THE NATION'S WATER RESOURCES 1975-2000

Volume 4: South Atlantic-Gulf Region

Second National Water Assessment by the U.S. Water Resources Council

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Second National
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by the
U.S. Water Resources Council

December 1978

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Stock Number 052-045-00061-4

Foreword

The Water Resources Planning Act of 1965 (Public Law 89-80) directs the U.S. Water Resources Council to maintain a continuing study of the Nation's water and related land resources and to prepare periodic assessments to determine the adequacy of these resources to meet present and future water requirements. In 1968, the Water Resources Council reported the results of its initial assessment. The Second National Water Assessment, a decade later, provides a comprehensive nationally consistent data base for the water resources of the United States. The results of the Second National Water Assessment were obtained by extensive coordination and collaboration in three phases.

Phase I: Nationwide Analysis

The Council member agencies researched, analyzed, and prepared estimates of current and projected water requirements and problems and the implications of the estimates for the future.

Phase II: Specific Problem Analysis

Regional sponsors, one for each of the 21 water resources regions, surveyed and analyzed State and regional viewpoints about (1) current and future water problems, (2) conflicts that may arise in meeting State and regional objectives, and (3) problems and conflicts needing resolution.

Phase III: National Problem Analysis

The Council conducted this final phase in three steps: (1) An evaluation of phases I and II, (2) an analysis that identified and evaluated the Nation's most serious water resources problems, and (3) the preparation of a final report entitled "The Nation's Water Resources--1975-2000."

The final report of the Second National Water Assessment consists of four separate volumes as described below. These volumes can assist Federal, State, local, and other program managers, the Administration, and the Congress in establishing and implementing water resources policies and programs.

Volume 1, Summary, gives an overview of the Nation's water supply, water use, and critical water problems for "1975," 1985, and 2000 and summarizes significant concerns.

Volume 2, Water Quantity, Quality, and Related Land Considerations, consists of one publication with five parts:

Part I, "Introduction," outlines the origin of the Second National Water Assessment, states its purpose and scope, explains the

numerous documents that are part of the assessment, and identifies the individuals and agencies that contributed to the assessment.

II, "Water-Management Problem Profiles," identifies ten general water problem issues and their implications and potential consequences.

Part III, "Water Uses," focuses on the national perspectives regarding existing ("1975") and projected (1985 and 2000) requirements for water to meet offstream, instream, and flow-management needs. State-regional and Federal perspectives are compared.

Part IV, "Water Supply and Water Quality Considerations," analyzes the adequacy of fresh-water supplies (ground and surface) to meet existing and future requirements. It contains a national water budget; quantifies surface- and ground-water supplies, reservoir storage, and transfers of water within and between subregions; describes regional requirements and compares them to supplies; evaluates water quality conditions; and discusses the legal and institutional aspects of water allocation.

Part V, "Synopses of the Water Resources Regions," covers existing conditions and future requirements for each of the 21 water resources regions. Within each regional synopsis is a discussion of functional and location-specific water-related problems; regional recommendations regarding planning, research, data, and institutional aspects of solving regional water-related problems; a problem-issue matrix; and a comparative-analysis table.

Volume 3, Analytical Data, describes the methods and procedures used to collect, analyze, and describe the data used in the assessment. National summary data are included with explanatory notes. Volume 3 is supplemented by five separately published appendixes that contain data for the regions and subregions:

Appendix I, Social, Economic, and Environmental Data, contains the socioeconomic baseline ("1975") and growth projections (1985 and 2000) on which the water-supply and water-use projections are based. This appendix presents two sets of data. One set, the National Future, represents the Federal viewpoint; the other set, the State-Regional Future, represents the regional sponsor and/or State viewpoint.

Appendix II, Annual Water Supply and Use Analysis, contains baseline water-supply data and baseline and projected water withdrawal and water-consumption data used for the assessment. Also included are a water adequacy analysis, a natural flow analysis, and a critical-month analysis.

Appendix III, Monthly Water Supply and Use Analysis, contains

monthly details of the water-supply, water-withdawal, and water-consumption data contained in Appendix II and includes an analysis of monthly water adequacy.

Appendix IV, Dry-Year Conditions Water Supply and Use Analysis, contains both annual and monthly baseline and projected water-withdrawal and water-consumption data for dry conditions. Also, a dry conditions water-adequacy analysis is included.

Appendix V, Streamflow Conditions, contains detailed background information on the derivation of the baseline streamflow information. A description of streamflow gages used, correction factors applied, periods of record, and extreme flows of record, are given for each subregion. Also included is the State-Regional Future estimate of average streamflow conditions.

Volume 4, Water Resources Regional Reports, consists of separately published reports for each of the 21 regions. Synopses of these reports are given in Volume 2, Part V.

For compiling and analyzing water resources data, the Nation has been divided into 21 major water resources regions and further subdivided into 106 subregions. Eighteen of the regions are within the conterminous United States; the other three are Alaska, Hawaii, and the Caribbean area.

The 21 water resources regions are hydrologic areas that have either the drainage area of a major river, such as the Missouri Region, or the combined drainage areas of a series of rivers, such as the South Atlantic-Gulf Region, which includes a number of southeastern States that have rivers draining directly into the Atlantic Ocean and the Gulf of Mexico.

The 106 subregions, which are smaller drainage areas, were used exclusively in the Second National Water Assessment as basic data-collection units. Subregion data point up problems that are primarily basinwide in nature. Data aggregated from the subregions portray both regional and national conditions, and also show the wide contrasts in both regional and national water sources and uses.

The Second National Water Assessment and its data base constitute a major step in the identification and definition of water resources problems by the many State, regional, and Federal institutions involved. However, much of the information in this assessment is general and broad in scope; thus, its application should be viewed in that context, particularly in the area of water quality. Further, the information reflects areas of deficiencies in availability and reliability of data. For these reasons, State, regional, and Federal planners should view the information as indicative, and not the only source to be considered. When policy decisions are to be made, the effects at State, regional, and local levels should be carefully considered.

In a national study it is difficult to reflect completely the regional variations within the national aggregation. For example, several regional

reviewers did not agree with the national projections made for their regions. These disagreements can be largely attributed either to different assumptions by the regional reviewers or to lack of representation of the national data at the regional level. Therefore, any regional or State resources-management planning effort should consider the State-regional reports developed during phase II and summarized in Volume 4 as well as the nationally consistent data base and the other information presented in this assessment.

Additional years of information and experience show that considerable change has occurred since the first assessment was prepared in 1968. The population has not grown at the rate anticipated, and the projections of future water requirements for this second assessment are considerably lower than those made for the first assessment. Also, greater awareness of environmental values, water quality, ground-water overdraft, limitations of available water supplies, and energy concerns are having a dramatic effect on water-resources management. Conservation, reuse, recycling, and weather modification are considerations toward making better use of, or expanding, available supplies.

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Description

The South Atlantic-Gulf (SAG) Water Resources Region, which lies south and east of the Tennessee and Ohio River Basins, is that portion of the southeastern United States from and including the Chowan River Basin in southeast Virginia to the Mississippi River Basin in Louisiana and Mississippi (Figure 3-1). It contains 24 major river systems and many minor river systems along the Atlantic and Gulf Coasts. The region covers almost 167 million acres of land area and 6.8 million acres of fresh-water area. This 173.6 million acres (271,300 square miles)[1] includes all of the States of South Carolina (11.6 percent of the region) and Florida (20.8 percent) and parts of the States of Virginia (3.2 percent), North Carolina (16.2 percent), Georgia (21.6 percent), Alabama (16.8 percent), Mississippi (9.5 percent), and Louisiana (0.3 percent).

There are 1,945 miles of ocean shoreline and 11,847 miles of bay/estuary shoreline along the south Atlantic Ocean and eastern Gulf of Mexico. Large bay/estuary water areas exist along both the Atlantic and Gulf Coasts. These are important fisheries as well as nursery areas. Coastal waters also provide recreation opportunities for millions of visitors per year.

The SAG Region rises on the eastern slope of the Blue Ridge Mountains and encompasses mainly the Blue Ridge, Piedmont, and Coastal Plain Provinces. The Valley and Ridge and the Appalachian Plateau Provinces cut across a small area in northwest Georgia and into northeastern Alabama. This Fall Line is a dividing line between the Piedmont and Coastal Plain Provinces from Virginia into northwest Alabama. This Fall Line in Alabama becomes the dividing line between the Appalachian Plateau and Blue Ridge Provinces and the Coastal Plain Province. The area, at one time largely agrarian, is becoming highly industrialized along major interstate highway systems and near ports on both the Atlantic and Gulf Coasts. The I-85 highway corridor from Atlanta to north-central North Carolina supports a great deal of industry and is rapidly growing into an urban area. Urban areas (4.7 million acres) make up about 3 percent of the total land area (167 million acres) and cropland about 15 percent. Approximately 63 percent of the region is forested, 9 percent is pastureland, and the remaining 10 percent is highways, airports, industrial sites, and agricutural land. Figure 3-2 shows the distribution of Standard Metropolitan Statistical Area (SMSA) counties and forestlands in the region.

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[1]This is the sum of the areas of counties to approximate the hydrologic area of the region. Land use and other socioeconomic data are related to this area. The drainage area within the hydrologic boundary is 277,200 square miles.

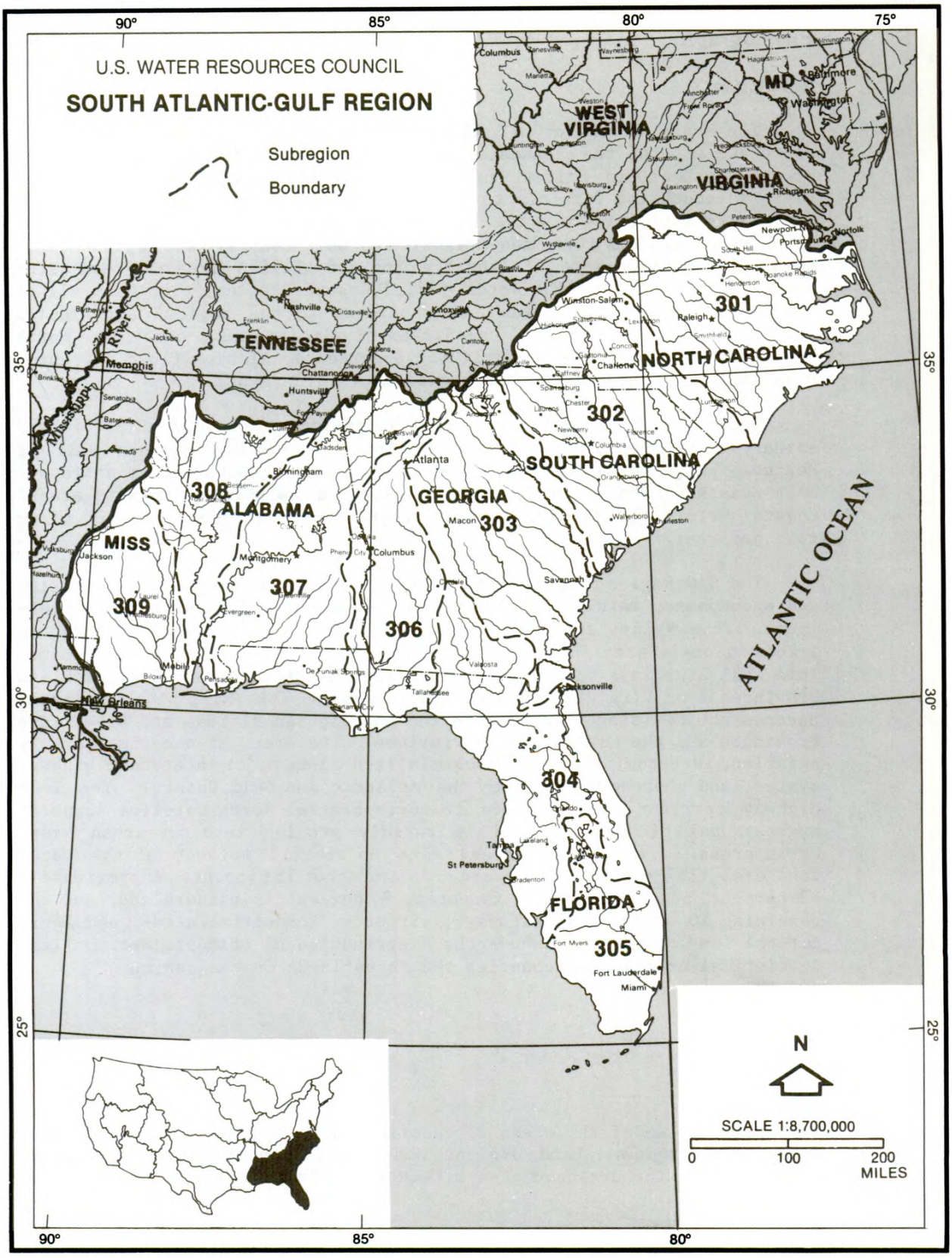


Figure 3-1. Region Map

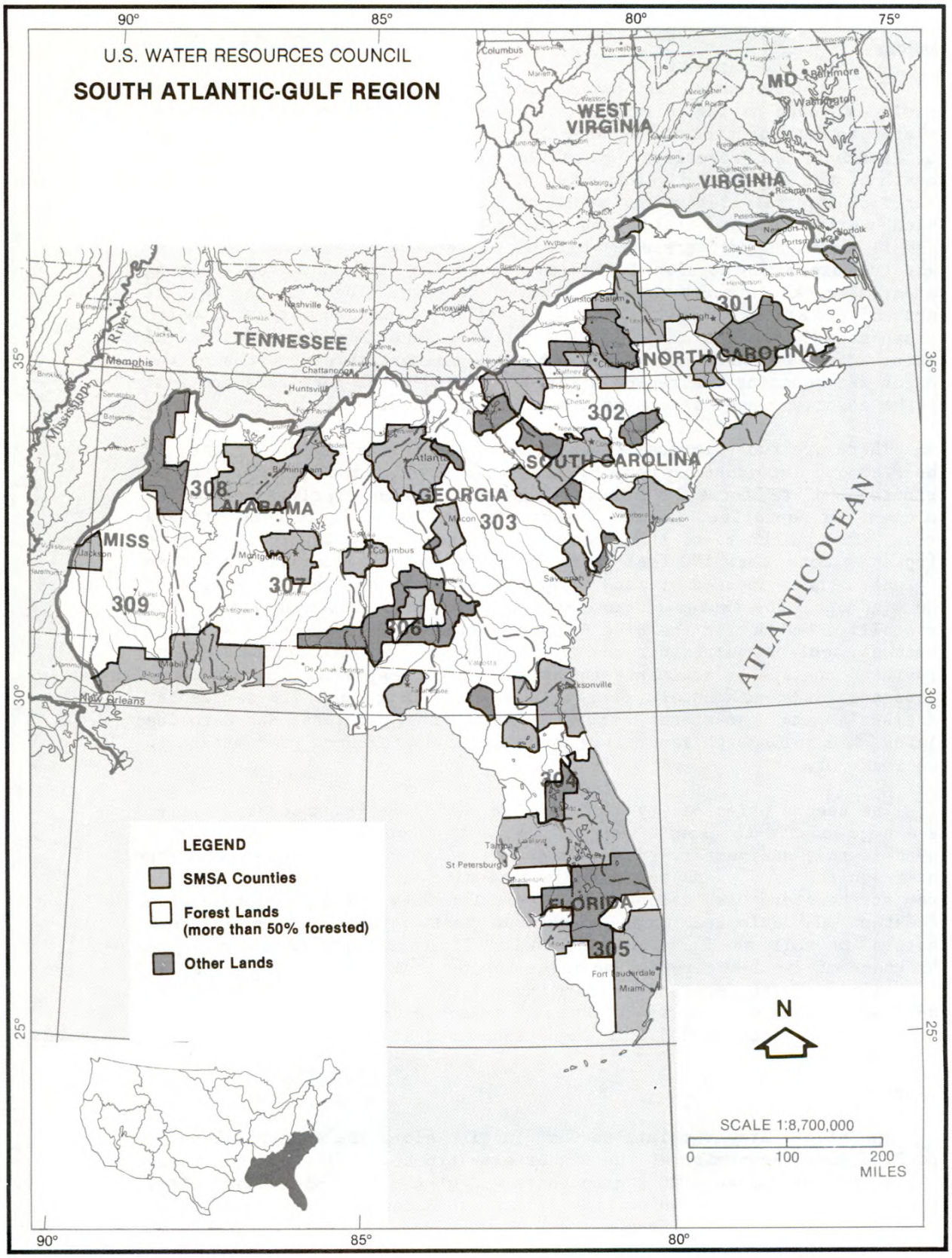


Figure 3-2. Present Land Use

Geology

The South Atlantic-Gulf Region includes parts of five physiography provinces, each having distinctive features of ground-water occurrence related to the character of the underlying rocks. These provinces include the Piedmont, which overlies crystalline rocks and encompasses about one-fourth of the region and which extends in a broad northeastward-trending belt from central Alabama to southern Virginia; the Valley and Ridge, which overlies strongly folded and faulted carbonate rocks and encompasses a small northeastward-trending belt in south central Alabama and northwestern Georgia; the Appalachian Plateau, overlying horizontal coal-bearing sandstone rocks in northwestern Alabama; the Blue Ridge, in the western parts of the States of South Carolina, North Carolina, and Virginia, which encompasses the eastern slopes of the Blue Ridge Mountains; and the Coastal Plain, composed of sediments, which encompasses almost three-fourths of the region and contains the region's largest ground-water resources and some of the country's most extensive and productive aquifers.

There are two principal types of aquifers in the region. First, in the Piedmont and mountain regions, fractured crystalline bedrock, such as granite and slate, forms the principal aquifer, with the overlying weathered portion, or saprolite, in some areas constituting a significant storage area. The thickness of this saprolite varies from a few feet on steep slopes to more than 100 feet in the valleys, but is generally less than 20 feet. When composed of sand or gravel rather than the usual clays of the Piedmont, the saprolite may form a highly productive aquifer. The crystalline bedrock in the Blue Ridge and Piedmont Provinces consists of gneisses, schists, quartzites, and granites. The saprolite of the Piedmont Province consists of sediments intruded by granites, which in some locations such as Stone Mountain, Georgia, have large outcrops. The sediments, once shales and sandstones, are now quartzites, schists, and Carolina slate. Red soils with sandy clay and silty clay textures predominate in the Piedmont.

The second principal type of aquifer, which is in the Coastal Plain, is a huge seaward-thickening wedge of generally unconsolidated, but locally consolidated, sedimentary rock on Precambrian and Paleozoic bedrocks. The chief aquifers are sands and gravels extending in a broad arcuate belt from northeastern Mississippi to southern Virginia and highly productive limestone and dolomite areas throughout most of Florida and adjacent Georgia as well as in coastal South Carolina and North Carolina. The thickness of fresh-water-bearing rocks ranges from a few hundred feet in Virginia and North Carolina to more than 2,000 feet in parts of Florida and Georgia and as much as 3,000 feet in southern Mississippi. Large saline water resources underlie the fresh-water aquifers.

Topography

The rivers from Virginia to Georgia rise along the eastern slope of the Blue Ridge Mountains at the higher elevations and flow southeastward to the Atlantic Ocean. At the southern end of the Blue Ridge Mountains, in the Appalachian Plateau and the Valley and Ridge Provinces, the Chat-

tahoochee and Coosa Rivers rise in northwest Georgia and flow southwestward to the Gulf of Mexico. Other river systems to the west in Alabama and Mississippi flow into the Gulf of Mexico.

Elevations in the region range from about 5,500 feet in the mountains to 1,200 feet in the mountain foothills of the Piedmont Province, to 200 feet near the Fall Line. The rugged, densely wooded mountains with conspicuous relief and well-defined narrow valleys change to a rolling and hilly Piedmont and then to a gently rolling terrain at the Fall Line.

For descriptive purposes the higher, undulating portion of the Coastal Plain Province is referred to as upper Coastal Plain and the relatively flat, low-lying portion along the coast as lower Coastal Plain. In the flat coastal areas the lands are poorly drained. In these areas drainage and water-control measures are necessary if the land is to be used for development or crop production. These low, flat lands contain valuable natural lakes, swamps, and wildlife areas. In Florida, which for the most part has little geographic relief, drainage divides are difficult to delineate and frequently are not meaningful. Where the ridge between the basins is indistinct and is low enough to be topped by flood waters, it will function as a boundary only part of the time. Therefore, the Florida peninsula is generally divided into the St. Johns River Basin; south Florida (that portion of the State draining into Lake Okeechobee and to the south); and southwest Florida, encompassing an area between the St. Johns and Suwannee River Basins.

The Coosa and Black Warrior Rivers originate in the Valley and Ridge and the Appalachian Plateau Provinces, flow through the valleys in north and northeastern Alabama, and cross the Fall Line in central Alabama. The Fall Line runs northwestward from Phenix City, Alabama, to the Tennessee River at the northern end of the Alabama-Mississippi State line. The Alabama area south of the Fall Line and all of Mississippi are in the Coastal Plain Province, sometimes referred to as the Gulf Coastal Plain Province.

Climate

The climate is characterized by well-distributed rainfall (except in portions of Florida), mild winters, and warm-to-hot humid summers. Average annual rainfall generally ranges from 41 inches in small areas of the interior of Georgia and South Carolina to 80 inches in the southern reach of the Blue Ridge Mountains. A minimum annual average of 40 inches occurs locally at Key West, Florida. Rainfall along the Atlantic coast areas, in Florida, and in the central portion of the Gulf states is 50 to 55 inches per year. The Gulf coastal area receives 60 to 67 inches per year. Average annual rainfall of approximately 50 inches per year for the region compares very favorably with the national average of 30 inches per year.

South Florida experiences a considerable variation in precipitation during the year. This area receives almost one-half of its annual average rainfall in the period from June through August. One-fourth occurs in the

fall from September through November, and the remaining one-fourth occurs during the 6 month period from December through May.

Normal daily average temperatures range from 55°F in the mountains to 75°F in south Florida. Freezing temperatures are rare in south Florida, but they usually occur about 40 times per year along the Fall Line and 70 or more times per year in the mountains. The high mountain barrier aligned in a northeast-southwest direction protects a large part of the region from severe cold. Along the Atlantic Coast, the climate is tempered by the Atlantic Ocean, landlocked sounds, and the warm Gulf Stream just offshore. The Gulf of Mexico tempers the climate of the States adjoining it.

January temperatures vary from an average of 30°F in the mountains to 70°F at the southern tip of Florida. The average daily temperature range is about 20°F, with extremes of 10°F to 30°F. Average July maximum daily temperature varies from about 80°F in the mountains to 94°F in central Georgia. Temperatures much higher than 100°F and lower than zero are extremely rare in the region. The growing season varies from 180 days in the mountains to the entire year in south Florida.

Rainfall, except as discussed above for south Florida, is fairly well-distributed throughout an average year, with most of the rain occurring during the growing season. In the inland areas of the region, early spring peaks are a product of frontal storms which sweep across the continent. These storms migrate seasonally. The summer peaks are products of thunderstorms which produce abundant rainfall. Autumn peaks may occur along the coastal areas from hurricanes and lesser tropical storms. These hurricanes hit the Florida coast an average of every 2 years, the Gulf coast every 3 years, the Atlantic coast every 5 years, and inland areas every 10 years. Northeasters, generated off the northeastern United States coast, sometimes hit the coasts of North Carolina with heavy rainfall.

People and the Resources

Problems of water quantity and quality are closely related to population and standard of living. As the population increases and the standard of living is improved, higher demands are made on the available water resources for supply and for the disposal of wastes. Projections of population and economic indicators have been made in order to arrive at water needs and to project water-quality management and other requirements. For this purpose the OBERS "E" data have been used by the Bureau of Economic Analysis to develop (under contract with the Tennessee Valley Authority and the Corps of Engineers) a set of economic activity projections at the county and/or Standard Metropolitan Statistical Area (SMSA) level of aggregation for the nine southeastern States. These projections are closely coordinated with State agency projections and projections of other parties interested in small area data. These were used as a basis for the State-Regional Future (SRF) in the national water assessment reports.

Population

The region is shifting from an agrarian economy to an industrialized and diversified economy. As a result there is a shifting of a rural population to an urban population. Urban areas are expanding into adjoining rural areas. This shifting of rural to urban population will continue during the period from 1975 to 2000.

According to the National Future (NF) viewpoint, total population in the region is projected to increase from 25.4 million in 1975 to 34.7 million in 2000. Past trends have shown a change in SMSA population from 49.5 percent of the total population in 1950 to 61.5 percent in 1970. It is projected to increase to 67.5 percent in 2000. In 1975 the population of the region was approximately 12 percent of the national population; by 2000 it is projected to be 13 percent.

Economy

There were 10.3 million persons employed in the region in 1975. The total personal income, measured in 1975 dollars, was about $134 billion, or over $5,200 per person. Earnings from manufacturing were 25 percent of the total earnings, the largest of any single category earnings. The "other" category of earnings was 70 percent of the total (See Table 3-1) and includes wholesale and retail trade; government; services; transportation, community and public utilities; contract construction; and finance, insurance, and real estate.

Table 3-1.--South Atlantic-Gulf Region earnings--1975, 1985, 2000
(million 1975 dollars)

Earnings sector	1975	1985	2000
Manufacturing	25,954	38,949	64,366
Agriculture	4,583	4,628	5,504
Mining	444	543	709
Other	73,903	115,622	210,874
Total	104,884	159,742	281,453

Manufacturing earnings are projected to increase 148 percent between 1975 and 2000, while agricultural earnings are projected to increase only 20 percent. The "other" category of earnings is projected to increase 185 percent from 1975 to 2000. In 2000, manufacturing earnings will be 23 percent of total earnings, and agricultural and other earnings are projected to be 2 and 75 percent, respectively. In 1975, textiles accounted for 21 percent of the manufacturing earnings; lumber products and furniture, 9 percent; food and kindred products, 8 percent; and apparel and other fabric products, 8 percent. Paper and allied products, chemicals and allied products, fabricated metals, electrical machinery and supplies, and motor vehicles each accounted for 6 percent of the total manufacturing earnings.

In 2000, textiles and other manufacturing categories will rank highest in their percentage of manufacturing earnings with 15 and 13 percent, respectively. Electrical machinery and chemicals will increase their percentage share of total manufacturing earnings to 9 and 8 percent, respectively. Food and kindred products share of the earnings will drop to 5 percent. Other categories will have about the same percentage share of total manufacturing earnings as experienced in 1975.

Natural Resources

Abundant land and water resources have contributed to employment in the region. The region has been attractive to industry that needs these resources along with human resources for operation. The total land area is 166.8 million acres and the water area of all water bodies of 40 acres or more is 6.8 million acres, for a total of 173.6 million acres of surface area. Urban and built-up areas occupy 3 percent and forested areas cover over 60 percent of the total surface area. Urban land uses will increase slightly by 2000, resulting in conversion of land used for other purposes. Forestlands will decrease slightly from 1975 to 2000. These forestlands are used extensively for the growing of softwoods and hardwoods. Lumbering and paper manufacturing are major users of this timber.

Table 3-2.--South Atlantic-Gulf Region surface area and 1975 land use

Surface area or land use type	1,000 acres	Percentage of total surface area
Surface area		
Total	173,630	100
Water	6,807	4.0
Land	166,823	96.0
Land use		
Cropland	25,259	14.5
Pasture and range	15,344	8.8
Forest and woodland	105,334	60.7
Other agriculture	4,293	2.5
Urban	4,747	2.7
Other	11,846	6.8

The region has an abundance of raw materials such as sand, gravel, clay, stone, and cement for use in the building industry. It also produces sulfur, mica, fuller's earth, phosphates, and titanium. Iron ore deposits are abundant in north-central Alabama. There is also coal, petroleum, and natural gas in the region.

Both the Atlantic and Gulf shores offer considerable opportunities for recreation, swimming, fishing, and boating. Large numbers of tourists are attracted to the region, particularly to developed areas. The estuarine waters are important aquatic habitat, nursery areas, and shellfish harvesting areas. These areas are sensitive to environmental changes.

Agriculture

Only 15 percent of the total land area is cropland. Approximately 69 percent of this cropland is harvested, and the other 31 percent is unharvested. Only 8 percent of the total cropland is irrigated. Total croplands are projected to increase slightly by 2000, while croplands harvested will increase about 36 percent. Irrigation of crops is increasing rapidly in some farming areas and will increase about 49 percent from 1975 to 2000 regionwide (See Table 3-3).

Table 3-3.--Projected changes in cropland and irrigated farmland in the South Atlantic-Gulf Region--1975, 1985, 2000
(1,000 acres)

Land category	1975	1985	2000
Total cropland	25,259	25,747	27,515
Cropland harvested	17,478	18,908	23,686
Irrigated farmland	2,035	2,563	3,040

Energy

An abundance of water and significant stream gradients have led to the development of hydroelectric power projects, mainly above the Fall Line. Private industry has in the past depended upon numerous small hydroelectric projects in this area. The large hydroelectric projects accounted for 7 percent of the power generated in 1975, but are projected to generate only 1 percent of the power in 2000.

In 1975, the 93 steam electric power plants in the region generated 220.1 thousand of the total 237.7 thousand gigawatt-hours of power. Of these plants, 88 were fossil fueled, generating 80 percent of the region's power and five were nuclear fueled, generating 13 percent of the power. Electric power expected to be generated by steam plants in 2000 (Table 3-4) is 1,757.9 thousand gigawatt-hours. According to NF projections, 57 percent of this power is expected to come from nuclear fueled plants and 42 percent from fossil fueled plants.

Table 3-4.--South Atlantic-Gulf Region electric power generation--1975, 1985, 2000
(gigawatt-hours)

Fuel Source	1975	1985	2000
Fossil	189,757	328,585	747,660
Nuclear	30,344	331,477	1,010,231
Conventional hydropower	17,602	15,102	15,461
Total generation	237,703	675,164	1,773,352

Alabama has proven petroleum production from over 50,000 acres, and oil and gas are being produced or have been produced from 41 fields. Florida and Mississippi also produce significant amounts of petroleum and natural gas. In 1975, the three States produced over 3 percent of the Nation's petroleum and about 1 percent of the natural gas.

Alabama coal fields constitute the southernmost part of the Appalachian coal field, and the State ranks eighth nationally in coal production. Coal-bearing rocks underlie approximately 18,630 squares miles of the State. There is a resource base of 1,920 million tons of bituminous coal and 1,027 million tons of lignite accessible to strip-mining. In 1975 Alabama produced 22.5 million tons of coal.

Navigation

The South Atlantic-Gulf Region has an extensive navigation system (Figure 3-3) including intracoastal waterways along the Atlantic and Gulf Coasts, several inland waterways, 18 ports handling over one million tons of cargo each per year, numerous small harbors and channels, and a major

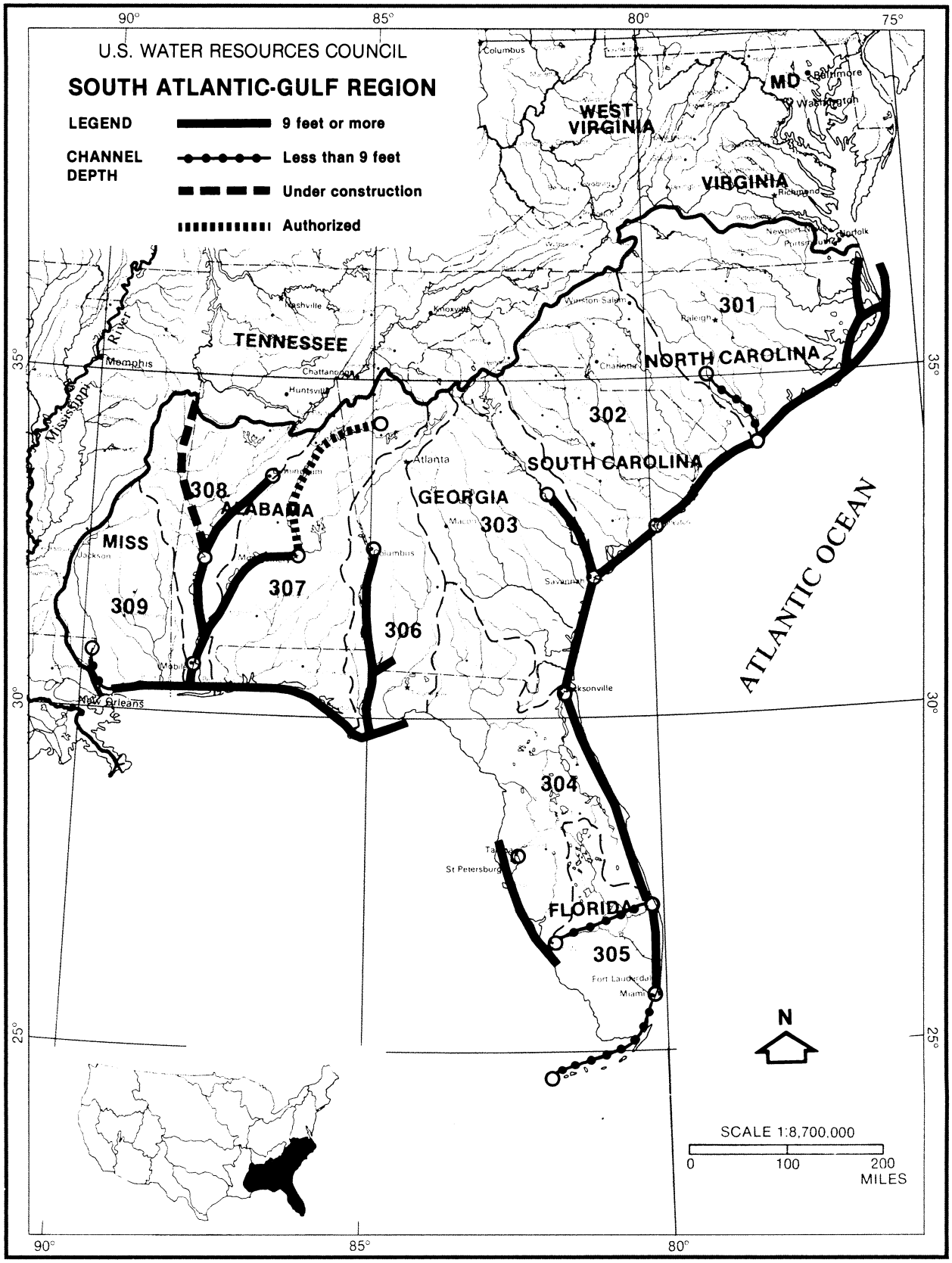


Figure 3-3. Navigation System

navigational channel under construction to connect the Tombigbee River in Alabama with the Tennessee River. An existing waterway cuts across south Florida through Lake Okeechobee. The region's ports are important receiving terminals for national and international goods for the southeastern United States. They also serve as export points for raw materials produced in the region. Mobile Harbor and the connecting Tennessee-Tombigbee Waterway will be important navigation facilities serving the internal portions of the eastern United States.

These navigation systems transported approximately 230 million tons of freight in 1975. This is projected to increase considerably by the year 2000. Improved facilities will be required to accommodate this increased traffic.

Environment

The region's fresh-water bodies and coastal areas serve as recreation areas for the urban population of the southeastern United States as well as for people from other parts of the United States and Canada. Its many undeveloped and natural areas are also an attraction for recreation and tourism. In recent years there have been large increases in boating, camping, hiking, fishing, picnicking, and swimming. These activities add to the area's economy, but place demands on land and water resources.

There are 47 large manmade reservoirs in the region, plus a number of large natural lakes such as Mattamuskeet in North Carolina, Waccamaw in North Carolina, and Okeechobee (730 square miles) in Florida. Water bodies of 40 acres or more account for about 6.8 million acres of surface area. The many miles of beach and other shoreline in the region and protected sounds behind the barrier islands of the North Carolina coast provide tremendous recreation use opportunities. The Blue Ridge Mountains to the west of the region with their many natural areas are a significant tourist attraction.

Several thousand historic places in the region are listed in the National Register of Historic Places. Unusual natural areas occur in each State and include swamps, rivers, marshes, and wildlife habitat. Among these are Dismal Swamp, Congaree Swamp, Okefenokee Swamp, Ogeechee River, Suwannee River, Big Cypress Swamp, St. Martins Marsh, Cahaba River, and the Everglades.

In 1975, an estimated 161 million instances of water-dependent recreation activities occurred in the region, plus an additional 58 million instances of water-enhanced recreation activities. The participation in these activities in 2000 is projected to increase 46 and 47 percent in each category, respectively. Surface water is abundant in the region, but more access points need to be provided and facilities constructed to meet future recreation needs. Nine Federal reservoir projects accounted for 46.5 million visits in 1975. Lake Lanier in Georgia provided for 14.5 million of these visits and was the most utilized Corps of Engineers reservoir in the Nation. Four of the Corps of Engineers reservoirs in the region were among the 10 most used Corps of Engineers reservoirs. All

of these are located in or border on the State of Georgia.

In the region, 19 wilderness areas with a total of 529,000 acres have been designated. Another 20 potential sites are located in the region. There are 91 critical areas which have been identified for outdoor recreation use, while another 115 sites have been identified as having scenic, historical, or archeological value (Figure 3-4). There are 13 designated endangered species and another possible 10 which are inhibitants of the region. The States have identified considerably more than this number which are in the rare, endangered or threatened category. For example, Alabama lists over 100 species.

There are 3,000 miles of nationally significant streams for fish and wildlife in the region. Trout and warm water fisheries streams have been so designated by the States and classified as public fishing streams needing protection. Only 40 miles of the Chattooga River in South Carolina and Georgia is included on the national list of wild and scenic rivers. There are from 2,500 to 3,000 miles of streams identified by the States as having potential for preservation as wild, scenic, or natural streams.

The region has 18 national forests, more than 10 State forests, 23 national parks, and over 100 State parks. Five national seashores have been designated. There are 22 national wildlife or management areas plus many such areas managed by the States. These resources have been planned and are being managed to meet the physical and recreation needs of the region's people. Additional areas are being obtained to protect the habitat of threatened species such as the sandhill crane.

Water

Water availability and water use data were collected and projected for the purpose of assessing the current and potential problems related to the region's water needs. As discussed below, the indicated streamflows are average annual values. Water withdrawals and water consumption in millions of gallons per day (mgd) are based upon average daily values for the year 1975; comparable figures have been projected for the year 2000.

Surface Flows

The region has 24 major rivers and a number of small coastal streams. It is not one large integrated basin. Hence, data will be presented in smaller, more meaningful units, such as subregions. Annual mean flows for the nine subregions vary from 7,310 mgd to 41,800 mgd (see Figure 3-5). Corresponding 80 percent probability flows on an annual basis are 4,140 and 32,100 mgd, respectively. Total annual mean flows for the region are 228,010 mgd, and the annual 80-percent probability flow is 164,140 mgd.

Under mean annual conditions, the lowest flows occur in October and November in seven of the subregions, in April in subregion 305, and in May in subregion 304. The lowest flow is generally 50 to 65 percent of

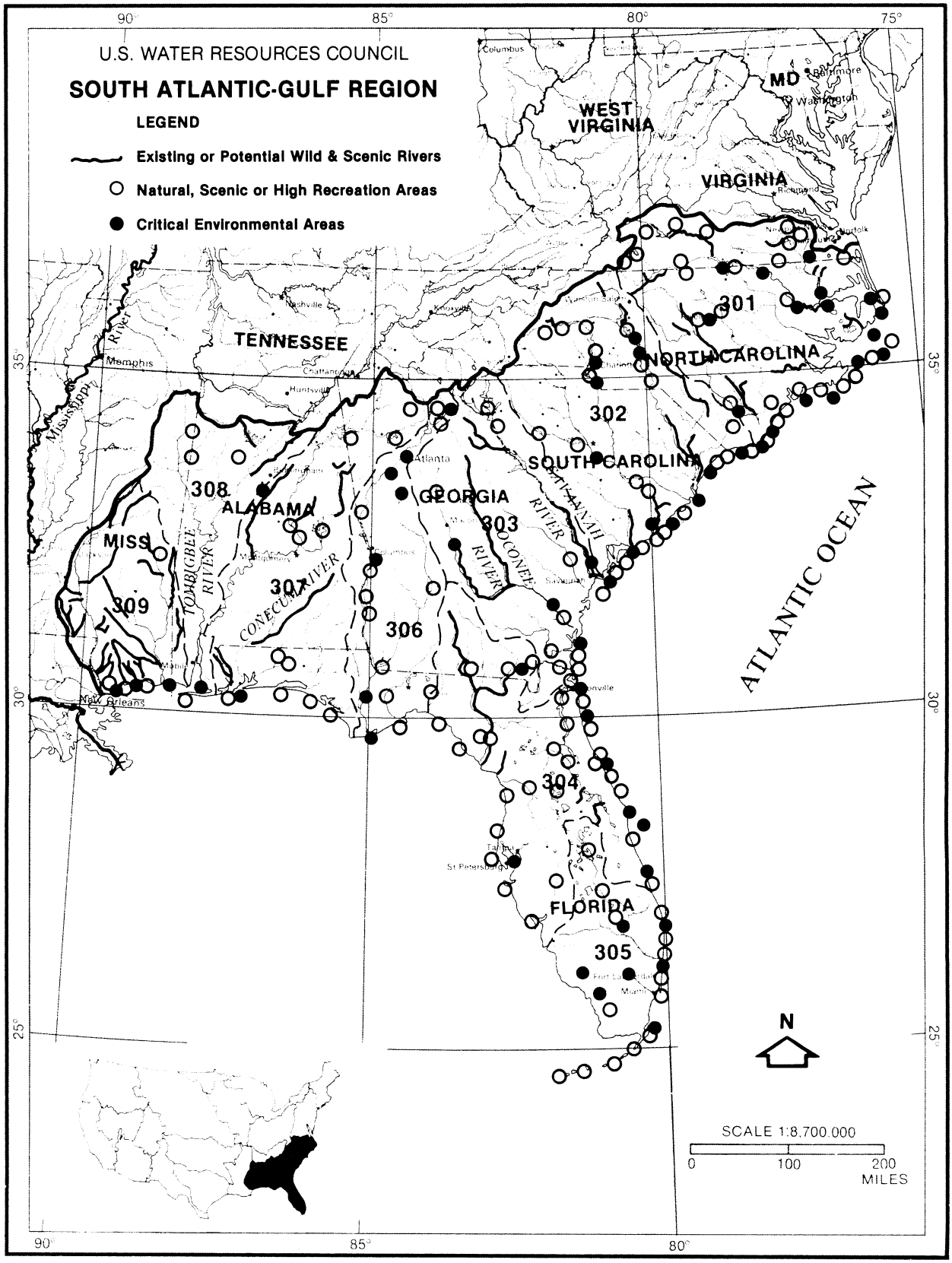


Figure 3-4. Environmental Resources

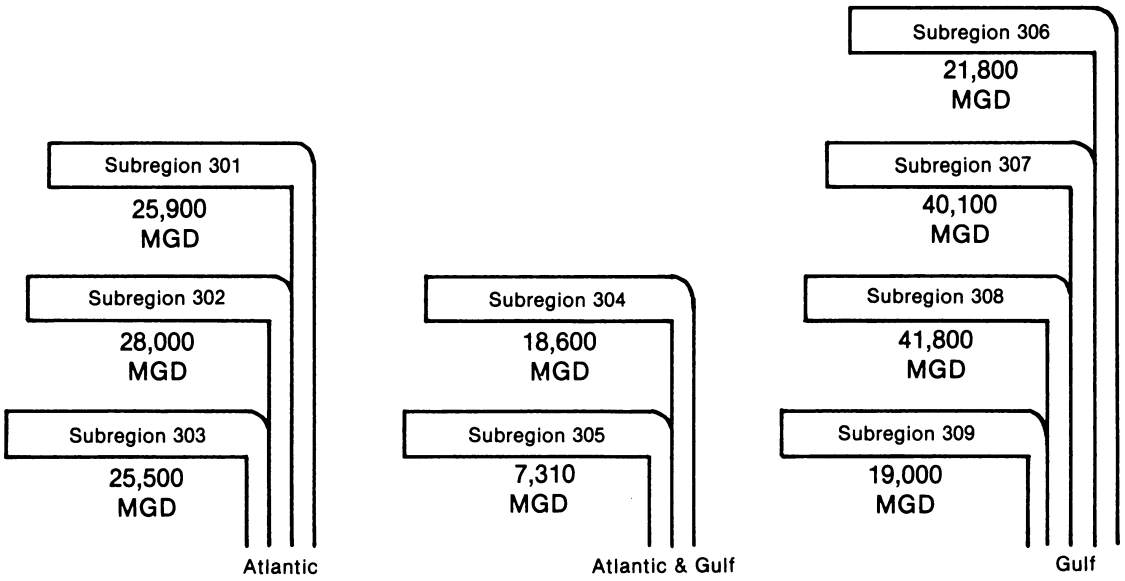


Figure 3-5. Streamflow

the average daily flow calculated on an annual basis, except that for subregion 305 it is 18 percent, for subregion 308 it is 34 percent, and for subregion 309 it is 36 percent. The 80-percent probability flow[1] for the dry month ranges from less than 1 percent to 48 percent of the annual 80-percent probability flow. Table 3-5 provides data on the mean daily flow calculated on an anuual basis and mean dry-month flows by subregion, as well as the 80-percent probability flow on a day-month basis.

Table 3-5.--Streamflow, annual and dry month (mgd)

ASR no.	Mean		80 percent probability	
	Annual	Dry month	Annual	Dry month
301	25,900	15,100	18,800	3,680
302	28,000	18,600	19,600	8,140
303	25,500	12,900	17,500	6,980
304	18,600	11,400	10,500	4,010
305	7,310	1,290	4,140	26
306	21,800	12,200	16,600	7,950
307	40,100	21,800	31,700	14,800
308	41,800	14,300	32,100	8,340
309	19,000	6,790	13,200	3,300

[1]The 80-percent probability flow is the average daily flow calculated on an annual basis that will be exceeded statistically 4 out of 5 years.

Ground Water

Figure 3-6 shows the major ground-water aquifers. In the Piedmont Province, ground water occurs in fractures of the crystalline rock. Well yields are generally low, averaging less than 50 gallons per minute (gpm); however, the ground-water potential and yields of the area have, for the most part, been underrated. Supplies adequate for domestic and rural use are consistently available, and supplies yielding several hundred gpm are available locally from fractured bedrock. Throughout much of the province, a thick mantle of weathered rock overlies the fractured bedrock and functions both as a reservoir and a recharge area. This water is slowly released to underlying bedrock fractures, thus sustaining a high base flow of streams.

The Valley and Ridge Province at the southern end of the Blue Ridge Mountains encompasses about 7,000 squares miles in northern Alabama and Georgia. Ground water occurs in fractures and solution openings in the carbonate bedrock, and highly productive cavernous limestones characterize the ground-water hydrology. Dolomite and limestone of the Cambrian and Ordovician ages are the most important aquifers. Many springs are used for municipal and industrial supply. Coldwater Spring, with flows up to 32 million gallons per day (mgd), provides the municipal supply for the city of Anniston in Calhoun County, Alabama. Locally, wells yield more than 1,000 gpm. A weathered residuum overlies the carbonate bedrock and functions as a reservoir that stores water and slowly feeds the underlying solution channels and fractures. The base flow of streams is well sustained as a result of ground-water discharge through springs and seeps.

Potential for ground-water development in the Coastal Plain Province, which is almost three-fourths of the region, is very great and ground water plays a major role in the region's economy. Large springs are numerous, with yields ranging up to hundreds of millions of gallons per day from carbonate rocks in Florida, Georgia, and Alabama. Locally, wells yield as much as 20 thousand gpm from carbonate rocks and as much as 5,000 gpm from sand aquifers. Extensive fresh-water aquifers are virtually untapped in Mississippi.

The sediments of the Coastal Plan Province contain the region's largest ground-water resources and some of the country's most extensive and productive aquifers. There are six major aquifer systems in the Coastal Plain of the region. They are discussed below.

1. The Tuscaloosa Formation and associated sand aquifers of late Cretaceous age constitute one of the most important regional aquifer systems. These aquifers yield large quantities of water in the Fall Line zone and in the zone's downgradient, extending in an elongated belt about 50 miles wide from southeast Virginia to northeast Mississippi. Well yields of 1,000 gpm are common, and locally wells yield more than 2,500 gpm. The only poorly productive areas are in west-central Alabama where the waters are saline and along the innermost edge of the Coastal Plain where the sands are thin. The outcrop of this aquifer functions

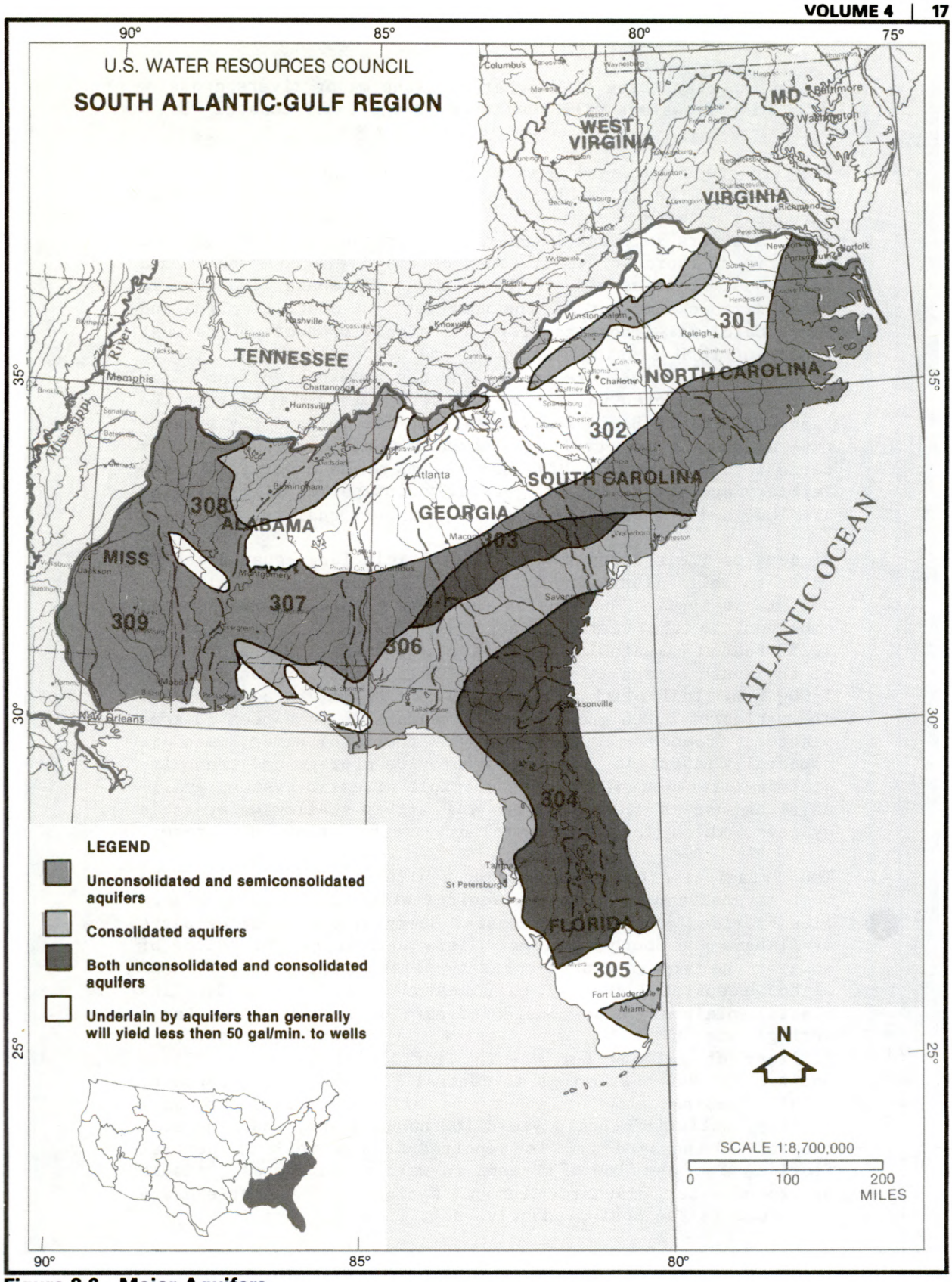


Figure 3-6. Major Aquifers

as an important area of discharge to the major rivers crossing it. Base flows are well sustained in the inner Coastal Plain.

2. The limestone and sand aquifers of early Tertiary age are an important source of ground-water supplies in a continuous belt extending across the region from North Carolina to Mississippi. These aquifers immediately overlie the Cretaceous sands and are the primary source of water south of the Cretaceous belt in a band about 50 miles wide in Mississippi, Alabama, and Georgia which narrows somewhat to the northeast in South Carolina and North Carolina. These aquifers are highly productive and most important in Mississippi, Alabama, and western Georgia. Yields of 2,000 gpm or more are common and can be expected from efficiently constructed wells almost anywhere in this belt in the Pascagoula River Basin in Mississippi. The only poorly productive area is in west-central Alabama and extending a short distance into east-central Mississippi, where the underlying early Tertiary age strata are of generally low permeability, yields are low, and the water is generally of poor quality.

3. Miocene to Pleistocene sand aquifers yield large quantities of water to wells along the Gulf Coast in western Florida, Alabama, and Mississippi. The aquifer thickens toward the Mississippi embayment to the west. Fresh water extends to a depth of 1,250 feet at Pascagoula, Mississippi, and to more than 3,000 feet at the mouth of the Pearl River. Well yields commonly exceed 1,000 gpm. Individual well yields of 2,000 gpm are commonplace, and yields of 5,000 gpm are not unreasonable to expect in some places. Ground-water reservoirs in the Pearl River Basin are especially important because they provide storage and transmission facilities within immense multiple artesian systems available for use as water supplies and within shallow water-table systems, which largely control dry-weather flow of streams.

4. The Principal Artesian Limestone aquifer of Tertiary age, the most extensive and widely used aquifer within the region, underlies Florida, southern and coastal Georgia, and adjacent parts of Alabama and South Carolina. This aquifer is the source of some of the largest ground-water supplies in the United States. Although separated areally, the limestones of the North Carolina coastal plain are also considered part of this system. Large springs are numerous, with yields ranging up to hundreds of millions of gallons per day in Florida and Georgia. Silver Springs and Rainbow Springs in central Florida are the largest, with a combined flow of about one billion gallons per day. Locally, wells in Georgia yield 10 thousand gpm, and a natural flow of 20 thousand gpm is reported from a well in central Florida. The base flow of streams is well sustained as a result of ground-water discharge through springs. The Castle Hayne Limestone is the most productive unit in North Carolina.

5. The Biscayne aquifer is a highly productive aquifer and a most

important source of fresh water for populous southeast Florida, including the Miami area. The aquifer, consisting predominantly of highly permeable limestone and sand of the Quaternary age, underlies about 3,000 square miles of Dade, Broward, and parts of Palm Beach Counties in Florida. It is wedge-shaped, extending from the land surface to a depth of about 200 feet along the coast and thinning to a few feet in the western part of the area. Well yields commonly exceed 2,000 gpm. The Biscayne aquifer is an integral part of a complex regional water management system for both ground and surface waters in southeast Florida. Water management practices were initiated in 1952 and have effectively stabilized salt-water intrusion. The objective has been to maintain adequate fresh-water heads in the Biscayne aquifer and in the canals above salinity-control structures so as to prevent sea-water intrusion and to provide replenishment to well fields by infiltration from the canals.

6. Shallow aquifers in the area are composed of sand, shell, and/or limestone of Miocene to Holocene age. This material forms a relatively thin blanket of surficial material that overlies the generally more productive Tertiary aquifers in a belt along the Atlantic Coast from North Carolina to Florida and extending across southwest Florida. Although yields are generally low, less than 250 gpm, these aquifers are important sources of water supply in areas where the more productive aquifers are not available, and they are the conduit for recharge by leakage to the prolific Tertiary aquifers which underlie them. The shallow aquifer is the major source of ground water in parts of southern Florida, in Dade County in coastal North Carolina, and on offshore barrier islands.

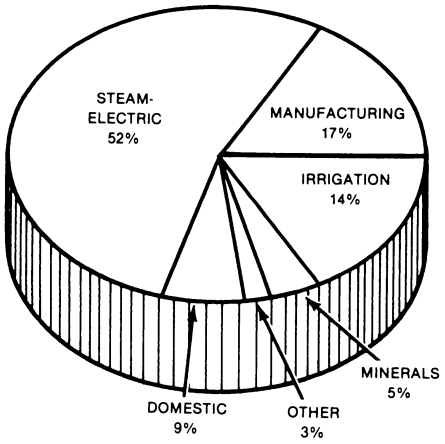
   An extensive shallow aquifer underlies the Big Cypress Swamp and adjacent areas of southwest Florida. In view of the good water quality, the large areal extent of permeable limestone, and the high yield to wells, there is an indication that this aquifer represents a principal factor in present and future growth and development in southwest Florida.

Water Withdrawals

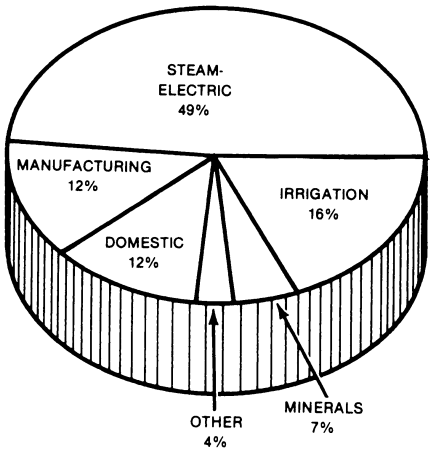
According to National Future estimates, total fresh-water withdrawals from surface- and ground-water sources in 1975 averaged 24.5 billion gallons per day (bgd). The largest withdrawal was 52 percent of this total for steam electric power generation. Irrigation use was about 14 percent, manufacturing use was 17 percent, and central plus noncentral water system use was 9 percent. Total water withdrawals are expected to increase 16 percent by the year 2000 to 28.3 bgd.

Once-through cooling for steam electric power generation occurs to a large degree at the present time. By the year 2000 recirculation will be only 9 percent while steam electric power production will increase about 700 percent (see Figure 3-7).

ANNUAL FRESHWATER WITHDRAWALS

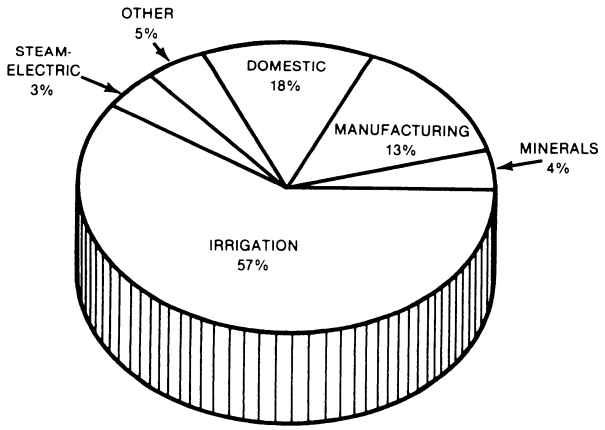


1975
Total Withdrawals — 24,510 MGD

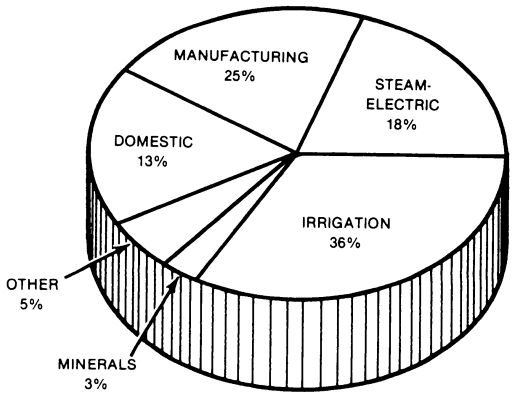


2000
Total Withdrawals — 28,340 MGD

ANNUAL FRESHWATER CONSUMPTION



1975
Total Consumption — 4,867 MGD



2000
Total Consumption — 10,053 MGD

Figure 3-7. Withdrawals and Consumption

Ground-water pumping is extremely heavy in much of the Coastal Plain area, with total withdrawals in 1975 estimated by the NF to be about 5,449 mgd for domestic, municipal, industrial, rural, and agricultural needs. These heavy withdrawals result in the formation of extensive cones of depression and lowered artesian heads over broad areas encompassing hundreds of square miles, encroachment of salt water into fresh-water aquifers from vertical or lateral migration, and subsidence and catastrophic collapse in karst terraces due to localized ground-water pumping.

Significant amounts of saline cooling water are used by steam electric generating plants along the Atlantic and Gulf Coasts. These plants presently use 7.0 bgd and by 2000 will be using about 20.2 bgd. Manufacturing operations presently use almost one-half bgd. The only significant desalination plants for domestic water are located at Siesta Key and Key West, Florida; they produce 3.1 mgd, according to SRF sources.

Water Consumption

National Future data indicate that average daily fresh-water consumption in 1975 was 4.9 bgd and it will rise to 10.1 bgd by 2000. In 1975, 20 percent of the total water withdrawals were consumed, and this will rise to about 35 percent in 2000. Higher consumption rates occurred in Florida, where the rainfall was not as evenly distributed throughout the year. Irrigation accounted for 57 percent of the consumption in 1975 but will only account for about 36 percent of the total in 2000. Steam electric power plants accounted for 3 percent of the total water consumed in 1975; this will increase to 19 percent in 2000. Domestic and manufacturing uses accounted for 31 percent of the consumption in 1975 and will account for 38 percent in 2000 (Figure 3-7).

Instream Uses

The most significant regional problem regarding instream needs is the lack of an adequate legal and institutional basis for management of instream flows. There are numerous and large instream uses of all the major streams plus many of the minor streams. The large heads above the Fall Line have been utilized for hydropower production. Anadromous fish runs occur on a number of the streams in North Carolina and South Carolina. Warm water fisheries is a major use of most of the streams except in the Blue Ridge Province where trout fishing streams are significant. A put-and-take trout fishery has also been developed below several major hydroelectric power reservoirs such as Lakes Hartwell and Lanier in Georgia. Navigation occurs on a number of major streams, and flows are generally regulated to aid this navigation. In general, the States in the region require waste dischargers to meet stream water quality standards based upon a 7-day low flow having a recurrence frequency of one in 10 years. This flow is a minimum required continuous release from some reservoir projects. In some cases, specific flow requirements over and above this design flow are maintained to protect stream water quality. Major recreation use of streams and reservoirs also occurs throughout the region.

Water Supply and Demand

The region has an abundance of fresh surface- and ground-water, but unfortunately it is not always located in the areas of need. National Future figures show that there is an annual average daily outflow of 228 bgd, whereas only slightly over 24.5 bgd of this is presently being withdrawn. By the year 2000, water withdrawals will have increased to slightly over 28 bgd. Water withdrawals from both surface- and ground-water sources are expected to increase.

Total consumptive use of the region's waters will increase from 4.9 bgd in 1975 to 10.1 bgd in 2000. Increasing consumptive use will progressively reduce instream flows. There are shortage problems already noted in highly developing areas in the upper reaches of some of the river basins such as north-central North Carolina, the Atlanta metropolitan area, and the Birmingham area. Also, peninsular Florida, which experiences seasonal low flows, will have to depend more upon development of ground water. A number of coastal areas are experiencing large drawdowns because of heavy ground-water pumping; salt-water intrusion is a threat. Timely, extensive planning and management of the water resources will be necessary in these problem areas.

Coordinated management of streams, as well as withdrawals, will be necessary to provide for instream flow needs. Fisheries resources, water quality, hydroelectric power generation, recreation, and navigational uses of the streamflows are important to the region's economy. Flows for these purposes are critical at some locations and must be closely managed.

Comparative Analysis

Table 3-6 presents a comparative analysis of the National Future (NF) and State-Regional Future (SRF) with regard to estimates of streamflows and water needs in the South Atlantic-Gulf Region. In many instances the SRF data agree with the NF data in individual subregions, but totals for the region differ. The totals for flows reflect total outflows from the nine subregions of the South Atlantic-Gulf Water Resources Region.

Table 3-6.--Socioeconomic and volumetric data summary: the South Atlantic-Gulf Region

Category	1975		1985		2000	
	NF	SRF	NF	SRF	NF	SRF
SOCIOECONOMIC DATA (1000)						
Total population	25,423	26,164	29,334	30,736	34,680	36,761
Total employment	10,345	10,518	12,282	12,682	14,727	15,542
VOLUMETRIC DATA (mgd)						
-Base conditions-						
Total streamflow	232,538	NE	232,538	NE	232,538	NE
Streamflow at outflow point(s)	228,010	228,036	225,766	227,960	222,485	227,443
Fresh-water withdrawals	24,510	26,461	25,457	29,256	28,340	34,777
Agriculture	3,598	5,262	4,174	6,123	4,711	6,955
Steam electric	12,768	13,262	12,912	12,930	13,952	13,937
Manufacturing	4,103	3,824	3,377	5,061	3,318	7,194
Domestic	2,288	3,016	2,801	3,701	3,486	4,714
Commercial	553	[a]	632	[a]	769	[a]
Minerals	1,178	1,069	1,538	1,409	2,077	1,939
Public lands	5	28	6	32	10	38
Fish hatcheries	17	[b]	17	[b]	17	[b]
Other	0	NE	0	NE	0	NE
Fresh-water consumption	4,867	6,062	6,772	7,760	10,053	10,272
Agriculture	2,886	4,210	3,350	4,904	3,799	5,586
Steam electric	153	156	722	721	1,857	1,856
Manufacturing	611	735	1,203	972	2,532	1,381
Domestic	880	786	1,079	934	1,345	1,139
Commercial	118	[a]	138	[a]	161	[a]
Minerals	214	165	274	215	349	291
Public lands	5	10	6	14	10	19
Fish hatcheries	0	[b]	0	[b]	0	[b]
Other	0	NE	0	NE	0	NE
Ground-water withdrawals	5,449	7,037	NE	8,711	NE	10,688
Evaporation	0	0	0	0	0	0
Instream approximation						
Fish and wildlife	188,655	577[c]	188,655	648[c]	188,655	648[c]

NE - Not estimated.

[a] SRF domestic water use includes commercial and institutional requirements.
[b] SRF public lands water use includes fish hatcheries requirements.
[c] SRF lists legal requirements only; data were developed by specific river basins.

The difference between SRF and NF data reflect differences in assumptions, goals, and objectives at the regional and State level versus those at the national level.[1] There is an assumption at the regional level that water withdrawals will tend to increase at a fairly high rate because of an abundance of water and that, with proper planning and management, water will not be a constraining factor to growth. On the contrary, NF data assume a large reuse of water by 2000. The assumption made for the SRF that withdrawals will tend to increase is supported by the fact that only 11 percent of the available surface water is presently being withdrawn and, based on the projection for the year 2000, 15 percent will be withdrawn. Secondly, differences in manufacturing water use estimates reflect the assumption in the SRF data that no major changes will take place in the reuse of water. The NF data shows manufacturing plants going to a practice of large reuse of water by 2000, thus reducing the total manufacturing withdrawals in the future. Some of the SRF manufacturing water use data on central systems could not be separated for tabular analysis. The SRF data reflect a significant expansion of central public water systems to serve outlying areas, and they show a larger percentage of the future population being served by these systems than the NF data show.

[1] Such differences are not surprising for reasons given in the "Foreword." Changes may be expected as time goes on. When policy decisions are to be made, the effects at State, regional, and local levels should be carefully considered in light of conditions that exist at that time.

Problems

The status of total water supply and use in the region is excellent, but there are a number of problems in specific areas related to the availability, quality, and use of the water resources. These problems, which have been identified by the State and Federal agencies participating in this assessment, will affect economic growth in these specific areas unless resolved. The "Category A" severe problems, those needing further studies before solutions can be recommended, include a brief description of the problem. The "Category B" problems, those that have been or are being studied in sufficient detail to recommend an implementable solution, are listed after the discussion of the "Category A" problems and covered in detail under separate cover in a report prepared by the Southeast Basins Inter-Agency Committee during earlier stages of the national assessment.

Water Quantity, Fresh Surface

Several major urban areas were identified as facing critical water shortages that would hinder growth and development by the year 2000. Generally water was not available in sufficient quantity or quality from either surface- or ground-water sources in the immediate area of need and would have to be allocated from adjoining river basin(s) which in many cases involve an interstate stream. The areas with problems are:

CATEGORY A

1. Chowan-Lower Roanoke -- The rapidly growing southeastern Virginia area, Hampton Roads-Portsmouth, is spilling over into northeastern North Carolina. Solutions to the area's water needs require, and may continue to require, interbasin transfers of water. These transfers will result in losses to downstream users in the region.

2. North-Central North Carolina -- The highly urbanized areas of Winston-Salem, Greensboro, High Point, Burlington, Durham, Raleigh, Chapel Hill, and Asheboro place excessive demands on streamflows in the upper reaches of two adjoining river basins and may also require interbasin transfers from two additional interstate river basins. Long-range needs point up the necessity to utilize all possible flows in the upper reaches of the Tar-Neuse and Cape Fear River Basins. There may also be significant interbasin transfers from the Yadkin-Pee Dee and Dan Rivers. Highly detailed water management plans for water quantity and quality will be necessary in order to provide for the area's needs. Complicating these problems will be the necessity to store and control flood waters, control sedimentation, and meet downstream flow needs for fisheries resources, power generation, and navigation.

3. Southeast North Carolina -- This highly industrialized southeast North Carolina area involving six counties in the lower Cape Fear

River Basin will need large quantities of water which can probably be developed from the lower Cape Fear River. Management of the waters is needed to protect other uses as well as meet water supply needs. Ground water is a possible alternative. Some interbasin water transfers may take place.

4. Saluda Sub-Basin -- A highly industrialized corridor along Interstate 85 through northern South Carolina places large demands on existing water sources. Interbasin transfers may be necessary to meet some of the area's needs. These transfers will involve water from the Savannah River Basin, an interstate stream. Downstream problem needs on the Saluda River will also require solution with possible interbasin transfers from the Savannah River Basin. Large downstream needs on the Savannah River may be jeopardized by these transfers.

5. Apalachicola-Chattahoochee-Flint (Atlanta Metro Area) -- Large demands to meet the needs of a rapidly expanding population in the large Atlanta Metro Area cannot be met from existing stream sources in the immediate area. Major changes may be necessary in Federal reservoir operations, and other water-resource management techniques must be developed to insure adequate water quantity and quality to meet expanding needs. Existing interbasin transfers of water involve three major river basins, two in the Chattahoochee River will be allocated by the year 2000.

6. Black Warrior-Cahaba -- Major water needs are developing as the result of rapid industrial and urban expansion. Other competing uses such as power, navigation, and water quality make it necessary that water-resource management be initiated. Interbasin water transfers occur from the Cahaba River Basin, reducing flows to extremely low flow conditions at certain periods of the year. Flows needed for assimilation of wastes may not be available.

7. Mobile and Pascagoula -- High water demands to serve industries and municipalities occur in the Mobile and Pascagoula areas. There is competition for the same source of supply, the Escatawpa River. Water resource management and State agreements are necessary on this interstate stream. Worldwide commercial shipping could be adversely affected since it moves through the Mobile and Pascagoula ports.

CATEGORY B

Severe water quantity (fresh surface) problems classified as "Category B" occur in the following areas: Southeast South Carolina Coast, Savannah-Ogeechee, St. Johns, South Florida, Southwest Florida, and Alabama-Coosa.

Water Quantity, Ground

Problems associated with ground-water resources are generally ones of overpumping, low yields, and water quality. Overpumping of an aquifer can lead to a water quality problem if the ground-water table is lowered so much that salt-water intrusion becomes a threat. Areas in the Piedmont Province have problems in low or possibly inadequate yields. Limestone areas may have large quantities of water but quality often becomes a problem and restricts use of these aquifers. The following issues deal with overpumping.

CATEGORY A

1. Franklin Area -- Heavy pumping by a single large industry has resulted in significant lowering of the water tables for distances of up to 30 miles. Chlorides are higher in the pumped aquifer to the east. Potential yields at this one location may have already been reached.

2. Beaufort County Area -- Ground-water withdrawals to depressure the confined aquifer system for phosphate dry open pit mining have lowered the potentiometric surface over an area of more than 800 square miles in this North Carolina area. Potential mining operations could almost double the existing pumping rate, thus creating additional problems for this area.

3. Suwannee and Apalachicola-Chattahoochee-Flint (Southwest Georgia) -- Heavy ground-water pumping for municipal, industrial, and irrigation water use in an area of numerous limestone sinks in southern Georgia and northern Florida poses a threat from subsidence of land surfaces. The extent of the problem is not well known and the limitations necessary to solve it have not been defined. Ground-water withdrawals may have to be reduced to control the problem. This problem could develop in adjacent counties of Alabama.

4. Tombigbee in Mississippi -- Poorly productive ground-water aquifers in the Tombigbee River Basin could be a limiting factor in development of the area. With the completion of the Tennessee-Tombigbee Waterway, demands for water in the adjacent areas will increase, placing stresses on existing sources. Water quality is also poor in some portions of this same area in Mississippi.

CATEGORY B

Severe ground-water quantity problems classified as "Category B" occur in the following areas: Grand Strand, South Florida, and Southwest Florida.

Water Quantity, Surface/Depth

This problem is associated with the provision of adequate navigation depths to meet the needs of the region.

CATEGORY A

Lower Apalachicola-Chattahoochee-Flint River, Florida -- An existing navigation channel in the Apalachicola River in Florida does not have sufficient project-designed depths under low flow conditions to support barge traffic enroute to Bainbridge, Georgia on the Flint River and to Columbus, Georgia-Phenix City, Alabama on the Chattahoochee River. Solutions of the problem could impact on environmental resources in Florida.

Increasing consumptive use of water, evaportation losses on large reservoirs, and possible interbasin transfers in the Atlanta Metro Area could further reduce available flows for navigation.

CATEGORY B

Severe navigation surface/depth problems classified as "Category B" occur in the following areas: Lower Tar-Neuse, Lower Cape Fear, Coosa above Montgomery, Black Warrior, Tombigbee, and Mobile-Lower Tombigbee.

Water Quality, Fresh Surface

Water quality problems from point and nonpoint sources are to be addressed in the 208 water-quality management plans that are being developed by designated 208 planning agencies under Public Law 92-500. The entire region is covered by 208 planning grants by area or statewide. Some of these, however, are under-funded, and some problems cannot be adequately covered under existing grants. Others are so complex that 208 planning must be integrated with other water resource studies to be implementable. Those needing further evaluations and/or integration with other studies are:

CATEGORY A

1. Yadkin-Pee Dee -- Point and nonpoint source pollution that reaches streams and reservoirs throughout the basin is reducing water quality for recreation, water supply, and fisheries resources. Prime recreational areas could be affected and the area's economy seriously jeopardized. Weed growth and eutrophication is threatening water areas for many uses. Wild and scenic river areas are also threatened.

2. Catawba-Broad-Saluda -- Residual waste loads from a number of large metropolitan and industrial areas and nonpoint source pollution are placing a high demand on the area's waters to assimilate these wastes. Evaporation losses and peaking power operations with their resultant off-peak low flows compound these problems at a number of locations. Nutrient loads to hydropower reservoirs are causing eutrophic conditions and are threatening recreational areas.

3. Lower Chattahoochee and Atlanta Metropolitan Area -- Basinwide water quality problems occur along with a number of concentrated problems in Atlanta and Columbus, and there is a need to develop integrated solutions. Complicated interbasin transfers through waste discharges in the Atlanta Metro Area may affect downstream uses. Environmental effects need consideration along with groundwater problems. Streamflows are highly regulated for power production, navigation, flood control, and recreation. Increasing consumptive uses, evaporation, and losses due to interbasin transfers need consideration in a basinwide water-resources management program.

4. Coosa in Georgia -- The highly industrialized area in Dalton presents problems of a technical nature in the handling of carpet manufacturing wastes. Water supply needs, scheduling of reservoir releases, and a water resource management program are other considerations needing solutions concurrently with the water quality problems.

5. Upper Pearl -- The combination of agricultural runoff, large municipal and industrial waste loads, and a shallow receiving water supply reservoir (Ross Barnett Reservoir) present unique problems that may not be solved by a 208 water quality planning study. Excessive weed growth is occurring in this reservoir above Jackson on the Pearl River.

CATEGORY B

Severe fresh surface-water quality problems classified as "Category B" occur in the following areas: Lower Chowan-Lower Roanoke, Upper Tar-Neuse, Upper Cape Fear, Savannah-Ogeechee, St. Johns, South Florida, Southwest Florida, Suwanee, and Black Warrior.

Water Quality, Ground

Ground-water quality is most often affected by natural substances such as iron, hydrogen, sulfide, calcium carbonate, etc., which make it unsuitable, without treatment, for municipal and industrial water supply. This source can also be affected by man's operations, such as overpumping and improper well drilling and construction. Man's operations can cause salt-water encroachment problems or contamination from surface and underground sources. Problem issues involving ground-water quality are:

CATEGORY A

1. South Carolina Fall Line Area -- Pollutants from natural sources are causing water problems in this area and several adjacent counties in the upper coastal plain. These include high iron content, low pH, and related corrosive elements. These conditions make it costly for individual and small water users who must provide water treatment and cannot afford more expensive surface-water sources. Low ground-water yields along the Fall Line also complicate the problem.

2. Southeast South Carolina Coast and Northeast Georgia Coast -- Heavy ground-water withdrawals in Savannah, Georgia, have created a cone of depression in ground-water levels reaching into southeast South Carolina. Additional pumping will lower the ground-water table and accelerate salt-water intrusion. Alternate sources of fresh surface-water will cost considerably more.

3. Southeast Georgia and Northeast Florida -- Heavy ground-water withdrawals have resulted in brackish water encroachment in Brunswick, Georgia. Heavy withdrawals to the north in Savannah and to the south in St. Marys have resulted in a lowering of the ground-water table. Increased ground-water pumping to meet high future needs could result in salt-water intrusion.

4. Southwest Georgia (Apalachicola)-Chattahoochee-Flint and Suwannee) -- Limestone sinks permit surface water seepage into underground cavities and into the aquifer. Contamination of the aquifer may occur by this route from surface sources as well as septic tank systems. This condition could affect aquifer systems in the adjoining counties of Alabama.

5. Tombigbee -- The presence of natural elements in amounts greater than recommended drinking water standards increases costs of water treatment. There are problems with iron, fluorides, hydrogen sulfide, hardness, and chlorides. Some salt water is encountered at greater depths in coastal plain counties of Alabama.

6. Mobile-Lower Tombigbee -- Highly mineralized water has risen into the heavily utilized ground-water aquifer. There is also an area of little or no potable water in a northwest trending belt from west-central Alabama extending into Mississippi. Drilling for oil and gas and deep-well injection of liquid wastes are also potential sources of contamination of the ground-water aquifer.

7. Pascagoula -- There is plenty of water in the coastal area but it is degraded in quality. There is high iron content, low pH, and corrosiveness of water in other parts of the basin. There are unknown problems associated with deep-well injection of liquid wastes.

CATEGORY B

Severe ground-water quality problems classified as "Category B" occur in Grand Strand and St. Johns.

Water Quality, Marine and Estuarine

Extensive development of coastal areas for recreation, industry, and commercial navigation is placing great stresses on sensitive aquatic and marine environments. Much of this environment is used as nursery areas for the Atlantic and Gulf fisheries resources and as harvesting areas for a large shellfish industry. Pollution of these coastal areas jeopardizes these resources and affects the quality of the water used for swimming, skiing, and other water contact sports. Problem areas are:

CATEGORY A

1. North Carolina Coast -- Natural nutrients, plus those from municipal and industrial residual wastes, are causing eutrophication in the lower Chowan River and Albemarle Sound. High nutrient loads from large farming operations occur in Albemarle and Pamlico Sounds. Bacterial pollution is closing shellfish areas for harvesting as well as threatening a major recreational area. Fresh-water diversions are altering salinity levels.

2. Grand Strand -- Large areas are closed to shellfish harvesting because of bacterial and chemical pollution. Highly sensitive recreational waters are also subject to pollution if not adequately controlled. Anadromous fish runs and marine nursery areas are threatened.

3. Southeast South Carolina Coast -- Waste discharges in the Charleston and Beaufort County coastal areas have caused closing of shellfish harvesting areas. Rediversion of fresh-water flows from the Cooper River will change salinities in Charleston Harbor and the mouth of the Santee River.

4. Mississippi Coast -- Water quality degradation has caused closing of shellfish areas and threatens recreational beach areas. The lower reaches of streams in the Pascagoula area have degraded water quality, thus their use is affected.

CATEGORY B

Marine and estuarine water quality problems classified as "Category B" occur along the northeast Florida coast and in the Mobile area.

Related Lands, Flooding

Tropical storms originating in the South Atlantic area move inland or along the coast, bringing heavy rainfall to the southeastern United States, causing flooding conditions. These occur in late summer and early fall. Intense rainfall over a short period or extended rainfall over several days can also produce flooding conditions in the region's streams. Coastal, urban, and agricultural areas are subject to flood damages by swollen streams and high tides. Problem areas are:

CATEGORY A

1. North Carolina Coast -- Tropical storms and northeasters can bring damaging winds and rains to North Carolina's coastal areas and barrier islands. Resort areas, croplands, shipping interests, and urban areas are subject to damage. Most highly susceptible to damage are large coastal farms, resort and beach areas, national seashore areas, and navigation facilities.

2. Yadkin-Pee Dee -- Stream flooding causes extensive damage to urban areas and agricultural lands throughout the basin. There are 95 flood prone communities in North Carolina and South Carolina. Economic losses are the result of this flooding. There are two authorized but unconstructed projects (Reddics River and Roaring River) that would greatly reduce damages.

3. Apalachicola-Chattahoochee-Flint -- Local urban flood damages continue to occur on small tributary streams in urban areas such as Atlanta, Macon, and Albany. Major flood control structures have alleviated many flooding problems on the Chattahoochee River but limited flood protection is provided on the Flint River. Lack of flood-plain management has further complicated the problems.

CATEGORY B

Severe flooding problems classified as "Category B" occur in the following areas: Upper Roanoke, Tar-Neuse, Upper Cape Fear, Saluda Sub-Basin, St. Johns, South Florida, Southwest Florida, Alabama-Coosa, Tombigbee, Pascagoula, and Pearl.

Related Lands, Drainage

Lack of drainage in areas with excess surface and subsurface waters results in loss of production or prevention of use of agricultural lands. The area with a substantial problem is:

CATEGORY A

Lower Cape Fear -- Loss of substantial farmlands for production occurs because of excess moisture. Drainage may cause loss of some wildlife habitat. In this area 18 percent of the total acreage has drainage problems.

CATEGORY B

Severe drainage problems classified as "Category B" occur in the following areas: Northeast North Carolina, Tar-Neuse, and Yakin-Pee Dee.

Related Lands, Erosion/Sediment

Land use practices and construction activities cause increased erosion and movement of sediment into stream channels, reservoirs, navigation channels, and estuaries. Water quality is also degraded because of the presence of this sediment and suspended material loads. Problem areas are:

CATEGORY A

1. Lower Cape Fear -- Sheet, streambank, and coastal area erosion is taking place in the coastal plain portion of this basin below Fayetteville, North Carolina. Over 15 percent of the land is affected. Extensive erosion is occurring along streambanks and beach areas. Future coastal storms will cause tremendous damages.

2. Catawba-Broad-Saluda -- Highly erodable Piedmont soils are being heavily eroded by land-use practices and construction activities. Reservoirs are losing storage capacity because of a high sediment accumulation. Heavy shoaling occurs in Charleston Harbor.

3. Apalachicola-Chattahoochee-Flint -- All of the area, except the coastal uplands, is subject to erosion problems. Conversion of croplands to forestland and pastureland has eased the problem somewhat, but substantial erosion and sediment problems still exist. Construction activities add to the problem. Reservoir capacity is being decreased because of accumulating sediments.

4. Florida Coast -- Wind and wave actions are eroding Florida beaches and reducing their usefulness as resort and swimming areas. Beach restoration is necessary to maintain usable beaches, and large expenditures are required for this restoration.

5. Mobile-Lower Tombigbee -- Land, streambank, and coastal erosion is occurring, causing deposition of large sediment loads in Mobile Bay. Over 7 million cubic yards of sediment must be removed annually from river channels and the bay near Mobile. Beach erosion results in loss of recreational areas and threatens structures.

CATEGORY B

Severe erosion/sediment problems, classified as "Category B" occur in the following areas: Upper Roanoke, Tar-Neuse, Yadkin-Pee Dee, Choctawhatchee in Alabama, Tombigbee, and Black Warrior.

Related Lands, Water-Related Use Conflicts

Lack of land use controls and failure to implement them, competition for lands, and lack of water-resource management, coastal zone management, and environmental controls lead to exploitation of the area's resources. This often results in the destruction of resources that cannot be renewed, thus causing long-term damages. Problem areas are:

CATEGORY A

1. North Carolina -- Failure to implement land use controls, competition for land and water, overdevelopment of coastal zones, lack of proper management of mountain area resources, and destruction of scenic and natural areas are causing statewide problems. Lack of programs and necessary financing to control these conflicts further complicate the problems and delay an early solution.

2. Apalachicola-Chattahoochee-Flint -- Extensive urban development in the upper and central portions of this basin are competing with recreation, hydropower, and navigation for basin waters. Allocation of surface waters will be necessary to maintain expected rates of growth in the Atlanta Metro Area. Deepening of navigation channels may lead to destruction of environmental resources. There are no interstate agreements nor is there a water resource management plan for the basin. Environmentally sensitive areas needing protection are the wild and scenic rivers in the upper reaches of the basin, the recreation corridor from Buford Dam to Atlanta, the Apalachicola River in Florida, and the estuarine areas.

3. Mobile-Lower Tombigbee -- Industrial development on the Tennessee-Tombigbee Waterway will compete with recreation, fishing, and other uses for land and water resources. Lack of land use controls will result in long-term effects to the area. Disposal of dredged materials has caused conflicts in the past. Presently, plans are to use 3,000-4,000 acres of Mobile Bay bottoms for disposal of 66 million cubic yards of dredged materials.

4. Pascagoula -- Lack of land use controls is resulting in development of wetlands, thus jeopardizing the habitat of the sandhill crane. There is also a lack of control in flood plains and coastal zone areas.

CATEGORY B

Severe water-related use conflicts classified as "Category B" occur on the South Carolina Coast, Suwannee, and Mobile-Lower Tombigbee.

Individual Problem Areas

The Southeast Basin Inter-Agency Committee identified specific severe problems that could be grouped into two types of study areas. The first group consists of those areas with a number of interrelated problems that need to be evaluated through studies, and solutions recommended. This type of area would be a Level "B" study area. Second, there were areas with a single problem or only a few problems that could be evaluated by a specific study and for which solutions could be recommended. These were smaller scale projects and are referred to as other major planning studies. The problem areas are as follows:

A. Level "B" Study Areas

Apalachicola-Chattahoochee-Flint
Cape Fear-North-Central North Carolina
Catawba-Broad-Saluda
Chowan-Lower Roanoke-Pasquotank
Black Warrior-Cahaba

B. Other Major Planning Study Areas

Southeast South Carolina Coast
Florida Coast
Coosa in Georgia
Mississippi Coast
Upper Pearl
Central North Carolina Coast
Southeast South Carolina Coast, Georgia Coastal Plain and Northern Florida
Tombigbee
Mobile-Lower Tombigbee
Pascagoula

Figure 3-8a identifies the locations of the 15 areas. A tabulation of the type of problems found in each of the 15 areas is given in Figure 3-8b. A summary describing each area, its problems, and effects, follows. Monetary damages and magnitude (in 1975 dollars unless otherwise noted) from existing problems are shown where they could be calculated.

Apalachicola-Chattahoochee-Flint

Description

The Apalachicola-Chattahoochee-Flint Basin, with 64 counties, lies in north and west Georgia, southeast Alabama, and in the eastern portion of the Florida panhandle. Major water resources are the Chattahoochee, Flint, Chipola, and Apalachicola Rivers; Lake Blackshear, Lake Lanier, Lake Seminole, West Point Reservoir, Lake Harding, Bartletts Ferry Lake, Lake Walter F. George, Lake George W. Andrews, and the Gulf Intracoastal Waterway, as well as navigation channels on the Apalachicola and Chattahoochee to Columbus, Georgia-Phenix City, Alabama.

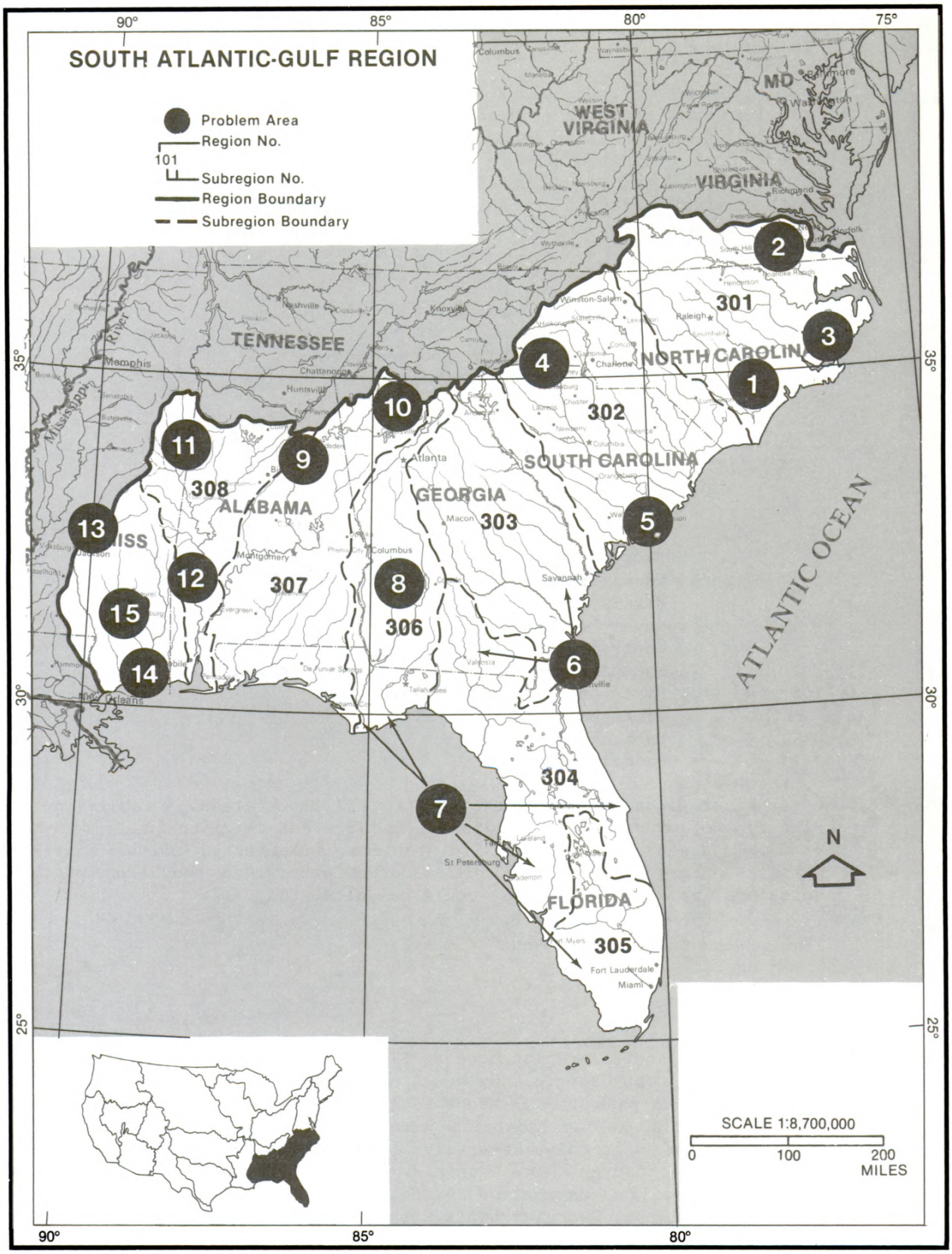


Figure 3-8a. Problem Map

SOUTH ATLANTIC-GULF REGION (3)

PROBLEM MATRIX

Problem area		Problem issues O= Identified by Federal Agency Representatives X= Identified by State-Regional Representative													
		Water quantity				Water quality				Related lands					
No. on map	Name	Fresh surface	Ground	Marine and estuarine	Surface/depth	Fresh surface	Ground	Marine and estuarine	Surface/depth	Flooding	Drainage	Erosion and sedimentation	Dredge and fill	Water related use conflicts	Other
Subregion 301	Roanoke-Cape Fear	O				O	O				O				
Area 1	Cape Fear – North Central, North Carolina	X				X		X		X	X	X		X	
2	Chowan-Lower Roanoke-Pasquotank	X	X					X		X				X	
3	Central North Carolina Coast		X					X		X				X	
Subregion 302	Pee Dee-Edisto					O									
Area 4	Catawba-Broad-Saluda	X	X			X	X					X		X	
5	Southeast South Carolina Coast							X							
Subregion 303	Savannah-St. Marys	O					O	O			O				
and 304	St. Johns-Suwannee														
Area 6	Southeast S.C. Coast, Ga. Coastal Plain & No. Fla.		X				X								
Subregion 304	St. Johns-Suwanee/Southern Florida/Apalachicola/														
305, 306, 307	Alabama-Choctawatchee	O				O	O					O			
Area 7	Florida Coast											X			
Subregion 306	Apalachicola	O										O			
Area 8	Apalachicola-Chattahoochie-Flint		X	X		X	X			X		X		X	
Subregion 307	Alabama-Choctawatchee	O								O		O			
and 308	Mobil-Tombigbee														
Area 9	Black Warrior-Cahaba	X													
Subregion 307	Alabama-Choctawatchee	O								O		O			
Area 10	Coosa in Georgia					X									
Subregion 308	Mobil-Tombigbee					O									
Area 11	Tombigbee		X				X								
12	Mobile-Lower Tombigbee	X					X				X			X	
Subregion 309	Pascagoula-Pearl					O					O				
Area 13	Upper Pearl					X									
14	Mississippi Coast							X							
15	Pascagoula	X					X							X	

Figure 3-8b. Problem Matrix

This Basin originates in the Blue Ridge Province and traverses the Piedmont and Coastal Plain Provinces. Elevations of about 4,500 feet above mean sea level occur in the Blue Ridge Mountains in the northern reaches of the basin. These are rugged, densely wooded mountains with conspicuous relief and well-defined narrow valleys. The red hills of the Piedmont Province range from about 1,200 feet elevation near the mountains to about 600 feet at the Fall Line where the Piedmont Province merges with the upper Coastal Plain Province. Here the valleys and slopes are steep because of the sharp descent of the streams and rivers through the Fall Line, which was at one time the shore of the ocean. From the Fall Line, the upper Coastal Plain Province extends south some 170 miles. This is a region of rolling plains with well-drained sandy soils and many diversified farms. The smaller streams flow in low-banked, tree-choked, meandering channels. The lower Coastal Plain Province is nearly flat with many wetlands and marshes. The streams and rivers of this region have wide flood plains. Much of the land is covered with pine forests and swamps and is sometimes called the flatwoods. The land bordering the Gulf of Mexico is low and comparatively flat. The mainland is sheltered by a narrow island barrier.

The Apalachicola River, which is the main stem of the river system, lies wholly within the Coastal Plain Province in Florida and is formed by the confluence of the Flint and Chattahoochee Rivers near the Georgia-Florida State line. The Apalachicola River is 113 miles long and is 600 to 800 feet wide in some areas, the upper and lower reaches being the widest. The average regulated low-water flow at Chattahoochee, Florida just below Jim Woodruff Dam (Lake Seminole), is about 15,500 cfs. Dense hardwood swamps occupy the 10-mile wide flood plain. The Chattahoochee River rises in the Blue Ridge Mountains of north Georgia and drains 8,770 square miles. The maximum width of its basin is 55 miles and its length is 436 miles. The upper reaches of the river and its headwaters tributaries are characterized by the steep slope of mountain streams, but below river mile (RM) 397 (18 miles above Gainesville, Georgia) the slope is fairly uniform and averages 2.6 feet per mile to West Point (RM 197). From West Point to Columbus (RM 160), as the river passes through the Fall Line area, it falls at a rate of 10 feet per mile.

The Flint River rises just south of Atlanta and flows 350 miles southerly in a wide eastward arc to its junction with the Chattahoochee River. Its 8,460 square mile drainage basin is 215 miles long and 40 miles wide. Above RM 285 the river slope averages 2 feet per mile. For the next 55 miles, the fall averages 2 feet per mile and as much as 48 feet per mile at the Fall Line. At Albany, the minimum regulated flow is 327 cfs and the maximum flow of record is 92,000 cfs.

Ground-water sources in the 14-county southwest Georgia area, parts of Alabama, and Gadsden County, Florida, are limestone aquifers of the upper Coastal Plain Province. The area overlies a limestone formation that is near the land surface and becomes thinner toward the south. It is part of a general limestone formation that extends through large parts of the coastal area in the South Atlantic-Gulf Region. North of the Fall Line ground water is found in fractures within metamorphic and igneous rocks or in the pore spaces of the weathered residuum of these rocks.

Well yields are small in this region.

Major population centers are Gainesville, metropolitan Atlanta, Columbus, Americus, Albany, and Bainbridge, Georgia; Dothan, Phenix City, and Auburn-Opelika, Alabama; and Tallahassee, Florida. The 1975 population was almost 3 million.

Problems

Water Issues

The authorized 9-foot depth navigation channel on the Apalachicola River below Jim Woodruff Lock and Dam cannot be maintained at that depth during low flow conditions in the fall. Solutions to the problem may affect environmental resources in Florida and shellfish resources in Apalachicola Bay. There are no long-term spoil easements to accommodate dredging requirements on some reaches of the project.

The Atlanta Metro Area and adjoining counties will be using the entire flow of the Chattahoochee River for water supply and water quality by 2000. This may require modification in operation of hydropower projects and will result in some interbasin water transfers. Downstream users as well as users of these hydropower reservoirs will be affected.

Large volumes of wastes generated in the Atlanta and Columbus, Georgia, areas will place excessive demands on streamflows to assimilate that waste. These point sources plus nonpoint sources of pollution will degrade stream water quality unless solutions are found to reduce this pollution. Small sreams originating in the Atlanta area are already seriously degraded in water quality.

Ground water levels in some areas of southwest Georgia appear to be declining. Heavy water use is occurring for irrigation, domestic, and industrial purposes. The ground-water aquifers are limestone and sandstone, and some overlie permeable sands. Limestone sinks are occurring because of excessive ground-water pumpage. These sinkholes could allow the rapid recharge of shallow aquifers with poor quality surface water in all three States. Drainage wells, septic tank systems, and sanitary landfills could be sources for ground-water contamination.

Related Land Issues

The Chattahoochee River has benefited from major flood control projects, but the Flint River has not. A conflict has arisen over maintaining the Flint River in its natural condition or developing it for flood control and possibly for water supply. Local flooding continues on small streams in urban areas such as Atlanta, Macon, and Albany.

Erosion of agricultural lands, streambanks, and lakeshores continues to destroy valuable lands as well as introduce large sediment loads into the streams and reservoirs. Beach and shoreline erosion occurs in Florida.

Institutional and Financial Issues

Conflicts in the use of the basin's waters, interbasin transfers, water rights, and the high cost of water source development complicate the technical solutions to problems. There are no interstate agreements on the management of the basin's waters.

There is a need for more flood-plain management. Recent legislation for allocation of ground and surface waters in Georgia does not cover all users. There is a lack of adequate legislation to manage the basin's water resources.

Conflicts have arisen in several areas of the Basin concerning the maintenance of natural conditions versus development to meet specific needs. The areas where these conflicts have arisen are the upper reaches of the Chattahoochee River, the sretch of the Chattahoochee River from Buford Dam to Atlanta, the upper Flint River, and the Apalachicola River.

Adverse Effects

Development of the basin's waters for navigation, flood control, and hydropower may damage some of the environmental resources and natural beauty of existing streams. A number of rare plants, fisheries resources, and wildlife habitat could be damaged or altered by this development. Restrictions in development of the water resources could result in some loss in economic growth to the area.

Flood damages will continue to occur and will increase if measures are not taken to control flooding and to restrict flood-plain development. Approximately 200 communities continue to have flood problems. In urban and developed areas, damage per acre is ten times the national average. Floodwater and sediment damages are occurring on about 1 million acres of agricultural land and approximately 30 thousand acres of urban lands.

Unless solutions are put into operation in the Atlanta Metro Area, the present controlled flows of the Chattahoochee River will only be sufficient for the population predicted for the area for 1985. Solutions may require major changes in operation of large hydropower projects, thus affecting the use of those projects for flood control, power production, and recreation.

Point and nonpoint pollution will continue to degrade stream-water quality which is already very low and cannot meet the 1983 national goals in some parts of the basin.

Ground-water management may become a critical factor in protecting this resource in southwest Georgia and adjoining States as water demand continues to increase at a rapid rate. Heavy ground-water pumpage could jeopardize water quality of the shallow aquifer system.

Apalachicola Bay produces up to 90 percent of Florida's oysters valued at approximately $1.5 million annually (1967 dollars-$1 million). Potential oyster production is several times higher. The Florida Department of Natural Resources valued the Apalachicola Bay oyster production at $7 million in 1974. Damages to the ecosystem could reduce the oyster harvest.

Flooding damages are in excess of $12 million annually (1967 dollars-$8 million). The developed urban and inland area damage is ten times the national average. Streambank erosion amounts to almost $1.5 million per year (1967 dollars-$1 million).

The agricultural and livestock industry in a 14-county area of southwest Georgia amounts to $199 to $250 million annually (1967 dollars-$130 to 163 million). About $30 million (1967 dollars-$20 million) of this total is for vegetable production which depends heavily on groundwater supplies and could be lost without this water for irrigation. Aquatic weed growth on Lake Seminole alone requires an annual expenditure of $9,965 (1967 dollars-$6,500) to keep small boat channels open.

Cape Fear—North Central North Carolina

Description

The proposed study area covers 14,779 square miles, including a total of 24 counties, 15 in the Cape Fear River Basin and nine in north-central North Carolina. These 9 counties are part of a 12-county water supply-water quality problem area consisting of Davidson, Durham, Forsyth, Guilford, Orange, Randolph, Stokes, Wake, and Yadkin counties, plus Alamance, Chatham, and Moore Counties in the Cape Fear River Basin.

The Cape Fear River Basin, with a drainage area of 9,223 square miles, rises in the Piedmont Province in north-central North Carolina and flows southeastward through the Coastal Plain Province to the Atlantic Ocean. The large metropolitan area of Greensboro and the industrial area around Burlington are located in the headwaters. Nearby metropolitan areas whose growth is expanding into the headwaters are Asheboro, Winston-Salem, Durham, Raleigh, and Chapel Hill.

A navigation channel on the lower reaches of the Cape Fear River extends up the main stem to Fayetteville, a distance of 143 miles. The Northeast Cape Fear River, a 130-mile tributary entering the main stem 30 miles above its mouth, has a cleared channel for 103 miles. The Wilmington area at the mouth of the Cape Fear River is an expanding industrial area with a deep harbor. The Atlantic Intracoastal Waterway, several smaller harbors, and ocean inlets provide connecting waterways to serve the coastal area. New River, a coastal stream in Onslow County, has a navigation channel and a flood control project. Also located along the coast are a number of significant resort areas and beaches.

Principal population centers are Winston-Salem, Greensboro, Burlington, Asheboro, Durham, Raleigh, Chapel Hill, Sanford, Fayetteville, Jacksonville, and Wilmington. The 1975 population was 2.1 million.

Problems

Water Issues

The problem of water quantity and water quality for the north-central North Carolina area is very complex. It involves water transfers, extensive waste treatment with possibly advance wastes treatment, protection of major water supply sources from pollution, and provisions for needs of downstream users in the Cape Fear River Basin. There are also waste discharges to the Cape Fear River Basin that are generated in other river basins.

The rapidly growing industrial and metropolitan 12-county area in north-central North Carolina is located primarily on small headwater streams with low flows, and ground water is not readily available. Possible solutions could involve four major river basins and require elaborate interconnecting water and sewerage systems, resulting in several interbasin water transfers. Two of the river basins involved are interstate streams with numerous downstream users of the water.

Water quality problems occur in north-central North Carolina as the result of discharges into streams with small flows and into reservoirs. Since all available surface-water sources must be developed for future water supply needs, high degrees of treatment of wastes or other methods of protecting water quality must be planned to maintain stream standards for water supply.

Shortages in available developed water sources to meet expanding needs are also occurring in southeast North Carolina. Ground-water sources are either not available in sufficient quantities or the quality is inadequate for a public water supply source.

Related Land Issues

Excess surface and subsurface waters prevent use of agricultural lands for production of food and fiber in the lower Cape Fear River Basin. Conversion of some of the wet soils to agricultural uses may not be their best use.

Erosion and sedimentation are occurring as the result of harvesting of timber, conversion of forestland to cropland and urban development; wind action and coastal storms erode beach areas, and high stream flows erode stream banks. Sediment loads generated in upstream areas are deposited in streams and navigation channels. Reduction in stream carrying-capacity increases flooding, and deposition of sediment in navigation channels increases the costs of maintaining adequate depths for navigation. Sediments also damage aquatic habitat and commercial fisheries.

Tropical hurricanes occasionally move up the East Coast producing heavy rains and tidal flooding of beaches. Recreational areas, structures, roads, farmlands, and historical sites are damaged by the associated flooding, and erosion of beaches and shorelines occurs.

Institutional and Financial Issues

There are conflicts over the use of water and related lands. The State of North Carolina has entered and expects to continue a period of vigorous economic growth. Conversions of agricultural and forested lands to urban and industrial development are resulting in losses of land for agricultural production. Higher property values result from the development of flood plains for urban and industrial uses and have greatly increased the economic loss from floods. Lack of a management program for planning and controlling the use of flood plains results in conflicts of use of land and water. Lack of a fully implemented coastal zone management program results in conflicts in use of wetlands, beaches, and associated water areas.

Adverse Effects

With existing storage and with storage that is presently proposed and under construction, there will be a water shortage by the year 2000 of 100 mcd for the north-central North Carolina area (excluding the two water service areas of Winston-Salem and Asheboro now using the Yadkin River). A general shortage will start around 1990, and growth of the area will be constrained beyond that time. Stokes, Yadkin, Forsyth, and Randolph Counties are not expected to be restricted in growth because of availability of water from the Dan and Yadkin Rivers.

Substantial acreage has already been drained and made available for agricultural production and other uses in the lower Cape Fear. In this area of over 3,500,000 acres, approximately 628,000 acres have a drainage problem.

Stream segments designated or proposed as scenic rivers will be jeopardized for this use if water quality is allowed to deteriorate. There are 495 miles designated in the Cape Fear River Basin. Anadromous fish runs on the Cape Fear River could also be affected.

Critical erosion is occurring on 66 miles of beach and non-critical erosion on another 32 miles of beach. Critical erosion occurs on 20 miles of the bay/estuary shoreline and non-critical erosion on 232 miles. Streambank erosion occurs on 396 miles of stream in the entire Cape Fear River Basin. The sediment load damages downstream areas and results in flooding/sedimentation damages in flood plains, damage to fisheries habitat and commercial fishing, and clogging of stream and navigation channels. Floodwater and sediment damage occurs on 535,000 acres, of which 10,000 acres are in urban areas, and the remainder, agricultural land.

Degradation of coastal water quality could seriously affect recreational potential, and shellfish grounds. An estimated 35,000 acres are closed to shellfish harvesting in the coastal area due to bacterial pollution. Potential annual monetary losses associated with the closing of shellfish areas are estimated at $10.6 million ($6.9 million in 1967 dollars).

An estimated $2.8 million ($1.8 million in 1967 dollars) in agricultural production is lost annually due to drainage problems.

If population growth and per capita income are constrained in north-central North Carolina at the 1990 level because of lack of water, annual economic losses could reach $5.5 billion by 2000 (1967 dollars-$3.6 billion). If this restriction also occurs in the lower Cape Fear River Basin, an additional economic loss of $2.1 billion annually in 1975 dollars in the year 2000 (1967 Dollars-$1.4 billion) could occur in that area.

The effect of coastal problems on the North Carolina coastal tourist industry, estimated at $100 million annually (1967 dollars-$65 million), is not known,.

Catawba-Broad-Saluda

Description

The problem area lies in 29 counties in west-central North Carolina and central South Carolina above Lake Marion, encompasing 15,523 square miles. Major water resources include the Catawba, Broad, Saluda, and Congaree Rivers; and Lakes James, Norman, Wylie, William C. Bowen, Fishing Creek, Wateree, Greenwood, and Murray. Major geographic provinces are the Blue Ridge, Piedmont, and Coastal Plain. The Fall Line traverses the area in a northeast-southwest direction at Columbia. Major land resources represented are the Blue Ridge, Southern Piedmont, and Georgia and Carolina Sand Hills.

The Catawba River Basin rises on the eastern slope of the Blue Ridge Mountains in the Blue Ridge Province and flows through the Piedmont Province and into the upper reaches of the Coastal Plain Province. The name of the Catawba River changes to the Wateree River at the mouth of Big Wateree Greek near Great Falls, South Carolina. The Wateree River joins the Congaree River in the headwaters of Lake Marion to form the Santee River.

The main stem of the Catawba-Wateree River has been highly developed for hydropower production. The free-flowing river has been greatly modified and low flows reduced. Drainage area is 3,253 square miles in North Carolina and 4,400 square miles in South Carolina.

The Broad River Basin rises in the Blue Ridge Province on the eastern slopes of the Blue Ridge Mountains in southwestern North Carolina. It flows in a general eastward direction in North Carolina and southeastward through the Piedmont Province in South Carolina. Total drainage area

is 7,850 square miles 1,503 square miles in North Carolina and 6,348 square miles in South Carolina.

The Saluda River rises in the Blue Ridge Mountains in northwestern South Carolina and flows southeastward to join the Broad River at the Fall Line near Columbia. Two major impoundments, Lake Greenwood and Lake Murray, are used for hydropower production and recreation. Lake Greenwood is also used as a water supply source.

The Saluda and Broad Rivers join near Columbia to form the Congaree River which flows southeastward through the Congaree Swamp to join the Wateree River at the headwaters of Lake Marion. The Congaree Swamp National Monument southeast of Columbia is a natural area with many record size trees. The Congaree River Flood Plain Forest in the area comprises 12 thousand acres; oaks and gums are the dominant tree species with an occasional cypress.

Principal population centers are Lenoir, Morganton, Hickory, Kannapolis, Gastonia, Charlotte, Marion, and Shelby, North Carolina; and Rock Hill, Columbia, Greenville, and Spartanburg, South Carolina. The total 1975 population for the area was 2.4 million.

Problems

Water Issues

This area is characterized by rapidly developing industry, primarily along four interstate highways that criss-cross the area. The economy is changing from rural-agricultural to urban-industrial. Major portions of this development are taking place in headwater areas of the basins near existing population centers where water is limited for supplies and waste assimilation. Also, the highly erodable Piedmont soils in a large part of the study area compound water use problems because the silt-laden streams are poor fisheries habitats, siltation reduces reservoir capabilities, and water quality is degraded. Ground water in the Piedmont is impractical to develop for large users and is therefore used primarily by individuals and small users. Ground water along the Fall Line is of questionable quality and quantity in many locations.

The impoundment and regulation of waters of the Catawba-Wateree River Basin have resulted in considerable alteration of national flows. Reductions in low flows and the lack of controls on withdrawals and maintenance of minimum flows in North Carolina complicate the instream use of the basin's waters for fishery resources, waste assimilation, and scenic values. Designing waste treatment facilities to meet water quality requirements for the changing streamflow conditions and to protect impounded water quality is difficult. In planning for steam electric generating facilities, the possibility of heated effluents further complicates water quality problems.

In the Broad River Basin, problems are primarily water supply needs, erosion and sedimentation, and some flooding. As the area develops, additional storage must be sought for water supply. Some small water supply reservoirs, as well as industrial hydropower reservoirs, have already been abandoned because of siltation. Flooding occurs primarily along small streams in urban areas. This rapidly developing and highly industrialized area of South Carolina will need large quantities of water in areas where surface waters are scarce. Impoundments and interbasin transfers may become necessary to meet additional demands and these should be investigated.

The Saluda River Basin is a rapidly developing industrial area of South Carolina. The low stream flows are generally not sufficient for any large, dependable yields or wastes assimilation. Therefore, any large surface-water needs would have to be developed through impoundments or by interbasin transfers.

Related Land Issues

The highly erodable soils of the Piedmont Province and rolling land surfaces are ideal conditions for erosion and siltation. Construction activities for highways and land development have added to the problem. Cutting of timber from steep-sloped land surfaces also exposes the soils to the elements, causing increased land erosion. Large sediment loads carried into flood plains, streams, farm ponds, natural lakes, and reservoirs result in siltation of those areas. Storage capacities of water supply, recreational, and hydropower reservoirs are reduced. Soil erosion also results in destruction or reduction in value of lands used for agriculture and wildlife.

A great amount of damage occurs to fish and wildlife habitats in the Piedmont Province portion of this area due to rapid runoff and erodible soil conditions. Excessive levels of turbidity and suspended solids from this runoff are found in the streams. Conditions are aggravated by erosion from agricultural and logging operations plus highway and development construction activities.

Institutional and Financial Issues

A number of water-related use conflict occur in the North Carolina portion of this area. The State of North Carolina has entered and expects to continue a period of vigorous economic growth. This is characterized by large scale conversions of agricultural and forestland to urban uses. The use of land for such purposes generally is to the detriment of other uses such as recreation and fish and wildlife habitat. Higher property values resulting from the development of flood plains for urban and industrial uses have greatly increased economic loses from flooding. Lack of a management program for planning and controlling the use of flood plains results in conflicts over use of land and water. Poor land management practices have resulted in unnecessary erosion and sedimentation.

There is no North Carolina water management policy for minimum releases below impoundments, controls of withdrawals, streamflow regulation, or management of lake levels. In certain locations excessive withdrawals deplete streamflows to such an extent that availability of water for downstream users is diminished with adverse environmental effects.

The mountain region of North Carolina is experiencing a rapid increase in second-home and recreational developments. These developments take place on steep-sloped sites and in valleys at lower elevations. An attendant problem with this rapid development is absentee ownership of the more valuable developable sites. Some of these large-scale developments have altered the landscape of the most scenically valuable regions. Additionally, some developments remain uncompleted because of underfinancing and other reasons.

Adverse Effects

The growth and development of this area will depend on the wise development and utilization of its water resources. The upper reaches of the area are inherently limited by small natural streamflows that, without impoundments, cannot yield the water that would be necessary.

Expanding industrial development in the Saluda River Basin will be limited by the availability of water. Even though Spartanburg, Greenville, and Pickens Counties have developed long-range plans to meet their water needs, the remaining portion of the basin does not have such plans. The fact that Greenville and Pickens Counties may grow industrially will complicate the problems for counties downstream because the upper counties will be discharging more wastes into the downstream waters.

An estimated 82,000 acres of land in the study area are subject to serious erosion damages. Over 60 percent of the land of the area has some erosion problem.

Several of the large lakes are in an early eutrophic stage as the result of excessive nutrients. Fecal coliform counts are high in a number of streams and in a few of the tributary arms of the large lakes. If not corrected, these water quality problems will increase with growth of the area, and the recreational and water supply uses of the streams and lakes will be jeopardized.

Uncontrolled development and use of water resources in North Carolina by various entities acting for their own purposes have resulted in conditions that cause streamflows to be abnormally reduced during drought conditions. This results in diminished water quantity, water quality, and water-based recreation. Water uses affected would be water supply, fisheries resources, and recreation.

Uncontrolled use of flood plains results in damages and often compounds flooding problems. There are 3,571 thousand acres in South Carolina and 161 thousand acres in North Carolina subject to flooding and sediment damage.

Failure to solve the mountainous area's conflict problems will result in further decreases in the environmental quality of the mountains by an accelerated reduction in natural scenery, increased erosion and sedimentation, and decreases in water quality. If sound guidance for development is not provided, such development may result in irrevocable damage to land and water resources. There may also be losses in the tourism industry in areas most affected.

The construction costs of industrial and municipal wastes treatment plants for the North Carolina portion of this area will approach $0.5 billion (1975 dollars) with annual operating costs to exceed $14 million (1975 dollars).

Flood damages in North Carolina are estimated at $3.86 million (1975 dollars). Losses in South Carolina have not be estimated.

If population and per capita income in a three-county area (Greenwood, Laurens, Saluda) in South Carolina is constrained after 1985 because of water shortages, then the loss in projected economic growth would be $586 million annually in the year 2000 (1967 dollars-$382 million). Constraints on per capita income and economics growth of 36 percent of the population of the Fall Line Counties after 1980 because of water shortages would restrict projected economic growth with a loss of $1.7 billion annually in the year 2000 (1967 dollars-$1.1 million).

Annual erosion damages are estimated at approximately $3 million (1967 dollars-$2 million). Sediment loads result in storage capacity reduction of 4,400 acre-feet/year in major reservoirs which is valued at $530,000 annually (1967 dollars-$345,000).

Chowan-Lower Roanoke-Pasquotank

Description

A 24-county area comprises the Chowan River Basin, the southeast Virginia area, the lower Roanoke River Basin from John H. Kerr Dam to the river's mouth, and the Pasquotank River Basin in southeast Virginia and northeast North Carolina. This area drains into Currituck, Albemarle, Roanoke, and Croatan Sounds and that portion of Pamlico Sound in Dare County. The basin is primarily in the Coastal Plain Province, but part of the Chowan River Basin is in the Piedmont Province. Included is the water service area of the Southeastern Water Authority of Virginia which is already obtaining water from the Chowan River Basin and is proposing to obtain more water from the Chowan and Roanoke River Basins. The basin encompasses 9,386 square miles.

The Chowan River rises in the rolling hills of the Piedmont Province in Virginia and discharges into the western end of Albemarle Sound in North Carolina. Tributaries in the Piedmont exhibit moderate slopes, but the streams in the remaining portion of the basin are flat and traverse swamp and marsh areas.

The Roanoke River Basin has two main tributaries, the Dan River in North Carolina and the Roanoke River in Virginia. If flows in a generally southeasterly direction, crossing the Virginia-North Carolina State line 18 miles below John H. Kerr Dam. The area under consideration encompasses about 1,500 square miles of drainage area below John H. Kerr Dam, mostly in Coastal Plain Province. Two major power projects, Gaston and Roanoke Rapids Lakes, are located downstream from the dam, which is a multi-purpose project. A navigation channel extends from Weldon, North Carolina (49 miles below John H. Kerr Dam) for 131 miles to Albermarle Sound.

Large naval operations occur around the Norfolk area. Principal population centers are Emporia, Franklin, Petersburg, and the Southampton Roads area, Virginia; and Elizabeth City and Roanoke Rapids, North Carolina. The 1975 population for the area was 1.2 million.

Problems

Water Issues

The problems in this area are very much interrelated, since the major rivers under consideration drain into Albemarle Sound. These rivers are all potential sources of water to meet an increasing water supply demand in southeast Virginia and northeast North Carolina and contribute to marine and estuarine water quality problems in Albemarle Sound. The Roanoke River supports major commercial and sport fisheries. Interbasin water transfers from any of the rivers would put stress on the remaining rivers to provide flows needed for water quality and salinity balances in Albemarle Sound.

Shortages of surface water and salt-water intrusion into ground water, because of overpumping, have forced southeast Virginia, to look to the Chowan and Roanoke Rivers for additional sources of water. These transfers may deplete flows for navigation, fisheries resources, and waste assimilation and cause increases in salinities in the lower Chowan and Roanoke Rivers. Roanoke River flows are already closely controlled from hydropower projects to maintain striped bass and other fisheries resources and for assimilation of wates.

One major paper mill on the Chowan River at Franklin, Virginia, is a large user of ground water, and its pumping operations are lowering ground-water tables. Two existing paper and pulp mills are located on the Roanoke River below the John H. Kerr Dam and a third mill is planned. These industries are large surface-water users, and they also need large streamflows to assimilate their residual waste loads. Any depletion of streamflows may damage these industries and affect an already depressed economy. However, if the two existing paper mills and the third meet the "Best Practicable Treatment and New Source Standards" of the Clean Water Act, these mills would not tax the assimilative capacity of the highly regulated Roanoke River, even with proposed transfers of water out of the basin for municipal use. Transfer of waters from any of the power pools of the Roanoke River would result in the loss of hydropower production.

The major source of ground water in southeast Virginia is the Potomac Formation, which is a sand aquifer of the Late Cretaceous age. Deep wells in this aquifer system already show high levels of chlorides in the eastern portion of Suffolk City, which borders on the lower Chowan River. The next water-bearing strata below the bedrock underlying the Potomac Formation have an even higher chloride content ranging from 800-1800 mg/liter. The chloride content of wells in some southeastern Virginia communities already exceeds the standard of 250 mg/liter for public drinking water supplies.

Water quality degradation of the streams and estuaries in the area occurs as the result of residual domestic and industrial waste loads, nonpoint source pollution, and large natural pollution loads from swamps and marshlands. Eutrophication is already occurring on the lower Chowan River and western Albemarle Sound, primarily from natural pollutants. These problems may be further aggravated by reductions in streamflows from diversions and increased residual point source pollution.

Natural nutrient loads from the Dismal Swamp in the Chowan River Basin and nutrients from both nonpoint sources and residual point sources are causing eutrophication problems in the lower Chowan River and western Albemarle Sound. These are a matter of concern for both recreation boating and the fisheries resources. High nutrient loads are transported by the runoff from large farming operations in those counties adjoining the south side of Albemarle Sound; these farming operations are also contributing herbicides, pesticides, and sediment loads to the Sound.

Bacterial pollution of estuarine areas is resulting in the closing of large areas for the harvesting of shellfish. North Carolina loses revenue from the decline in oyster leases, and oystermen suffer financially. Thermal pollution from steam electric generating plants, both fossil and nuclear fueled, will affect aquatic life.

Related Land Issues

Some upstream flooding and major coastal flooding occur in this area John H. Kerr Dam provides substantial flood protection on the lower Roanoke River except during high sustained flows. Flooding damages plus damages from erosion and sedimentation are problems that remain to be solved.

Institutional and Financial Issues

Lack of flood-plain management, conversion of wetlands to agricultural use, uncontrolled development, and rapid land development in coastal areas are current conflicts.

Adverse Effects

A water withdrawal of 40 mgd from the Roanoke Rapids Lake to meet southeast Virginia's future water supply needs would result in a loss

in potential power production. This loss of energy production plus energy needed for pumping this water would reduce the area's available electrical energy. Reduction in required water releases may also jeopardize the $1 million (1967 dollars) striped bass fisheries resource in the lower Roanoke River.

The lower Roanoke and Chowan Rivers have anadromous fish runs that may be damaged from reduced streamflows and/or water quality degradation. Bacterial pollution has already caused the closing of 338,430 acres of shellfish areas in the estuaries of the Chowan and Pasquotank Rivers.

From 1939 to 1966, heavy ground-water pumping at Franklin, Virginia, resulted in lowering the artesian head by 130 feet at the center of the cone of depression. In 1970, water levels had declined 185 feet at the center of the cone of depression from 1939 levels and most wells no longer flowed.

Floods damage agricultural lands and some small communities in the Chowan River Basin. The main stem of the lower Roanoke River is protected most of the time by the John H. Kerr Reservoir, but at times damages occur downstream when unusually high releases are necessary. Recreation and beach areas are heavily damaged by coastal storms. There are 215 miles of shoreline subject to critical erosion amd 210 miles subject to non-critical erosion in this area. Sixty-six miles of the critically eroding area is ocean shoreline.

Potential losses in 1975 dollars to the bass fisheries resources on the lower Roanoke River are $996,000 annually (1967 dollars-$650,000). The annual commercial fish catches in Albemarle Sound and the lower Chowan River, which are valued at $750,000 and $400,000, respectively ($489,000 and $261,000 in 1967 dollars), are also jeopardized. Potential value of shellfish from closed shellfish areas is $101 million annually (1967 dollars-$66 million).

Estimated expenditures of $32 million (1967 dollars-$21 million) would be required to correct 66 miles of critically eroding shoreline, and an estimated $1.5 million (1967 dollars-$1 million) annually would be required to nourish the corrected beach areas. The effect of coastal problems on the North Carolina coastal tourist industry, estimated at $100 million annually (1967 dollars-$65 million), is not known.

Black Warrior — Cahaba

Description

This is a 10-county area located primarily in the Black Warrior and Cahaba River Basins in north-central Alabama encompassing a total surface area of 7,962 square miles. The area includes the Birmingham and Tuscaloosa metropolitan areas as well as areas that will be affected by water supply withdrawals for, and waste discharges from, these metropolitan areas.

The Black Warrior River is formed by the junction of the Mulberry and Locust Forks about 20 miles west of Birmingham and flows southwesterly for about 174 miles to its junction with the Tombigbee River at Demopolis. The basin rises in the Appalachian Plateau where the topography is rugged and elevations range from 500 to 1,000 feet above mean sea level. The Fall Line, where the Appalacian Plateau meets the Coastal Plain Province, crosses the basin just north of Tuscaloosa. The Coastal Plain Province is characterized by low and gently rolling topography ranging from 225 feet above mean sea level at Tuscaloosa to 100 feet at Demopolis.

The Cahaba River rises near the boundary of Jefferson and St. Clair Counties and flows southwesterly to a point to Dallas County where it empties into the Alabama River. The upper portion of the Cahaba is characterized by swift-moving water and widely fluctuating flows. This may be attributed to the prevalent Parkwood and Pottsville geologic formations which give rise to a rocky stream bottom with numerous shoal areas and to many bluffs and rapids. In southern Shelby County, the river flows through deposits of limestone and dolomite.

Principal centers of population are Birmingham, Tuscaloosa, Bessemer, Homewood, Cullman, Jasper, and Fairfield. The 1975 population of the area was 1.1 million.

Problems

Water Issues

The major problem is a shortage of fresh surface-water to meet the needs of a rapidly expanding industrial area which produces coal and steel for national needs. Since the area is located mainly along tributary streams, there are interrelated problems of inadequate low streamflows for assimilating the large industrial and domestic waste loads and nonpoint source pollution. Four dams with navigation locks provide navigation depths on the Black Warrior River up to Birmingham. Controlled releases through these and other hydropower dams upstream present problems since flows need to be maintained for waste assimilation. Dewatering operations associated with mining, proper treatment of mining wastes, and subsidence are also issues.

Water needs for manufacturing processes and domestic water supplies result in large withdrawals and transfers across river basin boundaries. Consumptive uses are expected to increase greatly, aggravating further the low flow conditions in both the Black Warrior and Cahaba River Basins. The instream flow needs for navigation, power production, fish, recreation, and wastes assimilation will also increase at the same time that flows are being reduced by transfers and consumption.

The upper Cahaba River Basin presently supplies about as much drinking water as it can without capture of major flood flows. Its usefulness as a source of public water supply requires that constant efforts be made to maintain a satisfactory qualtity of water in the river. In dry seasons, the combined flow of the river and Lake Purdy's storage is used

almost exclusively for public water supply. As a result, there is very little water in the Cahaba River for several miles downstream where it receives the discharges from the Shades Creek and Patton Creek waste treatment plants. The river's ability to assimilate these wastes is greatly reduced during these low flow conditions.

Related Land Issues

Due to a combination of steep slopes and impervious substrata, the Cahaba River and its tributaries have been subject to frequent flooding. The problem is complicated by increasing development in the Birmingham metropolitan area which increases the runoff rates. Local flooding also occurs in other highly developed areas.

Institutional and Financial Issues

Protection of portions of streams in the Cahaba River Basin as wild and scenic rivers is a major item for consideration in the planning and management of water and related land resources. Developing and carrying out a water resource management plan is complicated by the high costs of facilities and the inability of local and State agencies to finance construction.

Adverse Effects

By about the year 2000, the consumptive use of water by industries and municipalities in and above Tuscaloosa County on the Black Warrior River could possibly be several times the 7-day 10-year low flow. If thermoelectric plants are located above this point, consumptive losses would be even higher. Comsumptive losses would also mean losses to downstream hydropower, navigation, and fisheries resources.

Mining of coal and other minerals produces waste products that affect the water quality of several of the area's streams. This limits their usefulness for water supply for domestic and industrial purposes, fisheries resources, and recreation and as natural or scenic areas.

The Goldline darter and Cahaba shiner are two fish species threatened by mining activities. The Watercress darter is threatened by water supply withdrawals. Other species of fish would be threatened by degradation of water quality due to industrial and domestic waste discharges and nonpoint source pollution. Land development will modify habitat and affect wildlife.

Southeast South Carolina Coast

Description

Four coastal counties of southeastern South Carolina extend from the mouth of the Santee River to the Savannah River included in the problem area, encompassing 3,677 square miles. The area is within the Coastal Plan Province and includes many bays, estuaries, coastal streams, and navigation systems. Charleston Harbor, Port Royal Harbor, and the Atlantic Intracoastal Waterway are in the area. Population centers are Charleston and Beaufort. The 1975 population was 448,200.

Problems

Water Issues

Waste discharges in the Charleston and Beaufort areas have resulted in bacterial pollution, making it necessary to close shellfish harvesting areas. Large organic loads reaching coastal waters and poor mixing have resulted in depressed oxygen levels.

Rediversion of fresh-water flows from the Cooper River and Charleston Harbor to the Santee River will increase salinities in the fresh-water zone in the Cooper River and will decrease salinities in the estuarine area at the mouth of the Santee River, thus affecting shellfish in both areas. There is also the potential problem to industrial water users of increased salinity.

Adverse Effects

Out of 249,715 acres of shellfish growing areas (mixed oysters and clams), 56,701 acres have been closed because of present pollution conditions. If this problem is not solved, even more shellfish areas may be affected. Approximately 3.2 percent (1,410 acres) of the closed shellfish growing areas are producing a commercially harvestable crop.

The increased flows, following Cooper River re-diversion, could change the salinity regimes at the mouth of the Santee River which affect shellfish. An estimated ten thousand bushels of oysters are transplanted from this area each year. It is estimated that two-thirds of these resources would be lost from re-diversion. The Wando River estuary, one of the most productive oyster seed beds on the Atlantic Coast, will be adversely affected by re-diversion, as will the shellfish areas in the Santee Delta.

Charleston Harbor receives large pollution loads, and re-diversion may adversely affect assimilative capabilities. Reduced flows will result in wastes being assimilated in the inner harbor areas, whereas under present conditions, this occurs farther out in the harbor where greater volumes of water are available.

Additional effects of pollution include stress on marine life populations with a lowering of numbers of more desirable species. Recreational restrictions are a probable result. Discharge limitations because of an already impaired water quality will restrict future development because of higher wastes treatment requirements.

Actual monetary losses from the closing of shellfish harvesting areas is $490,000 annually.

Florida Coast

Description

The east coast of Florida from the Florida-Georgia line to the Florida Keys, a distance of more than 500 miles, consists of a series of sandy barrier islands, broken here and there by inlets. The barrier islands, which are generally backed by low tidal marshes or lagoons, separate the mainland from the Atlantic Ocean. They vary considerably in length, width, elevation, and development. The ocean beaches range in form from wide and flat beaches to narrow, steep strips fronting seawalls, and in texture from the hard, fine sand at some locations to the soft sands and coquina outcrops of northern Florida.

The entire west coast of Florida on the Gulf of Mexico from Key West to Apalachee Bay south of Tallahassee is characteristically mangrove swamp or marsh, with sandy beaches occurring in places. Approximately 45 percent of this gulf shore, from the southern tip of Florida to the Pinellas-Pasco County line, is composed of offshore barrier islands which extend almost continuously for 150 miles. The beaches in this lower region, where they exist, are composed of fine white sand and contain a considerable amount of shell. The remaining 180 miles from the Pinellas-Pasco County line northward to Apalachee Bay is almost devoid of barrier beaches and is not included in this area.

The Florida coast west of Apalachee Bay is characterized by wide sandy beaches backed by dune lines with heights ranging from 10 to 15 feet. Most of the beach material along this reach is white sand composed primarily of quartz.

The length of shoreline covered in this area is 5,984 miles of which 1,066 miles is ocean/gulf shoreline and 4,918 miles is bay/estuary shoreline. A total of 1,353 miles is beach, of which 781 miles front on the ocean or gulf and 572 miles front on bay and estuaries. There are no beaches on the remaining 4,631 miles of shoreline. Surface area of the coastal counties is 26,146 square miles. The 1975 population was 6.7 million.

Future projections indicate that the coastal areas will continue to grow and develop at a very rapid rate. Extensive residential development for both summer and year-round use is anticipated. Continued intensive development for tourism and industry is also expected, with commensurate population increases.

Problems

Related Land Issues

The shoreline is continually adjusting to the change in forces affecting it. The entrapment of sand in river reservoirs; offshore dumping of channel and harbor dredge material; opening, closing, and migration of coastal inlets; the relative rise of sea level; and the expansion of development along the shoreline are some of the factors contributing to an apparent increase in shoreline erosion. One of the more easily identified causes of serious coastal erosion is that caused by the wind and wave action of coastal storms.

The extensive population growth in Florida has put an unusually high demand on use of beaches for recreation. Since both coastal storms and unusually high tides often destroy these beaches by erosion or breaching of low areas, restoration and protective programs are needed.

Adverse Effects

Of the 5,984.4 miles of shoreline in this area, 209.8 miles of ocean/gulf shoreline and 82.3 miles of bay/estuary shoreline are experiencing critical erosion problems. Another 332.8 miles of ocean/ gulf and 357.0 miles of bay/estuary shoreline are experiencing noncritical erosion. No erosion is occurring on the remaining 5,002.5 miles of shoreline.

Annual losses because of beach erosion of Florida's coastline are estimated at $66 million annually (1967 dollars-$43 million). These are the estimated benefits that would be derived from correcting critical erosion on 292 miles of shoreline.

Coosa in Georgia

Description

This 13-county problem area lies in northwest Georgia and encompasses 4,478 square miles. Principal drainage is provided by the Coosa River system. This river system rises in the Blue Ridge Province and flows southwesterly through the Piedmont, Valley, and Ridge Provinces to the Georgia-Alabama State line. Three large lakes, two national forests, and several State parks provide recreational opportunities. Principal population centers include Rome and part of the Atlanta, Georgia SMSA. The 1975 population was 379,300.

Problems

Water Issues

Industrial and municipal residual wastes, sediment, and nonpoint source pollution are degrading sections of the Tallapoosa, Conasauga,

Oostanaula, and Coosa Rivers in Georgia. Sediment loads contributed by sand and gravel operations and land erosion affect the color and turbidity of the water. Agricultural and urban runoff contribute nutrients, pesticides, herbicides, and bacterial pollution. Low level releases from stratified hydropower projects in late summer have low dissolved oxygen. Also, minimum releases made during no power generating periods are not sufficient to maintain needed assimilative capacities of streams where large waste discharges are made.

Adverse Effects

Stretches of stream receiving large waste discharges are seriously polluted, and oxygen levels are being decreased to marginally acceptable levels for fish life. Fecal coliforms are so high that the waters are unusable for water contact sports, and stream biota are being damaged. Dissolved oxygen standards are occasionally violated in reservoir releases from Lake Allatoona and below Dalton on the Conasauga River. The Coosa River shows evidence of nutrients and organic materials in the headwaters of Lake Weiss.

Mississippi Coast

Description

Three coastal counties of Mississippi from the Alabama-Mississippi State line to the Mississippi-Louisiana State line, encompassing 1,803 square miles of surface area, make up this problem area. The Escatawpa, Pascagoula, Biloxi, and Pearl Rivers, along with several small streams, flow through this area. The Pascagoula area is highly industrialized and has a commerical port. Located along the remaining coast is the Gulf Intracoastal Waterway, Port of Gulfport, and a number of recreational beaches. Population centers are Pascagoula, Moss Point, Biloxi, Gulfport, and Picayune. The 1975 population was 285,100.

Problems

Water Issues

The industrialized areas at Pascagoula and Moss Point contribute large waste loads in the form of residual wastes, urban runoff, and agricultural runoff to the Pascagoula and Escatawpa estuaries. The Escatawpa River in its lower reaches has a 7-day, 10-year low flow of 130-150 cfs. With the low flows and tidal action, the large waste loads are not flushed from the estuary so as to prevent deterioration of estuarine water quality. Water quality is degraded to the point that productive shellfish areas must be closed to harvesting. Conditions would not readily

improve, and the economic losses would continue to occur over the next few years even if pollution were eliminated now. Beach areas are threatened by bacteriological pollution fron nonpoint sources and possibly some isolated discharges of raw sewage.

Adverse Effects

Water quality in the lower 10 miles of the Escatawpa River and the lower Pascagoula River in the vicinity of Pascagoula is degraded. Water quality requirements may become the limiting factor for growth of the Pascagoula area.

The 69.8 miles of mainland beach are vulnerable to bacteriological pollution. Wastes from untreated and nonpoint sources discharged into the Gulf of Mexico along this beach section are degrading water quality in some areas enough to make it unfit for water contact sports.

Shellfish reefs have been closed to harvesting of shellfish on 1,050 acres of the estimated 2,050 acres in Mississippi, resulting in an estimated annual loss of $2.5 million (1967 dollars-$1.6 million).

Upper Pearl

Description

This eight-county area in central Mississippi encompasses 5,393 square miles of surface area. Major water resources are the Pearl River and Ross Barnett Reservoir. The entire area lies in the upper coastal plain. Jackson, the State capital, is the principal population center. The 1975 population was 410,200.

Problems

Water Issues

The Ross Barnett Reservoir above Jackson is a large, State-constructed recreational lake and water supply storage for Jackson. Large areas of the lake are extremely shallow, and nutrients from upstream have caused large areas of aquatic weed growth. Chemical control of these weeds is questionable since it might affect the quality for Jackson's water supply.

Residual municipal and industrial wastes, urban runoff, nonurban runoff, septic tank seepage, and low streamflows combine to cause poor water quality conditions below Jackson. Low streamflows are not adequate to assimilate the treated wastes and nonpoint source pollution.

Adverse Effects

At extreme low flow, the stream below Jackson has dissolved oxygen levels of 4.0 mg/liter, the minimum allowed. A total of 35 miles of the Pearl River has dissolved oxygen levels below 7.0 mg/liter.

A large portion of Pelahatchie Bay and approximately 8,000 acres of the main portion of Ross Barnett Reservoir are covered with aquatic weeds that prevent any type of recreational use of the reservoir in the area affected. Weed problems are expected to increase. The average depth of the reservoir is about 10 feet, but it is filling with sediment.

Central North Carolina Coast

Description

The five-county problem area of 3,012 square miles includes those coastal counties between the Roanoke River Basin and the Cape Fear-New River Basins, all within the State of North Carolina. The area is entirely within the Coastal Plain Province and, more specifically, is in the lower coastal plain. All of the counties are included under the North Carolina Coastal Zone Management Act.

The ocean shoreline of North Carolina consists of an emergent ridge of barrier islands separated from the mainland by shallow sounds. Salt marshes lie to the mainland side of these islands, which are very narrow ridges composed of recent marine deposits of sand and shell. The average elevation of the islands ranges between 6 and 10 feet above mean sea level; however, dune systems reach considerably greater heights (as much as 100 feet above mean sea level). Along most of the islands, however, dune elevations average between 10 and 30 feet above mean sea level. The 100 miles of ocean shoreline in this area have a sandy beach. Of the remaining 1,766 miles of shoreline, 403 miles normally have a beach zone and 1,363 miles do not.

The mainland shoreline of North Carolina is classified as a submerged coastline, meaning that the sea has risen relative to the landmass in the geologic past. Beaches exist along the bay and estuarine shoreline where there is a high sand content eroded from banks. These beaches are normally very flat and narrow.

The Outer Banks, which lie at places 20 to 30 miles from the mainland, form expansive sounds along the North Carolina coast. Associated with these sounds are large saline bays and both fresh-water and saline tidal rivers. All of these places have recreation potential and also serve as nursery areas for many types of marine fisheries.

Population centers are Wilmington, Morehead City, New Bern, Washington, and Elizabeth City. The 1975 population was 152,800.

Problems

Water Issues

High nutrient loads occur in the runoff from large farming operations in counties adjoining Pamlico Sound. These farming operations are also contributing herbicides, pesticides, and sediment loads to the sounds. Fresh-water diversions are altering salinity levels.

The lower portions of the Tar and Neuse Rivers are anadromous fish runs. These fisheries resources are sensitive to low dissolved oxygen, chemicals, and organic discharges. Low-level releases from stratified reservoirs, which are low in oxygen, will have a detrimental effect on fish propagation.

Bacterial pollution of estuarine areas is closing large areas to the harvesting of shellfish. The State loses revenue from oyster leases, and oystermen suffer financially.

Organic matter, which originates in swampy areas drained by a number of the streams flowing into the estuarine areas, increases color and reduces available oxygen and pH. Further development of beach areas for recreation and increased industrial development along the harbor and navigation channels may increase pollution loads that, without adequate treatment, will degrade marine and estuarine water quality.

Large ground-water pumpage for dry open-pit mining of phosphate has lowered the potentiometric surface for a considerable distance from the center of pumping. Water has been pumped at rates of 43-71 mgd since 1965, increasing with the rise in phosphate production.

Phosphate mining operations are expected to expand, possibly more than doubling ground-water withdrawals. Possible salt-water intrusion would be a threat to other ground-water uses in the area.

Related Land Issues

Tropical hurricanes occasionally move up the East Coast, producing heavy rains and tidal flooding of beaches and low inland areas and damaging the barrier islands and beaches. Other storms, particularly northeasters with prolonged strong winds, create "wind tides" which flood low areas and cause extensive shore erosion. Recreation areas, roads, farmlands, and historical sites are damaged by this erosion and flooding. Flood waters from this coastal flooding and from upstream flooding interfere with water uses and damage water treatment facilities.

Institutional and Financial Issues

Financing of waste treatment facilities to meet 1983 goals will be an economic burden to local communities. These goals may not be met.

Adverse Effects

Monetary losses associated with the closing of 89,265 acres of shellfish growing areas have been estimated at $17,500,000 annually in 1967 dollars.

Many stream segments and coastal areas have been proposed for inclusion in the scenic, wild, and recreational rivers program of North Carolina. A 50-mile stretch of the Neuse River has been proposed as a recreational river. Protection of these streams for these designated purposes will require water resource management, including water quality control.

Flooding and wave action along the 1,866 miles of shoreline are causing critical erosion problems along 57 miles of ocean shoreline and 180 miles of bay/estuary shoreline and noncritical erosion on 6 miles of ocean shoreline and 243 miles of bay/estuary shoreline.

Shorelines may retreat as much as 140 feet during a hurricane. The high risk in developing these areas threatens the full realization of the economic benefits from the tourist industry. Damages to fishing vessels and channels make it expensive to operate in these areas. High wave action threatens national monuments and causes navigation channels in inlets to shift.

Ground-water pumping has resulted in the lowering of the potentiometric surface over an area of more than 800 square miles. Artesian pressure has been lowered more than 5 feet in an area of more than 1,400 square miles and substantially for a distance of 40 miles from the center of pumping, including large areas in Washington and Hyde Counties.

An estimated 30 to 40 percent of the annual $100 million (1967 dollars-$65 million) North Carolina coastal tourist industry is centered in this area. It is jeopardized by these coastal problems. An estimateed first cost of $57 million (1967 dollars-$37 million) and an annual nourishment cost of $0.8 million (1967 dollars-$5 million) would be needed to correct 180 miles of eroding shoreline.

Southeast South Carolina Coast, Georgia Coastal Plain, and Northern Florida

Description

The problem area encompasses three rather specific sections in the Coastal Plain Province of South Carolina, Georgia, and northern Florida with a total area of 18,121 square miles. Severe problems are concentrated at Savannah, Brunswick, the Suwannee River Basin, and southwest Georgia. The effects of heavy ground-water pumping in Georgia extend into southeast South Carolina and northern Florida. Total 1975 population for the area was 1.5 million.

Included in the Savannah vicinity are two counties located in southeastern South Carolina and three counties in Georgia. These coastal counties

are influenced by heavy ground-water pumping on the lower Savannah River in Chatham County, Georgia. Population centers are Beaufort, South Carolina, and Savannah, Georgia.

A second portion, the Brunswick area, includes four coastal counties located in southeast Georgia and five counties located in northeast Florida. These counties are in the Coastal Plain Province where there is an abundance of ground water in two known aquifers, one shallow and one deep. Most of these counties have heavy water-using industries. Population centers are Brunswick and St. Marys, Georgia, and Jacksonville and Fernandina Beach, Florida.

The third portion, the 21-county Suwannee River Basin area, lies in south-central Georgia and northwest peninsular Florida. Major surface-water resources are the Withlacoochee, Alapaha, Little, Aucilla, Santa Fe, and Suwannee Rivers. Principal population centers are Valdosta, Georgia, and Lake City and Gainesville, Florida.

The geologic formations in the coastal areas are sand and some clay and silt. In the Suwannee Basin the formation is limestone, sand, clay, marl, and some dolomite. The principal artesian aquifer in the Georgia portion of this area and the Florida Aquifer in the Florida portion of the area supply large quantities of water. The aquifer system contains many minerals and is somewhat hard. Part of the Floridan Aquifer's recharge area is in Georgia and thus is influenced by withdrawals there.

Problems

Water Issues

Heavy ground-water withdrawals in the Savannah area are creating a cone of depression that extends into southeastern South Carolina. This lowering of the ground water piezometric level results in higher pumping costs and, if carried to the extreme, could deplete ground water so as to make it uneconomical to pump for certain uses. A cone of depression with a piezometric surface lowered below mean sea level is inducing salt-water intrusion that contaminates the fresh-water aquifer. Surface sources are available and are used, but these are some distance from the coastal areas.

In the Brunswick and northeast Florida areas, surface-water sources are generally available, but ground-water sources are abundant and require little treatment for industrial and municipal use. Heavy water-using industries have located in the area because of the availability of raw materials, the ease of transportation, and the abundance of water. These water users are pumping large quantities of ground water. In Brunswick, large ground-water withdrawals have resulted in brackish water encroachment. Similar potential problems exist in St. Marys, Fernandina Beach, and Jacksonville to the south.

Ground-water tables the coastal area are high, and during rainy weather septic tank tile fields may intersect them, thereby contamina-

ting the ground water. The aquifer near the surface consists of sand and gravel and is used by individuals as a water supply source. Industry may also use this source.

The source of ground water in the Suwannee River Basin is a sand and limestone formation. Yields from the aquifer are high, often reaching several thousand gallons per minute. Limestone sinks and solution cavities occur in the area. Subsidence may occur when ground-water levels fluctuate. The sinkholes and underground streams are a means of transport of low quality surface waters to the ground-water supply.

Ground water in the Suwannee River Basin is plentiful and is extensively used by municipalities, industry, and agriculture. In the Georgia portion of the basin, extensive irrigation of high-value crops is occurring and is projected to increase significantly. Livestock watering from ground water occurs. Possible upward migration of the underlying brackish water which contains high sulfates threatens groundwater quality in a large area of Georgia. Use of ground water occurs in the phosphate mining process in Florida. This use, plus a potential transfer of ground water out of the area to serve water short areas, threatens the quality of the remaining waters for downstream users.

Adverse Effects

Independent pumping operations in a relatively small area in Savannah and at Hilton Head, South Carolina, have caused a reversal of the natural hydraulic gradients in the vicinity of pumping. Heavy ground-water withdrawals which lower ground-water levels increase the costs of pumping to these users. Should the pumping rates increase and exceed recharge capabilities, salt-water intrusion may be accelerated and make this source of water unsuitable for use.

Under present rates of pumping, ground-water quality is threatened by increases in chlorides in the Savannah-Hilton Head area, and salt-water intrusion is beginning to occur in the Brunswick area. Ground-water withdrawals are expected to double between 1970 and the year 2000 and will greatly accelerate salt-water intrusion. Contamination of the ground water beyond the 250 mg/liter of chlorides limit will prohibit its use as a domestic supply. Quality of water and high development costs make it almost prohibitive to use surface sources for domestic water supplies. High chlorides may also reduce ground-water usefulness for many industries within a large area of Brunswick. The combined influence of these heavy withdrawals could be catastrophic, affecting large areas of the coast from South Carolina to Florida.

Large ground-water withdrawals in the Suwannee River Basin may lower the water table and cause sinkholes, which will allow surface contamination to enter the ground water. This could result in contamination of ground water to the extent that it could not be used as a domestic source, which would necessitate the use of more costly surface sources or a restriction on growth of the area. Reduction in the use of water for irrigation and industrial purposes may also result.

Tombigbee

Description

This 16-county area in northeast Mississippi and northwest Alabama in the Coastal Plain Province is the problem area, and it encompasses 9,921 square miles. Major water resources are the Sipsey, Noxubee, and Tombigbee Rivers, and the proposed Tennessee-Tombigbee Waterway. Major land resource areas represented are the southern coastal plains and the Alabama and Mississippi Blackland Prairies.

Principal population centers are Columbus, Starkville, Tupelo, Amory, Aberdeen, and West Point, Mississippi; and Aliceville and Eutaw, Alabama. The 1975 population was 377,200.

Problems

Water Issues

The limestone and sand aquifers of the early Tertiary Period are an important source of ground water in this area. However, there is a low-production area from west-central Alabama into east-central Mississippi. Saline content is high in some areas.

Heavy pumping of ground water by municipalities and industry has resulted in a lowering of the ground-water table. There are quantities of iron, fluoride, hydrogen sulfide, and hardness present in ground-water sources in the area. The Tennessee-Tombigbee Waterway may in the future lower ground-water levels near the channel. Dry weather streamflows in the Mississippi portion of the area are extremely low. Ground-water sources become more attractive because of limited yields from natural streamflows, lack of storage reservoirs for surface waters on tributary streams, and the higher cost of development and treatment of surface waters.

Related Land Issues

Other severe problems for which solutions have already been recommended include adequate navigation depths for the Tennessee-Tombigbee Waterway, flooding, and erosion and sedimentation. These solutions should be considered in this study along with environmental considerations in order to develop a total water resources management program for the area.

Adverse Effects

Available ground-water sources will determine the limits of growth of the area unless surface-water sources can be developed. Since streamflows are low, impoundments will become necessary to obtain dependable yields for any substantial growth. Water costs will rise as the demand

for the limited supply of water increases. These costs could then determine the growth of the area and become the limiting factor of economic development.

If per capita income and economic growth is constrained after 1995 because of water problems, economic losses could reach $510 million annually (1967 dollars-$333 million) by the year 2000.

Mobile — Lower Tombigbee

Description

The problem area is in six counties in southwest Alabama, which encompass 7,005 square miles. Major water resources are the Tombigbee, Tensaw, Escatawpa, Styx, and Mobile Rivers; Mobile Harbor; and the Gulf Intracoastal Waterway. Principal drainage is provided by the Mobile River which drains 64 percent of the land area of the State of Alabama as well as portions of Georgia, Mississippi, and Tennessee.

The Mobile Harbor navigation project provides access to the Gulf of Mexico and worldwide deep water ports. Upon completion of the Tennessee-Tombigbee Waterway, Mobile Harbor will have navigational access to the interior of the Nation.

Principal population centers include Demopolis, Jackson, Bay Minette, Fairhope, and Mobile. The 1975 population of the area was 483,900.

Problems

Water Issues

By 1985, Mobile's water demands will exceed its existing source on Big Creek, which is on a tributary of the Escatawpa River. Mobile is seeking to divert some water from the Escatawpa River Basin to meet future needs, but this interstate-interbasin transfer may interfere with uses in Pascagoula, Mississippi.

The 7-day low flow with a 10-year recurrence frequency in Mobile River is 8,000 cfs. There is a problem in using this water because it has a saline concentration under normal conditions of 1,000 mg/liter 20 miles above Mobile. Industries now using municipal water could possibly switch to the Mobile River source, but they, too, would be faced with a possible water quality problem as well as the need to build facilities to use saline water.

Salt-water encroachment in ground water occurred at Mobile during the 1940's. In the area west of Demopolis (Marengo County) highly mineralized water has risen along faults and has intruded into a heavily used fresh-water aquifer. This area is associated with a northwest trend-

ing belt of little or no potable water across west-central Alabama and extending a short distance into Mississippi.

Ground-water management is needed in order to provide for proper controls of pumping and water use.

Waste discharges into surface waters degrade water quality and possibly damage marine life. This damage, plus nonpoint source pollution and low streamflows in tributary streams, makes it doubtful that some streams will meet future water quality objectives.

Related Land Issues

Flood flows in rivers and tital flows along coastal areas cause erosion of streambanks and beaches. Gully, sheet, and rill erosion is a problem in Clarke County from the standpoint of land voided or destroyed as a resource, sediment produced, and cost of treating the problem.

Sediment loads carried from upstream into this area present many problems as sediments drop out in the estuarine areas. Sediments blanket the bottom organisms used for fish foods, fill in bay areas, and accumulate in navigation channels where they interfere with commercial shipping and boating recreation. Periodic dredging is necessary, but is difficult to find spoil disposal areas for the dredged materials.

Tropical storms moving inland from the Gulf of Mexico produce high winds and wave action which damage beaches and shorelines in Mobile and Baldwin Counties. Recreational areas are destroyed and structures near the beaches are damaged.

Institutional and Financial Issues

Competition for land has resulted in the dredging and filling of low areas to develop suitable industrial lands near navigation facilities. The lack of control of these operations results in conflict of land uses and destruction of wetlands which are valuable for fish and wildlife habitat. Lack of control over development in low areas and flood plains increases the damages that might be sustained from flooding.

Adverse Effects

If water cannot be developed at a reasonable cost and within a reasonable distance of Mobile, the area's growth will be limited to about that projected for the year 1985. Development of the Mobile River as a water source would provide sufficient quantities for most reasonable growth levels, but the cost of such an undertaking would become a limiting

factor. Treatment costs would probably be prohibitive for nearby river waters, and transmission costs would be prohibitive for distant waters.

Lack of suitable quality ground-waters may also contribute to the limitation of growth in this area. At present, ground water furnishes about 4 percent of the total water withdrawn. Its use cannot be greatly expanded because salt-water contamination is already occurring.

Sedimentation in navigation channels necessitates periodic dredging to remove solids and to maintain navigation depths. Sediments carried by the Mobile River system and by currents eroding the shorelines are gradually filling Mobile Bay. Removal of sediments from Mobile Harbor has cost almost double the original construction costs.

Beach erosion destroys recreational areas and endangers structures along the beach. Approximately 56 percent of the shoreline of coastal Alabama is eroding.

The authorized Theodore Industrial Channel and main channel improvements in the Mobile Bay area will require an initial dredging of 163 million cubic yards of material. The present plan is to place 66 million cubic yards of this material in Mobile Bay to cover about 3,000 to 4,000 acres of bay bottom.

Loss or reduction of recreation areas together with the inability of local and public interests to meet future demands will deny some local residents recreation opportunities and will result in a loss of tourism revenue. Sediment removal and maintenance of Mobile Harbor has cost about double the original construction cost.

Streambank erosion damages are $63,773 annually (1967 dollars-$41,000).

Pascagoula

Description

The problem area encompasses 9,854 square miles and 16 counties in southeast Mississippi. Major water resources are the Pascagoula, Escatawpa, Chickasawhay, Leaf, and Biloxi Rivers; Okatibbe Lake; Gulfport, Biloxi, and Pascagoula Harbors; and the Gulf Intracoastal Waterway. Major land resource areas represented are the southern coastal plains and the Alabama and Mississippi Blackland Prairies.

The Miocene-Pliocene sand aquifers along the Gulf Coast in Mississippi yield large quantities of water. Practically all domestic and municipal water supplies and most industrial supplies are obtained from the ground water reservoir. Fresh water extends to a depth of 1,250 feet at Pascagoula and to more than 3,000 feet at the mouth of the Pearl River to the west of the study area.

Principal population centers include Meridian, Laurel, Hattiesburg, Pascagoula, Moss Point, Biloxi, and Gulfport. The 1975 population for the area was 624,600.

Problems

Water Issues

Surface-water flows during low flow periods in the vicinity of Laurel and Hattiesburg do not have sufficient dependable yields for water supply and for the assimilation of residual and nonpoint source pollution. Minimum 7-day 10-year runoffs for tributary streams in the area are as little as .05 cfs per square mile. Generally, ground waters are sufficient for water supply, but inadequate spacing and overpumping jeopardize these sources. In Jackson County and other coastal counties, there is competition for surface waters for municipal, industrial, and cooling water needs.

Although ground water is plentiful, there are areas of Mississippi in which this abundant supply is degraded in quality. In the Miocene-Pliocene sands along the Gulf Coast there are areas of high iron content, low pH, and corrosive water. There are unknowns associated with deep-well injection of liquid wastes in some areas of the State. Of particular concern is the injection of oil brines used in extraction of oil from the ground.

Related Land Issues

Subsidence may occur in coastal areas that overlie unconsolidated sand aquifers, should ground-water withdrawals be greatly increased in the future.

A study on flooding and some other problems in the Pascagoula River Basin needs to be updated. In addition, the problems enumerated above need to be studied, and related environmental considerations need to be evaluated.

Institutional and Financial Issues

The lack of an interstate compact between Alabama and Mississippi complicates the solution of the Pascagoula and Mobile water supply problems. The Gulf coastal areas are becoming more industrialized, and population growth is requiring more land for residential and recreational facilities. Competition for land and lack of land use controls have resulted in the destruction of wetlands and the draining of marginal lands with the consequent loss of valuable fish and wildlife habitat. Floor plains have been used unwisely, resulting in higher flood damages and aggravation of flooding problems.

State laws protecting wild and scenic rivers and natural areas and establishing land use controls are lacking.

Adverse Effects

Dry weather streamflows may be the limiting factor of industrial development in the upper portion of this area unless impoundments are constructed, because natural steamflows cannot assimilate waste lands.

In the coastal area there is considerable competition for water for municipal and industrial growth, recreation, irrigation, cooling, and navigation. Without proper water resource management, one or more of these needs may not be met as a result of water being allocated to other uses.

Ground-water quality degradation along the coast has resulted in the need for long range pans to obtain future water from surface-water sources. Natural pollutants, oil brines, and possibly other liquid wastes may cause sufficient degradation of ground-water quality to make it unusable for municipal water supplies.

Development is continuing in flood plains, resulting in more damaging floods and larger losses to agricultural and urban areas. Development along unprotected coastal and beach areas has led to tremendous damages during hurricanes.

Lack of land-use control is jeopardizing the habitat of the sand-hill crane in the Pascagoula area.

If water problems constrain per capita income and economic growth of the area after 1985, economic losses could be $3.4 billion annually in the year 2000 (1967 dollars-$2.2 billion).

Yearly flood damages are not available, but Hurricane Camille in August 1969 caused over $92 million in coastal damages and $311 million in inland damages in the three Mississippi coastal counties.

Summary

The South Atlantic-Gulf Water Resources Region has ample surface waters and ground water to provide for an expanding economy. Except for peninsular Florida, the climate is characterized by well distributed rainfall, mild winters, and warm-to-hot humid summers. The average yearly rainfall of 50 inches compares favorably with the national average of 30 inches per year. Peninsular Florida has a period of low rainfall from December through May and streamflows reach a critical low at the end of this period.

The region is becoming more urbanized, and the once agrarian area is moving toward a more diversified economy. Industry is growing rapidly and is using more of the region's natural and human resources. Water is an important resource for this expanding industrial growth. There is an abundance of navigable waters along the coast and on a number of major streams to serve industry.

The abundance of forested lands provides a resource that is being heavily exploited. As a result there are large water demands by the paper and pulp industry which uses timber resources. Forested lands account for over 60 percent of the total regional area. Croplands cover 15 percent of the region but only about two-thirds of the croplands are harvested. Only 8 percent of this land is presently irrigated, but irrigation of croplands is projected to expand by almost 50 percent by the year 2000.

The region is dependent upon steam electric power for a large portion of its electrical energy. Use of water for steam electric power production presently accounts for over 50 percent of the average daily water withdrawals--by far the greatest single purpose withdrawal. Irrigation utilizes 14 percent and manufacturing accounts for 17 percent of the average daily withdrawals. Water withdrawals for steam electric are projected to increase only 9 percent by 2000 while steam electric power production will increase almost 700 percent. Withdrawals for manufacturing, irrigation, and other uses also are projected to change.

The 24 major river basins and the many minor coastal river systems provide resources for recreation, power production, manufacturing, municipal growth, navigation, and fisheries. There is an abundance of generally good quality ground water that can be developed below the Fall Line in the Coastal Plain Province.

Major problems with the region's water and related land resources occur as the result of growth and related water demands in areas where water is limited. The growth in stream headwater areas places a great deal of stress on the limited water resources where the contributing drainage area is small. Also, most of these streams originate in the mountain or Piedmont areas where ground water sources are very limited.

In the Coastal Plain Province, below the Fall Line, there is generally an abundance of ground water. Problems occur when this source is heavily pumped in concentrated areas near the coasts and salt-water intrusion becomes a threat.

In addition to water quantity problems, there is the problem of excessive pollutants reaching the streams and coastal waters, and in some areas threatening ground-water resources. Nonpoint source pollution and eutrophication of surface waters are two major issues that may not be resolved by present areawide water quality management planning programs. Water quality planning for nonpoint source pollution has been promoted by the statutory authorization for cost-sharing provided by the Clean Water Act of 1977 (Public Law 95-217).

Lack of flood-plain controls along with the need for structures to control flooding are problems in many areas of the region. Protection from erosion and water quality degradation of the beach areas and associated waters in this region is of major concern. Restoration of degraded beaches has proven valuable in a number of the areas along the Atlantic and Gulf Coasts. Dredging and filling of wetlands have been major issues in the past but with proper controls and management, it should be possible to reduce the issues to a minor or negligible status in most areas of the region.

Administrative problems occur as the result of inadequate control, legislation, and/or resources to carry out resource management programs. There are a number of management problems on interstate streams regarding interbasin and interstate transfers of water. No interstate agreements exist for resolving these problems. Financing of water supply source development is a major financial burden for many small communities, and generally there is no financial assistance available to assist local agencies.

There are a number of environmentally sensitive areas in the region, and the lack of an environmental plan to State and Federal levels causes difficulties when project developments are planned for such areas. There is a need for more specific environmental goals and a plan for attaining these goals.

Conclusions and Recommendations

The ultimate goal of this analysis is the resolution of the severe problems that have been identified. This can be accomplished by Federal, State, and local government agencies in partnership. Appropriate multi-objective planning studies, relevant data collection and timely research, necessary changes in laws and institutions, appropriate financing, and fully staffed resource development and management programs are required for the partnership to do the job. Nongovernmental interests should be given a role in comprehensive planning and in implementation of such planning.

Federal Role

The Federal Government has a responsibility to assist in the resolution of problems involving interstate commerce, problems having regional or national implications, and to assist research for general applications. Such assistance in the SAG has been provided by Federal agencies that have water and land resources management responsibilities under Constitutional and Federal laws. Assistance of this kind should be accelerated and increased in the future.

It is recommended that Federal agencies continue to provide technical and financial assistance needed by State and local agencies in resolving those problems for which the Federal Government has responsibility. This would include such programs as construction of major navigation systems, gathering of streamflow and other hydrologic data, research on technology for advanced waste treatment, cooperative river basin studies, and continued Public Law 566 and other water resource development assistance. Financial assistance as provided by Federal legislation should continue for such programs as areawide planning for waste-water treatment and construction of water based recreational facilities. Funding should be provided for legislated programs that have either not been funded or have received inadequate funding, such as Section 209 or Public Law 92-500, Title 3 or Public Law 89-80, Section 701 of Public Law 83-560 as amended by Public Law 90-448, and the National Dam Safety Act, Public Law 92-367.

It is recommended that an evaluation be made of the Federal Government's role in the planning, design, construction, and operation of water sources to be used for public water supplies. Limited financial assistance is presently available through the Water Supply Act of 1958, USDA programs, and HUD programs. An evaluation should be made to determine whether the Federal Government's financial participation in water source development for public supplies should be increased.

It is recommended that communities within the region that have not already done so, give consideration to establishing flood-plain ordinances and enrolling in the National Flood Insurance Program. Federal agencies should continue to assist localities in the data collection necessary to delineate flood plains and describe the extent of flooding problems,

and to provide the expertise in planning and implementing structural and nonstructural programs relating to flood control, such as those of the Corps of Engineers and the Soil Conservation Service.

Level "B" Planning Studies [1]

Utilizing criteria from the Water Resources Council's "Proposed Guidelines for Regional or River Basin (Level "B") Planning" and additional criteria developed in the SAG and discussed with Group "A" representatives, five geographic areas have been identified as potential Level "B" study areas (the Yadkin-Pee Dee, this region's number one priority, has recently been funded for a Level "B" study). The areas recomended for study are arranged in priority order as follows:

1. Apalachicola-Chattahoochee-Flint (A-C-F). This 64-county area is Water Resource subarea 313 plus seven additional counties in the Atlanta SMSA. The area is located in north and western Georgia, southeastern Alabama, and along the eastern edge of the Florida panhandle. It is characterized by the problems of surface- and ground-water quantity and quality, inadequate depths for navigation, flooding, erosion/ sedimentation, environmental conflicts, and water-related land use conflicts.

2. Cape Fear-North-central North Carolina. This proposed 24-county study area is located in north-central and southeastern North Carolina. The Cape Fear-North-central North Carolina proposed study area has overlapping counties with the Yadkin-Pee Dee study area. This overlap is due to the interrelationships of the water quantity-water quality problems and exisiting and potential interbasin transfers. It is characterized by problems of surface-water quantity and quality, marine and estuarine water quality, flooding, drainage, erosion and sedimentation, and water-related land use conflicts.

3. Catawba-Broad-Saluda. This proposed 29-county study area is located in west-central North Carolina and central South Carolina above Lake Marion. It is characterized by problems of surface- and ground-water quantity and quality, erosion and sedimentation, and water-related land use conflicts.

4. Chowan-Lower Roanoke-Pasquotank. This proposed 24-county study area is an expansion of an earlier proposal to WRC by SEBIAC for Level "B" study for the Chowan River Basin. It

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[1] A Level "B" study is a preliminary or reconnaissance level water and related land study for a selected area where problems are interdisciplinary and of such complexity that an intermediate planning step is needed between framework and implementation level studies.

is now located in southeast Virginia and northeast North Carolina and includes the Chowan River Basin, the southeast Virginia area, the lower Roanoke River Basin from the John H. Kerr Dam to the river's mouth, and the Pasquotank River Basin. It is characterized by problems of surface- and ground-water quantity, marine and estuarine water quality, flooding, and water-related land use conflicts. A problem exists regarding interbasin water transfers to southeast Virginia.

5. Black Warrior-Cahaba. This proposed 10-county study area is located in north-central Alabama and encompasses the Birmingham and Tuscaloosa metropolitan areas. It is characterized by a water quantity problem involving interbasin transfers which create problems of water quality and interfere with other uses.

Other Major Planning Studies

Analyses of the problems and effects information indicate a need for other major planning studies in 10 areas of the SAG. The areas recommended for study, and problem issues to be addressed are:

Southeast South Carolina Coast

o Water quality, marine and estuarine

Florida Coast

o Related lands, beach erosion

Coosa in Georgia

o Water quality, fresh surface

Mississippi Coast

o Water quality, marine and estuarine

Upper Pearl

o Water quality, fresh surface

Central North Carolina Coast

o Water quality, marine and estuarine

o Water quantity, ground
(Beaufort County Area)

o Related lands, flooding

o Related lands, water related-use conflicts

Southeast South Carolina Coast, Georgia Coastal Plain, and Northern Florida

o Water quality, ground
(Southeast South Carolina coast and northeast Georgia coast)

o Water quality, ground
(Southeast Georgia and northeast Florida)

o Water quantity, ground
(Suwannee)

Tombigbee

o Water quantity, ground
(Tombigbee in Mississippi)

o Water quality, ground

Mobile - Lower Tombigbee

o Water quantity, fresh surface

o Water quality, ground

o Related lands, erosion/sedimentation

o Related lands, water-related use conflicts

Pascagoula

o Water quantity, fresh surface

o Water quality, ground

o Related lands, water-related use conflicts

The degree of financial participation by local levels of government in the other major planning studies such as those listed above varies from State to State. This participation is in some instances legislated by the State in that taxes are imposed to operate water management districts

that participate in the planning for water resource projects. In other States, local agencies may not participate financially in planning.

It is recommended that all levels of government become or continue to be involved in these studies.

Data Collection and Research

During the Specific Problem Analysis, a number of needs were identified for data collection and research which would facilitate more effective planning and management of the water and related land resources. These needs are not always regionwide since some States do have adequate programs for some of the items listed below. It is recommended that in those instances where such programs are not adequate, consideration should be given to taking the necessary action to correct deficiencies. Data collection and research needs are many. The lack of adequate information and data in many categories essential to comprehensive, multi-objective planning dictates the following needs:

Data Collection

- o Streamflows--More data on small streams, including published data for low flows that can be utilized for planning, such as the 7-day low flow with a 10-year frequency of recurrence; and in-stream flow requirements and utilization for specific uses, such as fish and wildlife.

- o Water Quality--Up-to-date data on point sources of pollution and stream water quality information, including data on non-point source pollution.

- o Water Withdrawals and Consumptive Use--Up-to-date information on water withdrawals for all uses of both surface and ground water and on consumptive use and water reuse, including information and data on source location for each user.

- o Inventory Data for Lakes and Ponds and Structures--More extensive data on location and storage capacities of natural and manmade lakes and ponds and on evaporation from water surfaces for specific geographic locations, and data on dam structures especially.

- o Dependable Yield Data--Yield data for specific locations for existing and potential surface- and ground-water sources used or to be used for municipal and industrial water.

- o Groundwater Aquifers--Specific information on aquifer yields, recharge, water quality, movement of water in the aquifer, physical characteristics, and the aquifer's interface with the the ground surface, other aquifers, and salt water.

- Marine and Estuarine Water Resources--Data on the withdrawal and in place use of such resources, including sufficient water quality data to aid in determining the possibility of development and use of these resources for shellfish production, nursery areas, etc.

- Related Land Resources--A more thorough identification of all critical land areas, including: identification of wetlands, critical environmental areas, recreation sites, historical sites, archaeological sites, natural areas, and habitat areas for rare, endangered, or threatened species; identification and documentation of existing and potential wild and scenic streams with regard to location, length, and other characteristics; and development of a uniform system of land use classification.

- Data Storage and Retrieval System--Standardization in the collection and processing of all data for each of the planning, design, construction, and management processes of water and related land resources projects or programs, including a system that provides for storage and rapid retrieval of this information.

Research

Timely research results are needed for solutions of problems. Action is recommended to obtain information and data on the following:

- Improvement in technology on the use, reuse, and reclamation of water.

- Evaluations of the impacts of organic, inorganic, and thermal wastes discharges on water use, reuse, and reclamation.

- Evaluations of the impacts from nonpoint source pollution and how this pollution reaches surface waters.

- Technology to utilize storm waters in water-short areas.

- Evaluations of the impacts of resuspended solids on water quality.

- Technology for more effective control of aquatic weeds or plants and for protection of water quality.

- Evaluations to determine the effects of heavy pumping, dewatering, and/or mining of ground-water aquifers.

- Evaluations of the effects on ground-water quality of leaching from sanitary landfills, spray irrigation of wastes, recharge of ground-water with treated sewage, land subsidence, lateral and

vertical migration of saline water, deep-well wastes injection, and discharges into abandoned mine areas.

- o Technology for backpumping and recovery of excess water.
- o Evaluations of impacts of non-structural methods of flood damage prevention.
- o Evaluations of impacts of land use changes on water quantity, water quality, and flow regimes, including such sensitive areas as flood plains, wetlands, coastal areas, estuarine areas, mountainous areas, and resource deposits.
- o Development of more effective models to estimate soil erosion.

Institutional Arrangements

Legal implications, inadequate program management, insufficient financing of the necessary water resource programs, and lack of policies and goals were identified as problems needing resolution in the SAG. It is recommended that legislation, funding, and staffing necessary to bring about resolution of these problems be considered at the appropriate level of government. Institutional arrangement problems needing consideration and the level of government responsibility to resolve these problems are as follows:

- o Water allocation programs for all users of surface- and groundwater with the States have the primary responsibility and Federal and local governments a secondary responsibility.
- o Interstate agreements on interbasin water transfers from interstate streams with the States taking the primary responsibility and Federal and local governments a secondary responsibility.
- o Contingency plans for development and utilization of shortterm water supplies with the States having the primary responsibility and local governments secondary responsiblity.
- o Improved implementation of developed guidelines for considering environmental issues in Federal projects and programs. Development of statewide environmental guidelines. The States and Federal governments should share the primary responsibility for the environmental considerations with local government having a secondary responsibility.
- o Improved coordination between Federal, State, and other entities in all planning phases of water resource development projects and programs, including plans for project operation. State, Federal, and local governments should share the primary responsibility for this coordination.

- Implementation of adequate control techniques for location, construction, operation, and abandonment of water wells with the States having primary responsibility and local governments secondary responsibility.

- Improved implementation of established land use controls for sensitive areas such as coastal areas, wetlands, flood plains, mountainous areas, and other critical environmental areas. State, Federal, and local governments should share the primary responsbility for this.

- Improved coordination in data collection, storage and retrieval; research; and application of research findings with States and Federal governments sharing primary responsibility.

- Development of executive orders or legislation adopting specific goals, desires, and objectives for growth and development so that water resources are not unnecessary constraints. State, Federal, and local governments should share the primary responsibility for this.

- Programs and controls for improvement of water use efficiencies. State, Federal, and local governments should share the primary responsibility for this.

- Reduction of time lapse between conception and construction of Federal projects. Some possible causes of delay are limitations in project funding, coordination, staffing, litigation, data collection, public participation, and review time. States and the Federal government should share primary responsibility for this.

- A continuing assessment program is needed to keep the information gathered in the 1975 National Water Assessment current, to continually assess national water and related land resource use problems, and to arrive at suggested studies to obtain solutions to these problems. States and Federal government should share in the primary responsibility for this.

- Certain areas in the SAG cannot afford their current share of costs for all necessary water resource development and management projects and programs. Federal government has the primary responsibility for this.

- There is a need to allocate underground storage space so that long range needs for this space is not jeopardized. The States and Federal Government should share the primary responsibility with local government having secondary responsibility.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1979—O-306-614

ACKNOWLEDGMENTS

The Second National Water Assessment program, including the technical data input and the final report, was the responsibility of the U.S. Water Resources Council's National Programs and Assessment Task Group. Participants in the Group included technical representatives from the Federal member agencies, Regional Sponsors, Regional Study Directors, numerous State agencies, Council staff, and others as listed on the facing cover.

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THE NATION'S WATER RESOURCES — 1975-2000

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Authorization

The United States Water Resources Council was established by the Water Resources Planning Act of 1965 (Public Law 89-80). The purpose of the Council is to encourage the conservation, development, and utilization of water and related land resources on a comprehensive and coordinated basis by the Federal government, States, localities, and private enterprises with the cooperation of all affected Federal agencies, States, local government, individual corporations, business enterprises, and others concerned.