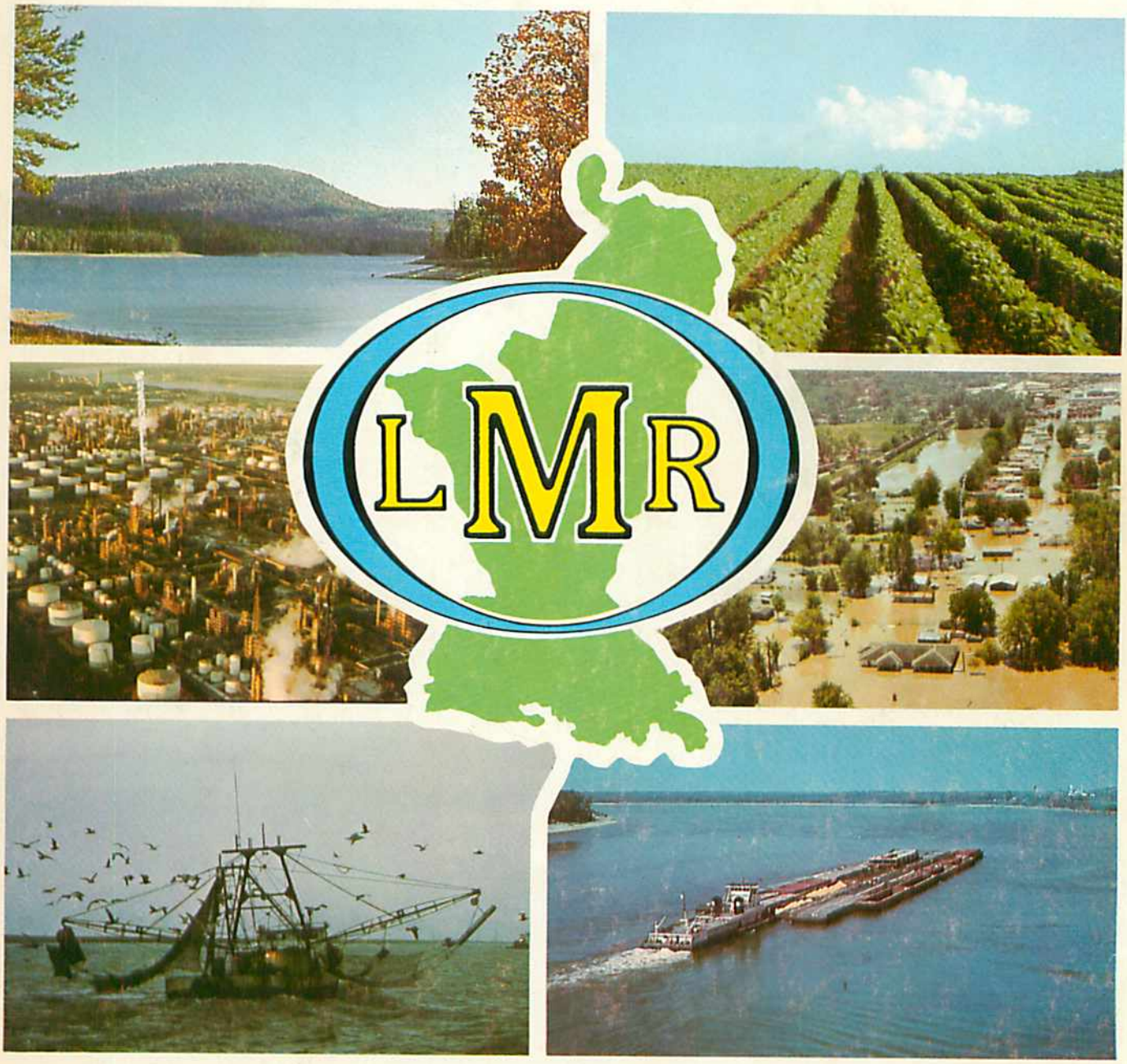
Robbins

Lower Mississippi Region
Comprehensive Study



Main Report

1974

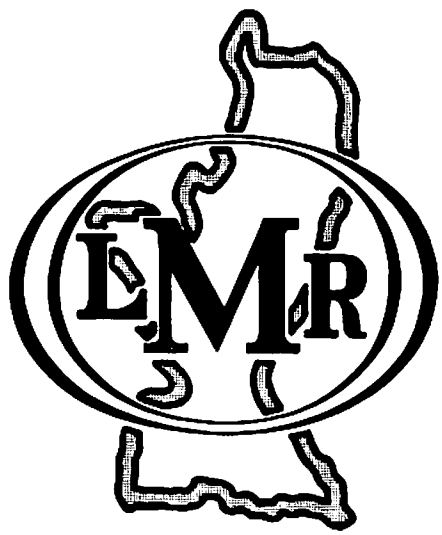
This appendix is one of a series of 22 documents comprising the complete Lower Mississippi Region Comprehensive Study. A list of the documents is shown below.

Main Report

Appendixes

Appendix	Description	Appendix	Description
A	History of Study	K	M and I Water Supply
B	Economics	L	Water Quality and Pollution
C	Regional Climatology Hydrology & Geology	M	Health Aspects
D	Inventory of Facilities	N	Recreation
E	Flood Problems	O	Coastal and Estuarine Resources
F	Land Resources	P	Archeological and Historical Resources
G	Related Mineral Resources	Q	Fish and Wildlife
H	Irrigation	R	Power
I	Agricultural Land Drainage	S	Sediment and Erosion
J	Navigation	T	Plan Formulation
		U	The Environment

MAIN REPORT



LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY

PREPARED UNDER THE SUPERVISION OF
THE LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY
COORDINATING COMMITTEE

This report was prepared at field level by the Lower Mississippi Region Comprehensive Study Coordinating Committee and is subject to review by interested Federal agencies at the departmental level, by Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

SYLLABUS

Off the prow of the explorer's caravel, there was a primeval expanse of half-land, half-water stretching from the Gulf's edge to the swirling gray sky. Beyond the land-water interface, there was the awesome weight and power of an unknown continent. If the land that lay hidden beyond the sea-marsh was vast and uncharted, it was also rich in natural resources that had hardly been interfered with for time untold: an abundance that was constantly referred to by the first Europeans as "unbelievable." The primal riches held great promise for man, new in a new land.

Geologically, of course, the land was not new at all; it only seemed so to civilizations already old and steeped in tradition. The image of the unknown continent is gone now, forged by man into a thriving, complex society, a nation of unparalleled prosperity and human progress. A significant portion of national prosperity is centered in the area defined in the Comprehensive Study as the Lower Mississippi Region. This area is the site of one of the oldest commercial agricultures in North America and the heart of a hydrology system draining 31 states and two Canadian provinces. In 1970, the region handled one of every seven tons of waterborne commerce in the United States, supplied from one-fourth to one-third of the nation's energy, made substantial contributions to national food and fiber requirements, and supported $8 billion in industrial development along the lower reaches of the river.

Despite the extent of human development, the grand natural setting still exists largely intact. One of every five acres possesses special environmental quality, in the form of near-wilderness areas, wetlands, unique geological, botanical, and ecological systems, beaches and shores, bottomland hardwood forests, and lands bordering scenic lakes, rivers, and streams. Notable scenic beauty and esthetic value are characteristic of about one-half million acres of natural lakes, rivers, and streams. Forests cover nearly one-half the land area and support a bountiful and diverse wildlife resource, some species of which are more numerous today than prior to European settlement.

The current level of social and economic development would not have been possible without adequate provisions for flood control. Even in the earliest days of settlement, there was an essential need to protect the land from the annual rises of the Mississippi River and its tributaries. The history of the DeSoto expedition in 1541 described the first recorded flood of the river as severe and of prolonged duration, cresting about 40 days after its beginning, and lasting for a total of 80 days. Since that time, explorers, traders, farmers, men of commerce, engineers, and planners have known--sometimes too well--the Mississippi at flood.

Much has been accomplished during the past two centuries to curb the devastating effects of flooding, but much remains to be done. The region's main line of defense against flooding (the Mississippi River and Tributaries Project) is now only 50 percent complete and cannot withstand the largest reasonable flood that might occur in the area. As a consequence, about one-half the land area is still subject to flooding. Nearly seven of every ten acres of flood-prone lands are used for crop production and pasture; hence, flooding in these areas hampers the region's capability to produce food and fiber so critical to the economy and well-being of the people. Average damages in urban and built-up areas are estimated at $40 million annually, based on 1970 conditions. High waters not only pose threats to man and the economy, but also to fish and wildlife, outdoor recreational facilities, and areas of outstanding scenic or esthetic quality. Without adequate and timely provision of flood control, future needs in other areas cannot be fulfilled. Clearly, flooding is the single most critical problem to be considered in preparing for the substantial economic growth predicted for the region during the next 50 years.

This economic growth is expected to occur slowly at first, with less than a 10 percent increase in population to 1980. Thereafter, accelerated growth is foreseen. The Water Resources Council has projected a regional population of 10.2 million by 2020; but if regional growth rates equal the national average, the population will be 11.7 million, as foreseen by the Comprehensive Study Coordinating Committee. The 2020 population in expected to have nearly eight times the personal income and five times the per capita purchasing power of the 1970 population. Economic output is expected to expand steadily throughout the period of study. Agricultural production will double, petroleum output will quadruple, and manufacturing will expand tenfold.

Economic growth will place increased demands upon regional resources. Water withdrawals by 2020 are expected to be four to five times as large as present. Significant increases in population, per capita income, and leisure time are expected to generate a threefold increase in water-oriented recreation (primarily in and near major metropolitan areas) and a twofold increase in the need for all types of sport fishing. Competition for land among a multiplicity of uses is likewise expected to increase in response to larger demands for food and fiber, minerals, industrial products, recreational sites, and hunting and fishing. Before the year 2000, the high priority land needs are expected to exceed the land resource base. Directly tied to projected economic and social growth will be a six- to sevenfold increase in organic pollution loads from municipal and industrial sources and a nine- to tenfold increase in the need for electric power.

The recommended framework program demonstrates that future needs will require judicious planning for fulfillment, and that capital investment in water and related land resources management and development is one method of satisfying the needs. The program involves such investment and is formulated to satisfy as many as possible of the foreseeable problems and needs through the year 2020, without sacrificing significant environment quality features. Major elements of the program consist of plans for water supply, water surface area, land use, problem amelioration, and public investment.

As presently scaled, the plans for water withdrawal, water surface area, and navigation would permit full satisfaction of all needs in these areas through 2020. The recommended plan for water quality deals specifically with biodegradable organic wastes and only generally with other pollutants. Solutions posed are presently judged technically feasible. The primary requirement is that municipalities and industries attain secondary treatment by 1980, advanced treatment by 2000, and continued advanced treatment by 2020.

The recommended land use plan contains provisions for insuring that lands are available for recreation, fish and wildlife, and for environmental quality insofar as these purposes do not detract materially from the satisfaction of urban and built-up needs and needs for food and fiber. Satisfaction of these higher priority needs will infringe upon satisfaction of needs for forested wildlife habitat.

The recommended flood control plan contains three basic components. The first is completion of the present backlog of works already under construction, including the immediate raising and strengthening of the Mississippi River levees system and the expeditious completion of the channel improvement feature of the MR&T Project, and accelerated completion of other works, including hurricane protection works in the coastal area and the existing backlog of upstream watershed projects. The second component is construction of authorized and proposed new works within the recommended time frames. The third is expansion of governmental flood plain information activities and development and implementation of appropriate local controls to govern the growth of damageable property in flood plains.

Conversion of eroding land to vegetation and stabilization of banks and channels will alleviate the region's most critical needs for sediment and erosion control through 2020, reducing damages by an average of $7 million

per year by 1980, $13 million per year by 2000, and $20 million per year by 2020. Recommended drainage measures--such as on-farm ditches, secondary ditches, project channels, and management practices--are expected to solve 55 percent of the identifiable problems through 2020.

The recommended hydropower plan provides primarily for continued use of peak power produced by existing regional hydroelectric plants and provision of all the additional feasible hydroelectric power which can be developed.

Measures of the fish and wildlife plan include easements and fee purchases designed to increase primary land use more than 1.4 million acres by the year 2020 and additional activities designed to increase access, propagation, and productive capacity.

The recommended plan for recreation provides for satisfaction of future needs for both water and land areas and includes measures which provide maximum site development at existing areas and acquisition of additional areas. Demand for water-oriented recreation on large lakes and reservoirs will exceed available supplies within the near future. Although part of the demand can be met through more intensive use of existing and proposed water bodies, the potential for development of large lakes is limited. Some needs, therefore, will not be met unless recreationists are willing to accept lesser space standards than assumed for this study.

The recommended program further recognizes a number of opportunities for the enhancement, conservation, and preservation of environmental quality, coastal and estuarine resources, archeological and historical resources, and public health.

The total public investment cost of the recommended program, in terms of January 1972 dollars, is estimated at $14.7 billion, half of which is federal cost and half non-federal. Average annual operation and maintenance costs are estimated at $329 million. Effective implementation of the program will require coordinated and expeditious action at all levels in government and in the private sector, and meaningful and sustained financial and legislative support in some areas.

Veiled in early morning mist, the Upper Mississippi meanders through wooded marshlands in northern Minnesota, on its way south to Cairo, Illinois, and the great wide flood plain of the lower valley.

MAIN REPORT

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Photographs

Photographs in this report were furnished by:

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U.S. Army Corps of Engineers 8, 20, 32, 35

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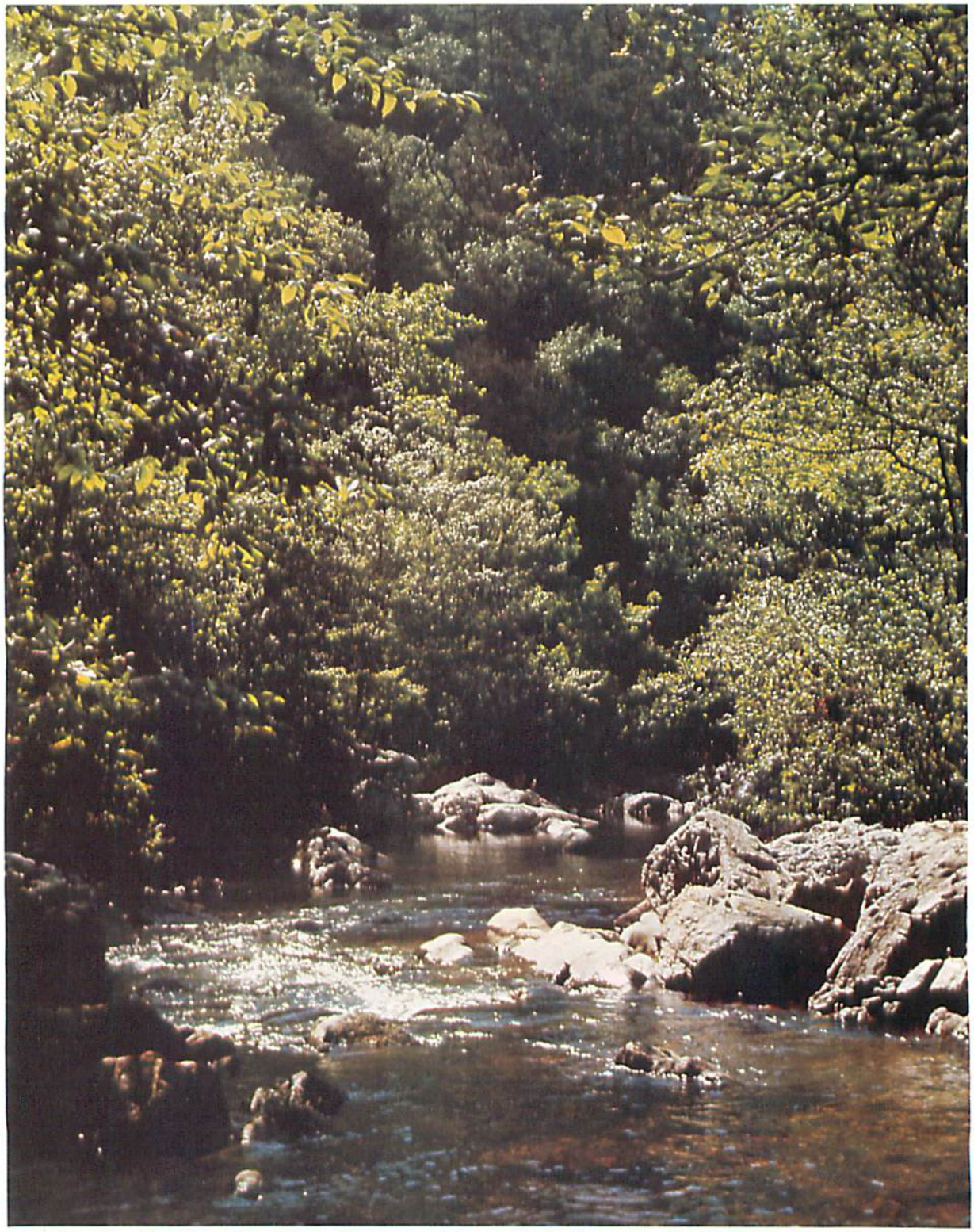
INTRODUCTION

The Lower Mississippi Region is the land of the Mississippi River and of the Great Valley, where Indian civilizations flourished in the days before the explorers DeSoto and LaSalle. . . where, in later years, trappers ranged, and soldiers fought great battles for faraway kings. . . where a few immigrants came to work the river soil and to settle the wilderness.



Sunlight glints from the clear waters of a stream at Little Missouri Falls.

For those immigrants, the lure of the valley was its great natural wealth of soil, water, sunlight, vegetation, and game. In the words of the Frenchman Radisson, the valley "was delicious and under so temperate a climate, plentiful in all things, the earth bringing forth its fruit twice a year, the people live long and lusty and wise in their way."

These words described the Mississippi Valley nearly three centuries ago, when the area was still sparsely settled and when demands on its land and water resources seemed negligible in comparison with the vast quantities available. In the early years of European settlement and expansion, development was concentrated along the Mississippi and its tributaries, in agricultural communities where the primary activities were hunting, fishing, forestry, and farming. As the population of the area increased, development progressed inland and the economic base was gradually expanded to include activities other than these primary ones. The increase in population and economic activity has been accompanied through the years with ever-increasing demands on the natural resources of the area.

Today, as in the days of Radisson, the region is plentiful with cypress and cane and cottonwood and water oak; magnolias, palmettos, and pine forests; and hardwoods mixed along the bluff ridges and mountain slopes. The land is still "under so temperate a climate," and rich with mineral resources, soils, vegetation and game, and water in an abundance and variety of forms. The Mississippi River, with all its strength and volume, continues its awesome influence in the area. At normal stages, it is still the benevolent Father of Waters, blessing each generation along its banks with social and economic growth. At flood, it is the Old Devil River of yesterday: raging at its levees, sweeping life and property before it like straws on the wind, and burying nearby lowlands in a moving sea. Now, as of old, it is both a blessing and a curse, depending upon one's point of view.

And now, as never before, the natural environment of the region is being rapidly modified by man, his technology, and his organization. By 1970, the population of the region had increased to 6,293,233, and today large metropolitan areas occupy the sites of earlier villages. Millions of acres of formerly wooded terrain have been cleared for agricultural, urban, and industrial development, and increasing emphasis is being placed on industrial activities, such as mining, quarrying, petroleum production, and manufacturing of food, textile, chemical, and paper products.

As urban and industrial growth has continued, regional and national demands on natural resources have become increasingly larger. Today, it is realized that these resources are not inexhaustible nor exempt from misuse, and that comprehensive and coordinated planning are essential in order to conserve and develop adequate amounts for the use of present and future generations, in a manner that will best serve their economic and social needs.

A giant step was made in this direction by the U.S. Congress in July 1965, with passage of the Water Resources Planning Act. That act molded into law the previously expressed national interest in the orderly conservation, development, and utilization of water and related land resources, taking into account the diverse interests of federal, state, and local agencies and private interests.

The act formally created the Water Resources Council (which had previously functioned as an ad hoc group) and continued its responsibility for instituting a program for comprehensive planning which called for the development of framework studies for all major river basins in the United States. In addition, the act provided financial assistance to states in order to increase their participation in coordinated planning efforts.

The comprehensive study for the Lower Mississippi was begun in early 1970, in response to specific authority contained in the Flood Control Act of 1966.

This report summarizes the findings of the comprehensive study, describes how the study objectives were met, and presents the consensus conclusions and recommendations of the study participants. The report is structured into

nine sections: the introduction; regional description; regional economy; water and related land resources availability; present resource management, use, and development; resource needs; the framework program; additional data needs; and conclusions and recommendations. A complete documentation of study data, methodology, and sources is presented in the 21 appendixes prepared on specific elements of the study.

History and Organization

Specific authority for the Lower Mississippi Region Comprehensive Study was provided in Section 209 of Title II of Public Law 89-789, which directed the Secretary of the Army to have the Chief of Engineers undertake surveys for flood control and allied purposes with respect to a framework plan for the Lower Mississippi Region.

In February 1968, the Water Resources Council designated the Mississippi River Commission as the lead agency for the study, and requested that the Commission develop a preliminary plan of study and a budget estimate, in cooperation with various state and federal agencies. These tasks were completed in the summer of that year by an ad hoc Coordinating Committee, chaired by the president of the Mississippi River Commission representing the Department of the Army, and comprised of representatives of the states of Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee; and the federal departments of Agriculture; Commerce; Housing and Urban Development; Health, Education, and Welfare; Interior; Transportation; and Labor; the Environmental Protection Agency; and the Federal Power Commission.

The ad hoc Coordinating Committee established the study scope and plans of work, and organized the appropriate federal-state committees and subcommittees to conduct the work. After completing this initial planning step and submitting a preliminary plan of study and budget request to the Council, the Committee continued to function on an "as needed" basis until federal agency funds were received in fiscal year 1970 to carry out the study. The approved federal cost estimate was approximately $3.5 million, with state participation estimated to cost an additional $324,000. The federal funds were distributed in part by direct appropriation and in part by reimbursement of federal agencies by the Mississippi River Commission. State participation was financed by federal funds from the Water Resources Council.

Working in close liaison with the Plan Formulation Committee were two committees, originally established on an ad hoc basis, and 11 subcommittees. The two ad hoc committees (Environmental and Publicity) were later given permanent status and played important roles throughout the study. One subcommittee--Laws and Regulations--ceased to function on an active basis about midway through the study, as a result of the Coordinating Committee decision to eliminate preparation of the Legal and Institutional Appendix.

Work on the study began in early 1970, under the guidance of the Coordinating Committee. The decisions of the Committee were implemented by a Plan Formulation Committee (Figure 1), which served as an administrative center and central clearinghouse between Coordinating Committee meetings, and was responsible for formulating the plan. Work on the formulation of plans was delegated to a Plan Formulation Task Force, with membership open to the ten federal agencies and seven states participating in the study. The chairman of the Plan Formulation Committee was coordinator for the total study.

Purpose and Scope

The primary purpose of the Lower Mississippi Region Comprehensive Study was to develop a program which could be used as a guide to the best use, or combination of uses, of water and related land resources in the region, to meet all foreseeable needs, and which, at the same time, would be responsive to the people living in the region.

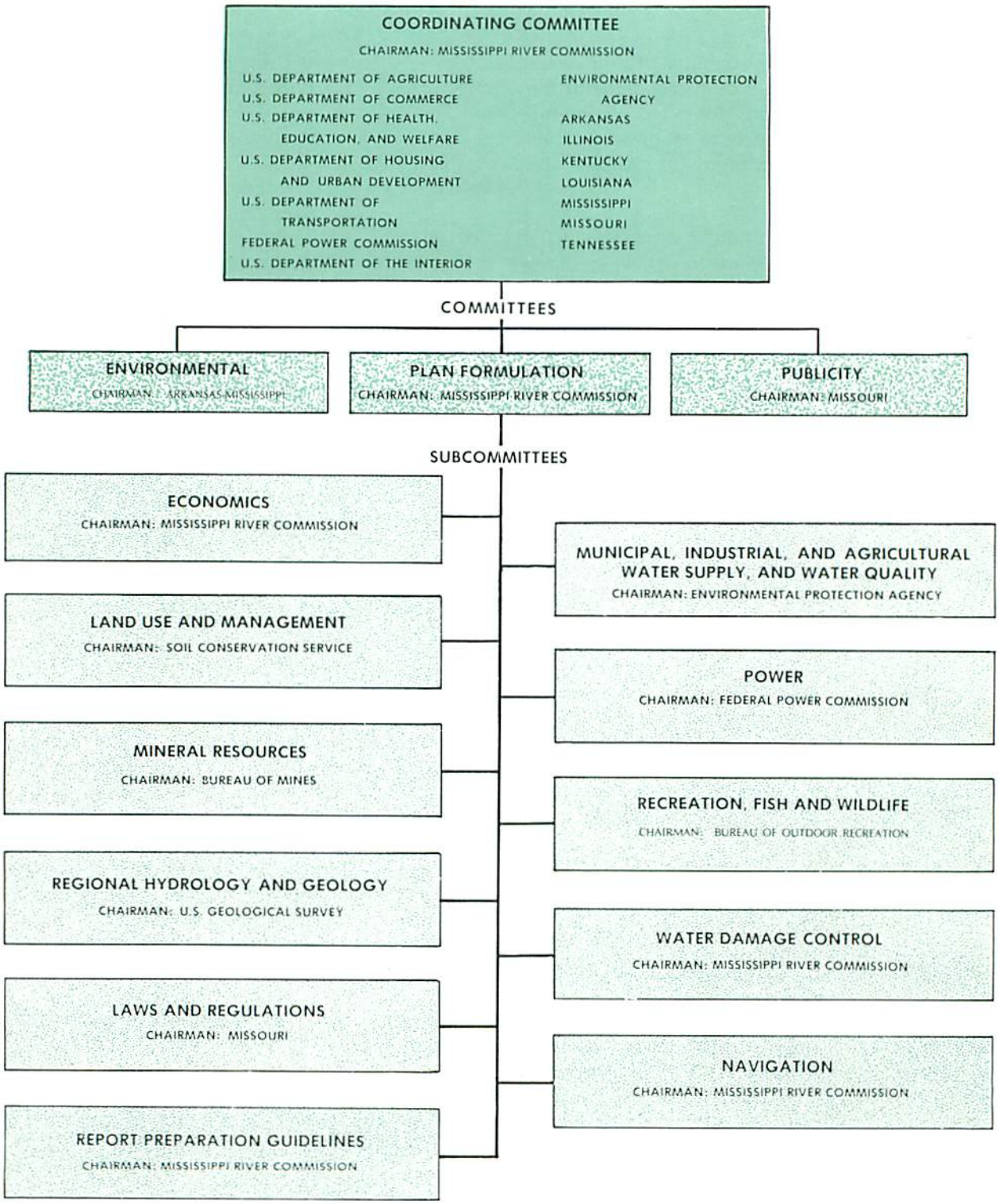


Figure 1. Organization Chart for Lower Mississippi Region Comprehensive Study

The study goal was accomplished through a series of multidisciplinary investigations relating to the use and availability of and needs for all water and related land resources in the region. The investigations consisted of preliminary or reconnaissance type studies, detailed only to the extent necessary to achieve the study purpose.

To permit study refinement in the usual planning units, the region was divided along hydrological boundaries into ten Water Resource Planning Areas (WRPAs). The central area, designated WRPA 1, includes the main stem and levee system of the Mississippi River. The adjoining areas include major tributaries of the Mississippi or coastal drainage systems, as follows:

WRPA 2 The St. Francis Basin, St. Johns-New Madrid Floodway, Lower White and Bayou Meto basins, including the Arkansas River below Pine Bluff, Arkansas.

WRPA 3 The drainage basins in west Kentucky, west Tennessee, and extreme northern Mississippi, and the Cairo, Illinois, area.

WRPA 4 The Yazoo River Basin.

WRPA 5 The Ouachita River Basin and the Red River below Hot Wells, Louisiana.

WRPA 6 The Boeuf and Tensas River basins.

WRPA 7 The Big Black River Basin and basins of southwest Mississippi streams that drain into the Mississippi River.

WRPA 8 The Baton Rouge area, including the drainage area of streams that flow into Lake Pontchartrain, except for the Tchefuncte River and streams to the east.

WRPA 9 The Louisiana coastal area from the east limits of the Atchafalaya Floodway to the east hydrologic boundary of the Sabine River.

WRPA 10 The New Orleans area, including the Tchefuncte River area and the area east of the Atchafalaya Floodway.

The hydrologic boundaries of these areas were used in measuring water and related land resources availability and in formulating a framework program for future management of these resources. Political boundaries were used in the assembly, manipulation, and interpretation of economic data because these data are not available on hydrologic units. Similarly, some needs were quantified on the basis of the political definition. In terms of total area, the political boundary is roughly three percent larger than the hydrologic. Accuracy of estimating did not warrant reconciliation of this minor difference; therefore, regardless of which boundary was followed, totals are considered applicable to the WRPAs throughout the report. Only in Appendix B (Economics) is a definite distinction made between the two areas. Figure 2 shows the political boundary superimposed on the hydrologic.

In the study, consideration was given to all geographic areas within the region and to all needs served by the conservation, development, and use of resources Planning covered the 50-year period from 1970 to 2020, with intermediate benchmarks set at 1980 and 2000.

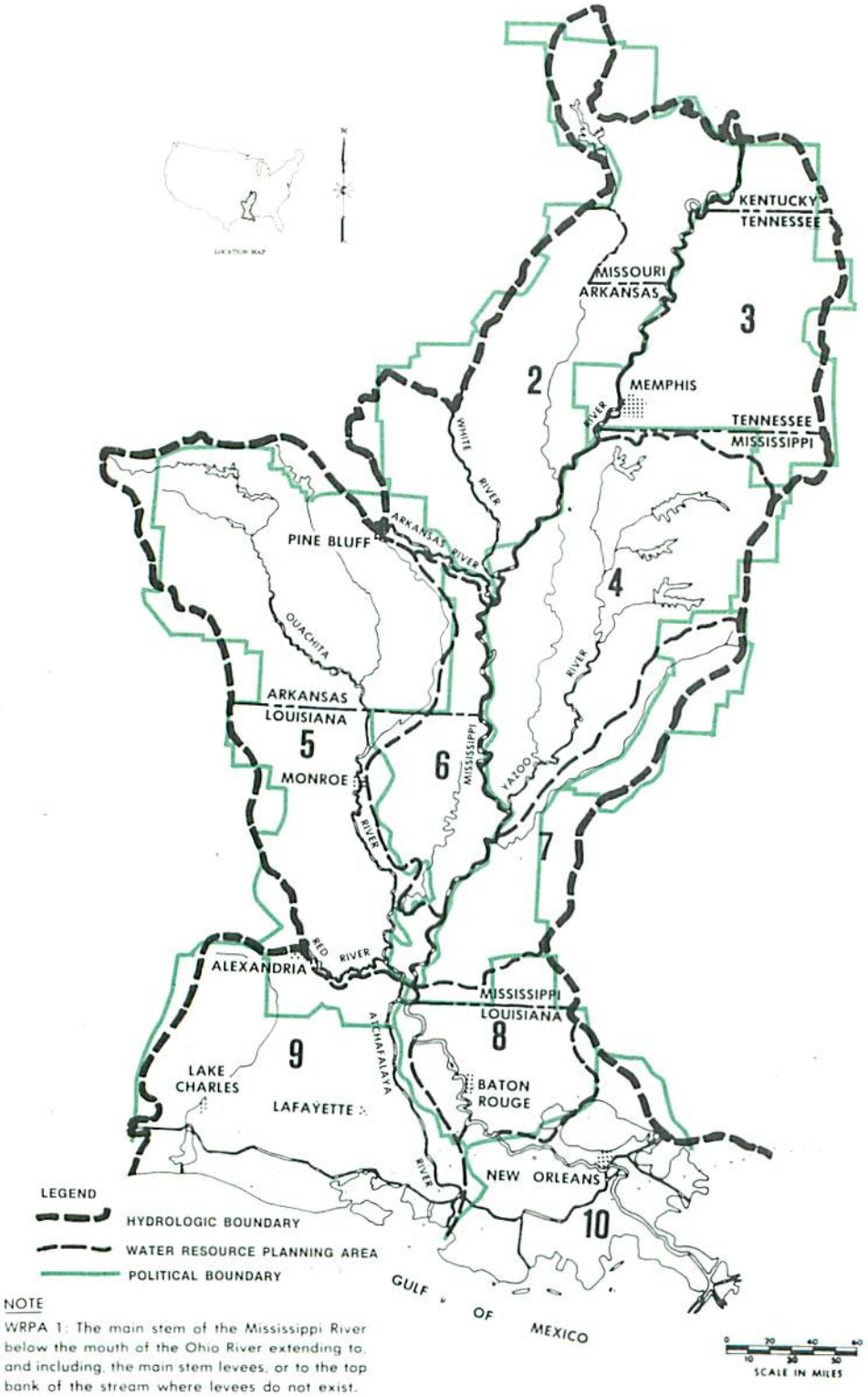


Figure 2. Political and Hydrologic Boundaries of Lower Mississippi Region

Whenever possible, information already available from local, state, and federal sources was used. Additional basic data was collected only when it was absolutely necessary to develop the program. Data collected or produced by one agency or group was made available to other study participants.

Complete and detailed documentation of data, methodology, and sources for all studies which led to development of the formulated program can be found in the following 21 appendixes to this report:

- A History of Study
- B Economics
- C Regional Climatology, Hydrology, and Geology
- D Inventory of Facilities
- E Flood Problems
- F Land Resources
- G Related Mineral Resources
- H Irrigation
- I Agricultural Land Drainage
- J Navigation
- K Municipal and Industrial Water Supply
- L Water Quality and Pollution
- M Health Aspects
- N Recreation
- O Coastal and Estuarine Resources
- P Archeological and Historical Resources
- Q Fish and Wildlife
- R Power
- S Sediment and Erosion
- T Plan Formulation
- U The Environment

In addition to these 21 appendixes, a Glossary of Terms was published.

On a clear day, the wind whispers through pines crowding the shore of a large scenic lake in WRPA 5.

Planning Objectives and Methodology

PLANNING OBJECTIVES

Broad overriding objectives for planning the use and development of water and related land resources were set forth by the Water Resources Council in a policy statement effective July 22, 1970. According to the Council, one of the major objectives of planning is to provide a guide for the efficient and timely conservation, development, and use of water and related land resources by federal, state, and local interests. Another basic objective is to provide a sound basis on which rational, well-considered decisions can be made concerning alternative or competing uses of these resources. In the process of identifying these alternatives, all interests--federal, state, local, and private--must be involved in order to achieve joint plans and programs. Above all, planning decisions must be responsive to the well-being of people, which includes the improvement in the quality of the environment, the enhancement of national economic development, the betterment of the quality of life, and stimulation of regional development.

In accordance with these basic objectives, the Lower Mississippi Region Comprehensive Study included consideration of three specific planning objectives: national income, regional development, and environmental quality. The well-being of the people in the region was the overriding determinant in all objectives.

The national income objective seeks to achieve the greatest national economic benefits in return for investments in water and related land resources development and conservation. The objective is enhanced by increasing the value of the nation's output of goods and services and by improving national economic efficiency. Increases in crop yields, expanding recreational use, and peaking capacity for power systems are examples of direct increases in the nation's output which result from development of these resources. Examples of direct increases in productivity include increased earnings from changes in land use; reduced disruption of economic activity due to droughts, floods, and fluctuating water supplies; and removal of constraints on production through increased water supplies.

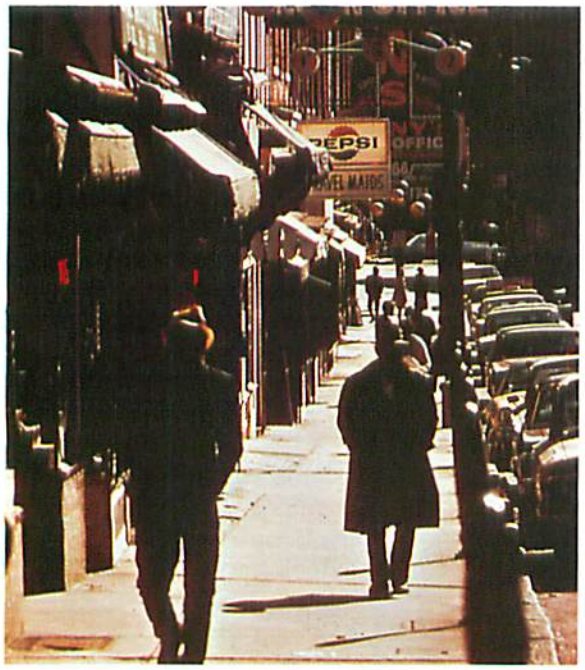
The regional development objective encourages the expansion and growth of the economy of the region. Water and land resource plans contribute in a variety of ways to a given regional economy, including increases in regional income and employment; and enhancement of regional economic stability, educational, cultural, and recreational opportunities, and environmental conditions.

The environmental quality objective is concerned with maintaining or improving the quality of the environment. It includes not only preservation, but also positive actions to create an improved, esthetically pleasing living environment and to avoid preventable losses or deterioration of resources. This objective reflects society's concern for the natural environment as a source of present enjoyment and a heritage for future generations. Components of the objective include preservation of areas of natural beauty and especially valuable resources; enhancement of water, land, and air quality through control of pollution and erosion; and avoidance of irreversible commitments of resources.

PLANNING METHODOLOGY

General

The planning for the Lower Mississippi Region Comprehensive Study began with orientation of study participants and preparation of a plan of study. After the plan was finalized, an inventory was made of current water and related land resources in the region, and work was begun on development of historical and current economic and demographic data for each WRPA. Projections of population, employment, income, earnings, and production were prepared for the national income and regional development objectives. These projections were translated into resource needs, which were, in turn, compared to available resources opportunities. Alternative means of satisfying these needs were developed to meet the national income, regional development, and environmental quality objectives.



Automobiles line the curb along historic Beale Street in Memphis, one-time mecca for the giants of jazz.

Assessment of Local Viewpoints

The involvement of interested citizens and the consideration of human needs and desires were of overriding importance throughout the study. Every effort was made to keep individuals informed of study activities through informal public meetings, brochures, and press releases. Interested individuals and groups were encouraged to obtain additional information and to voice their opinions at public meetings, through letters to the Mississippi River Commission, and through discussions with local water resource managers. Viewpoints expressed by the public were considered in developing the recommended program.

Evaluation of Present and Future Economy

During the Comprehensive Study, forecasts of future economic growth and development of the region were made for two programs, designated as A and B. Program A, which reflects the national income objective, was based on forecasts made jointly by the Bureau of Economic Analysis (formerly the Office of Business Economics) and the Economic Research Service, under contract with the Water Resources Council. The forecasts (collectively known as OBERS) indicated what to expect nationally in terms of population, gross product originating, personal and per capita income, employment, and earnings by 28 industry groups, and average per worker earnings.

Separate forecasts were developed for Program B, which reflects the objective of regional development. These forecasts were based on the criterion that economic growth for the Lower Mississippi Region, as measured by employment opportunities, will in the future at least equal the average rate of growth for the nation. The detailed program methodology is also included in Appendix B (Economics). In general, the economic forecasts developed for each planning area under Program B held the same relationships to each other as they did under Program A.

A unique set of projections for the environmental objective was not defined. Projections used for the national income program were generally adopted for the environmental objective, with emphasis and priority on environmental items.

Analysis of Water and Land Resources

Preliminary or reconnaissance type studies were conducted covering all water and related land resources elements in the region. These studies were completed by interdisciplinary teams of experienced personnel, using readily available information and existing materials from federal, state, and local sources. Needs and problems for these elements were quantified on the basis of, and in relation to, the current and projected economic and demographic parameters for each of the planning objectives. Single-purpose plans were then formulated to satisfy each particular need, with minimal regard to the impact on other resource users. This was done in order to insure equal treatment and to obtain the maximum possible array of single-purpose alternatives.

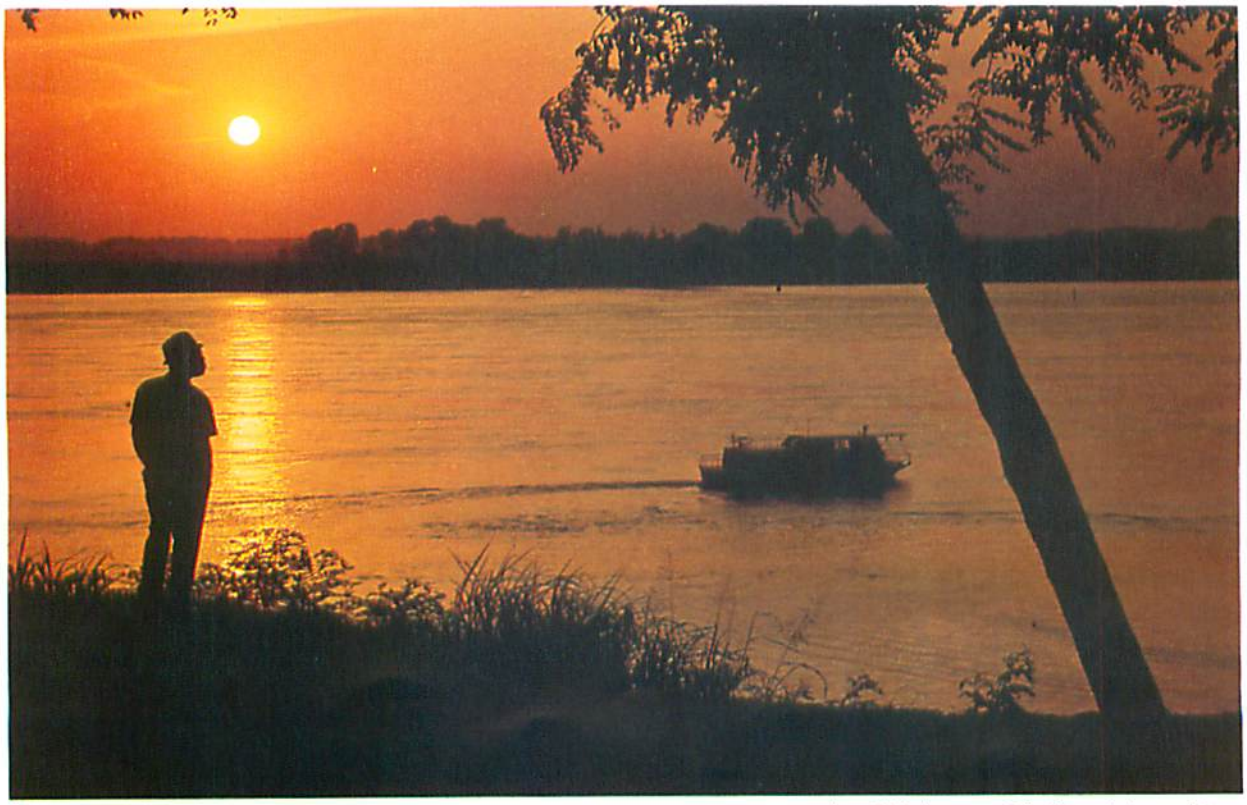
Development of Framework Program

The first step in development of the framework program was to summarize the needs identified in the detailed studies of water and related land resource use and availability. Measures that expanded the ability of resources to meet these needs or that reduced the needs were then formulated. These included both single- and multi-purpose solutions and ranged from resource preservation and management to development of structural facilities. These measures were fused into three programs which alternatively placed primary emphasis on the environmental quality, regional development, and national income objectives. The recommended program was then developed to include a combination of components from the three unique programs which appeared to best satisfy the needs of the people of the region, as expressed through the study's public involvement program.

Program costs were estimated and compared to historic expenditures for water and related land resource development in the region. This comparison indicated the present rate of development and the magnitude of demands that will be made on future national expenditures in order to satisfy a reasonable plan for future water and land resources development in the Lower Mississippi Region.

Throughout the development of the framework program, every consideration was given to local viewpoints, and adjustments were made wherever possible or necessary.

The impact of this recommended program upon the region was then assessed, and all irreversible commitments were identified. The program was timed-phased to indicate which portions should be operational by the years 1980, 2000, and 2020. For each time phase, methods of implementation were given, and indications were made of the entities responsible for implementation.



Crimson in the glow of sunset, the broad Mississippi sweeps past the Chickasaw Bluff at Memphis, where a lone figure stands watching night fall on the Arkansas lowlands across the way.

DESCRIPTION OF REGION

The Lower Mississippi Region is an admixture of physical elements and socioeconomic and cultural influences. The physical environment is concerned with the air, land, water, and natural elements, such as geology, physiography, hydraulic and hydrologic characteristics, climate, soils, vegetation, animal life, and mineral resources. The socioeconomic and cultural environment is concerned with the people: their sex, age, education, income, and occupation; their location and distribution in the region; and their various cultures and life patterns.

These two environments intermingle in a complexity of relationships, each in its turn affecting, and being affected by, the other. The elements of these environments and their diverse interactions are discussed in this chapter as a basis for understanding the scope and content of the Comprehensive Study.

The Physical Environment

The lower valley of the Mississippi River begins at Cairo, Illinois, where the Ohio River, carrying nearly twice as much water as the Upper Mississippi, joins the smaller stream to form a mighty riverroad. Below its confluence with the Ohio, the Mississippi River is no longer sweet, pretty, or friendly; it is grand, majestic, unpredictable, awesome. It is what Ojibway Indians in the upper valley originally called *Meche Sebe* (or *Misi Sipi*): the Great River; what early explorers called the Father of Waters; and what settlers in the delta later called the Old Big Strong, Old Man River, and Old Devil River.

Unlike the Upper Mississippi, with its relatively narrow flood plains, steep slopes, and wooded islands interrupted by towering bluffs, the Lower Mississippi has a great, wide flood plain and is relatively unconfined by nature. Since it flows near the top of the land, man must confine it to protect crops and cities along its banks.

For 954 miles, the Lower Mississippi pursues an erratic course to the Gulf, through the alluvial valley of its own making. It advances in broad loops and horseshoe bends, like a wide ribbon carelessly unwound. If one watches it on a summer day, dawdling down to New Orleans,

The broad Ohio, at right, joins the smaller Mississippi at Cairo to form the great river early explorers in the delta called the Father of Waters.

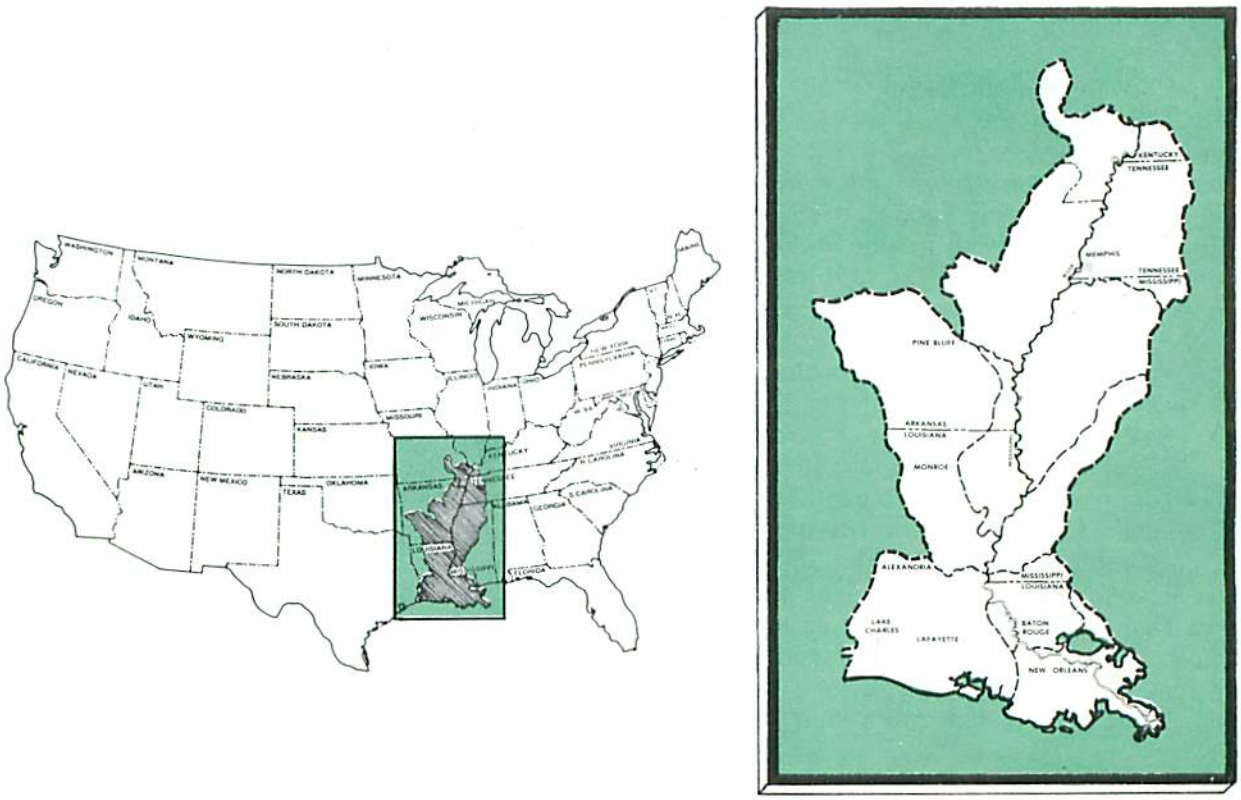


Figure 3. Geographic Location of Lower Mississippi Region

it hardly seems to move at all. But beneath its quietness, there is fearful strength. Even at normal stages, its waters are quietly gouging new curves and horseshoe bends, eating away banks and islands at one point, and using the sand and mud to choke channels at another.

The Lower Mississippi and its alluvial valley became deeply incised in the coastal plains area during the last glacial advance of the Pleistocene, when sea level was several hundred feet lower than present. During and subsequent to this period, the valley was gradually filled with alluvium deposited by the river. The river, therefore, brought into the area much of the material that is present today and has been a major influence in building and shaping the physical environment.

GEOGRAPHIC LOCATION

The Lower Mississippi, with its immense strength, scope, and volume, is the backbone of the Lower Mississippi Region study area. The region includes the drainage basin of the Mississippi below its confluence with the Ohio River, except for portions of the Arkansas, Red, and White river subbasins above the backwater limits of the Mississippi River. It also includes the flood-protected area at Cairo, Illinois, and the Louisiana coastal area, which drains primarily into the Gulf between the Pearl River on the east and the Sabine River on the west. The region encompasses a total of 102,404 square miles (or 65.54 million acres), occupying portions of seven states: Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee (Figure 3).

TOPOGRAPHIC FEATURES

All of the region, except for the area of the Ouachita Mountains and the Ozark Plateaus, is located in the Central Gulf Coastal Plains Province. This extensive lowland is underlain by unconsolidated sand, gravel, clay, silt, marl, and limestone of both marine and non-marine origin. Within the region, the most sharply defined land forms of the province are the coastal plain uplands east and west of the valley, and the coastal marshes area along the Gulf edge.

The alluvial valley, containing about one-third of the region's area, is a gently sloping and undulating lowland bordering on the river from Cape Girardeau, Missouri, to the Gulf (Figure 4). Its elevation ranges from 320 feet above mean sea level in Missouri to mean sea level at the Gulf. The flat topography is broken in several places, however, by ridge systems, ranging in height from 20 feet to more than 300 feet.

East of the valley, an uplands area extends from the northern portion of the region into southeastern Louisiana. It includes, along the Mississippi River, a narrow, rugged zone called the Bluff Hills, which are characterized by a mantle of wind-blown material (loess) which is subject to severe sheet and gully erosion. The uplands area west of the valley is less distinctive and more gently rolling. It extends southward from the Arkansas River to within a few miles of Alexandria, Louisiana. South of Alexandria, the uplands flatten into a vast prairieland which slopes seaward until it merges with the coastal marshes.

The natural marshes (land areas covered by marsh-type vegetation) stretch along the Louisiana coast and extend about 35 miles inland from the Gulf. The natural marshes which surround the active delta at the mouth of the Mississippi River are predominantly fresh water marsh, totaling about 120,000 acres. Natural marshes in the inactive delta between Grand Pass and Cheniere-au-Tigre occupy more than 1.4 million acres and are mostly fresh to brackish, with a salt belt along the Gulf. The Cheniere-au-Tigre Plain Zone, located west of Cheniere-au-Tigre, contains some 860,000 acres of natural marshes. The salt, brackish, and fresh water portions of this area are separated by old beach formations called *chenieres*, which run parallel to the present-day coast and average only a few feet above sea level.

Both the Ouachita Mountains and the Ozark Plateaus are located outside the Central Gulf Coastal Plains Province and are therefore quite different topographically from the rest of the region. The Ouachita Mountains area rests on coarse sedimentary rocks, which were highly folded and faulted during the Paleozoic era. The terrain, therefore, is very rugged and elevations are much higher, extending to 2,000 feet or more. Most of the stream valleys are narrow and have steep gradients, but wide terraces and flood plains border the Ouachita River in western Arkansas. Between the mountains and the coastal plain uplands is a shelf called the Athens Piedmont Plateau, which slants from 1,000 feet above sea level near the mountains to 400 feet at the edge of the coastal plain.

The Ozark Plateaus in Missouri is a maturely dissected rolling upland developed on gently uplifted rocks ranging in age from pre-Cambrian to Pennsylvanian. The area is characterized by sharply dissected limestone plateaus, with narrow, rolling ridgetops that break sharply to steep side slopes. Valleys are narrow, and have steep gradients, especially in the upper reaches. Local relief ranges from less than 100 feet to several hundred feet.

HYDROLOGY

The Lower Mississippi Region is water-rich, in comparison with other major river basins in the United States. On its surface are examples of nearly every type of water form except glacial lakes and fiords. Under its surface is one of the most extensive and potentially productive ground water areas in the United States.

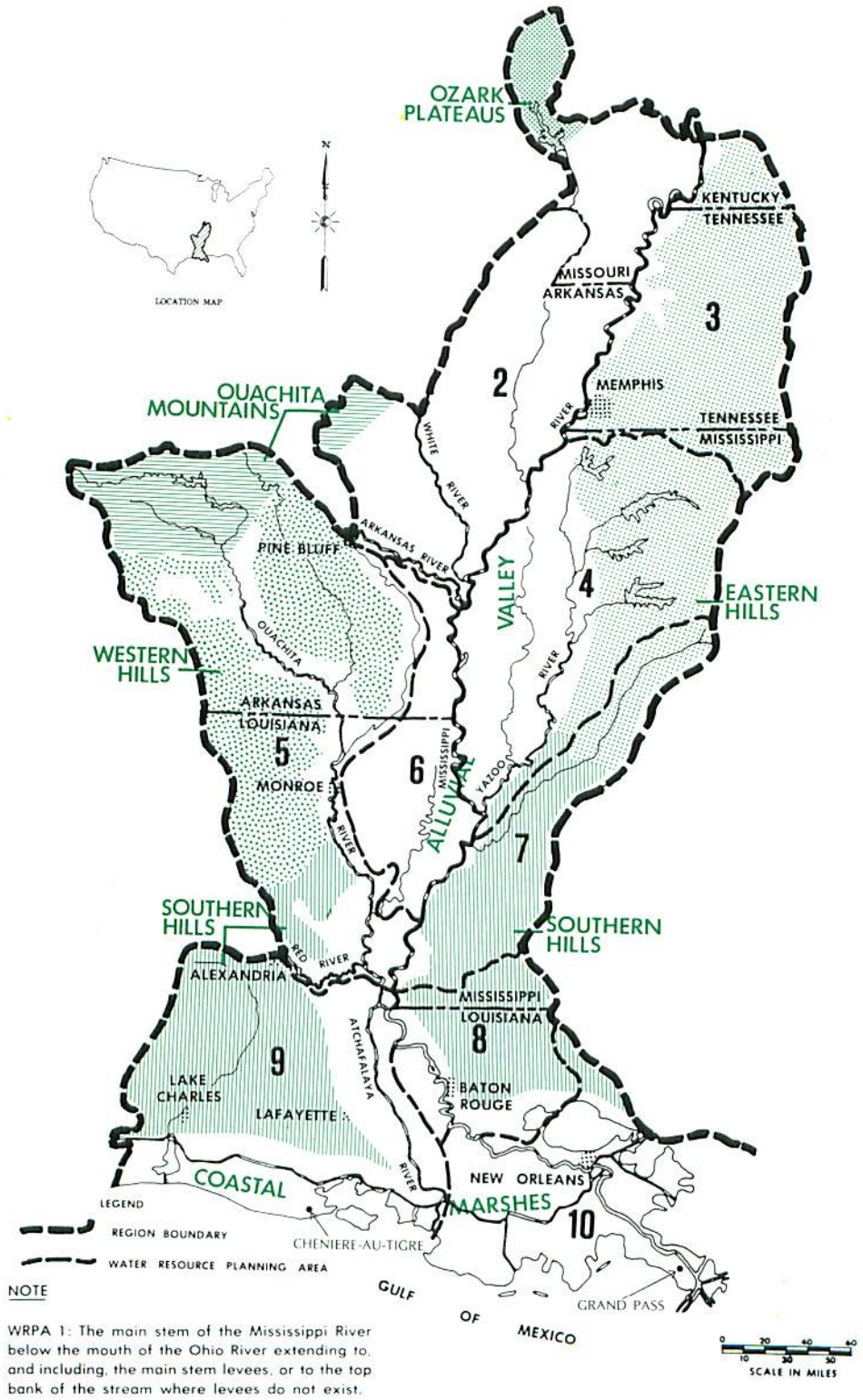


Figure 4. Topographic Features, Lower Mississippi Region

Surface Water

Surface water covers about five percent of the area and is derived principally from precipitation and runoff, inflows to the region, and ground water. The Mississippi River, with its system of tributaries, is the major surface water feature. On the average, the river pours directly into the Gulf 328 million acre-feet per year (a flow rate of 453,000 cfs).

Maximum flows on the main stem of the river generally occur in the spring; and minimum flows, during the late fall. The greatest flow of record on the river at Vicksburg was 2,060,000 cfs in February 1937; however, a greater flood occurred in 1927, when the measured portion of the maximum flow past Vicksburg was 1,806,000 cfs. Based on today's confining works and improved channel, it has been estimated that the maximum flow of the 1927 flood amounted to about 2,278,000 cfs. The lowest flow was 93,800 cfs in August 1936.

The largest Mississippi River tributaries within the region, such as the St. Francis, Ouachita, and the Yazoo, usually experience maximum flows in late winter or early spring, after the general frontal storms. Heavy rainfall and severe flooding sometimes occur, however, when hurricanes sweep northward through the area, usually in late summer to early fall.

On the small streams, maximum flows generally result from heavy local rainstorms and can occur during winter, spring, or summer. During late summer to late fall, the dry season causes minimum flows in these streams.

Surface water features, in addition to the Mississippi River system, include natural and man-made lakes, reservoirs, channels, bayous, swamps, and sloughs. Surface water sources in 1970 furnished about seven of every 10 gallons of water withdrawn, two-thirds of which was used by self-supplied industries and steam-electric power plants.

The bell-shaped trunks of old cypress cast wavery shadows in the rippled waters of Old Town Lake.

Surface Water Quality

Large quantities of good quality surface water are available on a regional basis, although significant water quality problems do exist in some WRPAs. The waters of the Mississippi main stem are moderately hard, with a maximum observed dissolved solids content of 344 milligrams per liter (mg/l) at Luling Ferry, Louisiana, in December 1965. Tributaries east of the river generally contain soft to moderately hard water, of good chemical quality and low mineral content. West of the river, hardness and dissolved solids content vary drastically, with concentrations generally increasing from north to south. Bacteriological quality, although variable, generally reflects the density of urban, industrial, and agricultural development.

The major surface water pollutants are chloride from oilwell brine in some creeks; oxygen deficiency caused by municipal and industrial effluents; natural acidity; and both natural and oilfield brines brought into the region in large amounts by the Arkansas and Red rivers. Color and turbidity impair the physical quality of streams in some areas, and heavy concentrations of sediment are prevalent in all streams draining the hill sections on the east and west during storm periods.

Ground Water

The region contains some of the most extensive and productive fresh water aquifers in the United States. The capability of individual wells range from 50 gpm for very poor aquifers, to 500-1,500 gpm for productive aquifers. Nearly all large wells yield water with a dissolved solids content of less than 1,000 ppm. Several areas, however, contain no productive fresh water aquifers. Notable examples are in north central Louisiana, where the area is underlain by tight rocks of early Tertiary age; and in the coastal areas, where nearly all ground water is saline.

Highest yields are obtained from beds of coastal plain sands and locally occurring gravels. South of Angola, Louisiana, these Quaternary deposits form a gulfward-thickening wedge. Most of the ground water withdrawn is pumped from aquifers in stream terrace and alluvial valley fill, with the largest amount being taken from the Mississippi River valley alluvial aquifer, which underlies one-third of the region.

In the northern part of the region and around the periphery of the coastal plain, Paleozoic aquifers are the principal source of ground water, and are generally lower yielding than aquifers in the unconsolidated rocks. The Paleozoic aquifers are water-bearing primarily because of porosity. Where rocks have not been subjected to extensive compaction or deformation, as in the Ozark Mountains, ground water occurs in porous zones and in solution openings. Compaction destroys this primary porosity, and in areas such as the Ouachita Mountains, ground water commonly occurs in joints and fractures.

Ground water accounts for about 30 percent of the total water withdrawn and for about 70 percent of the water withdrawn for agricultural purposes only.

Ground Water Quality

Ground water in the region has a higher, more constant mineral content than surface water, and is generally free of biological contaminants, although it does sometimes contain undesirable color and acidity. In many places, ground water does not require treatment although the mineral content may be moderately high. In other places, it requires treatment only for softening, iron removal, or pH adjustment to meet standards for most uses. Most aquifers gradually become saline at depth, the depth depending upon the extent to which different strata in the aquifer have been flushed of salt water. In general, however, salt water strata are not encountered at depths of less than 1,000 feet, except in the coastal area.

Salt-water intrusion into fresh ground water is a problem in coastal areas, where most ground water supplies are saline. At some locations in these saline areas, however, fresh water can be skimmed from above salt water,

Blakely Mountain Dam in WRPA 5 is the site of a hydroelectric plant, one of four in the region.

and fresh artesian water is available at varying depths from wells drilled offshore.

Sources of ground water pollutants include oilfield wastes, industrial wastes, agricultural chemicals, and sanitary landfills.

Interrelationship of Ground and Surface Water

An abundance of precipitation, reasonably distributed throughout the year, is usually available to sustain surface water supplies in the region. A part of the precipitation infiltrates into the soil and moves into the ground water system; part returns to the atmosphere by evapo-transpiration; and part finds its way into streams in the form of surface runoff. During dry periods, streamflow is sustained by ground water discharge from the aquifers, which is the normal direction of ground water movement in the region. During floods, this direction is reversed, but the effect on water table aquifers is temporary and local.

CLIMATE

The region's humid and subtropical climate is characterized by long, hot, humid summers and short, moderate winters. During the winter, southerly flows of warm, moist air predominate, but periodically this pattern is interrupted by cold northerly winds from the polar continental air masses which spill over the Appalachian and Ozark mountain ranges. On these occasions, it is not unusual for sudden temperature and precipitation changes to occur. By May of most years, persistent southerly winds become dominant and prevail throughout the summer. During late summer and autumn, periods of transitory higher pressure over the continent modify the wind flow patterns to easterly or northeasterly.

Precipitation is abundant and well distributed, ranging from less than 50 inches in the extreme northern portions to more than 60 inches along the southeastern coastal section. Although droughts do occur, extended periods of severe drought are uncommon, and region-wide occurrences are very rare. Maximum precipitation in the northern portion occurs during winter or early spring; and in the southern section, during summer. A significant portion of precipitation is the result of convective thunderstorms which occur most frequently in June, July, and August.

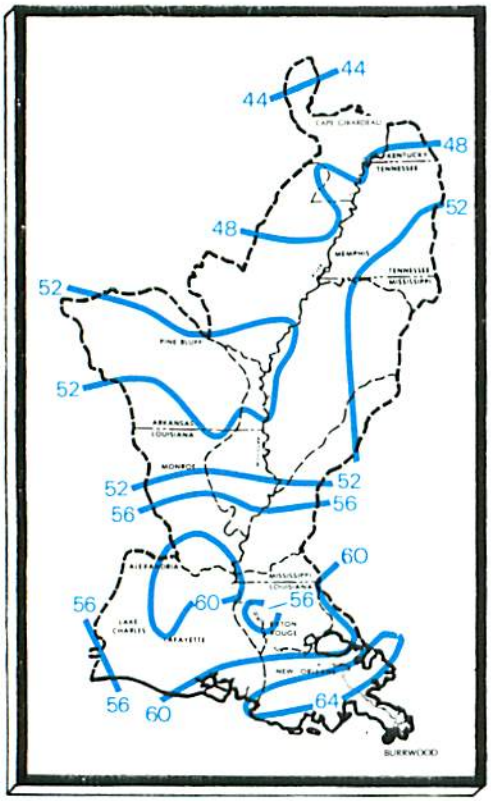
Average annual runoff is 16 inches, except in extreme southwest Louisiana, where it is 10 inches, and extreme southeast Louisiana, where it is 20 inches. The amount of "precipitation retained," or the approximate difference between annual rainfall and annual runoff, increases from 22-44 inches in lower Missouri, to 36 inches in middle Louisiana, to 42 inches near the Gulf.

January temperatures average 40°F in the north and 55°F in the south, and average temperatures in July are 78°F and 82°F, respectively. Extreme maximum temperatures range from 112°F at Burrwood, Louisiana, to 99°F at the latitude of Cape Girardeau, Missouri. Extreme minimum temperatures for these locations are 10°F and -26°F, respectively. The frost-free period ranges from 182 days at the latitude of Cape Girardeau to 353 days at Burrwood. The first killing frost usually occurs at the latitude of Cape Girardeau on October 16 and at Burrwood on December 30. The last killing frost for these locations usually occurs on April 17 and January 11, respectively.

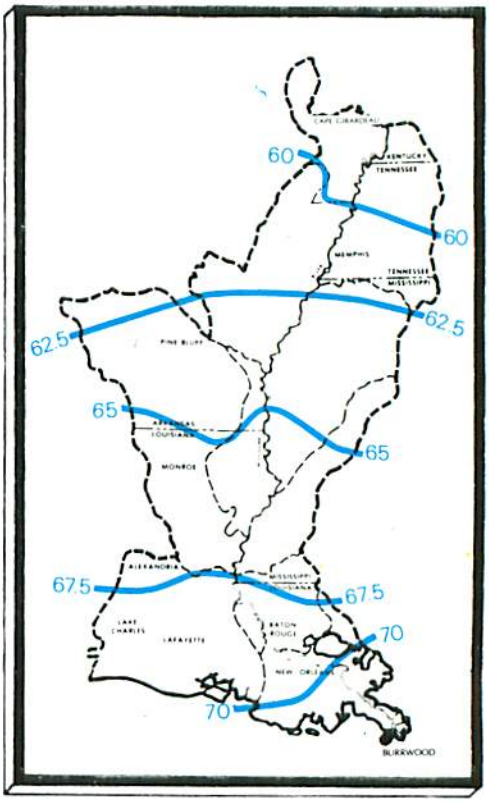
Snow and sleet for the most part are minor climatic elements. Total annual snowfall ranges from six to 12 inches in southeastern Missouri, to two inches along the Louisiana-Arkansas border, to less than one inch from central Louisiana southward. Measurable snow falls annually in the northern portions, but is much less frequent in the southern sections. Freezing rain or glaze occurs over the northern half of the region, but rarely extends to the coast. Hail occurs in all sections, but is seldom of sufficient size to cause large-scale damages to crops or property.

Tornadoes in the region occur primarily during April, May, and June. Because of the convective processes involved, they are most frequent during the warmer part of the day. Between 1951 and 1970, 624 tornadoes were verified in the region.

Hurricanes, tropical storms, and tropical depressions are especially damaging along the coastal area between May and October. Many of these bring only brief, gusty winds and locally heavy rainfall. Others are accompanied with violent winds in excess of 100 miles per hour, massive inundations of broad sections of coastal area 10 to 15 feet above mean gulf level, and rainfalls of 10 inches to more than 20 inches in 24 hours, which produce extensive flooding in interior areas. Within the past decade, two extremely intense hurricanes struck the central Gulf coast and caused extensive damage in many areas of the region. Climatological data for the region are presented in Figure 5.

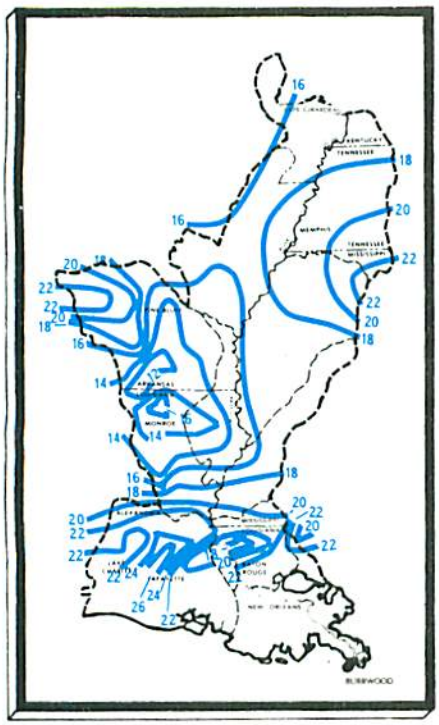


Normal Annual Total Precipitation, Inches, 1931-1960

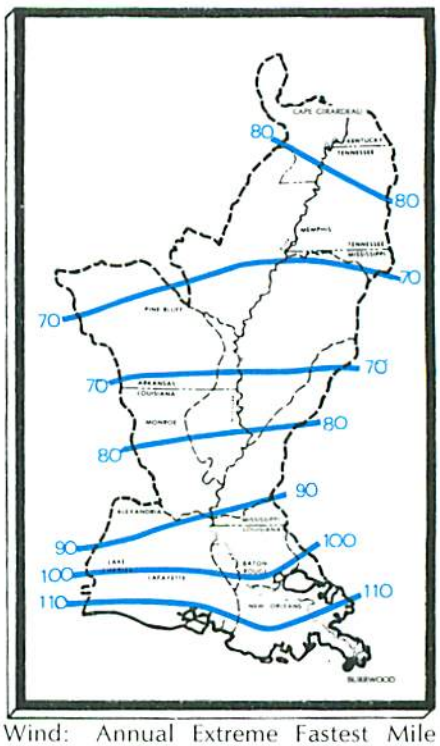


Normal Annual Temperature, °F, 1931-1960

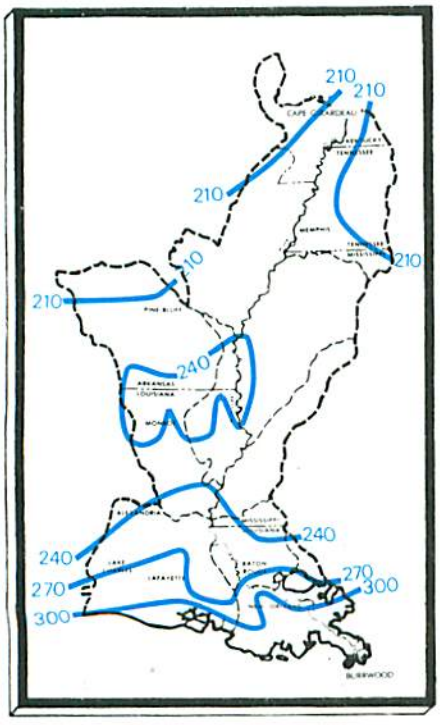
Figure 5. Climatological Data, Lower Mississippi Region



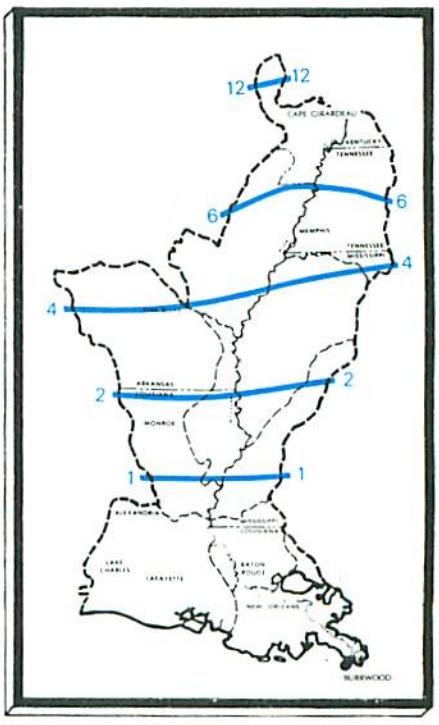
Mean Annual Runoff, In Inches, 1973



Wind: Annual Extreme Fastest Mile (Standardized 30 Feet Above Ground) 100-Year Mean Recurrence Interval



Mean Length of Freeze-Free Period (Days), 1921-1950



Mean Annual Snowfall, Inches (Period of Record Through 1960)

Figure 5. Climatological Data [continued]

VEGETATION AND CROPS

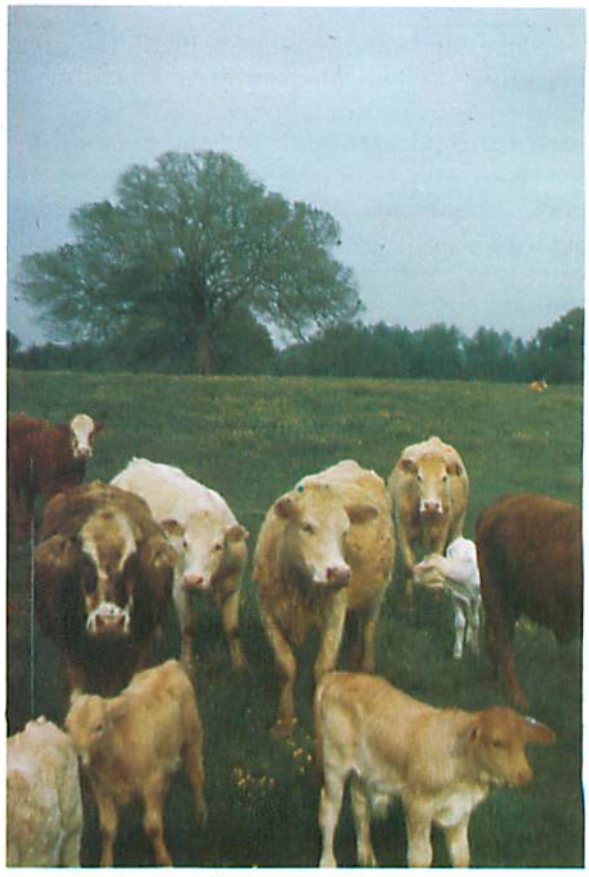
Differences in soil, moisture conditions, and temperature generally account for the variations in vegetation within an area and from one area to another. Throughout most of the study area, these three factors are conducive to the support of a lush vegetation, dense forest lands, and a variety of row and close-seeded crops. In the alluvial valley, soils are rich, with a fairly thick layer of humus; and throughout the region, precipitation is generous and fairly constant, and the climate is warm to temperate, with long frost-free seasons.

Forests cover nearly 30 million acres, or about 45 percent of the region. Oak-gum-cypress forests, located in the Mississippi delta and along the major and minor tributaries, are the most plentiful type, accounting for about 30 percent of the acreage. Closely associated with this type are elm-ash-cottonwood forests which occur primarily on the better-drained terraces of the flood plains. Oak-hickory and oak-pine forests are predominant on the higher ridges and mountains and on the loessial bluffs bordering the alluvial valley. On the rolling terrain of the uplands, the major forest type is loblolly-shortleaf pine, and on the well-drained sandy coastal plains near the Gulf, the most plentiful type is longleaf-slash pine. Most of the coastal area is unforested because of natural environmental limitations. Vegetation consists primarily of grasses, rushes, and a few small and medium-sized plants, such as palmetto, French mulberry, switch cane, and sumac.

Differences in natural conditions, drainage, and soils also influence the distribution of domesticated crop plants. Crops such as cotton, corn, sorghum, hay, soybeans, sweet clover, sweet potatoes, and pecans are grown at normal seasons throughout the region, as are summer and winter pastures. Native grasses are generally used in summer pastures, while oats, winter wheat, ryegrass, and fescue are common in winter pastures. Crops such as rice, sugar cane, and winter vegetables occur mostly in the southern portion; other crops, such as deciduous fruits, rye, barley, wheat, tobacco, and peanuts, are more common in the northern portions.

ANIMAL LIFE

The Lower Mississippi Region contains an abundance of mammal, bird, amphibian, reptile, and aquatic species, as well as extensive numbers of domestic animals such as livestock and poultry. Surface water bodies contain more than 200 species of fresh water fish, among these, several commercially important species, such as catfish. The coastal area is famous for its salt water fishes, as well as its fresh water varieties. Economically important species include pompano, redfish, Spanish mackerel, menhaden, bluefish, flounder, and grouper. In the shellfish and turtle groups, the area leads the nation in the production of shrimp, diamond-back terrapins, crabs, and oysters. Fresh water crayfish (crawfish) are a unique feature of natural waterways in the Atchafalaya River Basin, where they are harvested during spring by commercial and private interests alike.



One of every ten acres of land in the region is used for the grazing of livestock.

Because of the instability of supply from natural sources, increasing quantities have been harvested in recent years from commercially managed ponds and from rice fields where they are rotated annually with the rice crop.

Because of its abundance of water, the region contains a variety of amphibians and reptiles. The largest of these is the American alligator, limited generally to the swamps, lakes, and bayous of Louisiana and portions of southern Mississippi and Arkansas. Of the large number of snakes, five species are poisonous: the coral snake, copperhead, cottonmouth (water mocassin), pigmy rattlesnake, and canebrake rattlesnake. Bullfrogs are especially plentiful in Louisiana. Although the state continues to lead the nation in production, frogging as a commercial enterprise has declined sharply because of water level fluctuations caused by the drainage of marshlands.

Since the study area lies beneath the great migratory flyway of North America, many transient species are common in addition to the native bird population. Especially plentiful are the many species of perching birds, ducks and geese, shore-birds, and upland game varieties, such as dove, quail, and turkey. Hawks, vultures, owls, pigeons, and the red-winged blackbird are also widely represented. Less common are such species as the blue heron, American egret, and bald eagle.

Common mammal species include opossum, raccoon, moles and shrews, insect-eating bats, and carnivores, such as weasel, mink, otter, skunk, fox, bobcat and gnawing mammals like the groundhog, squirrel, muskrat, and nutria. Less common carnivores include the black bear and mountain lion. Several species, including the muskrat and nutria, are commercially important as fur-bearers. The Eastern cottontail and swamp rabbits, the gray and fox squirrels, and white-tailed deer are popular game animals. All of these species are fairly abundant.

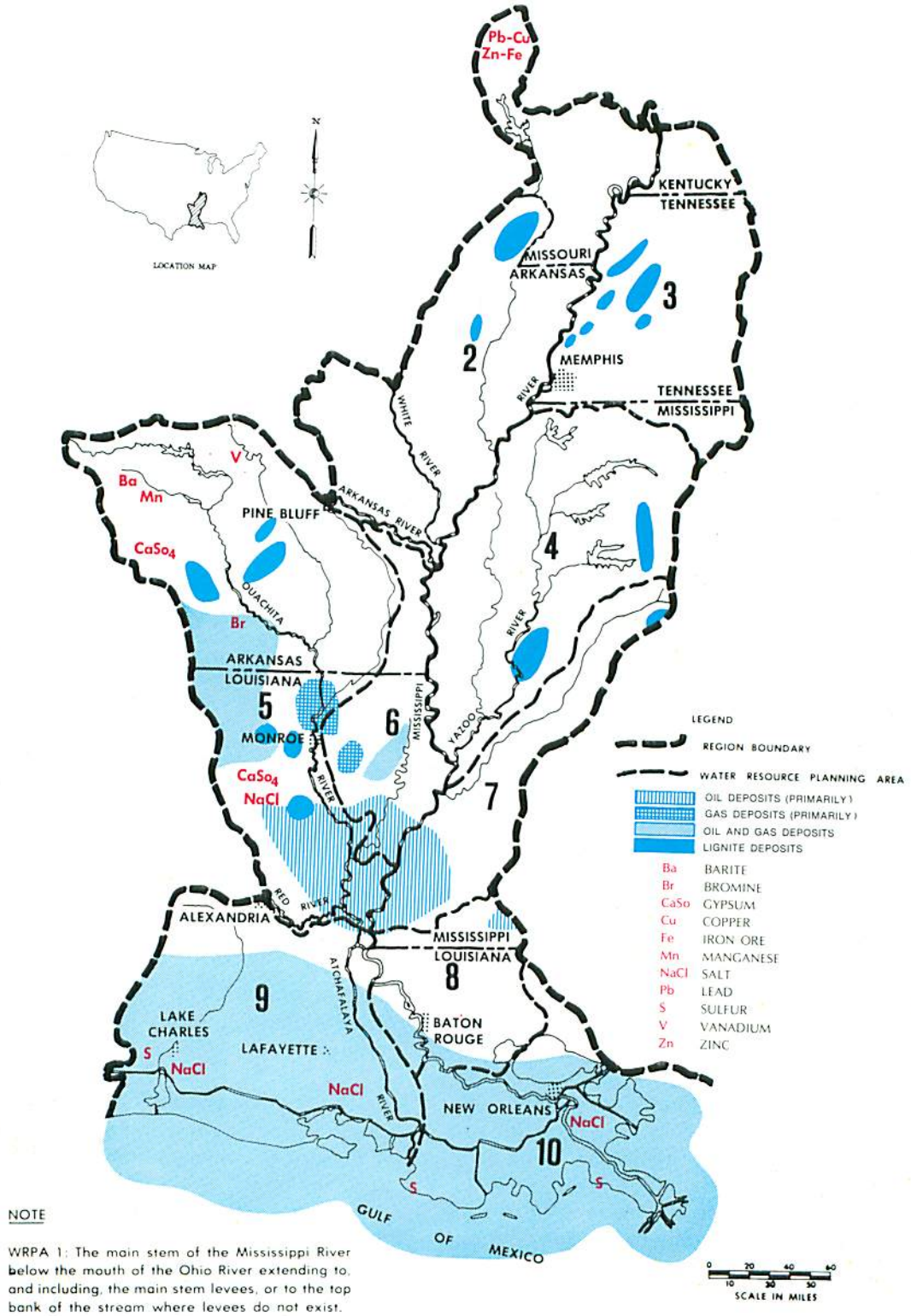
MINERAL RESOURCES

The region's mineral resources can be grouped into three categories: mineral fuels, such as petroleum, natural gas, natural gas liquids, and lignite; metallic minerals, such as lead, zinc, copper, iron ore, silver, and vanadium; and nonmetallic minerals, such as sand, gravel, stone, gypsum, clays, barite, bromine, salt, and sulphur (Figure 6). The most widespread of these are the so-called "construction" minerals: sand, gravel, stone, gypsum, and clays. The most important, however, are petroleum, natural gas, and sulphur. All three of the latter are produced extensively in the coastal area and offshore in the Gulf. Moderate quantities of petroleum and natural gas are also produced in Arkansas and Mississippi. In 1969, the region accounted for about one-third of the natural gas and natural gas liquids produced in the United States, plus about one-fourth of the petroleum and two-thirds of the sulphur.

Lignite deposits occur in northern Louisiana, southern and eastern Arkansas, western Mississippi, and western Tennessee, but none of these have been developed into production. Lead, zinc, copper, and iron ore are produced in southeastern Missouri. The principal by-products include silver and some minor amounts of nickel and cobalt. Vanadium, barite, and bromine are extracted primarily in central Arkansas. About one-fifth of the nation's bromine came from this area in 1969.

The Socioeconomic and Cultural Environment

Physiography, geology, and climate have had a direct and pronounced effect upon the physical appearance of the region. This effect, however, has been increasingly modified by man, his technology, and his organization. Today, the natural environment everywhere in the study area has become closely intertwined with and subordinate to the human element. The total environment of the region, therefore, is a combination of the physical elements and the human responses to these elements. The human response includes the social and economic spheres of influence, as well as the various cultural heritages.



NOTE

WRPA 1: The main stem of the Mississippi River below the mouth of the Ohio River extending to, and including, the main stem levees, or to the top bank of the stream where levees do not exist.

Figure 6. Location of Mineral Deposits, Lower Mississippi Region

Shrouded in mist, Confederate cannon stand silent and dark in the first light of day.

HISTORICAL DEVELOPMENT

Archeological and Pre-European Background

Archeologists have found convincing evidence that man has lived in the Lower Mississippi Valley since about 10,000 B.C., and it is believed he probably inhabited the area as early as 15,000 B.C. The data collected is sufficient to determine roughly the sequence of his cultural and temporal development in the region. This sequence is presented in eras, generally designated as Paleo-Indian, Meso-Indian, and Neo-Indian (Figure 7). Each of the eras is divided into strict chronological "periods," representing cultural continuities and discontinuities through time.

The earliest archeological evidence establishes the coexistence of man and many species of Pleistocene megafauna in the valley (circa 10,000-9,000 B.C.). Three famous examples are the possible relationship of an early tool complex and megafaunal remains at Avery Island, Louisiana; the apparent find of a human pelvis in a fossil-bearing stratum near Natchez, Mississippi; and the association of stone tools and mastodon bones at Island 35 above

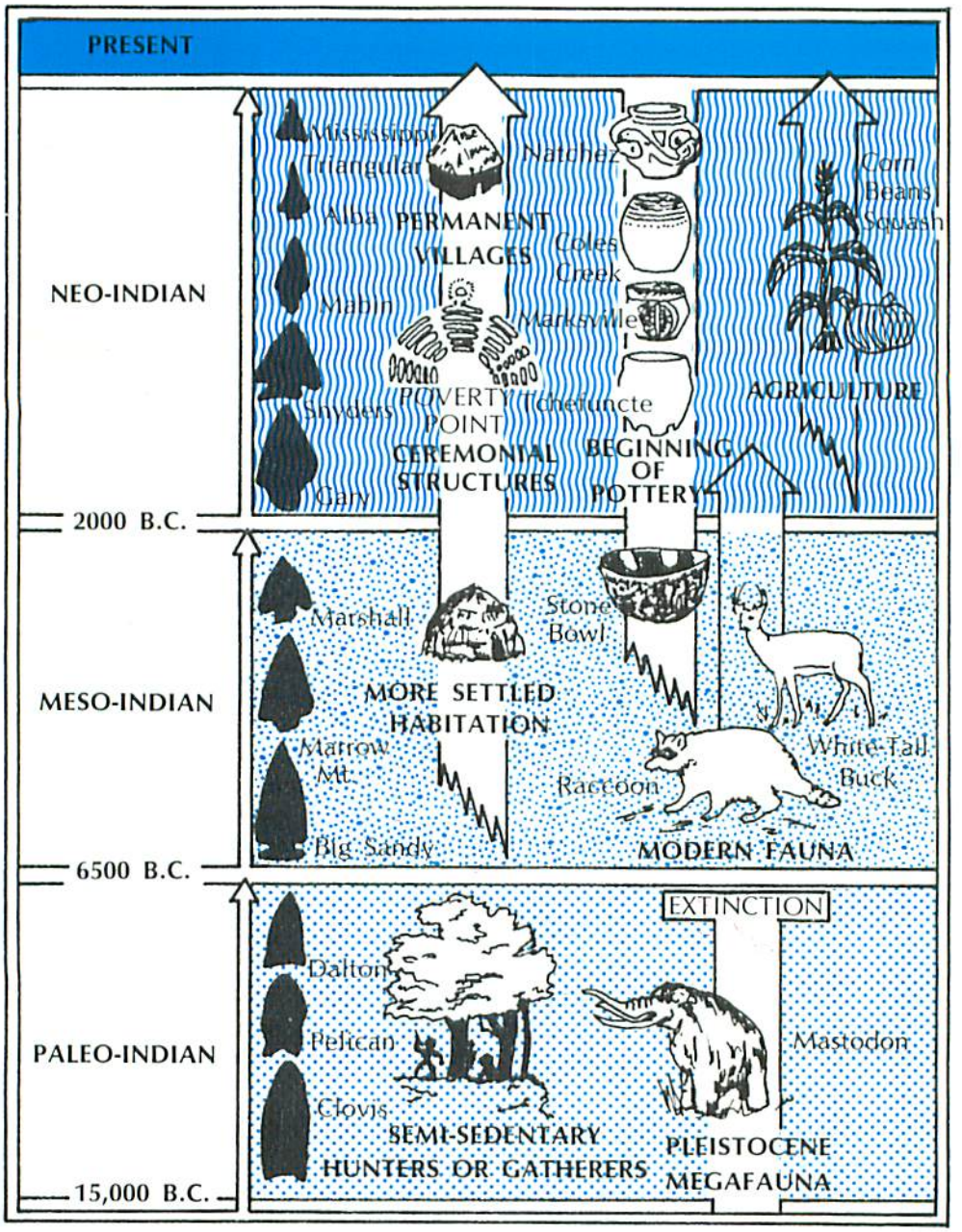


Figure 7. Prehistoric Eras of the Lower Mississippi Alluvial Valley

Memphis, Tennessee. Although scanty, other artifactual evidence from the Paleo-Indian Era and the subsequent Meso-Indian Era is adequate to reflect man's slow transition from a nomadic hunter and forager to a semi-permanent resident, to a permanent inhabitant with a rich culture. The earliest known identifiable culture is Poverty Point, named for its largest and most imposing site in northeastern Louisiana.

When the Spanish explorer Hernando de Soto entered the valley in 1541, he found the native population densely settled in large farm communities. Although there was no metalwork or sculpture in the area, some stone work was done, and pottery-making and basket-weaving were widespread. His expedition had little immediate effect upon the culture of the valley peoples, but in the years after his departure, the population was decimated by European diseases against which it had no resistance. At the end of the seventeenth century when French explorers entered the region, there was only a small and scattered population left in the area.

Although the native inhabitants were primitive in comparison to their European conquerors, they were the first shapers of the environment. They taught the first settlers what game was good to hunt and what plants were good to collect or cultivate. Their crops were developed by Europeans into a worldwide commerce. Settlers also adopted many of their habits, items of equipment, routes, and village sites. Their heritage laid a fertile ground in which Europeans were later able to strike firm roots.

Patterns of Early European Settlement

The first European settlements in the region were temporary military and trading posts established along the river by French explorers. These were quickly followed by a number of permanent settlements. All of these, except New Orleans, were agriculturally based, and nearly all were occupied by the French, who were also the principal early inhabitants of the upper valley, in what is now southeastern Missouri. Between the French settlements at either end of the basin, the area was hardly disturbed by Europeans. The population was scant, spotty in distribution, and overwhelmingly American. Much of it was in the form of individuals or families living in almost complete isolation. The economy consisted of subsistence agriculture, hunting and fishing, trapping and trading, and limited exploitation of timber. After the Revolutionary War, however, increasing numbers of Americans moved into the Kentucky, Tennessee, Arkansas, and Mississippi portions of the region. After the turn of the nineteenth century, the population of the central portion increased dramatically, as a result of the expansion of the cotton culture and the rapid influx of Americans into the lowlands north of the Red and Yazoo rivers.

Trends in Agricultural and Industrial Development

The Mississippi River valley is the site of one of the oldest commercial agricultures in North America. It had its beginnings in the early 1700s with the establishment of permanent agricultural occupations in the lower valley by the French. For subsistence, these early settlers first planted crops they had been accustomed to in Europe, notably wheat, but these did poorly in the humid subtropical climate. In time, the settlers adopted corn from the Indians and added other food plants strange to them, but better adapted to natural conditions: sweet potatoes, "Indian" beans, peppers, and okra. These crops were grown on small family holdings and used primarily to sustain the local population. Commercial activities were limited primarily to the sale of pelts and game by trappers and traders.

The first significant phase of agricultural development was the rapid spread northward after 1803 of the plantation single-crop system. This expansion occurred as the direct result of three developments late in the French Colonial period: the granulation of sugar, perfection of the cotton saw gin, and the mass importation of slave labor. These established sugarcane and cotton as the two great cash crops, made the plantation system profitable and encouraged the rapid clearing of land. As the system spread

northward, large land holdings gradually replaced small family plots. Since cane could be grown profitably only as far north as Pointe Coupee, cotton became the staple of plantation agriculture northward to its climatic limit at the mouth of the Ohio. Between 1840 and 1860, sugar refining in the valley developed into an elaborate system of manufacturing, as did the ginning of cotton.

After the Civil War, many of the large land holdings were broken into smaller units, and single-crop family farms were soon widespread. Lumbering, an adjunct of both plantation and small-holder agriculture since the earliest days of settlement, became an intensive industrial activity in the late nineteenth century. Steam power in the form of dredges, pullboats, skidders, tugs, and logging railroads replaced the old method of floating logs out individually at high water, and allowed professional lumbermen to strip thousands of acres of swamp forest in a relatively short time. The era ended in the mid-1920s, only 30 years after it began.

After the turn of the twentieth century and until 1917, settlers from the Lake States and the Corn Belt attempted to develop a diversified commercial agriculture in the valley. Land cleared for corn, oats, and other grains, however, was soon turned to the production of sugarcane and cotton. Although crop diversification failed at that time, the rice economy was expanded, and serious beginnings were made toward a livestock economy. Around 1900 petroleum was discovered in the southern portion of the valley, and for the next several decades, there was a slow, but steady, increase in industrialization.

After World War II, the demand for rice, cotton, and livestock initiated a new period of agricultural development, which was carried out largely by plantations and large-scale

Shrubbery partially obscures the porch of an old frame house, once the center of a small family farm.

farming businesses, rather than family farms. At the same time, there was an influx of industry along the banks of the Mississippi and its tributaries. Increasingly thereafter, economic emphasis shifted from agriculture to commercial forestry, mining, quarrying, petroleum production, and the manufacturing of food, textile, chemical, and paper products.

The mechanization of production and the extension of irrigated agriculture since World War II have increasingly favored large-scale agricultural operations and have added increased elements of commercialization. Since 1955, emphasis has been primarily on improvement and expansion of established farms and fields, rather than development of new units.

CURRENT LIFE STYLES

From the earliest days of settlement until about 1950, the life styles of most people in the region were closely tied to the soil, to agriculture, and to the traditional patterns of rural life. This common rural bond and a predominantly Anglo-Saxon ancestry have historically unified most portions of the region. With the shift in recent decades from agriculture to most major forms of economic activity, there has been a rapid and continuous expansion of urban areas and a simultaneous decline in rural population.

A carpet of leaves marks the entrance to a wooden foot bridge nestled amid the trees.

As a consequence, traditional social patterns are changing. Major metropolitan areas, such as Memphis and New Orleans, have become the dominant influences not only in cultural, financial, and commercial activities, but also in the areas of social and family life. Mass communications media and transportation systems have made possible the easier movement of people and the more rapid spread of ideas. As a result, urban influences have been extended into even the most remote areas.

Urban influences have affected so many social characteristics that "rural" and "urban" can no longer be referred to as absolute opposites. In many instances, there is an overlap and a merging of the two. Many rural residents, for example, commute to jobs in nearby cities. Others continue to farm, but maintain business and social ties with the closest urban area. Many urban residents, on the other hand, buy or maintain land in the country to escape periodically the pressures of city life. Increasing numbers seek open spaces on weekends to pursue boating, camping, hiking, and picnicking activities. Dude ranches and vacation farms, for example, have become popular only with the increase in urbanization.

Despite the influence of urbanization, some areas still maintain strong ties to the past and to the old values and cultures of their people. In some areas of Mississippi, the atmosphere is still one of leisureliness and easygoing hospitality. These traits are seen in the annual Natchez pilgrimage in March and in the annual recognition of a hospitality month. The life style of blacks in the delta reflects influences of conditions which developed during the era of plantation living.

The sparsely populated areas of the Ouachita Mountains in Arkansas contain a "mountain" culture of people who, in their speech and life patterns, have more in common with eighteenth-century England than twentieth-century America. Conservatism, or wariness of change, is a chief characteristic. In Tennessee, where American folk music originated, the song or ballad is still relied upon to transmit a lesson in morality or religious principle.

The French influence in south Louisiana is reflected in local place names and in the fact that French is still the household language of many families. The dominant religion in the area is Roman Catholic. Other distinct ethnic traits are apparent in the music, architecture, and cuisine and in the celebration of the pre-Lenten carnival season, which ends with Mardi Gras (Fat Tuesday).

POPULATION CHARACTERISTICS

Land forms and natural resources were major determinants in early patterns of settlement and land use. Although modern technology and organization allow man to live now in areas which were unoccupied during colonial years, these early settlement patterns, to a large extent, exist even today. Modern-day cities have emerged on the sites of earlier villages, which were either near a major water body, central to a large farming area, or close to valuable natural resources.

In 1970, about 60 percent of the 6,293,233 people in the region lived in urban areas. Eight of the urban places were classified as Standard Metropolitan Statistical Areas (SMSAs): Memphis, Tennessee; Pine Bluff, Arkansas; and Alexandria, Baton Rouge, Lafayette, Lake Charles, Monroe, and New Orleans, Louisiana.

Virtually all of the population is native-born, with the vast majority being white, Protestant, and Anglo-Saxon. The major portion is descended from English, Irish, Scottish, German, and Dutch families who migrated to the region from the Atlantic seaboard or from northern Europe. Blacks, concentrated primarily in lowlands along the Mississippi River and in the delta, comprise a small percent of the population.

South Louisiana, unlike the remainder of the region, has a highly mixed ancestry, which is reflected in its large French, Roman Catholic, and nonwhite populations. The area also includes smaller populations of Spanish, Hungarian, Slavic, and Italian descendants. Only a very small number of American Indians live in the region, and these are located primarily in Mississippi and Louisiana.

ECONOMIC ACTIVITIES

Industry

Regional economy, historically oriented toward agricultural productivity in the alluvial valley, is currently being balanced by expansion in a number of industrial sectors. Expansion and diversification, however, have not detracted from the importance of agricultural activities, but have altered the economic base, with manufacturing and mineral production now surpassing agriculture in terms of output.

The manufacturing sector had the highest gross product originating in 1970 and accounted for about one-fifth of total regional earnings. More than one-half of manufacturing earnings were in six industry groups: food and kindred products, lumber and furniture, chemicals, paper and allied products, apparel, and petroleum refining. The production of economically important minerals such as petroleum, natural gas, and sulphur comprised a second major segment of the economy. Forestry was another important industry, with a 1970 gross product of $202 million. The leading forest products were sawlogs, pulpwood, and such miscellaneous products as poles, pilings, posts, and cooperage. Agricultural activities involved the production of row and close-seeded crops, the growth of several important forest species, and the pro-

The region's forests play a vital role in meeting national needs for lumber and wood products.

Soybeans is the leading crop in the region, accounting for more than half of the harvested acreage.

Regional mineral production accounts for a substantial portion of the nation's liquid and gaseous fuels.

duction of livestock and livestock products. The 140,000 farms in the region in 1970 had a total gross income of $2.5 billion. About four-fifths of this amount stemmed from the marketing of crops such as soybeans, cotton, rice, hay, and corn. The remaining one-fifth came from the marketing of livestock, dairy, and poultry products and from sources other than product marketings.

Increased economic growth and productivity have greatly expanded the demand for services during recent decades. By 1960, noncommodity producing industries such as contract construction; transportation, communications, and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and government accounted for nearly two-thirds of total industry earnings and employment.

Employment and Income

About 35 percent, or slightly more than two million, of the regional population were employed in 1968. Only one of every ten workers was engaged in agriculture. Annual earnings totaled $12.3 billion (in 1967 dollars), for average annual earnings per worker of $5,550. Total regional personal income in 1968 was $15.4 billion, and per capita personal income was $2,447.

MAN'S INFLUENCE ON THE PHYSICAL ENVIRONMENT

Major changes have been made during the past 250 years in the natural landscape as a result of man's efforts to obtain food and shelter, creature comforts, and prosperity. Each successive generation has set its own goals and laid its own plans for development of the area, and each has left behind its own alterations in the natural landscape. As a consequence, today's environment is not solely a product of today, but is, instead, the sum of all man's activities, from past to present, from farm to factory, from work to play. The cumulative effect of these efforts has been to transform the region from an agrarian economy with complete dependence on natural resources to a modern, complex, technological society. In the process, man has cleared and drained extensive acreages for agricultural and urban development and has installed extensive works to protect these developments from flooding.

Flood Control

About one-half the total land area in the region is subject to flooding and steady progress toward the current level of economic and social development would not have been possible without the flood control and drainage programs which have been an integral part of man's activities in the region since the earliest days of settlement. In the beginning, these programs were rudimentary efforts by individual riparian holders to protect their own lands from the annual rises of the Mississippi and its tributaries. In time, this responsibility was shared by not only individual landowners, but also county governments, states and levee districts, and finally the federal government.

Although devastating floods have occurred several times in this century, congressional concern for adequate flood control measures was brought sharply into focus during the flood of 1927, termed one of the worst peacetime disasters in U.S. history. The Mississippi River levees in the region were breached at 13 principal points despite efforts to strengthen them, and 26,000 square miles of the region were inundated. The magnitude of the rescue and flood refugee problem was staggering. More than 637,000 people were driven from their homes. So quickly did crevasse waters sweep the lowlands that thousands had to be rescued from rooftops and trees. Volunteer and government agency workers fought to minimize the number of fatalities, but even so, more than 200 lives were lost. Property damage amounted to $236 million (equivalent to $930 million in 1970 dollars).

As a result of the flood of 1927, Congress passed the Flood Control Act of 1928, which hastened the prosecution of flood control works in the Lower Mississippi Valley. Much has been

done since then, but flooding still remains a serious deterrent to the economic and social well-being of the region. The current magnitude of this problem was clearly indicated in 1973.

The flood of 1973, although not so great as the record flood of 1927, caused nearly $760 million in damages, left thousands homeless for an extended period, and caused 28 deaths. Its impact on the national economy is difficult to quantify, but in a period of food shortages and rising prices, the flood losses had a significant adverse effect.

The region's main line of defense against such disasters is the Mississippi River and Tributaries (MR & T) Project, authorized in the Flood Control Act of 1928. The design flood for this project has a maximum flow of 2,720,000 cfs at Vicksburg. In comparison, the flood of 1973 had a maximum flow of 1,962,000 cfs at Vicksburg. The project is now less than half complete, but it is estimated that in its absence the tremendous dollar damages and human suffering experienced in 1973 would have been magnified nearly 18 times. The location of control structures and floodways in the project are shown in Figure 8, and the major elements of the project are described on pages 67 and 68.

The remainder of existing flood control works consists of four major hurricane protection projects in the coastal area; major non-MR&T tributary basin projects and reservoirs; and many local protection projects, such as levees, channel improvements, pumping plants, and small flood water retarding structures. The effect of increased flood security on the development and settlement of the region has been phenomenal, as evidenced by the scope and nature of man's activities today.

Land Use

All of man's activities in the region have been dependent upon land resources in some manner. Use of the land can be divided into the following categories: transportation, urban and built-up; cropland; pasture; forests; recreation; fish and wildlife; mineral production; and other. With the exception of the transportation, urban and built-up category, these uses are mostly land-extensive; that is, they involve primarily rural activities, vast amounts of land, and relatively few people. Urban and built-up areas, on the other hand, are land-intensive: they involve high-density urban functions, small amounts of land, and significantly large numbers of people. In 1970, extensive land uses accounted for about nine of every ten acres in the region.

Intensive Uses. Because transportation, urban and built-up areas displace extensive land uses, they represent maximum alteration of the natural environment. By 1970, man had converted nearly two and a half million acres in the region to such intensive uses as cities, villages and associated industrial sites, railroad yards, cemeteries, airports, golf courses, institutional and public administrative sites, roads, railroads, shooting ranges, and populated areas of more than ten acres. Although the urban environment represented only four percent of the land area, it was the location of most experience for nearly six out of every ten people.

The largest portion of transportation, urban and built-up land is used for residential purposes, and the second largest amount is devoted to transportation, communications, and utilities. The extensive transportation network consists of numerous local, state, federal, and interstate highways; railway lines; commercial air services; and shallow-draft and deep-water port facilities (Figure 9). Highways of major importance to passenger and domestic freight traffic include the high-speed interstate routes 10, 12, 20, 30, 40, and 55 and the twenty U.S. highways which crisscross the area. Among the several major railway lines which serve the region are the Missouri-Pacific, Illinois Central Gulf, Southern Pacific, Southern, and Texas Pacific.

Sixteen airports have scheduled commercial air service, a prime requisite in attracting business and industry and in handling the increasing volumes of domestic air freight traffic.

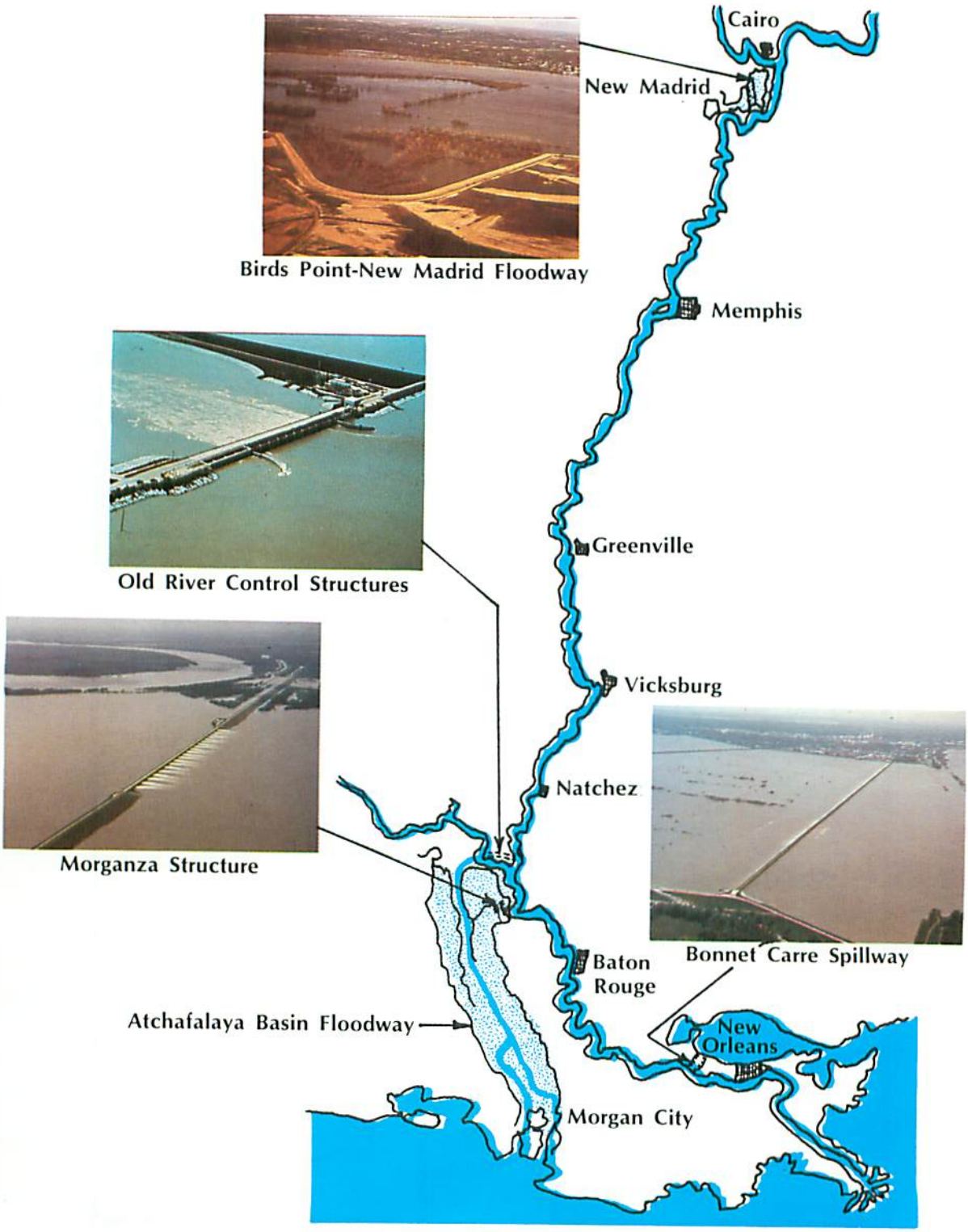
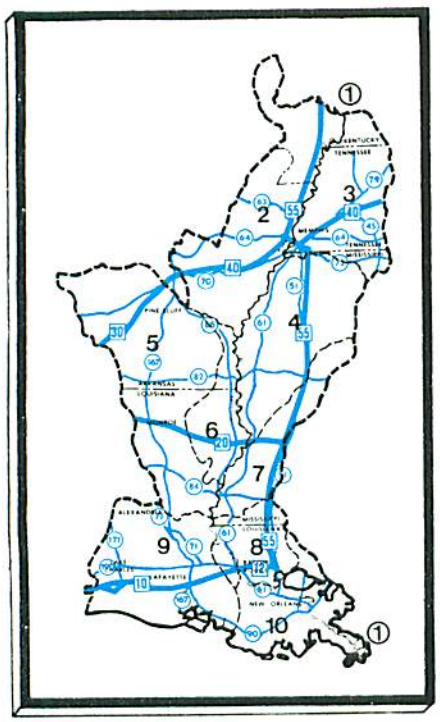
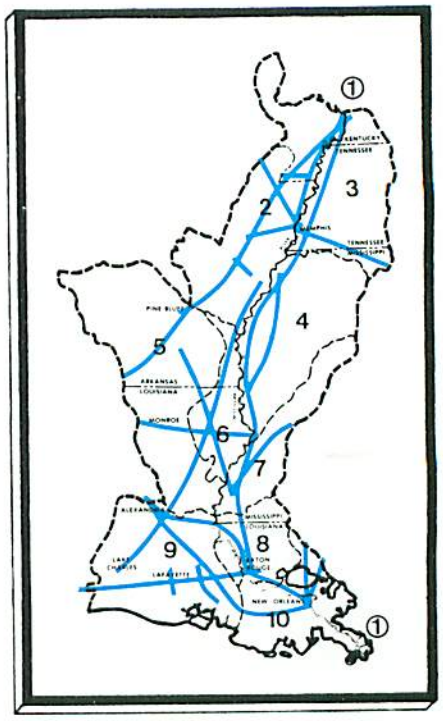


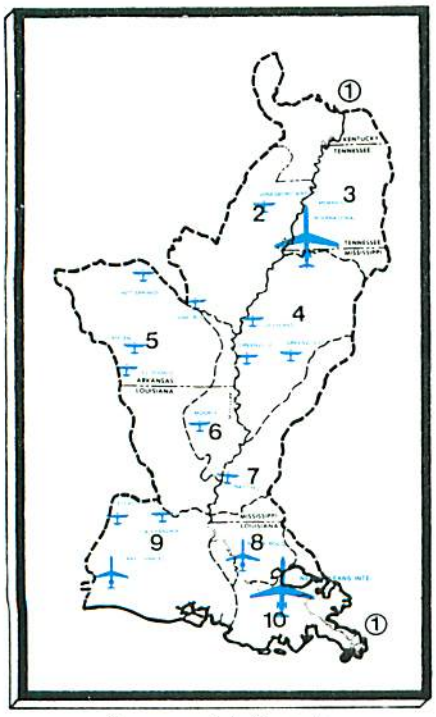
Figure 8. Control Structures and Floodways in Mississippi River and Tributaries Project



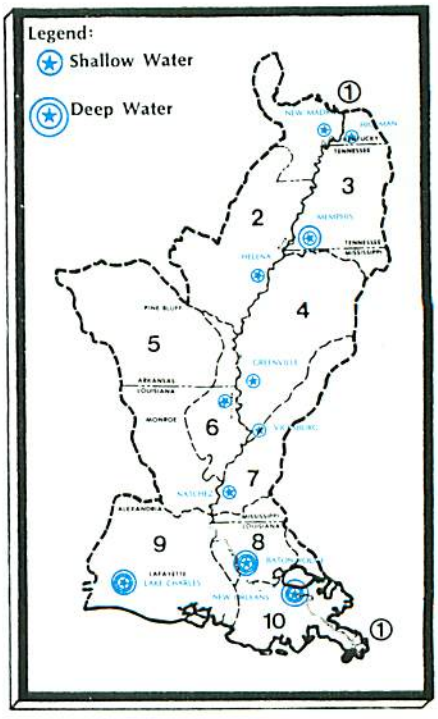
Interstate and U.S. Highway Routes



Major Railway Lines

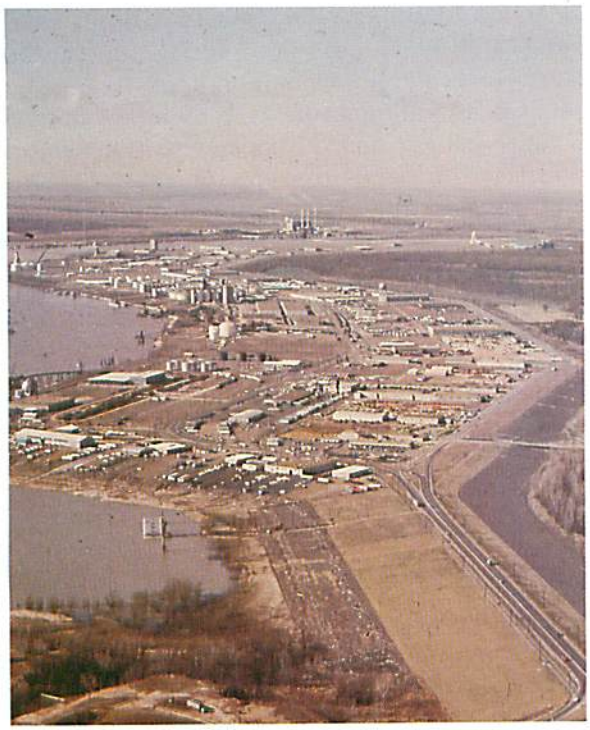


Commercial Airports



Major Port Facilities

Figure 9. Location of Transportation Routes and Facilities



The shallow-water port at Memphis Harbor is a major distribution center for the entire mid-South area.

Two of these facilities (Memphis International Airport and New Orleans International Airport at Moisant Field) handle national and international turbojets.

A large number of port and terminal facilities, both public and private, are located along major waterways in the region. In 1970, nine of these ports handled 13 percent of the total U.S. waterborne commerce. All of the facilities except three are shallow-draft (that is, with a minimum depth of nine feet).The three deep-water ports at New Orleans, Baton Rouge, and Lake Charles ranked second, seventh, and twentieth, respectively, in the United States in 1970 in the amount of waterborne commerce handled.

Although intensively used, urban and built-up places provide important opportunities for recreation and preserve certain environmental qualities in the form of parks and other open and green space.

Extensive Uses. The lands of the Lower Mississippi Region support a diverse range of land-extensive activities. Forests are by far the most predominant of these, accounting for nearly one-half of the land acreage. Included in the category are fast-growing stands of pine and vast tracts of high-quality bottomland hardwoods. These and other forest lands support a bountiful and diverse wildlife resource and provide opportunities for recreation and relaxation. Although forested, about four million of the 30 million acres in this category are used for grazing livestock. About seven of every ten acres of forest land are owned by farmers and other private interests. The remainder is owned by the forest industry and by the federal government and other public agencies.

Crop and livestock production occurs on about 43 percent of the land portion of the area. Like the forested acreages, these lands support a number of wildlife species and certain portions, like pasturelands, provide opportunities for recreation.

About three and one-half million acres of land contain such miscellaneous elements as farmsteads, farm roads, feedlots, ditch banks, fence and hedge rows, rural nonfarm residences, investment tracts, coastal dunes, and marshes not used for grazing. Nearly three-fourths of these lands are located in WRPAs 9 and 10 which contain the coastal marshes from the western hydrologic boundary of the Pearl River Basin westward to the eastern hydrologic boundary of the Sabine River Basin. Although used to a certain extent for agricultural production, these other lands are important as wildlife habitat, as the site of commercial fisheries and mineral production, and as sources of environmental quality and recreational opportunities.

Esthetics

Man's many uses of land and water resources have altered the natural environment, for better or worse. Adverse effects have resulted from the clearing and drainage of land for cultivated crops and pastures, from the harvesting of lumber, from the mining of mineral resources, and from the construction of

roads, ditches, recreational facilities, industrial sites, and urban and built-up areas. These activities in varying degrees have displaced or eliminated wildlife, increased water and air pollution levels, altered recreational values, changed stream patterns, stripped forest lands, decreased soil productivity, damaged or destroyed archeological and historical remains, and diminished scenic and other esthetic values.

Not all of man's activities, however, have been harmful. He has improved the region by practicing various erosion-control measures and by constructing drainage and flood protection works. Some man-made water areas, such as navigation canals along the coast, borrow pits adjacent to levees, and reservoirs, have added visual variety and scenic qualities to the landscape and have often provided additional recreational opportunities. Major portions of the Ouachita Mountains area are still wild in character, with few roads and a sparse population. Nearly one and a half million acres have been set aside in national forests, providing valuable wildlife habitat and outdoor recreation opportunities. Thousands of acres of coastal dunes and marshes and wetlands remain relatively undisturbed and of good environmental quality, providing habitat for many birds and small animals. State and national parks throughout the region preserve areas of scenic, historic, or recreational significance, and the wildlife refuges and sanctuaries in the region are among the world's largest.

In general, man's effect on the quality of land resources varies from minimal alteration in the mountainous and more rural areas to maximum change in urban and built-up areas, primarily in the flood plains of the Mississippi and its tributaries.

Held to its course by earthen levees, the Mississippi winds past New Orleans, called the Crescent City locally because of the deep river curve embracing the metropolis.

REGIONAL ECONOMY

General

Historically, economic activity in the Lower Mississippi Region has been oriented toward the production of row and close-seeded crops, valuable forest species, and livestock and livestock products. Although these activities continue to play important roles in the regional economy, there has been a significant trend in recent years in industrial development and a greater diversification and expansion of the economy. As a result, emphasis has shifted from the agricultural base to other major forms of activities, such as mining, quarrying, petroleum production, and the manufacturing of food, chemical and paper products. Between 1950 and 1970, for example, agricultural employment declined from one-half of the regional total to only 10 percent, while employment in the manufacturing groups tripled.

In 1968, the manufacturing sector had the highest gross product originating, and earnings in this sector represented two dollars out of every ten earned that year. A major portion of these earnings was in heavy water-using industries, such as food and kindred products, chemicals, paper and allied products, and petroleum refining. The rapid expansion in these and other industry groups has been due to abundant supplies of timber, petroleum, natural gas, chemical raw materials, and fresh water--in combination with low-cost water transportation and labor supply. These factors give the region a unique advantage which will continue to encourage ever-increasing industrial development.

Future needs for water and water-related resources will depend upon the total growth of the area. Forecasts have therefore been made for the region's population and personal income of the citizens, for their earnings and employment, and prospective production by each of the major industries (as presented in Appendix B). From these projections or forecasts, the several study elements have determined future needs for municipal and industrial water supply, water quality, navigation, irrigation, recreation, fish and wildlife, and related needs categories.

The rising sun gilds the operating towers at the Humble Oil complex on the outskirts of Baton Rouge, site of the largest oil refinery in the United States.

BASES FOR PROJECTIONS

During the Comprehensive Study, forecasts for future economic growth and development were made for two programs, designated as A and B. Program A refers to projections underlying the national income objective. These projections, collectively called OBERS, were prepared by the Bureau of Economic Analysis (formerly the Office of Business Economics) and the Economic Research Service, under contract with the Water Resources Council. The projections covered population, gross national product, total personal and per capita income, employment and earnings by 28 industry groups, and average per worker earnings in the United States for the years 1980, 2000, and 2020. The national projections were used as control totals to develop economic area projections, which were then converted to water resource planning areas. A revised set of OBERS projections were released after the main text of Appendix B was finalized. Some minor differences were noted, but no revision in study projections was made. Appendix B contains a discussion of these differences.

Program B refers to projections underlying the regional development objective. These were prepared as separate forecasts, based on the criterion that economic growth for the region, as measured by employment opportunities, would in future years at least equal the average rate of growth for the nation. The philosophy behind Program B projections is that regional growth can be accelerated in part by capital investments in water and related land resources development.

Both sets of projections are consistent with the general assumption that the region will follow a pattern of substantial increases in population, income, employment, industrial production, and agricultural activities (Figure 10). The magnitude of these increases is greater under the Program B projections because the employment growth rate of 1.1 percent forecast for the region by OBERS was increased to the national average of 1.4 percent to reflect the regional development objective.

PROJECTED GROWTH

Under Program A, agricultural output through the year 2020 is projected to lag slightly behind that for the United States, while mining and manufacturing is expected to expand at a slightly higher rate. Growth in most other industries is expected to follow national trends. Projections are that population will exceed 10 million by 2020, and that employment during the next 50 years will increase 1.1 percent annually, compared to 1.4 percent for the United States. By 2020, the employment participation rate is expected to have increased from 35 percent in 1970 to 40 percent (compared to 41 percent for the nation). The projected decline in agricultural employment is expected to be offset by major expansions in manufacturing and other areas. Future changes in employment characteristics and greater urbanization are projected to bring earnings per worker up to 90 percent of the national average by 2020, from 80 percent in 1970. Projections are that average per worker earnings will increase fourfold between 1968 and 2020 in actual purchasing power (to $23,937, compared to $26,569 for the United States).

Program B reflects the impact of a 1.4 percent employment growth rate upon the region's future economy. Under such impact, total employment is projected to be 4.6 million by 2020 and the population is expected to reach 11.7 million (an 85 percent increase over 1970). Earnings per worker are the same under both programs, based on the assumption that a three percent annual increase in productivity would apply to both programs. Per capita income, calculated by dividing the projected total annual personal income by the corresponding population projection, is slightly higher under Program B, because a higher proportion of the population is projected to be employed.

In general, economic output in all sectors is expected to expand steadily through 2020–with significant contributions coming from the agricultural sector; production from the forest lands; and continued growth in the industrial sector, especially petrochemical manufacturing. Future water requirements under Program B

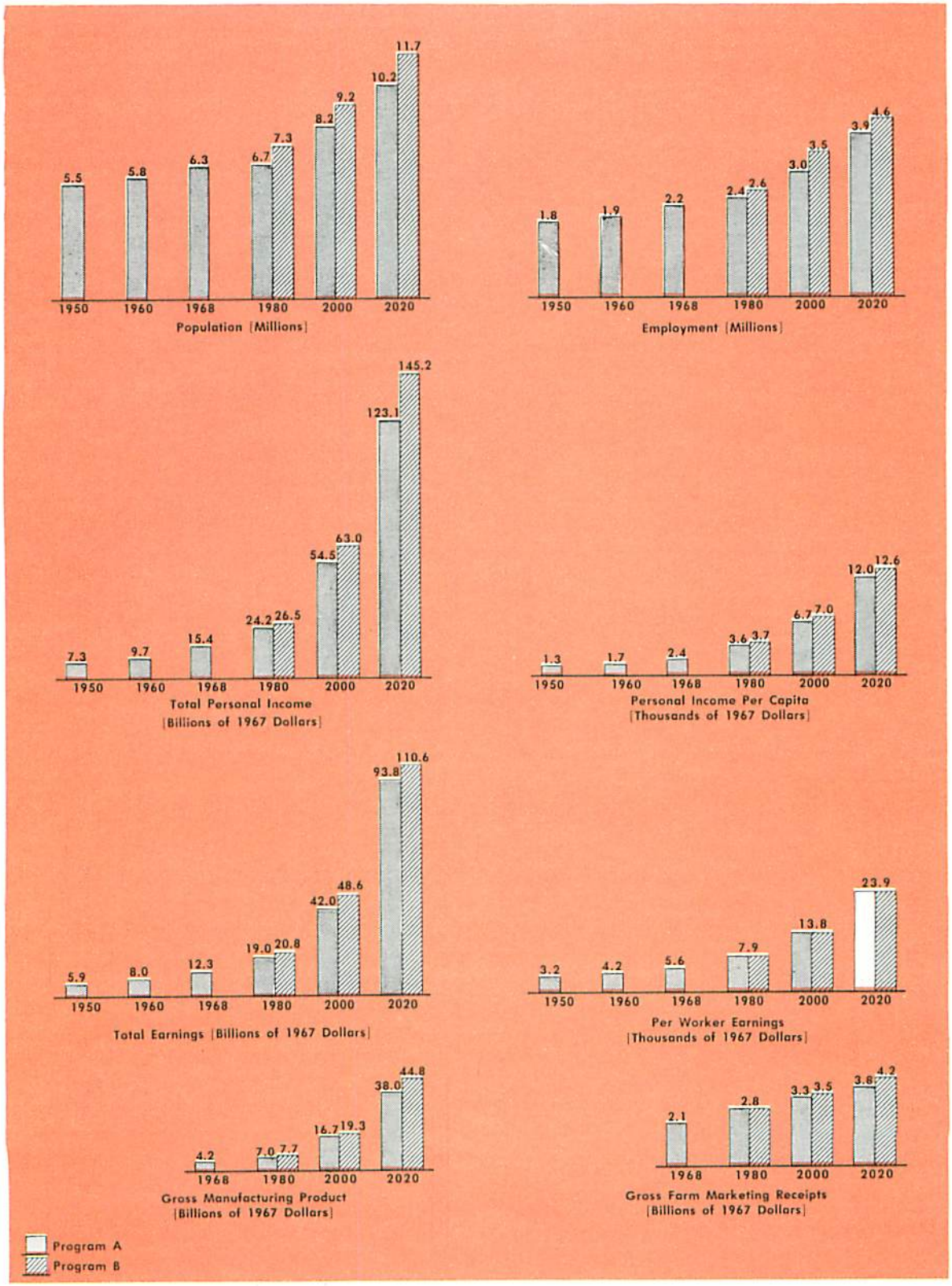


Figure 10. Economic Profile, Lower Mississippi Region

projections are about 15 percent higher by 2020 than under Program A, a reflection of greater activity in all sectors of the regional economy.

Population

The 1970 regional population of 6,293,233 represented three percent of the U.S. total. About 60 percent of regional population was classified as urban in 1970, in contrast to 43 percent in 1950; and the projection is that at least 76 percent will be urban by 2020 (Figure 11). Nearly one-half of the 2020 population is expected to be located in the three metropolitan areas of Memphis, Baton Rouge, and New Orleans. As previously indicated, the 2020 population is projected to be 10,196,000 under Program A and 11,655,000 under Program B.

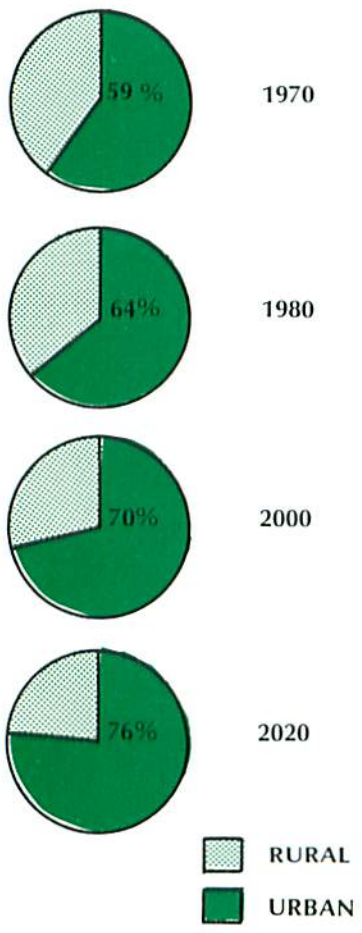


Figure 11. Current and Projected Urban Population, Lower Mississippi Region

Employment and Income

Approximately 35 percent (or 2,212,522) of the regional population was employed in 1968, with total annual earnings of $12.3 billion (in 1967 dollars). Earnings per worker was $5,550, which was 83 percent of the national average of $6,715. Total personal income was $15.4 billion, and per capita income averaged $2,447.

By 2020, employment is projected to reach 3.9 million under Program A and 4.6 million under Program B. Changes in employment characteristics, increased urbanization, and technological advancements are projected to increase per worker earnings to $23,937, in terms of 1967 dollars. Total personal income by 2020 is expected to be $123.1 billion under Program A and $145.2 billion under Program B, and projections are that per capita income will increase by the year 2020 to $12,076 under Program A and $12,570 under Program B. Tables 1 and 2 include data on current and projected employment and earnings, by major industry.

Industry

The major economic activities in the Lower Mississippi Region in 1968, in terms of earnings, were the noncommodity industries, manufacturing, and agriculture, in that order (Table 3). Industries in the noncommodity categories accounted for nearly two-thirds of total earnings and employment in the region in 1960. The manufacturing sector accounted for 17 percent of employment and about 21 percent of earnings. Approximately 57 percent of manufacturing earnings was in the category of "other manufacturing," which includes apparel and other textiles, printing and publishing, lumber and furniture, machinery, transportation equipment, fabricated metals, and miscellaneous manufacturing. The six heavy water-using industries accounted for the remaining 43 percent of earnings in this sector. Of especial importance were food and kindred products, chemical and allied products, paper and allied products, and petroleum refining. Agriculture accounted for about 16 percent of regional employment and 10 percent of earnings in 1968. The mining and forestry and fisheries categories accounted for less than four percent of total industry earnings.

Table 1

Employment by Major Industries in Lower Mississippi Region

Industry	Number of Persons Employed in Indicated Years				
	1950	1960	1980	2000	2020
Total, Program A	1,832,672	1,874,066	2,416,000	3,042,000	3,917,000
Total, Program B	--	--	2,649,000	3,519,000	4,620,000
Agriculture					
Program A	569,900 *	296,079*	135,000*	103,000*	101,000*
Program B	--	--	137,000*	112,000*	110,000*
Mining					
Program A	23,817	37,061	52,000	51,000	50,000
Program B	--	--	57,000	59,000	59,000
Manufacturing					
Program A	255,527	322,926	484,000	629,000	803,000
Program B	--	--	531,000	728,000	948,000
Food & Kindred Products					
Program A	39,443	53,101	48,000	45,000	43,000
Program B	--	--	53,000	52,000	51,000
Textile Mill Products					
Program A	8,772	8,894	12,000	14,000	15,000
Program B	--	--	13,000	16,000	18,000
Chemical & Allied Products					
Program A	19,143	27,308	49,000	75,000	106,000
Program B	--	--	54,000	87,000	125,000
Paper & Allied Products					
Program A	16,967	23,259	30,000	39,000	50,000
Program B	--	--	33,000	45,000	60,000
Petroleum Refining					
Program A	17,431	19,151	16,000	15,000	16,000
Program B	--	--	17,000	18,000	19,000
Primary Metals					
Program A	2,873	7,024	10,000	11,000	12,000
Program B	--	--	11,000	13,000	15,000
Other Manufacturing					
Program A	150,898	184,189	319,000	430,000	561,000
Program B	--	--	350,000	497,000	660,000
All Other					
Program A	983,428	1,218,000	1,745,000	2,259,000	2,963,000
Program B	--	--	1,924,000	2,620,000	3,503,000

* Includes forestry and fisheries data.

Table 2

Earnings by Major Industries in Lower Mississippi Region

Industry	Earnings for Indicated Years *					
	1950	1959	1968	1980	2000	2020
Total, Program A	5,908,523	7,919,503	12,280,220	19,003,000	42,028,000	93,758,000
Total, Program B	--	--	--	20,834,000	48,607,000	110,580,000
Per Worker						
Program A	3,224	4,226	5,550	7,865	13,813	23,937
Program B	--	--	--	7,865	13,813	23,937
Agriculture						
Program A	1,272,921	1,115,692	1,232,087	1,011,000	1,281,000	2,236,000
Program B	--	--	--	1,109,000	1,481,000	2,638,000
Forestry & Fisheries						
Program A	25,986	18,886	19,012	27,000	52,000	93,000
Program B	--	--	--	30,000	60,000	110,000
Mining						
Program A	137,298	344,697	450,991	636,000	955,000	1,348,000
Program B	--	--	--	697,000	1,104,000	1,590,000
Manufacturing						
Program A	977,238	1,431,140	2,550,755	4,104,000	9,159,000	20,105,000
Program B	--	--	--	4,499,000	10,593,000	23,712,000
Food & Kindred Products						
Program A	181,017	236,574	317,722	369,000	558,000	898,000
Program B	--	--	--	405,000	645,000	1,059,000
Textile Mill Products						
Program A	29,202	31,659	49,121	86,000	175,000	347,000
Program B	--	--	--	94,000	203,000	409,000
Chemical & Allied Products						
Program A	87,638	165,523	296,534	528,000	1,304,000	3,015,000
Program B	--	--	--	579,000	1,508,000	3,556,000
Paper & Allied Products						
Program A	76,694	129,903	193,640	311,000	667,000	1,434,000
Program B	--	--	--	341,000	772,000	1,691,000
Petroleum Refining						
Program A	93,798	123,659	151,855	206,000	356,000	618,000
Program B	--	--	--	226,000	412,000	729,000
Primary Metals						
Program A	8,685	44,828	74,192	100,000	173,000	294,000
Program B	--	--	--	110,000	200,000	347,000
Other Manufacturing						
Program A	500,204	698,994	1,467,691	2,504,000	5,926,000	13,499,000
Program B	--	--	--	2,744,000	6,853,000	15,921,000
All Other						
Program A	3,495,080	5,009,088	8,027,375	13,225,000	30,581,000	69,976,000
Program B	--	--	--	14,499,000	35,369,000	82,531,000

* All earnings except per worker earnings are given in thousands of 1967 dollars; per worker earnings are given in 1967 dollars.

Table 3

Gross Product Originating by Major Industries in Lower Mississippi Region

Industry	Gross Product Originating in Indicated Years (Thousands of 1967 dollars)				
	1967	1968	1980	2000	2020
Agriculture*					
Program A	1,981,052	2,145,000**	2,770,000	3,284,000	3,841,000
Program B	--	--	2,770,000	3,540,000	4,150,000
Forestry †					
Program A	--	201,500**	232,000	307,000	339,000
Program B	--	--	272,000	381,000	491,000
Mining, Petroleum					
Program A	1,981,052	2,099,915	3,130,000	4,239,000	7,350,000
Program B	--	--	3,432,000	4,903,000	8,668,000
Quarrying					
Program A	75,812	77,328	113,000	206,000	388,000
Program B	--	--	124,000	238,000	458,000
Manufacturing					
Program A	3,840,117	4,185,728	7,027,000	16,666,000	37,979,000
Program B	--	--	7,704,000	19,275,000	44,793,000
Food & Kindred Products					
Program A	543,057	564,779	701,000	1,108,000	1,808,000
Program B	--	--	768,000	1,281,000	2,133,000
Textile Mill Products					
Program A	64,567	67,795	120,000	245,000	486,000
Program B	--	--	132,000	283,000	573,000
Chemical & Allied Products					
Program A	597,122	680,719	1,302,000	3,595,000	9,070,000
Program B	--	--	1,427,000	4,157,000	10,698,000
Paper & Allied Products					
Program A	319,195	338,347	539,000	1,162,000	2,496,000
Program B	--	--	591,000	1,344,000	2,944,000
Petroleum Refining					
Program A	262,046	343,280	490,000	901,000	1,614,000
Program B	--	--	537,000	1,043,000	1,904,000
Primary Metals					
Program A	98,781	110,635	154,000	266,000	452,000
Program B	--	--	169,000	307,000	534,000
Other Manufacturing					
Program A	1,955,349	2,080,173	3,721,000	9,389,000	22,053,000
Program B	--	--	4,080,000	10,860,000	26,007,000

* Marketing receipts.
** 1970 data.
† Value at local point of delivery including stumpage, cutting, and hauling.

AGRICULTURE

Between 1949 and 1970, there was a decrease in the amount of farmland in the region, the total number of farms, and total agricultural employment. Average farm size during the period increased from 87 acres to 239 acres. It is anticipated that these trends will continue in future years, as a result of improved technology and the adoption of more modern farming methods to reduce costs and increase net returns. The rate of decline in the number of farms and farmers, however, is projected to be lower than that prevailing during the past two decades.

In 1970, there were roughly 140,000 farms in the region, with a total employment of about 200,000 and a total gross income of $2.5 billion. Approximately seven out of every ten dollars of 1970 total gross farm income was derived from the marketing of crops--primarily soybeans, cotton, rice, hay, and corn. These field crops accounted for all but seven percent of total harvested acreage in 1970 (Figure 12). Marketing receipts from livestock, dairy, and poultry products totaled $373 million in 1970 (14 percent of the total). The remaining 14 percent of total farm income came from other sources. Net farm income, after production expenses, was $748 million, for a derived income per farm of $5,244.

The 1970 net farm income of $748 million is projected to increase under Program A to $1.3 billion in 2020 (a 79 percent increase), and under Program B, to $1.4 billion (a 94 percent increase).

Agricultural earnings in the region declined from about 22 percent of the regional total in 1950 to 10 percent in 1968. During the same period, however, the regional contribution to U.S. agricultural earnings increased from five and a half percent to nearly seven percent. Under programs A and B, this figure is expected to decline about five percent in the years 1980, 2000, and 2020. As a share of total regional income, agricultural earnings are projected under programs A and B to decline to five percent in 1980, three percent in 2000, and less than three percent in 2020.

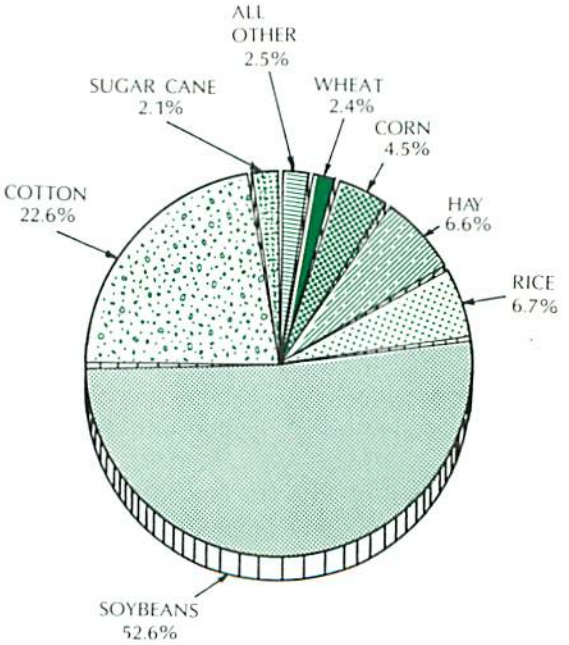


Figure 12. Major Crops Harvested, Lower Mississippi Region

FORESTRY

Forests and forestry products have historically played an important role in the development of the region. Prior to 1959, the accessibility of forest lands, the availability of local markets, and the presence of an excellent road and river system all contributed to the rapid development of forest resources. Between 1949 and 1959, there was a slight increase in total forest acreage, but since 1959 forest acreages have steadily declined, and forests are becoming increasingly restricted to areas where flooding, poor drainage, and soil conditions make the land unsuitable for other uses.

The forestry industry in 1970 had a gross product in the region of $202 million, which was the value at local point of delivery, including stumpage, cutting, and hauling. The leading products, ranked in terms of volume of wood processed, were sawlogs; pulpwood; miscellaneous products (such as poles, piling, posts, and cooperage); and veneer logs, mainly softwood. In connection with the commercial production of forest products, the region contains a large number of sawmills, pulpmills, veneer plants, wood-preserving plants, and miscellaneous wood-using facilities.

The demand for timber products is expected to increase steadily in the future, with production being limited only by the available supply. Gross product originating by the year 2020 is projected to be $339 million under Program A and $491 million under Program B.

MINING

The value of mineral production in the region in 1969 was $4.6 billion (in 1967 dollars), or about 18 percent of the total national output. During that year, the region accounted for 34 percent of the natural gas, 31 percent of the natural gas liquids, 25 percent of the petroleum, 20 percent of the lead, 20 percent of the bromine, 33 percent of the salt, and 67 percent of the sulphur produced in the United States.

Based upon reserve data, developing mineral projects, and on-going exploration efforts, increased output of all minerals produced in the region is virtually assured through 1980. After 1980, however, problems are expected to occur in connection with the supply of natural gas and natural gas liquids. The production of metallic and nonmetallic minerals is expected to expand steadily through 2020, although some quality problems are expected in the nonmetallic minerals resource base. The value of metallic minerals by 2020 may increase from 75 to 130 percent, while nonmetallic minerals could increase from 230 to 385 percent. The sharp increase expected in nonmetallic minerals production is due to the expected increase in salt and sulphur production in the coastal area through 2020. Overall, the value of mineral production in the region is projected to increase from $4.6 billion (in 1967 dollars) to a 2020 value of $9.5 billion (Program A) or $17.0 billion (Program B)

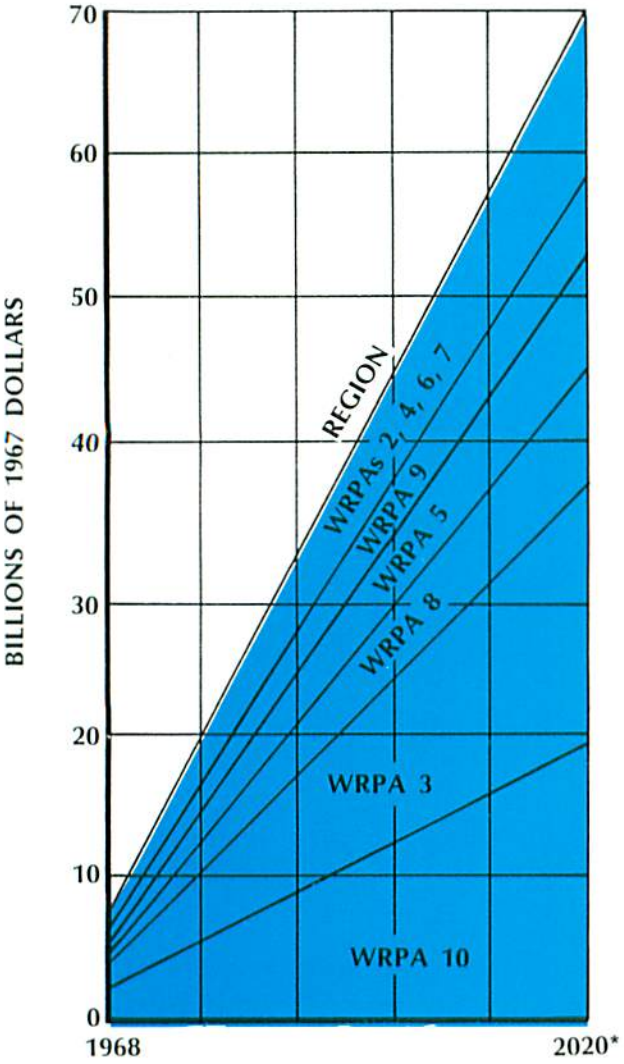
MANUFACTURING

Manufacturing is relatively less important in the region than it is in the nation, but it is steadily increasing in importance. In 1968, six industries were more important in the regional economy than they were in the national economy: petroleum refining, lumber and furniture, paper and allied products, chemicals, food and kindred products, and apparel. These accounted for more than half of manufacturing earnings in the region in 1968. Four of the six (food and kindred products, chemicals, paper and allied products, and petroleum refining) are heavy water users.

NONCOMMODITY INDUSTRIES

Noncommodity industries such as contract construction; transportation, communications, and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and government have experienced substantial increases in employment and earnings during recent decades, as a result of new and growing demands for construction, business services, public utilities, and other social goods and services brought on by increases in urban population and per capita income. By 1960, nearly two-thirds of industry earnings and employment

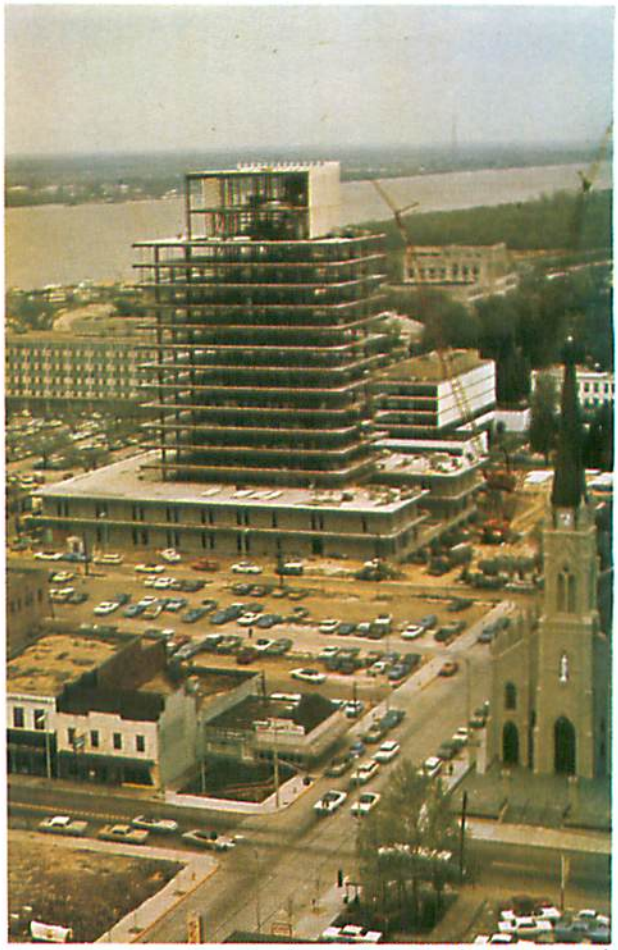
were in this sector. The growth trend is expected to continue (Figure 13).



* Projected under Program A.

Figure 13. Noncommodity Producing Industry Earnings Distribution, Lower Mississippi Region

Projections are that by 2020, 75 percent of the jobs and industry dollars in the region and nation will be in this sector. Earnings in contract construction and in transportation, communications, and public utilities are expected to decrease as a percent of total noncommodity earnings, but are still expected to represent a larger portion of the total, compared to the nation. New growth in professional, business and repair, and amusement and recreation services is expected to offset declines in private household services. Most segments within government are expected to increase to, or near, their national averages during the period, with greater regional concentrations in the military segment. By 2020, the region is expected to account for about 1.6 percent of national noncommodity industry earnings under Program A and 1.9 percent under Program B, compared to 1.4 percent in 1950.



On the banks of the Mississippi, men and machines labor to construct a new high-rise building.

WATER AND RELATED LAND RESOURCES AVAILABILITY

The Lower Mississippi Region has a great natural wealth of water and related land resources. Surface water features include the Mississippi River and its tributaries, a large number of lakes, channels, streams, reservoirs, bayous, swamps, and sloughs. Together, these account for slightly more than three million acres. Land resources are as equally diverse. These include the alluvial valley of the Mississippi River, upland areas along its edges, the rugged elevations of the Ouachita Mountains and Ozark Plateaus, and the unique features of the marsh and estuarine areas along the southern coast. Land resources in all account for 95 percent of the area of the region. Almost all of the land and water resources are suitable for one or more uses.

Wind billows the sails of a boat on one of the many large lakes used for recreation.

Water Resources

The availability and distribution of water from ground and surface sources are discussed in this section, along with development potentials and effects of overdevelopment.

ESTIMATES OF AVAILABILITY

Surface Water

The region's water surface resource covers slightly more than three million acres. As shown in Table 4, about two-thirds of this acreage is in lakes of 500 acres or more (large water), and one-third is in small lakes of 40 to 500 acres and streams more than one-eighth mile wide (small water). Water bodies smaller than two acres are classified as ponds and are included in the category of other agricultural lands. Some of the larger lakes, like Sardis and Grenada in WRPA 4, are man-made reservoirs; one, Reelfoot Lake, was created by an earthquake; and many others are oxbows formed naturally by the meandering of the river. In 1970, the region contained 29 major reservoirs, each with a storage capacity of at least 5,000 acre-feet (Table 5). Combined storage capacity was almost 10 million acre-feet, about 70 percent of which can be controlled for specific uses.

Table 4
Water Surface Availability, Lower Mississippi Region

Planning Area	Water Surface (1,000 acres)		
	Large Water	Small Water	Total
1	368	-	368
2	91	98	189
3	40	32	72
4	74	133	207
5	175	76	251
6	32	40	72
7	38	56	94
8	73	45	118
9	400	138	538
10	939	219	1,158
LMR	2,230	837	3,067

Table 5
Existing Storage in Impoundments, Lower Mississippi Region

Planning Area	Total Storage (Ac-ft.)
1	-
2	582,000
3	6,000
4	4,092,600
5	4,799,100
6	20,500
7	0
8	0
9	39,600
10	0
LMR	9,539,800

Nearly all of the region's surface water resource is suitable for recreational use and for fishing and wildlife habitat. Much of it, in addition, serves commercial navigation, as well as industry. About 474,000 acres of lakes and streams are especially valued for their contribution to the overall environmental quality of the region.

The surface water supply is derived principally from precipitation and runoff, inflows to the region, and ground water. Water not consumed within the region ultimately flows to the Gulf of Mexico or returns to the atmosphere by evaporation or transpiration. About one-third of the annual 52 inches of rainfall reaches surface water supply through runoff. This is equivalent to a mean annual discharge of 80,000 million gallons per day. An additional 292,000 mgd come from the Upper Mississippi and Ohio rivers; and 62,000 mgd from the Arkansas, Red, and White rivers outside the region. Mean annual inflow, therefore, amounts to 434,000 mgd, about 433,000 mgd of which enter the Gulf. The difference is accounted for by unmeasured discharges to the Gulf through salt and brackish marshes along the coast.

The annual discharge values represent the ultimate quantity of streamflow that can be made available for use. This quantity, however, cannot be realistically obtained because of physical limitations of available storage sites and increases in natural losses that occur with development. The availability of water supply from rivers and streams, therefore, must be defined on the basis of percent of time a given flow is available. Estimates are that a discharge of 220,700 mgd will occur 80 percent of the time; 166,700 mgd, for 90 percent of the time; and 139,800 mgd for 95 percent of the time.

The reliability of streamflow is an important factor in its evaluation as a source of meeting any specified withdrawal need. Failure of supply criteria are normally based on dry weather flows. These are low flows of a stream for a specified duration of time. Failure criteria are usually expressed in terms of the lowest mean seven-day discharge, with a recurrence interval of either 30 years (7-day Q_{30}) or 10 years (7-day Q_{10}). The longer interval is usually used in planning withdrawals for critical uses, such as municipal water supply. The 10-year period is used in stream pollution analyses.

Ground Water

Aquifers containing fresh ground water of good quality underlie most of the region, except for part of the Louisiana coastal area and a small area in central Louisiana. About 80 percent of these water table and artesian aquifers are capable of yielding large volumes of fresh water. Highest yields, often in the range of several thousand gallons per minute, can be obtained from sand and gravel alluvial terrace deposits of Quaternary age. Because good quality ground water is generally available when needed, wells provide most of the public and industrial water supply. In a few localities, demands for ground water have exceeded or are approaching the economically practicable limit of available supply. In most areas, however, the water supply potential is more than adequate to meet present requirements.

The dependable yield from aquifers in the region is conservatively estimated at 16,000 million gallons per day (Table 6). This estimate is based on withdrawals consistent with economically and environmentally acceptable water-level declines.

Table 6
Available Ground Water Resource, Lower Mississippi Region

Planning Area	Non-Artesian Aquifers	Artesian Aquifers	Total
	(Millions of Gallons per Day)		
2	3,155	661	3,816
3	370	769	1,139
4	1,720	34	2,085
5	2,495	249	2,744
6	1,932	55	1,987
7	116	155	271
8	414	540	954
9	595	2,014	2,609
10	46	310	356
Total	10,843	5,096	15,939

* Based on flow-through produced by hydraulic gradient resulting from an average drawdown of 200 feet during a 50-year period.

DEVELOPMENT POTENTIAL

The region contains a number of sites which have the potential for surface water development through impoundments (Table 7). Only a small portion of total streamflow can be economically impounded, however, because of the terrain features of the area. Total dependable yield from all potential impoundment sites is estimated to be in the range of 4,500 mgd to 6,500 mgd.

EFFECTS OF OVERDEVELOPMENT

Because of the vast quantities of water available in the region, few cases of over-

development are foreseen within the 50-year timeframe of this study. Those instances that do appear likely involve localized ground water withdrawals in excess of ground water replenishment. Such overdevelopment can result in lowered water tables, land subsidence, increased pumping costs, and water shortages.

Table 7
Surface Water Area Development Potential, Lower Mississippi Region

Planning Area	Surface Water Area (1,000 Acres)		
	Large Lakes[1]	Small Lakes[2]	Total[3]
1	0	0	0
2	14	99	113
3	158	511	669
4	14	146	160
5	50	230	280
6	0	15	15
7	88	70	158
8	0	155	155
9	140	0	140
10	14	2	16
LMR	478	1,228	1,706

[1] Water bodies over 500 acres in size.

[2] Water bodies between 40 and 500 acres in size.

[3] Excluding lakes between two and 40 acres in size, and ponds less than two acres in size.

Land Resources

Regional land resources occupied 62 million acres in 1970. Nearly 58 million acres of this was classified as agricultural land, as defined by the conservation needs inventory conducted by the Soil Conservation Service of the U.S. Department of Agriculture in 1966-1967. This inventory was made to develop detailed data on land use and conservation treatment needs on non-federal rural lands. Excluded from the inventory acreage were federal lands, urban and built-up areas, and surface water bodies, together accounting for about eight million acres.

LAND RESOURCE REGIONS

The Soil Conservation Service has divided the United States into 20 land resource regions, which in turn have been divided into 156 major land resource areas, on the basis of particular patterns or combinations of soils, climate, water resources, land use, and types of farming. The Lower Mississippi Region contains parts of five land resource regions and 12 land resource areas, as shown in Figure 14. About one-third of the region is located in the Southern Mississippi Valley Alluvium; another one-third is located in the Southern Mississippi Valley Silty Uplands; and about one-fourth is located in the Southern Coastal Plains of Mississippi, Tennessee, Louisiana, and Arkansas. Much of the remaining land area is located in the Gulf Coast Marsh and Gulf Coast Prairie of Louisiana; the Ouachita Mountains of Arkansas; and the Ozark Highlands in Arkansas and Missouri.

LAND CAPABILITY CLASSIFICATION

The suitability of land for the production of crops, pastures, forests, and other vegetation is a function of soil properties and other factors that may vary from area to area. In order to define this natural variation, the U.S. Department of Agriculture has grouped all soils available for agricultural use into eight land capability classes, based on limitations of soils, the risk of damage in use, and their response to use. Generally, the agricultural capability of soils decreases from Class I to Class VIII. Soils in the first three classes are suitable for use as cropland, pasture, forests, range, and wildlife food production and cover, with only minimal limitations. As indicated in Figure 15, about six out of every 10 acres of agricultural land in the region are included in these three classes.

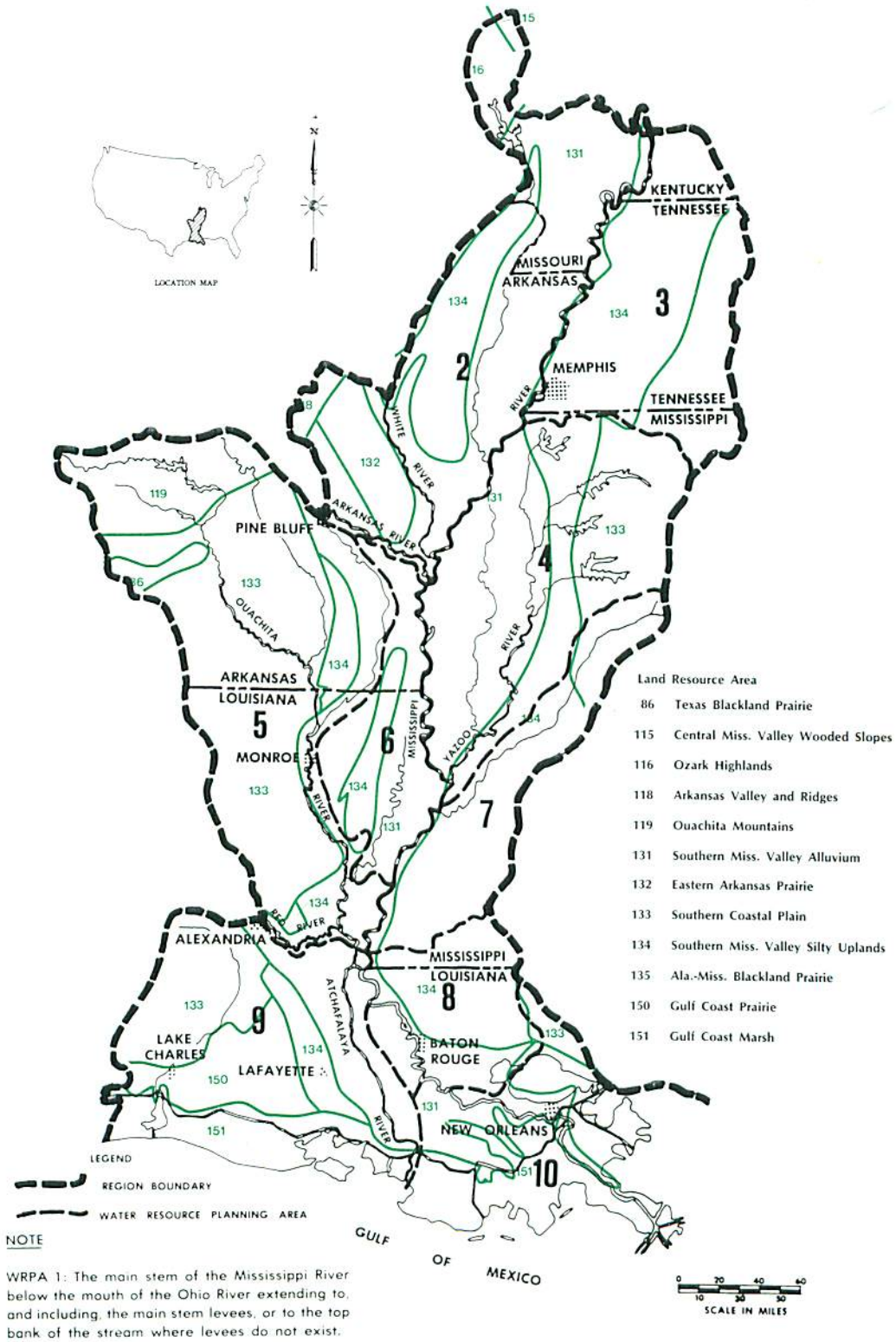


Figure 14. Land Resource Areas, Lower Mississippi Region

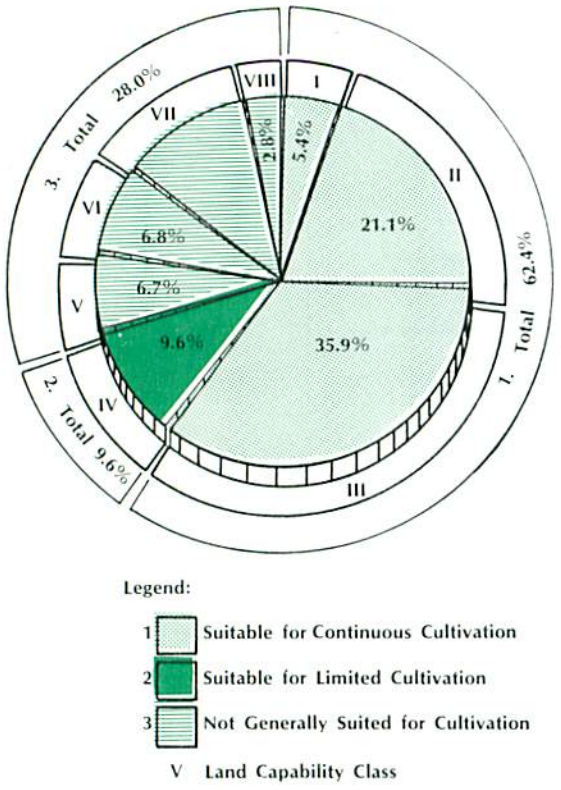


Figure 15. Land Capability Classes, Lower Mississippi Region

Soils in Class IV are suited to the same uses as classes I-III, but crop yields are usually low and only two to three crop types can be grown successfully. About 5.5 million acres of agricultural land in the region are classified in this category.

Classes V and VI contain marginal lands which are not well suited to cultivation, but are adequate for pasture, range, forests, and wildlife food production and cover. Included in these two classes are about eight million acres, most of which is in forests.

About seven million acres are included in Class VII, which is unsuitable for cultivation and not well suited to pasture use. These lands are best used for grazing, forests, and wildlife. Most of the Class VII acreage was in forests in 1970. The nearly two million acres of land in Class VIII are composed primarily of other lands, which are suitable only for recreation, wildlife, and esthetics. Nearly two-thirds of the Class VIII lands are located in WRPA 10, in the form of marshes and coastal dunes.

Erosion, wetness, and unfavorable soil conditions are major factors affecting land capability. In 1970, about 19 million acres of land had an erosion problem or were subject to erosion, and nearly 34 million acres had a wetness hazard. Unfavorable soil conditions, such as shallowness of rooting zones, stones, low moisture-holding capacity, low fertility, and salinity or sodium, were adverse factors on about two million acres.

LAND LOSS THROUGH SUBSIDENCE/EROSION

Erosion affected about 19 million acres of land in 1970, plus about 11,000 miles of stream banks. This erosion produced nearly 153 million tons of sediment, for an average rate of about seven tons per acre. Nearly two-thirds of the affected acreage was in forests and woodlands. In most areas along the coast, aggradation from additional vegetation and sediments is not sufficient to offset erosion and the consolidation of previously deposited materials. As a result, practically all of the shoreline, except for the Mississippi River delta area, is in retreat (Figure 16). The average subsidence is estimated at about one-half foot per century. Because of the very low elevation of the marsh, any subsidence or loss of barrier islands now extending along part of the zone will increase vulnerability to wave attack.

POTENTIAL LAND USE SHIFTS

An estimated four and one-half million acres of grassland in the region have been described as susceptible or feasible for development as cropland. Much of this acreage could be put into cultivation simply by turning the sod. The remainder would require the application of drainage or erosion control practices, and in some instances, clearing of scrub timber and brush. In addition, about 13 million acres of forests could be converted to cropland. This

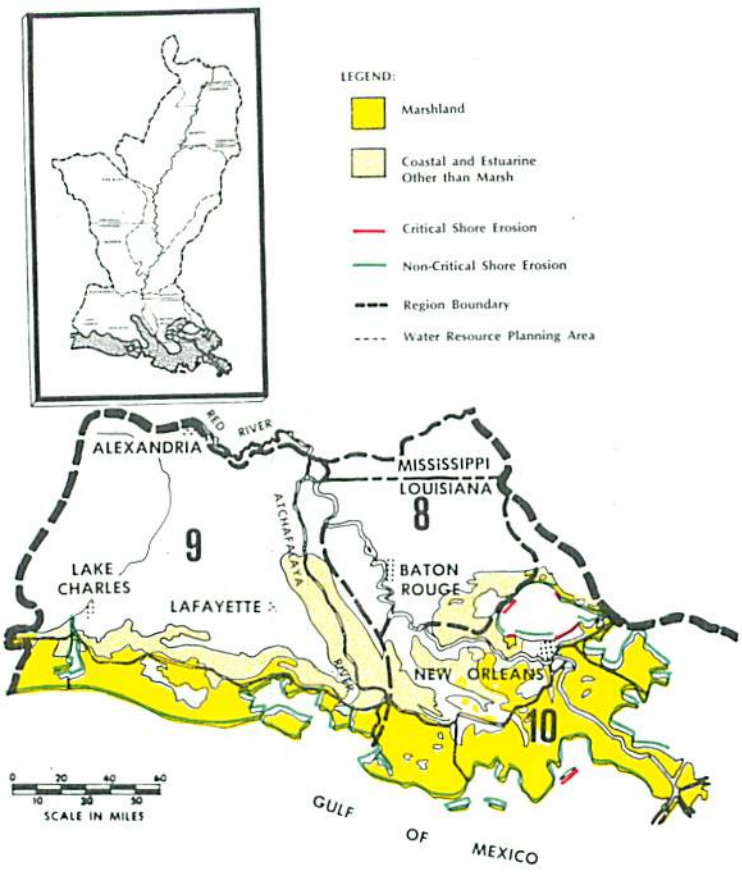


Figure 16. Subsidence and Erosion in Coastal and Estuarine Zone

acreage includes 342,461 acres now in generally level and fertile forest, which would make Class I cropland; about four million acres suitable for Class II cropland if simple erosion control practices are followed and fertility is corrected; and about eight million acres suitable for Class III cropland if special erosion control and soil management practices are followed. Partly offsetting this potential shift to cropland are an estimated half million acres of cropland that are best suited to grasslands or forests. This is primarily land which has so much slope that it should be kept in continuous sod or tree cover. No estimates were made of land use changes for the three and a half million acres of other land in the region, primarily because of the diversity of uses made of this land.

EFFECTS OF LAND USE CHANGE

The clearing or drainage of land for crop production increases the availability of land to meet projected increases in food and fiber requirements of the region and the nation. The harvesting of forest products produces benefits to the economy and meets increasing industrial demands. Adverse effects stemming from these changes include the loss or displacement of wildlife, alteration of recreational values, and increases in sediment and pollution loads. The conversion of cropland to grassland and forests partly offsets these effects, but reduces the amount of land available for production of food and fibers so essential to an ever-increasing population.

PRESENT RESOURCE MANAGEMENT, USE, AND DEVELOPMENT

The present utilization and management of water and related land resources are discussed in this section as a basis for understanding the role each plays in the economic and social spheres of the environment. Resource elements covered in the discussion are similar to those included in the study appendixes. Basically, these can be grouped into four broad categories: water withdrawals, or supply; water surface area; land area; and related problems.

Water Supply

In 1970 nearly 20 billion gallons of water were withdrawn each day from regional surface and ground water sources to meet requirements for nine categories of use: municipal, industrial, rural domestic, thermoelectric, irrigation, other agriculture, minerals, fish and wildlife, and commercial fishing (Figure 17). About four of every ten gallons withdrawn were consumed. The majority (63 percent) of withdrawals came from fresh surface water supplies such as the Mississippi River and its tributaries. About eight percent was from brackish surface water sources in the coastal WRPAs. The remainder came from ground water supplies, principally fresh water aquifers such as those underlying the alluvial valleys of the Mississippi and Red rivers.

More than 90 percent of water withdrawals in 1970 were used for industrial, irrigation, thermoelectric, and fish and wildlife purposes. Industry alone accounted for nearly 30 percent of the total, with the heaviest withdrawals occurring among major water-using industries along the lower reaches of the Mississippi River.

Agricultural irrigation accounted for about one-fourth of 1970 withdrawals. The largest portion of withdrawals was used in the production of rice, the only major crop requiring irrigation. The remainder was applied to soybeans, cotton, corn, pastures, and vegetable crops to increase unit production. Although there was no widespread shortage of irrigation water, water tables in some areas have declined to the point that careful management of ground water is required to insure adequate supplies for the future. Salt-water encroachment in portions of the coastal area continues to be a problem, but so far this situation has not seriously affected irrigation practices.

About one-fourth of 1970 withdrawals was used by thermoelectric power plants, primarily for condenser cooling purposes. There were no reported shortages in this area.

Withdrawals for fish and wildlife purposes amounted to less than one-fifth of the total. Most of this was used to provide water surface for duck resting areas, for maintaining mast production in green tree reservoirs, and for maintaining lake levels for sport fishing.

Municipal water supply systems used about three percent of the total withdrawal. Municipal systems, including rural water districts, supplied water to nearly five million people, or about 70 percent of the population. Two-thirds of the withdrawals were from ground sources, generally of good quality and requiring little treatment. Surface water withdrawals, mainly that from the Mississippi River, often required coagulation, sedimentation, filtration, taste and odor removal, and sterilization, in addition to treatment practices normally applied to ground water, such as chlorination, aeration, and iron removal. For the most part, municipal water supply needs were satisfied without noticeable shortages in 1970, although some isolated problems did occur as the result of insufficient capacity, land subsidence, or salt-water intrusion.

There were similarly no reported shortages of water for the minerals industry in 1970. Most withdrawals in this category were used for petroleum drilling and secondary recovery operations, mining of sulphur, metallic mineral ore washing, and production of nonmetallic minerals, cement, and salt.

Withdrawals for commercial fisheries, rural domestic supply, and other agricultural purposes constituted a very small percentage of the total. All of the water withdrawn for fisheries was used in the production of catfish and crawfish, and withdrawals for other agricultural purposes were used principally for watering livestock and poultry. Most rural domestic withdrawals were from individual wells which collectively furnished supplies to about 27 percent of the population.

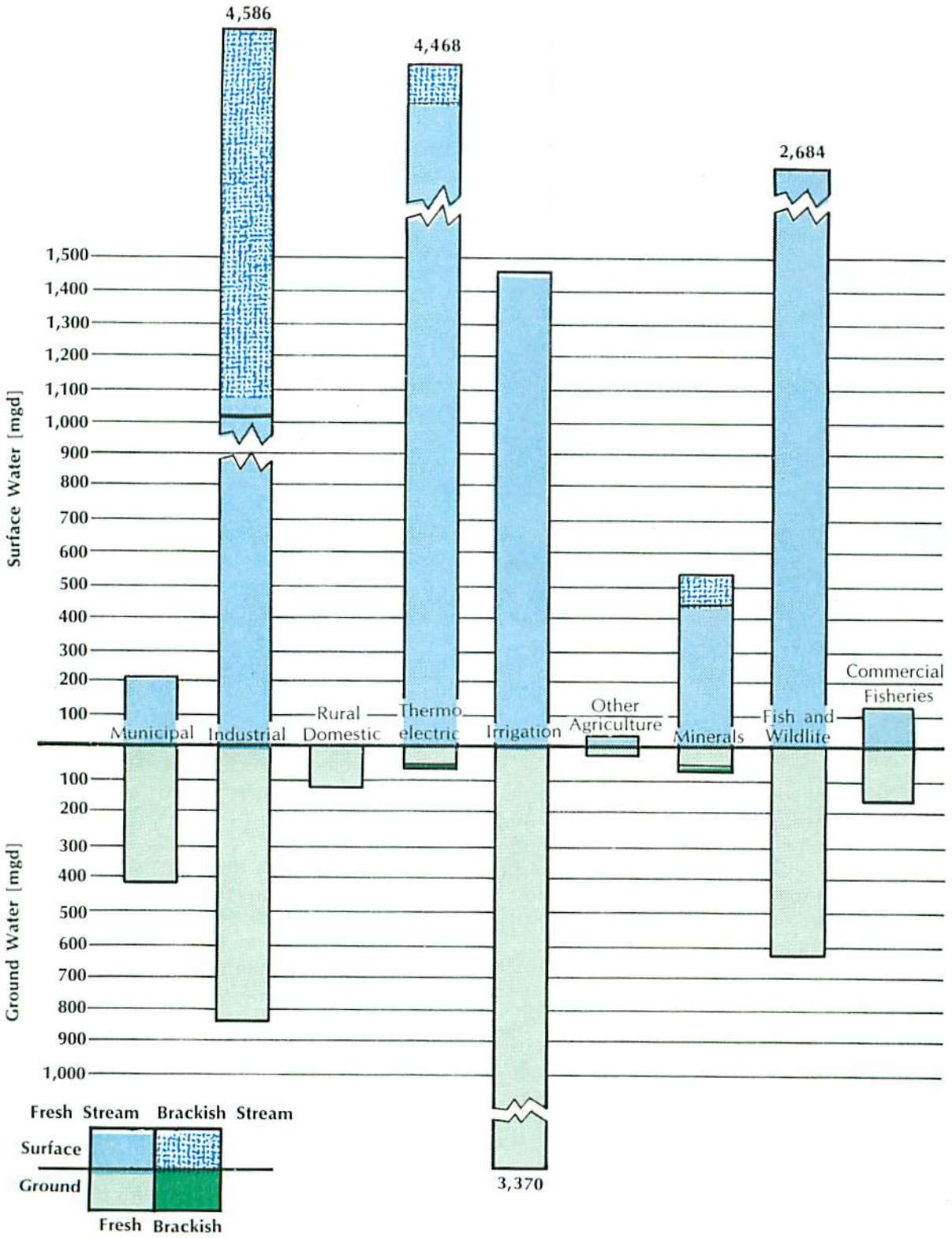
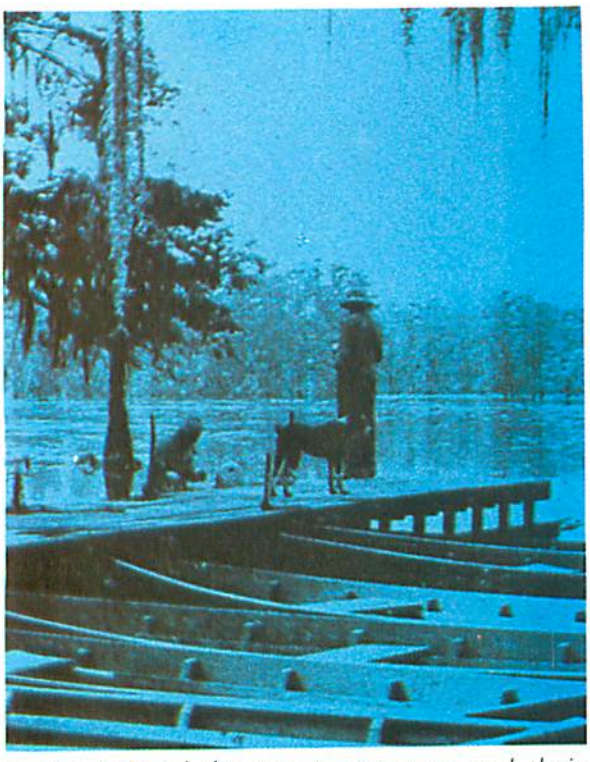


Figure 17. 1970 Water Withdrawals, by Category of Use, Lower Mississippi Region



In the light of the moon, two men and their canine friend end a day on the water.

Water Surface Area

The three million acres of surface water in the Lower Mississippi Region provide opportunities for recreational activities such as swimming, boating, water skiing, and canoeing; serve as habitat for fish and wildlife; and offer scenic qualities and other attributes which enhance environmental quality.

RECREATION

The region's abundant surface water resource, in combination with a mild climate and increased leisure time, help make outdoor recreation activities a popular pastime regionwide. Although extensive, surface water supplies are rather poorly distributed relative to some major population centers, such as Memphis. In 1970, about one-third of the two million acres of lakes and reservoirs with the potential for supporting recreational activities were in coastal lakes individually covering 500 or more acres. In WRPA 3, there was a serious need for lakes over 500 acres; moreover, there were several WRPAs which had a critical deficiency of lakes 40 to 500 acres in size. Because of inadequate supply, some recreationists in areas like Memphis probably spent a considerable amount of time and money on travel to avail themselves of water areas. Regionwide, however, most of the available water resource is suitable for intensive recreational activity. In 1970, it supported nearly 68 million user-days.

FISH AND WILDLIFE

Regional water and land characteristics allow bountiful amounts of nutrients and animal stocks to be transported over wide areas, resulting in a high productivity of fresh and salt water fish species. The region's diverse surface water resource provides suitable habitat for both varieties. Fresh water fish habitat includes about 8,000 miles of streams, three million acres of lakes, and about a half million acres of small ponds. Extensive inshore salt water finfish habitat is found in the salt and brackish water bodies in WRPAs 9 and 10. These areas also support important commercial species such as shrimp, oyster, blue crab, seatrout, croaker, and red drum. Additional habitat for commercial salt water species is provided in the intermediate and fresh water marsh areas, also located in WRPAs 9 and 10.

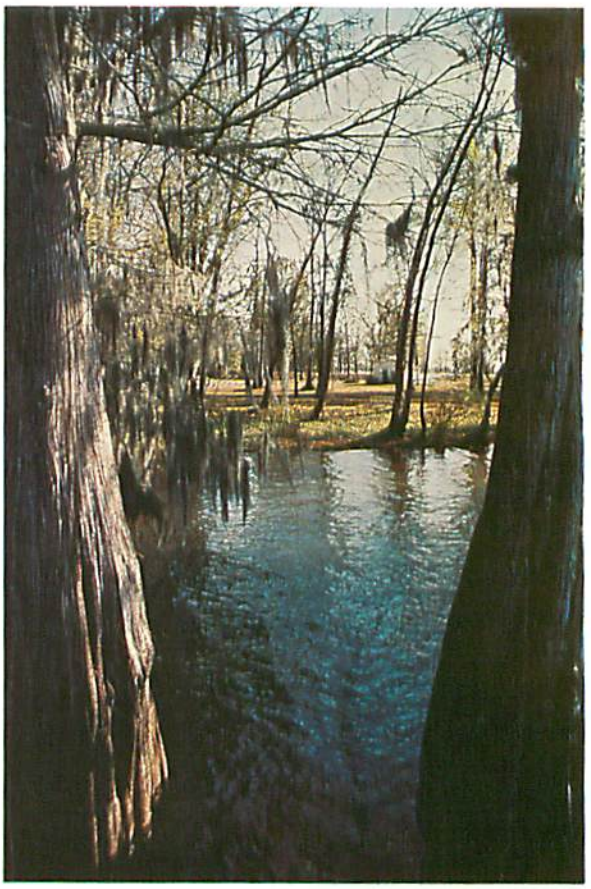
Associated with the rich fish resource are sport and commercial fishing activities and other forms of wildlife-oriented recreation. One of the most popular leisure-time activities is sport fishing, with an estimated 1970 usage of 28 million angler-days. Forty percent of this activity occurred on lakes. Additional demand for crabbing and shrimping is estimated at about two million user-days. Expenditures for lodging, transportation, equipment, licenses, fees, leases, bait and food totaled $223 million in 1970. Resource availability far exceeded use on all water bodies except streams. Problems in the latter case stemmed primarily from inadequate public access and from water pollution and channel alterations which rendered certain streams unusable.

ENVIRONMENTAL QUALITY

A substantial portion of the region's surface water area has been identified as having significant environmental quality because of natural splendor, esthetic quality, or other unique attributes. Included are 446,000 acres of lakes and 28,000 acres of rivers and streams (or about 2,362 miles). About one out of every three miles of environmentally significant rivers and streams has already been named in enacted or pending scenic rivers legislation of the states, and virtually all of the lake acreage is under some form of protective ownership or management. Many of the lakes, in addition to their scenic attributes, harbor unique ecological systems. In many instances, full enjoyment of scenic rivers and lakes is hampered by the lack of legal access. The sparsely developed and wooded shorelines of these water areas are furthermore subject to alteration whenever economic conditions warrant the removal of timber to allow agricultural development, or to provide raw materials for industry.

LAND RESOURCES

Continuing increases in population and in demands for food and fiber, minerals, industrial products, and recreation opportunities have intensified competition among a number of land uses. This competition is expected to become increasingly more intense within the near future as population and demand continue to rise. The 63 million acres of land in the region currently support a multiplicity of competing needs. Major uses are cropland, permanent pasture, pastured cropland, forests, transportation, urban and built-up, mineral production, recreation, fish and wildlife, environmental quality, and other lands. The last category includes not only unavoidably idle agricultural tracts, but also miscellaneous lands, rural roads, nonforested public lands, and the like. As indicated later in this discussion, some of these lands already serve several uses, and plans are that they will serve a larger and even more diverse number of purposes in the future.



A gentle breeze stirs the water at Lake Bruin State Park.

OWNERSHIP

More than nine out of every ten acres of land are privately owned by individuals, families, large and small farming enterprises, corporations, or some combination of these. Forests represent the largest single use of privately owned land. Lands owned or leased by the federal government total about two million acres, most of which are in national forests and parks and in wildlife and refuge areas. The remainder of public lands is owned by state, county, municipal, and other taxing entities, either individually or collectively. These lands are used for a variety of purposes, from small water areas to cropland. Large water areas are owned primarily by the states.

TREATMENT, MANAGEMENT, AND CONSERVATION

In 1970, approximately 19 million acres, or about one-fourth of the land in the region, had been adequately treated to reduce erosion and sedimentation and to aid in the reduction of surface runoff. Land treatment and management measures include crop rotation, pasture improvement, terracing, grassing of waterways, contour farming, drainage, land leveling, tree planting, and timber stand improvement. Drainage works are especially important in providing for the efficient and economical production of crops and forage. In 1970, more than 17 million acres of land in the region were contained in 2,000 organized drainage enterprises. Participants included drainage and levee districts, counties, watershed improvement districts, farmers' groups, and individual owners and operators.

CURRENT USE

The status of land resources development in the region is reflected in current patterns of land use. As indicated earlier in this section, the region's land area is capable of supporting a number of diverse activities, primarily because of favorable climate and soil conditions. Nearly one-half of the land area was in forests in 1970 (Figure 18), the major types being oak-gum-cypress, elm-ash-cottonwood, oak-hickory, oak-pine, loblolly-shortleaf pine, and longleaf-slash pine. Since 1959, forested acreage has been converted to other agricultural uses at the average rate of 230,000 acres per year.

About 17 million acres, or 31 percent of the region, was in crops. The acreage represented nearly half the land classified as suitable for continuous cropping. The annual harvest included substantial quantities of cotton, corn, soybeans, rice, wheat, sugarcane, and other commodities such as food and feed grains, tobacco, sorghum, peanuts, peas, potatoes, hay, and assorted vegetables. Nearly 14 million acres were in pasture, supporting production of five and a half million head of livestock. Half of the acreage was permanent pasture, and the remainder was pastured cropland and pastured forests.

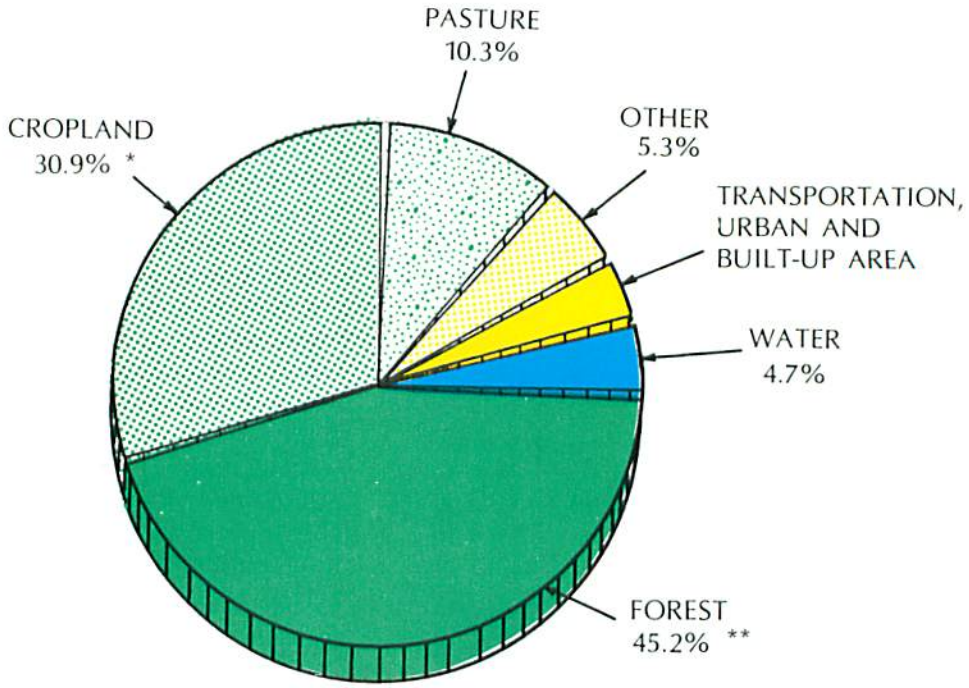
The 3.5 million acres classed as other land in 1970 included farmsteads, rural farm roads, feed lots, levees, drainage ditches and ditch banks, fence and hedge rows, rural residences, investment tracts, coastal dunes, and mineral lands. The category also included unforested federal land and marshlands not used for grazing. The latter use accounted for two-thirds of all lands in the category.

Cities and towns of 1,000 or more population and numerous smaller communities and their associated facilities occupied slightly more than two million acres in 1970. These urban and built-up areas contained the vast majority of the regional population. Sixty percent of the total resided in cities and towns with 2,500 or more inhabitants.

The commercial production of catfish and crawfish occupied 46,000 acres of shallow man-made ponds in 1970. This requirement is expressed in land area rather than water surface because these ponds are a dynamic part of the agricultural industry. Water withdrawal requirements for this category are included, however, in the previous discussion of water supply.

Lands used for mineral production totaled 67,000 acres in 1970. About 40 percent of this acreage was devoted to the mining of metallic and nonmetallic minerals in WRPA 2, and an additional 20 percent was used for petroleum production in WRPA 10.

Nearly 100,000 acres of land in 1970 were suitably developed for outdoor recreation activities. An additional two million acres were under suitable ownership for recreation, but most of the acreage had limited access and no development. About 16 percent of the 100,000 acres were highly developed and within, or in close proximity to, population concentrations (Class A). One-third of the acreage was within a reasonable driving time of urban areas, but had limited developments (Class B). The remainder was more wilderness-oriented, with little or no recreation development (Class C). The three land classes supported 577 million user-days of various land-based recreation activities. Although there are no regional acreage statistics



* Includes pastured cropland

** Includes pastured forest land

Note: Lands used for fish and wildlife and for recreation are not identified, but are included in categories shown.

Figure 18. Current Land Use, Lower Mississippi Region

on actual 1970 use, the needs for developed areas was estimated at 182,000 acres. Major inadequacies exist locally in regard to classes A and B because of poor resource distribution relative to population concentrations and because of the lack of development on available acreages. Pronounced overcrowding occurred in and near New Orleans and Memphis in 1970. These cities accounted for about one-fourth of regional population, but contained only about one-tenth of the lands developed for recreation.

Essentially all of the land provides habitat for one or more species of wildlife. Even urban and built-up areas support some songbirds, insects, reptiles, and mammals. For the most part, however, fish and wildlife habitat is provided by the region's vast acreages of forest land, wetlands, and agricultural lands. About one-fifth of the land area in 1970 was specifically dedicated to or oriented toward wildlife management. Because of effective management techniques, there are now more deer in the region than are thought to have existed at any other time, and other rare or endangered species, such as the American alligator, are being reintroduced into certain areas.

Wintering waterfowl soar aloft near a water body in the Arkansas portion of the region.

Hunting activities center around big game species such as white-tailed deer and Eastern wild turkey and a number of small game species. Hunters represent a smaller proportion of the regional population today than in years past, but their absolute numbers have increased, as well as their income and leisure time. As a result, increasingly more pressure is being exerted on the region's wildlife and waterfowl resources. Sport hunting demand in 1970, expressed in hunter-days, is estimated at nearly two million for big game; six million for small game; and 827,000 for waterfowl. Expenditures associated with these activities totaled $82.5 million. Other forms of non-consumptive wildlife-oriented recreation, primarily bird watching and nature photography, had a total 1970 demand of three million user-days. Problems in meeting the needs of sportsmen stem from continuing losses of habitat and a general lack of access to available habitat.

Lands possessing special environmental quality attributes include about 12 million rural acres and about 13,000 acres of open and green space in urban areas. Much of this is rural acreage that falls within more than one environmental category. The principal components are nearly 11 million acres of indigenous bottomland hardwoods in low-lying marshes and swamps; one million acres of wetlands; 850,000 acres of unique geological systems, and about 660,000 acres of near-wilderness. Other components account for significantly smaller acreages. These include unique ecological systems and beaches and shores, each covering about 175,000 acres; and lands bordering scenic lakes and streams, which occupy about 140,000 acres.

Related Problems

This discussion of related problems covers the elements of flood control, sediment and erosion, excessive wetness, water quality, navigation, energy, coastal and estuarine resources, archeological and historical resources, and health aspects.

FLOOD CONTROL

The lower valley of the Mississippi River has been the site of several devastating floods during this century, the most recent occurring in 1973, with high water continuing into 1974 (Figure 19). The frequency and severity of flooding in the area are related to three important factors: (1) the region drains 41 percent of the conterminous United States, plus two Canadian provinces; (2) rainfall is abundant year-round, with intense activity often occurring during short periods; and (3) about one-half the land area of the region is subject to flooding, as in the case of the vast and relatively flat Mississippi River flood plain, which is composed primarily of impermeable materials underlain by a water table near ground surface. In addition, the region is subject to the devastating effects of tidal floods from hurricanes, especially in the low-lying coastal areas.

Safe human habitation and continued economic growth in the area are thus dependent upon effective flood control measures. At the present time, these include the Mississippi River and Tributaries (MR & T) Project, now less than half complete; four hurricane protection projects in the coastal area, which are still far from complete; major non-MR&T tributary basin projects; and a number of small local protection projects constructed over the years.

The MR&T Project, authorized by the Flood Control Act of 1928, is an effective blend of three major elements designed to control the "project flood," which is eleven percent greater than the record flood of 1927 at the mouth of the Arkansas River and 19 percent greater at Vicksburg, Mississippi.

The major elements of the project are the Mississippi River system of levees and floodways, Mississippi River channel improvements, and tributary works. The first element includes more than 2,200 miles of levees and floodwalls, plus the Birds Point-New Madrid, Atchafalaya, Morganza, and Bonnet Carre floodways. All of these floodways are operational, and all but 28 miles of levees and floodwalls are in place. The channel improvement feature consists of concrete revetments, dikes, cutoffs, and dredging at various locations along 950 miles of the river. These works serve several important functions: they maintain alignment and flood-carrying capacity, protect the levee system, and provide a navigable channel for the nation's busiest inland waterway. Existing and authorized MR&T project works in basins tributary to the Mississippi include 1,666 miles of levees and nearly 5,000 miles of channels, plus 25 large pumping plants with a total capacity of 30,000 cfs and five major reservoirs with a total flood control storage of 4.4 million acre-feet. Of these tributary works, the five reservoirs, approximately 2,800 miles of channel improvement, 1,100 miles of levees, and 18 pumping plants (with 19,100 cfs total capacity) were completed or nearly complete in 1973.

The hurricane protection projects, major non-MR&T reservoirs, and many local protection projects that make up the remainder of the existing flood control works in the region consist of a total of 450 miles of levees, 7,826 (main stem subtracted) miles of improved channels (mostly PL 566 projects), 19 pumping plants, three major reservoirs with a total capacity of 8,516 cfs, three major reservoirs with a total storage of 972,000 acre-feet, and numerous small flood water retarding structures with a total storage of 664,100 acre-feet.

Non-structural measures include land treatment and technical assistance. They also include flood plain management, flood forecasting services, and hurricane, storm surge, and storm tide forecasts.

Clearly, much has been accomplished in the area of flood control, but much remains to be done. For the MR&T Project, considerable construction is required on the Mississippi River floodways, especially the Atchafalaya, to insure sufficient flow-carrying capacity. More than 800 miles of the mainline levee system, although in place, are considerably below full grade and section. Channel improvements on the river require additional work to provide for the channel dimensions and alignment required to fulfill project objectives. Until these features of the MR&T Project are completed, the flood situation in the region must be considered critical.

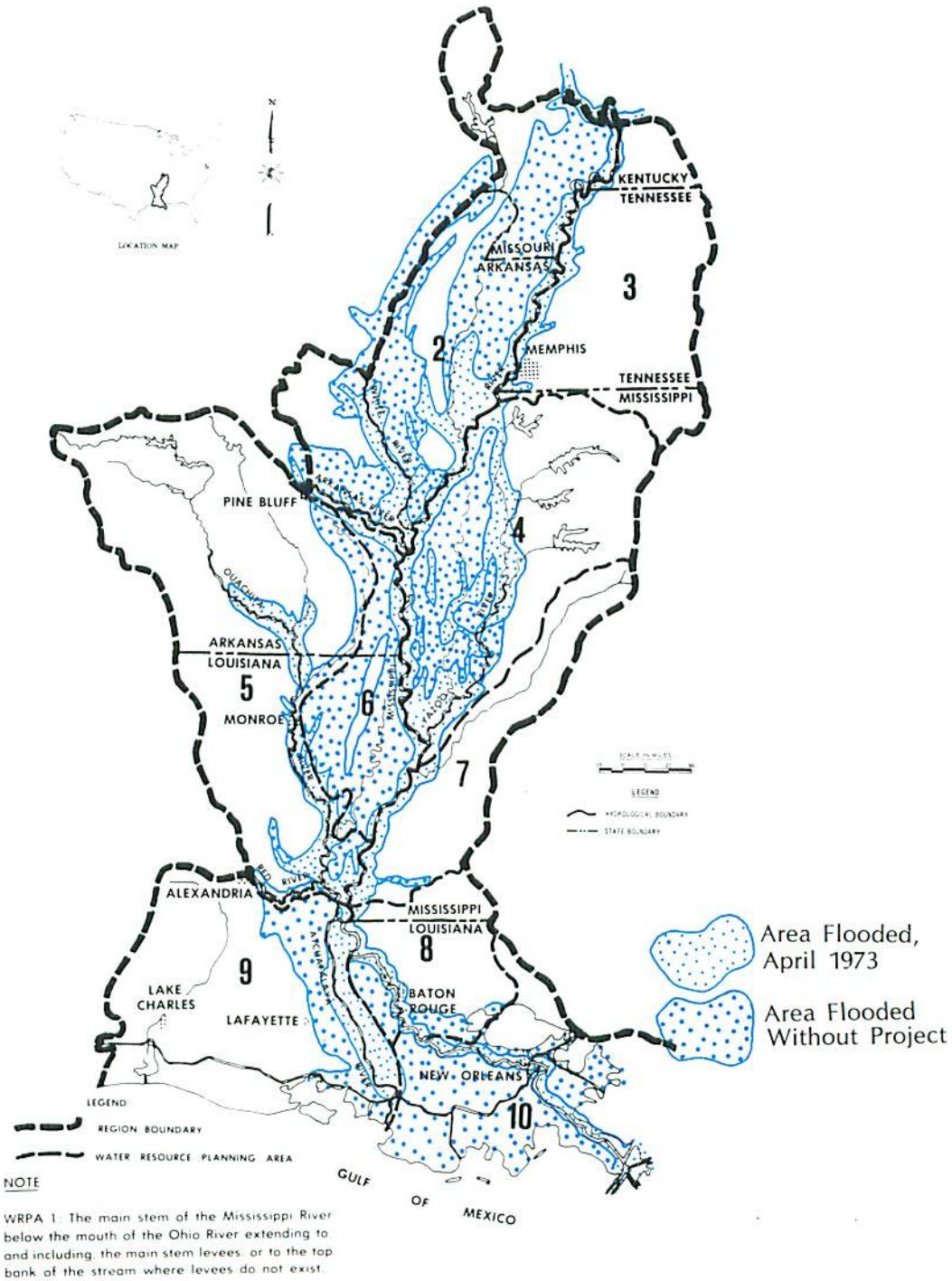


Figure 19. Extent of Flooding in Lower Mississippi Region, 1973

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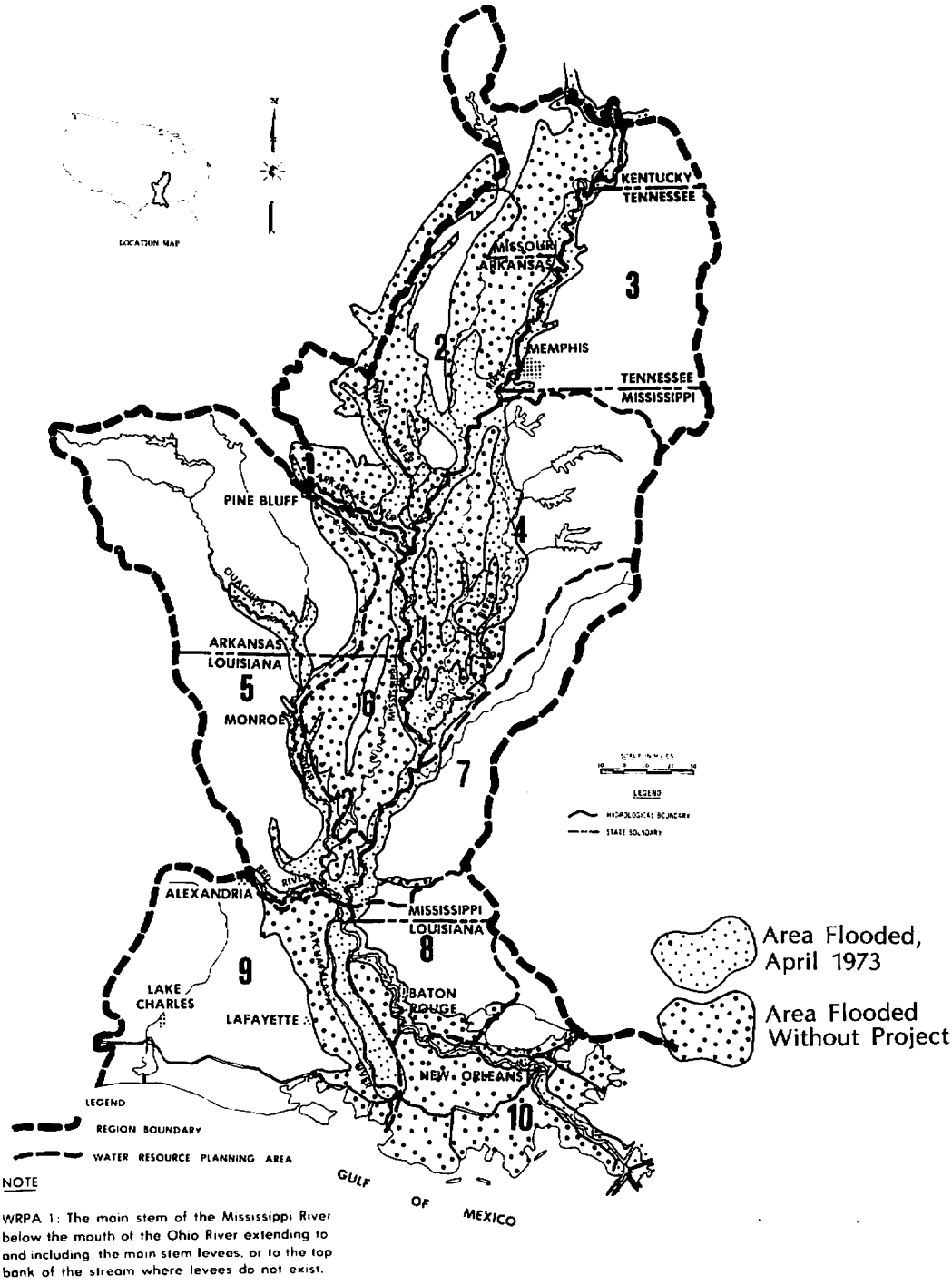


Figure 19. Extent of Flooding in Lower Mississippi Region, 1973

Much remains to be done in relation to non-MR&T projects, as well. Completed components of the four hurricane projects provide protection to only a small portion of the total area intended. In upstream watersheds, many PL-566 projects have not yet been completed.

At the current time, therefore, about one-half of the region's land area is subject to flooding, with average annual damages estimated at $212 million (1970 conditions). Roughly two-thirds of the annual flood damages are agricultural, about 20 percent are urban, and the rest are miscellaneous. Most of the damage (about 85 percent) is the result of headwater flooding on major tributary streams and in upstream watersheds. In the coastal area, tidal flooding is a major problem, accounting for nearly 60 percent of all urban flood damages in the region. Backwater flooding is a problem throughout the region, but is not so serious as the other types of flooding.

SEDIMENT AND EROSION

Erosion affected 19 million acres of land and 11,000 miles of streambank in 1970, causing $15 million in damages and producing nearly 133 million tons of sediment. The average annual gross erosion rate per acre was seven tons, ranging from 13 tons per acre in WRPA 3 to less than one ton per acre in WRPA 1. Nearly two-thirds of the land affected was in forests and about 20 percent was in crops.

EXCESSIVE WETNESS

Nearly six of every ten acres of land in the region had a wetness problem in 1970 which imposed limitations on some potential uses. About 42 percent of this acreage was used for crops, 41 percent for forests, and 17 percent for pasture and other purposes. Requirements for drainage of the land varied, however, as a result of the complex interrelationships among several factors, such as climate, cropping patterns, tillage practices, plant tolerance to water, and the particular configuration of drainage practices in effect at the time. In 1970, these factors were such that only eight and one-half million acres of cropland and pasture had a wetness problem which caused significant losses to agricultural production. Drainage was not needed on the excessively wet forest land.

Past drainage works in the region have been established by drainage and levee districts, counties, watershed improvement districts, farmers' groups, and individual owners and operators. In recent years, federally assisted projects by the U.S. Army Corps of Engineers have resulted in establishment of some major drainage outlets. Additional support for drainage improvements have been provided through Public Law 566 (the Watershed Protection and Flood Prevention Act), Section 102 of the Food and Agriculture Act of 1962, Public Law 87-703, and new and revised state laws. The Department of Agriculture (Soil Conservation Service), under Public Law 566, and through technical assistance to local conservation districts, assists with installation of drainage works. The Department provides additional assistance through Resource Conservation and Development projects, authorized under Public Law 87-703. In 1970, about 84 PL-566 work plans and five Resource Conservation and Development Projects had been approved for operation in the region, many of which contain drainage assistance elements.

Plans approved for operation consist primarily of constructed engineering works, which may represent deepening, widening, or straightening of a natural channel, enlargement or improvement of existing channels, construction of open channels, installation of underground tile or conduits, construction of drainage wells, installation of pumps for water removal, or some combination of these.

WATER QUALITY

Water quality records of at least a three-year duration are available at 460 monitoring stations operated in the region by federal and state agencies. Although the data collected thus far permit assessment of certain aspects of surface and ground water quality, the information is generally inadequate for a meaningful analysis of inorganic pollutants and their effects.

For the most part, surface water bodies have calcium bicarbonate waters of relatively good quality with narrow ranges in quality variation. Sodium chloride waters do occur, however, particularly during low-flow conditions in WRPA 5 and in the coastal zone rivers of WRPA 9. East of the Mississippi River, surface

water is generally soft and low in mineral content, with hardness as calcium carbonate usually less than 50 milligrams per liter. West of the river, hardness and dissolved-solids content varies from place to place, with concentrations generally increasing from north to south. Dissolved solids concentrations range between 100 and 350 milligrams per liter in the north up to 18,000 milligrams per liter in the coastal area. The latter is due primarily to brine from oil field wastes and salt-water intrusion from the Gulf of Mexico. Bacteriological quality, although variable, generally reflects the extent of urban, industrial, or agricultural buildup. Untreated or inadequately treated municipal and industrial wastes caused water quality problems at points along the Mississippi River, in reaches of the Arkansas, Ouachita, Calcasieu, and Vermilion rivers, on Bayou Teche, and in lakes Pontchartrain, Borgne, Calcasieu, Hamilton, and Catherine.

Most ground water aquifers in the region yield calcium bicarbonate waters of good quality. Brackish water high in sodium chloride or sodium bicarbonate does occur locally or regionally in areas of mappable size in these fresh water aquifers. Maximum concentrations occur in the Tertiary rocks of WRPA 7, with 3,490 milligrams per liter sodium and 3,110 milligrams per liter bicarbonate. Ground water high in sodium chloride occurs locally in rocks of Tertiary age, and high sulfate waters occur in some isolated areas.

The U.S. Geological Survey, in a recent unpublished study, identified 35 occurrences of ground water pollution in the region (Figure 20). All but two of these were caused by man, primarily as a result of oil field brine disposal and heavy pumping of fresh water aquifers.

Pollution Sources

A fairly reliable compilation of data is available concerning the treatment of bacteria and biodegradable wastes from agricultural sources, sewered communities, and the 1,059 industries in the region known to produce these types of wastes. These data indicate that the waste loads generated receive varying degrees of treatment. Although 295 of the 315 sewered communities with a population of 1,000 or more operated sewage treatment plants in 1970, these facilities served only 40 percent of the region's population. The remainder used septic tanks or disposed of the sewage untreated. Even when treatment was provided, the average level for municipal wastes varied by state from 50 to 85 percent BOD_5 removal, while the average, regionwide, for industrial wastes was about 55 percent of BOD_5 removal. Removal of harmful bacteria varied even more radically, ranging from five percent in one state to 100 percent in another. Bacterial pollution in 1970 was most serious in the New Orleans and Memphis metropolitan areas.

Data on non-BOD industrial wastes are insufficient to allow quantification of discharge. For this reason, problems caused by thermal wastes, heavy metals, nutrients, toxics, odor, color, and oil and grease can be addressed only in broad terms, although they are recognized as being quite serious. Between St. Francisville and Venice, Louisiana, 60 industries discharge highly concentrated non-BOD wastes into the Mississippi River. The extent of pollution is reflected in the fact that fish caught in the river below Baton Rouge are not salable because of off-flavors in their flesh. This reach, however, serves as a raw water supply for 40 utilities serving a population of one and a half million. Treated water supplies at two locations have been found to contain trace amounts of six organic chemicals capable of inducing histopathological changes in animals during chronic toxicity studies. Treated water supplies at two locations have furthermore been found to contain three organic chemicals described as carcinogenic (cancer-producing). Analyses are underway to determine the presence of these chemicals in the treated water supplies in New Orleans.

Water Quality Management Programs

The states of Arkansas, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee each have on-going management programs designed to improve water quality through such measures as stream and effluent monitoring, river basin and state program planning, surveillance and enforcement functions associated with industries, municipalities, and oil field operations,

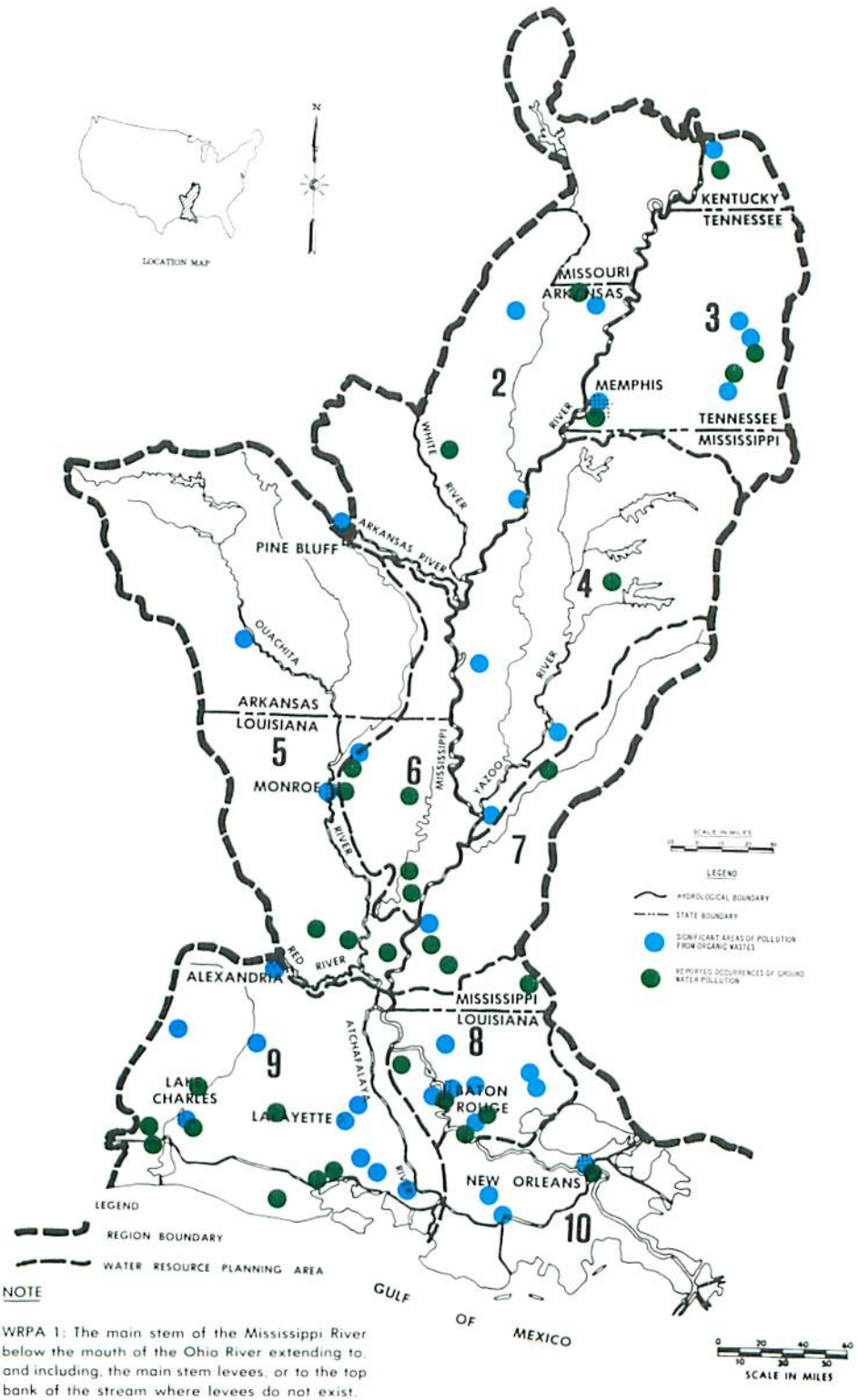


Figure 20. Sources of Ground and Surface Water Pollution, Lower Mississippi Region

plant operator training and certification, and laboratory analysis. The work of state agencies is supplemented by the efforts of three federal agencies--the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers, and the U.S. Geological Survey (USGS). The EPA assists states in preparing water quality management programs through grants and technical assistance, and maintains a water quality monitoring network on interstate waters. The Corps of Engineers, under its new urban studies program, is conducting three-year studies of the New Orleans, Baton Rouge, Memphis, and Pine Bluff metropolitan areas. Particular emphasis is given to water supply and pollution problems and to wastewater and storm water drainage management. The USGS, with district offices in each state, operates water quality monitoring networks on inter- and intrastate streams, usually in cooperation with one or more state agencies. Data is published annually, by states, in basic data releases, and is also available from computer storage.

NAVIGATION

One out of every seven tons of waterborne commerce in the United States in 1970 was moved on waterways and through ports in the Lower Mississippi Region. Traffic on waterways of the region totaled nearly 84 billion ton-miles, which is more than one-fourth the U.S. total, and movement through the region's ports amounted to 218 million short-tons. Most of this activity occurred on the Mississippi River and the Gulf Intracoastal Waterway and at the Port of New Orleans. Important commodities moved were petroleum and petroleum products, industrial chemicals, grain and grain products, iron and steel products, nonmetallic minerals, and unprocessed marine shells.

The vast navigational network of the region includes the main stem of the Mississippi River from Cairo, Illinois, to the Gulf, plus 12,000 miles of shallow-draft navigation channels. From Cairo to Baton Rouge (720 miles), the Mississippi River is maintained at a low-water depth of nine feet, and from Baton Rouge to the Gulf, the channel is maintained at a minimum depth of 40 feet. An alternate deep-water route from New Orleans to the Gulf is provided by way of the 76-mile tidewater channel, Mississippi River-Gulf Outlet. In the southwest part of the region, a 35-mile-long channel connects the Port of Lake Charles with the Gulf. The Gulf Intracoastal Waterway complements the Mississippi River system by providing east-west access to shallow-draft traffic moving from Florida to the Texas-Mexico border. The 300-mile segment that crosses the Lower Mississippi Region is the hub of the waterway. In addition to these features, numerous access channels and harbors are maintained along the Mississippi River and other major streams and along the coast.

The rapid growth of waterborne commerce and the transportation industry has resulted in the improvement of more than 3,000 miles of waterways, the expansion of existing facilities at 13 shallow-draft ports and terminals and at the three principal deep-water ports, and construction of navigation locks at 20 locations.

The principal types of vessels on shallow-draft waterways are towboats and tugs, barges, barge tows, and other craft such as fishing boats, oil field crew and supply boats, and offshore construction and drilling vessels.

A miniship enters the channel at Greenville Harbor, one of many shallow-water port facilities in the region.

Deep draft vessels have traditionally been grouped in three categories as general cargo vessels, bulk carriers, and tankers. Today, a rapidly changing marine technology has evolved–the container ship, the barge-carrying vessel, and the combination oil/bulk/ore carrier. The conventional general cargo vessels which require a 500' berth and a transit shed embracing about four acres of land are now giving way to the container ship which may require up to 800' of dock, plus a minimum of 22 acres of marshaling and service areas.

ENERGY

Energy requirements in 1970 totaled 71,221 gigawatt hours, with a peak load of 15,054 megawatts. These requirements were partially met by imported energy from the power market outside the region and were for all categories of use: farms, irrigation and drainage pumping, non-farm residential, commercial, industrial, streets and highways, electrified transportation, and all other.

Within the region, current power supply facilities (in operation at the end of 1970) include 40 plants with an installed capacity of 10,884 megawatts and a 1970 production of 50,713 gigawatt-hours. Four of the facilities are on-the-line hydroelectric plants. These include the Blakely Mountain, Carpenter, and Remmels plants on the Ouachita River, and the Narrows plant on the Little Missouri River.

Construction was underway in 1970 on one hydroelectric project (DeGray), and potential hydroelectric power development existed at seven other sites. The DeGray project on the Caddo River in Arkansas went into service in January 1972 with a dependable capacity of 68 megawatts and with a potential for installation of an additional 40 megawatts. Two of the potentials (Wappapello and Sardis) were improvements to existing projects; two others involved additions to existing licensed projects at the Carpenter and Remmels plants on the Ouachita River. The remaining potential was at three undeveloped sites. Major additions were also scheduled on a number of fuel-electric generating plants, six of which are nuclear plants.

The seasonal diversity exchange between the South Central Electric Companies (SCEC) and the Tennessee Valley Authority (TVA) is the largest interarea transfer in the region. The SCEC utilities experience a decided summer peak because of seasonal air conditioning loads, while the TVA has a high peak load in winter due to the influence of electric heating. In 1970, the exchange totaled 1,500 megawatts, but the amount can be increased if seasonal load differences increase. A smaller exchange occurs between the Southwestern Power Administration and the Missouri River Basin system of the Bureau of Reclamation. The 161-kilovolt interconnection has been used for the transfer of more than 60 megawatts of power to remedy hydraulic and electrical load diversities between the two areas.

COASTAL AND ESTUARINE RESOURCES

The basic character of the coastal and estuarine zone is continuously deteriorating as a result of man-induced changes during the past 250 years. Of primary influence is the construction of works to control devastating floods and to provide dependable navigation. These works have increasingly restricted the overflow of the Mississippi River and, as a result, have deprived the zone of new sediments. Through natural subsidence and the erosion of wind and water, the zone is gradually losing sediments deposited during centuries of repeated overflow. The situation is further affected by the construction of canals by the petroleum and fishing industries. These man-made channels provide additional means for salt water intrusion and subject more bank lines to wave attack.

ARCHEOLOGICAL AND HISTORICAL RESOURCES

Archeologists have found convincing evidence that man has lived throughout the Lower Mississippi Region for thousands of years. The total number of sites of his occupancy are unknown, but more than 5,000 sites have been recorded to date and are believed to represent but a small fraction of the total. Sufficient archeological work has been done on 64 percent of the recorded sites to provide an estimate of the total number of sites of man's occupancy,

and to roughly place the sequence of his cultural and temporal development in the region. Some 100 sites have been investigated. In 1970, 2400 sites in the region had been inventoried and 237 had been mapped. The listing includes battlegrounds, historic dwelling places, legendary sites, natural landscape features, roads, trails, waterways, cemeteries, machines and man-made structures, cultural sites and festivals, and those archeological sites listed in the National Register of Historic Places. Sites listed in the register or designated as national historic landmarks numbered 176 in 1970, and an additional 61 were recognized as historic assets by states of the region. Inventory surveys conducted during 1973 cataloged an additional 2,171 significant historic sites region-wide.

HEALTH ASPECTS

Tremendous strides have been made in the control of vector-borne and waterborne diseases in the Lower Mississippi Region, primarily due to water resource development, surveillance of drinking water supplies, and application of pesticides in areas highly conducive to insect-vector propagation. Climatic and topographical conditions historically have led to vector problems which exceeded the magnitude and variety in other sections of the United States. Prior to World War II, the population suffered hardships from outbreaks of malaria, yellow fever, and dengue. Similarly, consumption of water carrying pathogenic organisms in past years led to serious epidemics of cholera and typhoid fever.

Although there have been no widespread epidemics in recent years, there is still a significant incidence of waterborne and vector-borne diseases in the region. Principal vector-borne diseases include malaria, tularemia, Rocky Mountain spotted fever, leptospirosis (or Well's disease), and four viruses of encephalitis. The diseases most commonly associated with drinking water are cholera, typhoid fever, dysentery, and infectious hepatitis.

In general, drinking water supplies are of good quality and require little treatment. There are constant dangers to some surface supplies, however, from municipal waste discharges, agricultural runoff, and toxic material spills. The lack of complete water quality information is a problem in some areas. Most of the remaining vector-borne disease problems occur near natural swamps, sluggish streams, lake margins, salt marshes, residual ponds, and irrigated rice fields in southwestern Louisiana and the Grand Prairie of Arkansas.

A sun-dappled creekbed makes a refreshingly different bridle trail.

WATER AND RELATED LAND RESOURCES NEEDS

Projected increases in population and continued growth of the economy are dependent upon proper planning for a number of economic and social needs. Many of these relate directly to basic public works and institutions, such as schools, hospitals, and highways. Equally as important are requirements for water and related land resources. These elements are the bases upon which growth and change are projected to occur in the next several decades. A summary of resource requirements through the year 2020 is presented in this section for the four broad categories already identified. These are water withdrawals, or supply, water surface area, land area, and related problems.

Water Supply

As the competition among different uses for water intensifies and as regional population and economic growth accelerate, adequate provisions for water supply become increasingly more essential. By 2020, it is expected that regional water withdrawals will be four to five times as large as present, with industry using five of every nine gallons. Industrial expansion is expected to be especially dramatic in WRPAs 8, 9, and 10, with some industries requiring as much as a tenfold increase in water. As a result of this expansion, the three south Louisiana WRPAs are projected to account for three-fourths of use. All other categories of use, except rural domestic, are also expected to increase at a slightly higher rate than population. This will be due to the anticipated increase over time in per capita use and a continuation of past shifts from individual rural wells to municipal systems or organized rural systems. The largest increases are expected in WRPAs 3 and 10, which contain the Memphis and New Orleans SMSAs, respectively. The smallest increase is predicted to occur in WRPA 6, one of the more rural and less populous areas.

Thermoelectric water use requirements regionwide are expected to quadruple by 2020. On a WRPA basis, projected increases vary considerably, ranging up to as much as a nine to tenfold increase.

Acreages of cropland requiring irrigation are expected to show a slight temporary decline between 1970 and 1980 whereas acreages supplementally irrigated are predicted to show a steady increase throughout the study period.This is expected to result in an almost constant requirement for irrigation prior to 1980 and a steady increase thereafter. Requirements by 2020 are projected to be about 20 percent higher than present, with the heaviest withdrawals expected in WRPAs 2 and 9, accounting for about three-fourths of the total. Other agricultural uses, primarily the watering of livestock and poultry, are expected to increase steadily over the study period, more than doubling 1970 use by 2020.

Future water needs for the minerals industry are expected to increase substantially as a result of rapid growth in mineral production. By 2020, withdrawals are projected to triple under Program A, or be five times the 1970 use under Program B. The largest requirements are expected to occur in WRPAs 9 and 10, as was the case in 1970.

Future water withdrawal needs for fish and wildlife are related to an increasing population of sportsmen dependent in part upon existing and future management areas. Because this population can vary in size to some degree without affecting the form or operation of management areas, future needs are considered to be the same for both programs A and B. Withdrawals for this purpose are expected to increase 35 percent over the study period.

Although no fresh water withdrawals are required for future harvests of wild fishes, it will be necessary to maintain the quality and regimen of rivers and streams, to the extent practical, to allow continued harvesting of edible fish. A continued demand is anticipated for all the catfish and crawfish that can be produced by fish farms in the region. As a result, future water supply needs for this category are expected to quadruple by 2020 (Figure 21).

The broad Mississippi sweeps past a leaf-covered bank near St. Joseph, Louisiana, located about midway between Natchez and Vicksburg.

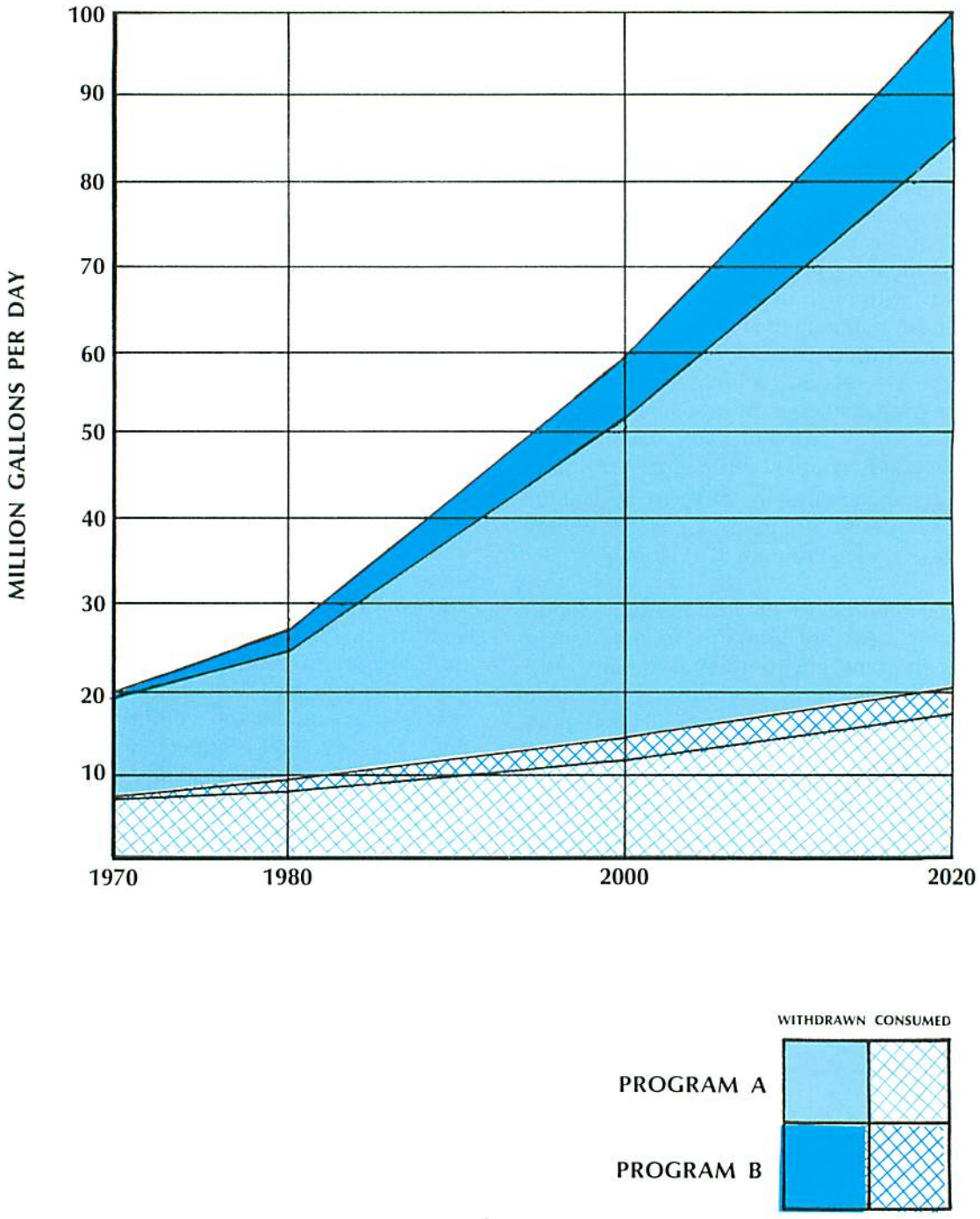


Figure 21. Projected Water Withdrawals, Lower Mississippi Region

WATER SURFACE

Surface water in the Lower Mississippi Region provides opportunities for recreation, fish and wildlife habitat, and scenic qualities and other attributes which enhance environmental quality. Significant increases in population, per capita income, and leisure time during the next 50 years are expected to generate a threefold increase in needs for water-oriented recreation, with most of the increase predicted in and near major metropolitan centers. Projected water surface needs for sport fishing, like recreation, are related to increases in population, per capita income, and leisure time. The total need for all types of sport fishing is expected to nearly double by the year 2020, from 30 million angler-days in 1970, to 50 million angler-days under Program A, or 58 million angler-days under Program B (Figure 22).

Needs relating to environmentally significant water areas are primarily to maintain or enhance present environmental quality attributes and to assure accessibility to the public by 1980. Estimated needs equal 484,000 acres, of which 446,000 acres are lakes 500 acres or more in size. Rivers and streams comprise 28,000 acres of the total, and the remaining 10,000 acres are in lakes 40 acres or less in size. Crowley's Ridge in WRPA 2 would be environmentally enhanced by creation of a number of small man-made lakes, totaling 10,000 acres.

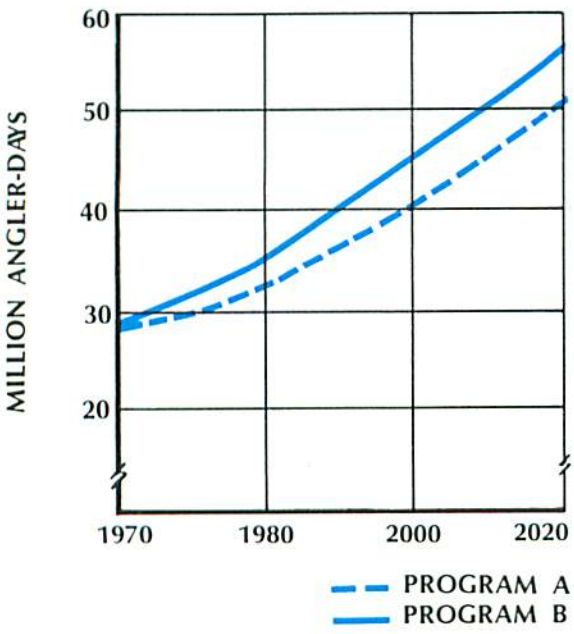


Figure 22. Projected Sport Fishing Needs, Lower Mississippi Region

Land Resources

As previously indicated, land areas in the Lower Mississippi Region are classed as cropland; permanent pasture; pastured cropland; forest land (including pastured forests); transportation, urban and built-up lands; mineral lands; recreation lands; fish and wildlife lands; environmental quality lands; and other miscellaneous lands. Competition for land among these categories is expected to increase continuously as a result of future population growth and increasing demands for food and fiber, minerals, industrial products, recreational sites, and hunting and fishing activities. High priority land needs for food and fiber production and for transportation, urban and built-up areas are expected to exceed the land resource base before the turn of the century. No resource deficiency by 1980 is expected under Program A, but a 1980 deficit of nearly one and a half million acres is expected under Program B. By 2020, however, Program A and B deficits are estimated to total one million acres and seven million acres, respectively (Table 8).

Needs for additional cropland are projected to increase in direct proportion to the future food and fiber requirements of an expanding population. On a regional basis, requirements are expected to more than double by 2020. Satisfaction of this need will require that more land be placed in crop production and that agricultural yields be increased through such measures as flood control, drainage, irrigation, and land treatment.

The need for meat and dairy products and other food items is projected to increase dramatically in the future, in line with increases in population nationwide. By 2020, needs for beef and veal are expected to be about three and one-half times present levels, while the need for milk products will be about one and

Table 8

Summary of 1970 Land Use and Future Land Needs, Lower Mississippi Region

Category	Objective[1]	Land Use and Needs (1,000 Acres)			
		1970 Use[2]	Future Need (Adjusted)[3]		
			1980	2000	2020
Cropland	NI, EQ	17,343	19,203	20,374	21,075
	RD		19,203	21,890	22,596
Pastured Cropland	NI, EQ	2,871	5,054	5,343	5,778
	RD		5,054	5,830	6,200
Permanent Pasture	NI, EQ	6,782	6,962	7,553	8,086
	RD		6,962	8,097	8,682
Pastured Forests[4]	NI, EQ	4,207[4]	5,993[4]	6,560[4]	7,033[4]
	RD		5,993	7,030	7,542
Other[5]	NI, EQ	3,506	3,915	3,718	3,478
	RD		3,915	3,718	3,478
Forestland	NI, EQ	29,637	24,477	23,025	21,621
	RD		26,110	25,539	24,105
Transportation, Urban & Built-up	NI, EQ	2,332	2,481	2,898	3,553
	RD		2,649	3,277	4,089
Total	NI, EQ	62,471[6]	62,092	63,002	63,591
	RD		63,893	67,955	69,150
Recreation	NI, EQ	99	226	326	497
	RD		240	374	581
Fish & Wildlife	NI, EQ	12,874[7]	27,811	34,092	43,190
	RD		30,059	38,376	49,258
Minerals	NI, EQ	67	87	127	183
	RD		101	167	253
Fish Farming	NI, EQ	46	70	117	164
	RD		70	117	164
Environmental	NI, EQ, RD		12,404	12,404	12,404

1 NI-National Income (Program A); RD-Regional Development (Program B); EQ-Environmental Quality

2 The study's base definition of land use is that presented in Appendix F, Land Resources, which contains only the first seven categories listed below plus large and small water areas. These categories collectively account for the entire aerial extent of the region. This does not mean that other listed categories of land use are not also primary users of the region's lands now or that they will discontinue being primary users in the future.

3 Land needs developed in functional appendixes were adjusted where necessary and appropriate during plan formulation to allow a comparison of competing needs on a compatible management base.

4 Included in forestland acreage.

5 Includes 2,052,000 acres of marshlands in WRPAs 9 and 10.

6 An additional 3,067,000 acres of the region are in water areas.

7 2,021,394 acres of this total were primary use fish and wildlife lands in 1970.

one-half times the 1970 production level. Total regional pasture land needs by 2000 are expected to be one and one-half times 1970 use, with additional increases expected by 2020.

The need for forest lands is expected to increase in the future as a result of a projected threefold increase in requirements for wood and wood products. With no allowance for potential increases in unit yield, needs by 2020 are projected to be about 46 million acres under Program A, or 51 million acres under Program B, compared to the 1970 availability of 30 million acres.

Regional needs for other lands by 1980 are expected to increase as a result of the conversion of an additional four million acres to food and fiber production. After 1980, however, a steady decline is expected due to increases in farm efficiencies and conversion of presently idle agricultural lands to productive uses. By 2020, it is estimated that needs for other lands will total less than four million acres, relatively the same as 1970 requirements. Variations in requirements will occur among WRPAs, however, due in some instances to differences in the composition of agricultural activities, and in some cases to the status of certain component lands, as in the case of large acreages of marshlands in WRPAs 9 and 10.

Concurrent with projected population increases and industrial growth, urban population is expected to increase from 59 percent of the region total in 1970 to 76 percent by 2020. Land occupied by transportation, urban and built-up areas is expected to be about one and one-half times more than 1970 use, under Program A, or about 1.75 times more under Program B.

By the year 2020, it is estimated that commercial fish production will have increased threefold under programs A and B, from 46,000 acres in 1970 to 164,000 acres. The projected increase applies to both programs because future demands under either program exceed the maximum reasonable productivity as now foreseen for commercial fish farming.

Problems likely to arise in providing adequate recreation facilities for the increasing population will be compounded by a continued shift of population from rural areas to major metropolitan centers. This shift will tend to increase present disparities in the distribution of classes A and B recreation lands with respect to centers of demand. By 2020, future outdoor recreation needs are estimated to be 497,000 acres under Program A, or 580,000 acres under Program B.

As shown in Figure 23, hunting needs are projected to double by 2020. In line with this increased demand, future land requirements for fish and wildlife habitat reflect a need for 70 to 80 percent of the region's total land area by 2020. The magnitude of these needs is compounded by the mix of habitat types comprising the total and by individual WRPA needs, often far in excess of the area presently available. The regional habitat need by 2020 under Program B, for example, includes 30.5 million acres of bottomland hardwoods, which is about half the area of the region, or about three times the acreage of hardwoods now in existence.

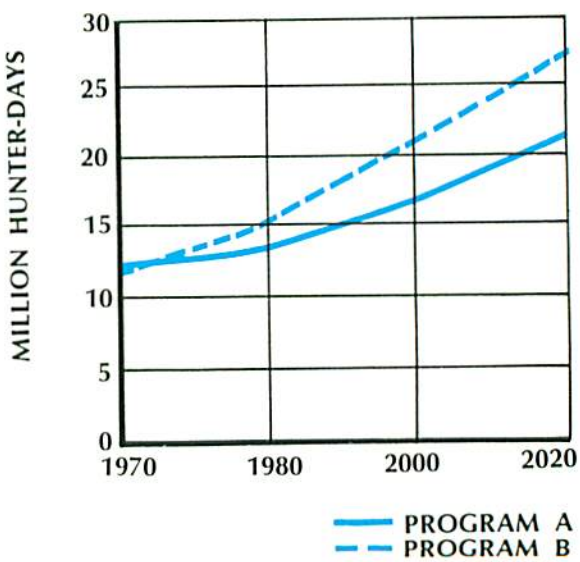


Figure 23. Projected Hunting Needs, Lower Mississippi Region

The need for all mineral commodities is expected to increase substantially by 2020, with the total value of production doubling under Program A, or almost quadrupling under Program B. Future land area needs for production of metallic, nonmetallic, and mineral fuel resources are projected to be about two to four times 1970 use.

About six out of every ten acres of land in the region possessing special environmental quality attributes in 1970 are estimated to be in firm supply during the study period. Net need, therefore, is estimated at slightly more than five million acres. About 80 percent of the projected need is comprised of bottomland hardwood forests, a large portion of which is predicted to occur in WRPAs 1, 2, and 3.

Related Problems

FLOOD CONTROL

Average annual monetary flood damages in the region, under assumed "existing conditions" and in the absence of any post-1973 improvements for flood control, are expected to increase from $213 million in 1970 to about $490 million by the year 2020 under Program A, or $513 million under Program B. Nearly half of the projected damages are expected to stem from upstream watersheds, about one-third from headwater flooding of principal streams, and the remainder from hurricane-induced tidal flooding in densely populated coastal areas. Projections are that the mix of damages will change in the future, with agricultural damages, as a percent of the total, decreasing from two-thirds in 1970 to one-half by 2020. Urban and built-up area damages as a percent of the total are predicted to increase from 19 percent in 1970 to 31 percent, and other types are anticipated to experience an increase from 13 percent of the total to 19 percent.

SEDIMENT AND EROSION

Future changes in land use and management practices are expected to cause a slight reduction in the extent of erosion. Total land area affected is projected to decrease from 19 million acres in 1970 to 18 million acres by 2020. Length of streambank erosion is projected to remain constant during the study period at the 1970 level of 11,000 miles. Extent of erosion, measured in sediment produced, is expected to decline from 133 million tons in 1970 to 84 million tons by 2020.

In the absence of additional measures to prevent erosion, the average annual damages stemming from sediment and erosion are expected to increase during the study period, due to increased unit yields. The increase by 2020 is projected to be 83 percent under Program A, or 90 percent under Program B.

EXCESSIVE WETNESS

Future wetness problems are expected to cause significant losses to production only on lands used for crops and pasture. Future needs, consistent with future acreages allocated to cropland and pasture, are expected to increase about 40 percent during the study period, from eight million acres in 1970 to 12 million acres by 2020. It is important to note, however, that future land use changes will have some effect on needs for drainage.

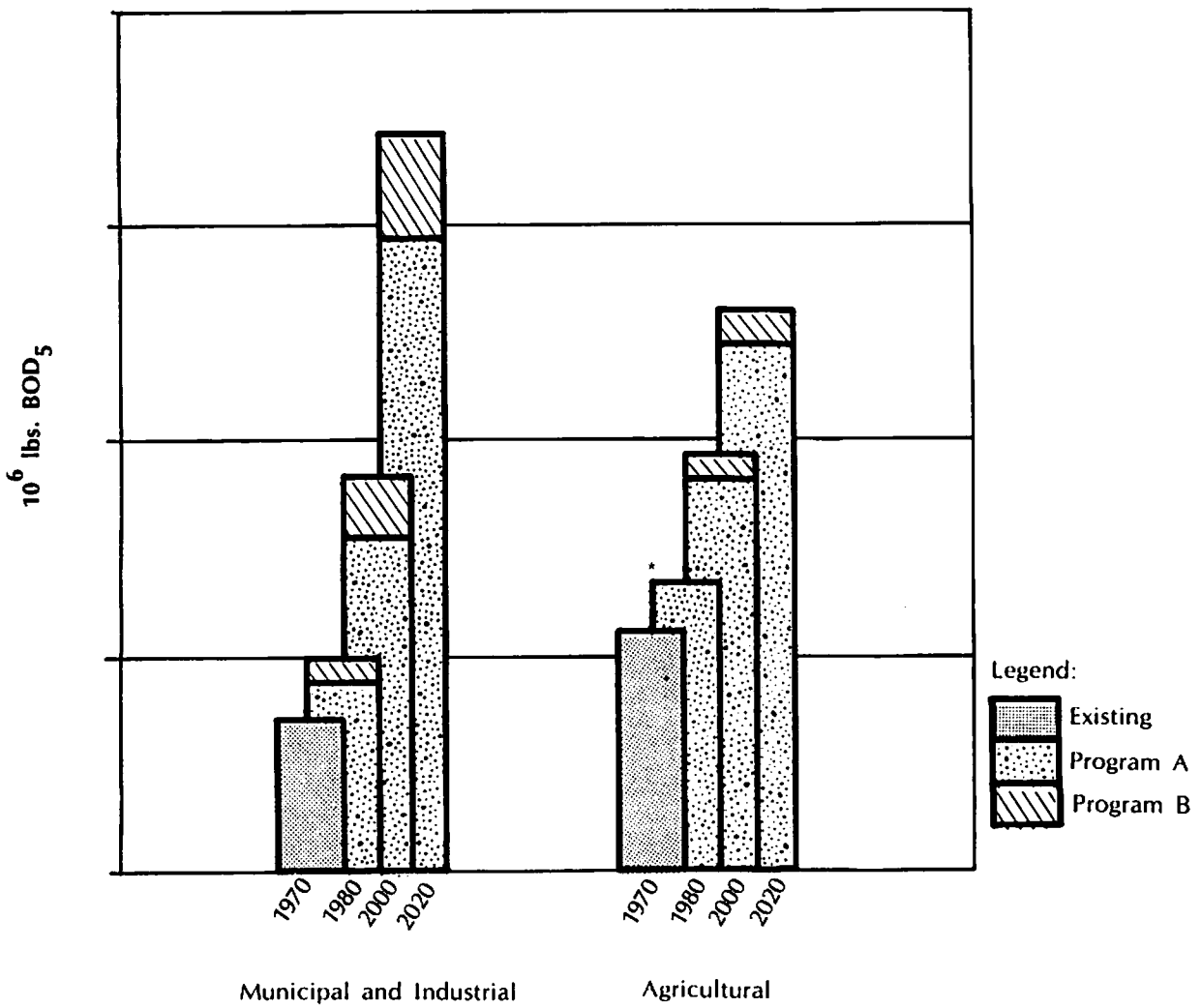
WATER QUALITY

Future water quality will be affected by the projected increases in urban and industrial growth, agricultural production, and recreational activity, all directly tied to projected increases in population. These increases will generate corresponding increases in waste products. By 2020, projections are that municipal and industrial organic pollution control needs for treatment of biodegradable waste will total 15 to 17 million pounds of BOD_5, compared to two million pounds removed by treatment in 1970 (Figure 24).

Agricultural organic waste loads from livestock and poultry by 2020 are projected to be more than double the 1970 load. Although the potential discharge to streams as equivalent point-sources of pollution represents less than

five percent of the total expected BOD waste production generated by the agricultural sector, these wastes can pose an ultimate surface water problem unless proper land management is established.

A need also exists for control of bacterial pollution at several points. By 2020, this type of pollution is estimated to be about two and one-half times as serious as it was in 1970. Another important need is for additional data regionwide on pollution sources, present methods and effectiveness of wastewater treatment, and stream and lake water quality.



*Program A and Program B projections are the same.

Figure 24. Projected Waste Loads, Lower Mississippi Region

NAVIGATION

Significant growth and development are expected in both shallow- and deep-draft shipping within the foreseeable future. Technological advances in areas of safety, navigation, maneuvering aids, and construction techniques will be of increasing benefit to shallow-draft transportation. Deep-draft shipping, on the other hand, will benefit from major investment and advancement stemming from increasing ocean-borne trade. Projections are that ships of all types will continue to increase in size and absolute numbers within the near future, slowing somewhat as the impact of increased tonnage capacities is felt. Other changes are anticipated in areas of automated control and in loading and unloading equipment.

Projected increases in the size of vessels will necessitate enlargement of inland waterways from the existing nine-foot depth to 12 feet and the enlargement of some deep-draft channels to depths greater than 40 feet. The latter is important if deep-draft ports on these channels are to continue as major transshipment points for world trade. For purposes of economy, enlargement of channels to accommodate projected commerce should be effected long before the physical capacity of the waterway is reached. Another major need is for a superport in the Gulf area to accommodate supertankers that will be used to import petroleum to meet the national demand for energy. During the study period, significant growth is projected in total inland, coastwise, and foreign commerce. By 2020, the regional waterway system is expected to accommodate almost 400 billion ton-miles of traffic under Program A projections, or about 500 billion ton-miles under Program B (Figure 27).

HYDROPOWER

The availability of low-cost, dependable power will continue to be an important factor in physical and economic growth. Because the region contains very few sites amenable to hydropower development, it is anticipated that a continuing need will exist for all the hydropower which can be economically developed. By the year 2020, the need for electric power is expected to increase ninefold under Program A or tenfold under Program B. As a percentage of all power generated in the region, however, hydropower is expected to decline during the next 50 years from the 1970 level of two percent, due primarily to the lack of available sites.

COASTAL AND ESTUARINE RESOURCES

Future needs in the coastal and estuarine zones relate to land building, salinity alteration, water level management, and shoreline erosion control. Satisfaction of these needs are expected to increase productivity of fish and wildlife in the zone and to enhance the area's physical condition. The need for land building, expressed in terms of riverflow, amounts to that flow which will deliver 352,000 mgd of sediment-laden water to strategic points in the estuarine zone to offset the estimated 16 square miles of marshland lost each year due to subsidence, erosion, compaction, organic decay, and the various works of man.

A long-term trend toward increased water salinities has occurred in certain areas of the marshes as the result of levee construction and channelization of the marsh for navigation and drainage. Both activities have provided avenues for the intrusion of salt water. It is projected that optimum conditions for commercial and sport fishes productivity in the zone can be achieved in problem areas by maintaining specified salinity levels during spring, summer, and fall. These requirements dictate water needs throughout the year at Calcasieu Lake in WRPA 9 and during fall and winter at several locations in WRPA 10. Overall coastal zone needs for salinity control, based on average annual requirements, are estimated at 28,000 mgd in WRPA 10 and 8,900 mgd in WRPA 9.

Supplemental flows, beyond that available from runoff, are required in the Grand and White lakes areas and in the Atchafalaya Floodway to maintain estuarine productivity. The requirement, for both locations, is for a combined average annual flow of 59,600 mgd.

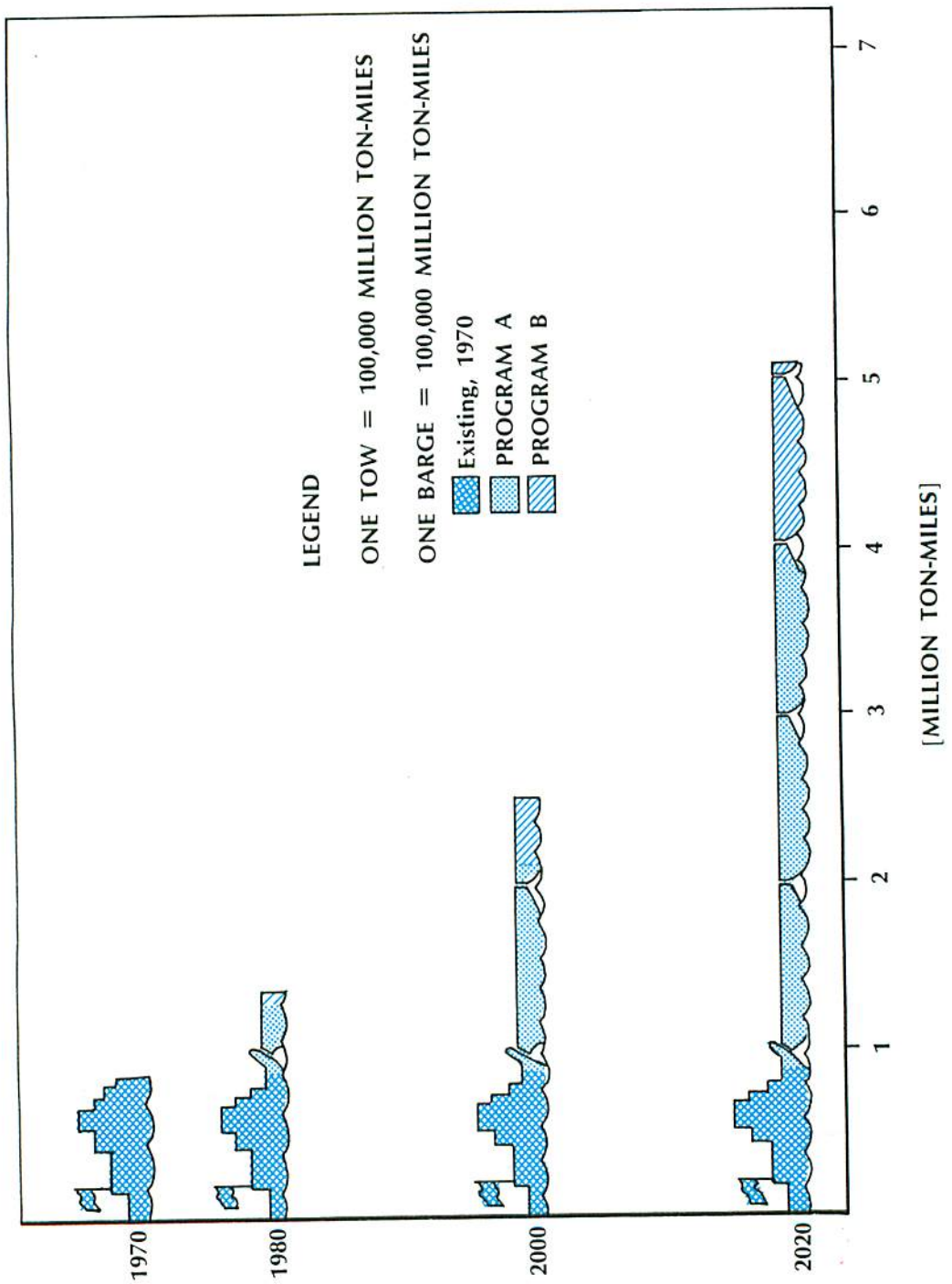


Figure 25. Projected Waterborne Commerce, Lower Mississippi Region

Six areas in WRPA 10, with a total shoreline of 10 miles, are undergoing critical erosion from the combined effects of wind, tidal action, and waves. These effects are compounded to an extent by the lack of overflows from the Mississippi River, which has been confined for the benefit of man.

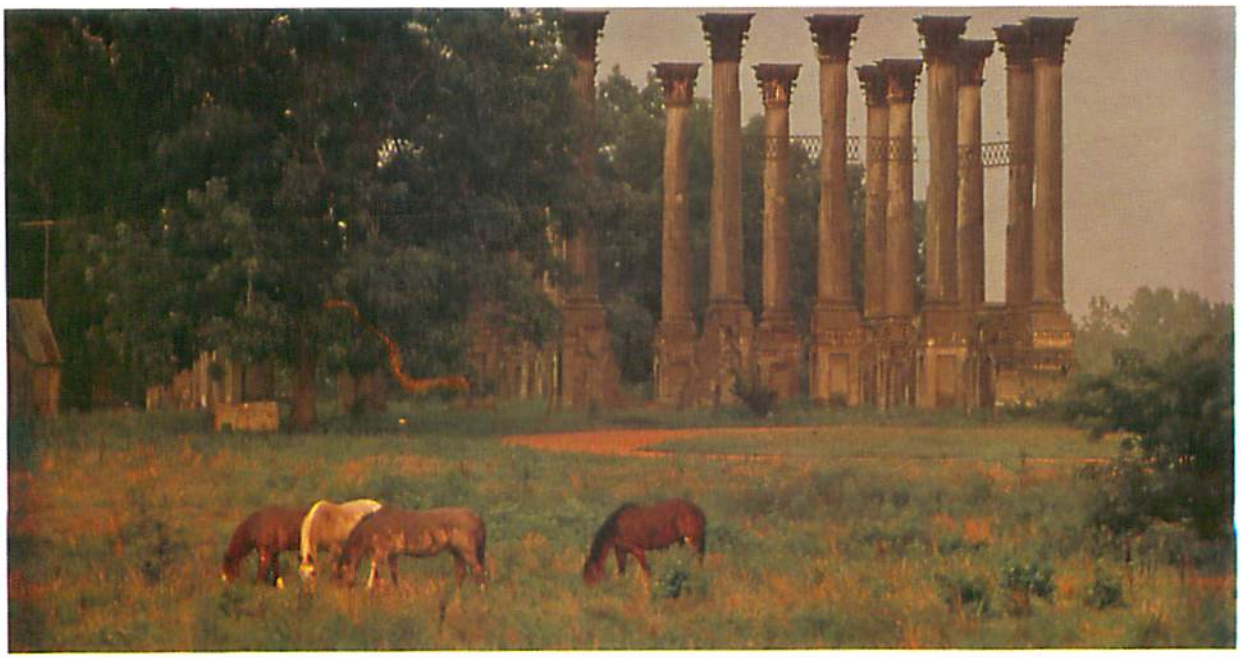
ARCHEOLOGICAL AND HISTORICAL RESOURCES

Although the data available is adequate to allow archeologists to estimate mans cultural and temporal development in the region, this information is estimated to represent only a minute fraction of that which exists. In 1970, no area of the region was considered well known archeologically when viewed in the context of the kinds and amounts of work required to describe satisfactorily the history of other areas of the nation which have received extensive attention. For this reason, future needs are heavily oriented toward completion of extensive surveys of archeological sites by the year 1980. Requirements for 1980 are for testing of 426 sites and for excavation of 97. By the year 2000, needs dictate testing of 1,848 sites and for excavation of 425. The 2020 time frame is omitted in this instance because work required beyond the year 2000 cannot be predicted until the results of needed surveys are analyzed.

The most pressing need in relation to historical resources is to conduct an objective and comprehensive survey in order to determine the total number of significant sites now in existence. These would include sites worthy of structural restoration, those which should be placed on special registers, historical trails or roads, and cemeteries.

HEALTH-RELATED ASPECTS

Projected health needs center around requirements for continued surveillance and treatment of public drinking water supplies, elimination of disease-related surface water pollution, provision of adequate public sanitation facilities in high-density water-oriented recreation areas, and institution of further comprehensive vector control programs. State drinking water programs are needed in the states of Arkansas, Kentucky, Louisiana, Missouri, Mississippi, and Tennessee. There is also a need for 50 abatement districts by 1980 and 67 by the year 2000.



With backs still wet from a summer rain, horses nibble in the grass near the stately ruins of a plantation house near Port Gibson, Mississippi.

THE FRAMEWORK PROGRAM

Planning Considerations

The major objective of the Lower Mississippi Region Comprehensive Study was to provide a guide for the efficient and timely conservation, development, and use of water and related land resources, to serve as the basis on which rational, well-considered decisions can be made concerning alternative or competing uses for these resources. To insure the proper balancing of elements, the philosophy of plan formulation required that a physically, economically, and socially feasible alternative framework program be developed for three planning objectives: national income, regional development, and environmental quality.

Plan formulation for the first two objectives was based upon the economic and demographic parameters developed in Appendix B (Economics), and identified as Program A (national income) and Program B (regional development). Parameters of the two programs were molded on an individual WRPA basis into single-objective water and land resource needs, as expressed in the functional appendixes. These needs were unconstrained by budgetary, legal, or institutional considerations. Separate sets of plans were then developed for the satisfaction of these problems and needs. At each step in the process, consideration was given to ways in which the region's finite resources could be pyramided to satisfy land and water needs for each planning area.

A unique set of economic and demographic parameters was not developed for the environmental quality objective. Planning for this objective was based upon the quantification of natural environmental quality needs summarized in Appendix U (The Environment). Plans thus defined for each objective were then grouped in three program sets, each emphasizing one of the three objectives and incorporating components from the other two. Because of the responsiveness to other objectives, the three completed programs are quite similar in content. Each provides a complete and implementable alternative framework for future action programs and continued planning. The programs are each composed of three basic parts: plans for resource use, plans for problem amelioration, and plans for public investment.

The recommended multi-objective regional framework program is a blend of the three single-objective programs. A detailed discussion of the rationale and methodology used to develop the single-objective and recommended programs is included in Appendix T (Plan Formulation), along with a discussion of alternatives, special facets of plan formulation, and deviations from the described methodology.

Sunlight drenches the slopes of Flatside Pinnacle Vista in Ouachita National Forest.

Development of Alternate Programs

Principal components and costs of the three single-objective programs are briefly described in this section as a basis for understanding the recommended program. Each of the alternate programs is described at length in Appendix T (Plan Formulation). A comparison of costs and schedules is shown in Table 9.

NATIONAL INCOME

The national income program (Program A) is directed toward increasing the output of goods and services and raising the standard of living. It also incorporates specific measures to preserve environmental quality. Action components of the program involve public investments which are used to satisfy regional needs for water supply, food and fiber, recreation, fish and wildlife, and natural environmental quality; and to solve needs relating to flood control, agricultural land drainage, irrigation, land treatment, water quality, navigation, health aspects, coastal and estuarine resources, and archeological and historical resources. Additional studies are also an important part of the program. This need, which is identical for all programs, is discussed in the following section.

The cost of implementing the program to 1980 is estimated at $2.8 billion for the federal government and $3.9 billion for non-federal entities. Annual costs of operation and maintenance are estimated to average $65 million federal and $87 million non-federal. By far the most expensive component of the program is provision of land and water areas for environmental quality purposes.

REGIONAL DEVELOPMENT

The extent to which capital investments or other measures might serve as inducements to regional development was not evaluated during the study, nor were any specific action plans formulated for stimulating regional economy. An attempt was made, however, to develop a program (Program B) responsive to conditions which might prevail should the short-term regional economy be accelerated to a growth rate equal to the national average. Because of the program's similarity to national income plans, it is discussed very briefly in Appendix T (Plan Formulation). Estimated costs of the program, expressed in terms of January 1972 dollars, total $16.6 billion, about half of which is federal and half non-federal. Annual operation and maintenance costs are estimated to average $395 million.

ENVIRONMENTAL QUALITY

Because Program A economic forecasts were adopted for the environmental quality objective, components of the two plans are identical, except with respect to land allocation, flood control, and water quality control. In these instances, the environmental quality program places highest priority on needs for preserving environmental quality. The total investment cost of the program is estimated at $15.3 billion, about half of which is federal and half non-federal. An estimated $331 million would be required annually for operation and maintenance.

The multicolored lights of a city twinkle brightly against the velvet blackness of a summer night.

Table 9

Funding Schedule for Alternative Programs, Lower Mississippi Region

Public Investor	Funds Required ($1,000,000)								
	National Income			Regional Development			Environmental Quality		
	1970-80	1980-2000	2000-20	1970-80	1980-2000	2000-20	1970-80	1980-2000	2000-20
Federal									
Total Investment	2,829	2,130	2,319	3,132	2,489	2,703	3,263	1,921	2,319
Annual Investment[1]	283	106	116	313	124	135	326	96	116
Annual Operation, Maintenance and Replacement	65	115	192	73	136	236	65	115	192
Total Federal[2]	348	221	308	376	260	371	391	211	308
Non-Federal									
Total Investment	3,884	1,414	2,016	4,078	1,695	2,554	4,423	1,344	2,016
Annual Investment[1]	388	70	101	408	85	128	442	67	101
Annual Operation, Maintenance and Replacement	87	162	275	98	193	337	89	165	277
Total Non-Federal[2]	475	232	376	506	278	465	531	232	378
Grand Total[2]	822	453	684	882	538	836	922	443	686

[1] Total investment averaged over time period.

[2] Average annual appropriation required.

The Framework Program

The national income program, as amended in Appendix T (Plan Formulation), is recommended as the framework for future conservation, development, and use of water and related land resources. Components of the program center around the efficient and timely solution of resource problems and needs in harmony with the preservation of significant environmental quality features. No specific action plans for stimulating the regional economy are recommended because of current national objectives and the apparently limited capabilities of regional land resources. This section contains a discussion of selected program measures and rationales, costs, impacts, and scheduling and implementation.

SELECTED MEASURES AND RATIONALES

Components of the recommended framework program relate to resource use (water withdrawals, water surface area, land area, recreation, fish and wildlife, and environmental quality) and to problem amelioration (flood control, sediment and erosion, land drainage, water quality, navigation, power, coastal and estuarine resources, archeological and historical resources, and health aspects). Plans recommended for these elements are detailed in Appendix T (Plan Formulation). The following discussion contains only a brief summary of these plans (Table 10).

Table 10

Recommended Program Composition, Lower Mississippi Region

Component	1970-1980	1980-2000	2000-2020	Total
Water Supply (mgd)				
Municipal	139.5	336.5	457.1	933.1
Irrigation	131.2	228.8	264.1	624.0
Fish and Wildlife	231.0	501.0	439.0	1,171.0
Total	501.7	1,066.3	1,160.1	2,728.1
Water Surface Area				
Recreation (1,000 acres)	147.0	257.0	362.0	766.0
Fish and Wildlife (stream miles)	7,699.0	0	0	7,699.0
Natural Environment (1,000 acres)	41.0	0	0	41.0
Land (1,000 acres)				
Recreation [1]	125.5	101.0	170.7	397.2
Fish and Wildlife	463.9	389.9	561.9	1,415.7
Natural Environment [2]	1,293.0	0	0	1,293.0
Total	1,882.4	490.9	732.6	3,105.9
Flood Control				
Principal Reaches: Levees (miles)	571.8	528.2	207.0	1,307.0
Principal Reaches: Channels (miles)	2,378.6	1,283.3	1,211.9	4,873.8
Principal Reaches: Reservoirs (number)	12	1	0	13
Principal Reaches: Pumping Plants (number)	22	40	15	77
Upstream Watersheds: Channels (miles)	17,147	2,459	1,851	21,457
Upstream Watersheds: Reservoirs (number)	977	333	171	1,481
Upstream Watersheds: Flood Plain Management (1,000 acres)	9,258	1,502	1,074	11,834
Upstream Watersheds: Watershed Management (1,000 acres)	26,196	5,389	3,819	35,404
Land Treatment (1,000 acres) [3]	18,409.7	19,688.2	21,228.0	59,325.9
Sediment and Erosion Control (miles)				
Streambanks	1,037	644	459	2,140
Roadbanks	4,533	3,967	2,830	11,330
Total	5,570	4,611	3,289	13,470
Drainage				
Watershed Management (1,000 acres)	1,296.4	2,592.5	2,592.7	6,481.6
Channels (miles)	15,070.0	14,620.0	13,920.0	43,610.0
Municipal Water Quality Control				
Secondary Treatment (1,000 lb BOD_5)	394	0	0	-
Advance Treatment (1,000 lb BOD_5)	0	747.0	1,112.0	-
Other (1,000 lb BOD_5) [4]	76.0	21.0	30.0	-
Bacteria Control (mgd) [5]	359.2	245.4	320.8	925.4
Navigation				
Channels (miles)				
Deep Draft	344.5	34.0	200.0	578.5
Shallow Draft	381.0	458.0	0	839.0
Total	725.5	492.0	200.0	1,417.5
Harbors (number)	18	11	6	35
Locks (number)	6	6	4	16
Hydropower Production (MW)	65.5	120.6	0	186.1
Coastal and Estuarine [6]				
Archeological and Historical [7]				
Public Health [8]				

[1] Overlaps Natural Environmental Quality acreage in some WRPA's. Double counting has been eliminated in cost tables.

[2] Excludes urban open and green space provided through the acquisition of Class A recreation lands in 1970-1980 time frame.

[3] Includes land treatment to reduce flood runoff and critical area treatment to reduce sediment and erosion.

[4] Includes mechanical reaeration and stream assimilation.

[5] Chlorination.

[6] Composed of measures for salinity control, shoreline erosion control, and water level management.

[7] Composed of surveying, testing and excavating archeological sites, and preservation, restoration and maintenance of historic resources.

[8] Composed of public drinking water programs and vector abatement districts at state level.

Resource Use

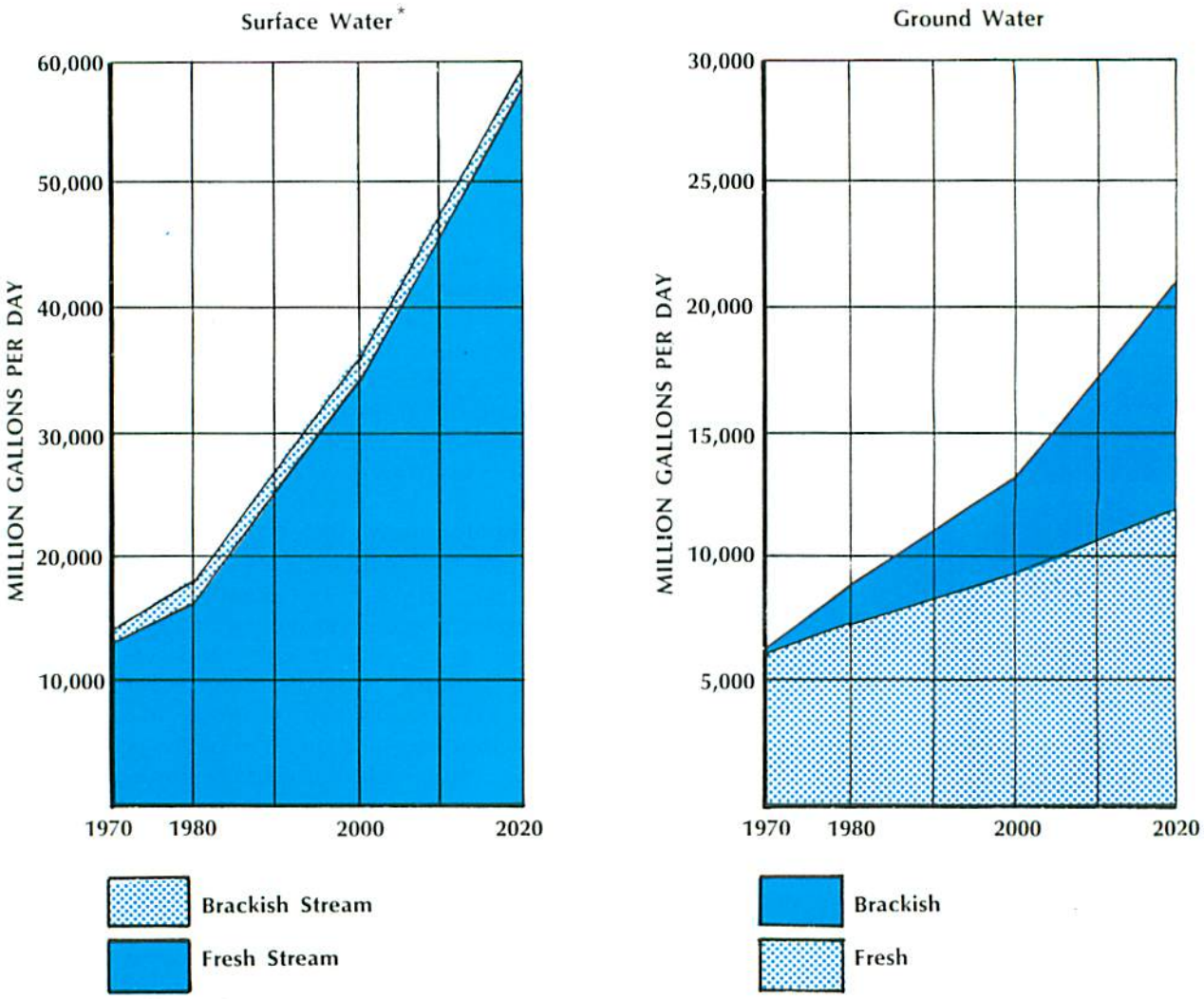
The recommended plans for resource use indicate how existing water and land resources should be developed and used to insure that supplies of adequate quality and quantity can be made available as needed in the future.

Water Withdrawal. The water withdrawal plan is based on the allocation of water supplies to satisfaction of needs on a least-cost basis wherein highest priority uses are assigned the least expensive water. Water priorities parallel adopted land-use priorities (urban-oriented, economic preference, and environmentally oriented), with each successive category assigned a more expensive water supply. The plan includes measures to solve distributional problems which are expected to occur at several locations in the future. The plan would require that some water users shift to new sources in the future as local supplies fall short of needs and as higher priority uses require more water. As presently scaled, the plan would provide for complete satisfaction of all foreseeable needs through 2020 (Figure 26).

Water Surface Area. The water surface area plan permits the full satisfaction of all identified water surface needs for environmental quality purposes and the satisfaction of all water surface area needs for fish and wildlife, provided some WRPA 3 needs are satisfied by surplus resources from neighboring planning areas. The plan also permits satisfaction of a significant portion of recreation needs. Because of limited development potential, however, there is no practical solution to meeting all projected recreational needs during the study period. The plan provides for an increasing large water surface, but includes no provision for creating small water areas since present acreages are already adequate to meet the foreseeable needs and since small ponds will probably continue to be constructed (Figure 27).

Land Area. The recommended land use plan (Table 11) contains provisions for insuring that lands are made available for recreation, fish and wildlife, and for environmental quality purposes insofar as multiple-use of the land resource can serve these purposes without detracting materially from the satisfaction of transportation, urban and built-up needs or from the higher priority needs for food and fiber production. Because it is highly likely that the region will be expected to meet an ever-increasing share of the world's food needs, and because future cropland needs defined for Program A on a lesser criteria are probably understated, it was concluded that it would be irresponsible to reduce the Program A acreages

A ribbon of blue marks the course of a stream through wooded slopes near Forked Mountain in Ouachita National Forest.



*In addition to withdrawals shown from fresh and brackish streams, the plan calls for inter-region transfer of 292.0 mgd in 2000 and 450.0 mgd in 2020; intra-region transfers of 276.6 mgd in 1980, 2,726.6 in 2000, and 4,251.6 in 2020. The plan also includes surface storage of 301.8 mgd in 1970, 000.8 mgd in 1980, 404.8 in 2000, and 448.2 in 2020.

Figure 26. Recommended Water Withdrawal Plan, Lower Mississippi Region

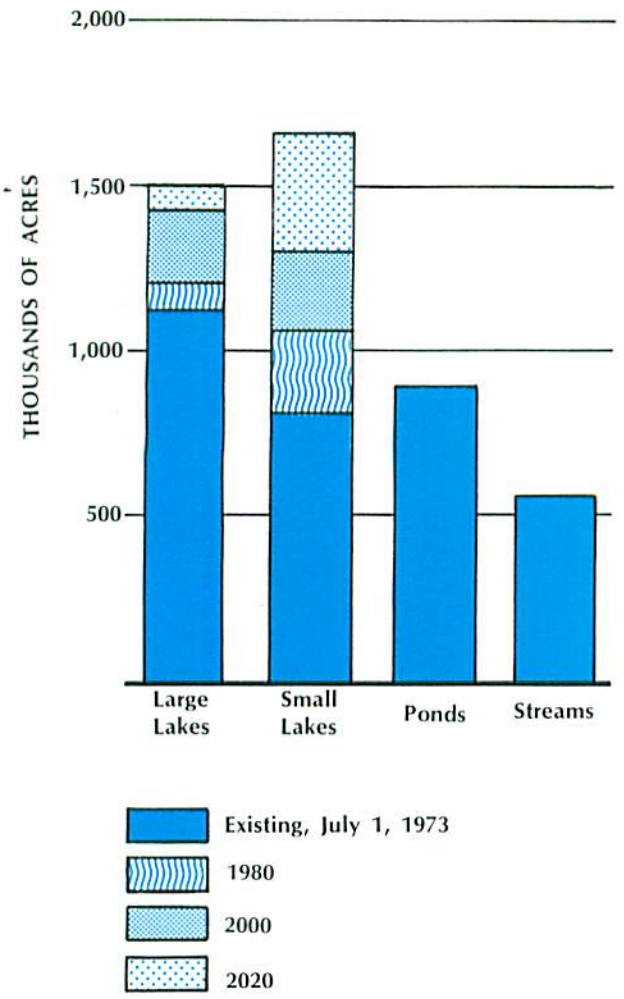


Figure 27. Recommended Water Surface Plan, Lower Mississippi Region

allocated to cropland. Thus, the Program A cropland acreages were adopted in the recommended land use plan, with the understanding that implementation of flood control, drainage, supplemental irrigation, and other plans is imperative to offset serious inadequacies in regional capability to produce food and fiber consistent with current conditions. In the case of pasture land, it was determined that the Program A allocations could be reduced in the recommended land use plan without materially affecting attainment of the region's food and fiber production goals. Evaluation of the impacts of future water resource developments revealed that 0.4 million acres of open agricultural land under Program A could be reallocated to other uses by the year 1980, and that 1.5 and 2.5 million acres could be reallocated by the years 2000 and 2020, respectively.

Recreation. The recommended plan for recreation provides for satisfaction of future needs for both water and land areas and includes measures which provide maximum site development of existing areas and acquisition of additional areas. The plan specifically provides for maximum use of the existing 1.9 million acres of water areas in accessible locations and otherwise suitable for use by recreationists; recreation use of about 257,000 acres of water surface that will be created primarily for flood control, power, water supply, or some other purpose; more intensive use of 190,000 acres of land, by provision of either facilities or access and facilities; acquisition and development of 206,300 acres of land expressly for recreation development; and creation of 766,000 acres of new water surface explicitly for recreational purposes.

Fish and Wildlife. Measures of the fish and wildlife plan include easements and fee purchases designed to increase primary use wildlife lands more than 1.4 million acres by the year 2020. The plan also includes provisions for a public education program to promote access to another 25 million acres of land and to nearly all of the 500,000 acres of water areas in the region less than two acres in size (ponds). Other measures call for diversion withdrawal of 4,473 mgd of ground and surface waters to maintain water levels for mast-producing green-tree reservoirs and duck-resting areas and to replenish water in lakes for sport fishing. Additional fish and wildlife enhancement measures are included in the agricultural sector. Although production of catfish and crawfish as an adjunct to agriculture satisfies a small portion of the regional fishing need, no assessment is made of the needs satisfied by that private sector activity.

Table 11

Recommended Land Use Plan, Lower Mississippi Region
[Thousands of Acres]

Need Category	1970	Allocated Future Use		
		1980	2000	2020
Open Land				
Transportation				
Urban and Built-up	2,332.0	2,481.0	2,898.0	3,553.0
Food and Fiber				
Cropland	17,343.0	19,203.0	20,374.0	21,075.0
Pastured Cropland	2,871.0	4,807.0	4,769.0	4,730.0
Permanent Pasture	6,782.0	6,825.0	6,726.0	6,626.0
Other	3,506.0	3,915.0	3,718.0	3,478.0
Commercial Fisheries[1]	(67.0)	(70.0)	(117.0)	(164.0)
Minerals[1]	(67.0)	(87.0)	(127.0)	(183.0)
Recreation				
Class A[2]	(16.4)	(62.0)	(94.0)	(145.5)
Class B[3]	(16.0)	(54.5)	(80.8)	(124.6)
Fish and Wildlife				
Cropland[4]	-	(3,100.0)	(3,807.0)	(4,817.0)
Pastureland[3]	-	(1,329.0)	(1,629.0)	(2,064.0)
Wetlands[1]	-	(658.0)	(754.0)	(959.0)
Environmental Quality				
Open and Green Space[5]	(16.4)	(122.0)	(122.0)	(122.0)
Beaches and Shores[1]	-	(176.0)	(176.0)	(176.0)
Botanical Systems[1]	-	(500.0)	(500.0)	(500.0)
Botanical Systems[6]	-	0.1	0.1	0.1
Ecological Systems[6]	-	1.0	1.0	1.0
Geological Systems[3]	-	(157.0)	(157.0)	(157.0)
Geological Systems[6]	-	3.4	3.4	3.4
Forest Land				
Food and Fiber				
Forest Products, et al	29,637.0	24,558.2	22,827.2	21,401.2
Animal Roughage (Pasture)	(4,207.0)	(5,993.0)	(6,560.0)	(7,033.0)
Recreation				
Class B[7]	(15.9)	(55.0)	(81.3)	(125.0)
Class C[7]	(50.9)	(54.2)	(70.1)	(101.8)
Fish and Wildlife				
Management Areas, etc[8]	(2,021.4)	(2,466.4)	(2,856.2)	(3,418.2)
Wetlands[7]	-	(809.0)	(1,047.0)	(1,320.0)
Environmental Quality[7]				
Botanical Systems[6]	-	(293.0)	(293.0)	(293.0)
Botanical Systems[7]	-	59.6	59.6	59.6
Bottomland Hardwoods[7]	(10,852.0)	(9,147.8)	(8,640.8)	(8,096.8)
Ecological Systems[6]	-	(115.0)	(115.0)	(115.0)
Ecological Systems[7]	-	28.0	28.0	28.0
Geological Systems[6]	-	(530.0)	(530.0)	(530.0)
Geological Systems[7]	-	28.7	28.7	28.7
Lake Shores[7]	-	(19.0)	(19.0)	(19.0)
Lake Shores[6]	-	1.0	1.0	1.0
Scenic River Banks[7]	-	(117.0)	(117.0)	(117.0)
Wetlands[7]	-	(185.0)	(185.0)	(185.0)
Wilderness Areas[7]	-	(453.0)	(453.0)	(453.0)
Wilderness Areas[6]	-	184.0	184.0	184.0
Land Covered by Water				
Large Water Areas	2,230.0	2,606.0	3,083.0	3,532.0
Small Water Areas	837.0	837.0	837.0	837.0
Total Area, LMR	65,538.0	65,538.0	65,538.0	65,538.0

[1] Multiple-use land. Counted in other open land acreage.
[2] Primary use for recreation. Counted in transportation, urban and built-up acreage.
[3] Multiple-use land counted in pasture acreage.
[4] Multiple-use land. Counted in cropland acreage.
[5] Multiple-use with Class A recreation land. Counted in transportation, urban and built-up acreage.
[6] Exclusive use for environmental quality purposes. Not counted elsewhere.
[7] Multiple-use land. Counted in forest products acreage.
[8] Primary use for fish and wildlife. Counted in forest products acreage.

Environmental Quality. The recommended plan for environmental quality includes measures to preserve land and water areas with esthetic qualities or other attributes worthy of preservation for the enjoyment of future generations. It provides not only for the preservation and enhancement of botanical, ecological, and geological systems, but also for the preservation of wetlands and wilderness areas, for the protection of scenic rivers and lakes, and the creation of needed open and green space in urban areas. The included measures provide for the regulated use of 1.3 million acres, of which 305,000 acres are designated for exclusive use for environmental quality purposes. Exclusive use within the context of the recommended plan precludes most development activities but permits certain activities and practices such as temporary overflows for flood control in the Atchafalaya and Morganza floodways.

Problem Amelioration

This section presents formulated plans for flood control, sediment and erosion, excessive wetness, water quality, navigation, hydropower, coastal and estuarine resources, archeological and historical resources, and health aspects.

Flood Control . Principal components of the recommended flood control plan include completion of the present backlog of works already under construction; construction of authorized and proposed new works; and expansion of governmental flood plain information activities and development of appropriate local controls to govern the growth of damageable development in flood plains. Completion of works now in progress is of critical importance to the safety of the valley and its contents, since it involves both the levee system and channel improvement features of the MR&T Project. As presently constructed, the system is inadequate to withstand the largest reasonable flood which might occur on the Mississippi River. A major failure of the system would result in a disaster of staggering proportions. The plan, therefore, calls for completion of the Mississippi River levee system within the next five years, completion of all remaining work on the MR&T Project by 1985, and accelerated completion of other vital works, such as major hurricane protection projects in the coastal area, numerous smaller local protection projects, and about 60 small watershed projects.

The plan also provides for funding and construction of authorized and proposed new flood control works at a rate allowing completion of much of the work by 1980 and the remainder by 1985. Authorized, unconstructed features include 10 reservoirs with a total flood control storage of 239,000 acre-feet, 2,238 miles of channel improvement, 530 miles of levees, and 10 major pumping stations–all associated with principal streams. Proposed new works included in the plan for principal stream improvement by 2020 are three major reservoirs having a total flood control storage capacity of about 300,000 acre-feet; about 2,600 miles of channel improvement, 782 miles of new levees, and 68 major pumping plants and miscellaneous works for hurricane protection.

Nonstructural measures in the plan consist of land treatment, provision of technical assistance, and general watershed management for all rural agricultural areas, and for technical assistance and flood plain information reports necessary to proper flood plain management in all urban and built-up areas, regardless of whether structural measures are included for these areas, and continued flood forecasting services and hurricane, storm surge, and tide forecasts for coastal areas. Flood plain information reports are now being provided to 43 urban areas, and plans are that the reports will be furnished to an additional 68 areas.

The recommended flood control plan, if implemented, will prevent about 40 percent of projected average annual flood damage levels by 1980, 49 percent by 2000, and 50 percent by 2020. The average annual damages prevented, based on 1970 flood protection conditions, would be $114 million, $185 million, and $258 million, respectively. If a straight line relationship is assumed from time frame to time frame, total damages prevented by the plan in the study period 1970 to 2020 will amount to $8 billion. The structural measures in the recommended plan are shown in Table 12.

Table 12

Recommended Flood Control Plan, Structural Measures, Lower Mississippi Region

Feature	Time Frame			
	1980	2000	2020	Total
Principal Streams[1]				
Reservoirs (Number)				
Authorized	10	0	0	10
Proposed	2	1	0	3
Total	12	1	0	13
Storage Capacity of Reservoirs (Acre-Feet)				
Authorized Reservoirs	239,000	0	0	239,000
Proposed Reservoirs	229,000	80,000	0	309,000
Total	468,000	80,000	0	548,000
Channel Improvements (Miles)				
Authorized	1,573.4	543.0	122.0	2,238.4
Proposed	805.2	740.3	1,089.9	2,635.4
Total	2,378.6	1,283.3	1,211.9	4,873.8
Levees (Miles)				
Authorized	447.1	83.0	0	530.1
Proposed	124.7	445.2	207.0	776.9
Total	571.8	528.2	207.0	1,307.0
Pumping Stations (Number)				
Authorized	11	1	0	12
Proposed	11	39	15	65
Total	22	40	15	77
Upstream Watersheds[2,3]				
Floodwater-Retarding Structures (Proposed)				
Number	977	333	171	1,481
Storage (Acre-Feet)	1,171,384	491,490	258,967	1,921,841
Proposed Channel Improvements (Miles)	17,147	2,459	1,851	21,457

[1] Includes "other" projects, primarily for hurricane protection: 7 proposed locks (2000), and one diversion structure and one low-flow structure (1980).

[2] Authorized projects in upstream watersheds are counted as "existing" and are not shown here.

[3] Includes also other proposed measures such as pumping plants, control structures, and levees.

Sediment and Erosion. The sediment and erosion plan includes measures for controlling the loss of topsoil from open areas with critical erosion problems and for controlling the erosion of roadbanks and streambanks. The two principal components of the plan are conversion of critically eroding open lands to vegetation (along with technical assistance to landowners) and stabilization of about 11,300 miles of roadbanks and 2,100 miles of streambanks (excluding the main stem of the Mississippi River in WRPA 1). These two measures are expected to alleviate the most critical regional needs for sediment and erosion control through the year 2020. It is estimated that implementation of the plan could reduce sediment and erosion damages by an average of nearly $7 million per year to 1980, slightly over $13 million per year between 1980 and 2000, and nearly $20 million per year for the period 2000 to 2020. The control of erosion at its source would maintain production potential of cropland and pastureland and would alleviate subsequent problems of turbidity and suspended matter in surface waters and damaging sediment deposits on agricultural and other lands (Table 13).

Excessive Wetness. The recommended drainage plan calls for the orderly removal of excess surface water from cropland and pastureland in future years to improve agricultural production efficiency, in order to meet expanding food and fiber needs. The plan includes more than 21,000 miles of on-farm ditches, nearly 13,000 miles of secondary ditches, and approximately 9,500 miles of project channels for drainage. It also provides for improved row arrangement, field diversion terraces, and similar watershed management practices (land treatment) to enhance the production potential of agricultural lands with a drainage problem. These recommended drainage measures are expected to solve 55 percent of identified regional drainage problems through the year 2020 (Table 14).

Water Quality. The recommended water quality plan deals specifically with the problems of biodegradable organic wastes and bacteria and with solutions presently judged technically feasible. It deals only generally with other pollutants such as thermal wastes, nutrients, toxics, dissolved solids, and exotics. The primary requirement of the plan is that municipalities and industries attain secondary treatment by 1980, advanced treatment by 2000, and continued advanced treatment by 2020. Where these levels of treatment do not provide an effluent with a five-day BOD which can be assimilated by receiving streams without violation of stream standards, treatment and assimilation are to be supplemented by mechanical reaeration. This option is used in all of the planning areas except WRPA 7 (Figure 28).

Navigation. The recommended navigation plan calls for continued operation and maintenance of existing projects and timely construction of authorized improvements. The plan also proposes a number of feasible additions. These include further improvement of 942 miles of channels and 415 miles of new navigation improvements; rehabilitation or replacement of six old locks; construction of new locks at 10 locations; expansion of 14 existing ports; and construction of 21 new ports. Provision of these facilities and a superport in the Gulf Coast area will satisfy all identified regional navigation needs through the year 2020. About half of the proposed new facilities, including the superport, are required for needs satisfaction through the year 1980. The remainder fall within the category of long-term requirements (Table 15).

Hydropower. The recommended hydropower plan provides primarily for continued use of peak power produced by existing regional hydroelectric plants and provision of all additional feasible hydroelectric power which can be developed in the region. In view of the current energy crisis and uncertainty about future energy requirements, the potential marketable additions to the Carpenter, Remmel, DeGray, Sardis, and Wappapello projects are included as 1980 components of the recommended hydropower plan. However, it is recognized that this may be a somewhat unrealistic time frame for planning and developing these additions. The Rowland Church, Benton, and Youngton projects are included as plan components for the

Table 13

Recommended Sediment and Erosion Control Plan, Lower Mississippi Region

Measure	1980		2000		2020	
	Incremental	Cumulative	Incremental	Cumulative	Incremental	Cumulative
Planting of vegetation in critical areas (acres)*	822,700	822,700	376,200	1,198,900	185,000	1,383,900
Roadside erosion control (miles)*	4,533	4,533	3,967	8,500	2,830	11,330
Streambank erosion control (miles)*	1,037	1,037	644	1,681	459	2,140
Total	5,570	5,570	4,611	10,181	3,289	13,470

* Treatment and technical assistance in addition to that existing in 1970. Excludes main stem, Mississippi River.

Table 14

Recommended Drainage Plan, Lower Mississippi Region

Measure		1980	2000	2020
Structural	On Farm Drains (miles)	6,900	20,570	34,100
	Project Channels (miles)[1]	8,170	9,120	9,510
Total		15,070	29,690	43,610
Non-Structural[2]	Watershed Management (acres)	1,296,400	3,888,900	6,481,600

[1] Drainage channels included in flood control plan for upstream watersheds.
[2] Measures additional to those existing in 1970.

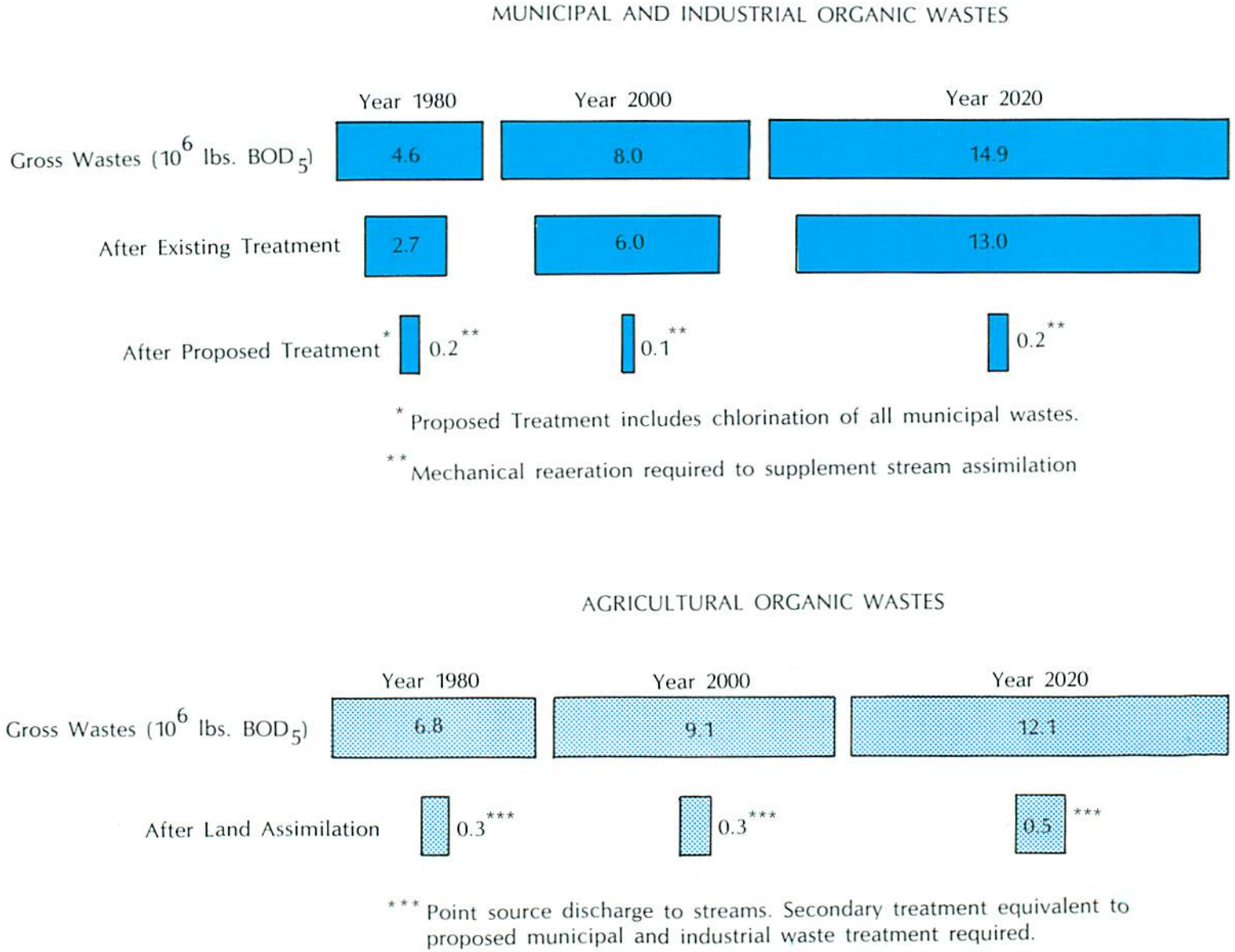


Figure 28. Recommended Water Quality Plan, Lower Mississippi Region

Table 15

Recommended Navigation Plan, Lower Mississippi Region

	Existing[1]	1980[2]	2000[2]	2020[2]
Navigation Waterways (Miles)				
Deep-Draft	452	504	504	704
New Facilities		(52)	-	(200)
Improvement of Existing Facilities		(290)	(34)	-
Shallow-Draft	2,966	3,252	3,267	3,267
New Facilities		(286)	(13)	-
Improvement of Existing Facilities		(1,396)	(181)	(443)
Navigation Locks (Number)	20	26	29	31
New Facilities		(6)	(3)	(2)
Improvement of Existing Facilities		(3)	(3)	(2)
Navigation Ports (Number)				
Deep-Draft	4	5[3]	5[3]	5[3]
Shallow-Draft	13	25	31	34
New Facilities		(12)	(6)	(3)
Improvement of Existing Facilities		(6)	(5)	(3)

[1] Active Federal projects and projects under construction as of 1970. Does not include existing private port facilities or existing Federal projects on which maintenance has been discontinued.

[2] Includes both new facilities and improvement of existing facilities.

[3] Includes superport in Gulf Coast area.

year 2000. The Youngton project is included with no apparent economic justification at this time. Future conditions regarding the criticality of need for electric power may require analysis of hydropower development using a criterion other than the benefit-cost analysis. Thus, the Youngton project, as well as the other projects proposed for 2000, could be considered for earlier development.

Coastal and Estuarine Resources. The coastal and estuarine plan provides for a number of fish and wildlife enhancement measures during the next 50 years. These include modification of a spillway gate and construction of salinity control structures; levees and channels to divert fresh water for salinity control and land-building; construction of water-saving devices such as a control structure, a navigation lock, and weirs for salinity control and land-building; and bank stabilization works for the control of shoreline erosion. The plan also calls for a total diversion of nearly 271,000 cfs (approximately 175,000 mgd) of Mississippi River flow, while all other higher priority needs are simultaneously satisfied.

By the year 2020, the plan satisfies all of the need for salinity control, 97 percent of the need for water level management, and 50 percent of the requirement for land-building. Diversions for salinity control and for water level management would also serve to meet a part of the flow required for land-building. No practical alternatives exist to obtain the quantities of water required to meet the remaining needs. Diversion of Mississippi River flows for enhancing the productivity of the estuarine zone is precluded during periods of extreme low flow, however. Points of diversion are located far enough upstream from the Head of Passes to be immune to the effects of river enlargement work currently proposed for that area.

Archeological and Historical Resources. The archeological portion of the plan provides for completion of surveys throughout the region and for testing of 426 sites and excavating of 97 sites by the year 1980. Between the years 1980 and 2000, the plan requires excavation of an additional 328 sites out of 1,422 sites to be tested. Since site testing and excavation work beyond the year 2000 cannot be predicted without the results of the short-term surveys, the scope of the extremely long-range site work is not specified in the plan. The historical portion of the plan calls for 9,354 structures to be added to the national or state register of historic places, with most of these structures requiring some amount of restorative work, by the year 2020. Also included are 125 and 1,216 historic districts and sites, respectively, which should be added to the register. Interpretative markers at many of these places and at historic roads, trails, and cemeteries are also program requirements.

Health Aspects. The recommended plan for health aspects includes the following measures:

1. Improvement of the epidemiology programs of the state departments of health through the development of consistent local contracts and increased emphasis on water and vector-borne diseases.

2. Expansion of water supply programs for the state departments of health to provide essential surveillance and technical assistance to all water systems in the region.

3. Improvement of measures for protecting drinking water supplies that are subject to contamination from municipal, industrial, and agricultural waste discharges.

4. Planning in Arkansas, Louisiana, and Mississippi directed to assistance and action for protecting water supply systems in the event of natural disasters.

5. Revision of water quality criteria for certain recreation waters in Arkansas, Kentucky, Louisiana, Mississippi, and Tennessee.

6. Development of comprehensive state programs to protect the health of water-contact recreationists.

7. Improvement of vector control programs at the state level to direct disease vector surveillance in Arkansas, Kentucky, Louisiana, and Missouri.

8. Revision of enabling legislation in Mississippi and Tennessee to permit the establishment and operation of vector abatement districts in those states.

9. Establishment of 50 vector abatement districts in the region by 1980, with the establishment of an additional 17 districts by the year 2020.

PROGRAM COSTS

Estimated costs for the recommended program, in terms of January 1972 dollars, are summarized in Table 16. Certain flood control features of the ongoing Mississippi River and Tributaries Project are included in the costs. The total public investment cost of the recommended program is estimated at $14.7 billion, of which $7.4 billion is federal cost and $7.3 billion is non-federal. Average annual operation and maintenance costs are estimated at $329 million.

SCHEDULING AND IMPLEMENTATION

The funding schedule necessary to implement the recommended framework program is presented in Table 17. Excluding the appropriations necessary to continue and accelerate ongoing federal programs (except for the certain features of the Mississippi River and Tributaries Project), average annual short-term (1970) expenditures for the program would be about $842 million. About $295 million of this amount represents federal investments in water and related land resources developments. This level of funding, although about one and one-third times the present federal level, is considered to be a necessary and reasonable commitment of financial resources. Present levels of non-federal investments have not been determined, but it is assumed that substantial increases will be required in these investments, as in the case of federal funding. The approximate percentages of funds required for main features of the recommended program through the year 2020 are given in Figure 29.

Provided the necessary funds can be made available, specific authorization studies will be required before actual implementation of the program. These studies will be necessary for all program components that are not currently authorized, such as reservoirs; land acquisition for recreation, fish and wildlife, and environmental quality purposes; sediment and erosion control measures; drainage measures; and waste treatment facilities for water quality control. Studies are not required for presently authorized projects such as the MR&T project, some projects for hurricane protection, several upstream watershed projects for flood control, and improvements to the system of navigation channels and locks in Louisiana. Future authorization studies will be required, however, for any proposed additions to these projects.

Where it is unlikely that program measures will be fully implemented within existing legal and institutional constraints, some changes may be required in federal and state legislation to permit needs satisfaction. Cases in which these changes may be necessary include proposals for subsidizing landowners; acquiring easements or otherwise regulating land use practices to preserve the environmental quality values of lakes and streams and to protect wildlife habitat

Trees line the road leading to a small community in a rural section of the region.

Table 16

Estimated Program Costs, Recommended Program, Lower Mississippi Region

[Thousands of Dollars]

Feature	1970-1980		1980-2000		2000-2020		Total Investment
	Investment	O&M	Investment	O&M	Investment	O&M	
Water Supply	39,666	12,575	180,830	29,366	198,276	45,656	418,772
Municipal	(33,153)	(11,336)	(89,414)	(20,706)	(152,649)	(33,480)	(275,216)
Irrigation	(0)	(0)	(78,150)	(5,572)	(26,400)	(7,711)	(104,550)
Fish and Wildlife	(6,513)	(1,239)	(13,266)	(3,088)	(19,227)	(4,465)	(39,006)
Water Surface	554,064	4,779	474,626	8,110	507,882	12,122	1,536,572
Recreation							
Small Water	(279,767)	(2,082)	(294,186)	(4,216)	(506,042)	(8,044)	(1,079,995)
Large Water	(245,766)	(1,084)	(178,600)	(2,098)	(0)	(2,098)	(424,366)
Stream Access	(4,150)	(415)	(825)	(538)	(750)	(613)	(5,725)
Fish and Wildlife	(10,100)	(1,010)	(1,015)	(1,112)	(1,090)	(1,221)	(12,205)
Natural Environment	(14,281)	(146)	(0)	(146)	(0)	(146)	(14,281)
Lands	3,631,853	96,326	722,015	175,176	1,306,315	314,905	5,660,183
Recreation	(927,600)	(93,485)	(585,550)	(170,775)	(1,111,750)	(308,280)	(2,624,900)
Fish and Wildlife	(147,172)	(1,932)	(136,465)	(3,492)	(194,565)	(5,716)	(478,202)
Natural Environment	(2,557,081)	(909)	(0)	(909)	(0)	(909)	(2,557,081)
Flood Control & Related Problems	1,646,332	16,529	1,110,872	32,920	896,356	52,084	3,653,560
Flood Control							
Principal Reaches	(563,802)	(3,873)	(355,258)	(6,053)	(149,967)	(7,216)	(1,069,027)
Upstream	(369,335)	(4,568)	(116,500)	(5,313)	(68,562)	(5,770)	(554,397)
Land Treatment	(451,684)	(0)	(495,454)	(0)	(543,642)	(0)	(1,490,780)
Sediment and Erosion							
Critical Land Treatment	(52,098)	(0)	(26,383)	(0)	(10,246)	(0)	(88,727)
Streambank	(42,343)	(2,055)	(41,976)	(4,013)	(35,975)	(5,665)	(120,294)
Roadbanks	(2,833)	(85)	(2,479)	(159)	(1,769)	(212)	(7,081)
Drainage							
Watershed Management	(20,861)	(4,173)	(56,224)	(15,417)	(78,759)	(31,169)	(155,844)
Channels	(143,376)	(1,634)	(16,598)	(1,824)	(7,436)	(1,909)	(167,410)
Water Quality and Pollution	244,717	3,233	606,580	3,734	408,573	4,407	1,259,870
Municipal Waste Treatment	(229,092)	(475)	(603,781)	(462)	(404,739)	(562)	(1,237,612)
Bacteria Control	(15,625)	(2,758)	(2,799)	(3,272)	(3,834)	(3,845)	(22,258)
Navigation	712,990	13,809	180,316	17,494	731,985	23,059	1,625,291
Hydropower	19,189	254	121,055	1,807	0	1,807	140,244
Coastal and Estuarine	5,800	36	21,000	166	240,000	1,716	266,800
Historical and Archeological	38,295	0	126,956	0	45,590	0	210,841
Health	0	5,402	0	9,336	0	11,723	0
TOTALS	6,892,906	152,943	3,844,250	278,109	4,334,977	467,479	14,772,133

O&M = Average annual operation and maintenance.

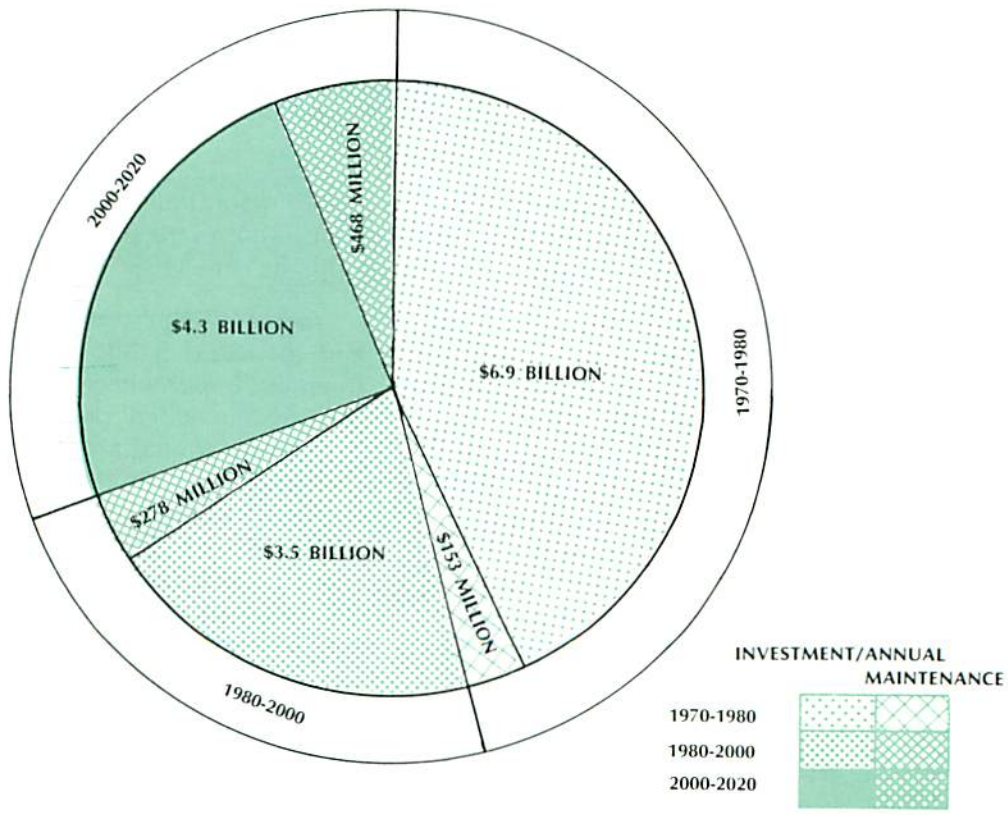
Table 17

Funding Schedule for Recommended Framework Program, Lower Mississippi Region

Public Investor	Funds Required ($1,000,000)		
	1970-1980	1980-2000	2000-2020
Federal			
Total Investment	2,951	2,130	2,319
Annual Investment[1]	295	107	116
Annual Operation, Maintenance and Replacement	66	117	194
Total Federal[2]	361	224	310
Non-Federal			
Total Investment	3,942	1,414	2,016
Annual Investment[1]	394	71	101
Annual Operation, Maintenance and Replacement	87	161	274
Total Non-Federal[2]	481	232	375
Grand Total[2]	842	456	685

[1] Total investment averaged over time period.

[2] Average annual appropriation required.



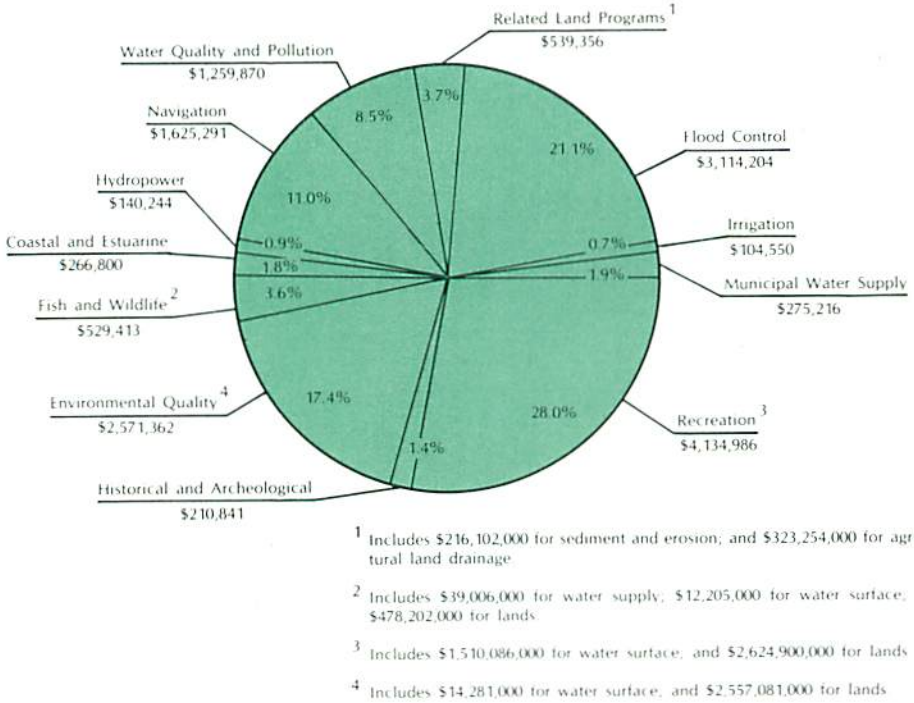


Figure 29. Percentage of Recommended Framework Program Costs for Main Features, Lower Mississippi Region [Thousands of Dollars]

values of certain land areas; and proposals for federal participation in the development of single-purpose reservoirs for recreation.

Many future needs of the region cannot be fulfilled without adequate and timely provision of flood control. Acceleration of the Mississippi River and Tributaries Project and the current backlog of related works in upstream watersheds is most critical, therefore, to the framework program. To implement completion of the MR&T project as scheduled, current appropriations would have to be increased to approximately $300 million per year. Although this increase would significantly advance the completion date under current funding levels, the full benefits of the project could not be realized until the mid-1980s.

Increased public awareness of the problems and increased public involvement in solving them are important elements in implementing the recommended program. Along this line, active educational programs are needed (1) to encourage agriculturists to match crops better to land capability so that program acreages allocated to cropland can produce the regional share of food and fiber; and (2) to promote public access to small ponds that can help meet future needs for fishing.

ADDITIONAL DATA NEEDS

During the conduct of the Lower Mississippi Region Comprehensive Study, participants noted basic data deficiencies in the areas of climatology, meteorology, hydrology, water use, and water quality. A need was also recognized for additional studies relating to the management, development, and use of water and related land resources in the Lower Mississippi Region. In view of increased awareness of and emphasis on ecological values and the effects of environmental conservation programs, it is essential that these deficiencies be corrected through more intensive and systematic studies and investigations.

Data Deficiencies

Additional data are needed to correct deficiencies in a number of areas. In the area of climatology, there is a need for:

Better definition of microscale variations of the many parameters that collectively determine regional climate

Instrumental monitoring of extensive crop management and irrigation practices

Research relative to evapotranspiration and soil moisture

Additional solar radiation measurements

Additional benchmark weather stations to insure accurate, correlative climatic records

Many of these data requirements are also applicable for meteorology, since many meteorologic techniques are dependent upon climatic data. In this area, needs are for:

Satellite imagery with a higher degree of resolution for severe weather monitoring and forecasting

More sophisticated radars with improved rainfall intensity evaluation

Automation of data acquisition networks that will permit prompt warnings of severe weather

Additional tide gages and wave recorders for coastal areas and certain water bodies

Investigations of factors that make up regional weather under similar synoptic and upper air systems

Additional data relating to drainage areas, streamflow and stage, and flow velocity, are needed to correct deficiencies encountered during conduct of hydrologic studies. In this area, needs exist for:

Additional drainage area publications

Streamflow data for large and small basins, defining low, mean and peak flows under various conditions

Additional streamflow gaging stations in coastal areas

Low-flow, frequency, and duration data in smaller drainage basins

Data on effects of climatic, topographic and man-made changes on streamflow characteristics

Data on effects of land use changes on basin runoff

Time of travel information for the Mississippi River and its main tributary systems and on small streams affected by pollution

There is a need for more systematic and standardized methods to inventory the amount of water diverted from the region's streams and the amount consumed, with responsibility for collection of the water-use data being delegated to a single agency to avoid misinterpretation and duplication of effort.

A critical need exists to establish criteria for quantification of accurate water quality data covering a full range of pollutants, especially stressing non-BOD constituents such as heavy metals, temperature, odor, color, phenolics, nutrients, toxics, insecticides and pesticides, dissolved solids, and exotics.

Additional Studies

Studies pertaining to the management, development, and use of the water and related land resources of the Lower Mississippi Region are needed to provide basic planning data and sufficiently detailed information for future authorization of specific water resource devel-

opments. These include traditional, single-purpose and multipurpose studies; urban studies such as those authorized for the Pine Bluff Metropolitan Area in Arkansas (WRPA 5), the New Orleans-Baton Rouge Metropolitan Area in Louisiana (WRPAs 9 and 10), and the Memphis Metropolitan Area in Tennessee, Arkansas, and Mississippi; studies for the purpose of formulating programs to solve urban waste water problems and to serve as a catalyst for solving other related urban problems; and flood plain information studies for communities in the region.

Special studies are needed to determine best application time for irrigation water in the region and development of more efficient irrigation systems. A study should also be undertaken indicating state-federal actions necessary to quantify inorganic pollutants, define ways in which public funds can be used most advantageously to supply cost sharing for pollution abatement works, establish definitive continuing water quality monitoring systems, recommend practical measures to insure the maintenance of clean water, and recommend legal, social, and institutional changes needed to insure attainment of these elements. The study should include an inventory of municipal, industrial, and agricultural wastes sources; water quality monitoring at key locations; cost analyses of waste treatment practices and levels of treatment; research into the applicability and feasibility of certain modes of water quality control; and research into sediment transport.

More detailed studies are needed relating to the effects of changes in streamflow patterns on the sedimentation of streams in the region. Ground-water investigations are needed throughout the region to define accurately the potential yield of all aquifers and to define the areal extent, hydraulic characteristics, potential yield, quality of water, and the effects of withdrawals on all aquifers.

In the area of land use, needs exist for an accurate expression of land use, especially as regards lands covered by lakes, ponds, and streams; for a comprehensive land-use plan for the lands lying adjacent to the main stem of the Mississippi River in WRPA 1; and for studies of means to implement an analytic system for continuous inventory of the forest resources within the region, with emphasis on forest conditions, present production, and potential production.

Moss-draped trees cast lengthening shadows in the deep purple of a tranquil lake.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The Lower Mississippi Region contains adequate natural resources to support substantial growth to the year 2020 in population, employment, earnings, agricultural production, mineral output, manufacturing, and other economic sectors. This growth will place increasing demands upon water and related land resources, primarily with regard to water supplies for municipal, industrial, thermoelectric power generation, and irrigation; and developments for navigation, flood control, land treatment and management, fish and wildlife habitat, and water-oriented outdoor recreation.

Most regional water supply problems are related to resource distribution, rather than availability. As requirements increase, careful management will be necessary to insure that adequate supplies are available when and where needed. Of especial importance to economic growth is the maintenance of water supplies for industry and the improvement of navigation facilities.

The region's vast navigational network is a major asset to national economic stability and an indispensable factor in the movement of inland waterborne commerce between the heart of the nation and major world markets. In 1970, the system handled one out of every seven tons of waterborne commerce and more than one-fourth of total ton-miles of traffic. The region plays another essential role in national economy in that it currently supplies from one-fourth to one-third of the nation's energy in the form of petroleum, natural gas, and natural gas liquids. Development of these resources must be continued to meet greatly increased energy requirements, but such development should incorporate measures to minimize adverse environmental impacts.

World conditions in 1974 indicate that exports of agricultural products beyond 1980 will probably increase at a faster rate than assumed during the comprehensive study and that the region will therefore be called upon to supply a greater proportion of the nation's food and fiber requirements. To meet this increased need for food, accelerated planning and resource development measures must be undertaken to ameliorate crop losses due to flooding. The continued institution of land treatment and drainage measures, sediment and erosion control measures, and the use of supplemental irrigation will also be required.

Flooding is still a serious problem in the region, although extensive improvements have been made. Average annual flood damages to urban and built-up developments are estimated at $40 million, based on 1970 conditions. Most of the flood-prone lands, however, are used for crop production and pasture. Flooding therefore hampers capability to produce the food and fiber essential to the economy and well-being of the region and nation.

The Mississippi River and Tributaries Project, although only half complete, prevented an estimated $13 billion in flood damages in 1973--more than six and one half times the amount expended on the project to that time. More than $760 million in damages still occurred, however. Until the project is completed, the potential for a disastrous flood event will continue to exist. Flood control on the Mississippi River and tributaries is clearly the most pressing problem in the region.

Discharges of raw or inadequately treated wastes are seriously degrading water quality in some reaches of the Mississippi River and its tributaries. Solutions to these problems will require establishment of an effective region-wide water quality program; definition of the nature and magnitude of pollution problems; and planning of adequate control measures.

Conversion of land to satisfy urban requirements, cropland and pasture needs, and other needs related to predominantly open land areas will infringe upon the satisfaction of needs for forested wildlife habitat. Although some forested areas can be restricted to primary use for wildlife habitat, most will have to be carefully managed under multiple-use sustained yield principles to satisfy requirements in both areas.

Demand for water-dependent and water-oriented recreation opportunities on large lakes and reservoirs will exceed available supplies within the near future. Part of the demand can be met through more intensive use of lakes and existing and proposed reservoirs. There is limited potential for developing large lakes in the region, however, and some needs will not be met unless recreationists are willing to accept lesser space standards than assumed for this study, or to substitute other recreation experiences.

The framework program recognizes a number of opportunities for the enhancement, conservation, and preservation of environmental values, coastal and estuarine resources, archeological resources, and public health, which can contribute substantially to meeting present requirements. Periodic reviews and updates of the program will be necessary, however, to keep it abreast of future changes in regard to these elements.

Effective implementation of the framework program will require coordinated and expeditious action at all levels of government and in the private sector; additional studies of sufficient scope to provide the basis for authorization of specific projects; meaningful and sustained local, state, and federal financial support; and new legislative support in some areas.

A sun-bleached tree trunk hugs the sand at the Gulf's edge.

Recommendations

On the basis of findings presented in the Lower Mississippi Region Comprehensive Study, the Coordinating Committee recommends that:

1. The comprehensive program presented in Appendix T (Plan Formulation) be adopted as the framework for development, management, and beneficial use of water and related land resources in the region.

2. The report serve as the base document for further detailed authorization reports covering component plans of the framework program.

3. Federal, state, and local plans and programs be implemented as necessary to support the economic growth projected for the national income objective and to make contributions to the environmental quality objective. Special emphasis should be given to the satisfaction of needs for food and fiber, flood control, water supply, inland navigation, sediment and erosion control, land drainage, fish and wildlife conservation and enhancement, outdoor recreation and water quality control, and for enhancement, conservation, and preservation of environmental values, archeological and historical resources, and public health.

4. Presently authorized flood control projects for principal streams and upstream watersheds be accelerated to meet short-term needs, with special emphasis on accelerated completion of the Mississippi River and Tributaries Project.

5. Ongoing studies and projects for management and development of water and related land resources be expeditiously funded to completion and accelerated wherever possible.

6. Plans be expedited for improving navigation waterways and port facilities to meet short-term transportation needs associated with projected economic growth.

7. Satisfaction of future needs of the mineral industry, especially those for petroleum, natural gas, and natural gas liquids, be given high priority through the provision of (1) reasonable access to mineral sources for both exploration and development purposes, (2) dependable water supplies based upon competitive principles, and (3) policies and programs encouraging domestic minerals development, supported by meaningful research efforts, and with due consideration to long-range social and environmental impacts.

8. Studies be accelerated to locate potential energy sources, to determine new locations for electric power plants and transmission facilities, and to devise new technologies for blending developments for energy generation with the natural environment.

9. Mining activities incorporate such measures as necessary to control the discharge of pollutants into streams and, in the case of surface mining, provide measures to restore the topography and vegetation of excavated areas to original conditions, insofar as possible, upon cessation of the mining activities.

10. Flood plain information studies be accelerated, and that joint action be taken by federal, state, and local agencies to establish and implement appropriate flood plain management programs.

11. The formulated water quality improvement plan for the region be implemented with high priority and that an accelerated effort be made to formulate a satisfactory total water quality plan which would include all pollutants--particularly those not included in the formulated plan.

12. Federal and state programs to solve water pollution problems be adequately funded; techniques for achieving higher levels of wastewater treatment be improved; state stream quality standards be enforced; measures be developed for controlling non-point sources of agricultural pollution; and that non-BOD pollutants be studied in sufficient detail to define the magnitude of the problem and devise adequate control measures.

13. An extensive land use and capability analysis employing satellite photographs and/or other techniques be made to define current use and enhance prospects for achieving the best future use of land resources.

14. A land management program be pursued for purposes of coordinating future land uses, matching land use to land capability, and instituting proper land treatment and protection measures. Land treatment and management, sediment and erosion control, and land drainage programs should be accelerated to preserve and enhance the productive capacity of the land resource base.

15. Studies of presently irrigated lands and potentially irrigable land be refined in sufficient detail to insure proper management and best use of land and water resources for future developments.

16. Effective land-use policy and planning be implemented to insure preservation of urban open and green space, unique natural areas, archeological and historical resources, scenic rivers, streams and lakes, and to insure the protection of fish and wildlife, including rare and endangered species.

17. Development of improved plant and crop species, fertilizers, and disease control be continued; that management practices such as clipping, proper cattle/acre ratio, and supplemental irrigation be continued; and that the use of feedlots be increased to help meet beef and veal production requirements.

18. Intensive forest management be accelerated, including timber stand improvement, increased protection from insects, fire and disease, and improved forest product utilization.

19. Regionwide information and education programs be initiated to make governmental agencies, private organizations, and individual citizens aware of the problems and needs in water and related land resources, so that coordinated action in regard to planning, development, and protection of all the region's natural resources can be attained. Special consideration should be given to educating landowners to the need for allowing cropping patterns to change so as to approach maximum production from each acre under cultivation; making more on-farm ponds available to the general public for fishing purposes; and for allowing the general public better access to scenic areas, to private lands for hunting and recreation, and to other multiple-use areas.

20. Continued emphasis be placed on formulation of improved policies and procedures for evaluating the feasibility of water and related land resource developments, for evaluating associated environmental aspects, and for reducing the time lag between authorization and implementation of feasible water and related land resource developments.

21. Reservoirs for flood control, power, water supply, and related purposes be designed and operated to provide maximum multiple-use within the reservoir basin and to provide optimum downstream benefits; that these provisions be enhanced through periodic review and updating of reservoir operations; and that single-purpose reservoirs for recreation be constructed to meet needs associated with the projected economic growth.

22. Sufficient land area and water supply be managed to satisfy primary use needs for fish and wildlife purposes; and that additional land areas and water supply be managed in such a manner as to yield maximum fish and wildlife benefits, but not to the exclusion of other compatible or complementary uses.

23. Environmental control programs be developed at all levels of government to support present programs which protect the public against health hazards from air, water, and vector-borne diseases.

24. A study be made to determine the adequacy of federal and state laws and policies to carry out needed water resource programs and make recommendations concerning new legislation and policies that may be required. Special consideration should be given to legislation and policies concerning plaintiff requirements, legal responsibility, and bonding requirements in environmental disputes.

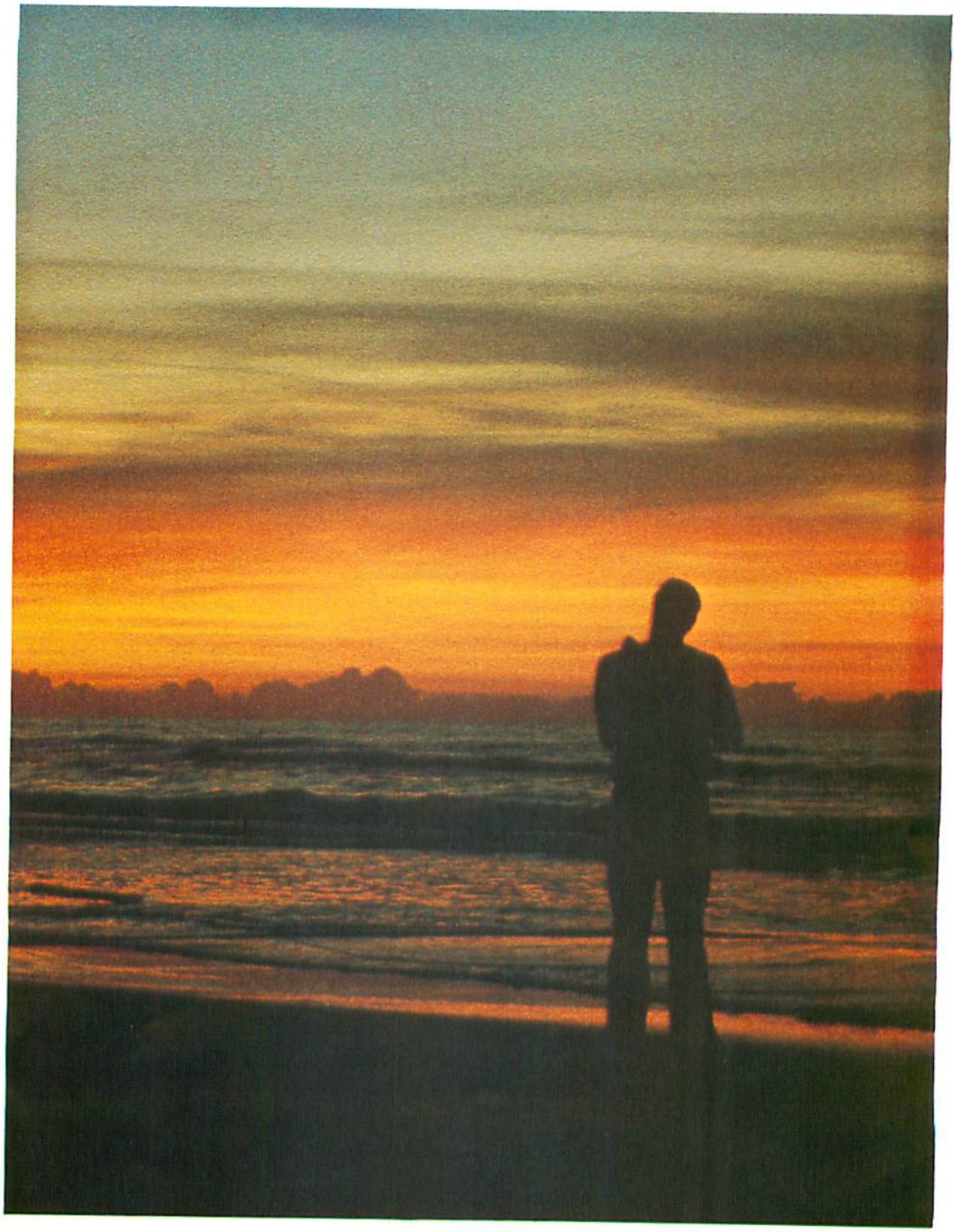
25. The additional data collection and studies discussed in this appendix be made as soon as practicable by appropriate entities to provide a more comprehensive data bank from which more effective detailed planning can be done.

26. The well-being of the people remain the principal criterion in formulating specific project proposals for management of the region's resources.

27. The affected and concerned federal and non-federal agencies make periodic review and update of the program components for which it is or may be, under law, assigned responsibility to maintain the framework outlined herein as a viable planning tool in light of changing regional and national priorities.

28. Components of the program be evaluated and implemented in a comprehensive, coordinated, and timely manner with due regard to the multiobjectives, system of accounts, and other criteria defined in the Water Resources Council's Principles and Standards published in the *Federal Register*, September 10, 1973.

29. Implementation of the framework program be funded at a level commensurate with needs.



WATER RESOURCES PLANNING AREAS