedure outlined in "Yazoo Backwater Project DM No. 4, Steele Bayou Floodgate, Yazoo Area," January 1963, and "Yazoo Backwater Project, DM No. 5, Little Sunflower Drainage Structure and River Closure, Yazoo Area," July 1966. Drainage structure and outlet channel discharge rating curves were combined for use in the routings and are presented on Plate C-5 along with the other curves specified above.

Seepage

20. The Yazoo Area is bounded by about 260 miles of levees; therefore, seepage was considered to contribute significant inflows to the ponding areas during high river stages. The levees were divided into reaches according to soil type, and curves relating seepage to head were developed for each type. The head for each reach was then correlated to the canal gage stage and a composite seepage curve for relating seepage inflow to canal gage stage was derived. The seepage curve used in the period-of-record routings is shown on Plate C-6.

DAILY STAGE AND DISCHARGE DATA

21. Stage and discharge data for each of the 1-day (24-hour) routing periods in the period-of-record consisted of the inflows to each ponding area, the stage on the Mississippi River at the Vicksburg (Canal) gage, and the Yazoo River discharge above the mouth of the Little Sunflower River. These data were derived and adjusted to present conditions by the following procedures.

Vicksburg Canal Gage Stages

22. Over the last 50 years, the Mississippi River stage resulting from any given meteorological condition would have been affected by many different natural and manmade changes. The more significant of these are the cutoff program initiated in 1929 and completed in 1942, and the construction of extensive regulation works, primarily flood control reservoirs in the Mississippi Basin above Vicksburg. Any difference in the flow hydrograph which might have resulted from the cutoffs and changing channel geometry was assumed to be negligible; therefore, canal gage stages observed after the completion

of regulation works (1953-1975) were adjusted to present Mississippi River channel conditions by adding the difference between the Mississippi River discharge rating curve for present conditions (1973) and the rating curve in effect at the time stage measurements were made. The rating curve changes since 1927 are shown on Plate C-3.

23. Regulation works not only produce decreases in the peak discharge, but reshape the entire stage and discharge hydrographs. These effects cannot be reasonably accounted for by simple adjustments to observed data; therefore, routed discharge hydrographs for 10 representative floods prior to 1953 and for the highest flood of record (1927) were obtained from the Mississippi River Commission. By applying the 1973 rating curve to routed daily flows, it was possible to determine stage hydrographs for these floods occurring under present Mississippi River conditions.

24. The period of record 1943-1975 was selected since it provided a near continuous period with only 5 years of data missing. In addition, comparison of the Mississippi River at Vicksburg discharge frequency curve for the period 1900-1975 (peak flows adjusted for regulation) with the curve computed for the selected period of record indicated that this period provided a representative sample of Mississippi River floods. In addition, the reliability of the routed flood hydrographs for the more severe floods in this group (1927 and 1937) was believed not to be comparable to the other hydrographs used. The floods used in the period of record routings were 1943, 1944, 1949, 1950, and 1953-1975. The locations of the Vicksburg Canal gage and other stream gages in the area are shown on Plates C-1 and C-2.

Ponding Area Inflows

25. Rainfall data at as many as 12 contributing stations were used in deriving inflow hydrographs. The locations of these stations are shown on Plate C-1. Station weights were assigned by the Thiessen Polygon technique and were recomputed as new stations were added and old ones were discontinued. Runoff percentages were determined for each storm in the period of record from observed rainfall and daily discharge data on the Big Sunflower River at Sunflower, Mississippi.

Yazoo River Flows

26. Daily Yazoo River discharges above the mouth of the Little Sunflower River were determined by adding estimated local inflows between this point and an upstream station (either Yazoo City or Belzoni) to the observed latitude flows at the upstream station. These discharges were then adjusted for headwater improvements and reservoir regulation.

ROUTING ASSUMPTIONS

27. The following conditions were assumed in the routing procedure:

a. Flooding in each of the two ponding areas is represented by the stage landside of the respective drainage structures. As discussed previously, for virtually all flooding conditions a nearly flat pool exists in each ponding area. Although there is obviously some effect on headwater overbank flooding above the limits of this pool, quantifying this effect would be difficult and time-consuming and would not produce significantly different results.

b. The effect of the various alternatives on Mississippi River stages was considered negligible.

c. Pumps were operated in 2,000-cubic-foot-per-second units; the number of units which could be operated in any routing period was determined by the storage available above the minimum pumping level at the end of the preceding routing period.

d. Pumps and gravity structures within the same ponding area were not operated simultaneously. Gravity structures were closed when the volume which could be pumped during a routing period exceeded the volume which could be evacuated by gravity flow.

MODEL VERIFICATION
AND SENSITIVITY

28. The routing model was verified by using the descriptive relationships, assumptions and methodology described above to route the 1979 flood, the only significant flood event since completion of the backwater levees in 1977. Plate C-3 shows a comparison of the routed stages with the observed stages for this event.

29. Considering the complex combination of factors which produce flooding in this area, this verification is considered excellent. In addition, it does not appear that the results are overly sensitive to the methodology or to the assumptions made in developing input data.

EFFECTS OF FUTURE LAND
USE AND CHANNELIZATION

30. Since most of the drainage area consists of cleared land and dedicated forest, future land use changes are expected to be minor in comparison to the total drainage area. The projected land clearing, both with and without the project, will constitute a very small fraction of the drainage area. Similarly, most of the area has already undergone extensive channelization. Although this trend is expected to continue in the future, the resulting acceleration of inflows into the ponding areas would not significantly affect the ponding area stages developed for this study.

ROUTING RESULTS

31. Complete period-of-record routings were performed for the upper and lower ponding areas for all alternatives considered. The Muddy Bayou Control Structure is opened to fill Eagle Lake when the lower ponding area elevation reaches 90.0 to 95.0 feet, NGVD. The actual operation during any given flood event is based on a number of factors and considerations which are beyond the scope of this study. Therefore, it was assumed that the gates would be opened when the lower ponding area reached elevation 90.

32. Routings of several representative floods indicated that, under these circumstances, Eagle Lake would reach the same peak level as the lower ponding area. In addition, since the storage available in Eagle Lake is very large compared to its drainage area, the lake would not rise above the damage level as a result of interior runoff. Eagle Lake stages and durations were therefore simulated from the lower ponding area routings. The routings were used to develop data for economic and environmental analysis as discussed in the following paragraphs.

FREQUENCY CURVES

33. Frequency curves were computed according to the procedures outlined in "Statistical Methods in Hydrology," Leo R. Beard, January 1962. Because of the peak stage regulating effects of the various pumping alternatives, the statistical distributions employed by analytical techniques such as the Log-Pearson Type III could not be reasonably applied to either peak stage or peak storage data. It was therefore necessary to use a graphical or "plotting position" method which assumes no uniform statistical distribution. The plotting positions for existing conditions and the recommended plan are shown on Plate C-7.

34. This method produces reasonably well-defined curves for frequencies below about the 20-year. Consideration was given to utilizing historical major flood data to improve the definition at higher frequencies; however, due to the considerable adjustments of observed data required to account for major changes in Mississippi River conditions, these data would be highly questionable. In addition, since almost all of the flood damages in the area are agricultural, the economic analysis is not sensitive to the frequency data above the 10- to 20-year range.

35. Most of the curves developed have one or more operationally imposed discontinuities. For minor floods and floods of intermediate magnitude, the pumping plant capacity may be sufficient to remove all of the inflows and the ponding area would rise above the minimum pumping level only high enough to cause the necessary number of pump units to be operated. Over this range, the

frequency curve is a straight line with a slight upward slope. For floods of greater magnitude, inflows exceed the pumping capacity, causing the ponding stage to rise above the minimum pumping level and the frequency curve becomes curvilinear. When the minimum pumping level is modified, as with the recommended plan, the annual frequency curve becomes even more irregular.

36. It can also be noted from frequency curves presented later in this appendix that there is no uniform relationship between flood frequency and the magnitude of stage reduction from existing conditions produced by the various pumping plant capacities. This is due primarily to the changed significance of various flood-producing factors. With existing conditions, flooding is primarily a function of the volume of storm runoff which occurs during high river stages and is virtually independent of the intensity of any single storm event. With a pumping plant in place, however, many flood peaks are determined primarily by a single storm and are independent of the total volume of storm runoff during the total period floodgates are closed.

SIMULATED DAILY STAGE DATA

37. The routed daily stage data were stored on magnetic disk for use in the economic evaluation of the various alternatives. Routings were summarized by tabulating the peak stage, the duration above the damage level (80.0 feet, NVGD), and pump operation data for each flood event in the period of record. Summaries of this type for existing conditions and the recommended plan are shown in Table C-3.

38. The routing results for other plans evaluated are summarized in Tables C-4 through C-10, which indicate the annual peak stages and the total duration in days above the damage level.

PUMP OPERATION SUMMARIES

39. The routing results were also employed to develop the data used to determine pump energy requirements. The average head and discharge duration while pumping and the average annual number of days of pump operation were developed for each alternative by numerically integrating the head and discharge duration "while pumping" curves. Head and discharge duration curves for pump operation Plan C alternatives are shown on Plate C-8. Pump data for all plans are shown in Table C-11.

40. In order to calculate the peak demand rate (an electrical energy cost based on the peak energy consumption in any given year), the average annual peak power was computed. The average annual peak power is the maximum product of the pumped discharge and the pumping head (static head plus 2 feet) during any 12-month period.

PRELIMINARY HYDRAULIC DESIGN

41. In order that excavation costs could be estimated, some preliminary pumping plant site selection and channel sizing was necessary. The selected preliminary pumping plant locations and channel alignments are shown on Plate 2 of the main report. Design levee grades are shown on Plate C-4. The plant will be designed so that water-damageable parts of the pump will be protected to elevation 116 feet, NGVD. Channel dimensions are listed in Table C-12.

42. The following criteria were used in developing preliminary hydraulic design considerations:

a. Inlet channels. The width, transition, and alignment of inlet channels were established to provide a uniform velocity distribution in the pumping plant forebay.

b. Outlet channels. The outlet channels were sized and aligned with the Yazoo River in such a way that bank stabilization and navigation problems might be minimized.

STANDARD PROJECT FLOOD

43. The Standard Project Flood (SPF) represents the flood that can be expected from the most severe combination of meteorologic and hydrologic conditions that are considered reasonably characteristic of the geographic region involved, excluding extremely rare combinations. Procedures for estimating the SPF usually involve a single storm event, the Standard Project Storm (SPS). However, with existing conditions, flooding in the Yazoo Area generally results from a number of storm events occurring over a period of several months.

44. With a large pumping plant, reasonable results might be obtained by routing the SPS runoff; however, a more severe and more probable flood could occur from overtopping of the backwater levees by the Mississippi River. For this reason, the Mississippi River project design flood (revised 1973 MR&T Project Flood Flowline) was considered to produce a flood of magnitude approximately equal to the SPF. Although pumping would shorten the duration on the rising leg of the hydrograph, the extent and magnitude of flooding with the SPF would not be greatly affected by any of the alternatives considered.

45. The peak stage, which includes future channel deterioration that can be expected to occur over the project life, would be 116.0 feet, NGVD, in both ponding areas. If a similar flood were to occur with existing conditions, the peak stage would be 114.8 feet, NGVD. The duration of flooding would probably be 3 to 5 months. Velocities resulting from the project flood would not exceed 2 feet per second, except in channels and in the immediate vicinity of the levee overtopping. Levee overtopping can be predicted with sufficient

lead time to facilitate evacuation of the area, thereby minimizing any threat to life or limb.

EFFECTS OF PLANS ON FLOODING IN THE YAZOO AREA

PLAN A (80 FEET, NGVD, MINIMUM PUMPING LEVEL)

46. The minimum practical pumping level was considered to be 80 feet, NGVD. Between elevation 75 and 80, the storage in the lower ponding area is sufficient to provide only one-third to one day of pumping for the range of plant capacities tested. Pumping below elevation 80 would require a more costly pumping plant and more frequent operation of pumps, and would result in no significant additional reduction in peak stage.

47. The 10,000-cubic-foot-per-second pumping plant provided capacity to pump the inflows from floods approaching the 1-year frequency and produced slightly more than 3 feet of reduction in the 100-year flood on the lower ponding area and about 2.5 feet on the upper, while the 30,000-cubic-foot-per-second plant could pump the inflows from floods in excess of the 10-year frequency and resulted in more than 12 feet of reduction in the 100-year peak on the lower ponding area and 8 feet on the upper.

48. The 25,000-cubic-foot-per-second plant with 80 minimum pumping level, which resulted in the highest excess benefits of all plans tested, had sufficient capacity to pump the inflows from floods slightly exceeding the 5-year frequency and produced about 10 feet of reduction in the 100-year stage on the lower ponding area and about 7 feet on the upper. Since the minimum pumping level was retained throughout the year, reductions were also realized during the period when it is desirable to pond water in low-lying areas for waterfowl (December-February).

49. As can be noted from the 100-year stages cited above, the difference between the upper and lower ponding area peak stages was, in general, found to increase with the pumping plant capacity. Frequency curves for these alternatives are shown on Plate C-10 and routing summaries are shown in Table C-4.

PLAN B (TWO-SITE PUMPING PLANT ALTERNATIVES)

50. With a single pumping plant located in the lower ponding area and a minimum pumping level of 80 feet, NGVD, the stage in the upper ponding area is generally several feet higher than the stage in the lower ponding area at the time pump operation is ceased. Therefore, by dividing the total pumping capacity between the two ponding areas, it should be possible to operate the

pumps for a longer period and thereby maximize the reduction in flooding which can be obtained from a given total pumping capacity.

51. Three combinations providing a total capacity of 25,000 cubic feet per second were evaluated and, as indicated by the ponding area frequency curves shown on Plate C-11 and the routing summaries in Table C-5, each of these alternatives produced additional reduction in upper ponding area stages. The combination of an 18,000-cubic-foot-per-second pumping plant in the upper ponding area and a 7,000-cubic-foot-per-second plant in the lower area resulted in the greatest reduction in interior ponding of any plan studied. However, the routings also showed that significant increases in Yazoo River stages and resultant flooding would result from a large pumping plant located in the upper ponding area. This effect is expressed by frequency curves for the Yazoo River at the mouth of the Little Sunflower River, also shown on Plate C-11.

PLAN G (85 FEET, NGVD,
MINIMUM PUMPING LEVEL)

52. Plan G involves a single minimum pumping level of 85 feet, NGVD. Pumping plants of 10,000, 15,000, 20,000, and 25,000 cubic feet per second nominal capacity were evaluated. Since floods with peak stages less than 85 were unchanged, these alternatives provided a water regime more nearly approximating existing conditions than other economically sound alternatives with comparable capacities.

53. Since the volume between 80 and 85 was not evacuated by pumping, peak stages for major floods were not reduced as much as with the 80 minimum pumping level; the 25,000-cubic-foot-per-second pumping plant with 85 minimum pumping level produced about 0.5 foot less reduction in major flood peaks than did the comparably sized pumping plant with an 80-foot minimum pumping level. As a result, substantial flood control benefits would be foregone.

54. Increasing the minimum pumping level from 80 to 85 produced approximately the same effect on flood control as reducing the pumping plant capacity by 10,000 cubic feet per second. Frequency curves for Plan G are shown on Plate C-10 and routing summaries are shown in Table C-9.

PLAN C (MODIFIED OPERATION
WITH 80 FEET, NGVD, MINIMUM
PUMPING LEVEL)

55. The 85-foot minimum pumping plans provided good flood control, though somewhat less than the 80-foot minimum pumping alternatives, and allowed ponding to occur as it would under existing conditions up to elevation 85. However, since this ponding is highly desirable in the months of December through February, it should be possible to retain the ponding benefits and further enhance flood control by implementing a modified or "rule curve" type operation. With such a scheme, the pumps would be operated to a minimum ponding

level of 85 feet, NGVD, during these months and to a minimum level of 80 during the remainder of the year.

56. As can be seen by comparing the stage hydrographs on Plates C-18 and C-19, the 80-foot modified plans produced effects in the ponding area identical to the 85-foot minimum pumping plans during the December-February period and very similar to the 80-foot minimum pumping level alternatives during the remainder of the year. In fact, the routings did not indicate a significant difference in flood peaks occurring after 1 March and before 1 December for any of the floods simulated. This effect is indicated by comparison of Tables C-4 and C-6.

57. The peak stage occurring between 1 December and 1 March, with existing conditions and Plan C, 17,500 cubic feet per second, is shown on Plate C-9. This comparison indicates the effectiveness of the modified operation in maintaining the present water regime during this critical period. Although the frequency curves on Plate C-8 show a deviation from the 80-foot minimum pumping level curves, this is entirely the result of annual peaks occurring during the December-February period. Seasonal frequency curves for March-November would be very similar to the 80-foot minimum curves. It can also be noted from Table C-11 that the pump energy requirements for the modified operation plan are somewhat lower than the 80-foot minimum plans.

58. The Plan C operation with a 17,500-cubic-foot-per-second pumping plant, along with an acceptable mitigation plan, was considered to provide the best solution to flood control and environmental problems and is therefore the recommended plan. Stage and discharge hydrographs for typical floods with the recommended plan are shown on Plates C-14 and C-15. Peak stages for the recommended plan are compared to peak stages for other Plan C pumping plant capacities on Plates C-16 and C-17. Ponding area stage hydrographs for various plans are shown on Plates C-18 and C-19.

PLANS D AND E
(INDUCED PONDING PLANS)

59. Since flooding during the winter and early spring is generally considered to be beneficial to the environment, Plans D and E involve a pumping plan similar to Plan C and induced flooding during the period 1 January-15 April. With these plans, the floodgate structures would be required to evacuate interior runoff with low river stages and interior stages at the induced ponding level or above. The existing stilling basins and outlet channel protection would not withstand such an operating condition, and replacement or considerable modification would be required.

60. These plans would also involve a considerable deviation from existing conditions, and the acquisition of easements to flood annually during the period 1 January-15 April on all lands below the induced ponding levels and

easements to occasionally flood to a higher level would be required. Requirements for the latter easements were estimated by routing a 10-year synthetic storm occurring with the interior stage at the ponding level and with various constant river stages. To account for impeded drainage and boundary effect, 1.5 feet were added to "right-to-flood" easements and 0.5 foot was added to the "right to occasionally flood" easements.

Plan D

61. Plan D involves a 25,000-cubic-foot-per-second pumping plant and induced ponding to elevation 85 feet, NGVD, from 1 January to 15 March, elevation 80 from 15 March to 15 April, and elevation 75 from 1 May to 1 September. Since only about 1 inch of runoff would be required to raise the ponding level from 68 feet to 85 feet, the 85-foot level would generally be reached by or before mid-January. Pump operation for Plan D would be similar to Plan C, except that the 85-foot minimum pumping level would extend to 15 March.

62. On the average, peak stages were similar but slightly lower than the peaks with Plan G, 25,000 cubic feet per second. However, individual peaks were considerably different, with those occurring prior to 15 April generally equal or higher, while peaks occurring after this time were equal or lower. In addition, the duration of flooding for most late spring and summer floods was shortened on the falling leg of the stage hydrograph. As a result, the flood control benefits were somewhat better than Plan G, 25,000 cubic feet per second, and approached Plan C, 25,000 cubic feet per second. "Right to flood" easements to about elevation 86.5 in both ponding areas and "right to occasionally flood" easements to elevation 90 in the upper ponding area would be required. Routing summaries for Plan D are shown in Table C-7 and frequency curves are shown on Plate C-12.

Plan E

63. Pumping Plan E is similar to Plan D except that induced flooding would be to elevation 80 during the entire 1 January to 15 April period. Only about 1/3 inch of runoff would be required to increase the interior stage from elevation 68 to 80. Plan E produced flood control benefits similar to but slightly less than Plan C, 25,000 cubic feet per second; peak stages were generally higher due primarily to the 15-day difference in minimum pumping elevation from 1-15 March.

64. Peak stages for some events would also be somewhat greater because of the difference in storage available during the 1 January to 15 April period. Plan E would require acquisition of "right to flood" easements to about elevation 81.5 in both ponding areas and the "right to occasionally flood" easements to elevation 85.5 in the upper ponding area. Frequency curves for Plan E are shown on Plate C-12 and routing summaries are shown in Table C-7.

PLAN F (MODIFIED OPERATION
WITH 83 FEET, NGVD, MINIMUM
PUMPING LEVEL)

65. Plan F is similar to Plan C except that the minimum pumping level during the 1 March-30 November period would be 83 feet. Pumping plants with 10,000-, 15,000-, 20,000-, 25,000-, and 30,000-cubic-foot-per-second capacities were evaluated. Frequency curves are shown on Plate C-12 and routing summaries are shown in Table C-8.

PLAN I (90 FEET, NGVD,
PUMPING LEVEL)

66. Plan I is similar in concept to Plan G. The water regime would be unchanged for flood events with peaks less than elevation 90. Pumping plants with capacities of 10,000, 15,000 and 20,000 cubic feet per second were evaluated but were not found to be economically feasible. Since this plan did not reduce flooding for events less than the 3-year frequency, it is unlikely that a pumping plant of any capacity could be justified if the minimum pumping level was limited to elevation 90. Frequency curves are shown on Plate C-13 and routing summaries are shown in Table C-10.

PLAN H (ENVIRONMENTAL
QUALITY PLAN)

67. Plan H would have an impact on flood damages which would be identical to Plan G, 15,000 cubic feet per second. Flooding above the minimum damage level (80 feet) would be the same as with Plan G, 15,000 cubic feet per second. Plan H also includes fee title acquisition of 30,000 acres. Routing summaries shown for Plan G (Table C-9) also apply to Plan H; frequency curves for Plan H are shown on Plate C-10.

EFFECTS OF RECOMMENDED PLAN ON OTHER PROJECTS AND FLOODING IN OTHER AREAS

68. Because of the size of the Yazoo Area and the large capacity of the recommended pumping plant, it was necessary to consider the effects of the recommended plan on other existing and proposed projects and flooding in other areas.

MISSISSIPPI RIVER

69. The impact of a large pumping plant (25,000-cubic-foot-per-second) in the Yazoo Area on Mississippi River stages was evaluated by use of the Mississippi Basin Model, which was calibrated to 1973 conditions. Flood hydrographs for

the 1973 and 1975 floods were introduced and stage hydrographs were recorded at stations on the Lower Yazoo and Mississippi Rivers for various conditions including preproject (no backwater levees), existing (levees and floodgates only), and the recommended plan. The tests indicated an increase of about 0.4 foot in all stages above bankfull at the Vicksburg (Canal) gage for both 1973 and 1975. Since these increases resulted at a time when the pumping plant would have been operating at maximum capacity for a prolonged period, it may be assumed that these differences represent the maximum increase which could be anticipated for floods of similar magnitude. With the recommended 17,500-cubic-foot-per-second pumping plant, the increase would be proportionally smaller. The effect was found to decrease downstream of Vicksburg and no measureable increase was indicated at stations below St. Joseph, Louisiana (mile 396.4 Above Head of Passes).

LOWER YAZOO RIVER

70. As stated previously, the routings did not show a significant increase in slope over the mouth of Steele Bayou to the Vicksburg Canal gage reach, indicating that the increase in stage in this area would be essentially the same as the increase in the Mississippi River stage at Vicksburg. The Vicksburg-Yazoo Area, which includes the Long Lake, Ford's, and Chickasaw Communities, is located within the flood plain in this reach. The effect would decrease upstream of the pumping plant location.

OTHER LEVEED AREAS OF THE
YAZOO BACKWATER PROJECT
(SATARTIA AND ROCKY BAYOU AREAS)

71. Any increase in interior flooding in these areas (shown on Plate C-2) would result from an increase in stages on the Yazoo River at their respective outlets. Such stage increases can safely be considered negligible at these locations.

YAZOO BACKWATER PROJECT
STRUCTURAL MITIGATION FEATURES

72. Operation of the Muddy Bayou control structure and existing and proposed greentree reservoirs and slough control structures would not be adversely affected by the recommended plan. In addition, flood damages to these structures should be reduced.

YAZOO RIVER NAVIGATION

73. The recommended plan would not reduce the discharge in the Yazoo River for river stages below 80.0 feet, NGVD. Therefore, navigation depth under low-flow conditions would not be adversely impacted. The pump outlet channel would be aligned to minimize crosscurrents in the navigation channel, and the necessity of training dikes or other features to further reduce the impact on existing and proposed navigation would be investigated in the detailed design.

SEDIMENTATION

74. Sediments transported by streams in the Yazoo Area consist primarily of fine silt and clay particles which are carried in suspension. Identifying the effects of the recommended plan on sediment transport and deposition in the area would require extensive and complex analysis which is beyond the scope of this study; however, because of the nature of the sediment load and past experience in the area, no sediment related problems are anticipated.

CHANNEL STABILITY

75. With the recommended plan, the water surface slope in the existing connecting channel is increased markedly over existing conditions. However, for the most severe condition indicated by the period-of-record routings, the mean channel velocity would be less that 4 feet per second, and no significant channel stability problems are anticipated. The necessity of providing erosion control measures in critical areas such as highway and railroad bridges will be addressed during detailed design.

TABLE C-1
ALTERNATIVES EVALUATED

Plan	Alternative Pumping Plant Capacities in CFS	Minimum Pumping Level in Feet, NGVD	Minimum Ponding Level in Feet, NGVD
A	10,000 15,000 20,000 25,000 30,000	80.0	a/
B	15,000 (U) 10,000 (L) 10,000 (U) 15,000 (L) 7,000 (U) 18,000 (L)	80.0	a/
C	10,000 15,000 17,500 b/ 20,000 25,000 30,000	85.0, 1 Dec-1 Mar 80.0, 1 Mar-1 Dec	a/
D	25,000	85.0, 1 Dec-15 Mar 80.0, 15 Mar-1 Dec	85.0, 1 Jan-15 Mar 80.0, 15 Mar-15 Apr 75.0, 1 May- 1 Sep a/, 1 Sep- 1 Jan
E	25,000	85.0, 1 Dec-15 Mar 80.0, 15 Mar-1 Dec	80.0, 1 Jan-15 Apr 75.0, 1 May- 1 Sep a/, 1 Sep- 1 Jan
F	10,000 15,000 20,000 25,000 30,000	85.0, 1 Dec-1 Mar 83.0, 1 Mar-1 Dec	a/

TABLE C-1 (Cont)

Plan	Alternative Pumping Plant Capacities in CFS	Minimum Pumping Level in Feet, NGVD	Minimum Ponding Level in Feet, NGVD
G	10,000	85.0	a/
	15,000		
	20,000		
	25,000		
	30,000		
H c/	15,000	85.0	a/
I	10,000	90.0	a/
	15,000		
	20,000		

U = Upper ponding area.
L = Lower ponding area.
a/ Same as present conditions. No higher than 70 feet, NGVD, with average minimum targeted at 67.5 to 68 feet, NGVD.
b/ Recommended Plan.
c/ EQ Plan includes purchase of 30,000 acres.

TABLE C-2
YAZOO AREA
INFLOW UNIT HYDROGRAPHS

Day	Lower Ponding Area Inflow in CFS	Upper Ponding Area Inflow in CFS
1	270	1,000
2	810	2,500
3	1,380	4,000
4	1,470	4,940
5	1,450	5,310
6	1,410	5,460
7	1,370	5,220
8	1,320	4,900
9	1,260	4,700
10	1,190	4,510
11	1,120	4,330
12	1,040	4,150
13	950	3,980
14	850	3,820
15	770	3,650
16	690	3,450
17	610	3,230
18	530	2,990
19	450	2,750
20	380	2,490
21	310	2,220
22	250	1,950
23	180	1,680
24	110	1,450
25	50	1,230
26	0	1,000
27	0	840
28	0	660
29	0	500
30	0	360
31	0	260
32	0	170
33	0	100
34	0	50
35	0	0
TOTAL	20,220	89,850

TABLE C-3
RECOMMENDED PLAN
(PLAN C - 17,500 CFS)
YAZOO AREA ROUTING SUMMARY

Water Year	Ponding Area	Existing Conditions		Plan C - 17,500 CFS		River	Pump Discharge		Static Head While Pumping		Number of Days -
		Peak	Duration	Peak	Duration	Peak	Average	Maximum	Average	Maximum	Pump Operation
1943	L	87.0	99	80.4	10	92.6	6,344	16,000	8.2	15.6	64
	U	87.1	102	82.7	17	92.7					
1944	L	90.4	84	84.3	56	90.2	14,890	17,500	4.6	9.6	73
	U	90.9	87	87.0	83	91.1					
1945	L	95.6	138	88.3	74	96.7	11,915	17,500	8.5	12.6	130
	U	95.7	139	89.8	81	97.3					
1949	L	91.5	103	86.4	83	92.7	14,069	17,500	6.3	11.3	87
	U	91.8	108	88.4	95	93.0					
1950	L	96.0	109	90.2	105	96.4	17,154	17,500	4.6	8.4	94
	U	96.3	111	91.5	109	97.1					
1953	L	<80.0	0	72.8	0	71.9	0	0	0.0	0.0	0
	U	<80.0	0	76.2	0	75.7					
1954	L	<80.0	0	74.2	0	73.7	0	0	0.0	0.0	0
	U	<80.0	0	75.8	0	75.7					
1955	L	89.1	37	83.3	34	88.7	17,056	17,500	4.5	6.3	27
	U	89.3	43	86.2	43	89.7					
1956	L	86.2	51	85.4	28	86.0	9,061	17,500	4.0	5.4	33
	U	86.7	55	86.5	35	87.1					
1957	L	86.3	74	82.2	22	90.6	6,384	17,500	7.3	12.9	56
	U	86.4	89	83.4	43	90.8					
1958	L	89.6	63	88.4	45	88.6	13,455	17,500	1.8	4.8	44
	U	90.7	80	90.2	75	89.7					
1959	L	82.3	13	81.9	9	82.0	12,875	17,500	1.7	2.3	8
	U	83.2	18	82.9	18	83.0					

TABLE C-3 (Cont)

Water Year	Ponding Area	Existing Conditions		Plan C - 17,500 CFS		River	Pump Discharge		Static Head While Pumping		Number of Days -
		Peak	Duration	Peak	Duration	Peak	Average	Maximum	Average	Maximum	Pump Operation
1960	L	81.6	13	80.1	2	84.1	7,333	12,000	3.9	4.8	3
	U	81.7	14	80.1	2	84.5					
1961	L	90.6	96	84.9	55	96.3	12,511	17,500	8.0	19.3	93
	U	91.3	109	87.4	73	96.3					
1962	L	91.9	103	84.6	45	93.1	9,287	17,500	11.6	16.1	68
	U	92.0	125	85.7	82	93.4					
1963	L	86.3	31	80.7	2	88.4	5,783	17,500	8.5	12.4	30
	U	86.3	33	81.3	14	88.6					
1964	L	86.2	63	83.9	24	86.8	10,390	17,500	4.6	10.2	59
	U	87.1	67	86.4	40	87.2					
1965	L	87.8	46	80.8	16	88.9	7,758	16,000	8.6	12.3	33
	U	87.9	55	82.8	34	89.3					
1966	L	84.1	39	83.9	16	84.0	8,065	17,500	4.2	7.2	31
	U	85.0	44	85.0	24	84.9					
1967	L	84.0	16	80.4	2	83.9	7,733	14,000	5.0	6.6	15
	U	84.2	37	80.6	5	84.1					
1968	L	86.6	54	80.5	8	86.5	8,522	14,000	5.7	9.1	46
	U	87.1	83	81.8	66	87.5					
1969	L	88.4	62	85.4	31	89.3	7,565	14,000	5.8	10.3	46
	U	88.5	65	86.4	45	90.0					
1970	L	90.0	50	80.6	20	90.8	10,583	16,000	6.5	11.7	48
	U	90.1	61	83.8	50	91.2					
1971	L	88.1	32	80.7	29	88.0	15,517	17,500	4.8	7.7	30
	U	88.7	44	83.6	44	88.6					
1972	L	86.3	29	80.6	21	86.0	13,846	16,000	4.1	5.7	26
	U	86.7	40	83.4	40	86.2					

TABLE C-3 (Cont)

Water Year	Ponding Area	Existing Conditions		Plan C - 17,500 CFS		River	Pump Discharge		Static Head While Pumping		Number of Days -
		Peak	Duration	Peak	Duration	Peak	Average	Maximum	Average	Maximum	Pump Operation
1973	L	100.3	207	94.9	199	101.3	16,801	17,500	2.8	6.4	148
	U	100.3	232	95.8	223	101.6					
1974	L	94.1	171	88.2	121	93.5	13,575	17,500	3.8	11.6	126
	U	94.7	183	90.3	157	94.4					
1975	L	95.1	127	85.9	94	97.8	14,879	17,500	8.3	12.1	95
	U	95.2	146	87.9	142	98.2					

L = Lower ponding area.
U = Upper ponding area.

TABLE C-4
PLAN A
YAZOO AREA ROUTING SUMMARY
PEAK STAGE AND NUMBER OF DAYS ABOVE DAMAGE LEVEL

Water	Ponding	10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS[a]		30,000 CFS	
Year	Area	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1943	L	82.7	22	80.3	10	80.3	10	80.3	10	80.3	10
	U	84.0	27	82.8	17	82.8	17	82.8	17	82.8	17
1944	L	89.0	63	85.5	61	82.3	49	81.4	48	81.4	48
	U	89.6	87	87.3	85	86.5	81	86.2	82	86.2	82
1945	L	92.4	107	90.0	91	85.4	60	81.5	54	81.5	54
	U	92.9	108	90.9	95	88.8	70	86.3	65	86.3	65
1949	L	90.2	103	86.8	82	81.4	64	81.2	63	81.2	63
	U	90.8	107	88.3	96	85.5	85	85.5	84	85.5	84
1950	L	93.8	109	91.5	108	86.4	96	81.4	92	81.4	92
	U	94.2	111	92.5	110	88.7	108	87.2	107	87.2	107
1953	L	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
1954	L	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
1955	L	87.7	36	85.3	36	81.3	32	81.1	31	81.1	31
	U	88.8	43	87.3	42	85.6	42	85.6	42	85.6	42
1956	L	85.4	38	84.4	28	82.0	22	81.1	22	81.1	22
	U	86.5	44	86.4	35	85.7	31	85.5	31	85.5	31
1957	L	81.5	19	80.3	11	80.3	11	80.3	11	80.3	11
	U	83.2	41	82.9	41	82.9	41	82.9	41	82.9	41

TABLE C-4 (Cont)

Water Year	Ponding Area	10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS[a/]		30,000 CFS	
		Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1958	L	89.6	41	89.2	41	87.3	41	85.0	38	82.5	38
	U	90.7	74	90.5	74	90.0	72	89.5	72	89.3	72
1959	L	81.1	13	80.3	1	80.3	1	80.3	1	80.3	1
	U	82.6	18	82.1	17	82.1	17	82.1	17	82.1	17
1960	L	80.0	1	80.0	1	80.0	1	80.0	1	80.0	1
	U	80.0	1	80.0	1	80.0	1	80.0	1	80.0	1
1961	L	89.4	70	86.8	60	82.4	50	81.4	50	81.4	50
	U	90.2	86	88.4	77	86.4	70	86.1	70	86.1	70
1962	L	84.6	63	82.1	35	80.8	35	80.8	35	80.8	35
	U	85.7	80	85.0	77	84.6	77	84.5	77	84.5	77
1963	L	80.7	7	80.7	2	80.7	2	80.7	2	80.7	2
	U	81.8	15	81.4	14	81.3	14	81.3	14	81.3	14
1964	L	85.8	34	85.1	26	82.4	20	81.3	20	81.3	20
	U	87.1	41	86.8	38	86.2	38	86.0	38	86.0	38
1965	L	82.5	26	80.5	11	80.5	7	80.5	7	80.5	7
	U	83.8	38	82.6	33	82.6	33	82.6	33	82.6	33
1966	L	83.5	15	80.8	11	80.8	12	80.8	12	80.8	12
	U	84.9	22	83.9	21	83.7	20	83.7	20	83.7	20
1967	L	80.4	2	80.4	2	80.4	2	80.4	2	80.4	2
	U	80.6	8	80.6	5	80.6	5	80.6	5	80.6	5
1968	L	81.5	16	80.4	1	80.4	2	80.4	2	80.4	2
	U	83.0	56	81.8	56	81.8	56	81.8	56	81.8	56

TABLE C-4 (Cont)

Water Year	Ponding Area	10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS[a/]		30,000 CFS	
		Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1969	L	82.4	28	80.7	2	80.7	2	80.7	2	80.7	2
	U	83.9	42	82.3	42	82.2	42	82.2	42	82.2	42
1970	L	85.1	45	80.1	18	80.6	17	80.6	17	80.6	17
	U	86.1	52	83.9	49	83.8	49	83.8	49	83.8	49
1971	L	86.1	32	82.2	30	80.7	29	80.6	19	80.6	19
	U	87.1	44	84.7	44	83.6	44	83.6	44	83.6	44
1972	L	84.9	25	80.4	19	80.4	19	80.4	9	80.4	9
	U	85.8	40	83.4	39	83.4	39	83.4	39	83.4	39
1973	L	97.2	205	95.5	193	93.8	187	91.0	163	88.1	146
	U	97.5	222	96.3	219	95.0	216	93.0	196	92.1	178
1974	L	94.1	138	92.8	119	90.5	117	87.8	113	85.1	105
	U	94.7	160	93.6	173	92.0	171	90.7	150	90.2	148
1975	L	91.5	127	88.0	116	83.5	78	81.4	76	81.3	72
	U	91.9	146	89.7	143	86.8	139	86.2	137	81.3	130

L = Lower ponding area.
U - Upper ponding area.
a/ NED Plan.

TABLE C-5
PLAN B
YAZOO AREA ROUTING SUMMARY
PEAK STAGE AND NUMBER OF DAYS ABOVE DAMAGE LEVEL

Water Year	Ponding Area	15,000 CFS Lower 10,000 CFS Upper		10,000 CFS Lower 15,000 CFS Upper		7,000 CFS Lower 18,000 CFS Upper	
		Peak	Duration	Peak	Duration	Peak	Duration
1943	L	80.2	1	80.2	1	80.2	1
	U	80.3	1	80.3	1	80.3	1
1944	L	81.3	13	81.4	13	81.3	13
	U	81.6	13	82.2	15	81.6	13
1945	L	80.1	2	80.3	2	80.1	2
	U	80.5	7	81.0	12	80.5	7
1949	L	80.2	2	80.3	4	80.2	2
	U	81.5	1	81.5	6	81.5	1
1950	L	83.7	24	83.5	24	83.7	24
	U	83.9	25	84.3	27	83.9	25
1953	L	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0
1954	L	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0
1955	L	80.3	1	80.3	1	80.3	1
	U	80.5	1	80.5	1	80.5	1
1956	L	82.4	17	82.6	17	82.4	17
	U	82.7	22	83.5	22	82.7	22

TABLE C-5 (Cont)

Water Year	Ponding Area	15,000 CFS Lower 10,000 CFS Upper Peak	Duration	10,000 CFS Lower 15,000 CFS Upper Peak	Duration	7,000 CFS Lower 18,000 CFS Upper Peak	Duration
1957	L	80.3	1	80.3	2	80.3	1
	U	80.5	4	80.5	6	80.5	4
1958	L	88.1	32	88.2	34	88.1	32
	U	88.4	42	88.8	47	88.4	42
1959	L	80.0	0	80.0	0	80.0	0
	U	80.2	1	80.2	1	80.2	1
1960	L	80.1	1	80.1	1	80.1	1
	U	80.1	1	80.1	1	80.1	1
1961	L	80.4	4	80.1	3	80.4	4
	U	80.8	7	81.0	15	80.8	7
1962	L	81.2	12	80.7	9	80.4	7
	U	84.4	26	82.5	19	81.4	6
1963	L	80.1	1	80.0	0	80.0	0
	U	80.1	1	80.1	1	80.1	1
1964	L	82.8	19	83.1	18	83.5	17
	U	84.8	23	83.7	17	83.7	17
1965	L	80.2	1	80.1	1	80.0	1
	U	80.7	8	80.4	1	80.4	1
1966	L	80.6	1	80.4	1	80.1	1
	U	80.9	7	80.6	3	80.6	1

TABLE C-5 (Cont)

Water Year	Ponding Area	15,000 CFS Lower 10,000 CFS Upper		10,000 CFS Lower 15,000 CFS Upper		7,000 CFS Lower 18,000 CFS Upper	
		Peak	Duration	Peak	Duration	Peak	Duration
1967	L	80.0	0	80.0	0	80.0	0
	U	80.1	1	80.1	1	80.1	1
1968	L	80.2	1	80.0	0	80.0	0
	U	80.3	2	80.3	2	80.3	2
1969	L	80.1	1	80.0	0	80.0	0
	U	80.1	1	80.1	1	80.1	1
1970	L	80.0	0	80.0	0	80.0	0
	U	80.6	10	80.3	2	80.3	2
1971	L	80.4	1	80.1	1	80.0	0
	U	80.2	2	80.2	2	80.2	2
1972	L	80.0	0	80.0	0	80.0	0
	U	80.0	3	80.2	1	80.2	1
1973	L	91.5	91	91.8	86	91.8	103
	U	92.2	142	92.0	93	91.9	101
1974	L	88.3	79	88.4	73	88.6	79
	U	89.3	100	88.7	78	88.7	78
1975	L	80.1	1	80.2	1	80.4	2
	U	81.6	21	80.2	1	80.2	1

L = Lower ponding area.
U = Upper ponding area.

TABLE C-6
PLAN C
YAZOO AREA
ROUTING SUMMARY
PEAK STAGE AND NUMBER OF DAYS ABOVE DAMAGE LEVEL

Water Year	Ponding Area	Existing Conditions: Peak	Existing Conditions: Duration	10,000 CFS Peak	10,000 CFS Duration	15,000 CFS Peak	15,000 CFS Duration	20,000 CFS Peak	20,000 CFS Duration	25,000 CFS Peak	25,000 CFS Duration	30,000 CFS Peak	30,000 CFS Duration
1943	L	87.0	99	82.7	21	80.3	10	80.3	10	80.3	10	80.3	10
	U	87.1	102	84.0	26	82.8	17	82.8	17	82.8	17	82.8	17
1944	L	90.4	84	89.0	69	85.5	65	82.3	56	81.4	51	81.4	51
	U	90.9	87	89.6	88	87.3	85	86.5	83	86.2	83	86.2	83
1945	L	95.6	138	92.4	108	90.1	95	85.4	63	82.0	57	82.0	57
	U	95.7	139	92.9	110	91.0	100	88.8	73	86.4	63	86.4	63
1949	L	91.5	103	90.2	103	87.7	87	85.8	83	85.7	82	85.7	82
	U	91.8	108	90.8	107	89.1	102	88.1	92	88.1	91	88.1	91
1950	L	96.0	109	94.0	109	91.8	109	88.2	99	85.9	94	85.9	94
	U	96.3	111	94.5	111	92.8	111	90.1	109	89.2	108	89.2	108
1953	L	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
1954	L	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
1955	L	89.1	37	87.7	37	85.3	36	81.3	34	81.1	34	81.1	34
	U	89.9	43	88.8	43	87.3	43	85.6	43	85.6	43	85.6	43
1956	L	86.2	51	85.5	39	85.2	30	85.1	27	85.1	26	85.1	26
	U	86.7	55	86.5	45	86.5	37	86.5	35	86.5	43	86.5	34
1957	L	86.3	74	82.2	24	82.2	23	82.2	22	82.2	22	82.2	22
	U	86.4	89	83.4	44	83.4	44	83.4	43	83.4	43	83.4	43
1958	L	89.6	63	89.6	45	89.2	45	87.3	45	85.0	43	82.5	43
	U	90.7	80	90.7	76	90.5	76	90.0	75	89.5	74	89.3	74
1959	L	82.3	13	81.9	13	81.9	9	81.9	9	81.9	6	81.9	6
	U	83.2	18	83.0	18	82.9	18	82.9	18	82.9	18	82.9	18

TABLE C-6 (Cont)

Water Year	Ponding Area	Existing Conditions: Peak	Duration	10,000 CFS Peak	Duration	15,000 CFS Peak	Duration	20,000 CFS Peak	Duration	25,000 CFS Peak	Duration	30,000 CFS Peak	Duration
1960	L	81.6	13	80.1	2	80.1	2	80.1	2	80.1	2	80.1	2
	U	81.7	14	80.1	2	80.1	2	80.1	2	80.1	2	80.1	2
1961	L	90.6	96	89.7	75	87.0	64	82.5	52	81.4	50	81.4	50
	U	91.3	109	90.4	89	88.6	79	86.4	71	86.1	71	86.1	71
1962	L	91.9	103	84.6	67	84.6	54	84.6	41	84.6	36	84.6	36
	U	92.0	125	85.7	90	85.7	84	85.7	82	85.7	78	85.7	78
1963	L	86.3	31	80.7	7	80.7	2	80.7	2	80.7	2	80.7	2
	U	86.3	33	81.8	15	81.4	14	81.3	14	81.3	14	81.3	14
1964	L	86.2	63	85.8	36	85.1	26	82.4	24	81.3	22	81.3	22
	U	87.1	67	87.1	43	86.8	40	86.2	40	86.0	40	86.0	40
1965	L	87.8	46	82.5	28	80.8	16	80.8	16	80.8	16	80.8	16
	U	87.9	55	83.8	40	82.8	34	82.8	34	82.8	34	82.8	34
1966	L	84.1	39	83.9	17	83.9	16	83.9	16	83.9	15	83.9	15
	U	85.0	44	85.0	24	85.0	24	85.0	24	85.0	22	85.0	22
1967	L	84.0	16	80.4	2	80.4	2	80.4	2	80.4	2	80.4	2
	U	84.2	37	80.6	8	80.6	5	80.6	5	80.6	5	80.6	5
1968	L	86.6	54	81.5	26	80.4	6	80.4	6	80.4	6	80.4	6
	U	87.1	83	83.0	71	81.9	45	81.8	45	81.9	45	81.9	45
1969	L	88.4	62	85.5	31	85.4	31	85.4	31	85.4	30	85.4	30
	U	88.5	65	86.4	45	86.4	45	86.4	45	86.4	45	86.4	45
1970	L	90.0	50	85.1	47	80.7	28	80.6	28	80.6	28	80.6	28
	U	90.1	61	86.1	61	83.9	50	83.9	50	83.9	50	83.9	50
1971	L	88.1	32	86.1	32	82.2	32	80.7	24	80.7	24	80.7	24
	U	88.7	44	87.1	46	84.7	46	83.7	38	83.7	38	83.7	38
1972	L	86.3	29	84.9	27	80.5	21	80.5	21	80.5	21	80.5	21
	U	86.7	40	85.8	42	83.4	40	83.4	40	83.4	40	83.4	40

TABLE C-6 (Cont)

Water	Ponding:	Existing Conditions:		10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS		30,000 CFS	
Year	Area	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1973	L	100.3	207	97.2	208	95.5	200	93.8	197	91.0	180	88.1	159
	U	100.3	232	97.5	225	96.3	224	95.0	222	93.0	201	92.1	183
1974	L	94.1	171	94.1	141	93.1	122	91.2	121	89.2	117	86.9	114
	U	94.7	183	94.7	163	93.9	158	92.7	157	91.6	155	90.9	153
1975	L	95.1	127	91.5	127	88.3	122	85.1	87	85.1	83	85.0	81
	U	95.2	146	91.9	146	89.5	146	86.8	142	86.3	139	86.3	129

L = Lower ponding area.
U = Upper ponding area.

TABLE C-7
PLANS D and E
YAZOO AREA
ROUTING SUMMARY OF PEAK STAGES

Water Year	Ponding Area	Plan D 25,000 CFS	Plan E 25,000 CFS	Water Year	Ponding Area	Plan D 25,000 CFS	Plan E 25,000 CFS	Water Year	Ponding Area	Plan D 25,000 CFS	Plan E 25,000 CFS
1943	L	85.0	81.6	1958	L	85.1	85.1	1968	L	85.0	81.4
	U	85.0	83.7		U	89.6	89.6		U	85.1	83.2
1944	L	85.0	82.7	1959	L	85.0	82.3	1969	L	85.4	85.4
	U	86.7	86.7		U	85.0	83.2		U	86.5	86.4
1945	L	85.9	85.8	1960	L	85.0	80.1	1970	L	85.0	82.0
	U	88.7	88.5		U	85.0	80.5		U	85.3	84.8
1949	L	85.8	85.8	1961	L	85.0	83.2	1971	L	85.5	85.5
	U	88.2	88.2		U	86.7	86.7		U	87.0	86.9
1950	L	85.9	85.9	1962	L	85.4	85.3	1972	L	85.0	81.9
	U	89.4	89.2		U	86.3	86.2		U	85.3	84.5
1953	L	85.0	80.0	1963	L	85.0	80.0	1973	L	91.4	91.1
	U	85.0	80.0		U	85.0	82.1		U	93.4	93.1
1954	L	85.0	80.0	1964	L	85.0	82.4	1974	L	89.3	89.2
	U	85.0	80.0		U	86.2	86.2		U	91.7	91.6
1955	L	85.0	82.4	1965	L	85.0	81.5	1975	L	85.4	85.4
	U	85.9	86.2		U	85.3	83.3		U	87.4	87.4
1956	L	85.4	85.4	1966	L	85.0	83.9				
	U	86.9	86.5		U	85.7	85.0				
1957	L	85.0	82.2	1967	L	85.0	80.8				
	U	85.7	83.4		U	85.0	81.5				

L = Lower ponding area.
U = Upper ponding area.

TABLE C-8
PLAN F
YAZOO AREA ROUTING SUMMARY
PEAK STAGE AND NUMBER OF DAYS ABOVE DAMAGE LEVEL

Water Year	Ponding Area	10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS		30,000 CFS	
		Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1943	L	84.3	99	84.2	99	84.2	99	84.2	99	84.2	99
	U	85.3	102	85.2	102	85.2	102	85.2	102	85.2	102
1944	L	89.0	77	85.7	76	85.1	76	85.1	76	85.1	76
	U	89.6	87	87.7	86	87.6	85	87.6	85	87.6	85
1945	L	92.6	138	90.3	137	86.9	137	85.3	137	85.3	137
	U	93.0	139	91.2	139	89.1	139	88.5	139	88.6	139
1949	L	90.2	103	87.7	101	85.8	101	85.7	101	85.7	101
	U	90.8	108	89.1	108	88.1	108	88.1	108	88.1	108
1950	L	94.0	109	91.8	109	88.2	108	85.9	108	85.9	108
	U	94.5	111	92.8	111	90.1	110	89.2	110	89.2	110
1953	L	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
1954	L	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0	<80.0	0	<80.0	0
1955	L	88.1	37	86.0	36	85.1	36	85.1	36	85.1	36
	U	89.1	43	87.9	43	87.5	43	87.5	43	87.5	43
1956	L	85.6	51	85.4	51	85.4	51	85.4	51	85.4	51
	U	86.5	55	86.5	55	86.5	55	86.5	55	86.5	55

TABLE C-8 (Cont)

Water Year	Ponding Area	10,000 CFS Peak	10,000 CFS Duration	15,000 CFS Peak	15,000 CFS Duration	20,000 CFS Peak	20,000 CFS Duration	25,000 CFS Peak	25,000 CFS Duration	30,000 CFS Peak	30,000 CFS Duration
1957	L	83.8	74	83.8	74	83.8	74	83.8	74	83.8	74
	U	84.4	94	84.4	94	84.4	94	84.3	94	84.4	94
1958	L	89.6	63	89.2	63	87.6	63	85.7	62	85.5	62
	U	90.7	80	90.5	80	90.1	80	89.8	79	89.8	79
1959	L	82.3	13	82.3	13	82.3	13	82.3	13	82.3	13
	U	83.2	18	83.2	18	83.2	18	83.2	18	83.2	18
1960	L	80.5	4	80.5	4	80.5	4	80.5	4	80.5	4
	U	80.5	4	80.5	4	80.5	4	80.5	4	80.5	4
1961	L	89.7	96	87.6	96	85.7	96	85.2	96	85.2	96
	U	90.4	108	89.1	108	88.4	108	88.3	107	88.3	107
1962	L	84.9	102	84.6	102	84.6	102	84.6	102	84.6	102
	U	85.8	122	85.7	122	85.7	122	85.7	122	85.7	122
1963	L	83.8	30	83.8	30	83.8	30	83.8	30	83.8	30
	U	84.3	33	84.3	33	84.3	33	84.3	33	84.3	33
1964	L	85.8	63	85.3	63	84.9	63	84.9	63	84.9	63
	U	87.1	67	87.0	66	86.9	66	86.9	66	86.9	66
1965	L	84.2	46	84.2	46	84.2	46	84.2	46	84.2	46
	U	85.2	55	85.2	55	85.2	55	85.2	55	85.2	55

TABLE C-8 (Cont)

Water Year	Ponding Area	10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS		30,000 CFS	
		Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1966	L	83.9	39	83.9	39	83.9	39	83.9	39	83.9	39
	U	85.0	44	85.0	44	85.0	44	85.0	44	85.0	44
1967	L	83.6	16	83.6	16	83.6	16	83.7	16	83.6	16
	U	84.0	18	84.0	18	84.0	18	84.1	18	84.0	18
1968	L	84.8	54	84.4	54	84.4	54	84.4	54	84.4	54
	U	85.8	82	85.5	82	85.5	82	85.5	82	85.5	82
1969	L	85.5	59	85.4	59	85.4	59	85.4	59	85.4	59
	U	86.4	63	86.4	63	86.4	63	86.4	63	86.4	63
1970	L	85.6	50	84.7	50	84.7	50	84.7	50	84.7	50
	U	86.6	60	86.2	60	86.2	60	86.2	60	86.2	60
1971	L	86.5	32	84.7	32	84.7	32	84.7	32	84.7	32
	U	87.4	44	86.4	44	86.4	44	86.4	44	86.4	44
1972	L	85.4	29	84.6	28	84.6	28	84.6	28	84.6	28
	U	86.3	40	86.0	40	86.0	40	86.0	40	86.0	40
1973	L	97.2	205	95.6	203	94.1	201	91.4	201	89.1	201
	U	97.5	222	96.3	221	95.2	219	93.3	219	92.6	219
1974	L	94.1	171	93.1	170	91.2	170	89.2	169	86.9	169
	U	94.7	183	93.9	182	92.7	182	91.6	182	90.9	182
1975	L	91.5	127	89.2	126	86.1	126	85.3	126	85.3	126
	U	91.9	146	90.2	145	88.6	145	88.4	145	88.4	145

L = Lower ponding area.
U = Upper ponding area.

TABLE C-9
PLAN G
YAZOO AREA
ROUTING SUMMARY
PEAK STAGE AND NUMBER OF DAYS ABOVE DAMAGE LEVEL

Water Year	Ponding Area	10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS[a]	
		Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1943	L	85.4	99	85.4	99	85.4	99	85.4	99
	U	85.9	102	85.9	102	85.9	102	85.9	102
1944	L	89.0	79	86.0	78	85.8	78	85.8	78
	U	89.6	87	87.9	87	87.9	87	87.8	87
1945	L	92.7	138	90.5	138	87.6	138	86.0	138
	U	93.2	139	91.4	139	89.6	139	89.0	139
1949	L	90.2	103	87.8	103	85.9	103	85.9	103
	U	90.8	108	89.2	108	88.2	108	88.2	108
1950	L	94.0	109	91.9	109	88.2	109	86.1	109
	U	94.5	111	92.8	111	90.1	111	89.2	111
1953	L	<80.0	0	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0	<80.0	0
1954	L	<80.0	0	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0	<80.0	0
1955	L	88.2	37	86.5	37	85.8	37	85.8	37
	U	89.2	43	88.2	43	88.0	43	88.0	43
1956	L	85.6	51	85.6	51	85.5	51	85.5	51
	U	86.6	55	86.6	55	86.6	55	86.6	55

TABLE C-9 (Cont)

Water Year	Ponding Area	10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS[a/]	
		Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1957	L	85.3	74	85.3	74	85.3	74	85.3	74
	U	85.6	89	85.6	89	85.6	89	85.6	89
1958	L	89.6	63	89.3	63	87.7	63	86.2	63
	U	90.7	80	90.5	80	90.2	80	90.0	80
1959	L	82.3	13	82.3	13	82.3	13	82.3	13
	U	83.2	18	83.2	18	83.2	18	83.2	18
1960	L	81.6	13	81.6	13	81.6	13	81.6	13
	U	81.7	14	81.7	14	81.7	14	81.7	14
1961	L	89.9	96	88.3	96	86.5	96	86.0	96
	U	90.6	109	89.6	109	88.9	109	88.8	109
1962	L	85.7	105	85.5	105	85.5	105	85.5	105
	U	86.6	125	86.6	125	86.6	125	86.6	125
1963	L	85.2	31	85.2	31	85.2	31	85.2	31
	U	85.4	33	85.4	33	85.4	33	85.4	33
1964	L	85.8	63	85.7	63	85.7	63	85.7	63
	U	87.1	67	87.0	67	87.0	67	87.0	67
1965	L	85.4	46	85.4	46	85.4	46	85.4	46
	U	86.0	55	86.0	55	86.0	55	86.0	55
1966	L	84.1	39	84.1	39	84.1	39	84.1	39
	U	85.0	44	85.0	44	85.0	44	85.0	44
1967	L	84.0	16	84.0	16	84.0	16	84.0	16
	U	84.2	37	84.2	37	84.2	37	84.2	37

TABLE C-9 (Cont)

Water	Ponding	10,000 CFS		15,000 CFS		20,000 CFS		25,000 CFS[a/]	
Year	Area	Peak	Duration	Peak	Duration	Peak	Duration	Peak	Duration
1968	L	85.6	54	85.5	54	85.5	54	85.5	54
	U	86.4	83	86.4	83	86.4	83	86.4	83
1969	L	85.6	61	85.5	61	85.5	61	85.5	61
	U	86.5	65	86.5	65	86.5	65	86.5	65
1970	L	86.1	50	85.6	50	85.6	50	85.6	50
	U	87.0	61	86.9	61	86.9	61	86.9	61
1971	L	86.7	32	85.6	32	85.6	32	85.6	32
	U	87.6	44	87.2	44	87.2	44	87.2	44
1972	L	85.7	29	86.5	29	86.5	29	86.5	29
	U	86.5	40	85.5	40	85.5	40	85.5	40
1973	L	97.3	207	95.7	206	94.2	204	91.6	204
	U	97.6	225	96.4	224	95.3	222	93.5	222
1974	L	94.1	171	93.1	171	91.2	171	89.3	171
	U	94.7	188	93.9	183	92.8	183	91.7	183
1975	L	91.6	127	89.7	127	87.0	127	86.0	127
	U	92.0	146	90.6	146	89.2	146	88.9	146

L = Lower ponding area.
U = Upper ponding area.
a/ Also applies to Plan H - EQ Plan

TABLE C-10
PLAN I
YAZOO AREA
ROUTING SUMMARY
PEAK STAGE AND NUMBER OF DAYS ABOVE DAMAGE LEVEL

Water	Ponding	10,000 CFS		15,000 CFS		20,000 CFS	
Year	Area	Peak	Duration	Peak	Duration	Peak	Duration
1943	L	87.0	99	87.0	99	87.0	99
	U	87.1	102	87.1	102	87.1	102
1944	L	90.3	79	90.2	79	90.2	79
	U	90.8	87	90.8	87	90.8	87
1945	L	93.6	138	91.9	138	90.8	138
	U	94.0	139	92.8	139	92.1	139
1949	L	90.7	103	90.3	103	90.3	103
	U	91.3	108	91.2	108	91.2	108
1950	L	94.7	109	92.7	109	91.0	109
	U	95.1	111	93.5	111	92.3	111
1953	L	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0
1954	L	<80.0	0	<80.0	0	<80.0	0
	U	<80.0	0	<80.0	0	<80.0	0
1955	L	89.1	37	89.1	37	89.1	37
	U	89.9	43	89.9	43	89.9	43
1956	L	86.2	51	86.2	51	86.2	51
	U	86.7	55	86.7	55	86.7	55
1957	L	86.3	74	86.3	74	86.3	74
	U	86.4	89	86.4	89	86.4	89

TABLE C-10 (Cont)

Water Year	Ponding Area	10,000 CFS		15,000 CFS		20,000 CFS	
		Peak	Duration	Peak	Duration	Peak	Duration
1958	L	89.6	63	89.6	63	89.6	63
	U	90.7	80	90.7	80	90.7	80
1959	L	82.3	13	82.3	13	82.3	13
	U	83.2	18	83.2	18	83.2	18
1960	L	81.6	13	81.6	13	81.6	13
	U	81.7	14	71.7	14	81.7	14
1961	L	90.8	96	90.8	96	90.8	96
	U	91.5	109	91.5	109	91.5	109
1962	L	90.8	103	90.4	103	90.3	103
	U	91.5	125	91.4	125	91.3	125
1963	L	86.3	31	86.3	31	86.3	31
	U	86.3	33	86.3	33	86.3	33
1964	L	86.2	63	86.2	63	86.2	63
	U	87.1	67	87.1	67	87.1	67
1965	L	87.8	46	87.8	46	87.8	46
	U	87.9	55	87.9	55	87.9	55
1966	L	84.1	39	84.1	39	84.1	39
	U	85.0	44	85.0	44	85.0	44
1967	L	84.0	16	84.0	16	84.0	16
	U	84.2	37	84.2	37	84.2	37
1968	L	86.6	54	86.6	54	86.6	54
	U	87.1	83	87.1	83	87.1	83
1969	L	88.4	62	88.4	62	88.4	62
	U	88.5	65	88.5	65	88.5	65

TABLE C-10 (Cont)

Water Year	Ponding Area	10,000 CFS		15,000 CFS		20,000 CFS	
		Peak	Duration	Peak	Duration	Peak	Duration
1970	L	90.0	50	90.0	50	90.0	50
	U	90.1	61	90.1	61	90.1	61
1971	L	88.1	32	88.1	32	88.1	32
	U	88.7	44	88.7	44	88.7	44
1972	L	86.3	29	86.3	29	86.3	29
	U	86.7	40	86.7	40	86.7	40
1973	L	97.5	207	96.0	207	94.8	207
	U	97.7	225	96.7	224	95.9	225
1974	L	94.1	171	93.4	171	92.1	171
	U	94.7	183	94.2	183	93.5	183
1975	L	92.6	127	91.2	127	90.4	127
	U	93.0	146	92.1	146	91.8	146

L = Lower ponding area.
U = Upper ponding area.

TABLE C-11
YAZOO AREA
AVERAGE HEAD AND DISCHARGE WHILE PUMPING

Pumping Plant Capacity (cfs)		Average Static Head While Pumping (feet)	Average Discharge While Pumping (cfs)	Average Annual Number of Days Pumps Are Operated
PLAN A				
10,000		4.2	8,900	49
15,000		5.1	11,900	62
20,000		5.9	13,700	66
25,000[a/]		6.7	14,200	67
30,000		7.1	14,300	67
PLAN B				
15,000	(L)	7.4	7,800	51
10,000	(U)	7.4	7,500	86
10,000	(L)	8.7	6,100	39
15,000	(U)	8.2	9,600	86
7,000	(L)	8.4	5,000	35
18,000	(U)	9.1	10,400	87
PLAN C				
10,000		3.8	8,900	46
15,000		4.7	11,900	56
17,500[b/]		5.3	12,700	57
20,000		5.8	13,400	58
25,000		6.6	14,200	59
30,000		7.0	14,500	60
PLAN D				
25,000		6.5	13,100	55
PLAN E				
25,000		6.3	13,200	54

TABLE C-11 (Cont)

Pumping Plant Capacity (cfs)	Average Static Head While Pumping (feet)	Average Discharge While Pumping (cfs)	Average Annual Number of Days Pumps Are Operated
PLAN F			
10,000	2.7	8,200	34
15,000	3.2	11,500	41
20,000	3.9	12,900	43
25,000	4.4	13,000	43
30,000	4.6	13,600	44
PLAN G			
10,000	2.1	8,900	28
15,000	2.5	12,200	33
20,000	2.8	14,000	36
25,000	3.0	15,000	36
PLAN H			
15,000 c/	2.5	12,200	33
PLAN I			
10,000	1.7	9,600	11
15,000	1.9	13,700	12
20,000	2.1	16,600	13

U = Upper ponding area.
L = Lower ponding area.
a/ NED Plan.
b/ Recommended Plan.
c/ EQ Plan.

TABLE C-12
YAZOO AREA
CHANNEL DIMENSIONS

Pump Plant Capacity (cfs)	Approximate Plant Width (feet)	Minimum Inlet Channel Bottom Width (feet)	Minimum Outlet Channel Bottom Width (feet)	Minimum Inlet Channel Transition Length (1:8 Flare) (feet)
PLANS A, C, D, and E				
10,000	455	200	185	1,020
15,000	655	305	260	1,440
17,500	765	355	300	1,660
20,000	875	405	335	1,880
25,000	1,120	500	390	2,480
30,000	1,330	585	455	2,610
PLAN B				
15,000 (L)	655	305	260	1,440
10,000 (U)	455	200	185	1,020
10,000 (L)	455	200	185	1,020
15,000 (U)	655	305	260	1,440
7,000 (L)	315	125	125	760
18,000 (U)	805	390	310	1,660
PLAN F				
10,000	455	160	130	1,180
15,000	655	260	210	1,580
20,000	875	360	280	2,060
25,000	1,120	460	350	2,640
30,000	1,330	550	410	2,980

TABLE C-12 (Cont)

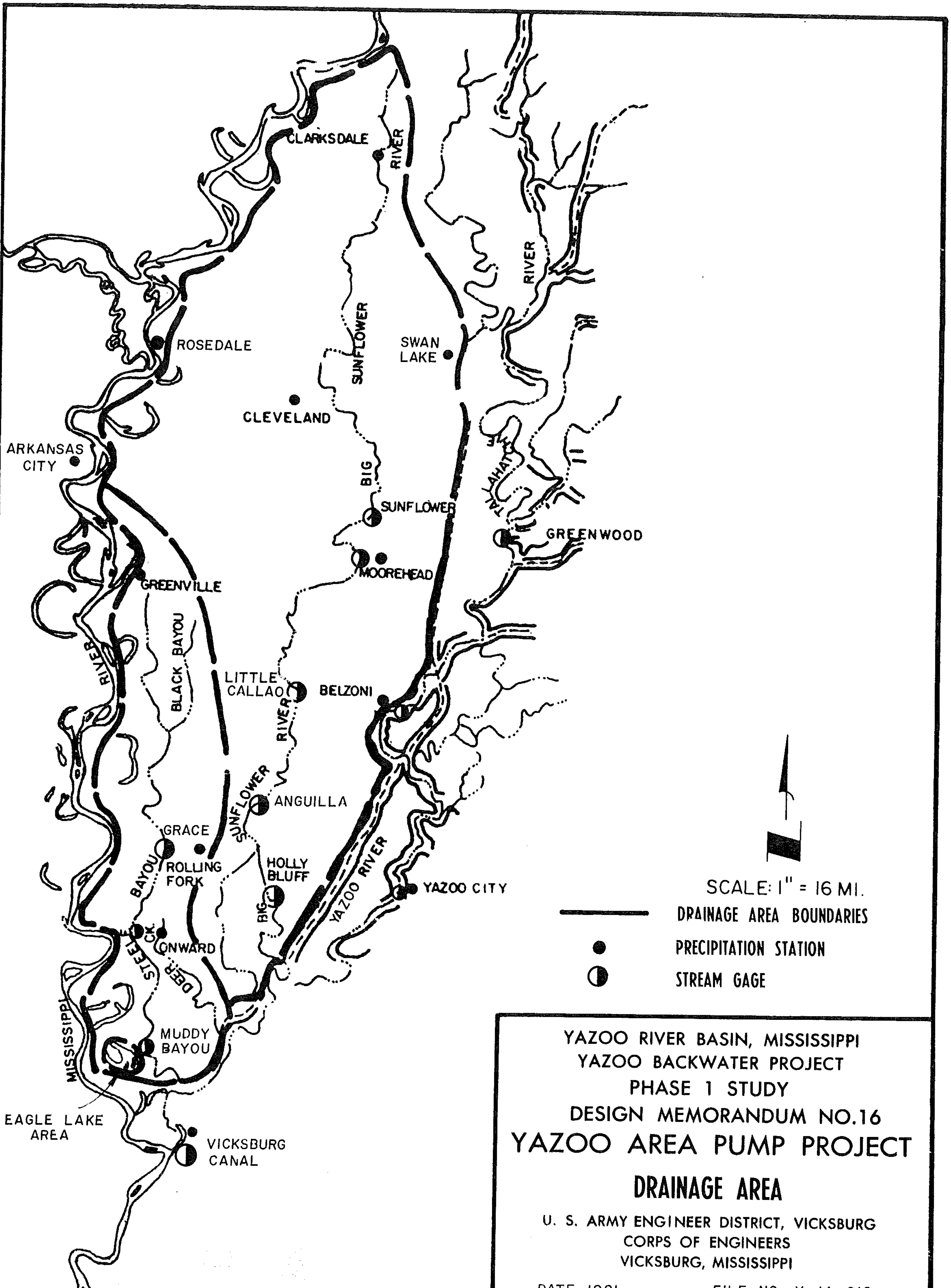
Pump Plant Capacity (cfs)	Approximate Plant Width (feet)	Minimum Inlet Channel Bottom Width (feet)	Minimum Outlet Channel Bottom Width (feet)	Minimum Inlet Channel Transition Length (1:8 Flare) (feet)
PLANS G and H				
10,000	455	125	100	1,320
15,000	655	225	170	1,720
20,000	875	325	245	2,200
25,000	1,120	425	320	2,780
PLAN I				
10,000	455	80	50	1,500
15,000	655	160	105	1,980
20,000	875	245	160	2,520

Inlet Channel Bottom Grade 60.0 Feet, NGVD

Outlet Channel Bottom Grade 68.0 Feet, NGVD

Channel Side Slopes IV on 4H

U = Upper ponding area.
L = Lower ponding area.



YAZOO RIVER BASIN, MISSISSIPPI
YAZOO BACKWATER PROJECT
PHASE 1 STUDY
DESIGN MEMORANDUM NO.16

YAZOO AREA PUMP PROJECT

DRAINAGE AREA

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

DATE 1981 FILE NO. Y-14-216