Publication No. 51

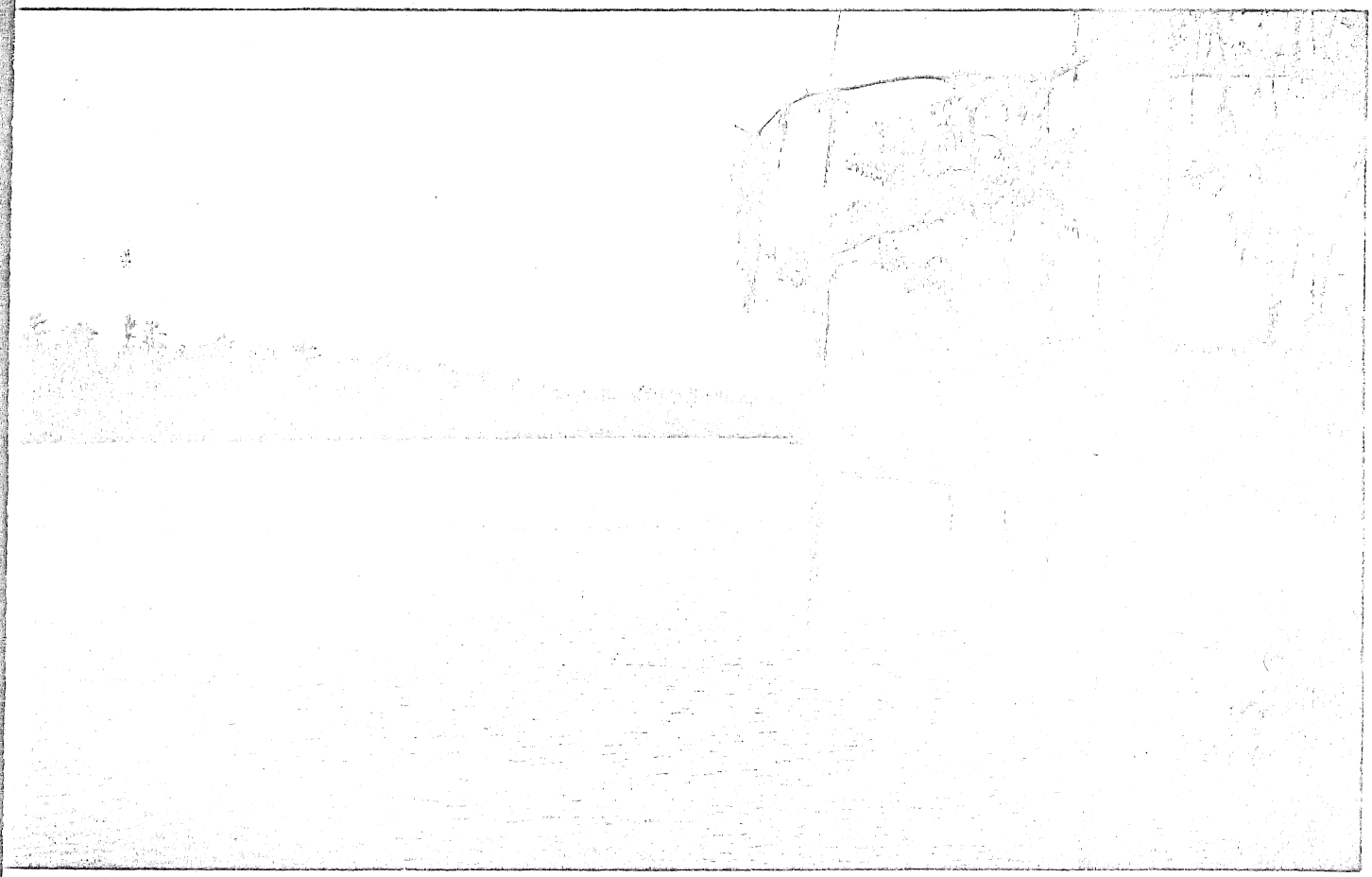
1982-1986 RESEARCH AND DEVELOPMENT PLAN

For

Florida Water Resources Research Center

By

James P. Heaney, Director
Florida Water Resources Research Center
University of Florida
Gainesville, Florida 32611



1982-1986 RESEARCH AND DEVELOPMENT PLAN

FOR

FLORIDA WATER RESOURCES RESEARCH CENTER

Submitted to

DIRECTOR
OFFICE OF WATER RESEARCH AND TECHNOLOGY
U. S. DEPARTMENT OF THE INTERIOR
Washington, D.C. 20240

by

James P. Heaney, Director
Florida Water Resources Research Center
University of Florida
Gainesville, Florida 32611

October 1980

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

I would like to thank numerous people who provided invaluable assistance in preparing this five-year plan. First, a general accolade to Dr. Marvin T. Bond, Executive Director of the Mississippi Water Resources Research Institute, for circulating early drafts of his five-year plan. These drafts and his final five-year plan provided an excellent guideline in preparing this plan. Next, I'd like to thank the seventy-five participants at the 1980 annual meeting for their participation and suggestions. Next, special thanks to agency representatives and faculty who returned questionnaires on research needs. Over 1000 news clippings were assembled by Ms. Anelia Crawford and Ms. Diana Phillips under the able direction of Ms. Dibbie Dunnam. Lastly, a special thanks to Ms. Peggy Paschall for transforming bits and pieces of text into final copy in a very short time.

Partial financial support to develop this five-year plan was obtained from the Engineering and Industrial Experiment Station (EIES), University of Florida, as part of their water resources research program. The cooperation of Dr. M. J. Ohanian, Director of EIES, is appreciated.

SECTION I

SUMMARY

A five year (1982-1988) research and development program has been developed by the Florida Water Resources Center to meet requirements of the Water Research and Development Act of 1978 as implemented by the Office of Water Research and Technology. Similar plans have been prepared by the 53 other centers and institutions. These results will provide the basis for similar plans being prepared at the regional and national levels.

The effort comprised three major tasks: 1) an inventory of Florida's water resources and current activities; 2) a summary of existing and projected water related problems; and 3) an estimate of how the resources expected to be available to the Center will be used to examine some of these problems.

Florida's Water Resources and Current Activities

Florida is blessed with a relative abundance of high quality surface and ground water. However, the water is not always when and where man would like to have it. Hurricanes, floods, and droughts are major problems. Likewise, water quality is deteriorating as areas develop.

An annual average of 56 inches of rain falling on Florida replenishes streamflow and ground water aquifers. The Floridan aquifer is the major water supply source for the State of Florida. Much of

the water movement in southern Florida is regulated by water control structures which have been installed during this century. The largest such project in the state is the Central and Southern Florida Flood Control Project.

A total of almost seven billion gallons of water are withdrawn daily. Approximately one half of this withdrawal is from surface sources. The other half is from ground water. This water is used for public supply (16%), rural supply (4%), industrial purposes (14%), irrigation (42%), and thermoelectric power generation (24%).

The State of Florida is divided into five water management districts (Northwest, Saint Johns, South, Southwest, and Suwannee), each of whose territory is established by hydrologic boundaries. The Florida Department of Environmental Regulation is the primary state agency for water management. The U.S. Army Corps of Engineers, Geological Survey and Soil Conservation Service are the primary Federal agencies. Two groups are actively pursuing research on industrial related activities: the National Council for Air and Stream Improvement, and the Florida Institute of Phosphate Research. Numerous university research groups are active in water related programs.

Problem Categorization and Ranking

Florida's water problems and priorities were established by soliciting input from several groups. Agency representatives were asked to rank Florida's problems using formal questionnaires and informal discussions. Another valuable perspective on "problems" was gained by subscribing to a news clipping service for all of

Florida's newspapers for six months beginning in April, 1980. These more than one thousand clippings were arranged by county. The Second National Water Assessment by the U.S. Water Resources Council expended much effort in prioritizing water problems in the southeastern United States. This effort was valuable in providing the regional and national perspectives. The major source of information regarding priorities for research in water problems related to agricultural areas came from a state-wide meeting sponsored by the Institute of Food and Agricultural Sciences. Another perspective was obtained by meeting with conservation groups. Lastly, university faculty were asked to suggest what they felt were the most important research topics that needed attention.

There are numerous ways in which water problems can be classified. The selected scheme was developed by the Virginia Water Resources Center using an outline of the South Atlantic Gulf Region as a point of departure. The five categories are shown in Table I-1.

Five-Year Program

Given the above information, estimates were prepared of how available resources could be allocated with available monies. Two levels of annual funding ($115,000 and $250,000) for the Annual Cooperative Program were to be used. In addition, anticipated matching grant and other funds were programmed into the plan. The resultant display of how monies could be used is shown in Table I-1. The Federal portion of the expenditures is shown in Table I-2. Of course, these are only planning projections. The actual amounts expended will vary.

Table I-1. Estimated Budget Requirements by Research Category: FY 1982-1986

Program Elements	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTALS
Institute Office Support						
Federal	45 (60)	50 (65)	55 (70)	60 (75)	65 (80)	275 (350)
Non-Federal	23 (30)	25 (33)	28 (35)	30 (38)	33 (40)	139 (176)
Sub-Total	68 (90)	75 (98)	83 (105)	90 (113)	98 (120)	414 (526)
I. Atmospheric, Hydrologic & Hydraulic Processes						
Federal	25 (70)	20 (65)	20 (60)	10 (65)	10 (65)	85 (325)
Non-Federal	13 (36)	10 (34)	10 (31)	5 (33)	5 (33)	43 (167)
Sub-Total	38 (106)	30 (99)	30 (91)	15 (98)	15 (98)	128 (492)
II. Hydrologic-Ecologic Relationships						
Federal	10 (50)	10 (50)	10 (50)	30 (70)	25 (70)	85 (290)
Non-Federal	5 (25)	5 (25)	5 (25)	15 (35)	13 (35)	43 (145)
Sub-Total	15 (75)	15 (75)	15 (75)	45 (105)	38 (105)	128 (435)
III. Water Quality Monitoring & Protection						
Federal	10 (20)	10 (20)	10 (20)			30 (60)
Non-Federal	5 (10)	5 (10)	5 (10)			15 (30)
Sub-Total	15 (30)	15 (30)	15 (30)			45 (90)

Table I-1. Estimated Budget Requirements by Research Category: FY 1982-1986

Program Elements	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTALS
IV. Water Development, Use, Conservation, and Management						
Federal	15	15	10			40
	(15)	(15)	(15)	(20)	(15)	(80)
Non-Federal	8	8	5			21
	(8)	(8)	(8)	(10)	(8)	(42)
Sub-Total	23	23	15			61
	(23)	(23)	(23)	(30)	(23)	(122)
V. Institutional and Economic Analysis and Water Resources Planning						
Federal	10	10	10	15	15	60
	(35)	(35)	(35)	(20)	(20)	(145)
Non-Federal	5	5	5	8	8	31
	(18)	(18)	(18)	(10)	(10)	(74)
Sub-Total	15	15	15	23	23	91
	(53)	(53)	(53)	(30)	(30)	(219)
PROGRAM BUDGET ESTIMATES						
Federal	115	115	115	115	115	575
	(250)	(250)	(250)	(250)	(250)	(1,250)
Non-Federal	59	58	58	58	59	292
	(127)	(128)	(127)	(126)	(126)	(634)
Totals	174	173	173	173	174	867
	(377)	(378)	(377)	(376)	(376)	(1,884)

( ) are estimates based on an Annual Cooperative Program appropriation of $250,000 Federal funds.

Table I-2. Proposed Distribution of Federal Funds: FY 1982-1986

Budget Activity	FY 1982			FY 1983			FY 1984			FY 1985			FY 1986		
	ACP Level I	ACP Level II	Match. Fund Prog.	ACP Level I	ACP Level II	Match. Fund. Prog.	ACP Level I	ACP Level II	Match. Fund Prog.	ACP Level I	ACP Level II	Match. Fund Prog.	ACP Level I	ACP Level II	Match. Fund Prog.
Institute Office Support	45	60	-0-	50	65	-0-	55	70	-0-	60	75	-0-	65	80	-0-
Category I: Atmospheric, Hydrologic & Hydraulic Processes															
Saline Intrusion		15			15			15			15			15	
Pollutants to Groundwater	15	30	40	10	25	40	10	20	40	10	50	40	10	50	40
Instream Flows															
Low Flow Predictions															
Supply															
Water Uses															
Flood Plain Management	10	25		10	25		10	25							
Erosion Control															
Category II: Hydrologic-Ecologic Relationships															
Wetlands	10	20		10	20		10	20		10	40		15	20	
Estuarine Quality Degradation															
Lake & Reservoir Quality		20			20			20			20			20	
Nonpoint Sources			40			40			40			50			50
Point Sources															
Water and Energy															
Acid Rain		10			10			10			10	40		30	40
Channelization										20			10		
Dredging & Filling															
Heated Water Discharges															
Water Quality Monitoring															
Aquatic Weed Control															
Category III: Water Quality Monitoring & Protection															
Reclamation and Reuse of Wastewater															
Water Treatment Processes	10	20		10	20		10	20							

Table I-2. Proposed Distribution of Federal Funds: FY 1982-1986

Category IV: Water Development, Use, Conservation, and Management															
Irrigation															
Large Reserves															
Water Conservation in Industry & Agriculture	15	15		15	15		10	15							
Salvage & Conservation of Excess Water															
Reclamation & Reuse															
Cost-Effectiveness/ Energy Requirements											20	40		15	40
Drainage						30			60			60			60
Category V: Institutional and Economic Analysis and Water Resources Planning															
Floods			40			40			40						
Dam Safety Considerations															
Hydroelectric Control of Water Use		15			15			15							
Integrating Water and Land Use Management	10	20		10	20		10	20							
Land Use Control in Water Resource Management															
Institutional Constraints										15	20	10	15	20	40
Legal Constraints			30			30			30						
Wastewater Treatment for Small Communities															
TOTALS	115	250	150	115	250	180	115	250	210	115	250	240	115	250	270

SECTION II

FLORIDA'S WATER RESOURCES

Florida is blessed with a relative abundance of water. Its coastal areas, springs, lakes, and rivers support a major tourist industry as well as meeting the usual needs for water. On the debit side, Florida suffers major damages from hurricanes and heavy precipitation causing serious flooding. South Florida is served by a complex network of water control structures whereas much of northern Florida's water system is still in its undisturbed state.

Unfortunately, a current comprehensive summary of Florida's water resources is not available. The last such summary was prepared in 1956 (Florida Water Resources Study Commission, 1956). An inventory of Southwest Florida was completed in 1966 (Florida Board of Conservation) followed by the St. Johns in 1970 (Florida Department of Natural Resources) and Southeastern Florida in 1974 (Florida Department of Natural Resources). Other primary sources of information are a 1975 Florida Atlas (Wood and Fernald, 1974), a consultant's report (Garcia-Bengochea, Pyne, and Black, 1975) and draft material from the State Water Use Plan (Florida Department of Environmental Regulation and the Water Management Districts, 1978). The information to follow is taken from these reports and other sources.

Precipitation

Average annual rainfall in Florida varies from a low of 52 inches along the east coast to more than 64 inches in northwest Florida. The statewide average is 56 inches per year (Hughes et al., 1971). About

60 to 98 percent of the annual rain fall is lost through evapotranspiration.

Surface Water

Part of the precipitation appears as surface runoff to river systems. Figure II-1 shows the average flow of the major surface streams. The largest rivers are in the northern part of the state. Lake Okeechobee is the largest lake in the state and the second largest lake in the United States with a surface area of some 700 square miles. Florida's springs are world famous. Silver Springs, the largest spring, has an average flow of 533 cubic feet per second. Wetlands comprise about 15 percent of Florida's acreage. These areas provide a large amount of water storage and help purify the surface and ground water.

The Corps of Engineers divides Florida into the five areas shown in Figure II-2. The boundaries of these areas correspond closely to those of the five water management districts. Summary descriptions of these five areas, extracted from the annual report of the Jacksonville District, are presented below (U.S. Army Corps of Engineers, 1979).

Central and Southern Florida Area (U.S. Army Corps of Engineers, 1979)

The area includes the central and southern part of the State south of Cape Canaveral and the city of Orlando, and lies generally east of the ridge which divides the waters which flow into the Atlantic from those which reach the Gulf of Mexico (see Figure II-8). The individual drainage basins included in this area constitute, for all practical purposes, a single watershed because in most cases their waters intermingle during periods of heavy rainfall and their problems of water control and use, as well as their economic problems, are closely

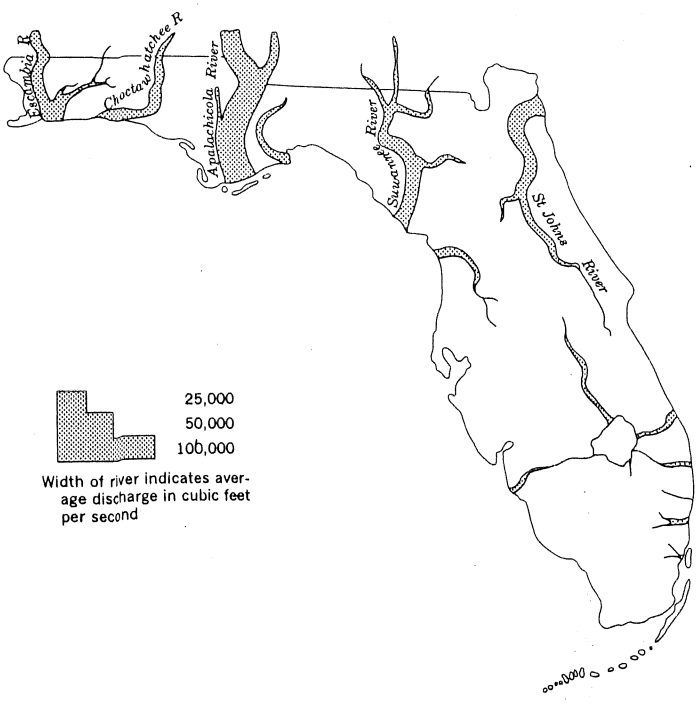


Figure II-1. Discharge of the Principal Rivers in Florida (Kenner et al., 1969).

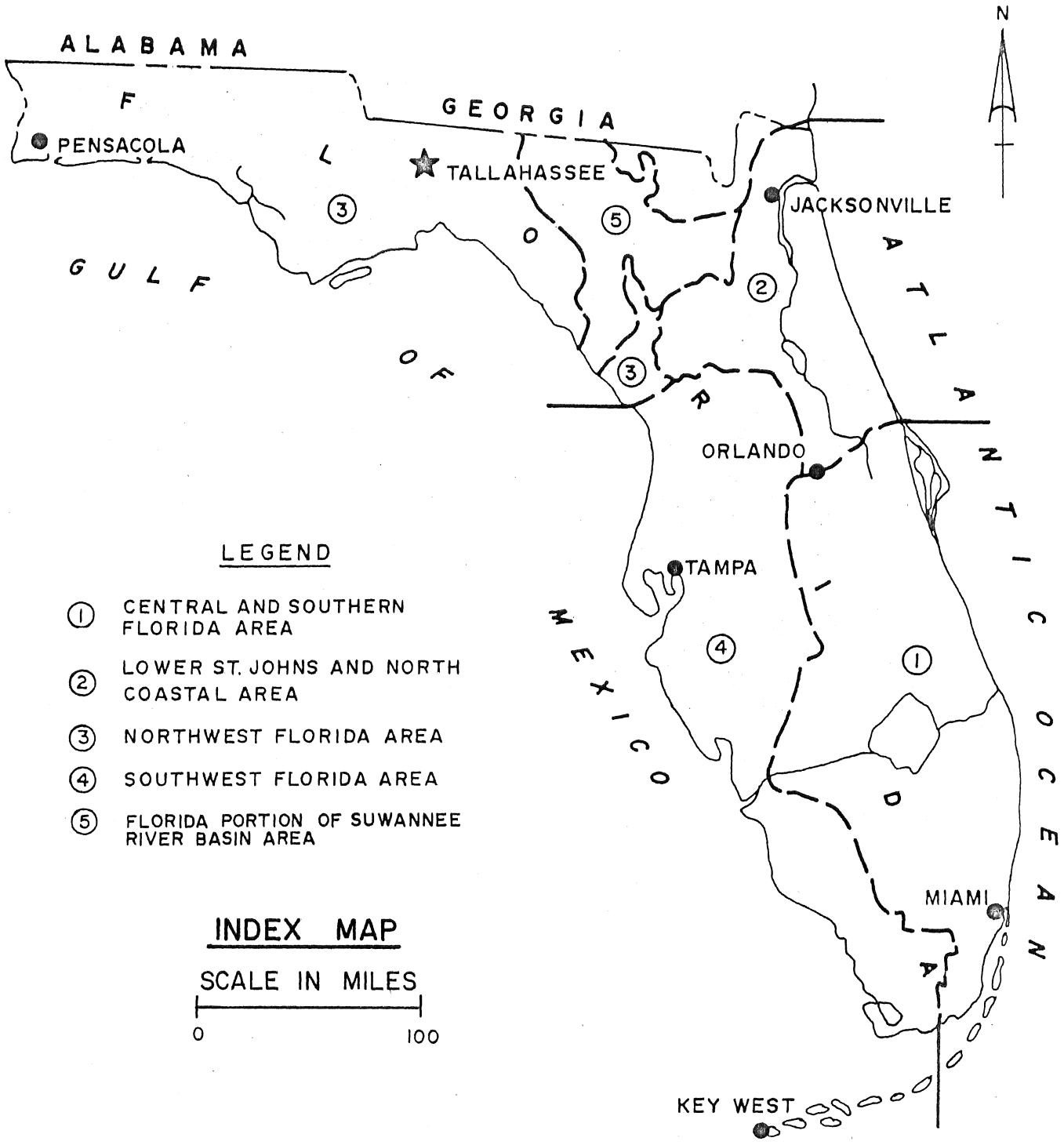


Figure II-2. Florida Index Map (U.S. Army Corps of Engineers, 1979)

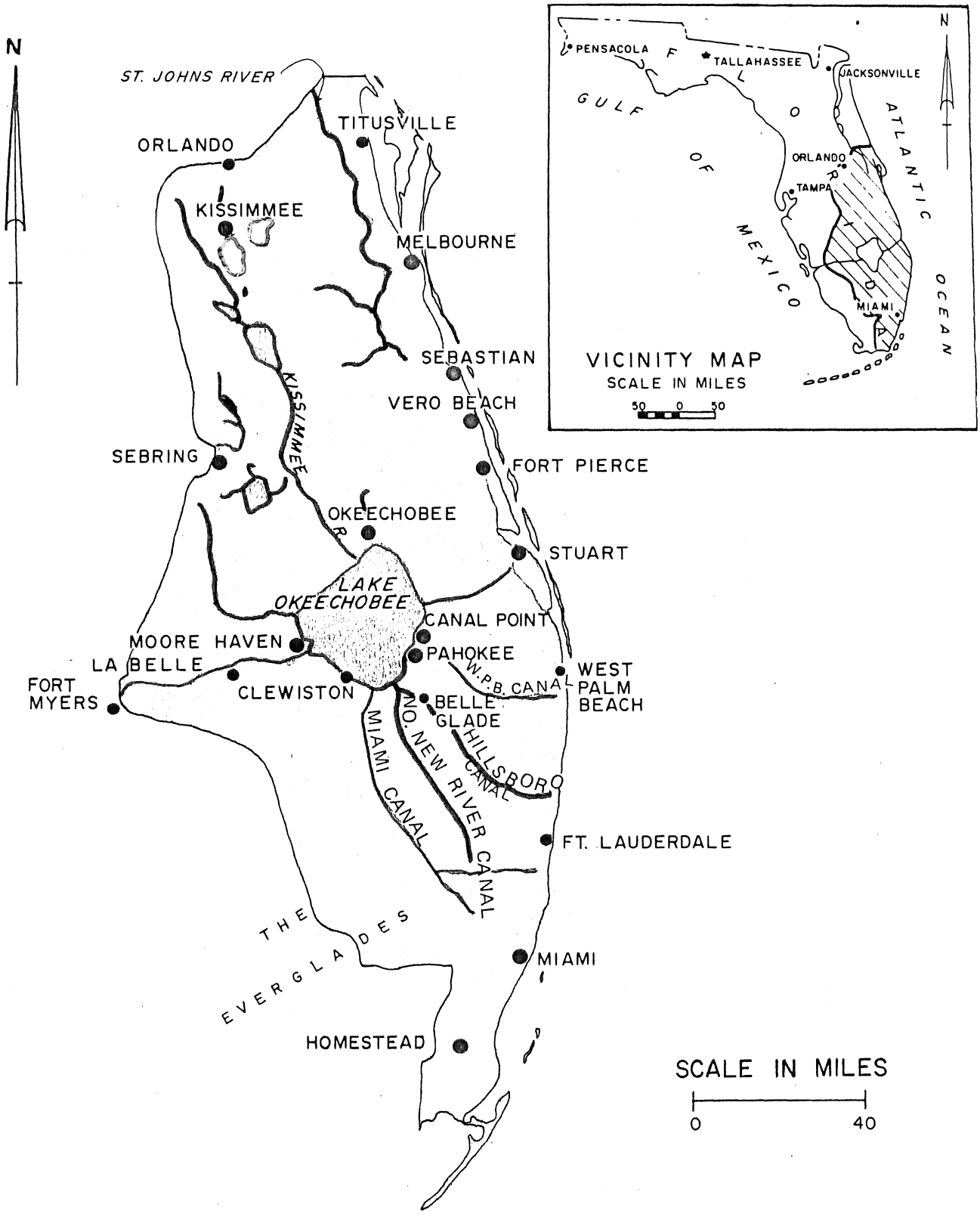


Figure II-3. Central and Southern Florida Area (U.S. Army Corps of Engineers, 1979).

interrelated. Principal subareas include the upper St. Johns River and related areas, Lake Okeechobee and its outlets, the Everglades, the coastal areas, and the northern portion of the Florida Keys.

Because of the nature of the climate, topography, and development, the area is subject to extremes of flood and drought. Lake Okeechobee, a large natural, shallow, freshwater lake, is the heart of the Central and Southern Florida area. The Okeechobee Waterway is a navigation channel which connects the Atlantic Ocean and the Gulf of Mexico via St. Lucie Canal, Lake Okeechobee, and Caloosahatchee River.

The source of the Kissimmee is in several streams which rise west of Ft. Pierce in St. Lucie County. The area is separated from the saline Indian River by a low coastal ridge 3 to 10 miles wide and ranging up to elevation 30. Direction of drainage is largely indeterminate and, depending on differences in rainfall and direction of winds, may be west toward the Kissimmee River, south toward the St. Lucie River, or to the north and east where waters collect to form the St. Johns. Open water and the beginning of the channel is in the latitude of Melbourne. In recent years, much of the original marsh has been converted to improved pasture, cropland, or citrus production.

The Everglades is the name generally applied to the area extending southerly from Lake Okeechobee to points west of Miami, then southwesterly about 40 miles toward Florida Bay and the Gulf

of Mexico. In its original state it was a vast solitude of sawgrass and water and was aptly termed by the indian inhabitants the "Pa-hay-okee" or "grassy water." Almost half of the Everglades proper is in the water conservation areas of the Central and Southern Florida project, less than 10 percent is in the Everglades National Park, which is in the Southwest Area.

By 1970, over 2¼ million people had settled along the south Florida coast, primarily along the coastal ridges in Dade, Broward, and Palm Beach Counties. Rapid population influx, the resulting development, and related environmental damage have resulted in serious water-resource-related problems. Poor water quality is a severe problem stemming from inadequate or untreated waste discharges, agricultural and urban storm-water runoff, and salt water intrusion and septic tank water seepage into groundwater. Competition for land resources also has forced development into flood-prone lands.

In recent years, Miami Harbor and adjacent Port Everglades have become the principal cruise ship ports in the southeastern United States. The cruise ship industry is one of south Florida's fastest growing industries.

Beach erosion is a problem along the coastal areas. A number of navigation, flood control, and beach erosion control projects have been authorized. A summary of the Central and Southern Florida Project is presented next.

The first phase of the Central and Southern Florida Project was authorized by the Flood Control Act of June 30, 1948. It consisted of most of the works necessary to afford flood protection to the productive agricultural development south of Lake Okeechobee and to the highly developed urban area along the lower east coast of the state.

Phase 2, consisting of all remaining works of the original Comprehensive Plan, was authorized by the Flood Control Act of September 3, 1954. Improvements in Hendry County and in Nicodemus Slough (just west of Lake Okeechobee) were added to the project by the Flood Control Acts of July 3, 1958, and July 14, 1960, respectively. Improvements in Boggy Creek, Cutler Drain Area, Shingle Creek, South Dade County, and West Palm Beach Canal were added to the project by the Flood Control Act of October 23, 1962.

Improvements in Southwest Dade County were added to the project by the Flood Control Act of October 27, 1965; the same act modifying the 1958 authorization for the Hendry County improvements.

The Flood Control Act of 1968 expanded the project to provide for increased storage and conservation of water and for improved distribution of water throughout much of the project area. Flood control measures for Martin County were added. The 1968 modification would also facilitate increased delivery of water to the Everglades National Park.

The project involves an area of about 16,000 square miles, which includes all or part of 18 counties in central and southern Florida. It embraces Lake Okeechobee, its regulatory outlets, a large portion

of the Everglades, the upper St. Johns and Kissimmee River Basins, and the lower east coast of Florida.

The project is one for flood relief and water conservation and provides principally for an east coast protective levee from the Homestead area north to the eastern shore of Lake Okeechobee near St. Lucie Canal; three conservation areas for water impoundment in the Everglades area west of the east coast protective levee, with control structures to effect transfer of water as necessary; local protective works along the lower east coast; encirclement of the Lake Okeechobee agricultural area by levees and canals; enlargement of portions of Miami, North New River, Hillsboro, and West Palm Beach Canals; enlargement of existing Lake Okeechobee levees and construction of new levees on the northeast and northwest shores of the lake; increased outlet capacity for improved control of Lake Okeechobee; floodway channels in the Kissimmee River Basin, with suitable control structures to prevent overdrainage, and facilities for regulation of floods in the Upper St. Johns River Basin. The project provides water control and protection from the recurrence of devastating floodwaters from the Everglades and local sources for the highly developed urban area along the lower east coast of Florida and for the productive agricultural areas around Lake Okeechobee (including the towns around the lake), in the upper St. Johns and Kissimmee River Basin, and in south Dade County. Another important project function is the conservation of floodwaters for beneficial uses during dry seasons. The project

also includes seven navigation locks, 20 feet wide and 90 feet long in the Kissimmee River Basin; six locks, 20 feet wide and 60 feet long in the St. Johns River Basin; and the necessary channel excavations and bridge alterations to provide needed facilities for additional recreational boating use.

Authorized project facilities include 30 pumping stations, 192 control and diversion structures, 897 miles of levees, 954 miles of canals, 26 navigation locks, and 57 railroad relocations (bridges).

St. Johns (U.S. Army Corps of Engineers, 1979)

This area includes that part of the St. Johns River Basin from Lake Harney downstream and those areas east and north of the St. Johns River (see Figure II-4). The St. Johns River begins in a broad, swampy area just west of Ft. Pierce in St. Lucie County, about 300 river miles from its mouth at Mayport. The St. Johns is one of the few northerly flowing rivers in the United States. It is one of the largest rivers in Florida, draining an area of 9,430 square miles. Some 1,900 square miles of this area are upstream of Lake Harney and referred to as the Upper St. Johns River Basin.

The St. Johns River and its principal tributary, the Oklawaha River, received much of their flow from the large perennial springs which are among Florida's many tourist attractions. The fall of the St. Johns River from the source to the mouth is only 25 feet. The river is perennially tidal as far upstream as Lake George (106 miles) and, under combined conditions of drought and high tide, the tidal effects occur as far upstream as Lake Monroe (161 miles). Approximately

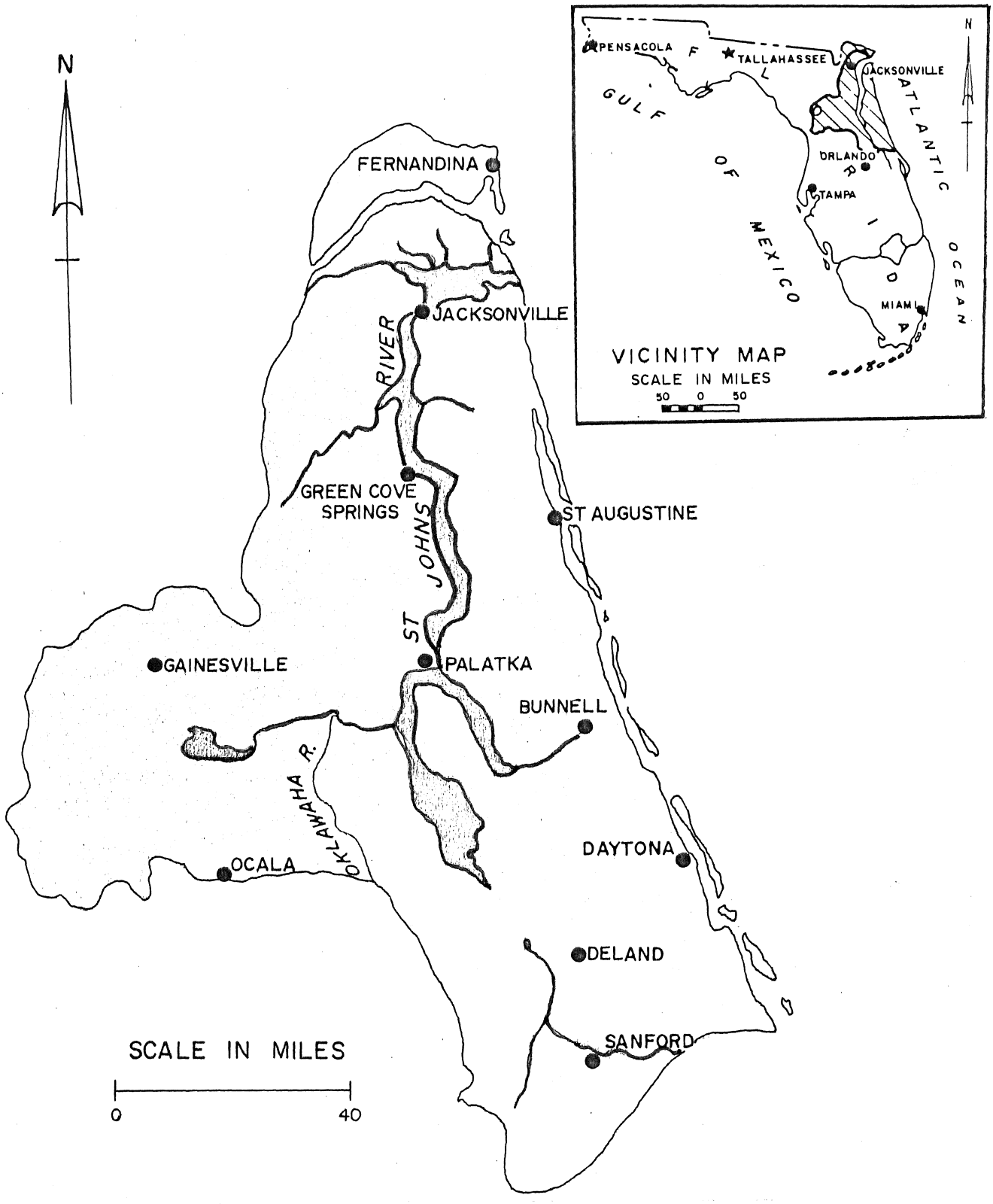


Figure III-4. Lower St. Johns and North Coastal Area (U.S. Army Corps of Engineers, 1979).

two-thirds of the drainage area in the St. Johns River Basin, including the Oklawaha River Basin, lies west of the main stem. Drainage in the coastal strip between the St. Johns River Basin and the Atlantic Ocean is into lagoons, formed by barrier islands, and to the ocean. The altitude of most of the area is less than 50 feet above mean sea level, although altitudes along the western drainage divides generally range from 75 to 200 feet and exceed 300 feet in the upper Oklawaha River basin.

No major improvements have been made to the St. Johns River proper upstream (south) from Lake Harney. Below Lake Harney, the river is used for navigation throughout its length. The existing project provides for a channel from Lake Harney downstream to Jacksonville, with depths of 13 feet from Jacksonville to Palatka, 12 feet to Sanford, and 5 feet to Lake Harney. From Jacksonville to the ocean, a channel ranging from 34 to 38 feet accommodates large ocean-going vessels. Improvements to provide flood protection and drainage in the upper St. Johns River consist principally of locally constructed levees and canals.

The principal urban concentrations occur in the Jacksonville Metropolitan area. Within this regional area, flooding poses a serious problem due to inadequate drainage facilities and the encroachment of development into flood-prone areas. Dwindling ground water supplies provide essentially all domestic and industrial water used in the area. Urban stormwater runoff, inadequate waste treatment facilities, failing sewerage systems and septic tanks, and other sources of contamination contribute to both surface and ground water degradation within the region.

Northwest Florida (U.S. Army Corps of Engineers, 1979)

This area includes the portion of Florida west of the Suwannee and St. Johns River Basins, as shown in Figure II-5. This section of Florida is generally characterized by rolling hills and sandy soils. Immediately south of the Alabama and Georgia lines are three small geographic areas known as the Western Highlands, the Marianna Lowlands, and the Tallahassee Hills. The Western Highlands, stretching eastward from the Perdido River, consist of a plateau sloping gently southward and crossed by several streams which flow in deep flat-bottomed valleys. In Walton County near the Alabama line is the highest point in the state, with an elevation of 345 feet above mean sea level. The Marianna Lowlands, lying between the Western Highlands and the Apalachicola River, comprise a flat or gently rolling area underlaid by limestone and dotted with "sinks" containing ponds or small lakes. The Tallahassee Hills, extending from the Apalachicola River eastward for about 100 miles, are rolling hills with the highest point about 300 feet above mean sea level. These are largely farming areas.

Bordering the coast are the Coastal Lowlands, flat plains less than 100 feet above the mean sea level. Pine forests cover much of the region. With the exception of the Apalachee Bay area, the coastline consists mostly of wide sandy beach backed by dunes ranging from 10 to 15 feet above sea level.

The economy of the area is based mainly on tourism, farming, pulpwood production, logging, commercial fishing, and manufacturing, with

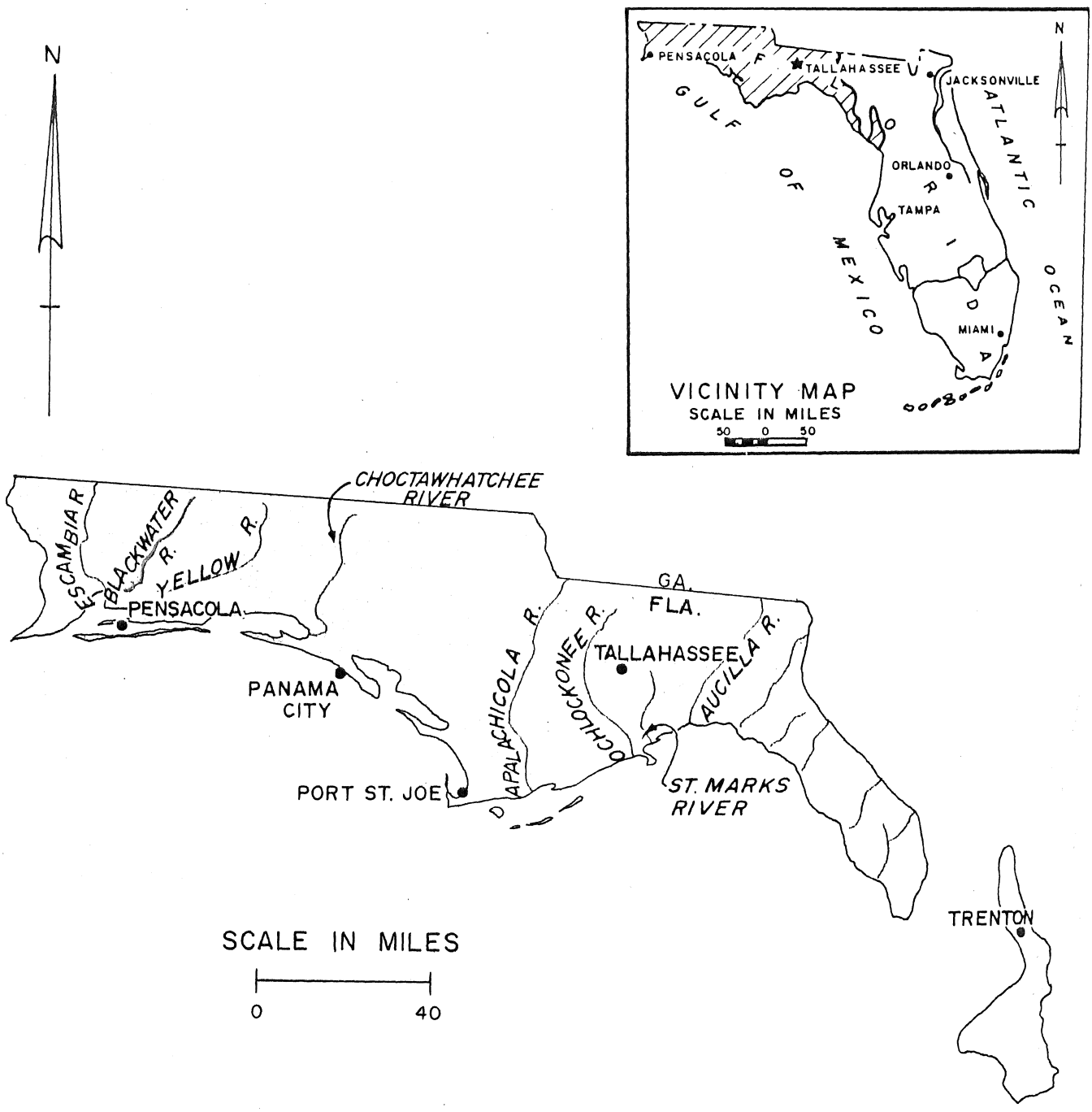


Figure II-5. Northwest Florida Area (U.S. Army Corps of Engineers, 1979).

primarily industrial centers at Port St. Joe, Panama City, and Pensacola. Crude oil production from an oil field near Jay, Florida, also contributes to the economy. Tallahssee, the capital of Florida, is the largest city in the area.

Major river systems draining to the Gulf of Mexico, progressing from west to east, are the Escambia, Blackwater, and Yellow Rivers, which drain through the Pensacola Bay system; the Choctawhatchee, draining into Choctawhatchee Bay; the Apalachicola, which empties into Apalachicola Bay; and the Ochlockonee, which drains through Ochlockonee and Apalachee Bays.

The beach zone along the Gulf is frequently backed by sounds or bays and is occasionally broken by tidal inlets. Tidal marsh occurs along much of the shoreline of the bays and sounds. Most of the beach material is fine white sand composed of about 98 percent quartz. Beach erosion is a problem in parts of the area. Navigation channels cut through the sandy beaches usually require extensive protective measures, such as rubble-mound jetties. Even with these, the natural instability of the beach material requires frequent maintenance dredging and special attention to problems of sand transport and beach nourishment. Tropical hurricanes occasionally cross the coastline in this area, and a few low-lying populated areas are subject to flooding from storm tides.

The Apalachicola River, part of a multiple-purpose waterway development serving Alabama, Georgia, and Florida, has been improved for barge navigation. Navigation channels are also maintained on the lower reaches of Blackwater and Escambia Rivers.

The Gulf Intracoastal Waterway parallels the coastline by way of numerous bays and sounds with connecting land cuts where necessary. Several local navigation projects provide small craft channels connecting towns or river systems with the waterway and with the Gulf of Mexico. Deep-draft channels and harbors are maintained at Port St. Joe, Panama City, and Pensacola.

Southwest Florida (U.S. Army Corps of Engineers, 1979)

The southwest area of Florida includes the Four River Basins project, which drains about 6,000 square miles, and a wide band along the southwestern part of the state that includes Everglades National Park, Key West and the lower part of the Florida Keys (see Figure II-6).

The four main streams which cover most of the Four River Basins area -- Hillsborough, Withlacoochee, Oklawaha, and Peace Rivers -- are interrelated in that all have common headwaters in the region known as the Green Swamp. All four streams have similar problems, such as flood control, major drainage, and water conservation, the solution to which depends partly on what plans might be developed for Green Swamp. Brief descriptions of each of these watersheds are given below.

... Green Swamp. This area, known locally as Green Swamp, is the highest land in the Four Rivers Basins area. The exact boundaries are indefinite, but it consists of about 850 square miles of swampy flatlands and sandy ridges varying in elevation from about 200 feet in the eastern part to about 75 feet in the stream valleys of the western part.

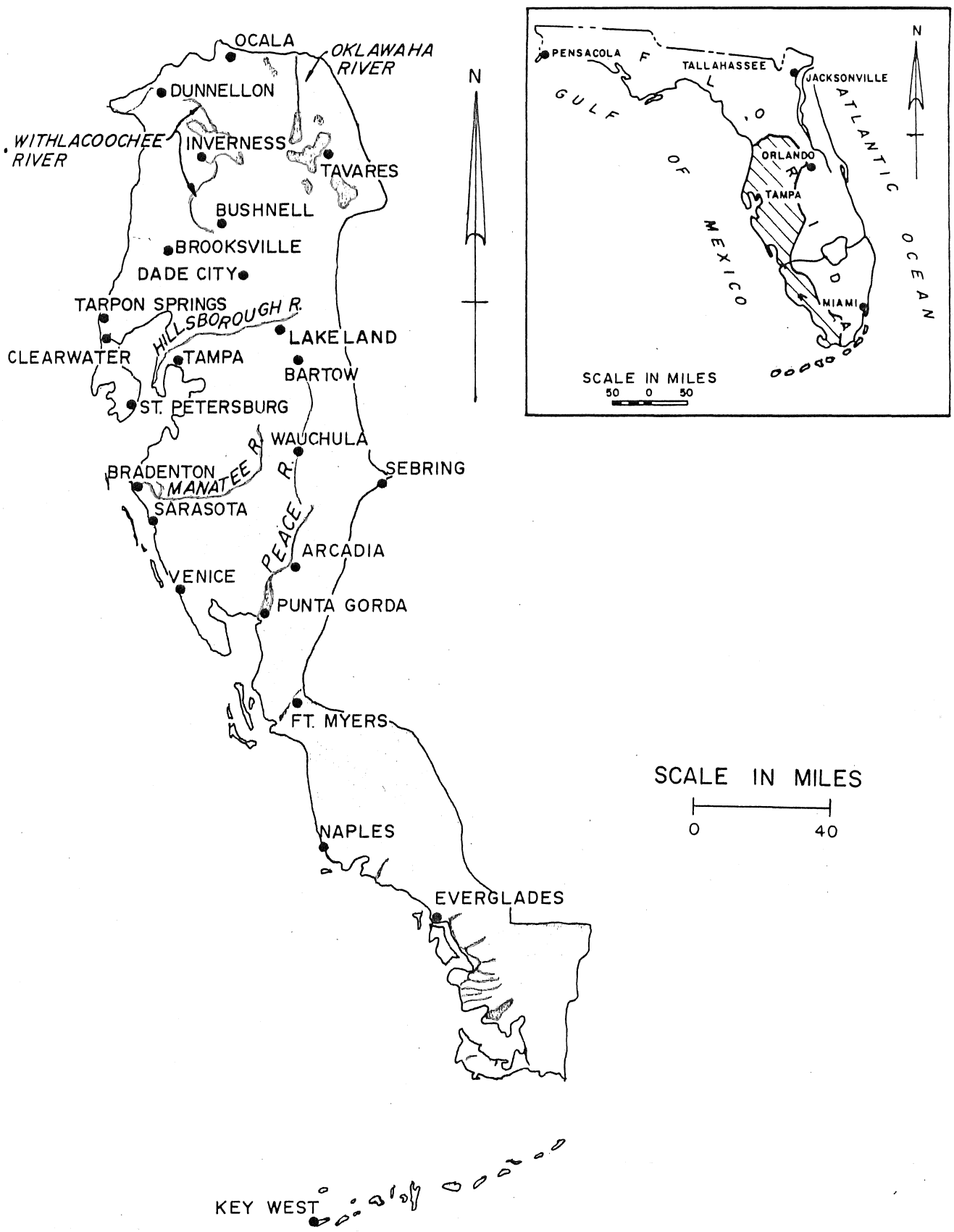


Figure II-6. Southwest Florida Area (U.S. Army Corps of Engineers, 1979).

... Hillsborough River, which drains about 690 square miles, originates at the edge of Green Swamp, north of Lakeland, Florida, and flows southwesterly about 54 miles to Hillsborough Bay at Tampa.

... Oklawaha River has its source in two chains of lakes and drains about 2,100 square miles. The Oklawaha River proper flows 75 miles northerly from Lake Griffin and joins the St. Johns River 77 miles upstream from Jacksonville.

... Withlacoochee River rises in Polk County in the Green Swamp area and flows northwesterly about 160 miles to the Gulf of Mexico at Yankeetown. The river drains about 1,980 square miles.

... Peace River has its source in a number of small lakes east of Lakeland, Florida. It flows southward about 120 miles and empties into Charlotte Harbor, an arm of the Gulf of Mexico.

Other major streams in this area include the Myakka River, which begins in Manatee County and flows generally southward to empty into Charlotte Harbor; the Alafia, which begins in Polk County and flows generally southwesterly about 24 miles to enter Tampa Bay; Little Manatee and Manatee Rivers, which begin in Manatee County and flow into Tampa Bay. Little Manatee River is about 39 miles long and Manatee River is about 35.5 miles long.

The Tampa-St. Petersburg metropolitan area is the second largest urban population center in Florida with a 1970 population exceeding one million. The rapid growth in this area has placed a severe strain on available water supplies for both domestic and industrial uses.

Associated with the increased uses of water are pollution problems stemming from wastewater disposal, urban storm-water runoff, and other sources of regional water supply contamination.

Some of the larger municipalities in the area include Tampa, St. Petersburg, Lakeland, Clearwater, Sarasota, and Ft. Myers. Authorized improvements provide for control of floods and improvement of drainage, and for water conservation through construction of necessary canals, levees, reservoirs, and control structures. Projects authorized for this area provide also for preserving the beaches and for navigation improvements.

Suwannee River (U.S. Army Corps of Engineers, 1979)

Suwannee River is the stream made famous by Stephen Foster in his immortal song of southern lore "Old Folks at Home." The Suwannee River flows out of the Okefenokee Swamp near Fargo, Georgia, and flows generally southwesterly about 222 miles where it empties into the Gulf of Mexico through two channels about 12 miles north of Cedar Key (see Figure II-7). It drains about 11,000 square miles of Georgia and Florida, about 4,300 of which are in Florida.

North of the Georgia-Florida State line, in the western part of the basin, are the low, rolling hills of the Georgia portion of the Upper Coastal Plain. This area, which is drained by the Alapaha and Withlacoochee Rivers, rises gradually from an elevation of about 120 feet at the State line to about 460 feet along the northern divide. Slopes here are generally steeper than in the other parts of the basin.

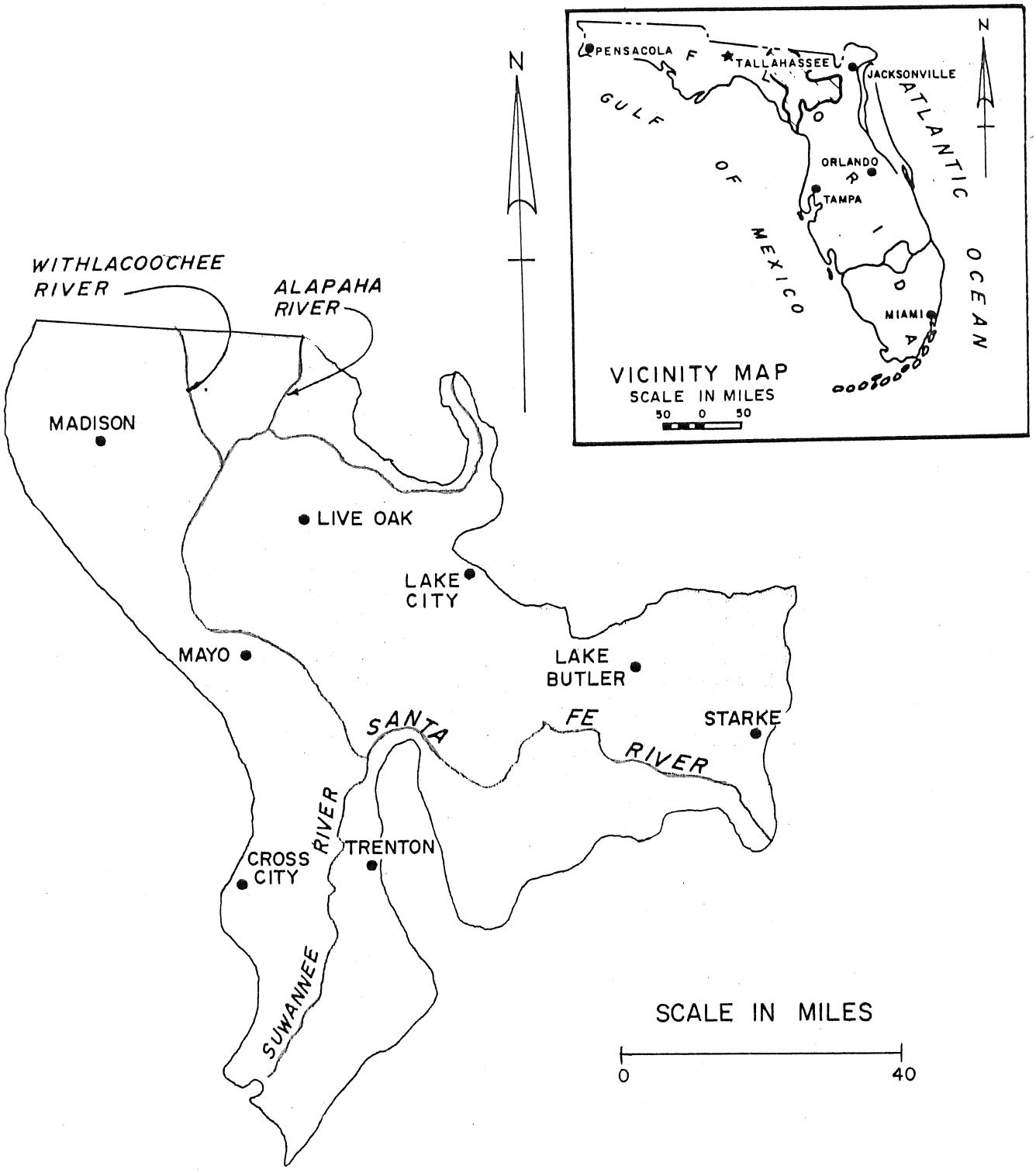


Figure II-7. Florida Portion of the Suwannee River Basin (U.S. Army Corps of Engineers, 1979).

Diversified agriculture is carried on throughout the area.

Okefenokee Swamp lies on the easterly side of the basin. It is fed by several small streams and totals about 1,100 square miles. The Suwannee River drains about 800 square miles of the swamp, and the St. Marys River drains the remainder. The swamp varies in elevation from 100 to 200 feet above mean sea level, in the Lower Coastal Plain. A low dam, or sill, on the Suwannee River at the swamp outlet controls the water level in much of the swamp to about elevation 115.

Extending from the Florida State line and Okefenokee Swamp flatlands southward to the Gulf of Mexico is an area, largely in the Upper Coastal Plain, drained by the Suwannee and Santa Fe Rivers. It is characterized generally by less relief, lower elevations, and fewer tributary streams than the rolling lands of Georgia.

The Okefenokee or "Land of the Trembling Earth" was so named by the Seminole Indians because of the unstable nature of its soil. The swamp is one of the largest fresh-water swamplands in the United States and by far the most significant inland body of water in the Suwannee basin. About two-thirds of the swamp, including 331,000 acres in Suwannee basin, have been set aside as a wildlife refuge administered by State and Federal agencies for wildlife preservation, recreation use, and to maintain its unique beauty and environment.

Short stretches of tidal marsh along the Gulf of Mexico adjacent to the river mouth are the only direct exposures to salt water.

The Suwannee basin encompasses some 7 million acres in a thinly populated area. More than two-thirds of the basin is forested. More than half of the forest is pine, and one-fourth is bottomland hardwoods.

Pure upland hardwood stands and hardwoods mixed with occasional pines are scattered througout the basin. About 119,000 acres of the basin forest land are in the Osceola National Forest, northeast of Lake City, Florida.

The Suwannee basin has a generous supply of good quality water from both ground water and surface sources.

Ground Water

Porous limestone underneath nearly the entire state of Florida provides large supplies of ground water. The principal sources of ground water are shown in Figure II-8. The major ground water problem has been salt water intrusion. However, there is increasing concern regarding contamination from land disposal of waters including toxic chemicals.

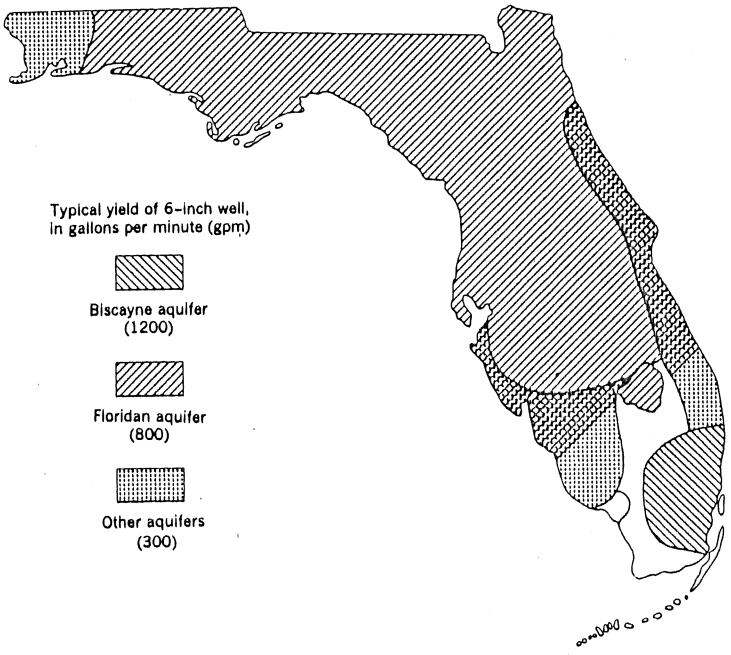


Figure II-8. Principal Sources of Ground Water (Hyde, 1965).

The Floridan aquifer is the principal source of ground water in Florida (Hyde, 1965). It is an artesian aquifer, i.e., one that contains water under sufficient pressure to rise above the containing formation. While the Floridan aquifer underlies all of Florida, it is too saline to be of use in the coastal areas indicated in Figure II-8. The Biscayne aquifer is a non-artesian aquifer which underlies about 3000 square miles of southern Florida (Hyde, 1965). It ranges in thickness from 100 to 400 feet in the coastal areas to only a few feet near its western boundaries.

The Floridan aquifer ranges in depth from zero to 1000 feet below the land surface as shown in Figure II-9. The potentiometric surface for the Floridan aquifer is shown in Figure II-10. Elevations range from 100 in the central highlands to -80 in the coastal area of the panhandle. Lastly, the areas where pumpage had most significantly affected the potentiometric surface are shown in Figure II-11.

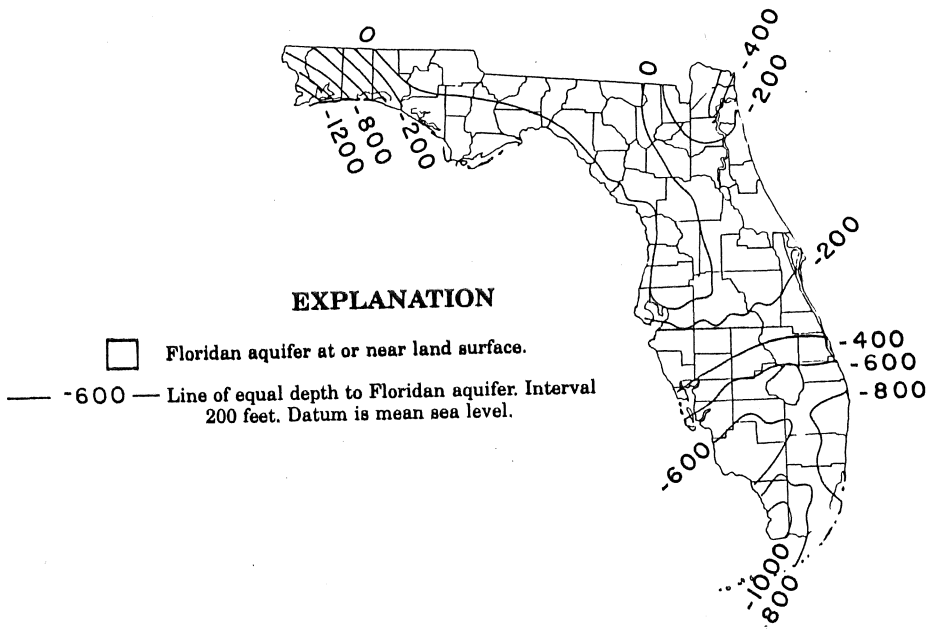


Figure II-9. Altitude of Top of the Floridan Aquifer (Healy, 1975; Vernon, 1973).

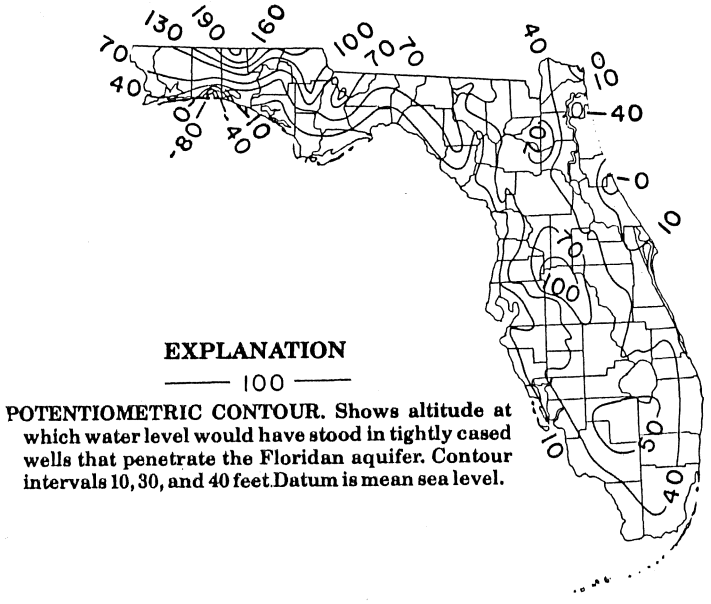


Figure II-10. Potentiometric Surface of Floridan Aquifer, May 1974 (Healy, 1975).

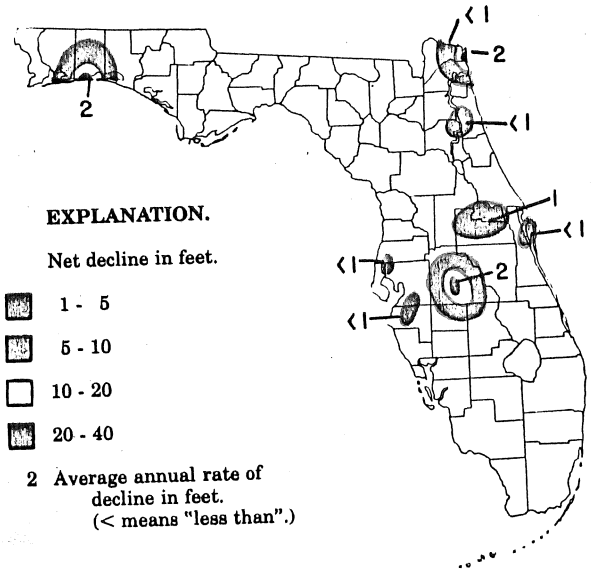


Figure II-11. Decline of Potentiometric Surface of Floridan Aquifer in Areas of Heavy Withdrawal of Ground Water, 1961-74 (Healy, 1975).

REFERENCES

Florida Board of Conservation and Division of Water Resources, "Florida Land and Water Resources, Southwest Florida," Tallahassee, FL, 1966.

Florida Department of Natural Resources, "Florida Water and Related Water Resources, St. Johns River Basin," Tallahassee, FL, 1970.

Florida Department of Natural Resources, "Water and Related Land Resources, Kissimmee-Everglades Area," Tallahasseee, FL, 1974.

Florida Department of Environmental Regulation and the Water Management District, State Water Use Plan, Phase 1 (Draft), Tallahassee, FL, Dec. 1978.

Florida Water Resources Study Commission, Florida Water Resources, Gainesville, FL, Dec. 1956.

Garcia-Bengochea, J.I., R.D. Pyne, and E.W. Black, Florida's Water Resources: An Evaluation and Management Philosophy, Project No. 272-75-80, Black, Crow, and Eidsness, Inc., Gainesville, FL, Nov. 1975.

Healy, H.B. Potentiometric Surface and Area of Artesian Flow of the Floridan Aquifer in Florida, Florida Department of Natural Resources, Bureau of Geology Map Series 73, Tallahassee, FL, 1975.

Hughes, G.H., Hampton, E.R., and Tucker, D.F.. Annual and Seasonal Rainfall in Florida, Florida Department of Natural Resources, Bureau of Geology Map Series 40, Tallahasseee, FL, 1978.

Hyde, L.W. Principal Aquifers in Florida, Florida Bureau of Geology Map Series 16, Tallahassee, FL, 1965.

Kenner, W.E., et al. Average Flow of Major Streams in Florida, Florida Bureau of Geology Map Series 34, Tallahassee, FL, 1969.

Southeast Basins Inter-Agency Committee, 1975 National Assessment of Water and Related Land Resources, South Atlantic Gulf Region, Volumes I, II, and III, Atlanta, GA, Dec. 1977.

U.S. Army Corps of Engineers, Water Resources Development by the U.S. Army Corps of Engineers in Florida, Jacksonville, FL, 1979.

Vernon, R.O. Top of the Floridan Artesian Aquifer, Florida Department of Natural Resources, Bureau of Geology Map Series 56, Tallahassee, FL, 1973.

Wood, R., and E.A. Fernald. The New Florida Atlas, Rose Printing Co., Tallahassee, FL, 1974.

SECTION III

THE USE OF FLORIDA'S WATER RESOURCES

Projected water uses and a water budget for Florida, prepared by Leach (1956), are shown in Figures III, 1 and 2. The subsections to follow are extracted from his work.

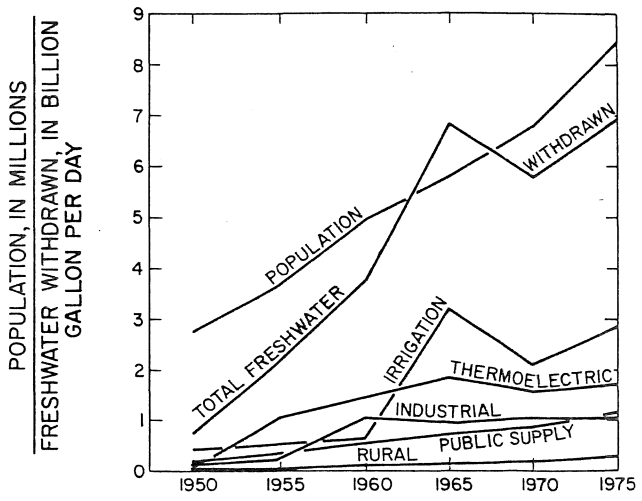


Figure III-1. Trends in Population and Fresh Water Withdrawn in Florida, 1950-75 (Leach, 1978).

The amount of freshwater in Florida remains relatively unchanged while the population growth, urban development, and agriculture continue to put increasing demands on the available supply.

Water use data for 1975 collected as part of a nationwide inventory are published in reports by Healy (1977) and Leach (1978). Data on use

of saline water for thermoelectric power generation were collected as part of the inventory but are not included because saline water is pumped from, and returned to, a saline source and is not considered part of the freshwater cycle. However, the quantity of saline water pumped for this purpose exceeds all freshwater used in the state. Nonwithdrawal use of freshwater, also not reported, includes 10,300 million gallons per day (Mgal/d) that flows through the hydroelectric power generation plant located on the Apalachicola River near Chattahoochee.

Freshwater use in 1975 was 6,917 Mgal/d compared to 5,768 Mgal/d in 1970 (Figure III-2). Public water supply demand increased from 884 to 1,146 Mgal/d, both largely reflecting the increase in population from 6.8 to 8.5 million. Water used for irrigation showed the greatest increase, from 2,099 to 2,868 Mgal/d. Water used for industrial (self-supplied) and thermoelectric power generation remained relatively stable as industrial use increased from 926 to 940 Mgal/d and thermoelectric power generation decreased slightly from 1,700 to 1,698 Mgal/d. Figure III-2 portrays the statewide freshwater use from source through use to disposition. For example, of the 1,146 Mgal/d used for public supply, 983 Mgal/d or 85.8 percent was ground water. Disposition of the public supply indicated that 48.9 percent was consumed, with the remaining 51.1 percent (586 Mgal/d) returned to the system for reuse. Figure III-2 also shows that the major freshwater source for irrigation and thermoelectric power generation is surface water whereas ground water is the major source of water for public, rural, and industrial supplies.

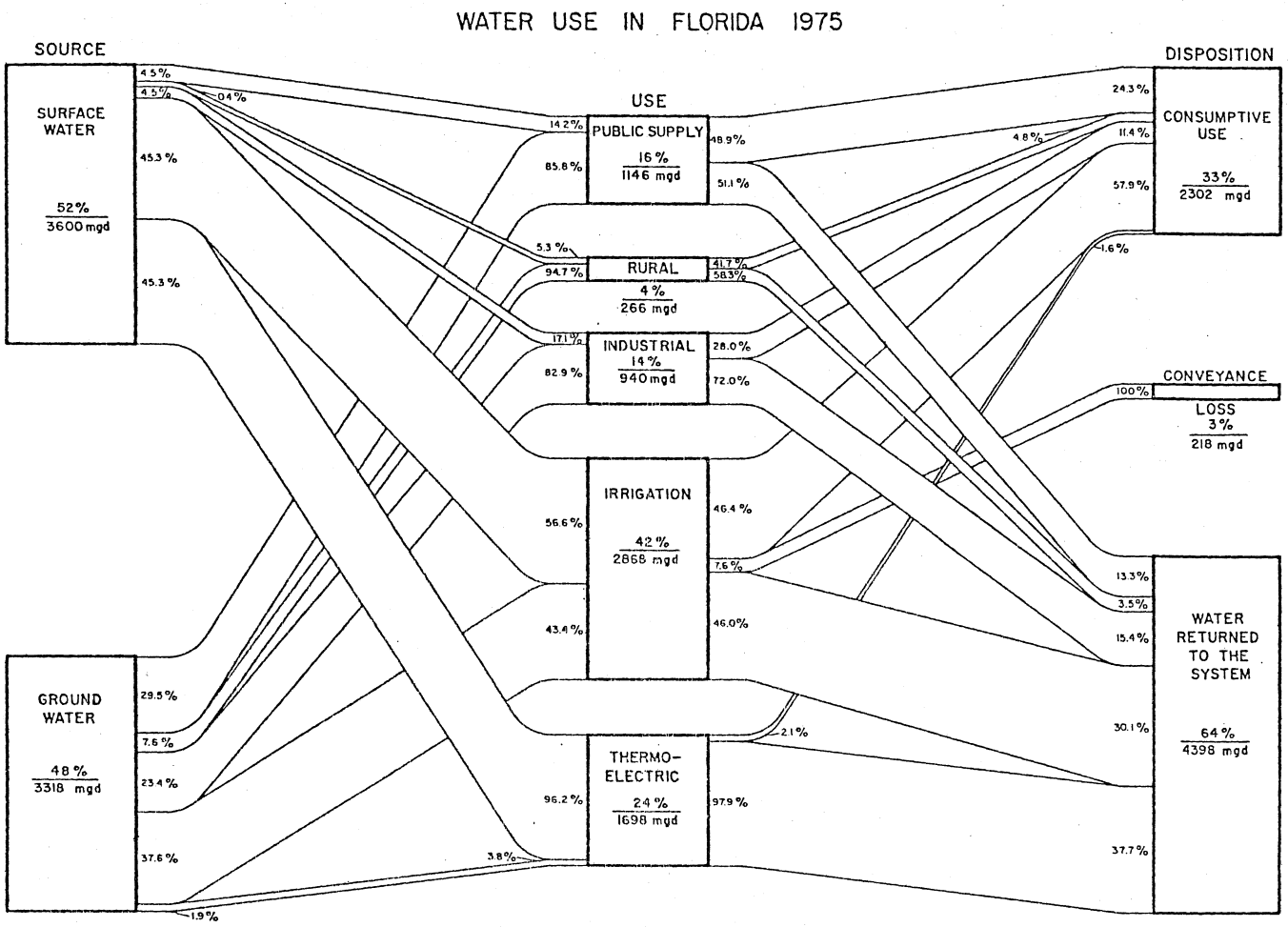


Figure III-2. Source, Use and Disposition of 6.9 Billion Gallons Per Day of Fresh Water in Florida in 1975 (Leach, 1978).

Public Supplies (Leach, 1978)

Information on total amounts of freshwater pumped for public supplies was obtained from 710 county, municipal, and private utility systems. The largest system in the state, operated by the Miami-Dade Water and Sewer Authority, serves more than 1.12 million people; the smallest, private systems, serve fewer than 100 people. The seven most populous counties: Broward, Dade, Duval, Hillsborough, Orange, Palm Beach, and Pinellas, account for almost 700 Mgal/d or 61 percent of the total 1,146 Mgal/d of freshwater withdrawn for public supply in 1975. The per capita use of water in Florida for 1975 was 168 gallons per day for the 6.8 million people served by public supply. In 1975, 1.4 million more people were served by public supplies than in 1970. If this rate of increase continues, the public water supply systems will have to withdraw about 47 Mgal/d more freshwater each year to supply the projected increase in population.

Rural Self-Supplied (Leach, 1978)

Rural (self-supplied) water use of 266 Mgal/d includes 203 Mgal/d pumped for domestic use and 63 Mgal/d pumped for livestock. Rural water use in the state is less than 4 percent of the total freshwater withdrawn for all uses. The rural self-supplied population represents 21.6 percent of Florida's population. The per capita rural water use is 142 gallons per day, as compared with 168 gallons per day for those on public water supply systems. Rural water use for Monroe County is small because the rural population in the county where adequate freshwater is available is small. The population of the county, concentrated

along the Florida Keys, is supplied by freshwater either from a pipeline from Dade County or from desalination plants. Little to no freshwater underlies the Florida Keys that can be tapped for private self-supplied systems.

Industrial (Leach, 1978)

The total quantity of self-supplied freshwater withdrawn by industries in 1975 was 940 Mgal/d, an increase of less than 2 percent since 1970. Of the 940 Mgal/d used by industry, 779 Mgal/d or almost 83 percent is withdrawn from ground water sources. Seven counties: Flagler, Glades, Lafayette, Levy, Monroe, Union, and Washington, reported no self-supplied industrial water use. In several counties large amounts of self-supplied water were used by industry: Hamilton and Polk Counties used 270 Mgal/d for phosphate mining; Duval, Escambia, Gulf, Nassau, Putnam, and Taylor Counties used 225 Mgal/d for pulp and paper processing; Lake, Pasco, and Polk Counties used 70 Mgal/d for food processing; and Escambia County used 100 Mgal/d for chemical products. The remaining 200 Mgal/d were pumped for lime rock mining, air conditioning, and many other smaller industries scattered around the state.

Irrigation (Leach, 1978)

Total freshwater pumped for irrigation in 1975 amounted to 2,868 Mgal/d. Figure III-2 shows that irrigation is the largest user of freshwater in the state and accounts for more than 41 percent of the total freshwater pumped. Irrigation also has the largest consumptive use: 1,332 Mgal/d, or about 46 percent. The smallest amounts of freshwater

for irrigation are withdrawn in 32 counties in the northern part of the state. Five counties in northern Florida -- Bay, Franklin, Liberty, Wakulla, and Washington -- reported no water used for irrigation; 16 counties used less than 1 Mgal/d; and 11 used between 1 and 10 Mgal/d. Although these counties contain about half of the land available for farming, they used only 34 Mgal/d -- slightly more than 1 percent of the total freshwater pumped for irrigation. By comparison, each of 20 other counties reported larger amounts of water used for irrigation than in the 32 northern counties combined. Most irrigation occurs in the central and southern parts of the state. In these areas more freshwater is required for irrigation because the winter and early spring growing seasons coincide with the dry season, when evapotranspiration rates are high. Further, the soils here are more porous and do not retain moisture as well as in other parts of the state.

Thermoelectric Power Generation (Leach, 1978)

Most thermoelectric power generating plants in Florida are near the coast where large quantities of saline or brackish water can be withdrawn from bays or estuaries for cooling. Power plants that are inland use freshwater from lakes or streams for cooling. During 1975, water withdrawn for thermoelectric power production totaled 13,138 Mgal/d which included 11,440 Mgal/d of saline water. This represents an 18 percent increase over the quantity of fresh and saline water withdrawn in 1970. During these same 5 years power production increased 42 percent. The disparity between increased water use and increased power production probably reflects the greater number of plants recycling water through cooling ponds or cooling towers.

Only 28 of the 67 counties used any freshwater for power generation. Of these 28 counties, 13 used less than 1 Mgal/d of freshwater, either to supplement the saline water for cooling or for other purposes. Counties where large quantities of freshwater are used for power generation include: Escambia, Polk, and Volusia, more than 200 Mgal/d; Jackson, Suwannee, and Wakulla, between 100 and 200 Mgal/d; Highlands, Orange, and Putnam, between 50 and 100 Mgal/d.

Although thermoelectric power production is the second largest user of freshwater in the state, it consumes only 36 Mgal/d, or less than 1 percent of the total freshwater withdrawn, because most of the water is recycled.

REFERENCES

Healy, H.G. Public Water Supplies of Selected Municipalities in Florida, 1975: U.S. Geological Survey Water Resources Investigations 77-53, 1977.

Leach, S.D. Freshwater Use in Florida, 1975, U.S. Geological Survey, Florida Map Series 87, Tallahassee, FL, 1978.

SECTION IV

WATER AND RELATED LAND PLANNING AND DEVELOPMENT ACTIVITIES

The material for this section is extracted from numerous reports and discussions of participants at the Annual Meeting of the Florida Water Resources Research Center A summary of the activities of the following groups is presented:

1) Water Management Districts
2) Special Studies
3) Federal Agencies
4) State Agencies
5) Industrial Research
6) University Research

Water Management Districts

Northwest Florida

The Northwest Florida Water Management District was created by the Florida Legislature as part of the Water Resources Act of 1972 (Fisher, 1980). The District is responsible for ensuring the availability of adequate water supplies, long-term water resources integrity and prevention of damages from flooding. Interstate water management is an important part of its activities since it receives water from Alabama and Georgia. The largest water users are industry and thermoelectric power generation (Northwest Florida Water Management District, 1979).

Research and development related needs of the District are as follows:

A. Scientific Research

1. Development and maintenance of computer or other models for simulation of District hydrologic systems;
2. Identification of criteria and procedures for establishing minimum levels and flows;
3. Analysis and evaluation of the sensitivity of natural systems to changes in hydrologic conditions;
4. Identification and evaluation of the effectiveness of alternative water use and reuse practices, as well as alternative water supplies or sources.

B. Data and Analysis Needs

1. Water Availability for Use
2. Saltwater Encroachment
3. Rainfall and Evapotranspiration
4. Recharge Areas
5. Water Management Needs of Estuaries
6. Public Supply Water Use
7. Agricultural Irrigation Trends
8. Land Use
9. Public Priorities

C. Methodologies and Comprehensive Water Management Capabilities

1. Comprehensive Planning and Water Management by Basin
2. Management of Interstate Waters
3. Identification of Beneficiaries and Equitable Cost Distribution for Water Resources Services and Projects

4. Water Management Issues in Coastal Areas
5. Assumption of Appropriate Management Functions by Local Government

St. Johns

The St. Johns Water Management District was created by the 1972 Florida Legislature as part of the Water Resources Act, Chapter 373 Florida Statutes (Munch, 1980). On January 1, 1977, the District assumed control of water regulation structures in the Upper St. Johns River Basin. Included in its boundaries are the entire St. Johns and Nassau River Basins, several coastal drainage basins and the Florida portion of the St. Mary's River Basin. Its 12,400 square mile service area comprises about 21 percent of the state total. Over 2,000,000 people reside in this district with Jacksonville as the major population center.

Organizationally, the District is divided into Departments of Water Resources, Resource Planning and Management, Environmental Sciences, and Administration. A list of on-going research and technical studies is shown in Table IV-1.

South Florida

The South Florida Water Management District is the oldest and largest district. Originally, the district was called the Central and Southern Florida Flood Control District. This organization has supported a wide variety of research studies over the years. They employ

TABLE IV-1: Research and Technical Studies: FY 1979-80, St. Johns Water Management District

1. Socio-Economic and Land Use Analysis

    a. Overlay Mapping
    b. Data Management System
    c. Land Use Mapping Report
    d. Compilation of Local Government Comprehensive Plan Information

2. Agricultural Water Use Research

    a. Crown Flood Irrigation Study
    b. Irrigation Pumping Efficiencies Study
    c. Fern Water Use Study
    d. Agricultural Lands Inventory

3. Annual Water Use Research

4. Urban Water Use Research

    a. Water Use Demand Elasticity Model
    b. Categorical Use of Public Water Supplies
    c. Residential Water Use Study

5. Jane Green Study

6. Investigation of Ground Water and Surface Water Availability

7. Salt Water Intrusion Study

8. Southwest Volusia County-Osteen Study

9. Effects of Frost and Freeze Irrigation on Floridan Aquifer

10. District-Wide Determination of Flood and Low Flows

11. Flood Irrigation and Water Use Investigations

12. Water Quality Monitoring

13. Water Conservation Program

14. Data Evaluation of Annual Report

15. Roughness Coefficient Study for Marsh Area

16. Analysis and Update of Tri-County Area Well Data

17. Effects of Sand Mining Operations in Johns Lake

18. Geology of the Ocala National Forest

19. Materials Investigation-Borrow Areas

20. Interbasin Diversion Investigation in the Upper St. Johns River Basin

21. Evaluation of Applicability of Various Ground Water Models to District Hydrologic Regime

Cooperative Agreements with USGS

22. Administration and Program Planning

23. Northwest Volusia County Hydrologic Investigation

24. Flagler County Hydrologic Investigation

25. Potentiometric Mapping

26. Monitoring Program

27. Hydrologic Atlas Series

28. Southeast Limestone Aquifer Study

numerous nationally recognized technical experts in various areas of water resources.

The proposed FY 1980/81 program lists 75 separate studies which are summarized in Table IV-2. New areas of interest for South Florida include: (Rhoads, 1980)

1) studies of the quantity and quality aspects of changing freshwater discharge patterns on estuaries. This effort would include studies of the impacts of dredge and fill operations;
2) intensified efforts in aquatic weed control;
3) studies of alternative energy sources to reduce costs;
4) studies of water conservation; and
5) studies of improved methods of drainage design.

Southwest Florida

The Southwest Florida Water Management District is the second largest district in the state (Southwest Florida Water Management District, 1979). It was created by the Florida Legislature in 1961 following widespread flooding in 1960 that caused a number of deaths, injury to hundreds of people and damages totalling nearly $200 million. The District covers more than 10,200 square miles. The District is managed not only by a General Board but also by ten watershed basin boards.

Major areas of activity include solving urban problems in the

Table IV-2. Proposed Program Activities: South Florida Water Management District (Rhoads, 1980).

RESOURCE PLANNING DEPARTMENT PROGRAMS - PROPOSED FY 1980/81

PROGRAM NUMBER AND TITLE	DESCRIPTION OF PROGRAM	PROGRAM DURATION
0076 Laboratory -Charges-WPB	To provide for the chemical analysis of plant, water and soil samples, and conduct physical & nutrient analyses supporting internal/ext. prog.	Continuing (As long as water analysis required)
0082 Laboratory Charges-Okeech.	Same as above, in support of KRCC programs.	Same as above
8004 Non-Ag Water Demand Studies	Measure costs, benefits and economic impacts of alternate water management policies in urban areas (incl. flood/drought damage assessment)	Continuing, each planning area must be updated periodically
8007 Ag. Water Demand & Cost Studies	Same as above for Agricultural areas.	Same as above.
8008 Water Use Plan Demand Studies	Analyzes water demand relationships, utility costs and pricing in support of water use and drought management planning.	Continues through completion of WUP, then needs updating.
8010 Geographic Info System	Develops land use data, land use acreages and projections of future land use changes. Support for numerous District and local Govt. programs.	Continuing, updates needed to track land use changes/trends.
8012 Application of System Studies	Develops and refines computer models for assessment of current and future water management systems and techniques.	After refinement is completed (3 years), reduction of effort.
8013 Syatem Optimization Studies	Evaluates alternatives for increasing water supplies in specific basins (through improved operational/structural methods).	Initial evaluations completed in 2 years
8014 Resource Control Support	Supports the regulatory function with modeling and analysis for water use and other permits.	Continuing, as a function of new permit applications.
8016 Ag. Irrigation Water Use/Pract.	Assists in the projection and analysis of water demands using best ag management practices. Studies irrigation and drainage methods.	First year of a new program. Projected for completion-3 yrs
8022 Drought Analysis	Provides guidance for types of operational water supplies that should be planned based on probable occurrence of normal and dry periods.	Two yrs completed, two yrs remain to cover other areas.
8026 Surface Water Model Develop.	Develop a model for simulating land use change and effects on surface and ground waters, and to serve as a transport mechanism for qual. studies.	Two years completed. Two years remain for validated model.
8030 Water Use Data Acquisition	To acquire water use data,primarily urban,rates of consumption & utility costs in support of current & future management decisions & alternatives.	Continuing, updates needed to establish trends.
8032 Water Chemistry General Eval.	To respond to internal/external requests for water quality data transfers, reviews/analyses. Documents data sets on rainwater quality etc.	Continuing, has been conductec for past two yrs.
8034 Agricultural Water Use DataColl	Develops water use data collection methods with emphasis on ag production. This is currently an area where there is great uncertainty.	Conducted for the past two yrs, with three yrs remaining.
8036 Application of Supply Altern.	Reviews, evaluates and recommends state-of-art systems for planning areas in WUP. Includes deep aquifer storage, desal and water reuse.	This has been eval. for past five yrs. Continuing.
8038 Water Budget Analysis	To develop a capability of computing more reliable water budgets for surface water storage areas (using ET, seepage and runoff).	This is a new prog. Will require three yrs to complete.
8040 Alternate Energy Studies	Assess availability, reliability and cost of alternate energy sources, with emphasis on pump stations.	This is a new prog. Should be continuing to update technology

Table IV-2. Proposed Program Activities: South Florida Water Management District (Rhoads, 1980).

RESOURCE PLANNING DEPARTMENT PROGRAMS - PROPOSED FY 1980/81 2

PROGRAM NUMBER AND TITLE	DESCRIPTION OF PROGRAM	PROGRAM DURATION
8044 Objective Design Infc Flow System	Develop better methods of info flow and improve efficiency of data collection, processing and applications (Optimize water resource operation	This is a new prog. Completion will require 2 to 3 yrs.
8046 Special Ground-Water Projects	Covers projects that evolve within the current fiscal year and include well drilling, logging and analyses within all planning areas.	This is a new prog. Should be of a continuing basis.
8048 USGS Groundwater Study Coord.	Provides for the monitoring of USGS studies being made for District, where early data availability is needed for WUP/other uses.	This is a new prog. Continuing.
8104 Environ. Science Statistical Sys.	Develop computer based statistical system to improve effectiveness of environmental projects. (Incl. species presence, relative abundance etc	This is a new prog. Continuing.
8106 General Environ. Evaluations	To provide for evaluations of that evolve within current fiscal year, such as fish kills, outside agency reviews etc.	This is a new prog. Continuing.
8108 Restoration Reconnaissance	To study the feasibility of restoring natural hydroperiods etc. to certain areas in District.	This is a new prog. Continuing.
8216 Borehole Geo-Physics/Logging	Provides logging services for info gathering on aquifer stratigarphy, water quality etc. Incl. logging wells, assistance in data interpretation	Conducted for one yr Continuing.
8402 Structure Ratings	To provide the ability to compute flows through control structures with minimum flow measurements needed for validation of actual flows.	Conducted for three yrs. Requires two more years to compl.
8304 Special Projects Land Resources	Provides for supporting internal/external requests for land use mapping and data on specific projects and areas within District.	This is a new prog. Continuing.
8426 Well Abandonment	An operational program which plugs abandoned wells in Lee County, which degrade quality of fresh surface water supplies.	This is the second year of a continuing program.
8428 Well Construction/Inspection	Provides for inspection of all new public water supply wells permitted by DER for proper construction and permit compliance.	This is the first year of a continuing program.
8502 Special Hydrologic Reports	Analyzes issues of current interest, including dry season operations, flood control studies, drainage boundary updating etc.	This is a continuing program.
8503 Hydrologic Data Collection	Provides for the collection of data from an extensive network throughout the District. Includes development of new methods/equipment.	This is a continuing program.
8504 Data Management	Provides for the management of hydrologic data through a data base (computerized). Furnishes data to support surface water, water quality etc	This is a continuing program.
8506 Water Quality Monitoring	Documents the quality of water at major control points and supports the WUP. Analysis of data and provision of inputs to LOK TOP programs.	This is a continuing program.
8508 Dissolved Oxygen Study	Documents the seasonal DO present in various S. Florida ecosystems. Used to support District aquatic weed program.	This is a new prog. It will continue throughout District.
8509 Instrumentation Eval./Develop.	Operates in coordination with Program 8503 by development of new instrumentation and processing techniques.	This is the fifth yr of a continuing prog.
8510 Electronic Support/Maint.	Provides for technical support of District electronic equipment such as loggers, modeling computers etc.	This is a continuing program.

2

Table IV-2. Proposed Program Activities: South Florida Water Management District (Rhoads, 1980).

RESOURCE PLANNING DEPARTMENT PROGRAMS - PROPOSED FY 1980/81

PROGRAM NUMBER AND TITLE	DESCRIPTION OF PROGRAM	PROGRAM DURATION
8511 Remote Sensing Evaluation	To improve the effectiveness of various topographic data gathering activities through the use of remote sensing techniques/equipment.	This is the second year of a continuing program.
8512 Remote Sensing-Flowing Wells	To determine the feasibility of locating flowing wells with available remotely sensed data to reduce time and cost of this process.	This program will continue for two yrs.
8620 Water Use Plan-LEC/LOK	To coordinate and document the analyses on the LEC and LOK for the WUP. Includes development of an updated Executive Summary for area.	This is the fifth yr of a program that is updated biennially.
8626 Geographic Info System-LEC/LOK	Develops the land use data for this planning area. Updates land use acreage and future projections based on latest aerials.	This is the fifth yr of a program, updated as above.
8630 Periphyton/Water Quality of WCA's	Provide an ecological baseline of species composition and distribution of algae in support of various water level studies in the WCAs.	This is the fourth yr of a program, with three yrs to complete
8631 Aquatic Macro-invertebrates	Same as above for study of macroinvertibrates in WCAs.	This is the third yr with two yrs to complete program.
8632 Impact of S-339 and S-340 on WCA	Determine how natural communities respond to changes in water level in support of decision-making on management of WCA's.	This is the third yr with three yrs to complete.
8634 Regional SE Fla. Aquifer Study	This program provides for the close coordination with the USGS in a study of the Biscayne aquifer.	This is a new prog. It will take about five years to compl.
8640 Nutrient Cycling in WCA2	To determine the ability of WCA vegetation to assimilate nutrients such as phosphorus and overall effects on water quality.	This is the sixth yr of prog., which will require two yrs more.
8641 Environ.Resp to Alter.in Reg.Sch.	This program will document the effects of the drawdown scheduled for WCA2 on the ability to restore Everglade plant communities.	This is a new prog. It should continue for at least five yrs
8644 WCA Material Budget Study	To provide data for assessing the impact of possible additional inflows to WCA's and the effect of drawdown, develop basic budget.	Two yrs completed. Two years remain after drawdown.
8646 Water Qual. and Sediment Eval.	Same as above for inflow/outflow stations such as S5A, S6, S7 and S8, with respect to quality parameters and sediments.	Two yrs completed. Two years remain after drawdown.
8652 East Everglades RP Project	Provides support for Dade County Planning Dept. with variety of inputs ranging from hydrological analyses to cross-reviews of project outputs.	Two yrs complete. Two years remain at low level of effort.
8656 Hydrologic Study C-103 Basin	To determine the existing groundwater and geochemical regime around the C-103 near Homestead.	Three yrs complete. One yr remains.
8668 Bird Survey-LOK	Update data and results of previous surveys to determine the impact of raised lake levels on bird populations.	Conducted periodically for past five years. Continuing.
8670 Submergent Vegetation-LOK	To expand the knowledge of submerged vegetation in LOK and any impact of raised lake levels or other management actions.	This is a new prog. Two more yrs to complete.
8671 Littoral Zone Vegetation-LOK	To update already documented vegetation profiles and determine effects of raised lake levels.	This is a continuing program.
8672 Water Qual.Monitor-Limnetic Zone	To update data base for limnetic zone to aid in evaluation of management alternatives for LOK.	This is a continuing program.

Table IV-2. Proposed Program Activities: South Florida Water Management District (Rhoads, 1980).

RESOURCE PLANNING DEPARTMENT PROGRAMS - PROPOSED FY 1980/81 4

PROGRAM NUMBER AND TITLE	DESCRIPTION OF PROGRAM	PROGRAM DURATION
8670 Ana. Limnetic Wat.r Chem.Data	Same as for 8672, with respect to analysis of data collected.	Two yrs complete. One yr remains.
8678 Special Water Qua.ity Studies	To assess long term trends and water quality impacts on northern Lake Okeechobee, particularly discharges from Nubbin Slough (S-191).	This is a new prog. It will be continuing.
8700 Water Use Plan-UEC	To evaluate water supply alternatives for UEC and provide an Executive Summary document on area for Water Use Plan.	This is the first yr of a program to be updated biennially
8706 Floridan Aquifer Monitoring-UEC	To maintain the existing data collection net, and provide additional data as required for long term trend analysis, of water levels.	This is the fourth yr of a continuing maintenance prog.
8711 Estuarine Studies-UEC	To determine the impact of upstream flows in the St. Lucie estuarine areas in support of WUP.	This is the third yr. Two years remain to be completed.
8714 Water Chem. Eval UEC	Support for WUP for understanding of proposed impacts of water management alternatives in this planning area.	This is the second yr of program. One year remains.
8716 Geographic Info System-UEC	Develops land use data, acreages and projection for future land use changes. Supports WUP and local requests.	This is the second yr of a program to be updated biennially
8740 Water Use Plan LWC	To evaluate water supply alternatives for LWC and update existing Eexcitive Summary document for WUP.	This is the third yr of a program to be updated biennially
8746 Water Resources Inventory-LWC	To inventory and analyze water resource capabilities of surface supplies in LWC in support of WUP.	This is the second yr of program. Two yrs to complete.
8754 Geographic Info System-LWC	Updates land use acreage and future projections for this planning area. Provides for analysis of trends.	This is the third yr of program. Low level for periodic updates.
8758 Biological Investigations-LWC	To support WUP in the recommendation of future water management alternatives for Caloosahatchee River and analyze such events as algae blooms.	This is the third yr of program. Two yrs remain to complete.
8759 Caloosahatchee River Estuary	To determine the impact of upstream flows in estuarine areas, in support of WUP.	This is the second yr of program. Two yrs to complete.
8760 Groundwater Recon.-LWC.	To determine the availability of groundwater resources in multi-layered aquifer system of LWC in suppprt of WUP.	This is third yr of program, with three yrs to complete.
8762 Caloosahatchee River Study-WQ	To provide water quality analyses of proposed alternatives in support of WUP.	This is the third yr of program. One yr to complete.
8780 Water Use Plan Kissimmee Area	Not worked this fiscal year.	
8786 Floridan Aquifer Recon.-Kissimmee	To obtain additional information on water levels in this aquifer system in support of WUP and future use decisions.	This is new prog. Three yrs to comp.
8792 Nutrient Cycling Boney Marsh	To determine ability of Kissimmee marshes to remove nutrients, an important consideration in evaluating proposed TOP and other actions.	This is the fifth yr of program. One yr to complete.
8796 Water Qual.Monitor-Kiss.Lakes	To estimate the major loads for each of the tributaries flowing into system and to examine lateral water transfer from lake to lake.	This is a new prog. Three yrs to complete

4

Table IV-2. Proposed Program Activities: South Florida Water Management District (Rhoads, 1980).

RESOURCE PLANNING DEPARTMENT PROGRAMS - PROPOSED FY 1980/81

PROGRAM NUMBER AND TITLE	DESCRIPTION OF PROGRAM	PROGRAM DURATION
9901 Uplands Demonstation Project	Acquire and analyze water quality data on nutrient loading into Kissimmee River and other basins in area. Supports KRCC.	This is the third yr of program. One yr to complete.
9902 Taylor Creek Headwater Monit.	Same as above for this basin. Supports KRCC	Same as above.
8798 Taylor Creek Nubbins Slough	Monitoring and analytical support program for the USDA research in this basin.	This is third yr. of program. Continuing.

rapidly growing cities of the Tampa Bay area, Sarasota-Bradenton, and Port Charlotte (Allee, 1980). Also, the phosphate industry in central Florida is a major concern from a quantity and quality point of view.

The Four River Basins Project covering 60 percent of the District is a major joint effort with the U.S. Army Corps of Engineers. The four rivers are the Oklawaha, the Withlacoochee, the Peace, and the Hillsborough. The District is also involved in a wide variety of other water management activities.

Suwannee River

The Suwannee River Water Management District was created by the 1972 Florida Legislature as part of the Water Resources Act, Chapter 373 Florida Statutes (Morgan, 1980). This district comprises 6900 square miles of North Florida. Approximately 146,000 people reside in the District. Lake City (pop. = 11,000), Perry (pop. = 7900), and Live Oak (pop. = 7100) comprise the urban centers. Over 75 percent of the land is in agriculture and timber production. Phosphate mining is a major industry.

Special Studies

South Florida Research Center (Rosendahl, 1980)

The National Park Service Research Center is located at the Everglades National Park. The Everglades National Park and Big Cypress National Preserve are located at the southern terminus of the larger Everglades/Lake Okeechobee/Kissimmee Valley drainageway extending

halfway up the Florida peninsula. Current management problems being addressed are:

1) provide recommendations for protection and restoration of the ecosystem of Shark Slough and its estuary;
2) provide recommendations for protection and restoration of the ecosystem of Taylor Slough and its estuary;
3) provide recommendations to meet short-term resource management needs of the Big Cypress and its estuary and establish a base of natural resources data;
4) maintain the long-term natural resources records necessary for managing south Florida parks; and
5) provide management recommendations for assuring ample fresh water quality and quantity within Everglades National Park and Big Cypress National Preserve to meet wildlife and vegetation needs.

Kissimmee Coordinating Council

The 1976 Florida Legislature created the Coordinating Council as part of the Kissimmee River Restoration Act (McCaffrey et al., 1980). The Coordinating Council was directed to develop measures to restore water quality in the Kissimmee River Valley and Taylor Creek-Nubbin Slough Basin. Restoration of natural changes in water levels, recreation of conditions favorable to wetlands and wildlife, removal of threats to agriculture, and protection of presently developed areas from floods were all addressed in the Act.

In April 1978, the U.S. Congress authorized the U.S. Army Corps of Engineers to undertake a restudy of the Kissimmee River Valley and the Taylor Creek-Nubbin Slough Basin. This effort is under way.

National Audubon Society

The National Audubon Society operates an Ecosystem Research Unit at the Corkscrew Swamp sanctuary in southwest Florida (National Audubon Society, 1979). This Ecosystem Research Unit (NAS/ERU) is a branch of the society's Research Department devoted to research relevant to natural area management. ERU's work is intended to bridge the gap between applied research programs directed towards human use of resources and basic research aimed solely at understanding nature.

ERU evolved out of a need that became apparent during an ecosystem study at National Audubon's Corkscrew Swamp Sanctuary in southwest Florida. The University of Florida Center for Wetlands was studying the sewage treatment potential of cypress swamps and needed data from a cypress strand to compare with that from their cypress dome sites. The virgin cypress at Corkscrew seemed ideal, so in 1973 NAS was given a Rockefeller Foundation grant subcontract to do an ecosystem analysis of the sanctuary. The Corkscrew project was a comprehensive analysis of the swamp ecosystem. As data came in, it became obvious how important such research was to proper management of the sanctuary. Corkscrew's problems had seemed fairly clear: everyone thought that drainage from nearby development canals had lowered the sanctuary's water levels and led to shrub invasion in the marshes and pinelands. But, in-depth study

revealed that Corkscrew was experiencing normal water fluctuations except where extensive dikes and pumps installed to correct the perceived water problems had extended hydroperiods abnormally. At the conclusion of the Corkscrew project, the Ecosystem Research Unit was made a permanent part of the NAS Research Department. Long-term monitoring of tree growth, litterfall, cypress regeneration, and water levels continues at Corkscrew.

The Corkscrew project gave ERU such a good background in Florida ecology that the group has been asked to do several other Florida studies. In cooperation with the University of Florida Center for Wetlands, ERU prepared the Resource Inventory and Analysis for the Big Cypress National Preserve. ERU is currently conducting an experimental study of off-road vehicle impacts on the preserve. The U.S. Heritage Recreation and Conservation Service, through Florida State University, has contracted ERU to classify peninsular Florida habitats and identify the best remaining examples for the Natural Landmarks Program.

Federal

Army Corps of Engineers

The Jacksonville District of the Corps of Engineers is responsible for the state of Florida. A summary of their present activities is presented in a recent annual report (U.S. Army Corps of Engineers, 1979). The information to follow is extracted from this report.

Nearly one billion dollars have been spent by the Corps of Engineers in Florida. The distribution of these expenditures is shown in Table IV-3. In addition to these activities, the Corps of Engineers has

TABLE IV-3: Expenditures by the Corps of Engineers in Florida

Activity	Amount Spent million dollars	Percent of Total
Navigation	470	51.3
Flood Control	327.3	35.7
Multiple-Purpose Lakes	66.3	7.3
Shore Protection	29.8	3.3
Aquatic Plant Control	16.8	1.8
Recreation	2.6	0.3
Urban Studies	2.8	0.3
Totals	915.6	100.0

studies under way for various aspects of flood plain management, e.g., flood hazard information, flood insurance (Salem, 1980).

Several major navigation projects have been completed or are under way in Florida, e.g., the Intracoastal Waterway, a cross Florida navigation system via Lake Okeechobee. A summary of these projects is shown in Figure IV-1.

The largest flood control project is the Central and Southern Florida Flood Control Project authorized June 30, 1948. This project involves an area of about 16,000 square miles in southeastern Florida. This project was designed to provide an overall water control plan to replace the piecemeal drainage activities which took place in southeastern Florida during its early development. The South Florida Water Management District operates this project. A summary of flood control projects is shown in Figure IV-2.

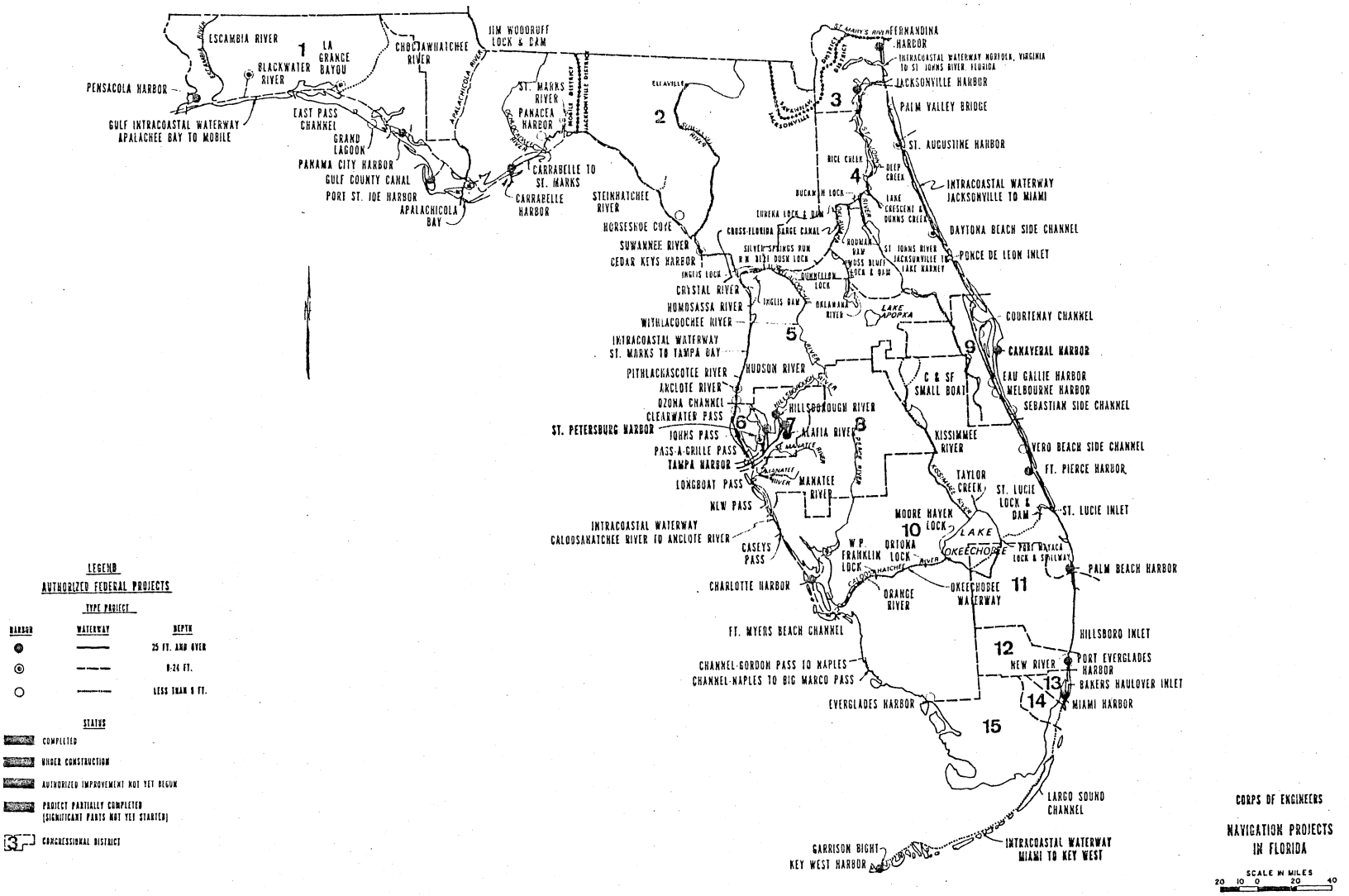


Figure IV-1. Corps of Engineers Navigation Projects in Florida (U.S. Army Corps of Engineers, 1979).

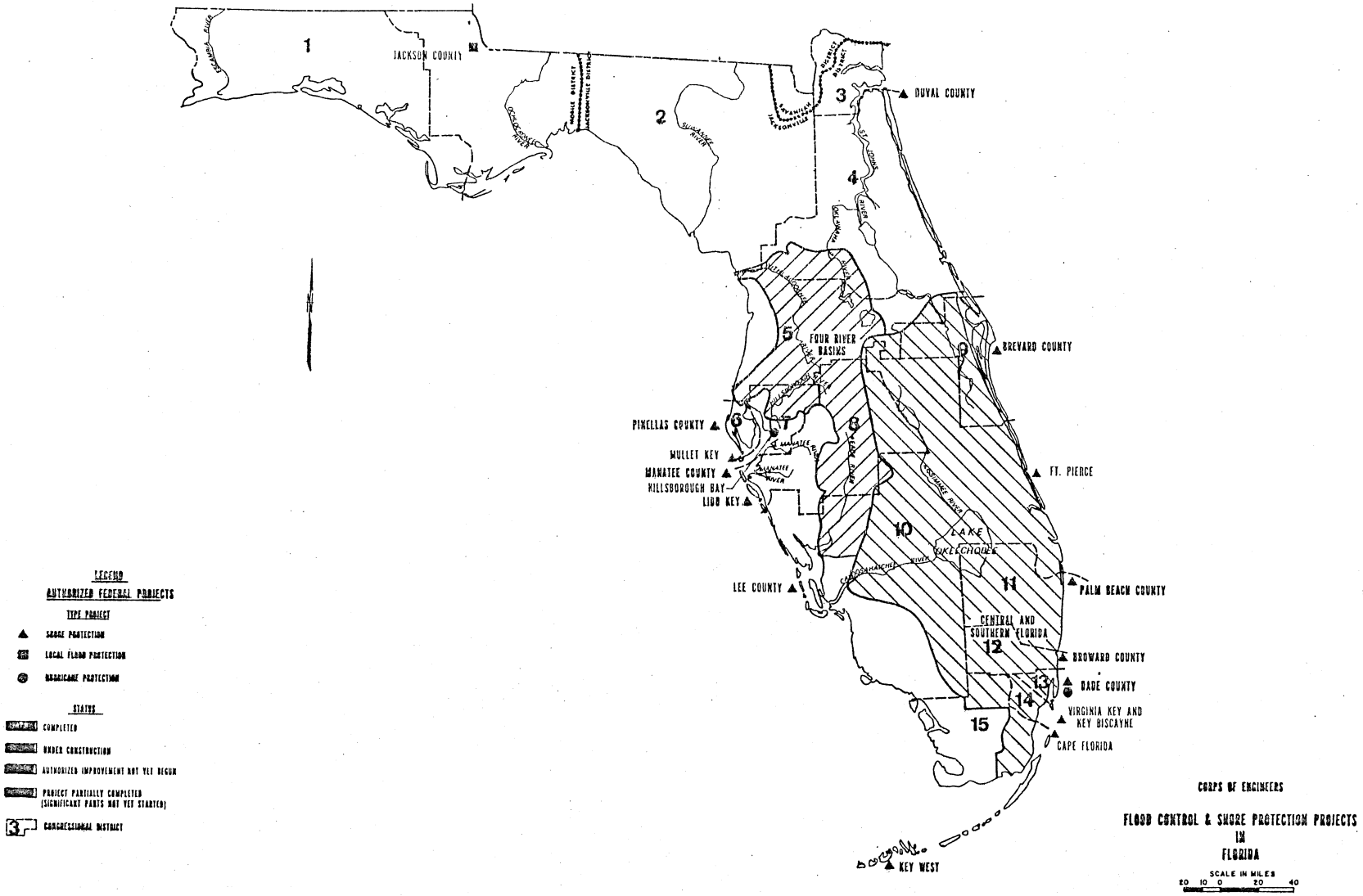


Figure IV-2. Corps of Engineers Flood Control and Shore Protection Projects in Florida (U.S. Army Corps of Engineers, 1979).

Geological Survey

The Florida District of the Water Resources Division, U.S. Geological Survey, has the principal responsibility at the Federal level for appraising water resources and providing basic hydrologic data (Kantrowitz, 1980). A summary of current activities is contained in an annual report (U.S. Geological Survey, 1979). Table IV-4 shows a topical classification of current U.S.G.S. studies in Florida. The location of these studies is shown in Figure IV-3. The Florida District has the largest cooperative program of any state in the United States. In fiscal year 1979, over $11 million of Federal, state, and local money was spent on this program in Florida.

The Apalachicola River is being studied as part of the U.S.G.S. national program. The primary purpose of this study is to test a variety of general wetland assessment procedures (U.S. Geological Survey, 1979).

U.S. Department of Agriculture

Soil Conservation Service (Livingston, 1980)

The Soil Conservation Service (SCS) gives technical assistance to individuals, groups, organizations, cities and towns, county and state governments in conservation, protection, development, and utilization of land and water resources. The authorities for participating in planning and implementing water resource developments are contained in the following laws:

Table IV-4. Topical Classification of USGS Investigations (USGS, 1979)

Aquifer Studies. FL-210, FL-230, FL-257, FL-258, FL-284, FL-286, FL-294, FL-297, FL-299, FL-301, FL-302, FL-303, FL-310, FL-311, FL-312, FL-317

Areal Water Resources. FL-048, FL-057, FL-090, FL-106, FL-109, FL-126, FL-150, FL-268, FL-270

Bridge Site Studies. FL-012

Environmental Impact. FL-264, FL-271, FL-286, FL-288, FL-292, FL-308

Estuarine Hydrology. FL-159, FL-314

Flood Control. FL-105

Flood Mapping. FL-006

Hydrologic Monitoring. FL-001, FL-002, FL-003, FL-041, FL-043, FL-044, FL-072, FL-179, FL-191, FL-280

Lake Hydrology. FL-091, FL-143, FL-233, FL-296

Modelling. FL-267, FL-282, FL-294

Remote Sensing. FL-263

Rivers (Canals), Water Quality. FL-099, FL-124, FL-290, FL-314

River, Water Supply. FL-265, FL-276

Saltwater Encroachment. FL-041, FL-043, FL-044, FL-285, FL-295, FL-298, FL-306

Sanitary Landfill. FL-106, FL-107, FL-316

Spray Irrigation, Waste Effluent. FL-195, FL-316

Subsurface Storage of Freshwater. FL-289, FL-291, FL-293

Subsurface Water Disposal. FL-113, FL-152, FL-154, FL-198, FL-245

Surface and Ground Water Relationship.

Technical Support. FL-208, FL-231, FL-232, FL-281

Urban Hydrology. FL-119, FL-136, FL-139, FL-158, FL-219, FL-309, FL-318

Water Management. FL-272

Water Use. FL-007

Water Resource Mapping. FL-256

Wetlands. FL-307

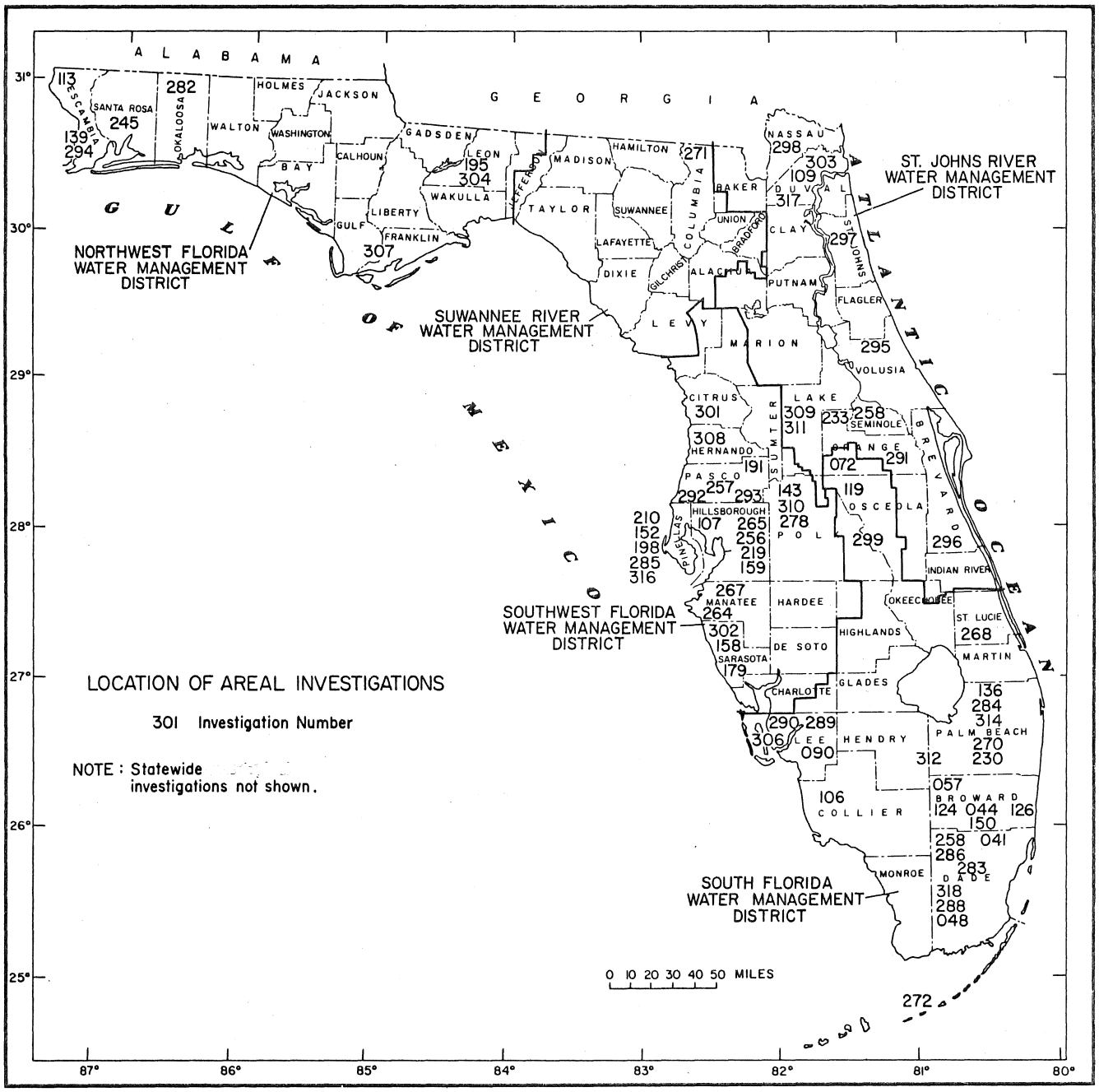


Figure IV-3. Location of Ongoing USGS Investigations (USGS, 1979).

1. Public Law 46 -- The Soil Conservation Act of 1935 authorizes the SCS to provide technical assistance in development and protection of natural resources to individuals, groups, and units of government through soil and water conservation districts.
2. Public Law 566 -- The Small Watershed Act authorizes providing financial and technical assistance in carrying out watershed protection and flood prevention projects in cooperation with local governmental units or state agencies.
3. Public Law 566 -- Section 6 authorizes SCS to carry out river basin investigations and flood hazard studies in cooperation with state and local agencies.
4. Public Law 81-516, The Emergency Flood Control Act -- Section 216 authorizes installation of emergency measures to safeguard lives and property whenever a natural element or force has caused a sudden impairment of that watershed.
5. Public Law 703 -- The Food and Agriculture Act of 1962 authorizes resource and development projects which cover multi-county areas. Projects for development, protection, or utilization of an area's natural resources may be eligible for financial and technical assistance.

The purposes for which financial and/or technical assistance may be made available and are basically common to all authorities are flood

prevention, agricultural water management (drainage and irrigation), agricultural pollution abatement, land stabilization, land treatment, public fish and wildlife development, and public recreation developments.

The Soil Conservation Service has local offices in most of the counties in Florida, staffed with a district conservationist. Questions concerning any of the programs may be directed either to the local district conservationist or to Mr. William E. Austin, State Conservationist, Soil Conservation Service, P.O. Box 1208, Gainesville, Florida 32602.

Agricultural Research

Research stations are located in Gainesville and Fort Pierce, Florida (U.S.D.A., 1979). On-going studies include the following topics:

1. The frequency and duration of periods between rains are more important than the amounts of rain in determining irrigation water requirements for shallow-rooted turf.
2. Blight and healthy citrus tree leaves have similar photosynthesis and transpiration rates.
3. High lime rates may compensate for lower water table control on potatoes.
4. High density cattle raises ammonia concentration of streamflow.

U.S. Fish and Wildlife Service

A new National Fisheries Research Laboratory has been opened

in Gainesville, Florida. This lab will develop a national research program associated with investigations of exotic and non-native fish species which have been or are likely to be introduced and become established in the nation's waters. This unit is a cooperative venture between the U.S. Fish and Wildlife Service, the Florida Game and Fresh Water Fish Commission, and the University of Florida.

Current research includes a study of the chemical and tropical characteristics of Florida lakes and a study of the growing bobcat population in eastern Florida (Shockley, 1980). The unit is currently operating on a $150,000 per year budget.

State

Department of Environmental Regulation

Bureau of Water Management (Bishop, 1980)

During the 1976 Florida Legislative Session, the Department of Environmental Regulation was designated to restore specific degraded water bodies within the state. A general revenue appropriation of $1.5 million and a total of $276,000 from pollution violations in the state were provided to the Department to effect this action. In July 1977, the Governor signed into law the Water Resource Restoration and Preservation (WRR&P) Program. This legislation officially authorized and required the Department to undertake both freshwater and marine water resource restoration projects throughout Florida.

Projects administered by the Water resources Restoration and Preservation Program have been located throughout the state and have

been diverse in their aims and approaches. A brief summary of WRR&P projects illustrating typical university involvement follows:

Lake Apopka - Since 1976, the Department of Environmental Engineering Sciences of the University of Florida has been conducting studies on Lake Apopka. These studies involved basic water quality monitoring for physical, chemical, and biological factors as well as basic research on sediment chemistry and sediment water nutrient exchange. Additional studies determine the nutrient sources and loading rates for Lake Apopka and other downstream lakes in the Oklawaha Chain. Non-point sources like rainfall, citrus grove runoff and seepage, and muck farm irrigation were evaluated.

The Institute of Food and Agricultural Sciences (IFAS) of the University of Florida also performed a frost/freeze study of the lake vicinity. This basic research effort was directed at determining the effect of lowered water level on the lake's ability to provide freeze protection for surrounding citrus crops.

Lake Eola - This research and demonstration project will develop cost effective methods to restore lake water quality by management of stormwater runoff. The Department of Civil Engineering and Environmental Science of the University of Central Florida is conducting this three-phase project in cooperation with the City of Orlando.

Phase I is now complete. This phase involved lake and stormwater monitoring for nutrients, organics, solids, metals, and pathogens. Algae bioassays, trophic state analyses, and sediment studies were also performed. Data from these studies were used by the University to

evaluate the cost and effectiveness of an array of management alternatives including watershed best land management practices, settling, filtration, and diversion.

During Phase II, now in progress, the university will provide a detailed engineering design of the selected alternatives as well as a critical evaluation of two experimental pilot systems being constructed. University responsibilities will include bid specifications, construction supervision and inspection, and systems evaluation of the completed project.

Lake Jackson - Florida State University is conducting lake and stormwater monitoring for this multi-phase research and demonstration project. The project will evaluate the effectiveness of several techniques (including marsh filtration) in nutrient and sediment removal from stormwater runoff.

The university is also investigating hydrocarbon transport through the watershed during storm and baseflow conditions.

Lake Washington - A comprehensive water quality and quantity study of Lake Washington, the drinking water supply for south Brevard County, was undertaken by the Florida Institute of Technology. The study focused on: (1) the existing water quality and trophic state of the lake, (2) historical water quality, trends, and comparisons with present water quality, (3) water quantity (hydrologic budgets were developed in which source and sinks of water to the lake were quantified), (4) the effect of drainage canals on water quantity and quality, and (5) recommendations to improve lake conditions.

Bayou Texar - The University of West Florida conducted a diagnostic study of Bayou Texar. This assessment included an analysis of sediment samples for salt content and heavy metals and a determination of bacterial levels in the water column and sediment.

Bayou Chico - Florida State University conducted an assessment of bottom sediments in Bayou Chico. The assessment involved analysis of sediments for toxic organics, heavy metals, oils, and greases.

"208" Program

This is the area in which the university system can best contribute to the needs of the Department. It is through basic research into environmental problems, and testing of BMP's, that we determine a reasonable approach to take in seeking to control pollutant sources. In the past, we have worked closely with several departments in the University of Florida, among them Agricultural Engineering, Environmental Engineering, Forest Resources and Conservation, the Institute of Food and Agricultural Sciences, and the Cooperative Extension Service. Depending upon the area under investigation, separate contracts have been let to individuals in these sections of the university, and the results have been mutually beneficial.

As far as the teaching functions of the university system, we are presently moving into the phase of implementation of the state water quality management plan which will require extensive training and education of the public in the ways of proper water and resource management. Of particular interest to us is the broad reaching Cooperative Extension System, which is a respected institution in most

communities. Techniques developed at the university research level can best reach the public through a system like Extension.

Another vital role of the university educational branch is that of teaching and training students in technical fields as well as general resource conservation and management. It is only through the process of education at all levels that a greater environmental awareness will be developed.

State Energy Office

The State Energy Office was assigned to the Governor's office by the 1979 Florida Legislature. It can support water resources studies as they relate to energy programs. The State's STAR program is used as the funding mechanism. This group is interested in talking to faculty interested in water/energy reserach.

Industry

National Council for Air and Stream Improvement (Berger, 1980)

Since 1943, the National Council for Air and Stream Improvement (NCASI) has supported research to solve environmental problems associated with the forest products industry. One of their four regional centers is located in Gainesville, Florida. Their regional centers interact with university professors and students through jointly sponsored research projects, and/or support of graduate students.

In the southeastern United States, the NCASI feels that additional research should include studies of:

1. development of conjunctive surface-groundwater quality models;

2. impact of pollutants on fish; and
3. additional ways in which the paper and pulp industry can reduce water use.

Florida Institute of Phosphate Research (Borris, 1980)

The Florida Institute of Phosphate Research was created by the State of Florida recently to support applied research. Support is drawn from a Phosphate Research Trust Fund. Problems can be addressed related to mining and processing of phosphate rock and reclamation of mined and disturbed lands. Approximately 1.5 million dollars is available during the 1980-81 fiscal year. Topics to be funded include:

1. Environmental studies related to radiation and water consumption and other environmental effects of phosphate mining and reclamation.
2. Wetlands reclamation.
3. Reclamation methods that can be applied to phosphate mining and processing.
4. Methods for more efficient recovery of phosphate and trace minerals from the matrix in the mining and processing industry.
5. Methods for phosphate clay disposal and utilization.
6. Mitigation of the environmental impact of accumulation of by-product gypsum.

University Research

Institute of Food and Agricultural Sciences (IFAS)

The largest single organizational unit studying water problems is within IFAS. A recent compendium listed 81 faculty working on a wide

variety of water-related problems (Institute of Food and Agricultural Sciences, 1980). Areas of future concern include (Davidson, 1980):

1. finding the optimal amount of water to apply to crops;
2. developing a state-wide computer based information network; and
3. ground-water contamination.

Rosenstiel School of Marine and Atmospheric Sciences, U. of Miami

The internationally recognized program has been in operation for forty years (University of Miami, 1980). Some of the on-going activities related to water resources include (van de Kreeke, 1980):

1. the effect of chlorinated effluent on the ocean;
2. sedimentation in shallow bay areas from urbanization;
3. Bangladesh/Indian water rights;
4. Lake Worth and Naples Bay estuarine impacts;
5. rainfall measures using radar;
6. groundwater pollutant transport models; and
7. reuse of industrial waste waters.

Florida Sea Grant College

The Florida Sea Grant program began in 1971 (Florida Sea Grant, 1980). In 1976, the program received the designation of a Sea Grant College. Its 1980 budget totals nearly $3,000,000. This college is the major source of information on water problems of coastal areas. It is the seventh largest program of its kind in the United States.

Center for Wetlands (Odum, 1980)

The Center for Wetlands is an intercollege research division of the University of Florida dedicated to wetlands, their ecology, problems, management, and effective land use. The Center advances knowledge through special research approaches as systems ecological modelling and simulation, energy cost benefit analysis and planning, and field experiments on vegetation responses to water control.

Representative research projects are "Cypress Wetlands for Water Management, Recycling, and Conservation," funded by The Rockefeller Foundation and the RANN Division of National Science Foundation. Work of the Center includes a section on energy analysis, evaluating environmental alternatives with data on energy flows.

The Coastal and Oceanographic Engineering Laboratory, a unit of the Engineering and Industrial Experiment Station, University of Florida, conducts research on problems of the shoreline and of coastal and inland waters and renders advisory service to public agencies and industry. Interdisciplinary and multidisciplinary research and graduate instruction are closely coordinated and related to applications of the coastal zone. Research programs of the COE Laboratory include (1) air-sea interaction and the generation of surface waves; (2) scale models of inlets and shore structures; (3) transportation of sediment by waves and currents; (4) wave and current effects at offshore nuclear power plants; (5) water temperature variations near power-generating plants; (6) tidal variations in inland waters; (7) littoral transport under wave action and (8) coastal defense measures (Sheppard, 1980).

Other University Faculty

In addition to the above organizations, water related research groups are located throughout the State of Florida. A recently completed compendium of faculty interested in water research is available (Florida Water Resources Research Center, 1980).

REFERENCES

Allee, W. Summary of Activities of the Southwest Florida Water Management District, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Berger, H. Summary of Current Activities of the Paper and Pulp Industry at the Southern Regional Center, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Bishop, A. Summary of University Related Activities, Bureau of Water Management, Presented at Second Annual Meeting of the Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Borris, D.P. Summary of Current Activities of the Florida Institute of Phosphate Research, Presented at the Second Annual Meeting of the Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Davidson, J. Summary of Current Activities of the Institute of Food and Agricultural Sciences' Programs in Water, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Fisher, G. Summary of Activities of Northwest Florida Water Management District, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Florida Sea Grant, Florida Sea Grant College, Annual Report, January 1/ December 31, 1979, Gainesville, FL, 1980.

Florida Water Resources Research Center, Directory of Florida's University Faculty in Water Resources Research, Florida Water Resources Research Center, Gainesville, FL, Aug. 1980.

Howells, D.H. A Summary Report on Southeast Conference on Groundwater Management, Water Resources Research Institute, the University of North Carolina, Raleigh, N.C., 1980.

Institute of Food and Agricultural Sciences, Programs in Water, Current and Planned Research and Extension, University of Florida, Gainesville, FL, July, 1980.

Kantrowitz, I. Summary of Activities of the Florida District, U.S. Geological Survey, Presented at the Second Annual Meeting of the Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Livingston, J. Personal Communication from Asst. State Conservationist, SCS, USDA, Gainesville, FL, 1980.

McCaffrey, P.M., et al. Kissimmee River Survey Review: Information Packet, Kissimmee Coordinating Council, Tallahassee, FL, 1980.

Morgan, D. Summary of Activities of the Suwannee River Water Management District, Presented at the Second Annual Meeting of the Florida Water Resources Center, Gainesville, FL, Oct. 3, 1980.

Munch, D. Summary of Activities of the St. Johns Water Management District, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

National Audubon Society, The Ecosystem Research Unit, Information Sheet No. 5, Naples, FL, Sept. 1979.

Northwest Florida Water Management District, Water Resources Management Plan, Executive Summary, Havanna, FL, 1979.

Odum, H.T. Summary of Current Activities of the Center for Wetlands, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Rhoads, P. Summary of Current Activities of the South Florida Water Management District, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Rosendahl, P. National Park Service/South Florida Research Center, Fiscal Year 1980, Programs/Projects, Paper presented at Florida Water Resources Research Center Annual Meeting, Gainesville, FL, Oct. 3, 1980.

Salem, E. Summary of Activities of the Jacksonville District, U.S. Army Corps of Engineers, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Sheppard, D.M. Summary of Current Activities of the Coastal and Oceanographic Engineering Laboratory, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

Shockley, B. Research Group Unites Fish and Wildlife Study, Gainesville Sun, Feb. 17, 1980.

Southeast Basins Inter-Agency Committee, South Atlantic-Gulf Water Resources Region, Specific Problem Analysis, Main Report, 1975 National Assessment of Water and Related Land Resources, Volume I, Dec. 1977.

Southwest Florida Water Management District, A Look at the Southwest Florida Water Management District, Information Series 921B, Brooksville, FL, Aug. 1979.

U.S. Army Corps of Engineers, Water Resources Development by the U.S. Army Corps of Engineers in Florida, Jacksonville, FL, 1979, 189 pp.

U.S. Dept. of Agriculture, Soil, Water, and Air Sciences Research, 1979 Annual Report, U.S. Government Printing Office, Washington, D.C., 1979.

U.S. Geological Survey, Water Resources Investigations in Florida, 1978-79, Tallahassee, FL, June 1979.

U.S. Geological Survey, USGS Yearbook, Fiscal Year 1979, U.S. Government Printing Office, Washington, D.C., 1980.

U.S. Water Resources Council, The Nation's Water Resources, 1975-2000, Volume 1: Summary 4, December 1978.

University of Miami, 1978-1979 Annual Report, University of Miami Rosenstiel School of Marine and Atmospheric Science, Miami, FL, 1980.

van de Kreeke, Co. Summary of Current Activities of the Rosenstiel School of Atmospheric and Marine Science, Presented at the Second Annual Meeting of the Florida Water Resources Research Center, Gainesville, FL, Oct. 3, 1980.

SECTION V

PROBLEM CATEGORIZATION

Florida's water problems and priorities were established by soliciting input from several groups. Agency representatives were asked to rank Florida's problems using formal questionnaires and informal discussions. Results from this 1979 effort are summarized in RUNOFF (Florida WRRC, 1979). Another valuable perspective on "problems" was gained by subscribing to a news clipping service for all of Florida's newspapers for six months beginning in April, 1980. More than one thousand clippings were arranged by county. Then, summaries of "problems" were prepared.

The Second National Water Assessment by the U.S. Water Resources Council expended much effort in prioritizing water problems in the southeastern United States (U.S. Water Resources Council, 1978). This effort is quite valuable in providing the regional and national perspectives. The major source of information regarding priorities for research in water problems related to agricultural areas came from a state-wide meeting sponsored by the Institute of Food and Agricultural Sciences (1979).

Another perspective on problems was obtained by attending the 1980 Annual Meeting of the Florida Defenders of the Environment. A summary of that meeting provided additional input. Lastly, and most importantly, university faculty were asked to suggest what they felt were the most important research topics that needed attention. A formal request and informal discussions were used to obtain this

information. The remaining parts of this section summarize these findings.

There are numerous ways in which water problems can be classified. The selected scheme was developed by the Virginia Water Resources Center using an outline of the South Atlantic Gulf Region as a point of departure. Much of the text in the material to follow is an adaptation of this regional material to better describe the situation in Florida.

Problem Categorization

Category I: Atmospheric, Hydrologic, and Hydraulic Processes

1. Saline Intrusion into Freshwater Aquifers

Intrusion of saline water into freshwater aquifers is an increasingly critical problem in Florida. Heavy pumping for industrial, municipal, and agricultural uses alters natural groundwater flow patterns causing landward movement of the freshwater-saltwater interface, eventually resulting in high levels of salinity in pumped water. Continued development of coastal areas, with increasing demands for water, will result in a rapid worsening of this problem.

Needed are descriptions of the magnitude and intensity of the intrusion problem, determination of aquifer characteristics and pumping patterns contributing to it, development of techniques for monitoring salinity levels, and development of techniques for reversing flow or buffering against saline intrusion. Models of aquifer systems must be developed which can be used to estimate safe yields and establish appropriate pumping schedules and well locations. Possible institutional arrangements for management of pumpage in coastal areas and for developing alternative water supplies need to be explored.

2. Pollutants to Groundwater

Waste treatment lagoons (both municipal and livestock), landfills, septic tank disposal fields, storm and wastewater injection wells, and land application of wastewaters and sludges are all important means for disposal of waste materials to avoid direct pollution of streams, lakes, and estuaries. However, all of these hold possibilities for leaching of pollutants to groundwater.

Attention should be given to the types of pollutants which may be present, the manner of movement of these materials, and application techniques to minimize the potential for groundwater pollution. Florida is particularly sensitive to this problem due to high ground-water tables and sandy soils (Howells, 1980). Also, Florida has the largest number of hazardous waste disposal sites of any state in the United States.

3. Instream Flow

With increasing pressures to divert flows for off-stream uses such as irrigation, industrial development and municipal uses, it is important that an information base and methods be developed for resolving in- and offstream uses conflicts. The information need is critical for those agencies with responsibility for permitting the construction and operation of flow control structures.

4. Low-Flow Predictions for Receiving Waters

The design of wastewater treatment systems to prevent stream pollution from reaching unacceptable concentrations requires information on low-flows by duration and frequency. Many relatively small streams are ungaged and for larger streams low-flow estimates are

often uncertain. Hydrologic models for simulating stream flows in the watersheds in several areas of Florida need to be developed, and these must be thoroughly evaluated for their specific applicability to low-flow periods.

5. Water Supply

Population and industrial growth, and electric generating facilities cause greater competition for existing water supplies. This competing demand is resulting in the formation of capacity use areas and restrictions on amounts of water for new users. Better data coupled with new approaches to finding alternative ways of meeting these problems is critical.

6. Water Uses

The extent of withdrawals from surface and groundwater sources needs to be documented if effective water budgets and management plans are to be developed. In most areas of Florida the quantity of water withdrawals is only a crude approximation. Virtually none of the agricultural water use, our largest user, is measured. Basic data are urgently required to facilitate the development of management plans for wise and efficient utilization of our water resources. Improvement in geophysical techniques for exploration for groundwater would be of great assistance.

7. Flood Plain Management

In coastal areas, flooding occurs due to the physical features of the land through which the rivers flow and is particularly serious during hurricanes. Reliable information is required on flood stages by frequency and the capacity of the river swamps to contain flood water. In the rapidly urbanizing regions, water runoff volume is increased by reduced locations available for evapotranspiration and infiltration and

higher peaks are caused by more efficient drainage ways. Remedial measures require (1) more reliable information on flood flows and stages by frequency, (2) better techniques for estimating the effect of land use and channel changes on flood peaks, and (3) overcoming social, political, and institutional obstacles to wider use of nonstructural measures.

8. Erosion Control from Excess Water

The transportation of sediment and other debris by the flood water is very significant in injury and environmental and property damages, especially in northern Florida. Erosion results from channel scour along stream and headwater tributaries, and man's land-disturbing activities. Damages also occur when the stream load and non-channelized water load are deposited. Research should be undertaken on (1) methods to stabilize erodible areas to prevent these kinds of damages, and (2) the combined problems of erosion, sedimentation, drainage and ecological impacts in agricultural areas.

Category II: Hydrological-Ecological Relationships

1. Wetlands

Wetlands and estuaries have certain functional attributes that make them valuable and productive resources of local, regional, or national significance. Wetlands comprised ten to fifteen percent of the state of Florida originally. They serve as key areas for biotic productivity and cycling of nutrients associated with the formation and maintenance of food chains. They provide feeding, cover, nesting reproduction, and nursery habitat for associated biota. They have a

major influence on drainage, current and sedimentation patterns, salinities and flushing characteristics. Certain wetlands have a major influence on surface water and groundwater recharge. Many wetlands provide physical protection against erosion and storm damage and serve as storage areas for storm and flood waters. Wetlands affect key water quality variables such as dissolved oxygen, temperature, turbidity, and nutrient load. Also, wetlands provide opportunities for recreation, education and research.

Research and development efforts are needed to gain the technical knowledge required to properly implement wetland management programs. Currently, sufficient knowledge and guidance are lacking to properly and consistently implement these laws, particularly when conflicting needs demand tradeoffs. For example, some wetlands were formed because inefficient systems and practices were used when irrigated lands were first developed. Continuation of all wetlands that were man-made in areas where water shortages and groundwater overdrafts exist must be reassessed if we are to make maximum beneficial use of our water resources.

The wetlands of the coastal regions in Florida are being affected by human utilization of nearby land and by changes in drainage, stream channels, and the prior use of inflowing water. They have considerable potential for land use and waste disposal, but a fragile and delicately balanced ecology is involved if they are to be used. Adequate models are not available for evaluating the impact of such changes on wetlands activity in storing water, utilizing nutrients, and interacting with pollutants. Developing this information will enable impact evaluations to guide beneficial uses and limit adverse ones.

2. Estuarine Quality Degradation

The importance of estuaries in the biological cycles of the oceans, their rather fragile and delicately balanced ecology, and the increasing pressures for development in coastal areas, all require that natural phenomena taking place within these areas be better understood and that the impact of man's encroachment and pollution be assessed. Research should center on the hydrological and biological processes in estuaries and the effect that dredging, filling, contamination with a variety of pollutants and encroachment of man may have on living processes within them.

3. Lake and Reservoir Quality Degradation

Rivers, lakes, and reservoirs in Florida are increasingly threatened by upstream waste residues, particularly by nutrients and toxic substances. Nutrient enrichment leads to eutrophication. Studies of cause and effect relationships on water quality must be continued in support of regulatory decisions, reservoir design and management. Working models of the physical, chemical, and biological processes producing eutrophication in Florida's 7000 lakes must be developed in order to predict the effect of nutrient loads and to formulate a cost-effective control approach.

4. Nonpoint Sources

Regional wastewater management efforts under the 1972 Water Pollution Control Act require documentation of nonpoint sources of pollution, and evaluation of land use impacts on water quality. The monitoring strategy, the economics of data collection, and the subsequent use of collected data is crucial to the program in wastewater management.

Pollutants include sediment, nutrients, pesticides, herbicides, acids, and a variety of other materials originating from agricultural croplands, pastures, dry lots, construction, urban runoff, septic tank fields, boat discharges, mining operations, and other sources. Phosphate mining in Florida presents special challenges.

It is necessary to identify types, quantities and sources of pollutants, assess their economic and environmental impacts, explore appropriate control measures, and develop best management practices to mitigate their undesirable consequences.

5. Point Sources

Industries, municipalities, and agricultural livestock production units represent sources of concentrated pollution. The pulp and paper industries present particular problems in Florida.

Better characterization of wastes from these various sources is required. Alternative methods of wastewater disposal and flow augmentation need to be evaluated. The cost-effectiveness of current water quality standards needs to be assessed.

6. Water and Energy

There will be more concern for interactions between sources of energy and water resources as the country strives for energy self-sufficiency. As energy development schemes are planned, it is prudent that anticipated water-related problems are analyzed in detail so that mitigation measures may become part of the initial plan. These problems involve areas that include electricity generation, oil refining, acid rain and geothermal groundwater pumping.

Currently, Florida is considered to have sufficient water resources to support existing and new electrical generating facilities. As

competition for water increases, however, it will be more difficult to justify the use of huge quantities of water for single purposes. Some experts estimate that within five years, more wells will be drilled for energy development than for water supply. An intense examination of potential problems is advisable in order to facilitate any increase in electrical generating capacity. Further, nuclear plants discharge hot water and fossil fuel plants contribute to acid rain conditions. All of these difficulties indicate that there is a need for research that will assist in decision-making concerning the optimum form of future energy development projects. Research can contribute to a combined energy-water plan, which will be necessary for future public satisfaction.

7. Acid Rain

Acid rain is a significant environmental problem which challenges the use of fossil fuels as an energy source. Research objectives should focus on information that will help maintain environmental integrity as the country achieves energy self-sufficiency. The current acid rain sampling network needs to be expanded.

8. Channelization

Stream channels are modified to increase drainage for flood control, reclamation and improvement of low-lying areas, and mosquito control. While channelization activities by federal agencies have been slowed by recent court actions, they will and--in appropriate circumstances--should continue to be used. Alternative channelization designs must be developed for minimum adverse impact, and the effects of these and existing channelization approaches must be defined more adequately than is currently done. Some of the field studies on the lower

Kissimmee River Basin should be continued. Quantitative guidelines for project evaluation should result from such research.

9. Dredging and Filling

This largely private work is evaluated on a project-by-project basis. Some activities have had a devastating impact on estuarine areas in Florida. Methodology for assessing the cumulative impact of several projects should be developed to guide the issuance of permits. Techniques are needed to determine the sensitivity of the aquatic damage to the system. A more subtle problem than the recognizable gross changes in habitat is the release of substances from disturbed sediment and the effect of these materials on aquatic life. More detailed design guidelines for finger canals are needed.

10. Heated Water Discharge

The demand for numerous additional electric generating plants will place considerable pressure on regulatory agencies to reevaluate the present limits of temperature increases in surface water due to cooling water discharges. Continuing studies should optimize heat dissipation from cooling water, identify reasonable upper temperature limits for protecting the aquatic biota in specific locations, assure that all adverse impacts of warmer water have been assessed, and place social, economic, and ecological impacts on comparable bases. Research activities should also be directed toward recovery of this waste heat for beneficial uses.

11. Water Quality Monitoring

Present water quality monitoring cannot be considered adequate for either planning or regulatory purposes. Objectives underlying

system design have never been explicitly defined and monitoring activities have grown without benefit of rigorous analysis. Continued research leading to cost-effective monitoring strategies is vital.

Category III: Water Quality Management and Protection

1. Reclamation and Reuse of Wastewater

Reclamation of wastewater for public supplies will have to increase, but state officials are concerned about public opposition to treatment practices or decreased distance between discharge and intake. Evaluation of those aspects of water reuse must identify acceptable and objectionable practices and implement approaches that can result in public support where safety has been established. More efficient water use must be developed as an alternative to new source development, together with research on the effects of pricing, new technology, and public education on efficient use, wastewater reclamation, and reuse.

2. Water Treatment Processes

The potential for movement of pollutants from raw water sources into treated water supplies is a matter of increasing concern. Routine safety of water supplies is determined by bacteriological examination of water supplies taken from distribution systems. These give no indication of the presence of hazardous chemicals which water treatment plants are not normally designed to remove. Such materials are usually present in low concentrations and may never give rise to acute symptoms associated with a classical water borne disease outbreak.

Studies on the implications of prolonged exposure to trace level contaminants should be accelerated by the Federal agencies. Concurrent studies at the state level of the presence of these materials and the effectiveness of supplemental water treatment processes for their removal should continue.

Category IV: Water Development, Use, Conservation and Management

1. Irrigation

Large supplies of groundwater are available for supplemental irrigation which would help optimize crop production and minimize crop failures - both important in meeting world demand for agricultural products and combating increasing costs for production. Research should define the potential for supplemental irrigation including consideration of techniques and economics.

Also, increasing use of supplemental irrigation will require information on how much evapotranspiration is increased and on development of ways to increase water use efficiency based on water balance, energy budget techniques, and yield data.

2. Large Reserves

Efficient development of large reserves of groundwater and surface water that are untapped in some areas will be dependent on reliable information about location, quality and availability of the resources and relative economics of the potential sources. Research should be done on political and legal constraints on the use of the resource. Continuing growth and urban concentration will impose demands on this resource. This stiffening competition for available water supplies

already is raising serious political, legal, technical and economic questions.

3. Water Conservation in Industry and Agriculture

As increasing demands are made on the available water supplies of the region, and as more stringent regulations are imposed on wastewater disposal, research must concentrate on techniques for the reduction of water requirements in various production processes and the treatment necessary to make the water reusable in the same process or usable in a less critical process.

4. Salvage and Conservation of Excess Water

Much of the runoff water which subsequently creates damage before reaching the ocean can be diverted and conserved to meet future water supply needs. For example: diversion of flood waters should be made from direct runoff to detention areas from which water can be drawn off for (a) aquifer recharge and (b) municipal and agricultural needs. Research on the social, economic, political, and health aspects are warranted before such alternatives can be realistically considered.

5. Reclamation and Reuse

Public Law 92-500 requires that the reuse of wastewater be considered as an alternate means of helping to meet future demands. Some of the ways of doing this are by aquifer recharge of used industrial and municipal sewerage effluents, land spreading and spray irrigation of biodegradable liquid wastes on land. Public Law 93-523 requires the protection of underground sources of drinking water. As a result of this type of disposal solution, other problems will arise; such as, groundwater contamination, air pollution, buildup of salts and heavy minerals in the soils, and problems and potential relating to recycling

of nutrients through vegetation. As a result of the importance of these systems and the approaching need for resource reuse of water in many areas, continued studies are necessary to determine all adverse effects of the method.

6. Cost-Effectiveness/Energy Requirements

Many communities, both large and small, are experiencing difficulties meeting escalating operation and maintenance costs for mechanical wastewater treatment plants. Research is urgently needed to reduce both the operating costs and the complexity of new wastewater treatment plants.

Category V: Institutional and Economic Analysis and Water Resources Planning

1. Floods

Problems associated with the control of excess water are of major concern. Flooding continues to take a great toll of human lives, and to leave behind property damages far in excess of any other natural hazard.

Although people in Florida are well acquainted with the devastation and tragedies caused by too much water, much research to date has not been conducted, and more must be done in order to: restate the goals and objectives of research application in terms meaningful to the public at large; determine the interaction between federal, state, and local government in research initiation and implementation; determine the role of alternative strategies for state government participation in research development and implementation; integrate flood plain management into comprehensive land use planning; evaluate the standards of

performance and methods for program evaluation; understand the effects of floodway fringe filling and occupancy; and project the effects of urbanization, on-site detention, and channelization on flood velocities and evaluations. There is an urgent need to develop engineering design and operation criteria for stormwater retention ponds. All of these are critical areas in which research should be undertaken.

2. Dam Safety Considerations

There is an increasing incidence of failures of small dams and levees throughout the region. This usually causes downstream areas to become inundated and on occasion has caused major damage and a number of fatalities. Numerical models are needed for predicting the magnitude of potential dam-break floods and delineating the potential flood plain for land use planning.

3. Hydroelectric

There is a keen national interest in the use of low head hydropower. The U.S. Army Corps of Engineers estimates that the southeast region has the potential to produce more electricity by expanding existing hydropower facilities or developing new ones. A gentle impact on the environment and low operating costs are benefits associated with hydroelectric plants that should be investigated further.

4. Control of Water Use

Proposals for re-regulating water use at existing reservoirs, diverting water between basins, and regulating water use among states require assessment of impacts to multiple publics in several categories. Methodologies are needed for evaluating these impacts on comparable bases and presenting them for public evaluation.

5. Integrating Water and Land Use Management

Land use planners regularly make decisions that affect water service requirements without due consideration of the impact of alternate land use arrangements. One research need with respect to regional land use management is to establish criteria for selecting the best overall land use policy. Important considerations in establishing usable criteria include identification of social effects and fair allocation of beneficial and adverse consequences of various land use policies. Public response to various land use management practices needs to be better integrated into the decision making through effective feedback loops.

6. Land Use Control in Water Resource Management

Florida is feeling intensifying resource-management pressures due to population increases. There is a priority need for more systematic and coordinated management of water and land resources. This can be accomplished only through consistent data-gathering, evaluation, planning, and implementation. It also requires resource-management strategies based on multi-disciplinary, inter-governmental approaches.

Growth in the coastal plains has resulted in the drilling of thousands of private wells with the consequences clearly evident in overpumping of aquifers. In a number of locations inadequate controls on timber harvesting have caused water quality degradation and increased erosion and sedimentation. More effective management of land resources would help to control the substantial percentage of water pollution due to non-point sources.

For the above reasons, increased effort is urgently required in the following areas: (a) determining ways in which land use controls might ensure that groundwater supply sources are recharged, thus making groundwater a renewable resource; (b) developing more effective training programs for resource-management personnel; (c) suggesting best ways in which water quality and water supply considerations should be incorporated into the land-management process, and (d) assessing, by water management district, the future demands that will be placed on the land and water resources of the various states according to projected population and industrial growth rates.

7. Institutional Constraints on Effective Management of Water

The political boundaries of municipalities, counties, authorities, and special districts often impede comprehensive planning and programming required to deal most effectively with water problems in Florida. This can be overcome by developing effective implementation programs which address specific water resource problems.

Throughout the state, water planning still is generally conducted independently of land use planning, water quality is considered separate from water quantity, and groundwater is dealt with as though it had no direct relationship to surface water. As the demand for withdrawal uses of water multiply and the need for advanced treatment of wastewater increases, it becomes imperative to look to new institutional arrangements through which costs can be minimized even as program effectiveness is increased. Regional management arrangements within a state offer the best potential of providing a statewide perspective for decision making and of ensuring greater efficiency in both water supply and wastewater disposal considerations.

The State of Florida is divided into five water management districts. Areawide planning agencies exist for all metropolitan areas. How well are these organizations functioning? Are they able to successfully overcome the problems of not being associated directly with the traditional city, county, and state organizational structure?

Identified needs include (1) development of systematic data about political and administrative procedures as well as financial, political and legal constraints on public water authorities; (2) determination of what political configurations for research management are both socially acceptable and operationally manageable; and (3) solutions to problems concerning departmentalized planning and lack of interdepartmental cooperation and coordination.

8. Legal Constraints on Efficient Use of Water

Florida follows the riparian law doctrine. Because this state is relatively water-rich, the 200-year-old doctrine has served the public adequately in the past. Recently, however, specific legal questions have been raised about interbasin transfers of water for supply purposes and about discharging effluents from one basin into the streams of another basin. Many conflicts arise from multiple demands on a given water resource.

For these and other reasons, riparian doctrine needs to be examined in detail to see whether it is an unnecessary constraint on the efficient use of water, whether it prevents equitable allocation, and whether in fact it is an impediment to effective management because it does not permit such activities as interbasin transfers.

9. Wastewater Treatment for Small Communities

Many small communities are faced with the prospect of providing advanced wastewater treatment to meet EPA water quality standards for receiving streams. These communities will have great difficulty in providing the capital and operating funds to construct and maintain complex wastewater treatment facilities. An economic analysis of alternative waste treatment measures is needed to describe, for each kind and magnitude of waste, the most appropriate waste treatment process for each locale. The possibilities of integrating several available waste treatment techniques should be investigated. The product of this research would be a set of design criteria for these techniques.

REFERENCES

Florida WRRC, Annual Meeting Held, Runoff, Vol. 1, No. 1, Nov. 1979.

Institute of Food and Agricultural Sciences, Proc. Water Planning Workshop, U. of Florida, Gainesville, FL, Jan. 29 and 30, 1979.

U.S. Water Resources Council, The Nation's Water Resources, 1975-2000, Volume 4: South Atlantic-Gulf Region, U.S. Government Printing Office, Washington, D.C., 1978.

SECTION VI

CENTER PRIORITIES AND JUSTIFICATION FOR THE SELECTION OF THOSE PRIORITIES

The Florida Water Resources Center, a federal/state partnership agency, is helping to solve Florida's water resource problems. The Center is one of 54 such research institutes located in each of the 50 states and four U.S. territories. Through a coordinated research and development program, the Center seeks to fulfill these goals:

- To provide a center of expertise in water and associated land-use problems and serve as a repository of knowledge for use in education, research, planning, and community service.
- To serve public and private interests in the conservation, development, and use of water resources.
- To provide training opportunities in higher education whereby skilled professionals become available to serve government and private sector alike.
- To assist in planning and regulatory bodies at the local, state, regional, and federal levels.
- To communicate research findings to potential users in a form that encourages quick comprehension and direct application to a water-related problem.

Organization of the Center

The Director of the Center reports directly to the Vice President for Academic Affairs, University of Florida. The Vice President appoints a faculty committee to oversee the operation of the Center. The responsibilities of the Water Resources Research Council include the following:

A. To establish policies and operating procedures of the Florida Water Resources Research Center.

B. To review the recommendations of the Director of the Center for the funding of research projects. The current membership is as follows:

Patrick L. Brezonik, Chairman	Environmental Engineering Sciences
Elizabeth Abbott	Geography
B. A. Christensen	Civil Engineering
James M. Davidson	Institute of Food and Agricultural Sciences
Jack D. Elzinga	Industrial and Systems Engineering
James A. Henry	Geography
Jerome Milliman	Economics
Daniel P. Spangler	Geology
Sherlie H. West	Agronomy
Francis G. Stehli, ex officio	Dean of Graduate Studies and Research
James P. Heaney, ex officio	Director

Research Priorities

Section V described the water problem categories and how research needs were identified by considering input from local, regional, state,

and federal agencies, university faculty, conservation groups, and the general public through articles appearing in newspapers throughout the state. The priority setting also reflects the views of related lists of research needs prepared by other groups, e.g., the Second National Water Assessment. The next section presents the results of this effort as the Center's five year research and development plan.

SECTION VII

FIVE-YEAR RESEARCH AND DEVELOPMENT PLAN

The Florida Water Resources Research Center encourages and supports research which is relevant to critical water problems at the state, regional, and national levels. The problems identified in Sections II through V and summarized in Section VI illustrate a wide variety of research needs within the State. Further, those research needs identified in regional and national documents will be addressed by the Center if expertise is available to meet those needs. The Center's program includes problem-oriented research, fundamental research, technology transfer, and information dissemination activities.

Estimated budget requirements are included in this section for specified levels of program activity. The Office of Water Research and Technology (OWRT) has requested budgets be prepared for (a) an annual cooperative program (ACP) budget level of $115,000, (b) a second ACP budget of $250,000, and (c) a national matching grant program appropriation by Congress which will increase from $6.0 million to $10.0 million over the five-year period. Programs developed using these guidelines are displayed in Tables VII-1 through VII-5.

OWRT has also requested that other sources of state and federal funds that can be identified with the Center be budgeted. Although the Center has had (and should continue to have) projects funded by other state and federal agencies, there are no long-term funding agreements

Table VII-1. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1982

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Institute Office Support	45,000	23,000	60,000	30,000	-0-	-0-	-0-
Category I: Atmospheric, Hydrologic & Hydraulic Processes							
Saline Intrusion			15,000	8,000			
Pollutants to Groundwater	15,000	8,000	30,000	15,000	40,000	40,000	
Instream Flows							
Low Flow Predictions							
Supply							
Water Uses							
Flood Plain Management	10,000	5,000	25,000	13,000			
Erosion Control							
Category II: Hydrologic-Ecologic Relationships							
Wetlands	10,000	5,000	20,000	10,000			
Estuarine Quality Degradation							
Lake & Reservoir Quality			20,000	10,000			
Nonpoint Sources					40,000	40,000	
Point Sources							
Water and Energy							
Acid Rain			10,000	5,000			
Channelization							
Dredging & Filling							
Heated Water Discharges							
Water Quality Monitoring							
Aquatic Weed Control							
Category III: Water Quality Monitoring & Protection							
Reclamation and Reuse of Wastewater							
Water Treatment Processes	10,000	5,000	20,000	10,000			

Table VII-1. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1982

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Category IV: Water Development, Use, Conservation, and Management							
Irrigation							
Large Reserves							
Water Conservation in Industry & Agriculture	15,000	8,000	15,000	8,000			
Salvage & Conservation of Excess Water							
Reclamation & Reuse							
Cost-Effectiveness/ Energy Requirements							
Drainage							
Category V: Institutional and Economic Analysis and Water Resources Planning							
Floods					40,000	40,000	
Dam Safety Considerations							
Hydroelectric Control of Water Use			15,000	8,000			
Integrating Water and Land Use Management	10,000	5,000	20,000	10,000			
Land Use Control in Water Resource Management							
Institutional Constraints							
Legal Constraints					30,000	30,000	
Wastewater Treatment for Small Communities							
Totals For ACP of $115,000	115,000	59,000			150,000	150,000	474,000
" " " " $250,000			250,000	127,000	150,000	150,000	677,000

Table VII-2. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1983

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Institute Office Support	50,000	25,000	65,000	33,000	-0-	-0-	-0-
Category I: Atmospheric, Hydrologic & Hydraulic Processes							
Saline Intrusion			15,000	8,000			
Pollutants to Groundwater	10,000	5,000	25,000	13,000	40,000	40,000	
Instream Flows							
Low Flow Predictions							
Supply							
Water Uses							
Flood Plain Management	10,000	5,000	25,000	13,000			
Erosion Control							
Category II: Hydrologic-Ecologic Relationships							
Wetlands	10,000	5,000	20,000	10,000			
Estuarine Quality Degradation							
Lake & Reservoir Quality			20,000	10,000			
Nonpoint Sources					40,000	40,000	
Point Sources							
Water and Energy							
Acid Rain			10,000	5,000			
Channelization							
Dredging & Filling							
Heated Water Discharges							
Water Quality Monitoring							
Aquatic Weed Control							
Category III: Water Quality Monitoring & Protection							
Reclamation and Reuse of Wastewater							
Water Treatment Processes	10,000	5,000	20,000	10,000			

Table VII-2. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1983

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Category IV: Water Development, Use, Conservation, and Management							
Irrigation							
Large Reserves							
Water Conservation in Industry & Agriculture	15,000	8,000	15,000	8,000			
Salvage & Conservation of Excess Water							
Reclamation & Reuse							
Cost-Effectiveness/ Energy Requirements							
Drainage					30,000	30,000	
Category V: Institutional and Economic Analysis and Water Resources Planning							
Floods					40,000	40,000	
Dam Safety Considerations							
Hydroelectric							
Control of Water Use			15,000	8,000			
Integrating Water and Land Use Management	10,000	5,000	20,000	10,000			
Land Use Control in Water Resource Management							
Institutional Constraints							
Legal Constraints					30,000	30,000	
Wastewater Treatment for Small Communities							
Totals For ACP of $115,000	115,000	58,000			180,000	180,000	533,000
" " " " $250,000			250,000	128,000	180,000	180,000	738,000

Table VII-3. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1984

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Institute Office Support	55,000	28,000	70,000	35,000	-0-	-0-	-0-
Category I: Atmospheric, Hydrologic & Hydraulic Processes							
Saline Intrusion			15,000	8,000			
Pollutants to Groundwater	10,000	5,000	20,000	10,000	40,000	40,000	
Instream Flows							
Low Flow Predictions							
Supply							
Water Uses							
Flood Plain Management	10,000	5,000	25,000	13,000			
Erosion Control							
Category II: Hydrologic-Ecologic Relationships							
Wetlands	10,000	5,000	20,000	10,000			
Estuarine Quality Degradation							
Lake & Reservoir Quality			20,000	10,000			
Nonpoint Sources					40,000	40,000	
Point Sources							
Water and Energy							
Acid Rain			10,000	5,000			
Channelization							
Dredging & Filling							
Heated Water Discharges							
Water Quality Monitoring							
Aquatic Weed Control							
Category III: Water Quality Monitoring & Protection							
Reclamation and Reuse of Wastewater							
Water Treatment Processes	10,000	5,000	20,000	10,000			

Table VII-3. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1984

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Category IV: Water Development, Use, Conservation, and Management							
Irrigation							
Large Reserves							
Water Conservation in Industry & Agriculture	10,000	5,000	15,000	8,000			
Salvage & Conservation of Excess Water							
Reclamation & Reuse							
Cost-Effectiveness/ Energy Requirements							
Drainage					60,000	60,000	
Category V: Institutional and Economic Analysis and Water Resources Planning							
Floods					40,000	40,000	
Dam Safety Considerations							
Hydroelectric							
Control of Water Use			15,000	8,000			
Integrating Water and Land Use Management	10,000	5,000	20,000	10,000			
Land Use Control in Water Resource Management							
Institutional Constraints							
Legal Constraints					30,000	30,000	
Wastewater Treatment for Small Communities							
Totals For ACP of $115,000	115,000	58,000			210,000	210,000	593,000
" " " " $250,000			250,000	127,000	210,000	210,000	797,000

Table VII-4. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1985

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Institute Office Support	60,000	30,000	75,000	38,000	-0-	-0-	-0-
Category I: Atmospheric, Hydrologic & Hydraulic Processes							
Saline Intrusion			15,000	8,000			
Pollutants to Groundwater	10,000	5,000	50,000	25,000	40,000	40,000	
Instream Flows							
Low Flow Predictions							
Supply							
Water Uses							
Flood Plain Management							
Erosion Control							
Category II: Hydrologic-Ecologic Relationships							
Wetlands	10,000	5,000	40,000	20,000			
Estuarine Quality Degradation							
Lake & Reservoir Quality			20,000	10,000			
Nonpoint Sources					50,000	50,000	
Point Sources							
Water and Energy							
Acid Rain			10,000	5,000	40,000	40,000	
Channelization	20,000	10,000					
Dredging & Filling							
Heated Water Discharges							
Water Quality Monitoring							
Aquatic Weed Control							
Category III: Water Quality Monitoring & Protection							
Reclamation and Reuse of Wastewater							
Water Treatment Processes							

Table VII-4. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1985

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Category IV: Water Development, Use, Conservation, and Management							
Irrigation							
Large Reserves							
Water Conservation in Industry & Agriculture							
Salvage & Conservation of Excess Water							
Reclamation & Reuse							
Cost-Effectiveness/ Energy			20,000	10,000	40,000	40,000	
Requirements							
Drainage					60,000	60,000	
Category V: Institutional and Economic Analysis and Water Resources Planning							
Floods							
Dam Safety Considerations							
Hydroelectric							
Control of Water Use							
Integrating Water and Land Use Management							
Land Use Control in Water Resource Management							
Institutional Constraints	15,000	8,000	20,000	10,000	10,000	10,000	
Legal Constraints							
Wastewater Treatment for Small Communities							
Totals For ACP of $115,000	115,000	58,000			240,000	240,000	653,000
" " " " $250,000			250,000	126,000	240,000	240,000	856,000

Table VII-5. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1986

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Institute Office Support	65,000	33,000	80,000	40,000	-0-	-0-	-0-
Category I: Atmospheric, Hydrologic & Hydraulic Processes							
Saline Intrusion			15,000	8,000			
Pollutants to Groundwater	10,000	5,000	50,000	25,000	40,000	40,000	
Instream Flows							
Low Flow Predictions							
Supply							
Water Uses							
Flood Plain Management							
Erosion Control							
Category II: Hydrologic-Ecologic Relationships							
Wetlands	15,000	8,000	20,000	10,000			
Estuarine Quality Degradation							
Lake & Reservoir Quality			20,000	10,000			
Nonpoint Sources					50,000	50,000	
Point Sources							
Water and Energy							
Acid Rain			30,000	15,000	40,000	40,000	
Channelization	10,000	5,000					
Dredging & Filling							
Heated Water Discharges							
Water Quality Monitoring							
Aquatic Weed Control							
Category III: Water Quality Monitoring & Protection							
Reclamation and Reuse of Wastewater							
Water Treatment Processes							

Table VII-5. Proposed Distribution of Funds by Budget Activity for Fiscal Year 1986

Budget Activity	Annual Cooperative Program				Matching Grant Program		Program Totals
	$115,000 Budget		$250,000 Budget				
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	
Category IV: Water Development, Use, Conservation, and Management							
Irrigation							
Large Reserves							
Water Conservation in Industry & Agriculture							
Salvage & Conservation of Excess Water							
Reclamation & Reuse							
Cost-Effectiveness/ Energy			15,000	8,000	40,000	40,000	
Requirements							
Drainage					60,000	60,000	
Category V: Institutional and Economic Analysis and Water Resources Planning							
Floods							
Dam Safety Considerations							
Hydroelectric							
Control of Water Use							
Integrating Water and Land Use Management							
Land Use Control in Water Resource Management							
Institutional Constraints	15,000	8,000	20,000	10,000	40,000	40,000	
Legal Constraints							
Wastewater Treatment for Small Communities							
Totals For ACP of $115,000	115,000	59,000			270,000	270,000	714,000
" " " " $250,000			250,000	126,000	270,000	270,000	916,000

that could be budgeted. All work to date of this nature has been on a project-by-project basis. Unlike a number of other centers, the Florida Center does not have a direct appropriation from the Legislature or from other agencies for its operation.

APPENDIX

OWRT INSTRUCTIONS FOR DEVELOPMENT OF FIVE-YEAR PLAN

United States Department of the Interior

OFFICE OF WATER RESEARCH AND TECHNOLOGY
WASHINGTON, D.C. 20240

IN REPLY REFER TO:

February 22, 1980

To: Directors, Water Resources Research Institutes and Centers

Subject: Five-year water resources research and development goals and objectives

Title 1, Sec. 101 (b) (4), P.L. 95-467 - "The designated State institutes shall cooperate with the Secretary in the development of five-year water resources research and development goals and objectives."

The OWRT memorandum dated October 19, 1979 suggested a procedure to effect compliance with the requirement that the Secretary of the Interior develop a five-year water resources research program. In a number of recent meetings with the NAWID program committee and the 5-year program regional coordinators it has been gratifying to learn that progress in developing the 5-year program is evident, that the attitude of the Institute Directors is cooperative and positive, and that the value of the 5-year program to the future welfare of the institutes is appreciated.

However, there is apparently still some uncertainty which needs to be addressed concerning the quality and quantity required for some of the material suggested for inclusion in the report. Also, it has become evident that some of the Directors are reading into the exercise a much more complex approach than is really necessary or expected.

It is intended that each state report show a proposed 5-year program for its own institute. The report should be written to make a case for the institute, to show the importance of the institute to the state, region, and Nation. The report should be a self-contained document and serve as a ready source of information on state water resource activities, issues, and the state institute's 5-year water research program.

It is hoped that the enclosed revision of Appendix A of the October 15, 1979 memorandum will be of assistance in the preparation of your 5-year water research program.

Gary D. Cobb
Director

Enclosure

Appendix A (Revised)

State Water Resources Research Institute
Five-Year
Water Resources Research Program

1. Summary

"The designated State institutes shall cooperate with the Secretary in the development of five-year water resources research and development goals and objectives."

The summary should include a brief description of the purpose of the report, a summary of the water problems of the State, and a synopsis of the institute 5-year research program proposed to address some of the problems.

2. State Water Resources

"It is the hope of the author of the bill, I know, that the state centers will be used by state and local government and other local water oriented agencies..."

It is the intent of this section of the report to provide background information on the meteorological, hydrological, and geological characteristics of the state to a reader unfamiliar with the state. It is only intended to point out to what extent the state is arid or humid, drought or flood prone, surface or ground water dependent, has high or low quality water, aware or unaware of its problems, and has a complete or incomplete inventory of its resource. Most of the information needed for this section may be found in the publication - The Role of Ground Water in the National Water Situation, Geological Survey Water - Supply Paper 1800 by C.L. McGuinness (1963). The material in that report should be updated with any new material generated by more recent GS inventories, River Basin Commission studies, State Reports, etc. Probably, no more than ten pages of your report need be devoted to this section.

3. The Use of the Resource and Introduction to Water Resource Problems

"There is one very basic law in political science, that the importance and urgency of any problem increases astronomically in direct proportion to its proximity to the district of any legislator, which ought to be known and understood by physical scientists working on such an epidemic problem as water resources."

This section of the report should present information on how the states water supply - both its surface and groundwater - is utilized. This section should also describe the circumstances under which shortages or deficits are expected to occur and display the data which lead to such conclusions. We look for a summary view of existing and future water requirements, the nature of problems, conflicts associated with efforts to meet the requirements, and implications for the future.

The National Assessment and state documents could be the prime sources for the information needed in this section of the report. Ten to twenty pages should be adequate to document existing or potential problems.

4. Water and Related Land Planning and Development Activities

"Due consideration shall be given to priority problems identified by water and related land resource planning, data acquisition, and like studies conducted by other agencies and organizations."

This section of the report is essentially a continuation of section 3 except that it deals with the identification of much more specific problems. What we seek to present in this section are summaries of those studies, plans, commissions, etc., that have examined water resource problems, evaluated them and have come to some conclusions. We need to be able to show that those studies conducted by "other agencies and organizations" are given consideration in the drafting of the institute 5-year research program. Ten to twenty pages of narrative should be sufficient to identify the agencies, the studies, and priority problems in sufficient detail to provide adequate justification for inclusion of those problems in the institutes 5-year research programs.

5. Problem Categorization and Ranking

"Water resources research and development programs carried out in accordance with this title may include, without being limited to water use conservation and efficiences; water and related planning; saline water conversion; water reuse; management and operations; legal systems; protection and enhancement of the water based environment; institutional arrangements; salinity management; and economic, social, and environmental impact assessment."

In sections 2, 3, and 4, probably a considerable number and range of problems have been identified. This section of the report should be used to summarize and display the water problem identification data from sections 2,3, and 4. The problems should be categorized in a format appropriate for the water problems associated with the state. Ranking of problems according to the importance of the problems to the state may be appropriate but at this time should only

be in general terms such as those used in the National Assessment. A brief presentation of the reasons why the highest ranked problems are of importance to the state should be included in this section. A strong case for the importance of a problem can be made if economic benefits or penalties can be assigned to the problem. If direct benefits or penalties cannot be computed, the potential economic implications could be estimated. What we need to avoid in this section is the presentation of a list of problems developed and ranked by researchers. Two or three pages of tables and four or five pages of narrative should be adequate for this section of the report.

6. Institute Priorities and Justification for the Selection of those Priorities

"I spoke also of the need for setting disciplined research priorities based on real public needs, then sticking with them to make the best use of scarce research dollars. Priorities, I indicated, must be more than scientific; they must recognize and build on social, political and economic realities."

This section of the report should summarize the overall program envisioned for the institute for the period 1982-1987. It should present the institute's research priorities and indicate how those priorities were chosen. This section of the report is also the place to highlight and describe interinstitute cooperation and collaboration on problems of a regional nature.

It is also appropriate in this section to note that certain important problems will not be addressed because they may be adequately covered by other programs, that other problems may be passed over because funding is inadequate for a research effort commensurate with the magnitude of the problem, that expertise required to address particular kinds of problems may not be available, and so forth.

This section of the report is the vehicle to explain why and how the water research institute is important to the state, the region, and the Nation. An effort should be made to show that the research priorities are related to real public needs and that the research program addressing those priorities is based on a reasoned, logical plan with specific objectives and goals. Perhaps no more than ten pages will prove adequate to describe the philosophy behind the institutes 5-year program, where that program will lead, and why that program direction was selected.

7. Institute 5-year Research and Development Plan

"The Secretary shall develop a five-year water resources research program in cooperation with the institutes and appropriate water entities, indicating goals, objectives, priorities, and funding requirements."

"I urge you to encourage research which is relevant to the critical water problems at the regional and national levels, and refuse to sponsor that which is not."

This section of the report should be used to present the institute's 5-year program in terms of the problems that are to be researched, the specific aspects of the problem to be studied, the five-year schedule, and the proposed distribution of funds among the problems. The elements of the problem to be researched should be spelled out in sufficient detail to avoid the appearance that institute programs are duplicative of each other. For example, it is not enough to show that a specified number of dollars will be budgeted for water quality research. Most of the institutes will probably support research dealing with water quality. Sufficient detail is needed to show that even though many institutes are engaging in water quality research the efforts are complementary and not duplicative.

The institute program display should show those program elements to be funded with allotment funds, those to be funded with anticipated matching grant funds, and those to be funded with other anticipated state and Federal funds that can be identified with the institute. Two levels of funding should be shown for the allotment program. One program that could be conducted at a $115,000 allotment budget level should be presented and a second program should show what could be accomplished at a $250,000 allotment budget level. It should be assumed that the OWRT matching grant appropriation will increase from $6.0 million to $10 million during the 5-year period.

The institute 5-year programs may include problem oriented research, fundamental research, demonstration and technology transfer, and efforts intended to initiate or stimulate research on important water problems. This section of the report should require no more than six to eight pages to display the proposed 5-year programs and the budgets associated with those programs.

There are few constraints imposed on institute programs. All that is required is that the programs be relevant to important water problems and that the expenditure of funds be justified to the Congress. Congress is aware that the Nation faces significant water problems but needs to be convinced that the OWRT program can make significant contributions toward the solution of those problems.