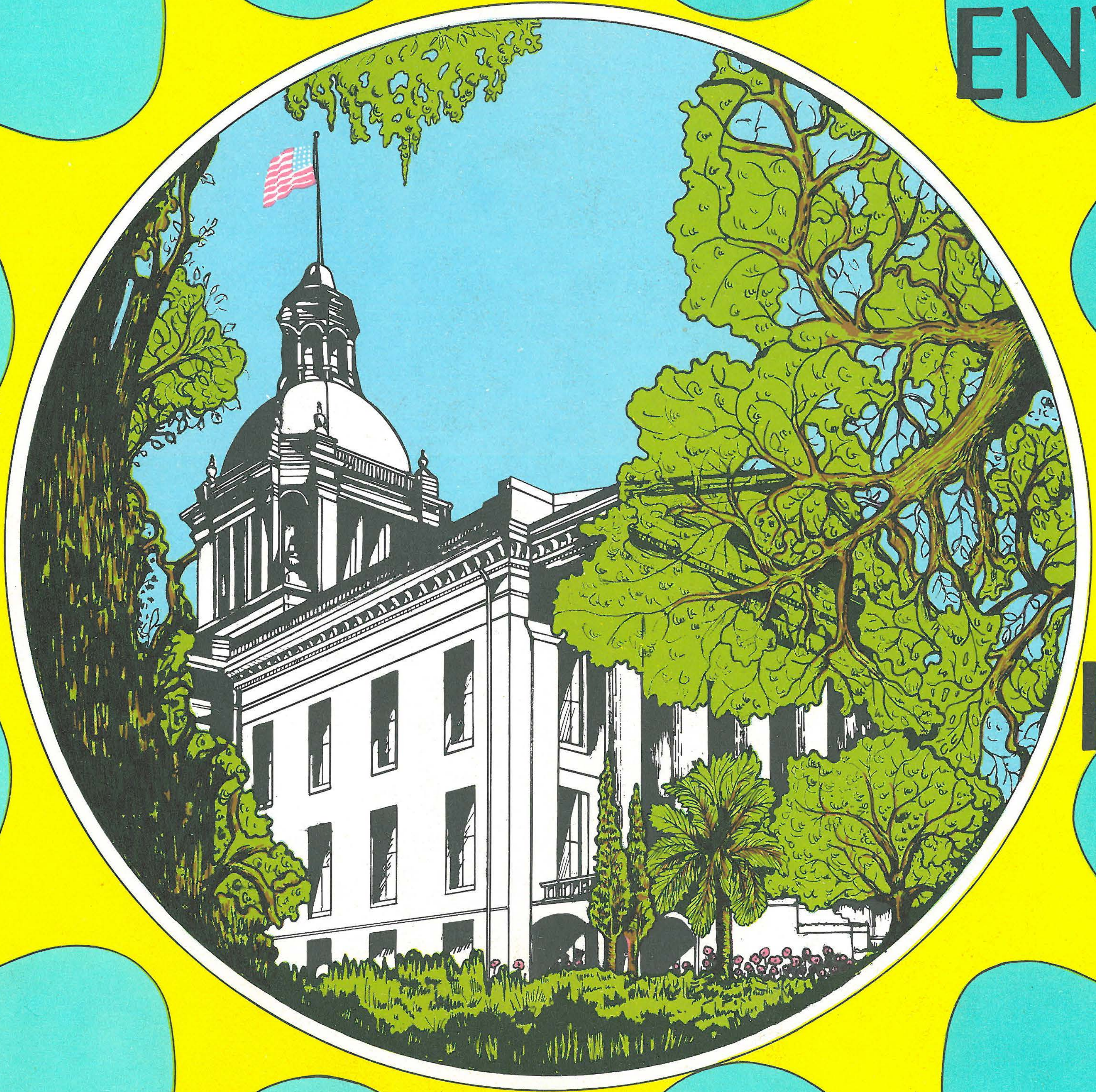
ENVIRONMENTAL GEOLOGY and HYDROLOGY



TALLAHASSEE AREA, FLORIDA

STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES
Randolph Hodges, *Executive Director*

DIVISION OF INTERIOR RESOURCES
Robert O. Vernon, *Director*

BUREAU OF GEOLOGY
C. W. Hendry, Jr., *Chief*

SPECIAL PUBLICATION NO. 16

ENVIRONMENTAL GEOLOGY AND HYDROLOGY TALLAHASSEE AREA, FLORIDA

Prepared by the
BUREAU OF GEOLOGY
DIVISION OF INTERIOR RESOURCES
FLORIDA DEPARTMENT OF NATURAL RESOURCES

TALLAHASSEE, FLORIDA
1972

CONTENTS

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Prepared by the
BUREAU OF GEOLOGY
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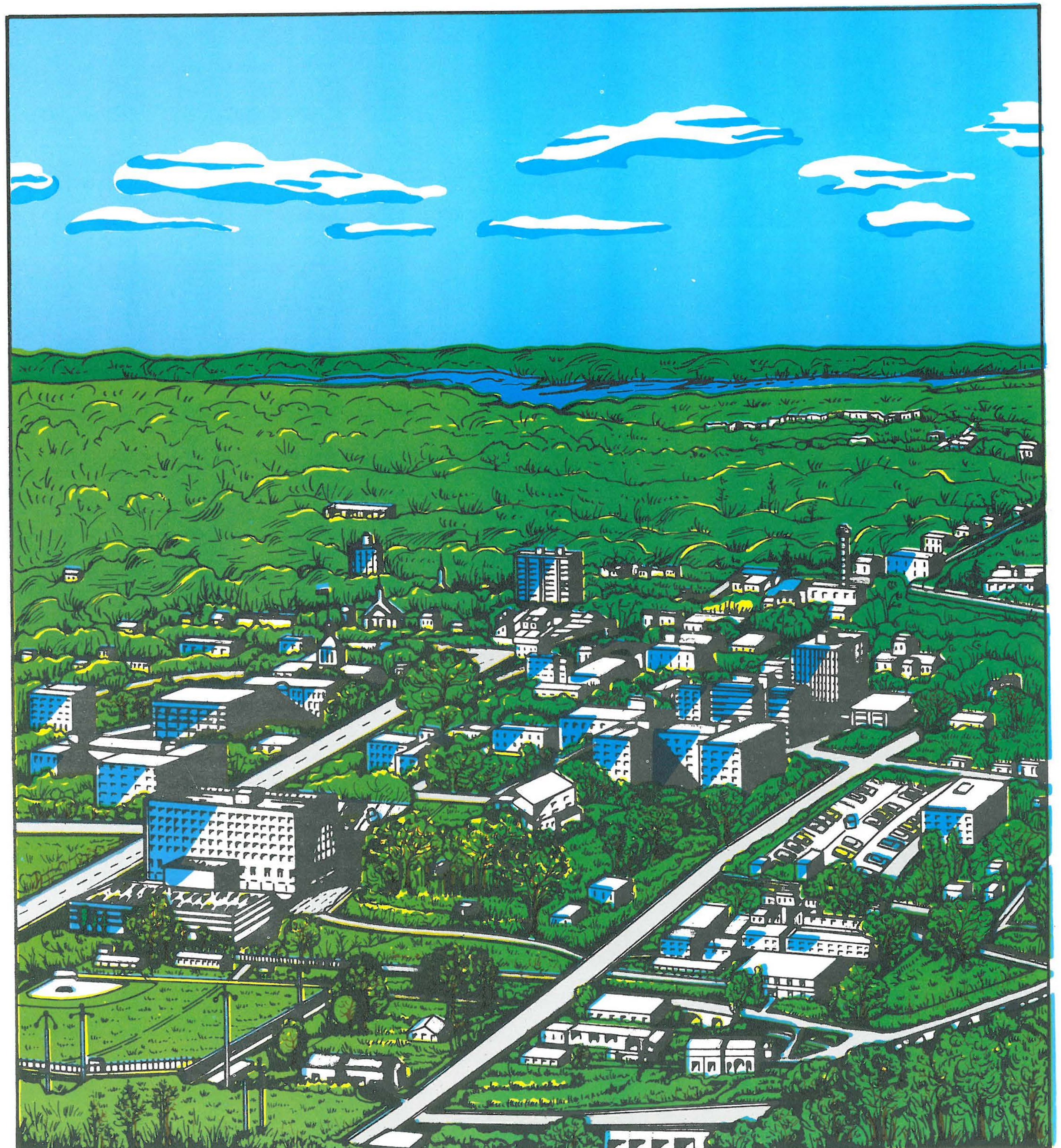
ENVIRONMENTAL GEOLOGY AND HYDROLOGY



TALLAHASSEE AREA, FLORIDA

INTRODUCTION

Florida has the purest water, the freshest of breezes, broad reserves of needed mineral resources, largely unsullied beaches and waterways, yet at the same time, it has the highest growth rate in the continental United States. The demand to clean our environment meets head-on with the need for raw mineral resources.

Some citizens have forgotten, or have never known, that man is part of the evolutional sequence and competition between species is fierce and will continue - - the rapid expansion of the human species drains the energies from many other species, uses up their nesting grounds, makes it difficult for them to reproduce, to feed and exist. Species will continue to be endangered and will disappear, as man continues to enlarge and dominate - - unless we control our own passions for reproduction, selfish possession, waste and failure to purge our environments of unneeded and toxic gases, liquids and solid wastes. Man, our most corrosive geologic agent today, has permitted his need for, and use of, raw mineral products virtually to exhaust his requirements for the aesthetics of environmental quality.

Earth scientists must provide the means and the forum necessary to express the greater need for mineral and fluid resources, to place the boundaries for utilizing these and provide the knowledge necessary for reclamation, reuse and restoration of disturbed lands.

Our forests, through wise and efficient management, are renewable within time limitations. Our air and water supplies are not diminished, but only rendered temporarily unusable due to our short sightedness. Not so our mineral resources; the supply is finite, but its wise utilization can extend its life until technology bridges the ultimate gaps by providing adequate substitutes. Demand and supply will upgrade our professional capabilities by taxing our ingenuity. Our ingenuity and efficient planning will yield bountiful harvests of usable byproducts and make economic wastes recoverable.

A less affluent society reaped the benefits of easy finds of the primitive world, and who can say this was not proper. A young, struggling republic seemed to have been nurtured by Mother Nature herself as she readily gave up her riches to those so needy. Time, demand, supply and aesthetic values have now far exceeded man's capabilities to balance a demand for a supply of raw resources with an opposing demand for a clean environment and stable ecology, and it now becomes our responsibility to bridge this gap.

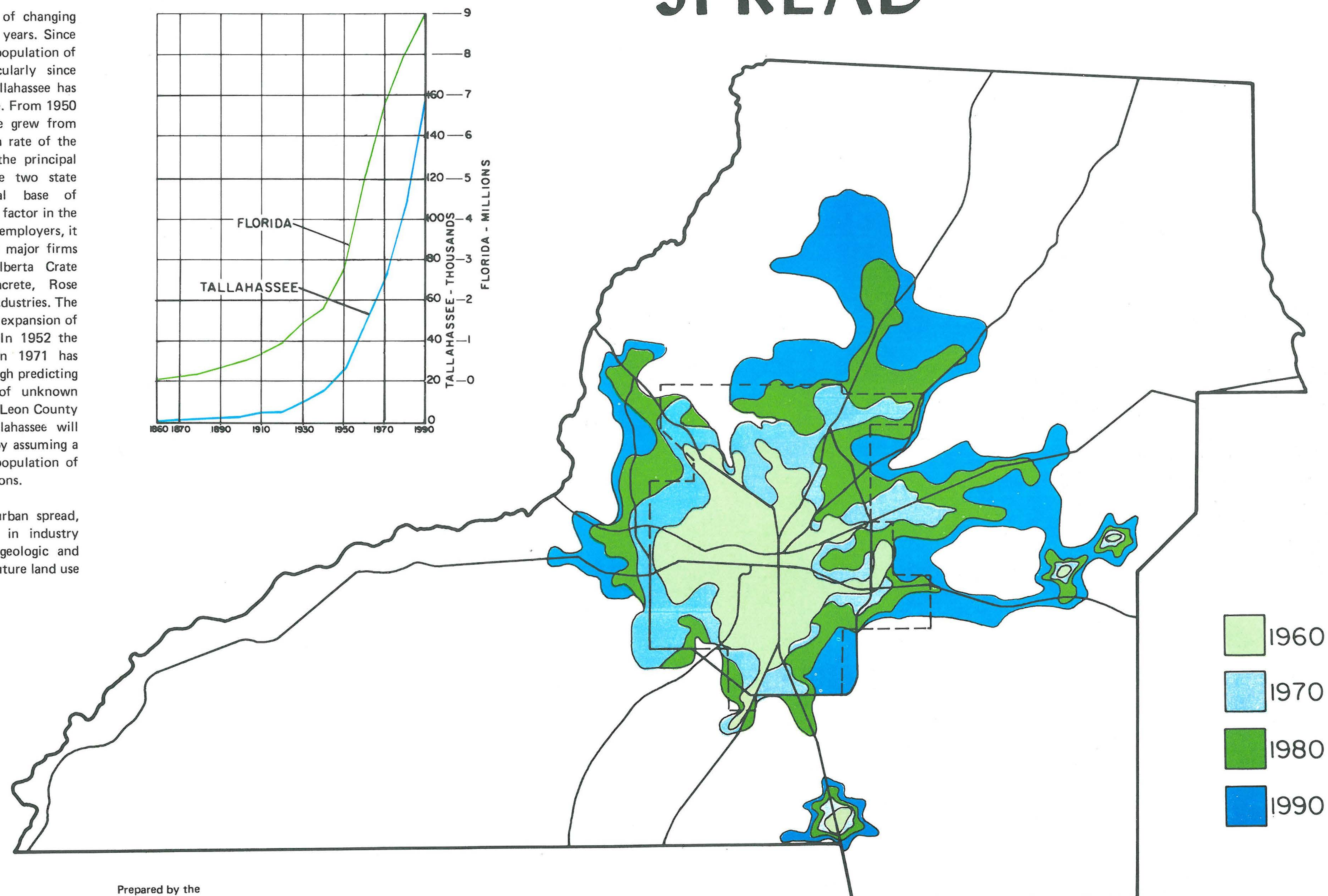
The basic framework for obtaining this balance must be: (1) complete and systematic recovery of the known mineral resources; (2) multiple simultaneous and/or sequential land use where possible; (3) adequate planning with consideration for all resources, now or here-in-after affected; (4) intensive and extensive exploratory work to uncover new reserves; (5) design of plants, mines, etc., with a smaller profit margin in mind and vastly extended production life; and finally, (6) an honest awareness of the total effect of our endeavors on our environment.

These are not insurmountable tasks nor do they violate the faith that nurtured this nation, they are simple challenges which spur us to new heights of achievement.

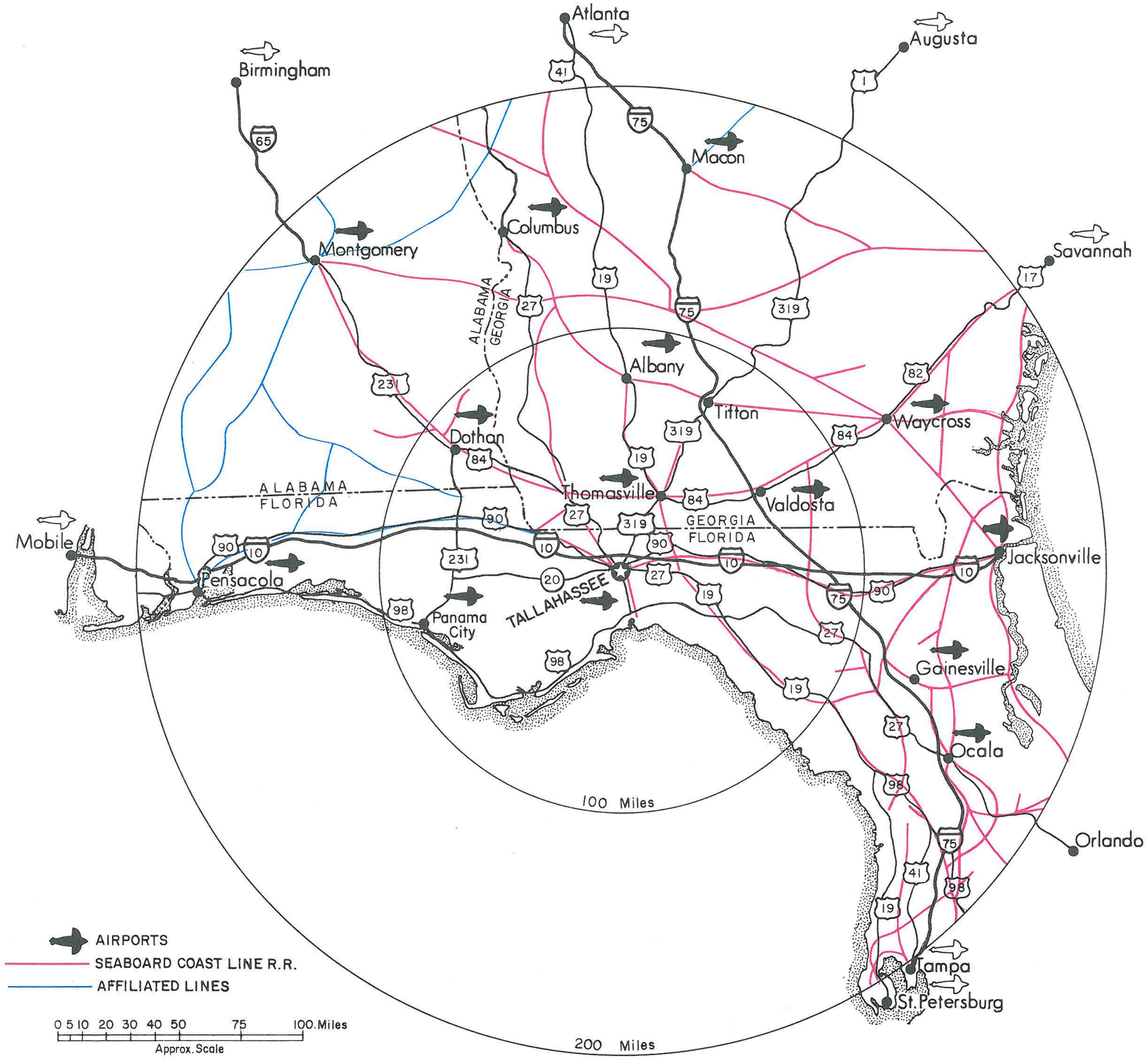
POPULATION INCREASE AND URBAN SPREAD

Tallahassee has been in the process of changing from a rural to an urban area for 150 years. Since 1930 there has been a rapid rise in the population of Leon County and Tallahassee, particularly since World War II. The growth trend of Tallahassee has kept pace with that of Florida as a whole. From 1950 to 1970 the population of Tallahassee grew from 27,237 to 71,763 persons. The growth rate of the area is influenced by the growth of the principal employers; state government and the two state universities. Although the industrial base of Tallahassee has not been as significant a factor in the growth rate as has that of the principal employers, it is nevertheless important. Some of the major firms include Vindale Corporation, the Elberta Crate Company, Southern Prestressed Concrete, Rose Printing Company, and Mobile Home Industries. The growth in population is reflected by the expansion of the incorporated area of Tallahassee. In 1952 the existing area was 5.80 miles and in 1971 has expanded to 26.14 square miles. Although predicting future population is risky because of unknown variables the planners of the Tallahassee-Leon County Planning Department predict that Tallahassee will continue to grow. They estimate that by assuming a 3.74% annual increase the projected population of Tallahassee in 1990 will be 160,600 persons.

The rapid increase in population, urban spread, coupled with the expected increase in industry creates the need for environmental geologic and hydrologic data that can be applied to future land use planning.



Prepared by the
Tallahassee-Leon County Planning Department



TRANSPORTATION

The City of Tallahassee is located in southeastern United States in the northwestern portion of Florida which is commonly referred to as the "big bend" area. It is served by an excellent combination of rail, land and air transportation which places it in the position of being able to serve not only other areas of Florida, but many parts of the South.

The rapid population growth of Tallahassee over the past two decades has increased the need for better facilities to transport people and the commercial traffic needed to support the populace. Consequently, in keeping with the growth trend, the transportation facilities of the area are continually studied and improved to meet this need.

AIRLINES

The Tallahassee Municipal Airport, dedicated on April 23, 1961 and located southwest of Tallahassee, provides the necessary modern facilities for handling air passengers and air freight. It has a 6,070-foot and a 4,100-foot runway capable of handling most types of aircraft.

Tallahassee is served by four airlines: Eastern, National, Shawnee, and Southern. The Eastern Airlines has daily flights to Atlanta, Georgia in the north, Orlando, Tampa-St. Petersburg, Sarasota-Bradenton, Ft. Myers, Cocoa-Titusville, West Palm Beach and Miami in the south with connecting flights to 107 cities in six countries. The National Airlines, with headquarters in Miami, provides daily flights to Jacksonville to the east and to Panama City, Pensacola, Mobile, New Orleans to the west. Shawnee and Southern Airlines provide flights throughout much of the state. Charter carriers that operate in and out of Tallahassee also provide additional facilities for air transportation.

HIGHWAYS

Highways are significant in the development of an area, and the Tallahassee area is presently served with a network of excellent highways. U.S. Highways 90 and 27 crosses Leon County from northwest to southeast and U.S. Highway 319 traverses the county from north to south. All of these highways place Tallahassee on transcontinental routes that bring many visitors to Florida. They also serve as important routes for commercial traffic entering the area. Interstate 10, a transcontinental superhighway, upon completion, will link Tallahassee with cities as far west as Los Angeles, California. State Highway 20 serves as a link with other Florida cities to west and carries traffic into Tallahassee from these areas. The many paved roads and unpaved county roads provide excellent transportation facilities within the county.

RAILROADS

Railroads have always been vital to development of an area and the completion of the Pensacola and Georgia Railroad from Lake City to Tallahassee in 1860 contributed greatly to the early growth and development of the Tallahassee area.

Presently the City of Tallahassee is served by the Seaboard Coastline Railroad. The railroad forms an important connecting link in freight service northward into Columbus, Georgia, eastward into Jacksonville, westward into Pensacola, Mobile, Alabama, and New Orleans, Louisiana. Rail freight from Tallahassee reaches Jacksonville, a major sea port, and Pensacola, another port with shipping facilities, in two days.

Comparative rates for shipping one ton of freight are given in the following table:

TYPE OF CARRIER	AVERAGE COST
Air Freight	$130.00
Rail Freight (rock products)	2.15
Motor Freight	10.25

TOPOGRAPHY

TOPOGRAPHY AND MAN

Topography can be defined as "the shape of the land surface". The effect of topography on the life and development of man, as well as that of lower forms of life, has been great. The existence and position of mountains, rivers, swamps, and oceans have formed natural boundaries within which man has had to develop. Settlement sites were selected on the basis of the availability of water, area suitable for agriculture, and defensability of the settlement against intruders . . . . all intimately affected by topography.

Even today we must consider topography in planning for cultural development. The choice of a farm site, the route of a road, the layout of an airport runway, the location of a dam, the selection of a recreation area . . . . the topography must be considered in the planning of such projects. The ignorance of topographic effects has, in the past, led to disasterous results due to flooding, erosion and deposition, subsidence and slides.

TOPOGRAPHIC MAPS

A *map* is a model of a geographic area, drawn to scale, showing certain selected natural and man-made features by a variety of symbols. The *map scale* is an expression of the ratio of a distance on the map to a distance on the actual ground surface (for example 1:24,000). Scale may also be expressed in graphic form as a horizontal bar marked off in feet or miles. The actual distance between two points on the map can be determined by comparison of the map distance to the graphic scale.

A *topographic map* differs from the common geographic map in that its purpose is to show the shape of the land surface: the topography. This type of map shows the position and form of hills, valleys, and other topographic features. Furthermore, the elevation with respect to sea level and the amount of surface slope can be determined at any point on the map.

The problem of demonstrating a three-dimensional feature (the topography) on a two-dimensional sheet of paper is solved by the use of contour lines. A *contour line* is an imaginary line that connects points of equal elevation. The accompanying figure illustrates the relation of contour lines to the features they describe. These lines are formed by the intersection of the land surface by imaginary, horizontal planes at given elevations. Imagine a set of transparent, horizontal planes, beginning at sea level (zero elevation), each one 20 feet higher than the one below. Further, imagine a hill such as the one on the right in the figure, and that these planes are capable of slicing right through the hill at their respective elevations. The marks left on the land surface by these intersections would coincide with the contour lines shown on the topographic map just below the sketch of the hill.

The *contour interval* is the vertical difference between two adjacent contour lines (i.e., between the horizontal planes they represent). In the example above, the contour interval was 20 feet.

A few of the characteristics of contour lines are worth noting. Contour lines on a topographic map never cross each other and coincide only when vertical cliffs are encountered. The "V" formed when a contour line crosses a stream valley always points upstream. All contour lines "close"; that is, if one could walk along a given contour line, he would eventually end up at the point from which he started.

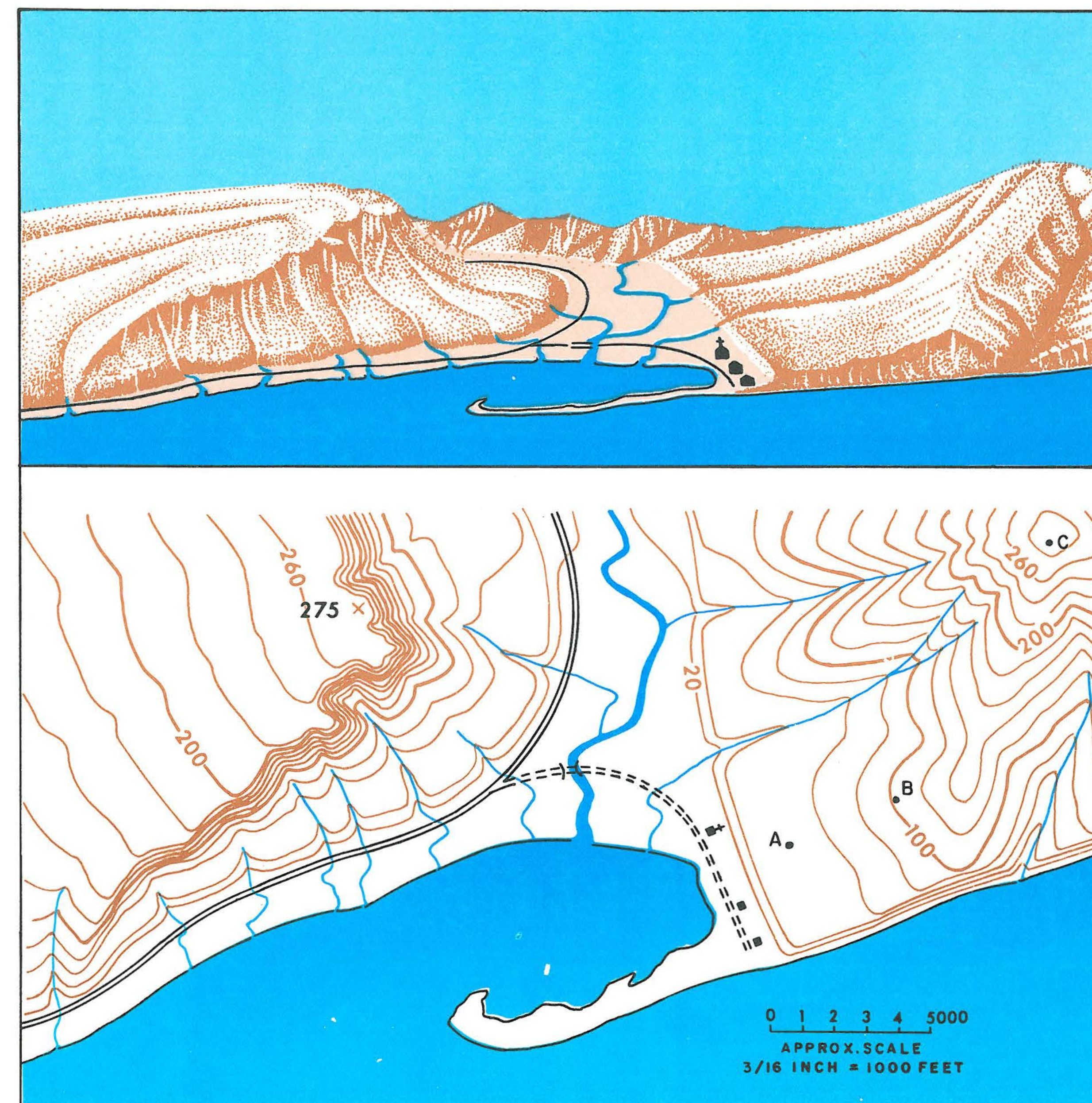
The elevation at any point on the map is determined by noting the values of the two adjacent contour lines and interpolating the elevation of the point based on the relative distances from it to the adjacent contour lines. For example, point A on the sample map falls half-way between the 40 and 60 foot contour lines, therefore, its elevation would be 50 feet. Point B is 1/10 the distance from the 100 foot to the 120 foot contour line, therefore its elevation is 102 feet. Finally, point C is on top of the hill enclosed by the 280 foot contour line. The next higher line would have been 300 feet, but the hill doesn't reach that high. In this instance, the elevation of the point can only be estimated . . . . 290 feet would be a reasonable estimate. Note that the top of the hill on the left has actually been surveyed in and is given as 275 feet at the point marked "X".

Slope is defined as the ratio of vertical to horizontal distance and can be expressed as a percentage. For example, if we climb in elevation one foot in traveling a horizontal distance of 100 feet, we have traveled up a slope of 1:100 or 1 percent. If we climb 20 feet vertically in 100 feet horizontally, we have a slope of 20:100 (or 1:5) or 20 percent. The slope can be determined from the topographic map by dividing the contour interval by the horizontal distance between two contour lines. For example, the slope through point B is determined as follows:

(1) the contour interval is 20 feet,
(2) the minimum distance from the 100 foot line to the 120 foot line through point B is about 1,000 feet (from the graphic scale),
(3) the slope is $\frac{20}{1,000}$ = 2:100 or 2 percent.

Note that gentle slopes are indicated by widely-spaced contour lines and steep slopes by closely-spaced contour lines.

*Modified from U.S. Geological Survey, 1969.



TOPOGRAPHY OF TALLAHASSEE AREA

The geographic location of the Tallahassee Area is shown on the accompanying index map and includes four 7.5′ topographic quadrangles in central Leon County, north-central Florida:

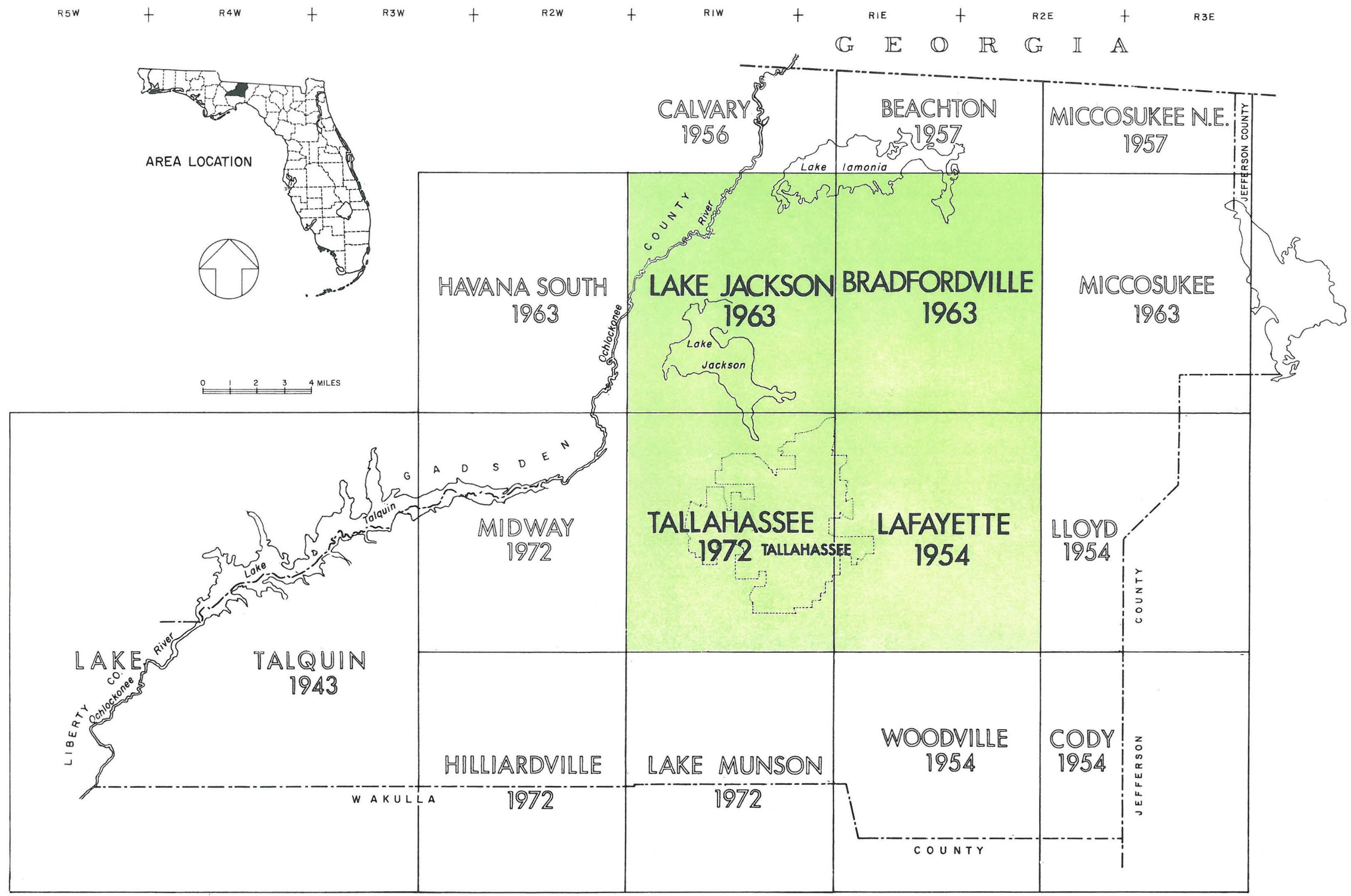
1. Lake Jackson Quadrangle (1963)
2. Bradfordville Quadrangle (1963)
3. Tallahassee Quadrangle (1972)
4. Lafayette Quadrangle (1954)

This includes an area of approximately 240 square miles. The elevations (above sea level) range from about 250 feet in the north to less than 50 feet in the south.

Except for the extreme southeastern portion, the Tallahassee Area falls within the greater topographic province called the Tallahassee Hills, which is an east-west trending strip extending about 20 miles southward from the Georgia line, westward to the Apalachicola River, and eastward to the Withlacoochee River. This topographic province generally consists of rolling hills with gentle-to-moderate slopes and hilltop elevations of 200 to 300 feet. Local relief (i.e., the height of hills above adjacent valleys) ranges from 100 to 150 feet.

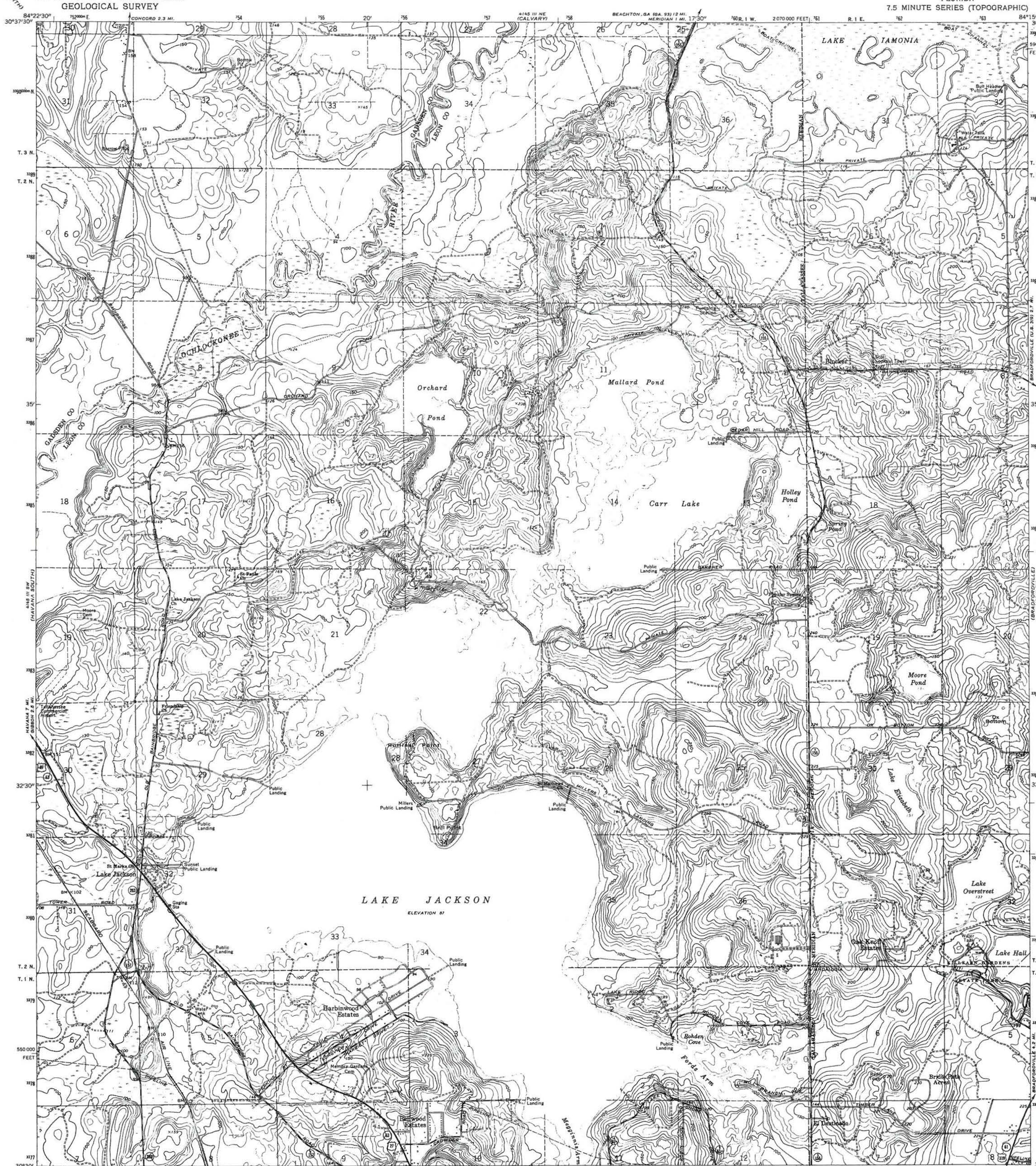
The hills of the Tallahassee Area are composed generally of a mixture of sand, silt, and clay several tens of feet thick overlying limestone. The mixture of fine with coarse grained material commonly results in a relatively impermeable soil that, locally, promotes surface drainage of rainwater. Because of the permeability of the underlying bedrock, however, this surface drainage is soon diverted to the subsurface in the valleys via the many sinkholes occurring in the region. The only permanent surface stream in the Area is the Ochlockonee River in the northwest portion.

The southern one-third of the Tallahassee Quadrangle and the extreme southwestern corner of the Lafayette Quadrangle display flatter terrain and lower elevations than that to the north described above. This area belongs to the topographic province called the Coastal Lowlands. This will be described in greater detail under the section on the Tallahassee Quadrangle.



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

LAKE JACKSON QUADRANGLE
FLORIDA
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1952 and by planetable surveys 1963

Polyconic projection. 1927 North American datum
10,000-foot grid based on Florida coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks,
zone 16, shown in blue

Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked

UTM GRID AND 1963 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

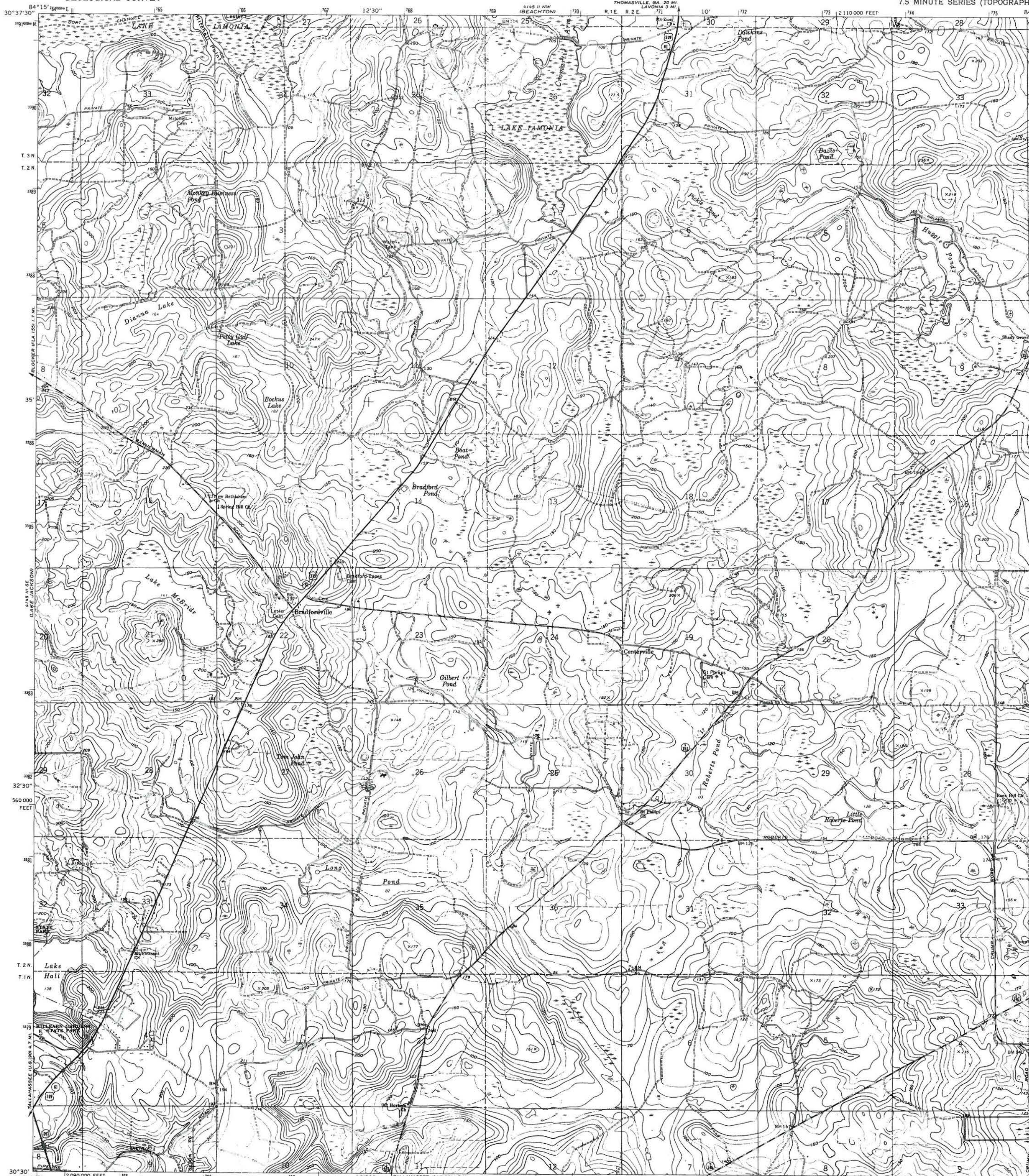
QUADRANGLE LOCATION

ROAD CLASSIFICATION
Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
U. S. Route — State Route

LAKE JACKSON, FLA.
N3030—W8415/7.5
1963
AMS 4145 III SE—SERIES V847

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BRADFORDVILLE QUADRANGLE
FLORIDA–LEON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



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BRADFORDVILLE, FLA.
N3030—W8407.5/7.5
1963
AMS 4145 II SW—SERIES V847

TOPOGRAPHIC MAPS OF THE TALLAHASSEE AREA

Brief descriptions of each of the four topographic quadrangles are given below. More detailed information regarding topography, geology, and additional references can be found in Florida Geological Survey Bulletin No. 47 (1966).

The accompanying maps are photographic reductions of the original 1:24,000-scale topographic maps prepared by the U.S. Geological Survey, Topographic Division, in cooperation with the State of Florida.

LAKE JACKSON QUADRANGLE (1963)

As implied by the name, this quadrangle is dominated by Lake Jackson and its northerly extensions Carr Lake and Mallard Pond. This broad, shallow lake responds actively to rainfall variation. It was essentially dry as recently as 1957 following three successive years of below normal rainfall and reached an all-time high in 1966 following three years of above normal rainfall. Most of the drainage in this area is into Lake Jackson or its tributaries.

Because of the low permeability of the clayey soils occurring in the area, slopes drain by surface runoff. The valley bottoms generally connect with subsurface drainageways allowing the surface water to eventually enter the ground water system. Hilltop elevations in this quadrangle range from 150 to 250 feet with a subtle regional slope to the west. Hillslopes are gentle-to-moderate and local relief is 100 to 150 feet. The drainage in the northwest past of the quadrangle is into the Ochlockonee River, the only permanent surface stream in the area.

BRADFORDVILLE QUADRANGLE (1963)

The topography of the Bradfordville quadrangle consists of rolling hills with gentle-to-moderate slopes. Hilltop elevations range from 150 to 200 feet and valley bottoms about 70 to 90 feet. The major surface drainage lines are to the north into Lake Iamonia and south into a northerly tributary of Lake Lafayette (located in the Lafayette Quadrangle to the south). The divide between these two drainage systems runs east-west across the central part of the map. The clayey soil forming the slopes commonly promotes local surface runoff of rainwater. However, subsurface drainage through the underlying permeable limestones dominates most of the time.

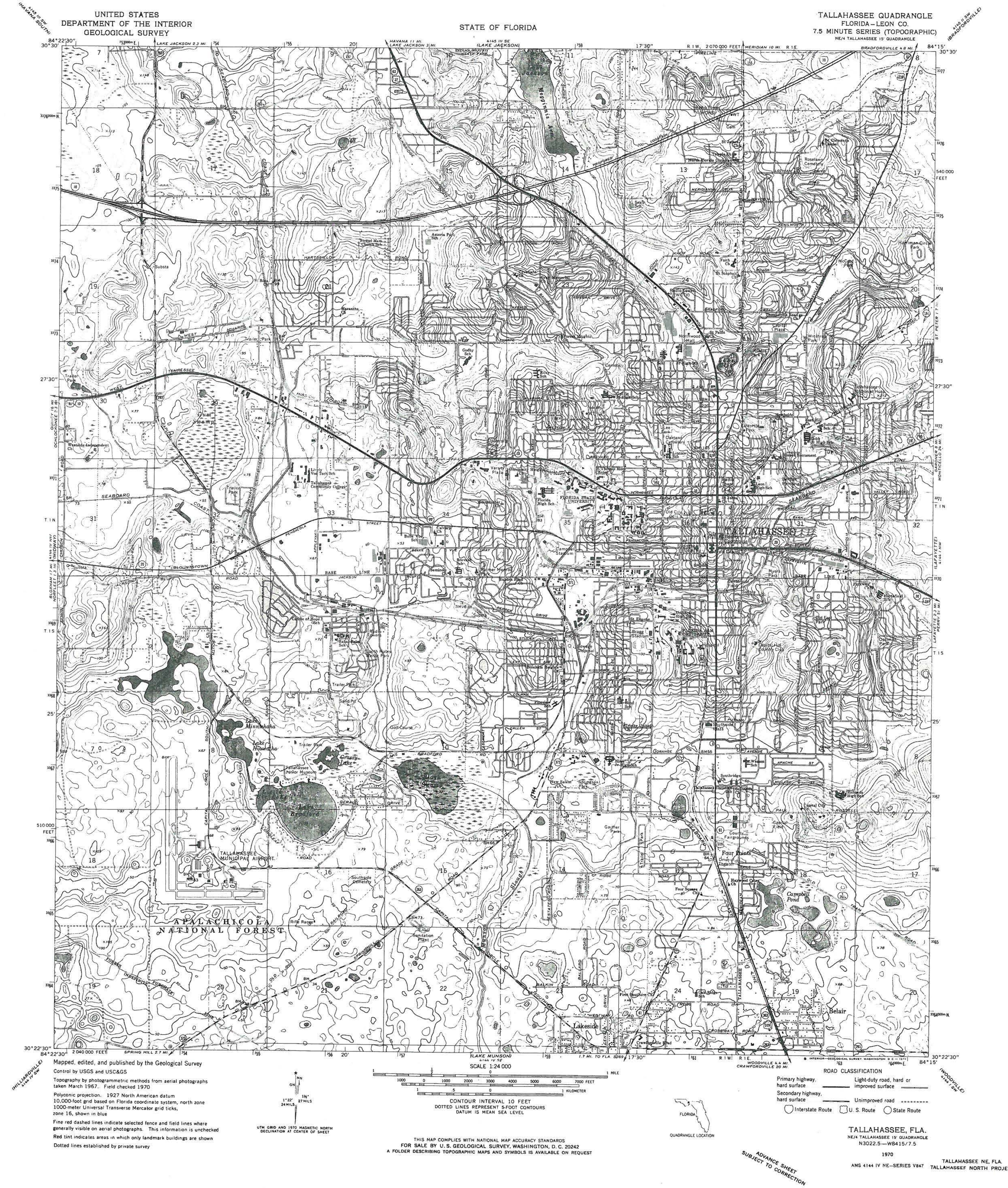
TALLAHASSEE QUADRANGLE (1970)

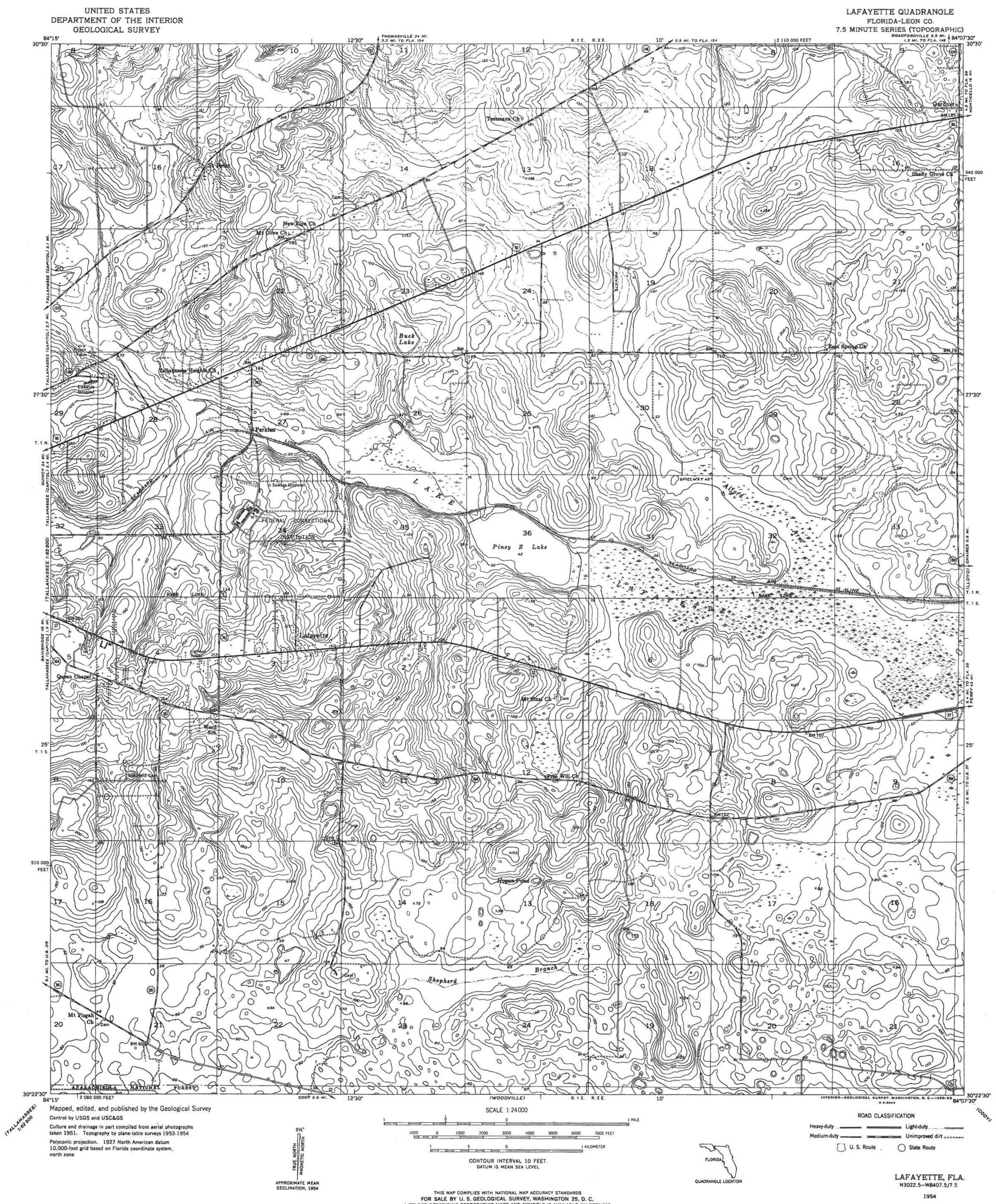
The Tallahassee Quadrangle can be divided into two parts based on the character of the topography. The northern two-thirds of the quadrangle falls within the Tallahassee Hills topographic province and the southern one-third lies in the Coastal Lowlands topographic province.

The northern portion consists of rolling hills with gentle-to-moderate slopes. Hilltop elevations range from 150 to 200 feet and valley bottom elevations are about 50 feet.

The soils are primarily clayey, several tens of feet thick, and overlie permeable limestone. The clayey soils promote local surface drainage of hillslopes which generally becomes subsurface through the permeable valley bottoms.

The southern part of the Tallahassee Quadrangle lies at a significantly lower level and the terrain is much gentler, though not flat. Hilltop elevations are about 70 to 80 feet and valley bottoms are at about 30 feet. A distinct escarpment separates this area, known as the Coastal Lowlands, from the Tallahassee Hills region to the north. The soils are generally sandy, which permits immediate infiltration of rainwater, thus surface runoff is minimal even in wet weather. The soil layer overlying limestone bedrock is thin, resulting in the frequent occurrence of small sinkholes caused by solution of the bedrock. These conditions cause the area to be well-drained.



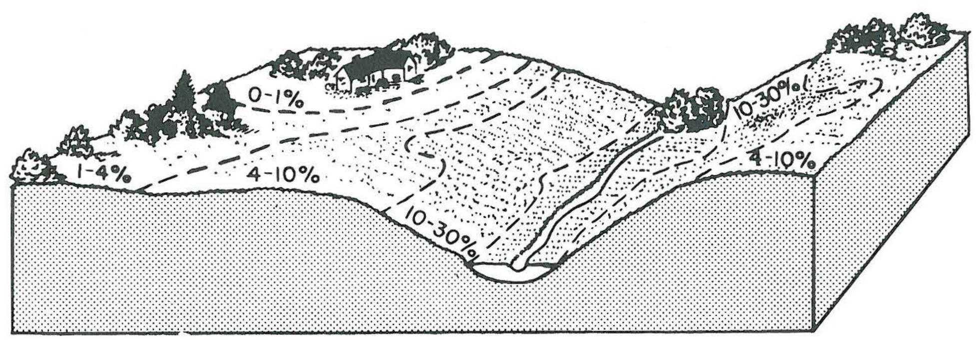


LAFAYETTE QUADRANGLE (1954)

The Lafayette Quadrangle falls within the Tallahassee Hills topographic province, except for the extreme southern part, which includes the escarpment leading down to the surface of the Coastal Lowlands province to the south. The upland area is divided into a north and south portion by the east-west trending Lake Lafayette, a headwater tributary of the St. Marks River, that is more swamp than lake. Most of the region drains into Lake Lafayette, except near the southern escarpment. Soils are clayey with drainage characteristics like those described to the north and west. Hilltop elevations range from 150 to 200 feet and valley bottoms are at about 40 to 50 feet. Local hillslopes are gentle-to-moderate, being steeper in the south due to the proximity to the escarpment and Coastal Lowlands.

SLOPES
TALLAHASSEE AREA

Relief of the area is characterized by the slopes of the land surface. Slopes can be expressed in several ways but all of them depend on the comparison of the vertical distance (difference in elevation between two points) to the horizontal distance (horizontal distance between two points). The slopes of the area covered in this report are expressed in per cent.

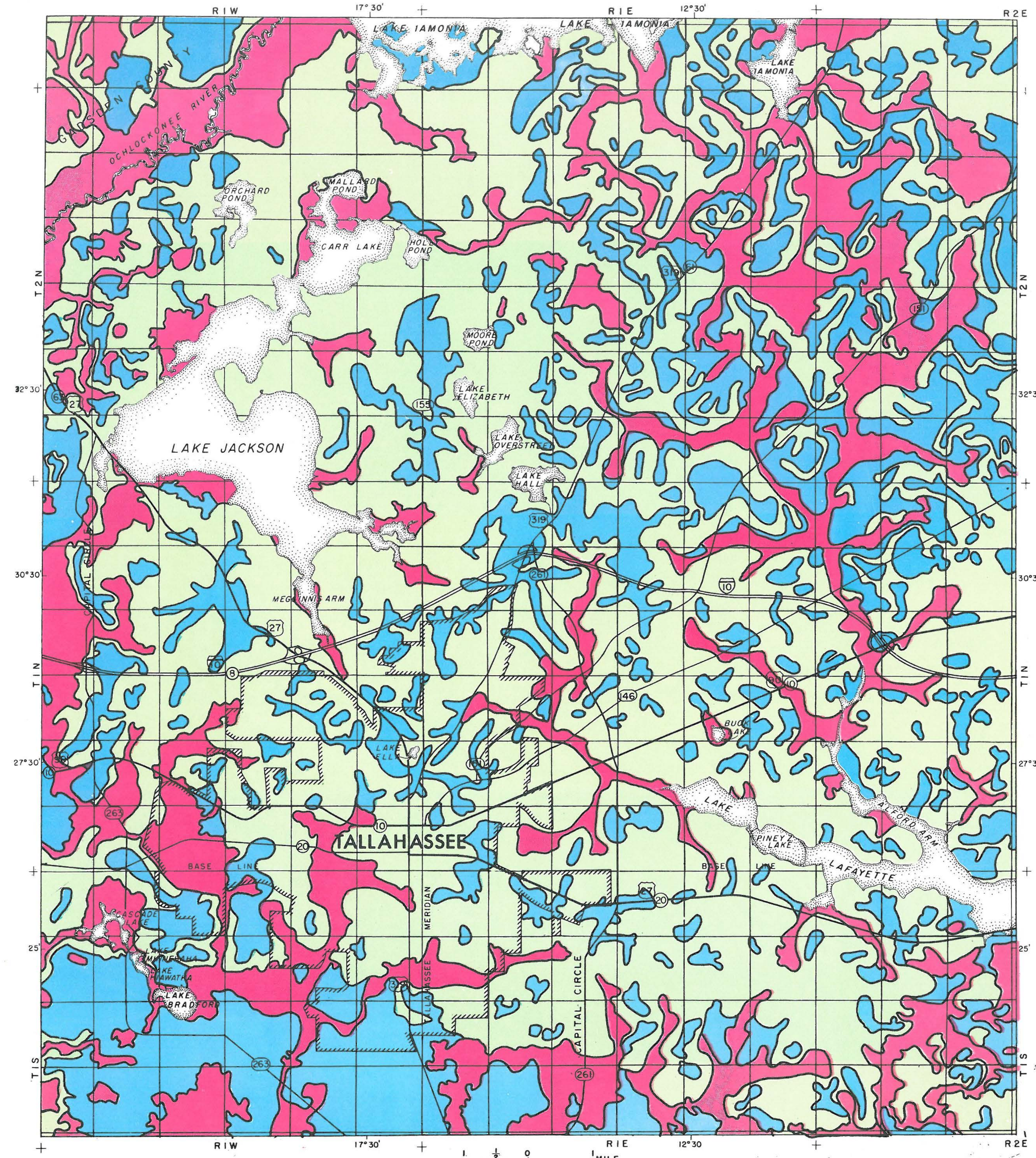


Modified from U.S. Soil Conservation Service, Bulletin No. 243.

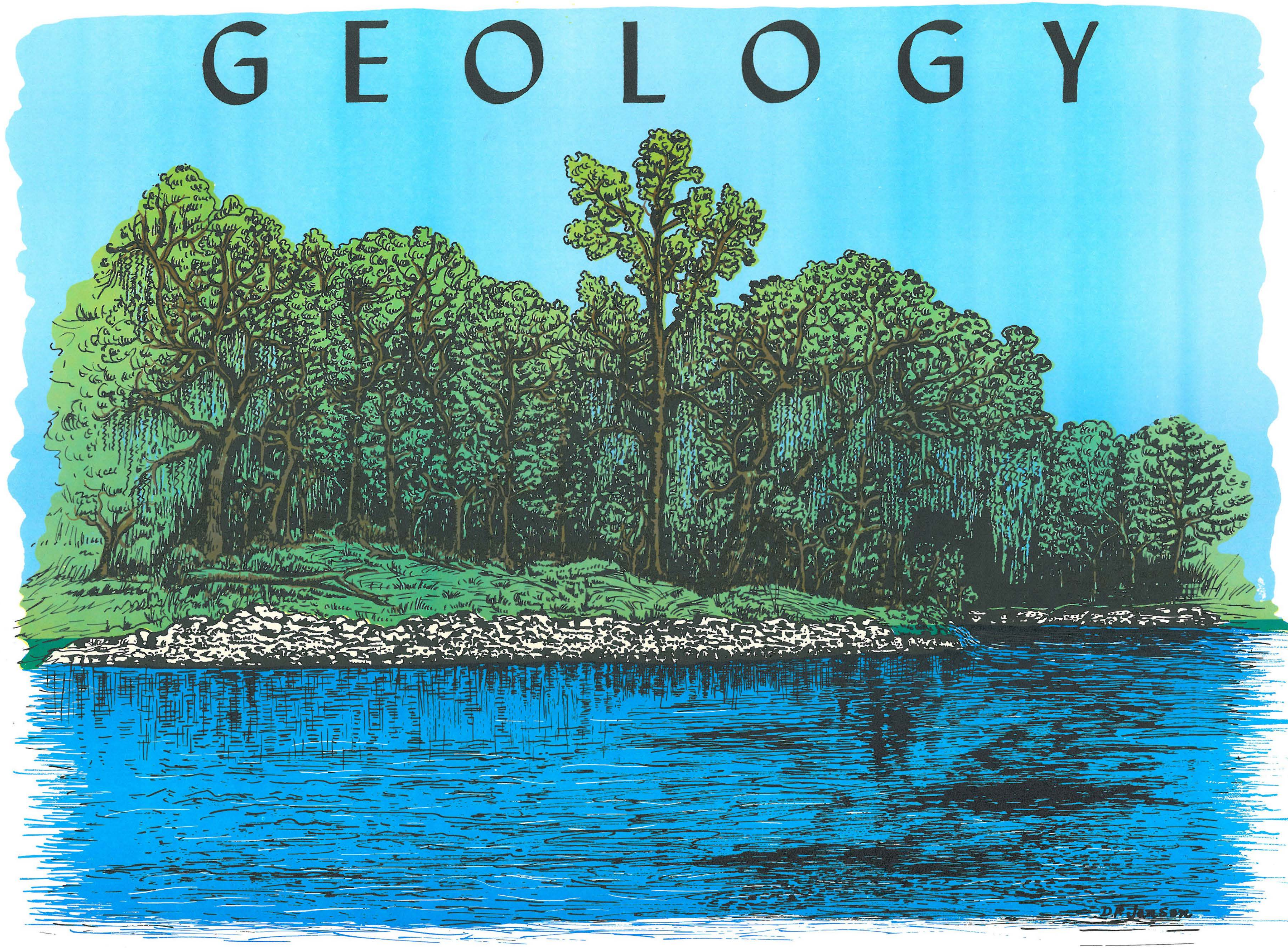
Slopes of less than one percent cover approximately 19.50 percent of the land surface. These areas are generally associated with streams and their flood plains. Land use in this area is somewhat restricted because of the possibility of periodic flooding.

About 25.00 percent of the area has slopes of one to four percent and represent the tops of hills or areas separating stream valleys from areas with steeper slopes. Generally these slopes impose no severe restraints to land use.

Slopes greater than four percent cover approximately 55.50 percent of the land surface. In this area gently rolling topography predominates and except for some areas along drainage ways where the slopes may exceed 10 to 15 percent restraints for land use imposed by slope should be at a minimum.



GEOLOGY



GENERAL GEOLOGY

This area exhibits some of the greatest relief found in Florida, up to 120 feet. It is part of a larger area known as the Tallahassee Hills.

The surface is formed on an ancient Miocene-Pliocene delta plain that has been dissected by streams and further modified by dissolution of sub-surface limestones. The highest hills are comparatively flat-topped with elevations of about 260 feet above sea level. The slopes and crests of the hills give the overall appearance of mature topography, resulting from a long period of weathering.

The hills are composed of a heterogeneous mixture of yellowish orange clays, silts and sands that are weakly cemented. In roadcuts and excavations, these earth materials resist erosion for years and may be seen standing in nearly vertical cuts.

Within the report area, there is one large lake basin (Lake Jackson Basin) and portions of two others (Lake Iamonia and Lake Lafayette); besides these, there are numerous smaller lake basins.

The most striking comparative feature of the lakes is that the larger ones are shallow, whereas the smaller ones are deep. An explanation of this is found in the geologic literature of Florida. In each case, the underlying limestone has been dissolved away with subsequent lowering of the land surface to form a basin.

Underlying the surface sands and clays is a thick sequence of essentially flat strata composed of limestones and dolomites.

The upper sands and silts are suitable for construction with little foundation preparation. However, where large structures are planned the subsurface must be investigated for the presence of clays and special foundation provisions made if clays are present. The underlying limestone section serves as an excellent aquifer, providing large quantities of pure water for municipal and industrial use.

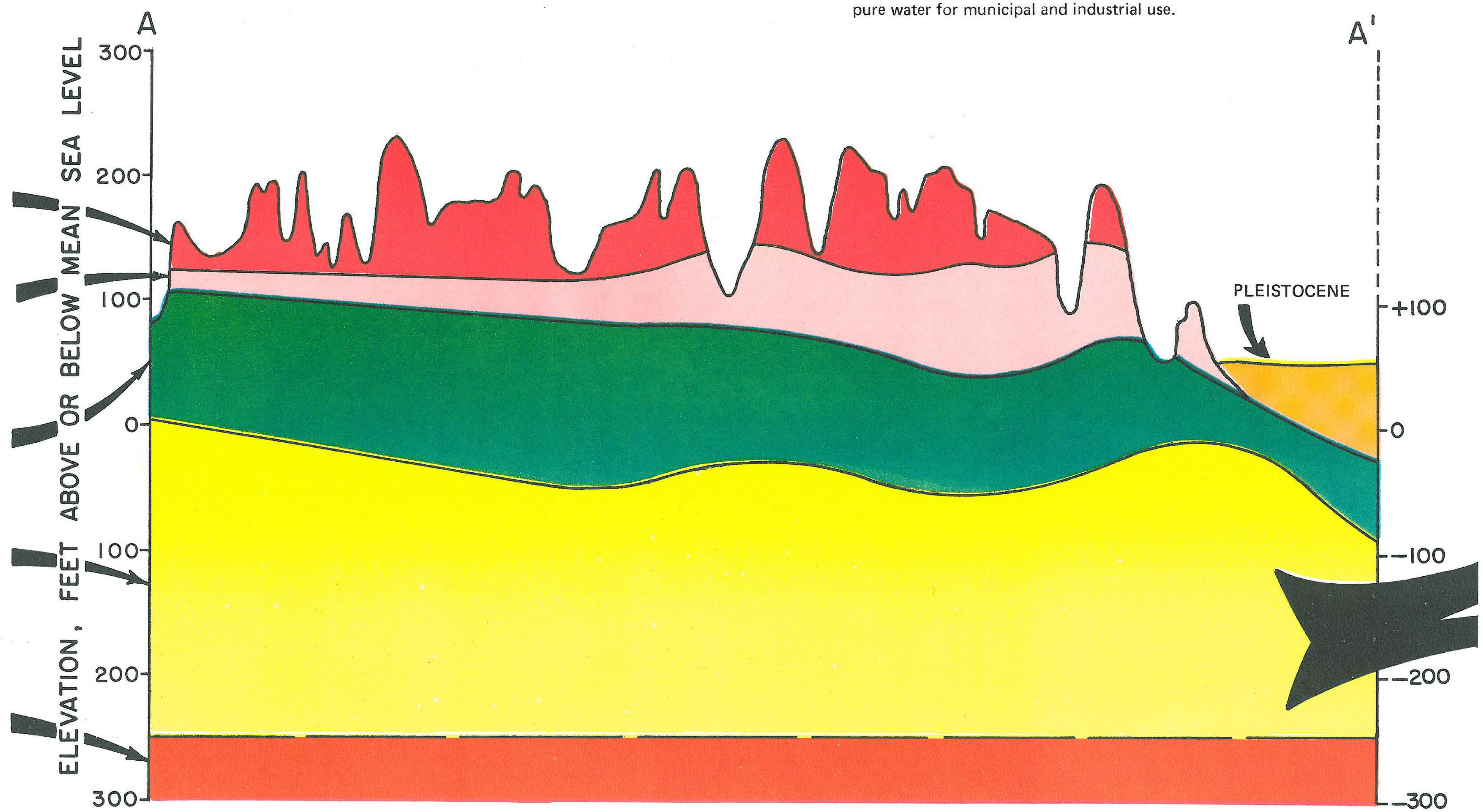
MICCOSUKEE FORMATION. The highest hills in this area are capped by the sands and clayey sands which comprise the Miccosukee.

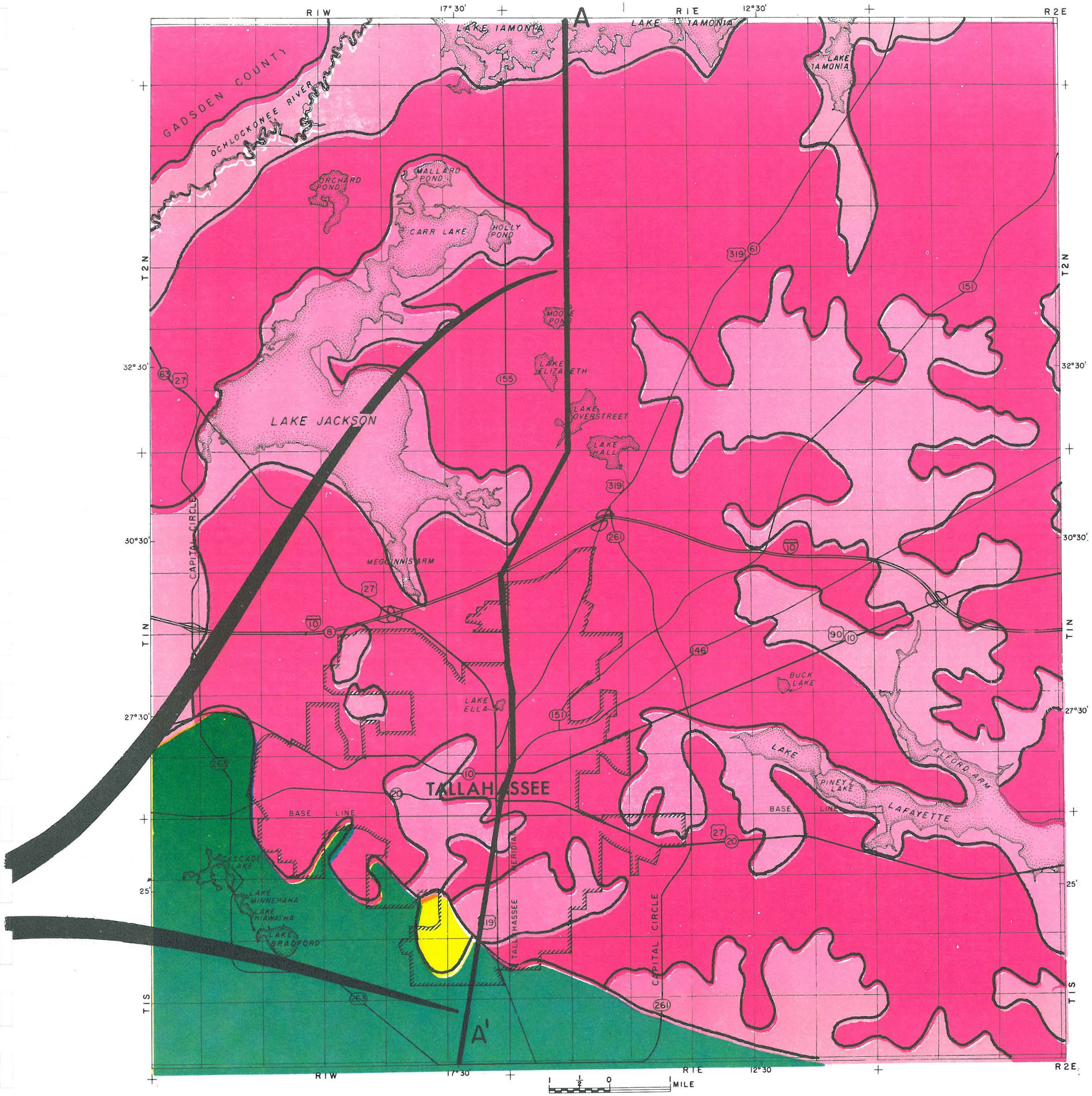
HAWTHORN FORMATION. Cropping out in areas where the Miccosukee has been removed through erosion are the sands and clays of the Hawthorn, which serve as a confining sequence on top of the main artesian aquifer.

ST. MARKS FORMATION. Forms the main sequence of beds within the principal artesian system which supplies large amounts of ground water in this area.

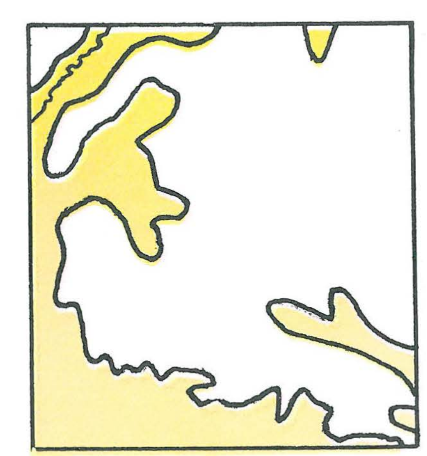
SUWANNEE LIMESTONE. Forms the main sequence of beds within the principal artesian system which supplies large amounts of ground water in this area.

CRYSTAL RIVER FORMATION. This and all underlying formations are present only in the subsurface strata of this area. The Crystal River is composed of a micro-fossiliferous, highly porous limestone, and very dense, crystalline dolomite. (Micro-fossils are the petrified skeletal remains of tiny organisms).





	The Miccosukee Formation is a heterogeneous series of interbedded and cross-bedded clays, silts, and sands and gravels of varying coarseness. These deposits cap the higher hills.
	The Hawthorn Formation is composed of medium grained quartz sand, phosphorite, silt, clay and impure limestone lenses near the base. The silt and clay fraction reduces the overall permeability of the formation and causes this unit to serve as a confining sequence on top of the principal artesian aquifer. The sand, silt, clay portion is locally used as a road base material.
	The St. Marks Formation is a sequence of carbonates with quartz sand and clay impurities that restrict its permeability. Though this formation is part of the upper sequence of the principal artesian aquifer, it is not an important water producing unit.
	The Suwannee Limestone is a very pale orange, abundantly microfossiliferous, granular, partially recrystallized limestone with a finely crystalline matrix. In this area it is entirely a subsurface formation that is porous and permeable. It is the principal aquifer from which most of the wells are supplied.

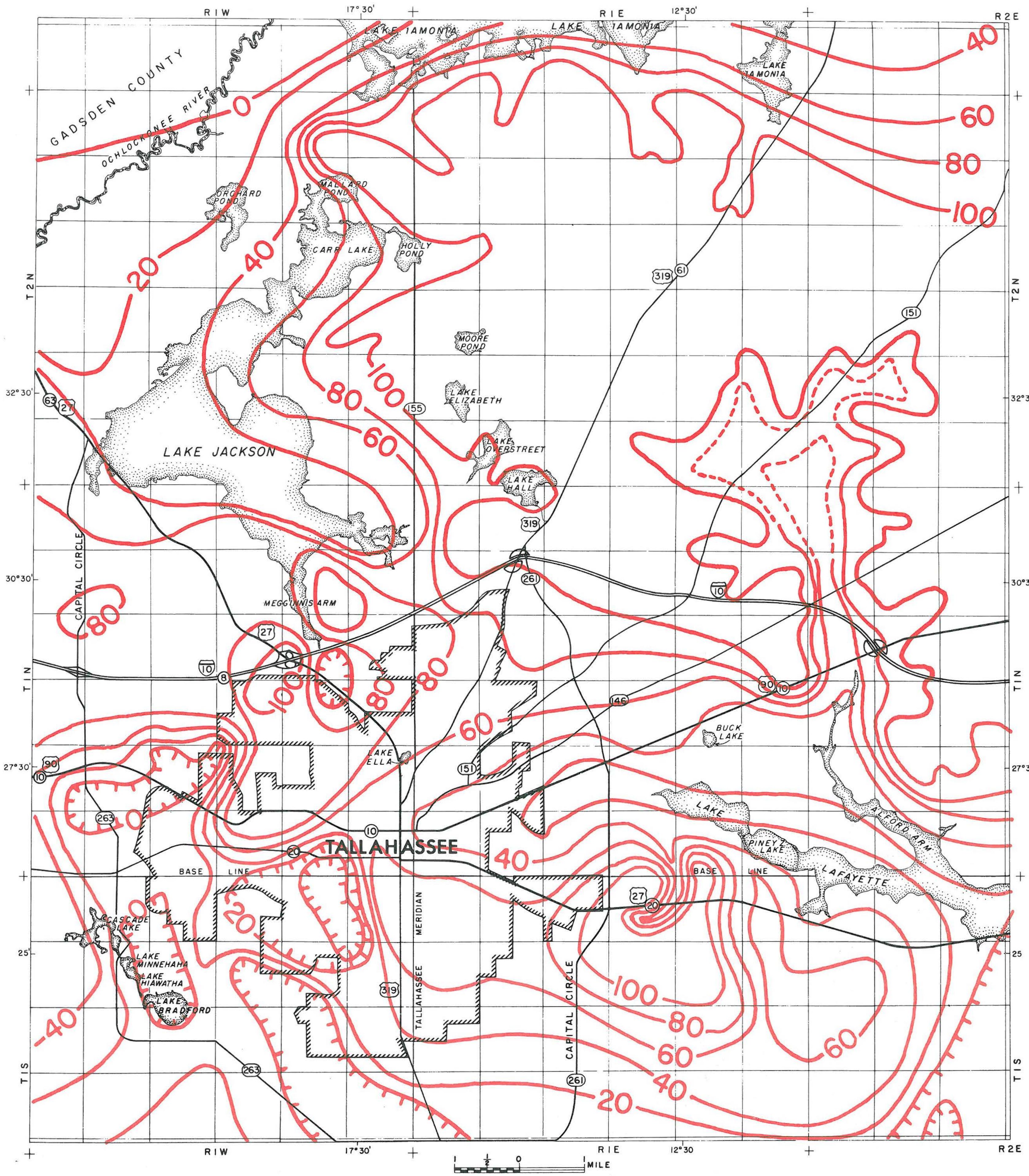


Pleistocene sands and clays covering formations shown on larger map are depicted in yellow.

GEOLOGIC STRUCTURE

Structural geology deals with the attitude of rock layers of which the Earth's crust is formed. An understanding of the geologic structure of an area is essential to the interpretation of surface geologic features, as well as the subsurface. Such understanding helps us delineate aquifers and beds known to contain mineral deposits.

Geologic strata in the Tallahassee area are uniformly flat lying, with southerly slopes of less than one degree. The accompanying structure map drawn on top of the bedrock reflects not only the slight regional slope of the earth material but the irregular surface caused by dissolution of the subsurface limestone by slightly acid circulating groundwater. A knowledge of the history of the solution cavities in an area is helpful in proper land use planning.



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Line showing top of the Lower Miocene, in feet, referred to mean sea level. Contour interval 20 feet.

SOIL ASSOCIATIONS

Soils are the weathered products of the rocks from which they develop. Their characteristics depend upon climate, parent material, organisms, topography and time. Soils are important in man's environment and should be carefully evaluated prior to construction of homes, highways, airports and dams.

According to the Soil Conservation Service soil series consist of two or more soil types that resemble each other in most of their physical characteristics, thickness and arrangement of soil layers. The U.S. Soil Conservation Service has grouped a number of soils into soil associations which are shown on the General Soil Maps of Leon and Gadsden counties. However, only the soil associations which fall within the limits of the area of investigation are shown on the accompanying soils map.

The Lakeland-Eustis soils consist of level to sloping, strongly acid, somewhat excessively drained soils with more than 42 inches sandy surface soil.

The Lakeland shallow-Eustis shallow-Norfolk soils are nearly level or gently sloping. They consist of strongly acid, somewhat excessively drained soils with more than 30 inches sandy surface soil, interspersed with areas of well drained soils with less than 30 inches to sandy clay loam subsoil.

The Norfolk-Ruston-Orangeburg soils are nearly level or gently sloping, well drained sandy soils with less than 30 inches to sandy clay loam subsoils. They are dissected by well formed stream pattern with short steeper slopes adjacent to stream.

The Magnolia-Faceville-Carnegie soils are well drained, nearly level, sloping, acid soils with loamy sand or sandy loam surface soils less than 30 inches thick and well aerated sandy clay loam or sandy clay subsoils, interspersed with lighter textured, well drained soils and narrow wet stream bottoms.

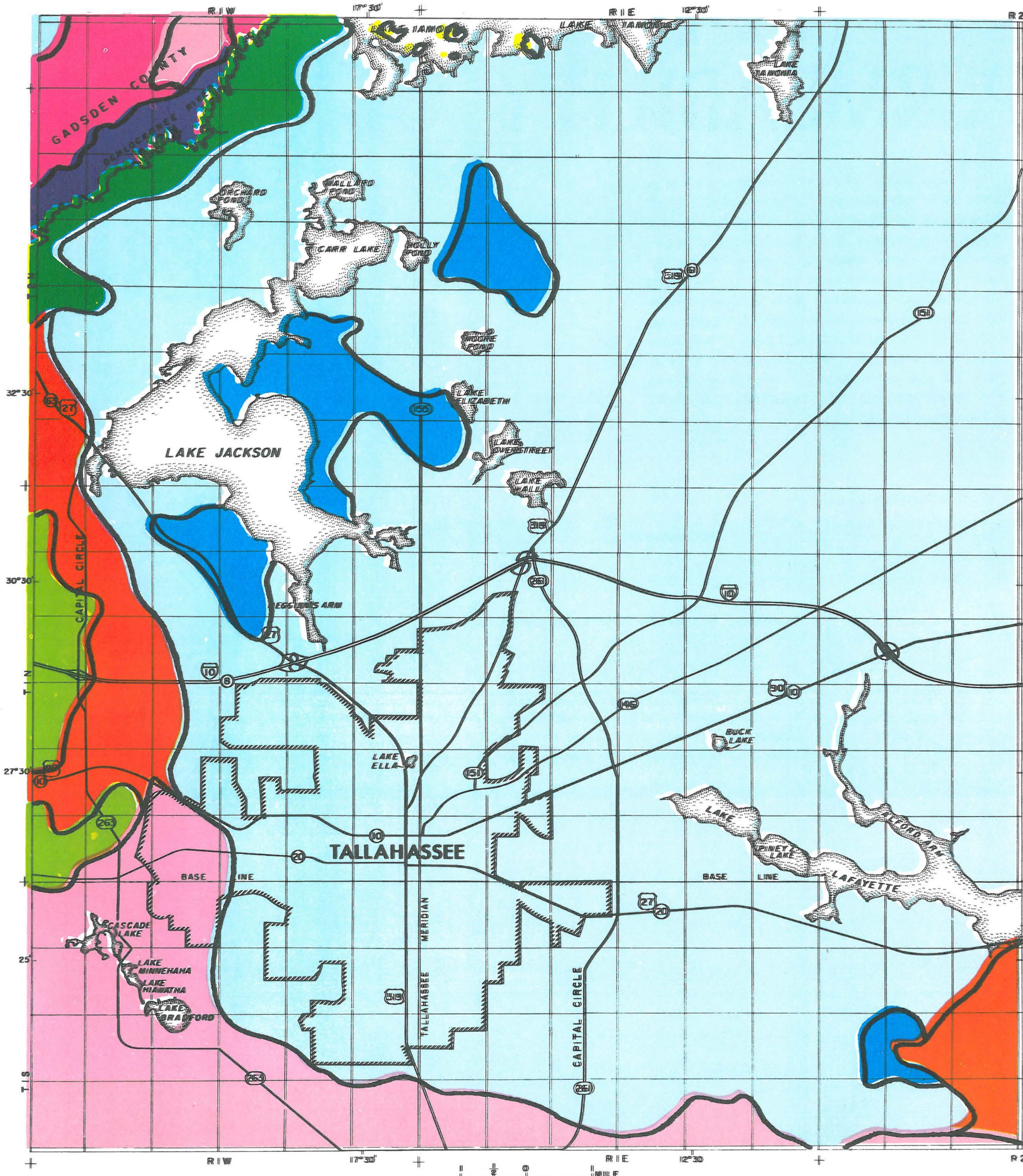
The Blanton-Klej soils are nearly level and gently sloping, moderately well drained, strongly acid soils with more than 30 inches sandy surface soil, interspersed with swampy areas.

Leaf-Izagora soils are well to poorly drained and occur on nearly level stream terraces. The surface layers are predominantly fine sand to very fine sandy loam.

Blanton-Klej-Plummer soils are nearly level moderately well and poorly drained. They contain sandy surface layers, more than 30 inches thick and are gently sloping.

The Barth soils are nearly level to gently sloping, moderately well to somewhat poorly drained river terrace soils with more than 30 inches sandy surface soil, interspersed with small well and poorly drained deep sands and small swampy areas.

The Plummer-Rutledge soils are nearly level. They consist of strongly acid, poorly to very poorly drained soils with more than 30 inches sandy surface soil, interspersed with occasional small moderately well and somewhat poorly drained areas and swamps.



SOIL PERMEABILITY

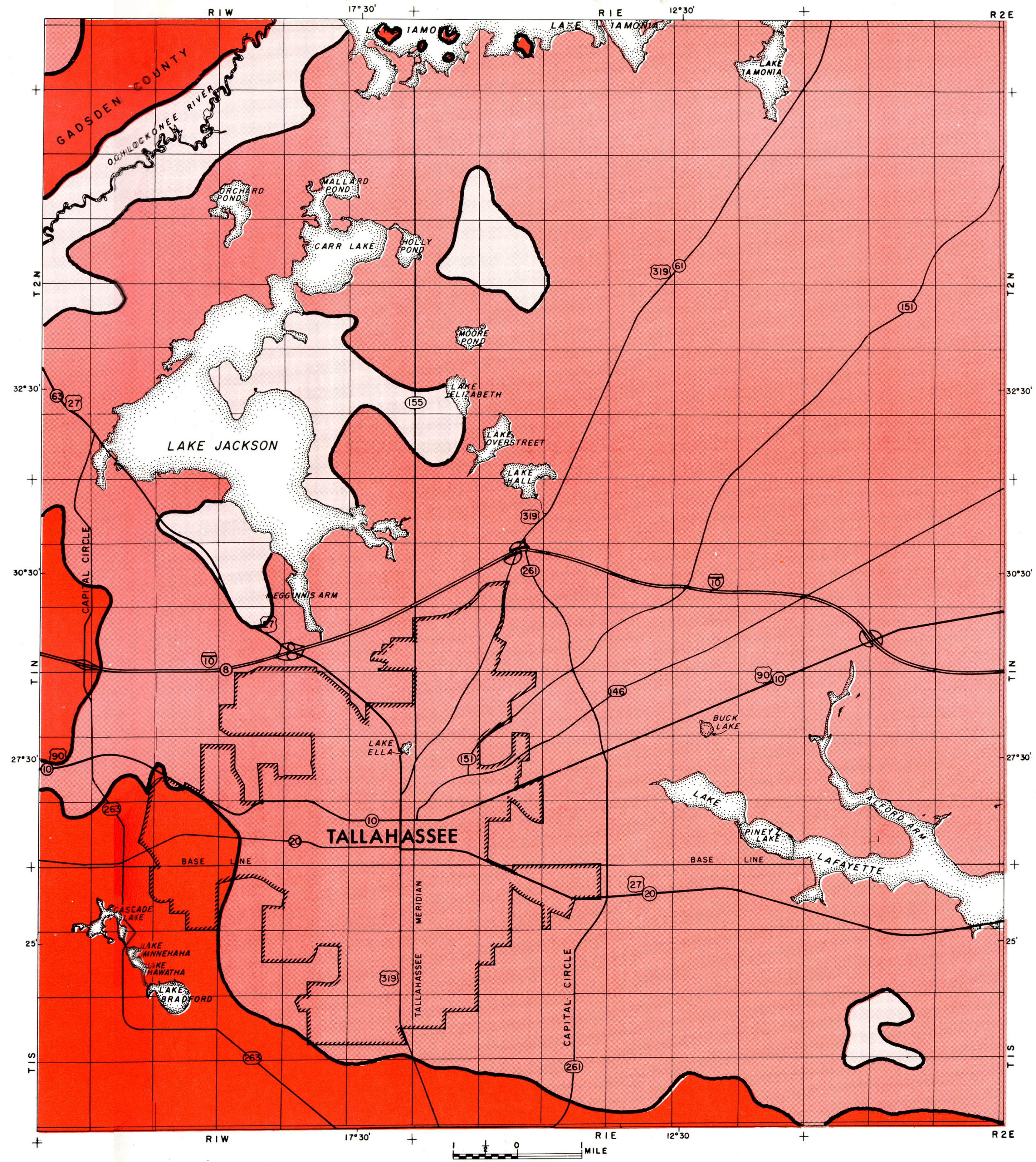
The permeability* of the soil influences the rate at which water will seep into the ground. The rate of infiltration is significantly influenced by the grain size of the earth material which is related to effective permeability. Soils consisting primarily of sand or gravel usually transmit water rapidly. On the other hand, water will move at a more moderate rate in soils containing some clay. In soils containing large amounts of clay that tend to swell the pore spaces are closed and water percolates very slowly through them. The rate at which water moves through the soil is important in locating sanitary landfills, septic tanks and construction sites.

Rapid. Soil has low water holding capacity and is well drained.

Moderate. Soil has high water holding capacity.

Moderately Slow. Soil has high water holding capacity.

*The soil permeabilities (infiltration rates) are based on data obtained from U.S. Soil Conservation Service.



SINKHOLES

In certain regions, solution becomes a dominant process in landform development resulting in a unique type of topography to which the name Karst has been applied. Most of the notable Karst areas are in regions where limestones underlie the surface although in some localities the rocks are dolomitic limestones or dolomites. Limestones are abundant in their distribution; hence it might be expected that Karst topography would also be widespread. In actuality, significant development of Karst features is restricted to a relatively small number of localities. Some of the important areas are in western Yugoslavia, southern France, southern Spain, Greece, northern Yucatan, Jamaica, northern Puerto Rico, western Cuba, southern Indiana, parts of Tennessee, Virginia, Kentucky and central Florida. In any of the above areas, numerous Karst features are found, but in none are all the possible individual forms to be seen, as they exhibit varying stages of Karst development and different types of geologic structures.

The geologic and hydrologic conditions necessary for the optimum development of Karst can be summarized as follows:

1) Soluble rock (limestone) at or near the surface.
2) The limestone should be dense, highly jointed, and thin bedded.
3) Major entrenched valleys exist in a position such that ground water can emerge into surface streams.
4) The region should have moderate to abundant rainfall.

Florida possesses the above-mentioned conditions only in part and consequently has only moderately well-developed Karst. Limestones are not highly indurated or dense and therefore possess some degree of mass permeability, however, Florida limestones are highly fractured and do possess moderate vertical differential permeability to concentrate water movement. If a rock is highly porous and permeable throughout, rainfall will be absorbed en masse and move through the whole of the rock resulting in no differential solution.

Florida also does not have major entrenched valleys into which ground water can emerge and drain off; however, the artesian aquifer accomplishes a similar result. In this case water entering the system moves down gradient discharging through springs or eventually into the Atlantic Ocean or Gulf of Mexico. The rate of movement in this system is very slow and this decreases the amount of solution taking place.

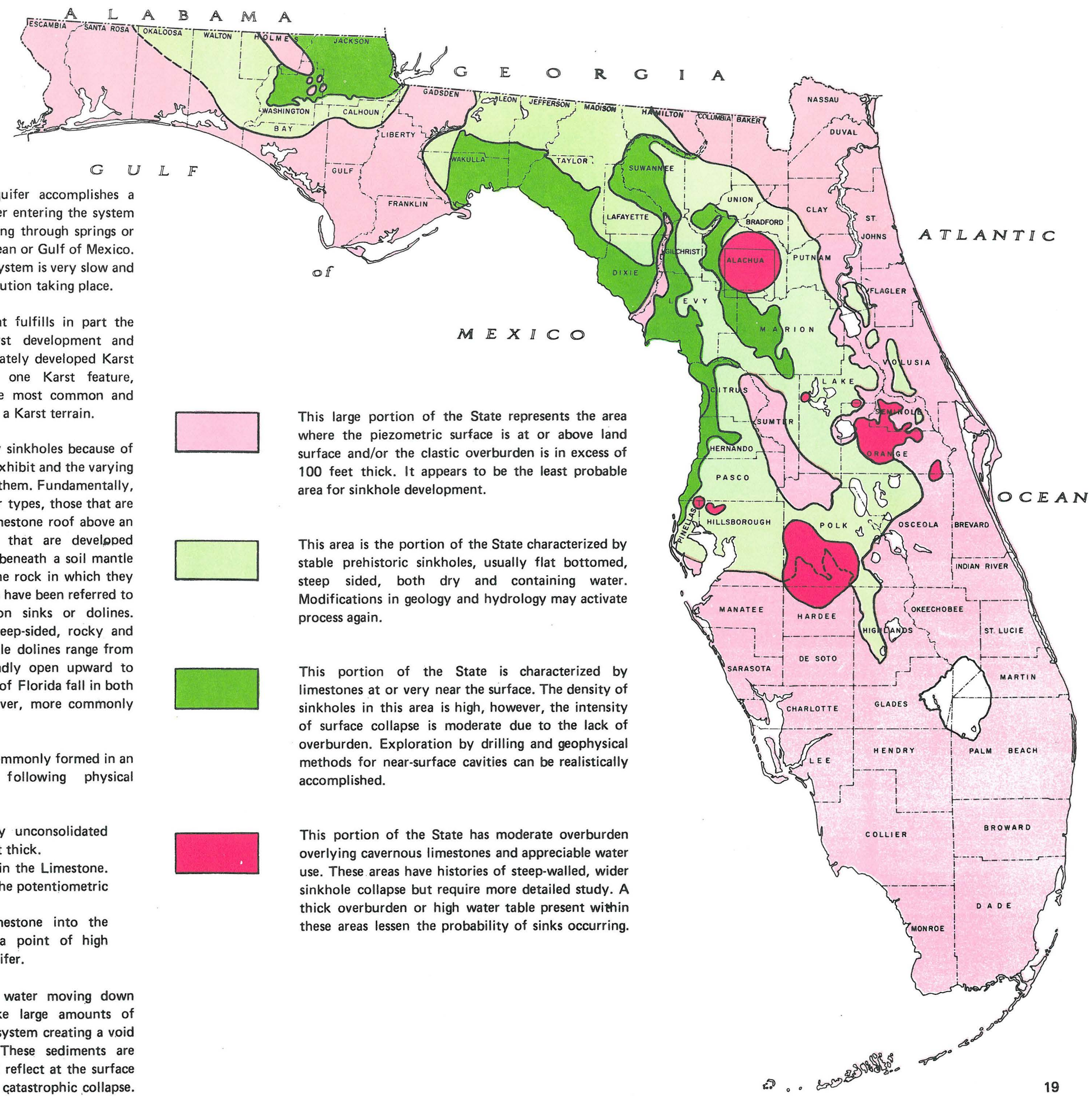
Thus Florida is an area that fulfills in part the conditions for optimum Karst development and reflects this in having a moderately developed Karst topography characterized by one Karst feature, sinkholes. The sinkhole is the most common and widespread topographic form in a Karst terrain.

It is most difficult to classfy sinkholes because of the many variations that they exhibit and the varying local usage of terms applied to them. Fundamentally, however, they are of two major types, those that are produced by collapse of the limestone roof above an underground void and those that are developed slowly downward by solution beneath a soil mantle with physical disturbance of the rock in which they are developing. These two types have been referred to as collapse sinks and solution sinks or dolines. Collapse sinks are normally steep-sided, rocky and abruptly descending forms while dolines range from funnel-shaped depressions broadly open upward to pan or bowl-shaped. Sinkholes of Florida fall in both of the above categories, however, more commonly they constitute a third type.

Florida sinkholes are most commonly formed in an environment with the following physical characteristics:

1. Limestones overlain by unconsolidated sediments less than 100 feet thick.
2. Cavity systems present in the Limestone.
3. Water table higher than the potentiometric surface.
4. Breaching of the Limestone into the cavernous zone creating a point of high recharge of the artesian aquifer.

Under these circumstances water moving down into the Limestone may take large amounts of sediments into the cavernous system creating a void in the overlying sediments. These sediments are generally incompetent and will reflect at the surface as either a structural sag or as catastrophic collapse.



This large portion of the State represents the area where the piezometric surface is at or above land surface and/or the clastic overburden is in excess of 100 feet thick. It appears to be the least probable area for sinkhole development.

This area is the portion of the State characterized by stable prehistoric sinkholes, usually flat bottomed, steep sided, both dry and containing water. Modifications in geology and hydrology may activate process again.

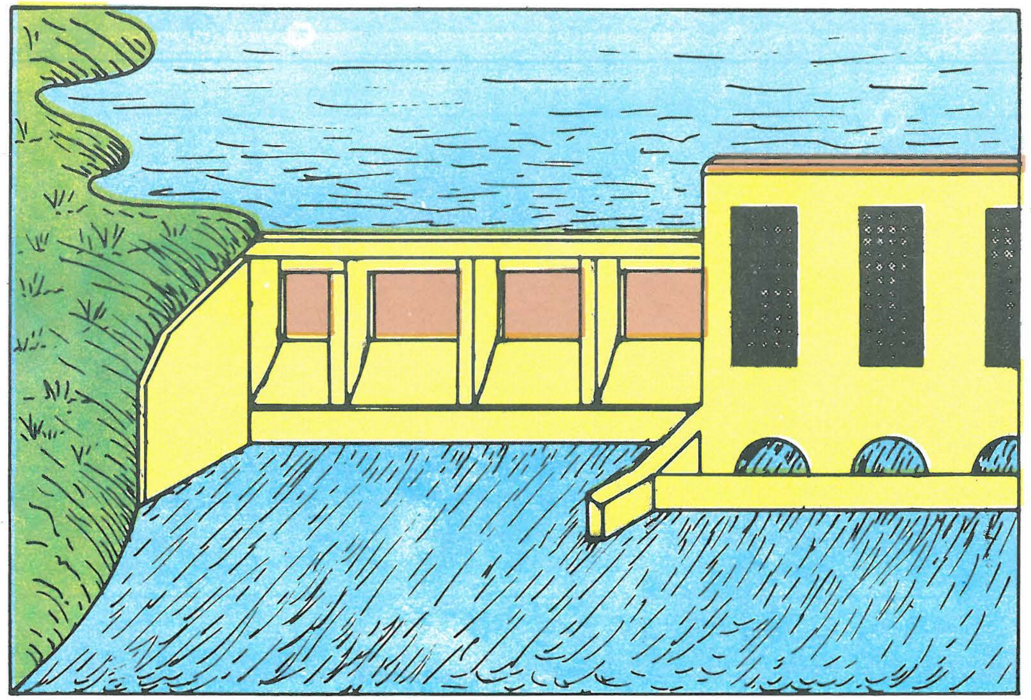
This portion of the State is characterized by limestones at or very near the surface. The density of sinkholes in this area is high, however, the intensity of surface collapse is moderate due to the lack of overburden. Exploration by drilling and geophysical methods for near-surface cavities can be realistically accomplished.

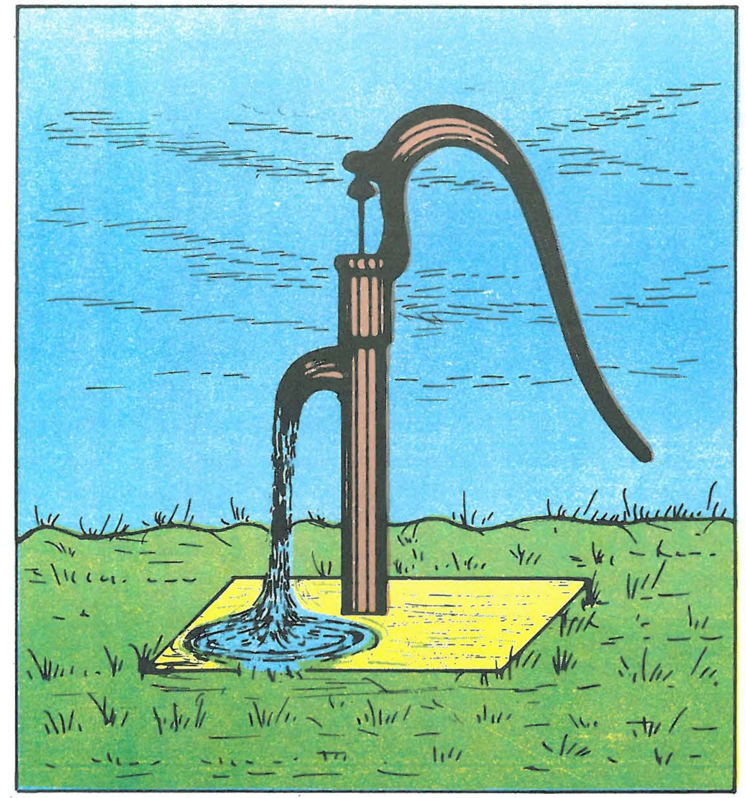
This portion of the State has moderate overburden overlying cavernous limestones and appreciable water use. These areas have histories of steep-walled, wider sinkhole collapse but require more detailed study. A thick overburden or high water table present within these areas lessen the probability of sinks occurring.

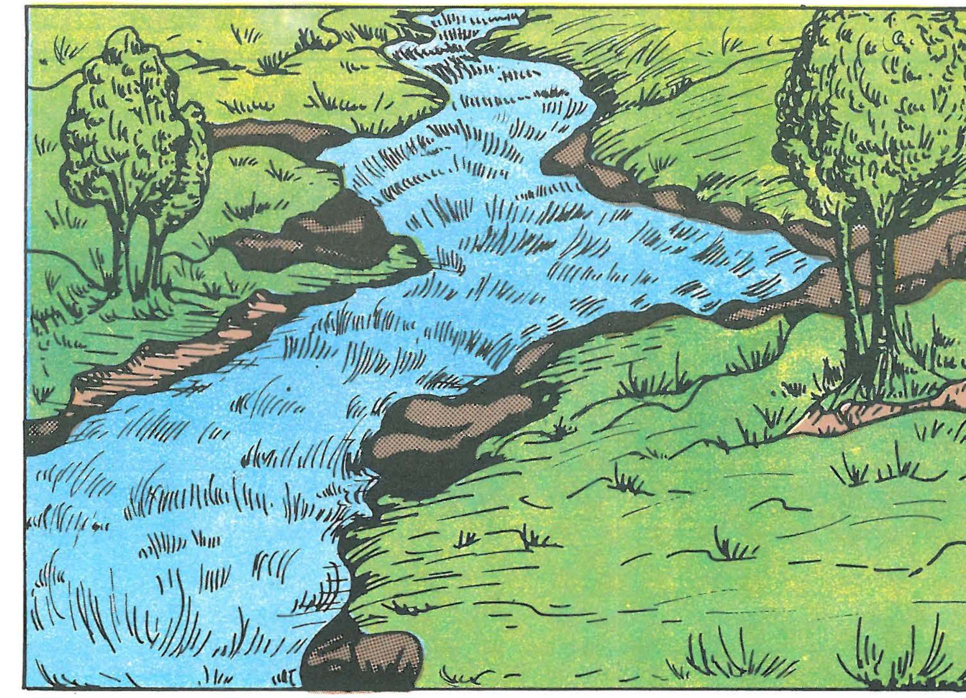
RESERVOIRS

GROUND WATER FROM WELLS

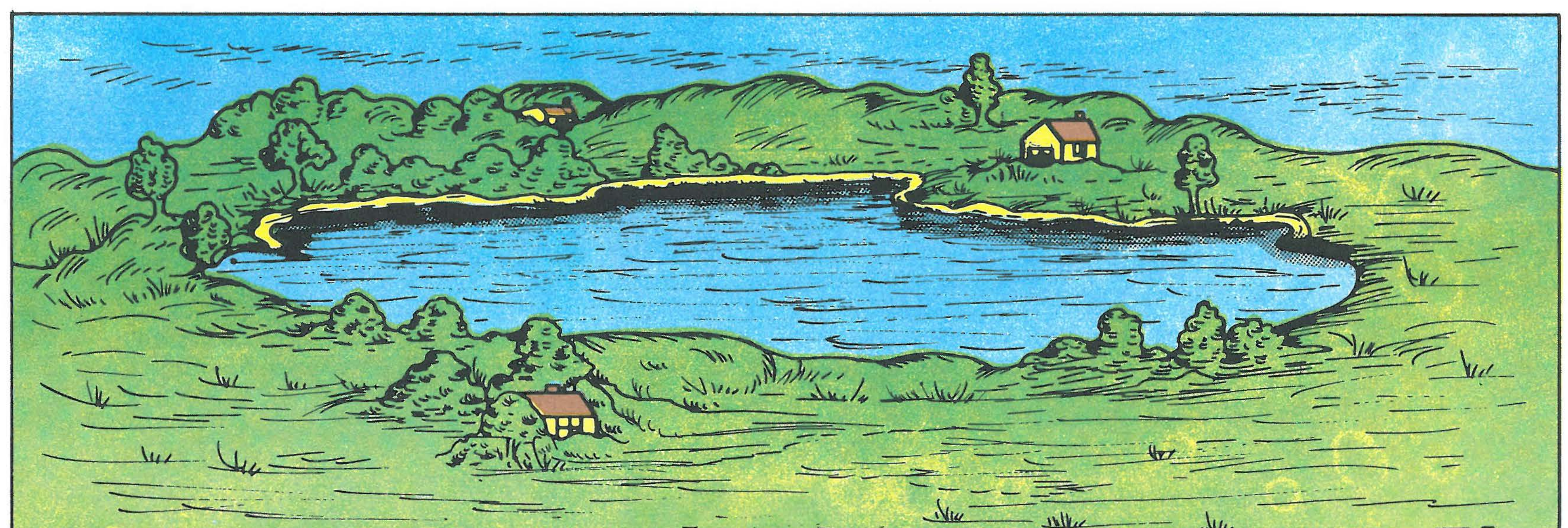
STREAMS







WATER RESOURCES



LAKES

THE WATER CYCLE

Management of Leon County's water resources requires knowledge of the interchange of water between the ocean, atmosphere, and land and of the cyclic processes involved.

Fresh water on land is derived from ocean water evaporated by the sun's heat. Evaporated water in vapor form is transported by convective air currents through the atmosphere to inland areas, where part of the vapor condenses and precipitates. In Leon County, where the lower atmosphere is usually too warm for snow, precipitation occurs as rain.

Rain that reaches the land returns either to the ocean by gravity flow or to the atmosphere by evaporation from land, water and plant surfaces. Before the basic cycle is completed, however, much interchange of water may take place between lakes, swamps, streams, and the ground. Time required for a water particle to complete the cycle may vary from an instant to many years, depending on the path it takes.

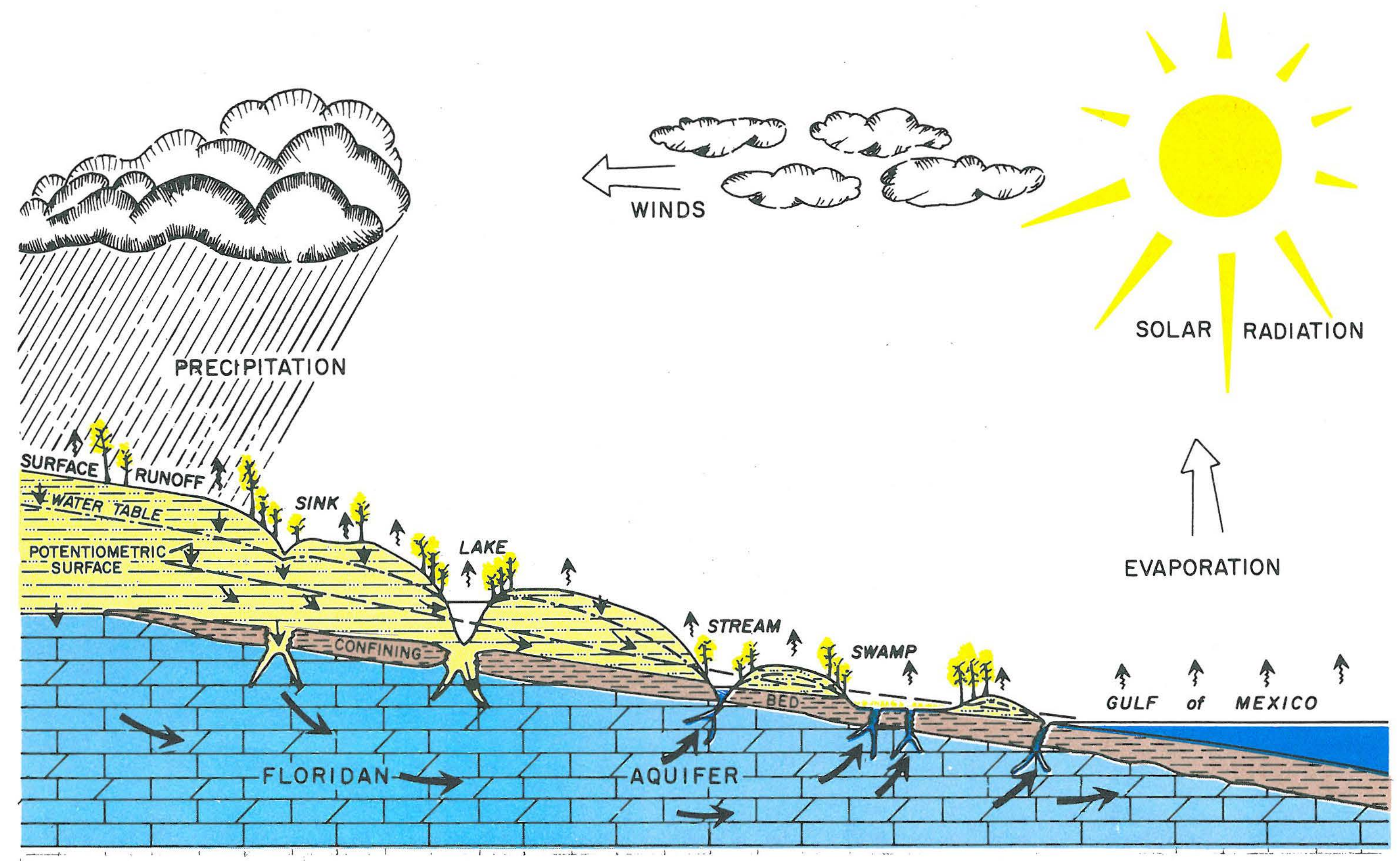
Once rain reaches the land surface its path depends on the terrain. Two important characteristics are the slope of the land surface and the permeability of the surficial and underlying materials.

Steep slopes and low permeabilities promote the runoff of rainfall to streams, or to lakes, swamps, and sinkholes which may or may not connect to streams leading to the ocean.

Gentle slopes and high permeabilities promote the infiltration of rainfall into the ground. Much of the water that infiltrates is stored in the soil zone, serving to supply water for vegetation, but part of it moves down to the water table, ultimately to emerge at some lower level, usually in areas that contain or adjoin streams, lakes, and swamps.

In Leon County water may also move downward into the Floridan aquifer, which underlies the water-table aquifer and is generally separated from it by a layer of relatively impermeable material called a confining bed. Sinks in the bottoms of some streams and lakes may connect directly with the Floridan aquifer. Water in the Floridan aquifer eventually emerges as springflow in streams, lakes, swamps, or the ocean.

Whether the Floridan aquifer takes in or discharges water depends on the potential energy of the water involved; water moves always from a higher to a lower level of potential energy. This potential energy relates directly to the level at which water stands when unconfined at the surface. Because water in the Floridan aquifer is confined, its potential energy is represented by an imaginary surface, called the potentiometric surface, which is determined by the level at which water freely stands in tightly cased wells that penetrate the aquifer. Given the necessary openings in the confining bed, water can move into the Floridan aquifer from water bodies which stand above the potentiometric surface; conversely, the Floridan aquifer can discharge water into water bodies whose levels stand below the potentiometric surface.

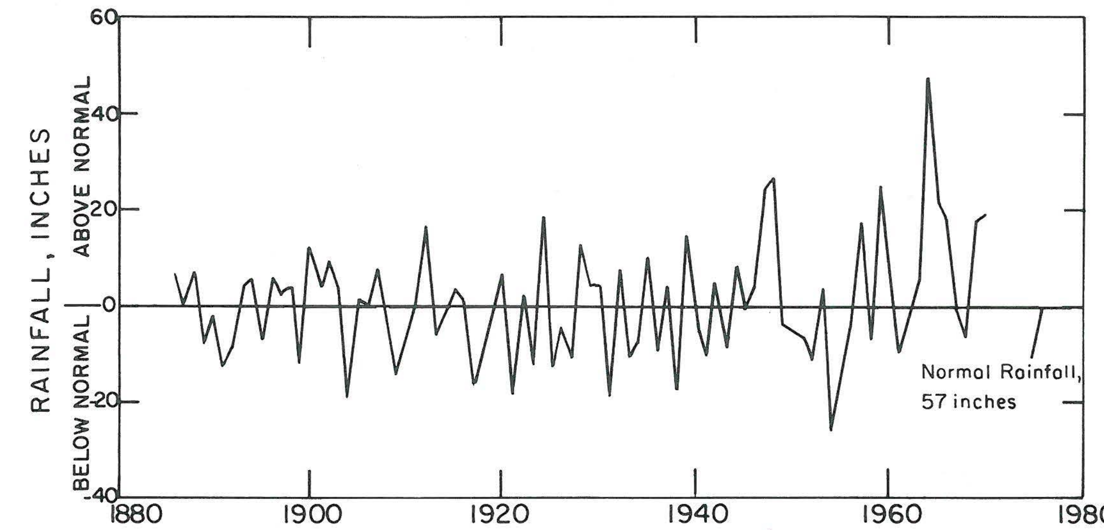


RAINFALL

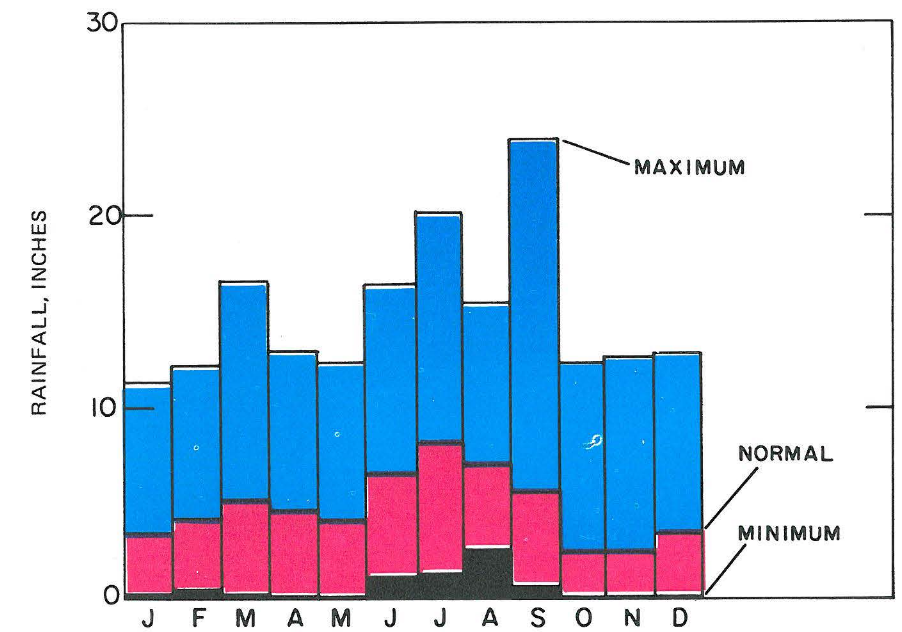
Much of Leon County's water resource is derived from rainfall within the county; however, most of the water that flows down the Ochlockonee River, and some of the water that moves underground through the Floridan aquifer, is derived from rainfall in neighboring counties in Florida and Georgia.

U.S. Weather Bureau records show that normal yearly rainfall ranges from 57 inches in southwestern Leon County to about 52 inches in the northeastern part of the county. The yearly rainfall is variable, however, ranging at Tallahassee from 31 inches in 1954 to 104 inches in 1964. Departures from normal yearly rainfall are greater than 10 inches about 40 percent of the time.

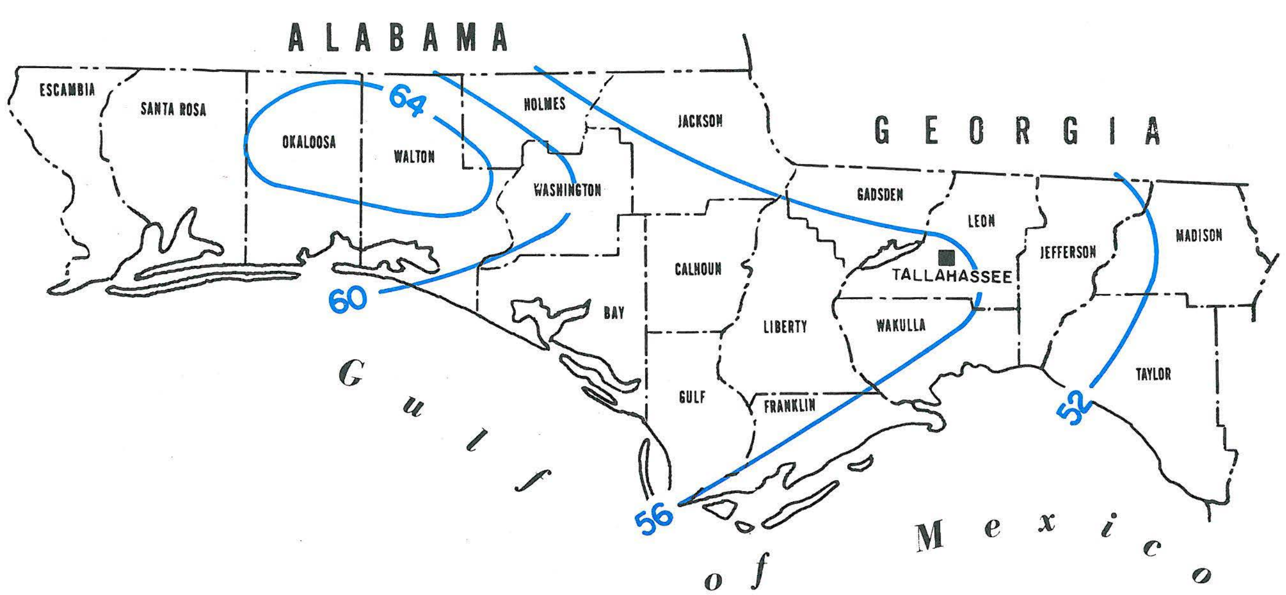
About half the yearly rainfall normally occurs between June and September, as a result of thunderstorms, hurricanes, and tropical depressions; but intense storms may occur at any time of the year. Rainfalls in excess of 5 inches in 24 hours have occurred at Tallahassee 13 times since 1952. In such intense storms, about half the total rainfall usually occurs within a 6-hour period. This is beneficial in that the water in lakes, swamps, streams, and aquifers is replenished, but these storms also cause flood damage in low-lying urban areas. Studies of the magnitude and frequency of floods that result from such storms are required for intelligent zoning and land use as well as for the efficient design of drainage systems.



Rainfall at U.S. Weather Bureau station, Tallahassee, Florida.



Monthly rainfall at Tallahassee.



Mean annual rainfall in northwest Florida, inches.

Summary of 24-hour rainfalls in excess of 5 inches recorded at Tallahassee, Fla. from 1952 to 1971.

Year	Date	Maximum 24-hour rainfall (inches)	Maximum concentration for indicated period (inches) 1-hour	2-hour	6-hour	Ratio of 6-hour to 24-hour rainfall
1958	April 9-10	5.53	–	–	1.86	0.34
1959	March 5-6	6.00	0.89	1.35	3.05	.51
1962	Mar. 31-Apr. 1	7.16	1.54	2.63	4.83	.67
1964	Feb. 27-28	5.60	.56	1.05	2.80	.50
	July 17-18	8.94	3.23	4.96	6.16	.69
	Oct. 14-15	5.95	.73	1.14	2.41	.41
	Dec. 3-4	9.26	2.15	3.35	5.23	.56
1965	June 14-15	5.29	2.03	2.50	3.97	.75
1966	June 9-10	6.75	–	–	–	–
	Sept. 18-19	5.49	.77	1.27	2.51	.46
1968	Sept. 8	6.52	4.83	5.66	6.52	1.00
1969	Sept. 20-21	9.47	2.18	3.42	5.74	.61
1970	July 21-22	8.18	3.46	5.11	6.08	.74

PHYSIOGRAPHY

INTRODUCTION

Leon County's physical features are separated into four major divisions - - the high, sandy, clay-hill northern part; the wet, low, sand and limestone southern part, dotted with innumerable small lakes and sinks; the flat, sandy, swampy, and forested western part; and the valleys of the two major rivers. The accompanying text and illustrations portray the major physiographic divisions and their pertinent features.

TALLAHASSEE HILLS

TOPOGRAPHY: Moderately rolling hills to a maximum elevation of 279 feet.

SOILS: Loamy and underlain by a mixture of rather impermeable yellow-orange clay, silt, and sand.

BEDROCK: Relatively deeply buried and highly permeable limestone with large solution cavities.

DRAINAGE: Moderately well-developed stream pattern. Streams generally short, many terminating at sinks or lakes.

LAKES: Four large shallow lakes with associated sinks, and many small and deep sink-type lakes.

SINKS: Many sinks, some of which open directly to the underground water supply. Those in or near the large lakes occasionally serve as drains.

WATER SUPPLY: The Floridan limestone aquifer. The water is of good quality, is moderately hard, and is adequate in quantity. The water supply is susceptible to contamination by wastes dumped on the surface or directly into the sinks.

WOODVILLE KARST PLAIN

TOPOGRAPHY: A gently sloping plain from 20 to 60 feet above sea level. Vegetation-covered sand dunes are as much as 20 feet high.

SOILS: A thin layer of loose quartz sand on bedrock.

BEDROCK: A highly permeable limestone with large solution cavities. It is near the surface and crops out at many places.

DRAINAGE: Few streams, but the area is generally well drained owing to the great numbers of sinks and the ease of percolation of water through the overlying sand and into the limestone.

LAKES: Numerous, generally small, circular, and deep (sink-type).

SINKS: So numerous as to be a major characteristic of the division. Generally direct connectors to the underground water supply.

WATER SUPPLY: From shallow and deep wells in the Floridan limestone aquifer. The water is of good quality, is moderately hard, and is available in adequate quantities. It is susceptible to contamination by wastes.

Blue Sink.

APALACHICOLA COASTAL LOWLANDS

TOPOGRAPHY: A nearly flat, sandy and swampy, tree-covered plain near elevation 100 feet, with an escarpment to 150 feet that is parallel to and south of State Road 20.

SOILS: Sandy and underlain by thick sand and clay sediments. Permeability is poor.

BEDROCK: Limestone at depths of 200 feet and greater. Apparently less permeable than the limestone underlying the eastern part of the county.

DRAINAGE: Poor. The area is normally wet. Few streams.

LAKES: Few, small, and all located along the north and east perimeter of the division.

SINKS: Few in number, and those located along the north and east perimeter of the division. The poor drainage and lack of lakes and sinks are major surficial characteristics of the area.

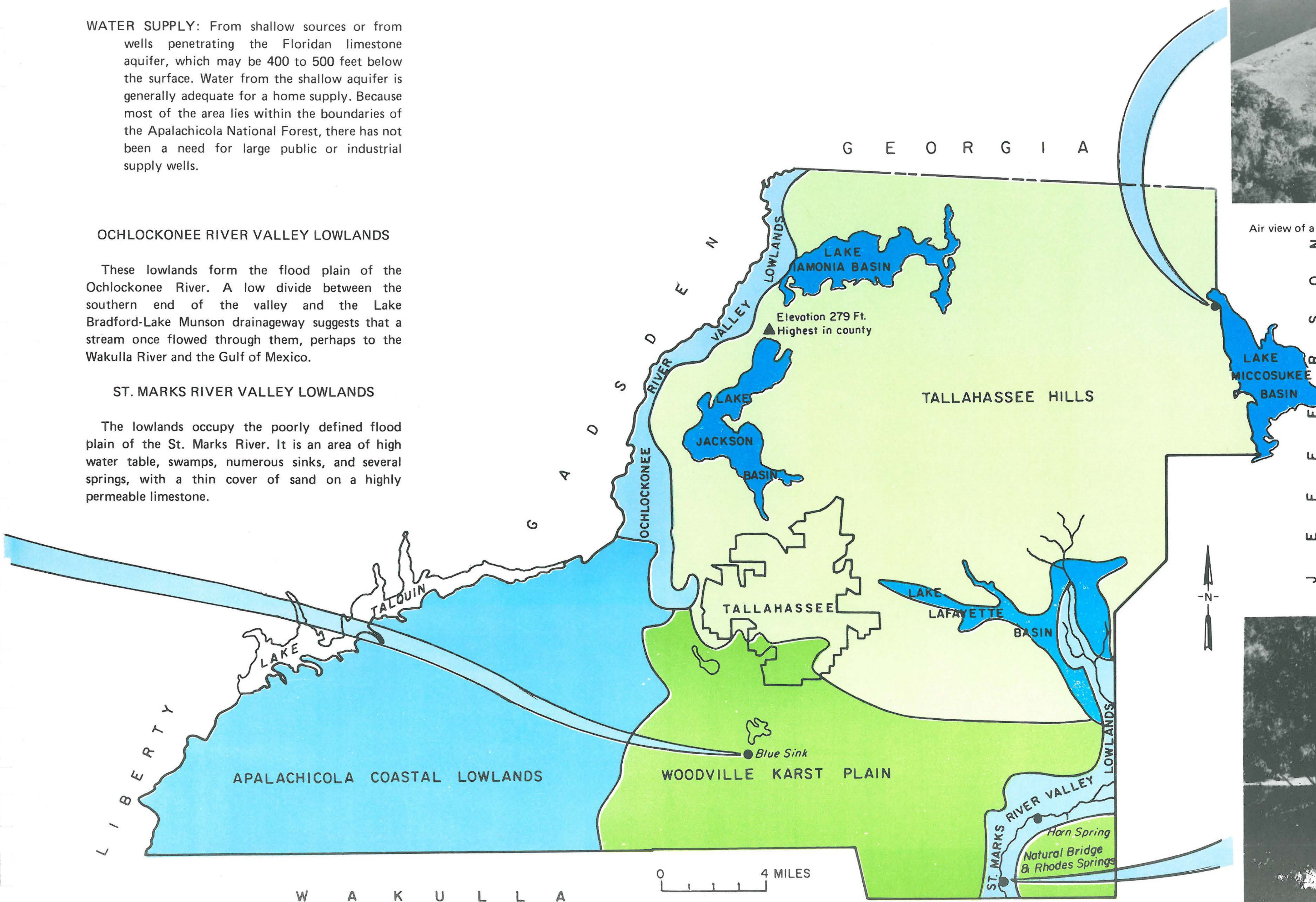
WATER SUPPLY: From shallow sources or from wells penetrating the Floridan limestone aquifer, which may be 400 to 500 feet below the surface. Water from the shallow aquifer is generally adequate for a home supply. Because most of the area lies within the boundaries of the Apalachicola National Forest, there has not been a need for large public or industrial supply wells.

OCHLOCKONEE RIVER VALLEY LOWLANDS

These lowlands form the flood plain of the Ochlockonee River. A low divide between the southern end of the valley and the Lake Bradford-Lake Munson drainageway suggests that a stream once flowed through them, perhaps to the Wakulla River and the Gulf of Mexico.

ST. MARKS RIVER VALLEY LOWLANDS

The lowlands occupy the poorly defined flood plain of the St. Marks River. It is an area of high water table, swamps, numerous sinks, and several springs, with a thin cover of sand on a highly permeable limestone.



Air view of a sink that has been isolated from Lake Miccosukee by a dike.

Natural Bridge Sink.

LAKES

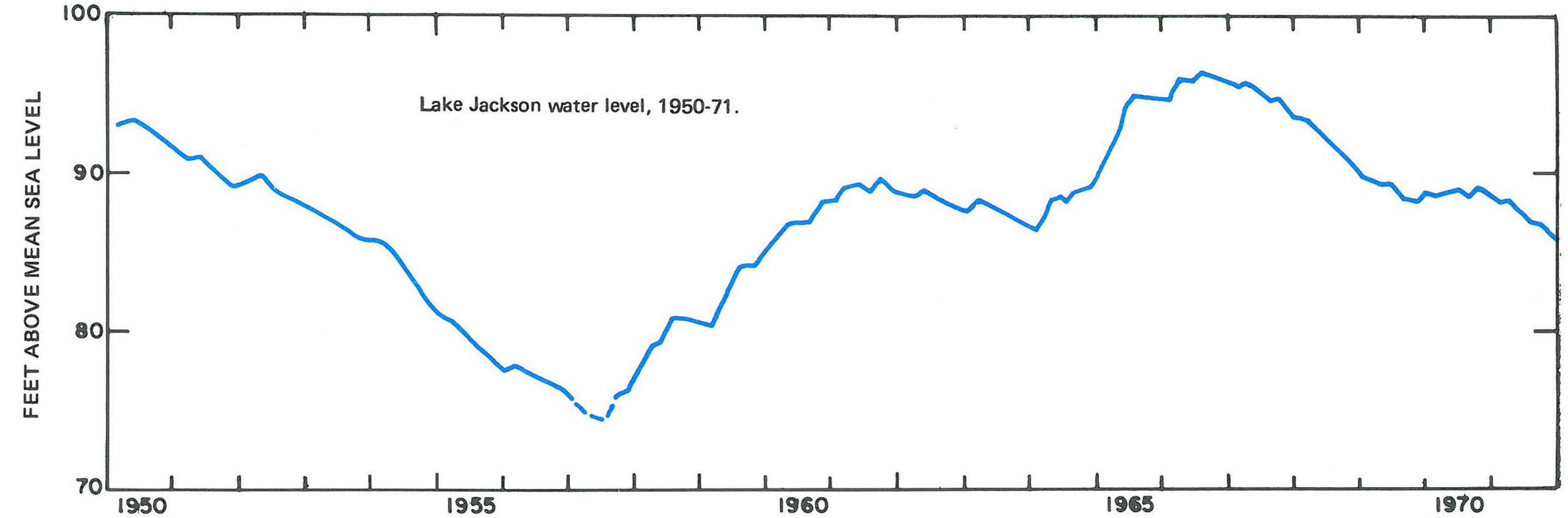
Leon County includes part or all of several large lakes that provide a base for water-oriented recreation within convenient reach of most of the people of the county. Continued beneficial use of the lakes ultimately entails the solution of problems related to pollution, aquatic weeds, and fluctuating water levels.

Lake Jackson, which is now nationally known for its good bass fishing, was dry in 1957 as a result of a drought; yet in 1965-66, after several years of greater-than-average rainfall, the lake rose high enough to flood prime residential areas. Other lakes fluctuate similarly, as a result of variations in rainfall.

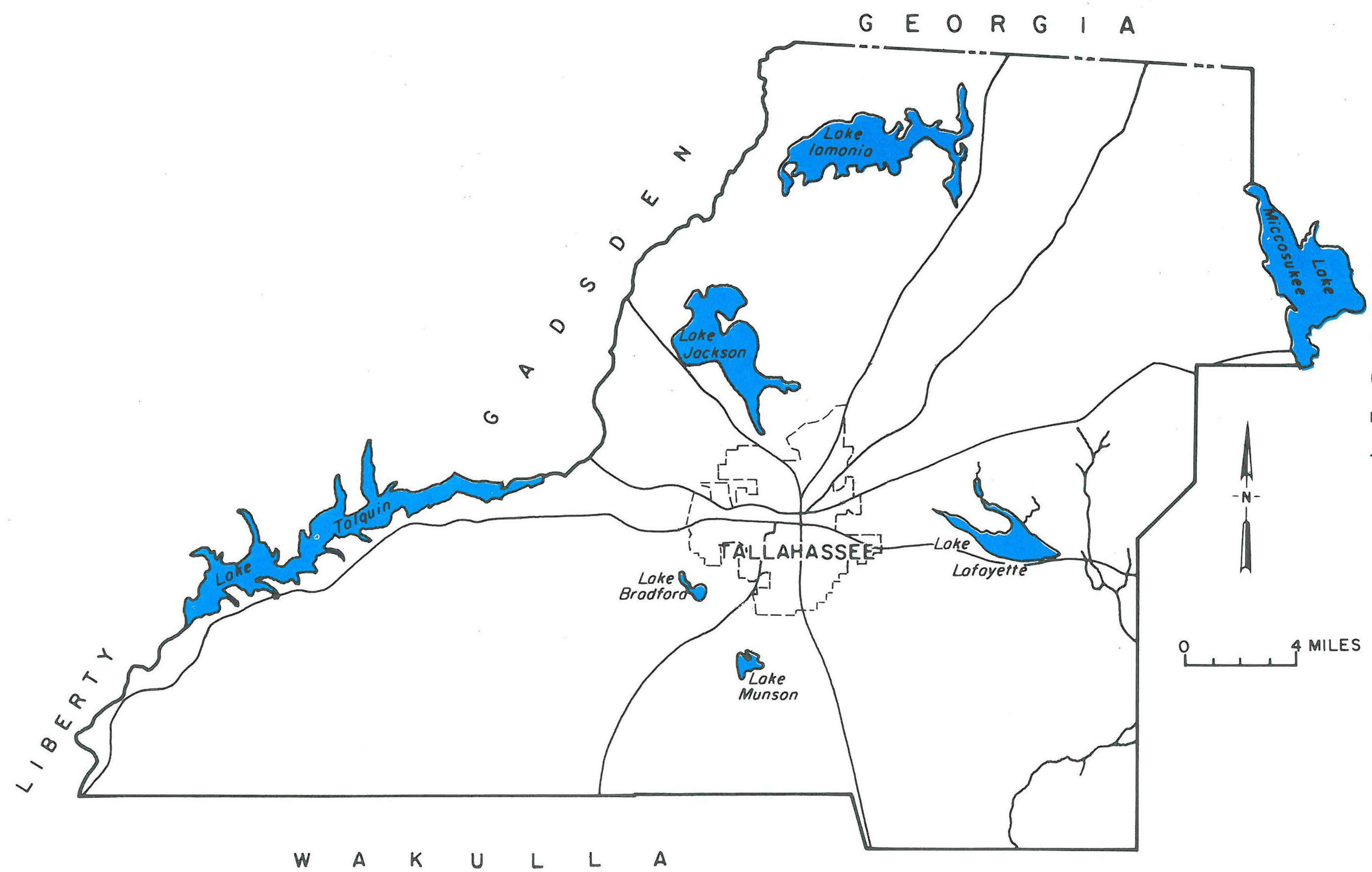
Lake Jackson lies in the path of urban expansion that eventually may lead to pollution of the lake unless precautionary measures are included as part of the development. Other lakes also could be polluted if shoreline properties were developed. Lake Munson already has been polluted by sewage from Tallahassee.

Lake Iamonia, Miccosukee, and Lafayette are relatively shallow lakes that are largely filled with aquatic weeds and other vegetation, as a result of natural processes of eutrophication. Extensive research is needed to determine the extent of eutrophication and to develop ways to retard or temporarily reverse this natural aging process.

Lake Bradford - - a picturesque lake at high and medium water levels -- tends to go dry during droughts.



Prolonged periods of greater-than-normal and less-than-normal rainfall since 1950 have led to a wide range in level of Lake Jackson.



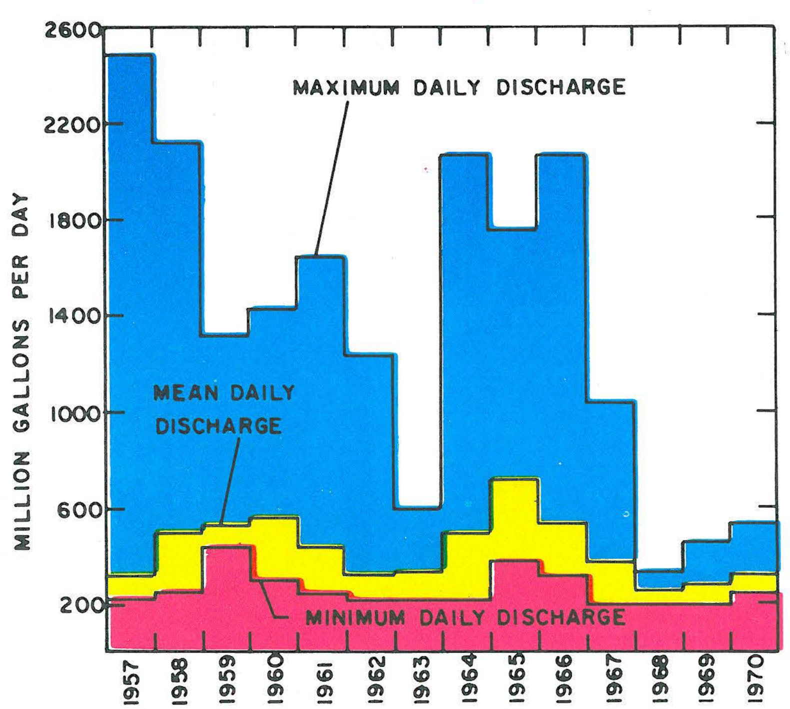
STREAMFLOW

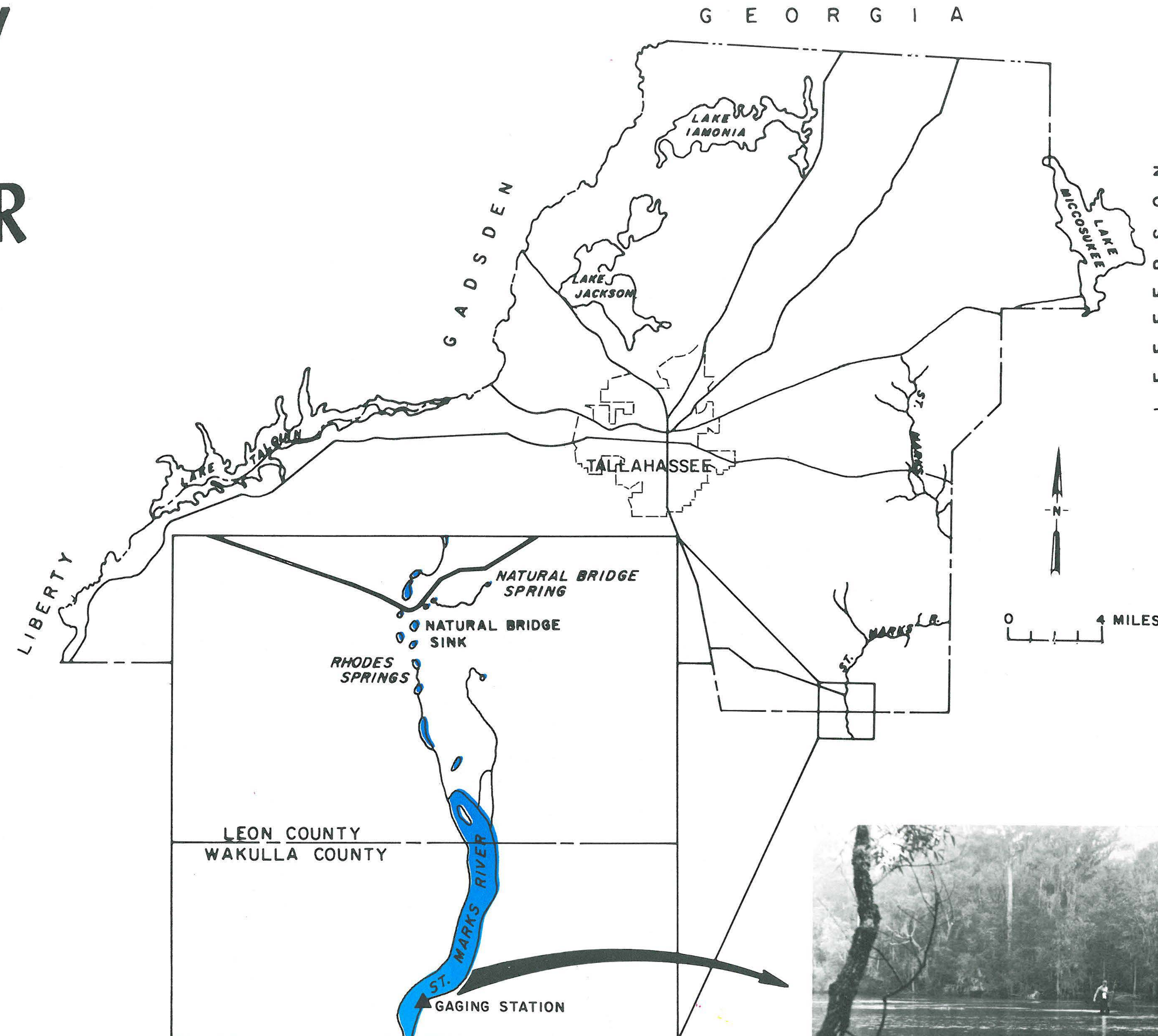
ST. MARKS RIVER

St. Marks River drains part of eastern Leon County as far north as Lake Miccosukee. Except during times of extreme floods the entire flow of the river disappears into sinks at Natural Bridge, just north of the Leon-Wakulla County line. From Natural Bridge northward the river channel is poorly defined, as it threads its way through flat, swampy terrain that is largely inundated during periods of high flow.

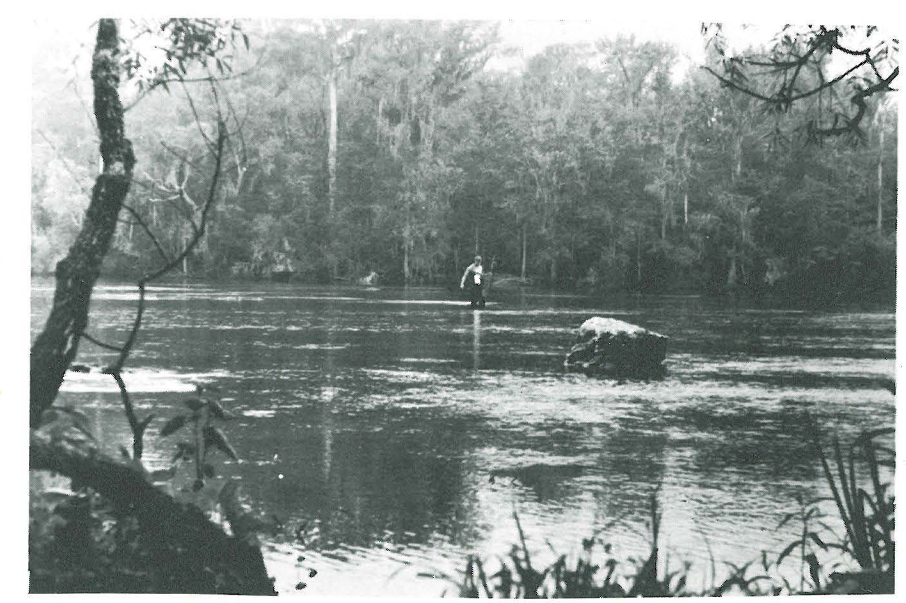
Just south of Natural Bridge the flow of the St. Marks River surfaces and continues on to the Gulf of Mexico in a well-defined channel cut into bedrock. Flow of the river increases markedly south of Natural Bridge, where ground water from the Floridan aquifer enters the stream.

Flow of the St. Marks River has been measured continuously since 1956 at the U.S. Geological Survey gaging station near the Leon-Wakulla County line. The amount of dissolved minerals in the water flowing at the gage site is well within the limits recommended by the U.S. Public Health Service for a municipal water supply.





At Natural Bridge the flow of the St. Marks River disappears into sinks and reappears as springflow at downstream points.



A U.S. Geological Survey gaging station site on the St. Marks River. Flow averages about 435 million gallons per day.

OCHLOCKONEE RIVER

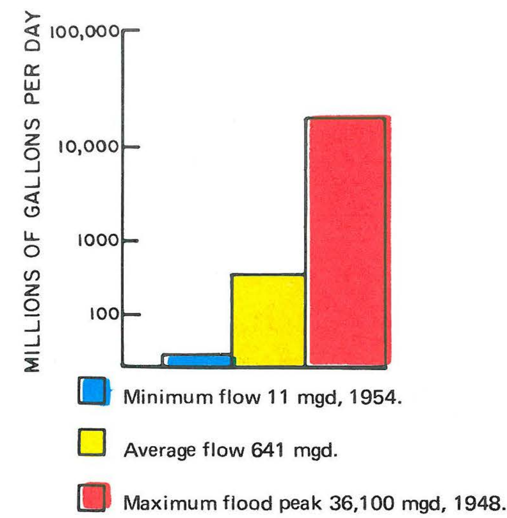
The Ochlockonee River, which forms the western boundary of Leon County, originates in the clay hills of southern Georgia. Starting its 162-mile journey to the Gulf of Mexico as a mere trickle, the river becomes a major stream by the time it reaches Florida.

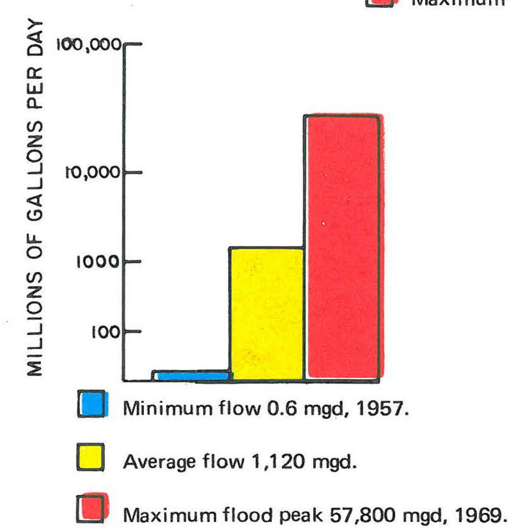
The reach of the Ochlockonee River upstream from Lake Talquin provides about 60 percent of the water that flows through Lake Talquin. Flow of the Ochlockonee is generally ample, but it varies widely between droughts such as occurred in 1954 and 1968, and floods such as occurred in 1948 and 1969.

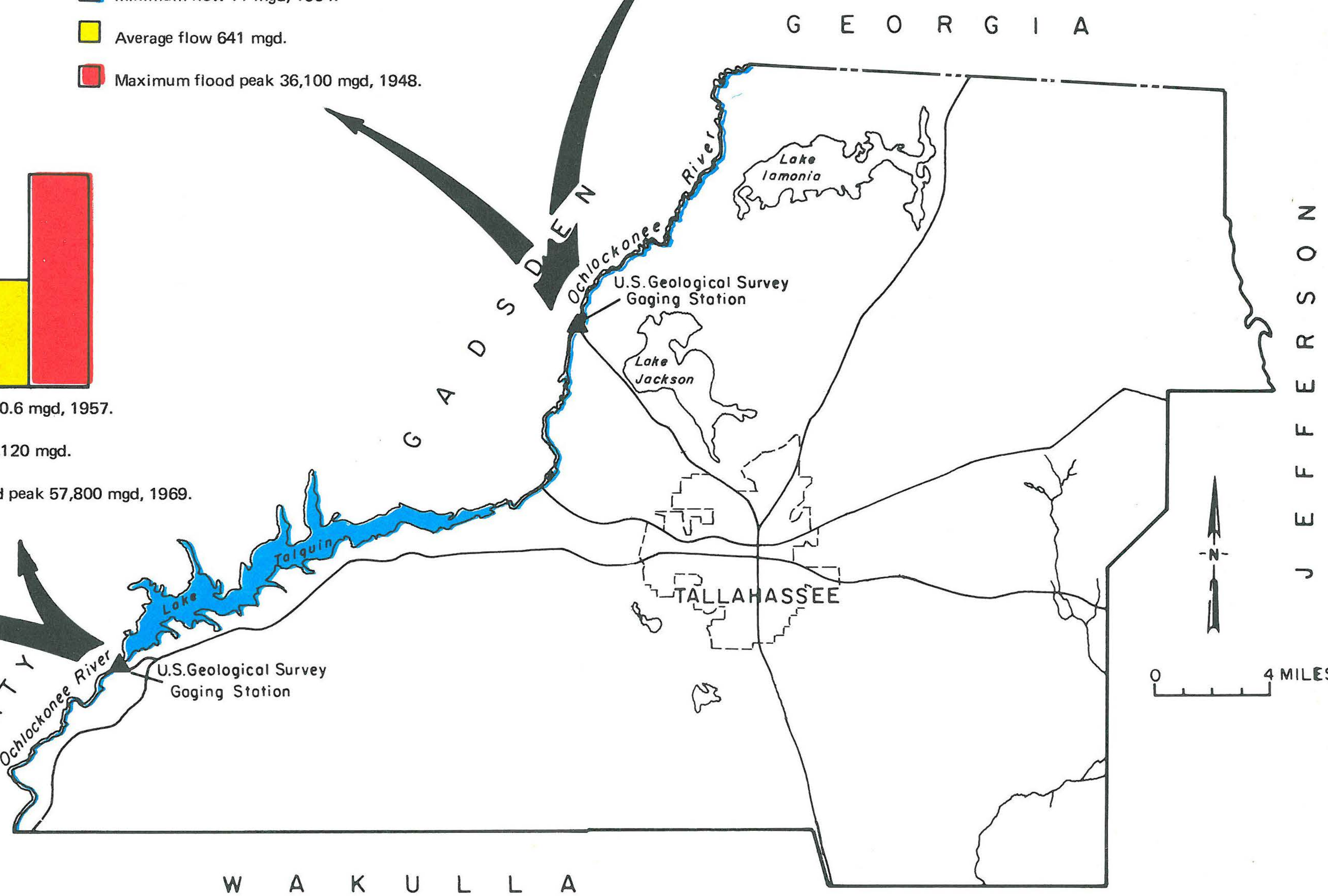
Ochlockonee is an Indian word meaning "yellow water", probably in reference to the yellow-to-brown hue that the water takes on from the fine clay sediment that it carries at times of medium to high flow.

The concentrations of major chemical constituents in the river fall within the limits recommended by the U.S. Public Health Service for municipal and recreational uses.

The flow of the Ochlockonee River at the bridge on U.S. Highway 27 near Havana, which has been gaged since 1926, averages about 641 million gallons per day.

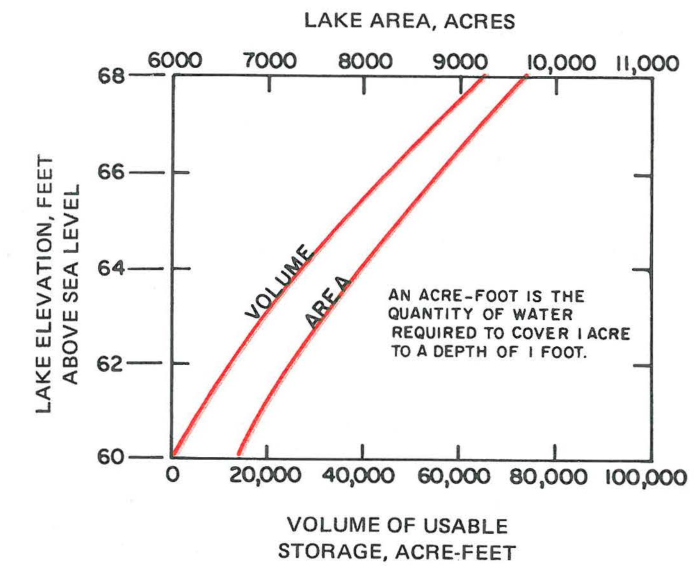






The flow of the Ochlockonee River at the bridge on State Highway 20 near Bloxham, which has been gaged since 1926, averages about 1,120 million gallons per day.

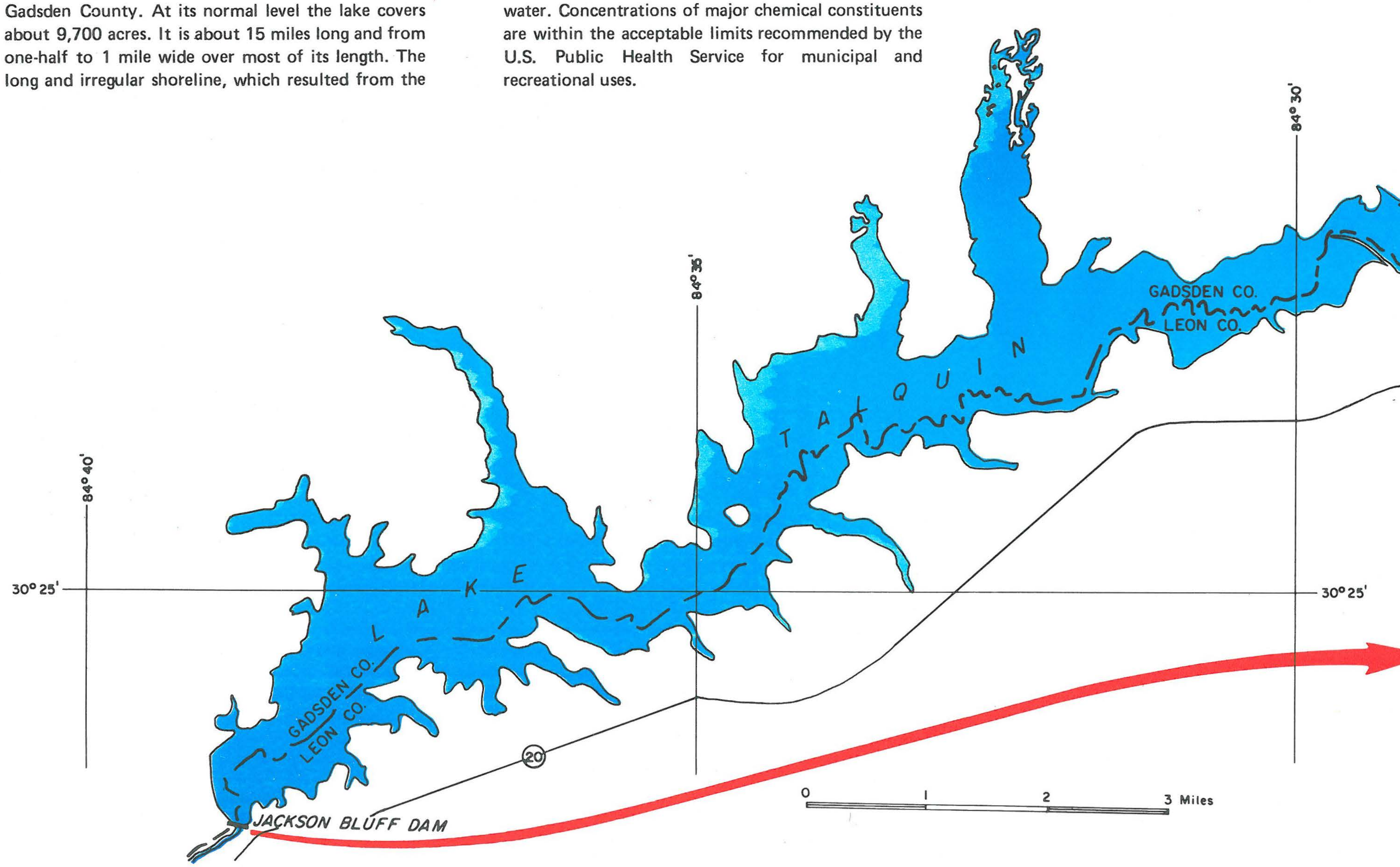
IMPOUNDMENTS

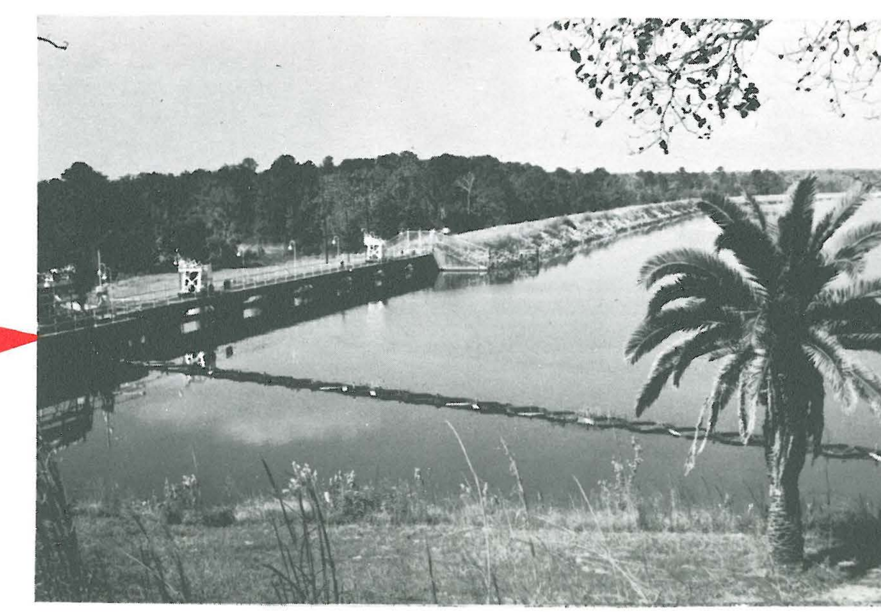


Lake Talquin was created by construction of Jackson Bluff Dam on the Ochlockonee River in the late 1920's. Originally owned by Florida Power Corporation and operated as a source of hydroelectric power since 1930, the lake and dam were donated to the State of Florida in 1970. Power generation was terminated at that time. The lake is being developed as a recreational area.

Lake Talquin derives its name from the neighboring cities of Tallahassee and Quincy, in Gadsden County. At its normal level the lake covers about 9,700 acres. It is about 15 miles long and from one-half to 1 mile wide over most of its length. The long and irregular shoreline, which resulted from the flooding of valley bottom lands of several small tributaries, gives wide distribution to sites that are ideally suited for recreational development. In a setting that is natural to north Florida, the lake provides one of the most attractive areas in the state for water-based recreation.

Considering the vast recreational potential of Lake Talquin, systematic monitoring of chemical and biological changes could be undertaken as part of a broad program to maintain the quality of the lake water. Concentrations of major chemical constituents are within the acceptable limits recommended by the U.S. Public Health Service for municipal and recreational uses.





Lake Talquin at Jackson Bluff Dam

AQUIFERS

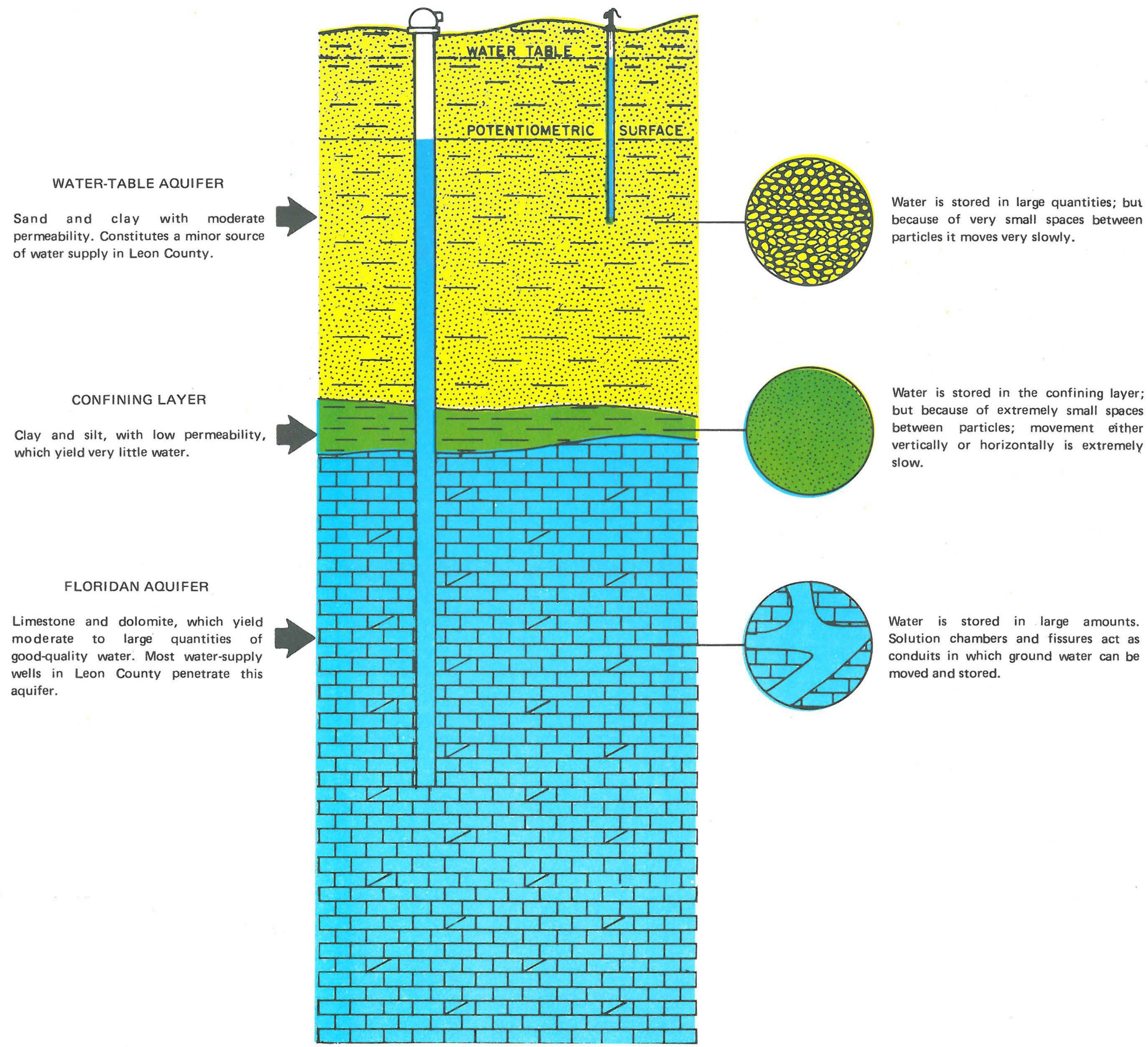
Aquifers are formations of rocks that yield significant quantities of water to wells and springs. The number and size of spaces between the rock particles, and the extent to which they inter-connect, determine the productivity of aquifers. Where the particles are small and tightly packed, aquifers generally are not productive, whereas those that contain coarse-grained particles are usually highly productive.

Two principal aquifers exist in most parts of Leon County: the water-table aquifer and the Floridan aquifer. The water-table aquifer consists of sand and clay and is generally underlain by beds of clay and silt, which form a relatively impermeable confining layer between the water-table aquifer and the deeper Floridan aquifer. The Floridan aquifer consists of limestone and dolomite, which contain many solution chambers.

Because of the confining layer, water in the Floridan aquifer in most places is under pressure greater than atmospheric. Thus, water generally rises to some level above the top of the aquifer in wells that tap the Floridan aquifer. The water level represents the potentiometric surface of that aquifer.

Aquifers are replenished by rainfall. The water-table aquifer is recharged by rainfall that infiltrates through the surficial materials down to the water table. Where the water table is above the potentiometric surface, water can move through openings in the confining layer to the Floridan aquifer. Where the Floridan aquifer is at land surface (that is, in places where the Floridan aquifer reaches the land surface and is locally unconfined), rainfall recharges the aquifer directly.

Most ground water used in Leon County is pumped from the Floridan aquifer. Well depths range from 150 to 500 feet; well yields range from 15 to 5,000 gpm (gallons per minute). Productivity is greatest in northern and central parts of the county and decreases southwestward.

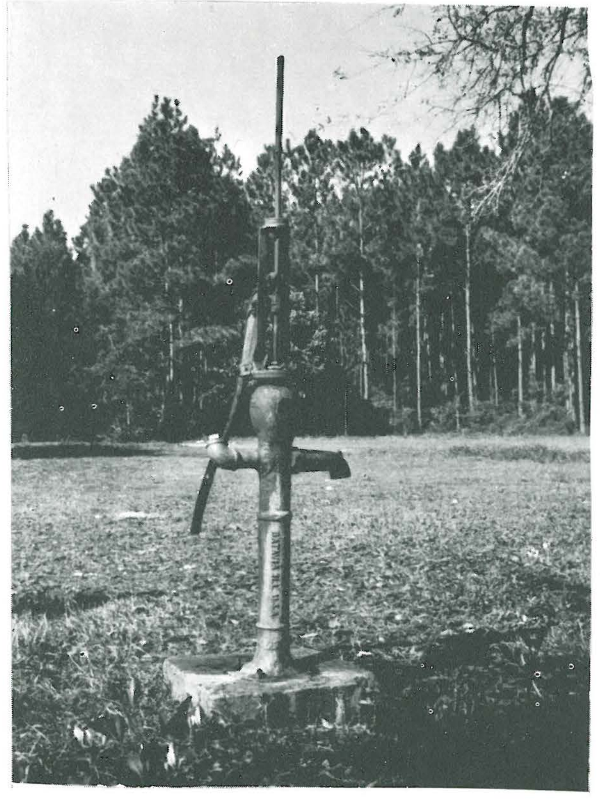


GROUND WATER

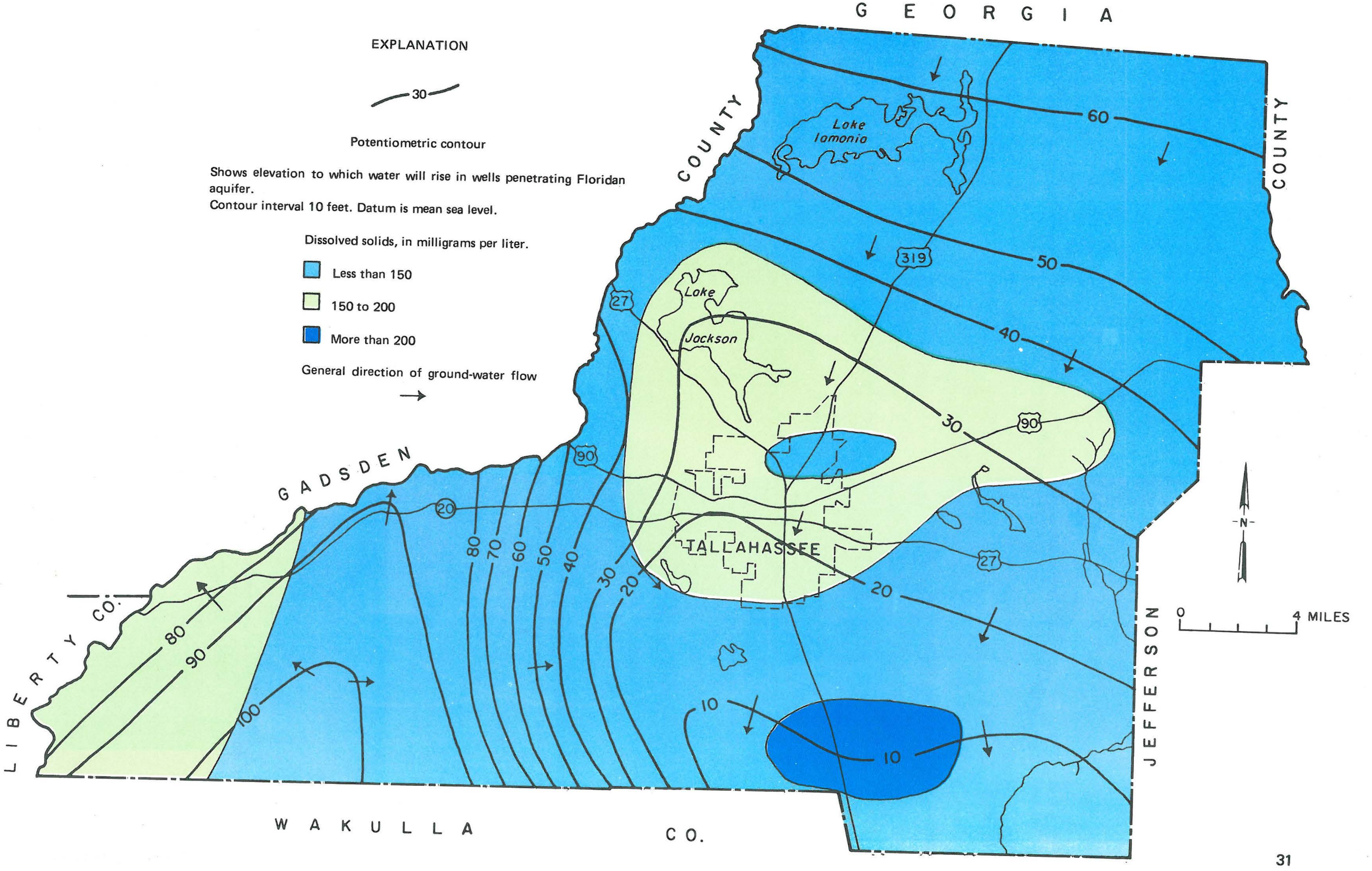
Ground water is the principal source of water in Leon County for municipal, industrial and domestic supplies. Most of the water is pumped from wells that penetrate the highly productive Floridan aquifer, which underlies all of Leon County and consists mostly of limestone and dolomite.

The accompanying map shows the altitude and shape of the potentiometric surface of the Floridan aquifer following a 3-year period of about-average rainfall. The configuration of the contours indicates that the ground-water body is recharged in the northern and the western parts of the county.

Most wells yield water of good chemical quality, ranging from 100 to 275 milligrams per liter dissolved solids. The concentration of dissolved solids reflects the degree of mineralization that results from the solution of the limestone and dolomite rock in the Floridan aquifer.



Old-fashioned lift pump.



TOTAL WATER USE

The Floridan aquifer provides most of the ground water used in Leon County. Over 95 percent of all water used is derived from this source (Hendry, 1966).

MUNICIPAL SUPPLIES

Water for the City of Tallahassee's system is pumped from 13 wells, ranging from 18 to 24 inches in diameter and from 290 to 470 feet deep. Their total rated capacity is 34 mgd (million gallons per day). The greatest demand for water usually occurs during May, June and July, when pumpage sometimes reaches about 18 mgd. Four elevated storage tanks provide 1.6 million gallons of storage.

INDUSTRIAL AND INSTITUTIONAL WATER, SELF SUPPLIED

Because the temperature of ground water is nearly constant at 21°C (70°F), water from the Floridan aquifer is used in air conditioning a majority of State office buildings, the two State universities, and a growing number of commercial establishments. Average daily pumpage during 1970 exceeded 27 million gallons, more than twice the municipal water use. Air-conditioning water is returned to the aquifer through wells and thus does not represent a net withdrawal of water from the aquifer.

The temperature of water returned to the aquifer usually exceeds 32°C (90°F), and, as a result, water temperatures in the aquifer are at least 3°C (5°F) above normal in the downtown Tallahassee area and in the vicinity of the universities. City supply wells are generally drilled outside those areas containing air-conditioning supply and return wells.

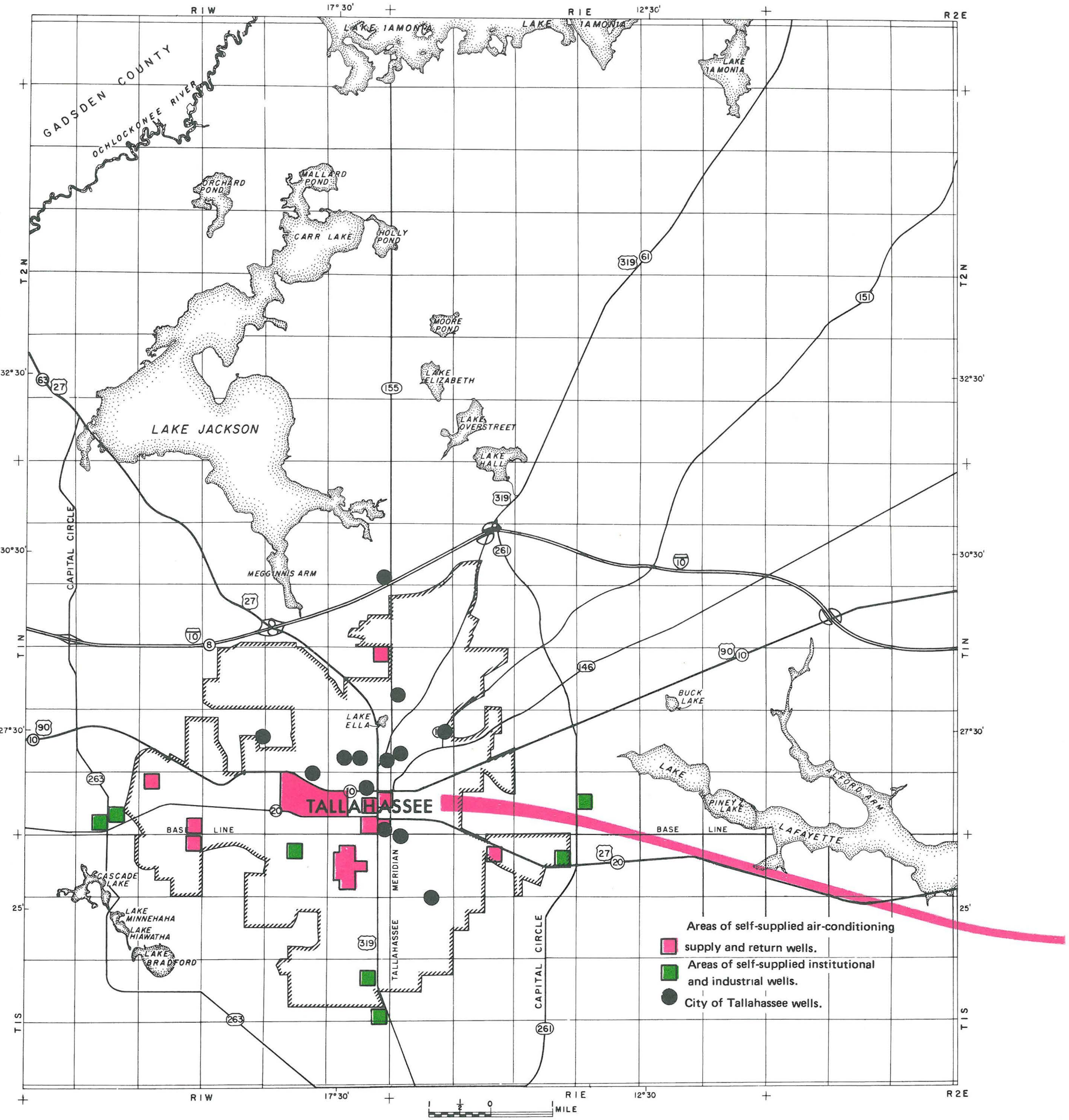
Institutional and industrial use of ground water for uses other than air conditioning was only 0.4 mgd in 1970.

PRIVATE SUPPLIES

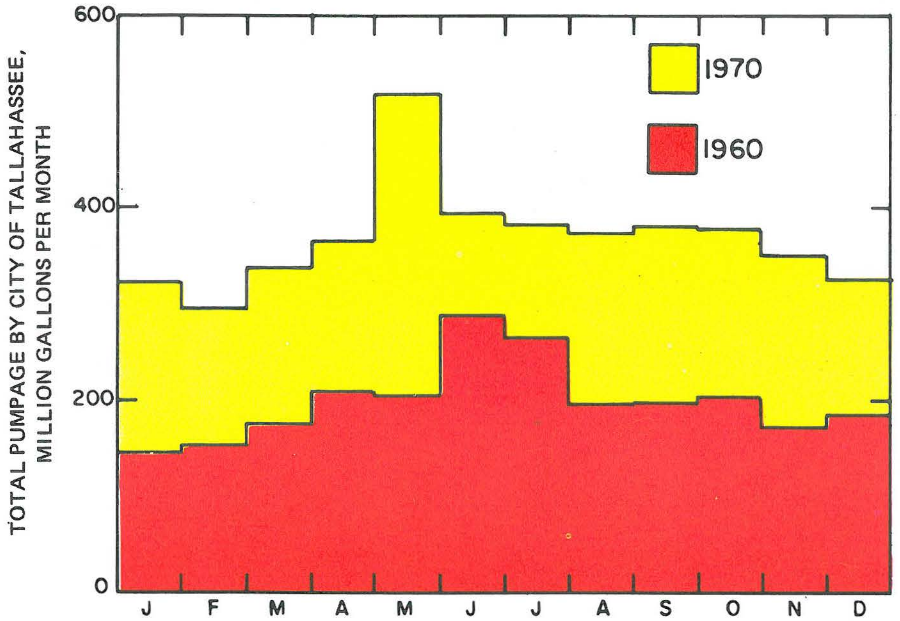
Most domestic water-supply systems outside the area served by the City of Tallahassee are privately owned wells penetrating the Floridan aquifer. The wells range from 2 to 8 inches in diameter and are generally less than 300 feet deep. From 5,000 to 6,000 private water systems are estimated to pump a total of about 2 to 3 mgd.

IRRIGATION

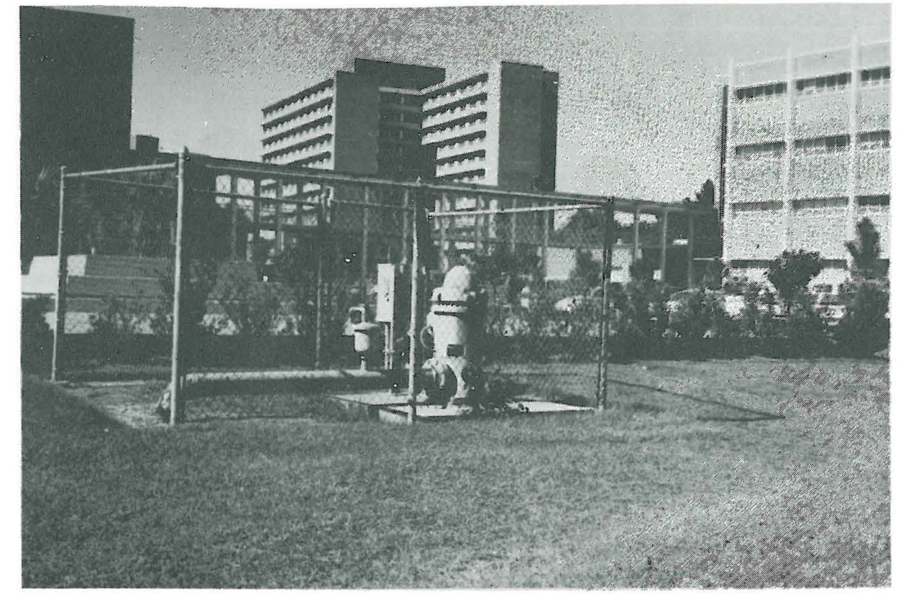
Irrigation is not extensively practiced in Leon County. About 20 million gallons of water was used during 1970 to irrigate about 70 acres.



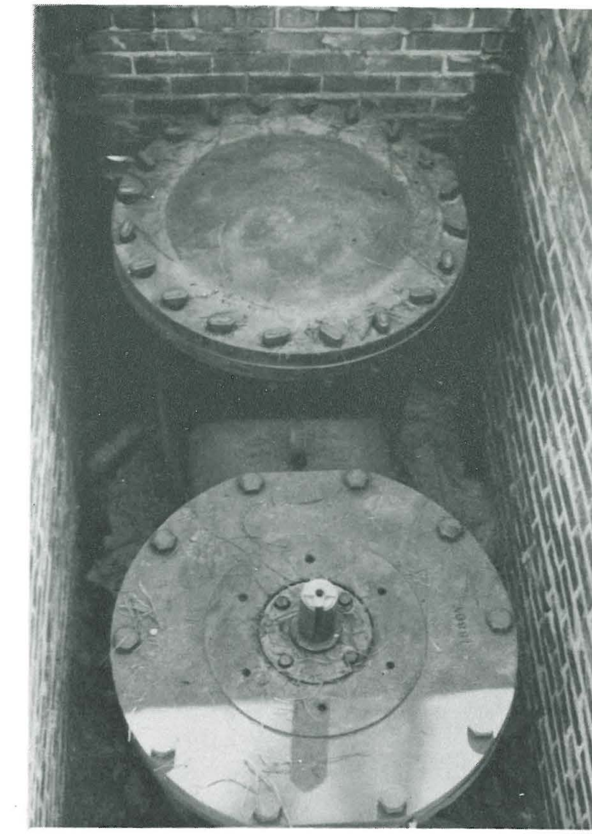
Cooling water for air-conditioning systems is pumped from and returned to the Floridan aquifer, with resultant increase in temperatures in the aquifer.



Seasonal trends in municipal water use.



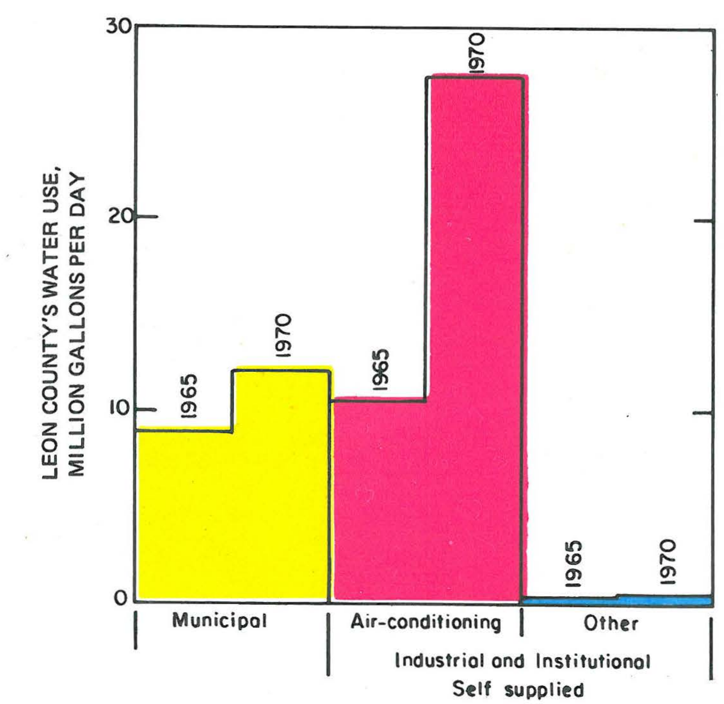
Air-conditioning supply well in the Tallahassee area.



Air-conditioning return well in the Tallahassee area.

Water is chlorinated at each of the City of Tallahassee's 13 widely distributed pumping stations and is pumped directly into the distribution system.

Elevated water-storage tanks supply pressure for the City of Tallahassee's water system.

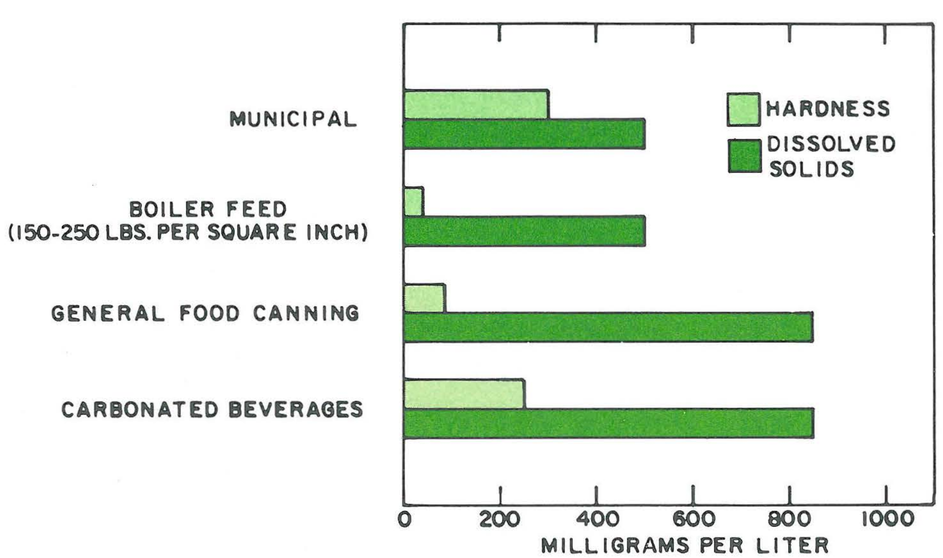


Water use increased from 1965 to 1970.

WATER QUALITY

Chemical Constituent	Recommended upper limit of concentration (milligrams per liter)[1]	Significance
Iron (Fe)	0.3	Causes red and brown staining of clothing and porcelain High concentrations affect the color and taste of beverages
Nitrate (NO_3)	45	Hazardous to infants
Chloride (Cl)	250	A large amount, in association with sodium, imparts a salty taste; also causes corrosion of plumbing fixtures.
Sulfate (SO_4)	250	Begins to produce a laxative effect at concentrations above 600 to 1,000 mg/l.
Dissolved Solids	500	Includes all of the materials in water that are in solution. Amounts up to 1,000 mg/l are generally considered acceptable for drinking purposes if no other water is available.

[1] U.S. Public Health Service, Drinking Water Standards, 1962.



SUGGESTED QUALITY OF WATER TOLERANCES FOR SPECIFIED USES

The chemical quality of water on and beneath the land surface is primarily determined by the type and solubility of rock formations with which water comes in contact and by the length of time that water remains in contact with each formation.

In Leon County, where the sand and clay of the surficial formations are relatively insoluble, the concentration of dissolved solids remains low in water that runs off the land surface into lakes and streams. Dissolved solids become more concentrated in water that reaches the water-table aquifer because water remains more completely in contact with the sand and clay materials for a long period of time; however, the low solubility of these materials limits the concentration to moderately low levels. The greatest concentration of dissolved solids occurs in water that reaches the Floridan aquifer, because the limestone and dolomite in this aquifer are relatively soluble.

Surface water in Leon County is of good chemical quality, being soft (hardness ranging from 0 to 60 mg/l) and low in chloride and dissolved solids. Recreation activities constitute its primary use.

Most wells in the county yield hard water (121 to 180 mg/l) of good chemical quality. Iron is the only constituent that appears in objectional quantities, and it usually occurs in wells close to lakes and sinks. Most wells in Leon County produce water suitable for use without treatment.

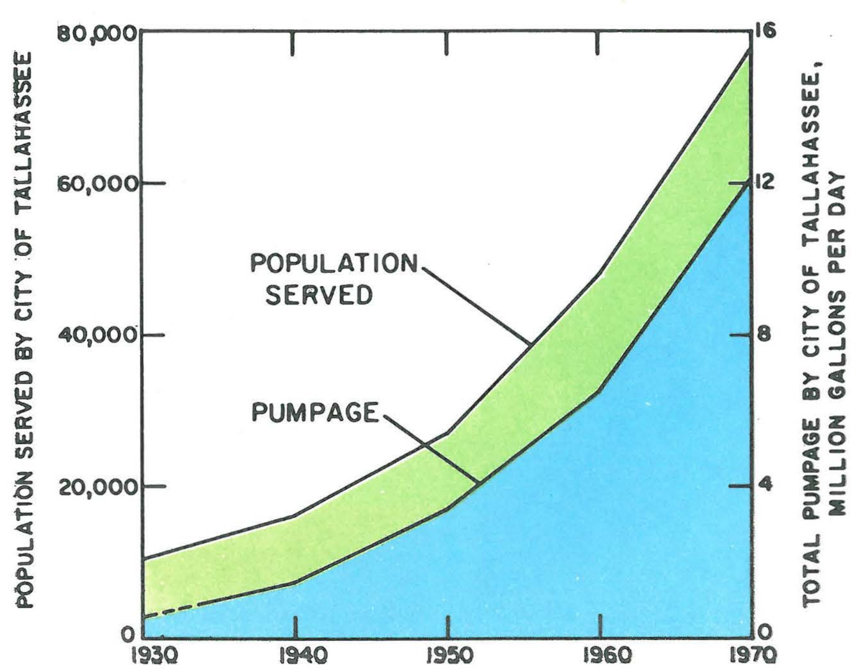
Selected chemical data for water from various sources in Leon County.

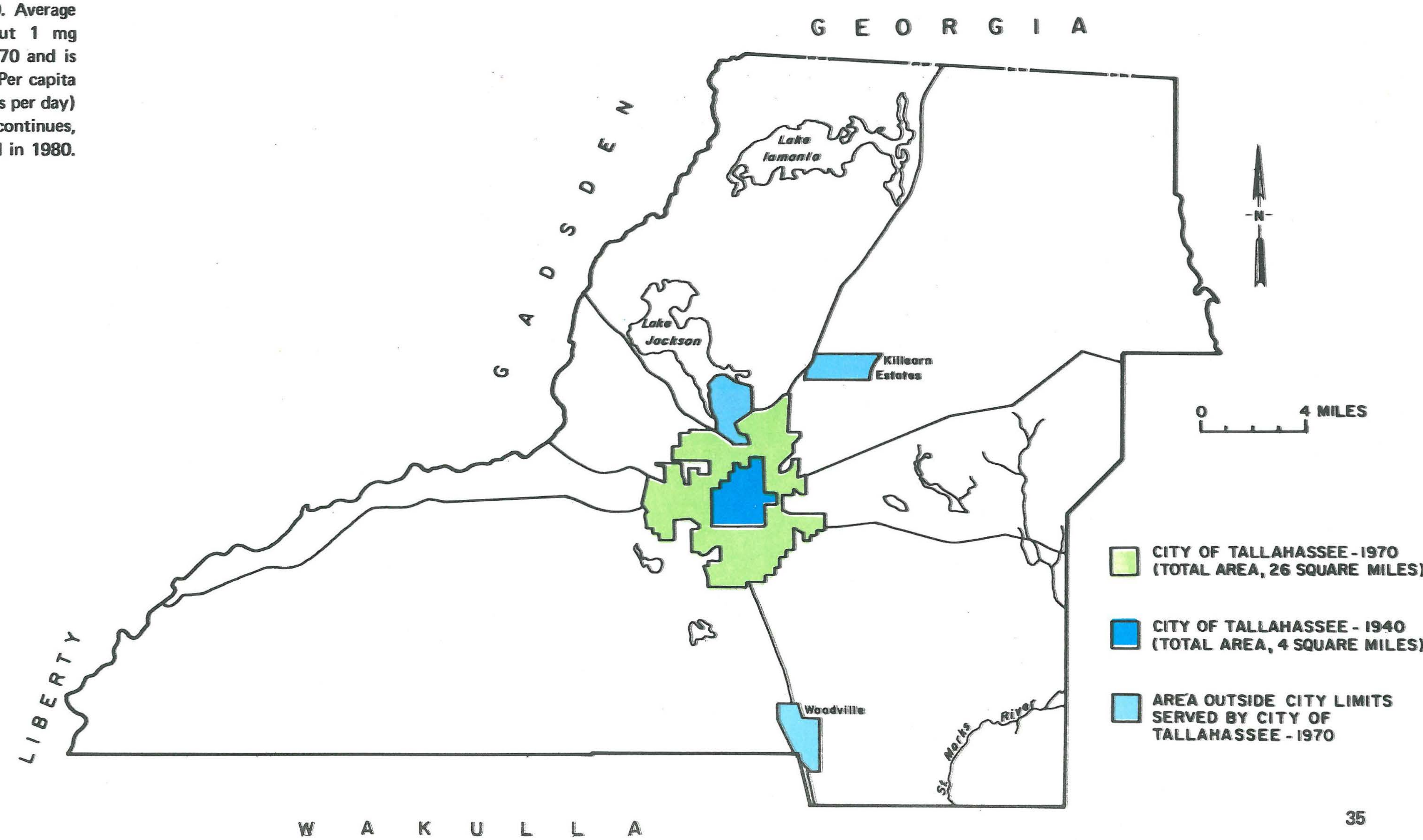
Constituent	Analyses of water, in milligrams per liter			
	St. Marks River	Lake Jackson	Ochlockonee River	Well penetrating the Floridan aquifer
Iron (Fe)	0.01	0.03	0.06	0.00
Nitrate (NO_3)	.6	.00	1.2	0.0
Chloride (Cl)	5.0	3.8	8.5	6.0
Sulfate (SO_4)	8.2	0.4	3.5	3.2
Hardness	136	7	19	146
Dissolved Solids	159	18	42	171

AREAS of MUNICIPAL WATER USE

The only municipal water system in Leon County is operated by the City of Tallahassee, which in 1970 supplied water to about 78,000 people in the city and its outlying service areas. The water is obtained from wells that penetrate the Floridan aquifer. The water is of good quality, with moderate hardness. Treatment is limited to chlorination.

The areas served by the City of Tallahassee's water system have expanded greatly since 1930. Average daily pumping has increased from about 1 mg (million gallons) in 1933 to 12 mg in 1970 and is projected to reach about 20 mg by 1980. Per capita water use has increased from 95 gpd (gallons per day) in 1940 to 160 gpd in 1970. If the trend continues, per capita water use will be about 180 gpd in 1980.



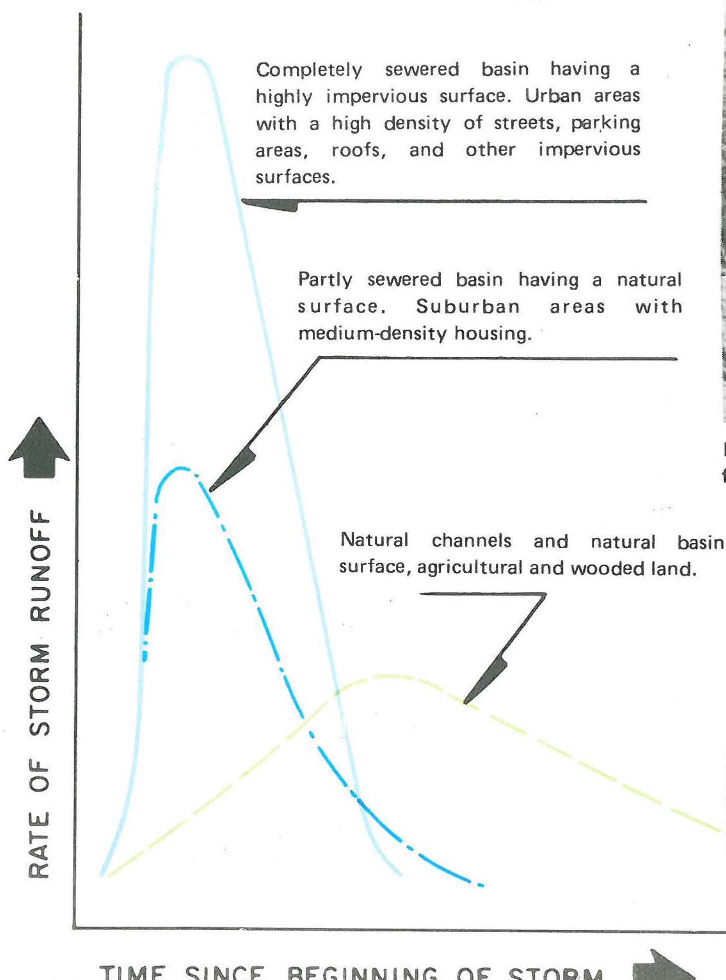


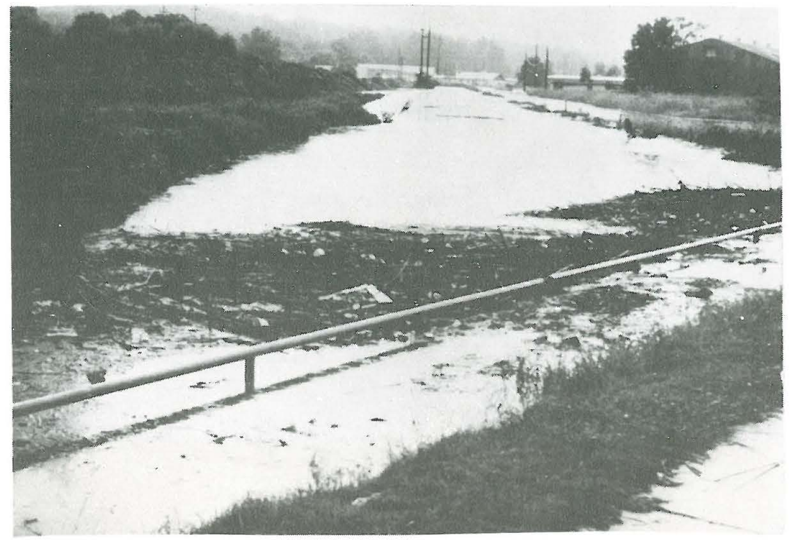
DRAINAGE and STORM RUNOFF

Storm runoff from the urban area of Tallahassee is handled through storm sewers and improved drainage channels. About 50 percent of the area inside the city is served by storm sewers.

Storm runoff from the 26 square-mile area of Tallahassee drains into three major lake systems. A small part of the city area drains north into Lake Jackson, and about 20 percent of the area drains east into Lake Lafayette. About 65 percent of the city area (17 square miles) drains south into Lake Munson. Rainfall of 2 inches or more per hour causes temporary flooding in some low lying places.

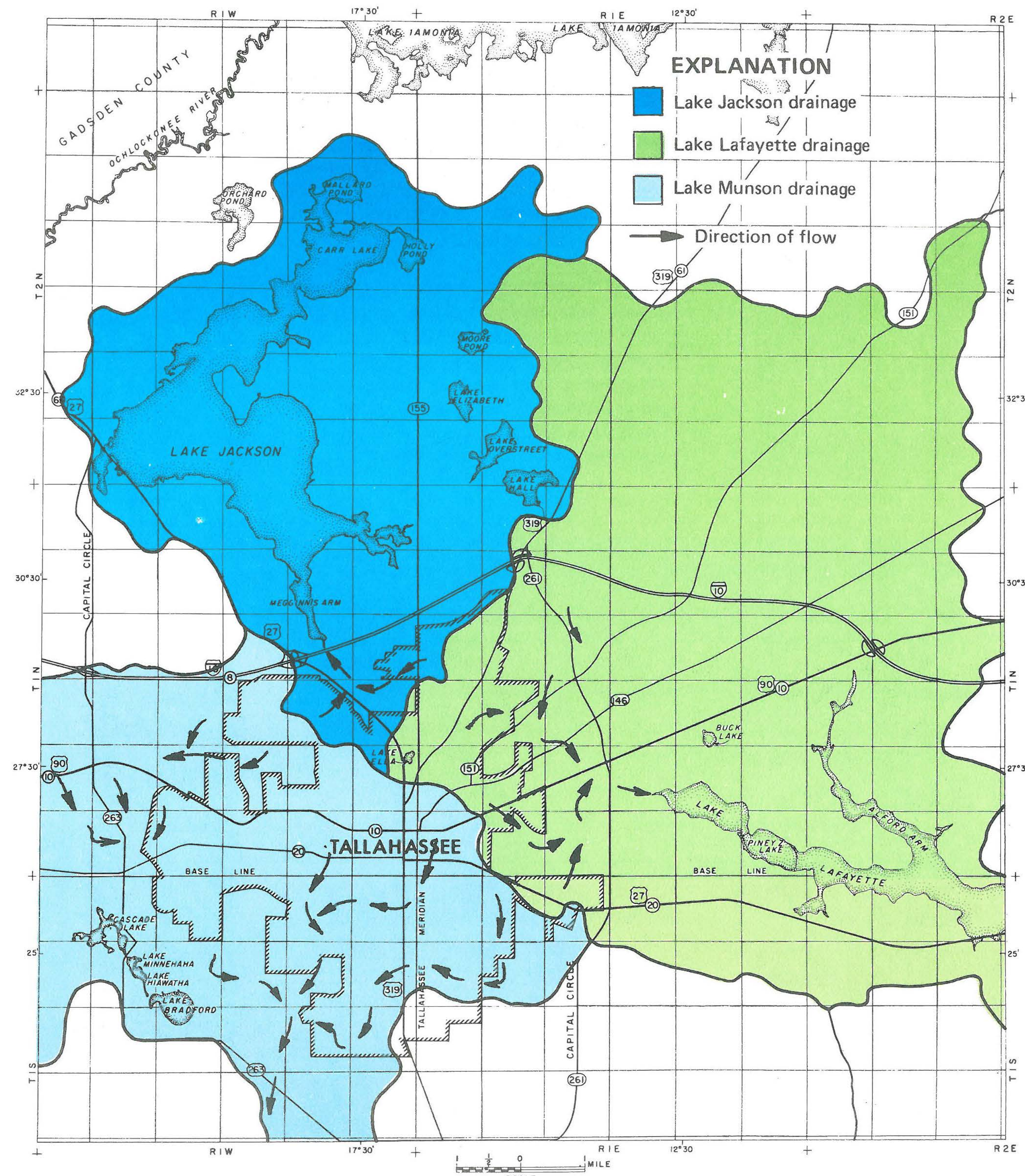
Data are not available on the flood volumes or the quality of water draining into these lake systems. As urbanization spreads and impervious areas (roads, parking lots, homes) increase, the volume of storm runoff will increase. This will cause an increase in the magnitude of flooding of the drainage system. Some stream channels in urban areas may have to be deepened, widened, and straightened to accommodate the increased volume of storm runoff.




On August 24, 1971, 3 inches of rainfall in about 1 hour caused flooding of drainage channel at Lake Bradford Road.


Drainage channel at Lake Bradford Road on day after flood. Water level about 10 feet lower than flood peak.


Large shopping center with 70 acres of roofs and paved parking causes almost total runoff of rainfall.



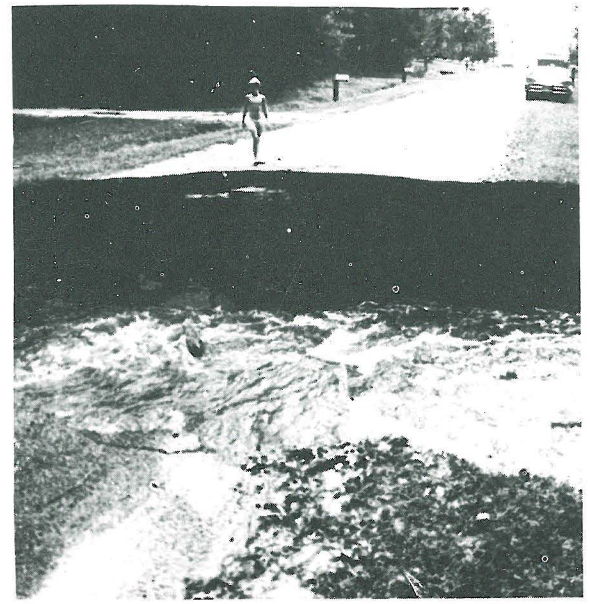
FLOODS

Flooding of low areas along streams, swamps, and lakes is natural. Because many of these flood-prone areas have scenic or commerical value, buildings are constructed on them. Damage to structures as a result of flooding can be severe. Flooding also can contaminate water-supply systems within these flood-prone areas.

Flood plains are suited to uses where infrequent inundations can be tolerated. Some flood-prone areas are used for agriculture. In Leon County, most are wooded, to form natural greenbelts, which prevent continuous and monotonous urban sprawl and provide refuge for wildlife.

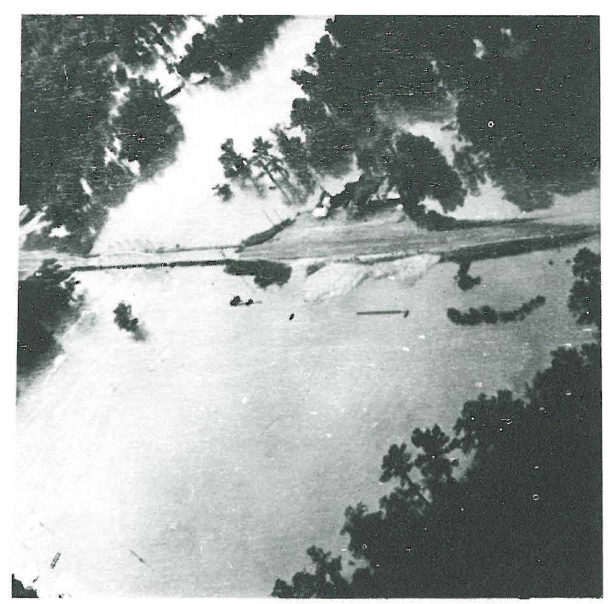
Flood plains can also be used for parks and other recreation facilities. The infrequent flooding of recreation areas results in negligible damage if the facilities are designed to accommodate flooding.

Some of the flood-prone areas in Leon County are occupied by residential housing and commercial buildings. Flood damage to buildings can be reduced by the use of special types of flood-proofing construction and remodeling.

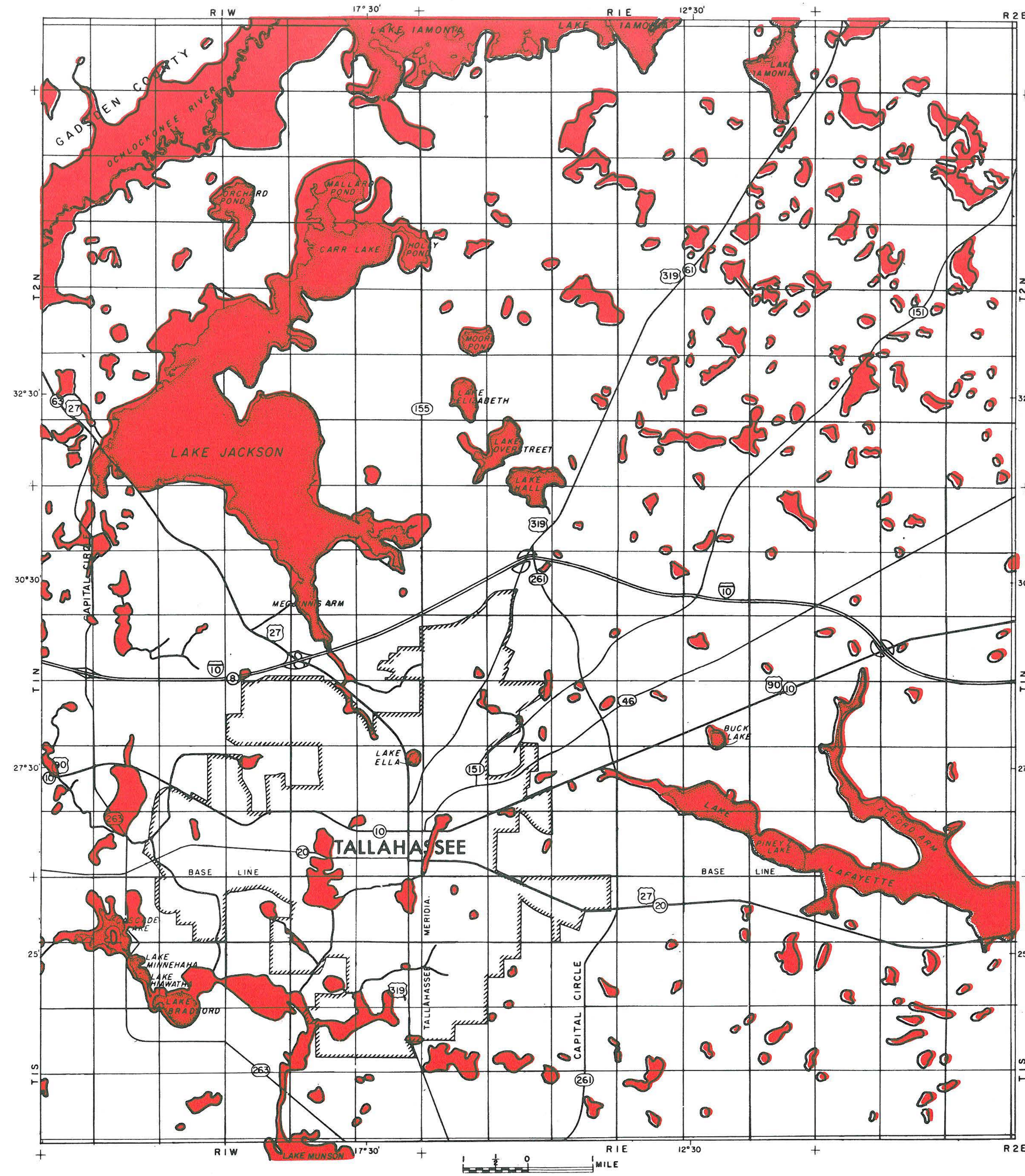


Road wash-out, North Lake Drive near Lake Jackson, Sept. 1969.

A flooded mobile-home park west of Tallahassee, Sept. 1969.

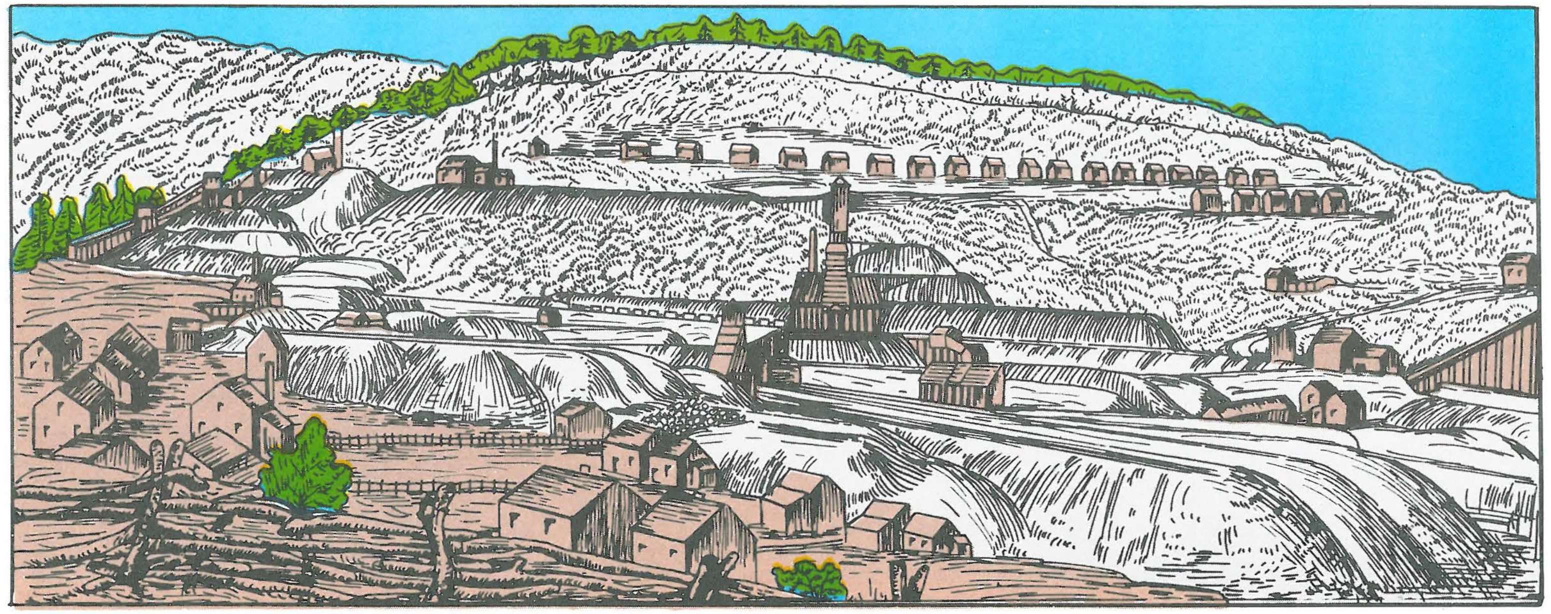


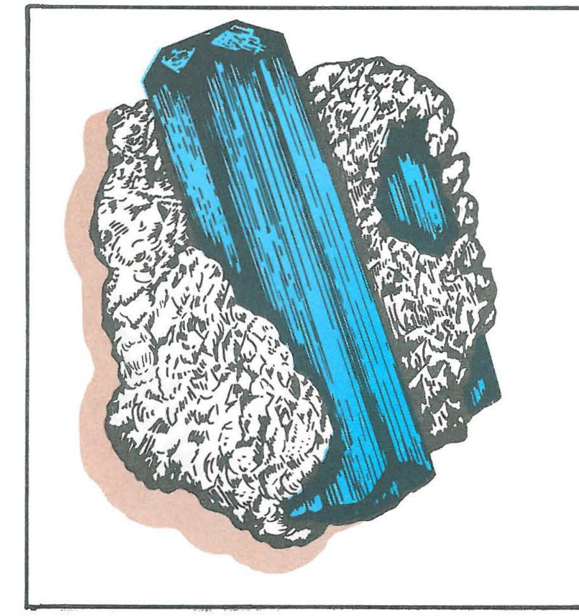
Ochlockonee River flooding in Sept. 1969.

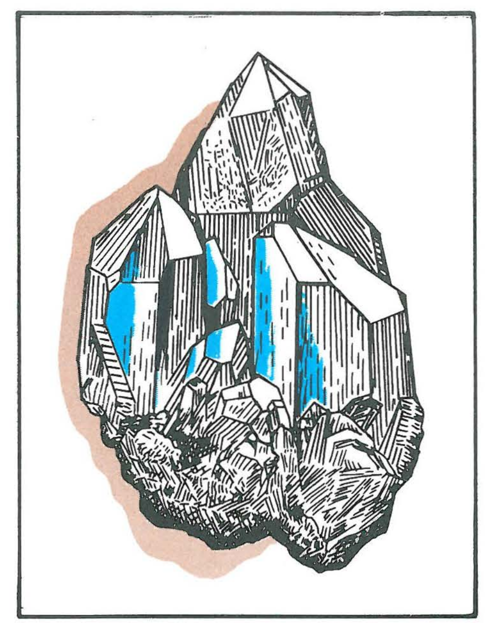


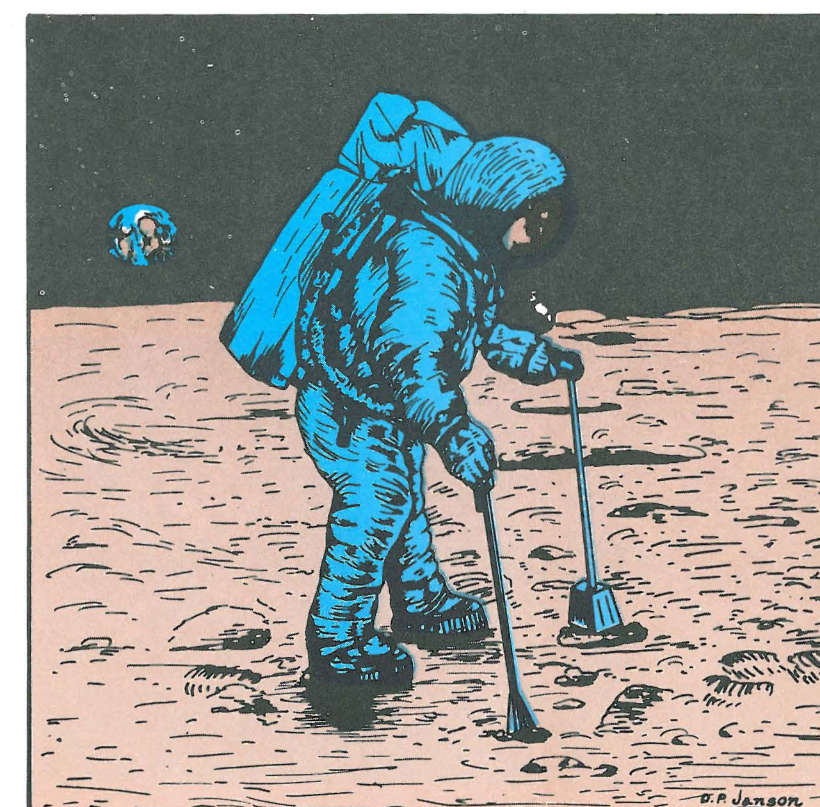
The chance that the entire flood-prone area, as shown in red, will be inundated in any given year is about 1 in 100. There are some low lying areas immediately adjacent to streams, swamps, and lakes that may be inundated every year, but not to the limits as shown in red.

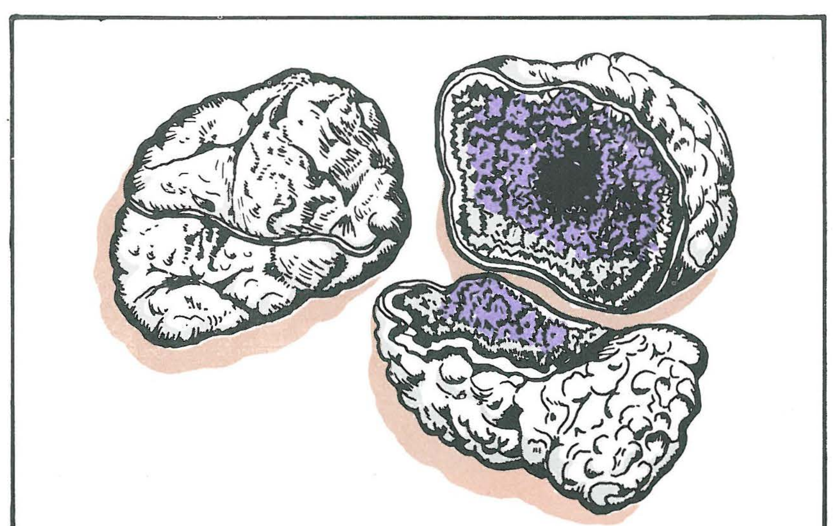
MINERAL RESOURCES







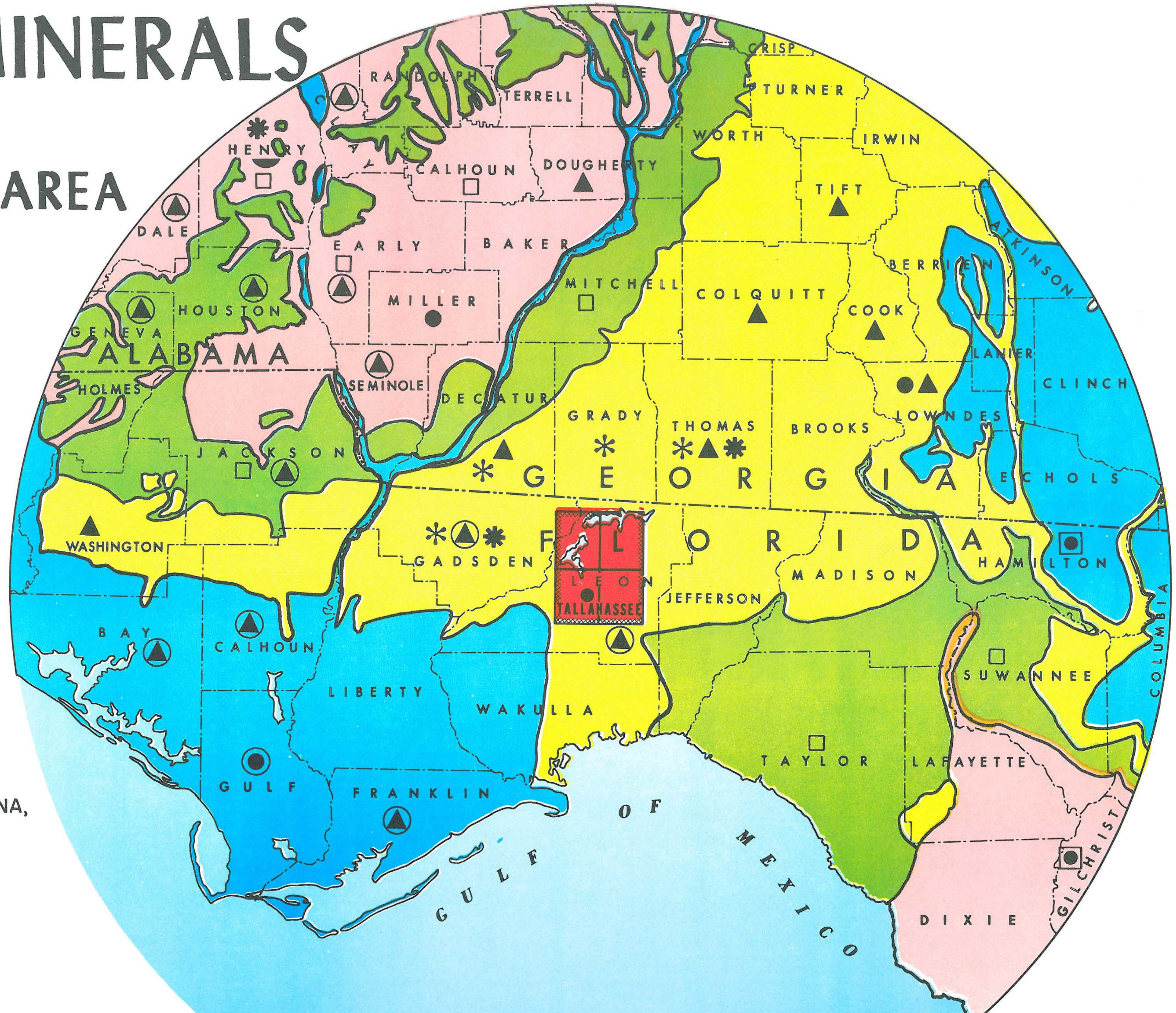




GEOLOGIC PROVINCES AND RELATED MINERALS

TALLAHASSEE AREA

- PLEISTOCENE
- MIOCENE
- OLIGOCENE
- EOCENE



EXPLANATION

- ▲ SAND
- SAND and GRAVEL
- FULLER'S EARTH
- STRUCTURAL CLAYS, HIGH ALUMINA, BAUXITE and REFRACTORY CLAYS
- ● PEAT and HUMIC PRODUCTS
- □ LIMESTONE
- ■ IRON ORE
- KAOLIN
- PHOSPHATE ROCK
- MAGNESIUM COMPOUNDS, LIME

MINERAL FACTS AND COMMODITIES

". . .Society should be reminded that nearly all the amenities of modern life which it takes for granted are products of the minerals industry and the engineers and others who serve it."

This statement by Professor R.A.L. Black upon his acceptance of the Chair of Mining Engineering of the Imperial College of Science and Technology at London, England during October, 1963, should serve to remind people everywhere of our dependence upon the mining or minerals industry.

Our standard of living is directly correlative with the development of our mineral resources. Our affluence is contingent upon the continued availability of mineral resources or reliable substitutes.

Mineral reserves are finite, they are not inexhaustible. Mineral substitutes, as well, must also come from the earth's mineral supplies. Mineral shortages come not only from the physical exhaustion of the minerals, but also from their unavailability at reasonable cost.

Paradoxes abound in minerals evaluation and their utilization by man. Petroleum exploration and development may be considerably more costly than the development of an open pit or quarry operation, *but* aesthetic or environmental problems are an inherent part of the strip mining operation. The exploration and extractive costs so comparatively cheap in the construction or industrial minerals industry are offset by the cost of pollution (air, water and noise), control equipment.

Paradoxically, petroleum and many of it's derivatives are transported by pipeline over vast distances at relatively small expense. Conversely, low unit value construction materials must be transported by mechanical surface vehicles with expansive and expensive handling operations.

Further, termination of production from wells drilled deep into the earth, does not leave grim public reminders of a depleted mineral resource. Not so with the surface mining operations!! Substantial costs are involved in restoration and reclamation and these in 1971 and in the future must now become part of the cost of the mining operation.

Mineral resource problems, that is the surface minable industrial minerals, are not to be solved through more extensive exploration programs, but through the broadening of technology to utilize those mineral resources known to exist. Continued and expansive exploration programs are paramount to the continued availability of our fossil fuels, and to a lesser degree the metallics. Conversely, new and significant finds of industrial mineral deposits are unlikely as their normal occurrence near the earth's surface has allowed them to be more readily tabulated. A more accurate reserve appraisal is therefore possible for the industrial minerals than for the fuels or metallics.

Within economical haul limits of Tallahassee 36 counties in three states produce six distinctly different minerals. Twenty-one of these counties produce sand while thirteen also have gravel production and eight produce crushed limestone. Iron ore, bauxite and various clays account for the remainder of the mineral production, while twenty counties have no recorded mineral production.

Most of the mineral production in the tri-state Tallahassee Environmental area, is of the construction type; sand, gravel and crushed limestone. These have direct application in the building trade after cleaning, crushing and screening. Since these are high volume, low unit cost, rough or basic construction materials, the economic haul perimeters are considerably more restrictive than for decorative or manufactured products. Transportation economics change with the supply and demand parameters of mineral resources, but a radius of 100 miles is commonly used.

CLAY

No commercial clay operations occur within the Tallahassee area. The nearest clay operation in Gadsden County, Florida and in Decatur and Grady counties, Georgia mine a specialty type of clay called Fuller's Earth, whose original use was as the name suggests, used for cleansing and fulling of wool to remove lanolin and dirt. Subsequent applications of Fuller's Earth have increased it's uses exponentially. Chief among these are uses as: a drilling mud, fungicide and insecticide carriers, absorbents, animal bedding and litter, adsorbents, extenders and fillers, pharmaceuticals, and in the manufacture of cement.

However, this processing is not done in the Tallahassee area and the clay is reintroduced to the area as a finished product.

Six counties in the tri-state area of influence commercially produce clay. Innumerable temporary pits, chiefly in the Miccosukee Formation and used for highway fill, may be found throughout the area. Much of the upland topography is a result of these sandy clay remnants and local "fill" sources are apt to be found near an existing or previous need locale.

Lumping of individual company and county statistics, prevent tonnage and value appraisals for the immediate area. On a statewide basis, the value of clay produced in Georgia almost doubles that of its nearest mineral competitor, while it ranks fourth in value in Florida and eighth in Alabama. Short ton values for recorded production during 1969 were: $2.30 in Alabama, $15.02 in Florida and $17.37 in Georgia. This discrepancy in unit values between the Alabama and the Georgia, Florida clays reflects the higher valued products obtained from fuller's earth and kaolin. The crude state or fill clays used in the Tallahassee area may sell for less than $1.00 per ton.

The national demand outlook for all clays shows an expected growth rate to the year 2000 ranging from 2.8 to 4.1 percent year' Uses in hydraulic

cement and as lightweight aggregates show the highest expected growth rates for this period. Therefore, the Tallahassee area should similarly experience the highest clay consumption rate based on its construction minerals economy.

Although attendant environmental problems are encountered primarily at the beneficiation stage and in the mined out areas, these problems are not insurmountable. Advances in pollution control technology plus tax incentives for land reclamation and ever increasing land values will allow the clay industry to remain compatible with our necessary and increasing environmental concern.

SAND AND GRAVEL

The normal conjunctive occurrence of these two materials, as well as their utilization, favors their combining when discussing production, value, reserves, and use. Quantitatively, the demand (in the U.S.) for sand and gravel alone exceeds the combined demand for the rest of the nonfuel nonmetallic minerals. It is one of the few commodities in which the nation is self sufficient. The annual growth rate for sand and gravel to the year 2000 is expected to be between 3.9 and 4.7 percent.

Remaining interstate highway construction and the need for residential building is likely to keep the sand and gravel demand for the Tallahassee area above the projected national growth rate for some years to come.

The withholding of individual company confidential data prevents an accurate disclosure of sand and gravel production in the Tallahassee area of influence. However, during 1969 both tonnage and value records were established in Alabama and Florida.

Problems associated with sand and gravel production are normally two-fold and somewhat diametrically opposed. First, the accretionary flood-plain deposits, which constitute one of the most common type deposits, are similarly some of the more desirable building sites. Waterfront, lake, or river property is a goal shared by many.

Conversely, adequate supplies of sand and gravel aggregate are quite often so remote as to make their transportation to areas of need, economically unfeasible.

Environmentally, sand and gravel operations are much less objectionable than some of their mineral production counterparts. An exception would be the dredge operation where turbidity factors are involved. Beneficiation may require large amounts of wash water, which may be recycled, but dust and noise are minimal.

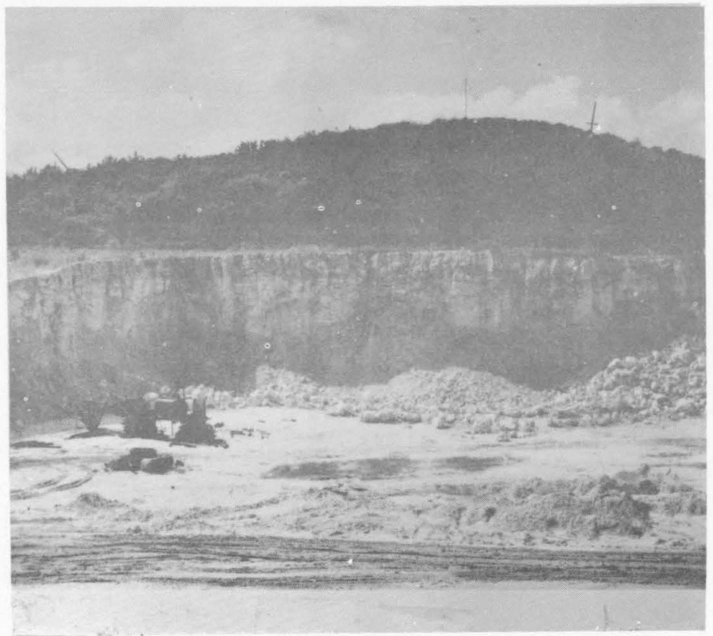
Land reclamation is usually at its cheapest and efficient mine planning can result in more valuable real estate afterward than before the mining venture.

STONE

Stone is an inclusive term used to denote any number of structural materials which may be chemically, physically, or mineralogically different and utilized in a similarly varied way. This is the highest valued nonfuel, nonmetallic mineral in the nation and is second only to sand and gravel in volume produced.

Stone, as used in the environs of Tallahassee, means crushed limestone and therefore excludes the finished dimension or decorative stones mined in other areas of the three states.

Eight counties in the tri-state area of economic consideration produce crushed limestone. Individual statistics for the counties in the Tallahassee area are not available, but 1969 statewide totals show Alabama producing 4.3 million tons with an average value of $1.26 ton, Georgia produced 17.8 million tons valued at $1.52 per ton while Florida produced 40.7 million tons with an average value of $1.32 per ton. Florida ranked fifth in the nation during 1969 in the production of crushed limestone, reflecting the near 20 percent increase in construction activity from the previous year.



A limestone quarry operation was begun early in 1972 near Tallahassee at Woodville. The operators claim to have an aggregate quality stone but existing knowledge and previous investigations indicate that the stone in this area is rather soft. Should this stone prove of aggregate quality, the area contractors should realize a substantial transportation saving as the nearest present operations are some 50 miles distant.

Nationally, the demand for crushed stone is expected to have a growth rate range to the year 2000 from 3.5 to 5.1 percent since this included the initial years of expanded interstate highway construction. However, the importance of Florida as a tourist and retirement state will cause a continued demand for new construction and its basic materials.

Shortages of aggregate quality stone have begun to be felt in the panhandle and northern peninsular areas of Florida. Reserve estimates for the "hard rock" area near Brooksville indicate a probable life of fifteen to twenty years. However, recent research by Yon indicates potentially much longer life in the area but with added exploration, development and operational costs.

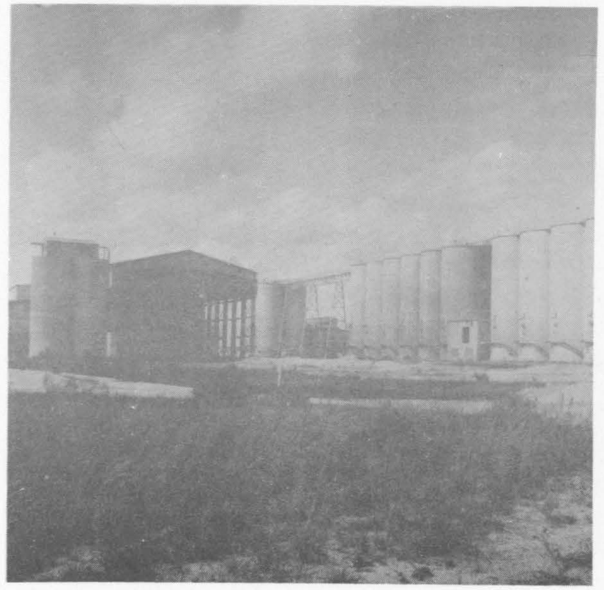
MISCELLANEOUS MINERALS

Of the remaining minerals produced within 100 miles of Tallahassee; Peat, Bauxite, Iron Ore, Oyster Shell, Kaolin, Phosphate Rock and Magnesium, only peat and oyster shell have direct application locally, and these in small quantities.

Peat, contrary to much of the world, is not used as a fuel in the United States but for agricultural and horticultural purposes only. Peat occurs throughout Florida in highly localized "pockets" but the only current production comes from Lowndes and Miller counties, Georgia. Production figures are not available but nearly three fourths of the commercial peat firms, produce less than 5000 tons per year.

Oyster shell is produced just outside the environmental area in Walton County, Florida and is used locally for dense road base material. No production figures are available. Estuarine considerations are likely to prevent any significant future expansion of this particular industry.

Other minerals produced within the 100 mile limits have no direct application locally, but return to the area as finished products. Also, these operations are so remote and products so varied as to have little effect on the Tallahassee economy, and similarly the local environment.



THE MINERALS FUTURE

Of the three proposals for solving future mineral shortages advocated by Park in "Affluence in Jeopardy" the second is perhaps the most appropriate to be applied at a local level. Park advocates national mineral policies for producing countries with the necessity for international cooperation. A similar policy, enacted at the state level with interstate cooperation, would alleviate many of the problems facing the mineral industry today. Equitable controls, particularly in the field of land reclamation, would effect equitable cost parameters for mineralogically similar regions regardless of political boundaries.

Sequential multiple land use as seen by Flawn is also a solution to mineral shortages. Land must be evaluated for its total value: at or near the surface and at depth. If minerals exist in economic amounts, then these must be recovered as efficiently and completely as possible; the land restored and then dedicated to a permanent useful purpose.

OIL AND GAS

HISTORY

Florida had no oil production until December 2, 1943 when Humble brought in the Sunniland field. This was the culmination of an exploration effort by many companies dating from 1900 and involving the drilling of 300 dry holes costing about $250 million. Now, twenty-eight years later, Florida has six producing oil fields.

THE JAY OIL FIELD

Most important by far in the history of the oil industry in Florida is the discovery of June 11, 1970 of the Jay field which produces from the Smackover Formation reached at a depth of about 15,500 feet. Recovery on the initial production test of the discovery well was at a daily rate of 1,712 barrels of high gravity oil plus 2.145 million cubic feet of gas. The recoverable reserves of the Jay field may be in excess of 200 million barrels of oil.

OIL PROSPECTS IN LEON COUNTY

Since the Jay discovery the oil industry has focused its attention on other parts of the Florida panhandle in the hope of finding another ancient marine embayment in which Smackover rocks might have been deposited. The Apalachicola National Forest, which embraces acreage in parts of Leon County, Liberty County and Wakulla County is included in such an embayment as contoured on shallow subsurface structural markers. This shallow feature may reflect a deeper embayment, and may have contributed to the acquiring of some 200 ten-year leases of the oil and gas rights to about 450,000 acres of the forest by a major oil company interest during the fiscal year ending July 1, 1971. A great deal of vibroseis, magnetic, and gravity work has been conducted over the area of these leases.

The oil and gas rights to a considerable but undisclosed amount of private acreage in the Big Bend area, has been leased to other oil companies.

THE NEED FOR HYDROCARBONS

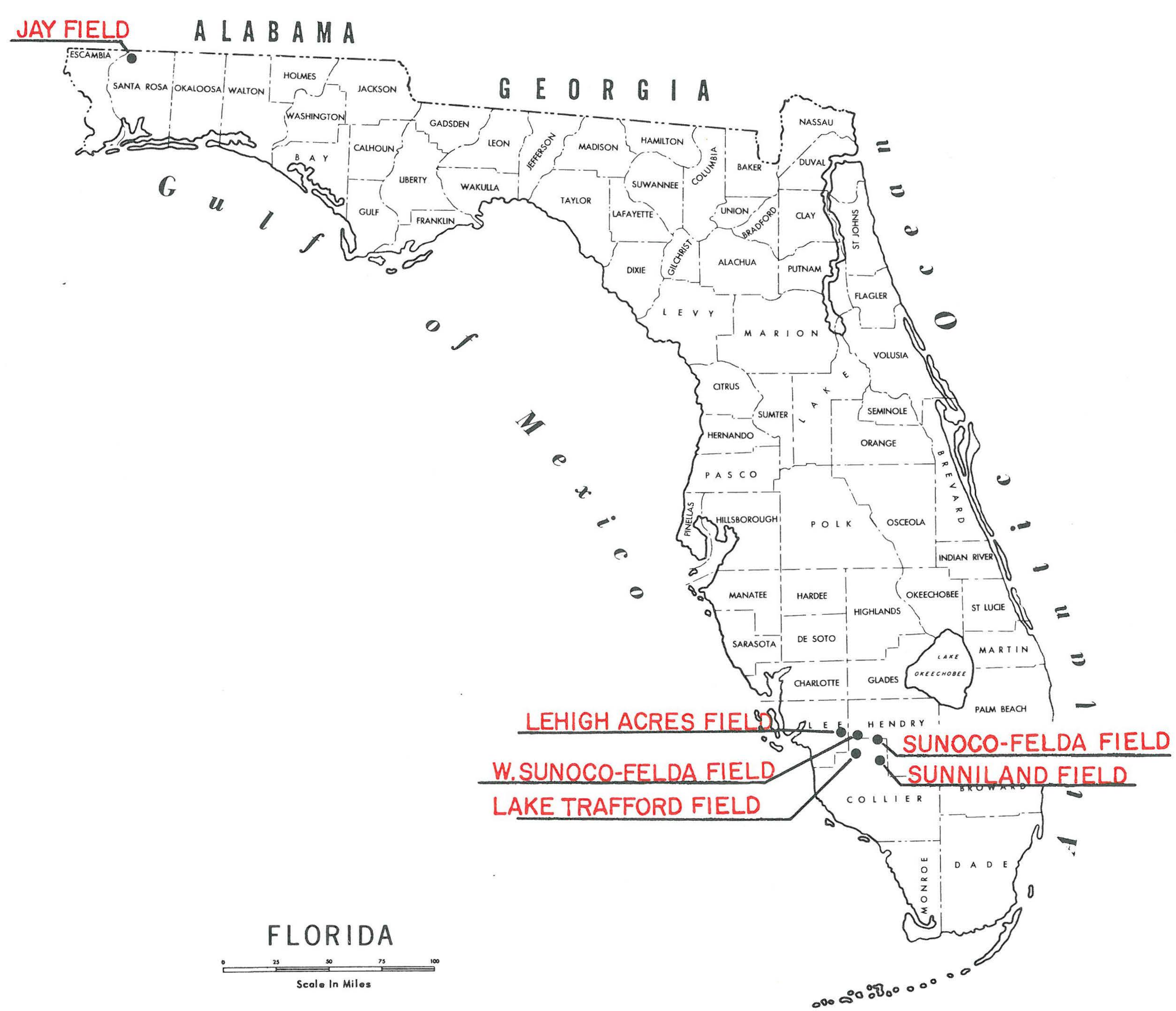
Within 14 years, or by 1985, our nation's demand for oil will be about 27 million barrels of oil per day, whereas in 1971 it is less than half that much. By 1985 domestic crude oil production from presently-known reserves will have declined to about one-fifth its 1971 level. Consequently unless there are new discoveries of domestic oil, our nation is facing an energy crisis which can only be met by imports.

Offshore production is important in supplying the nation's demand for petroleum. Dr. W. T. Pecora, Undersecretary, Department of the Interior, predicted recently that within ten years oilmen will be drilling into ocean bottoms under water more than one mile deep, and that at least a third of the nation's oil production will come from offshore.

Multimillions of dollars of geophysical work over the past nine years is reported to have revealed a number of structures on both Federal and State acreage offshore from Florida which may trap oil. Although acreage from the Florida's east coast is less desirable, geophysical exploration continues because the need for new petroleum reserves is great.

THE REVENUE FROM HYDROCARBONS

Florida has long had a vigorous mineral industry. With the advent of the Jay field, and recent discoveries in southern Florida, it appears that petroleum is destined to increase the value of the State's mineral industry. By 1975 the conservatively estimated value of hydrocarbons produced from fields already discovered will be $83 million; and the value of hydrocarbons will make a significant contribution to the state's mineral industry. It is significant that a 5 percent severance tax is paid to the State of Florida at this time on the oil and gas produced in Florida.



HYDROCARBON RESERVE ESTIMATES FOR FLORIDA

Estimated onshore and adjacent continental shelf recoverable reserves for Peninsula and Panhandle Florida, respectively, and for Alaska (to provide a very rough basis of comparison) are:

RESERVES

Onshore and Offshore	Oil (billion bbls)	Gas (trillion ft.^{3})	Sources
Florida			
Peninsula	7.8	13	NPC, July, 1970
Alaska	30	150	NPC, July, 1970

The National Petroleum Council (NPC) reserves were prepared at the request of the U.S. Department of the Interior; this source qualified the Florida reserve estimates as "speculative", whereas the Alaska estimates were not so qualified.

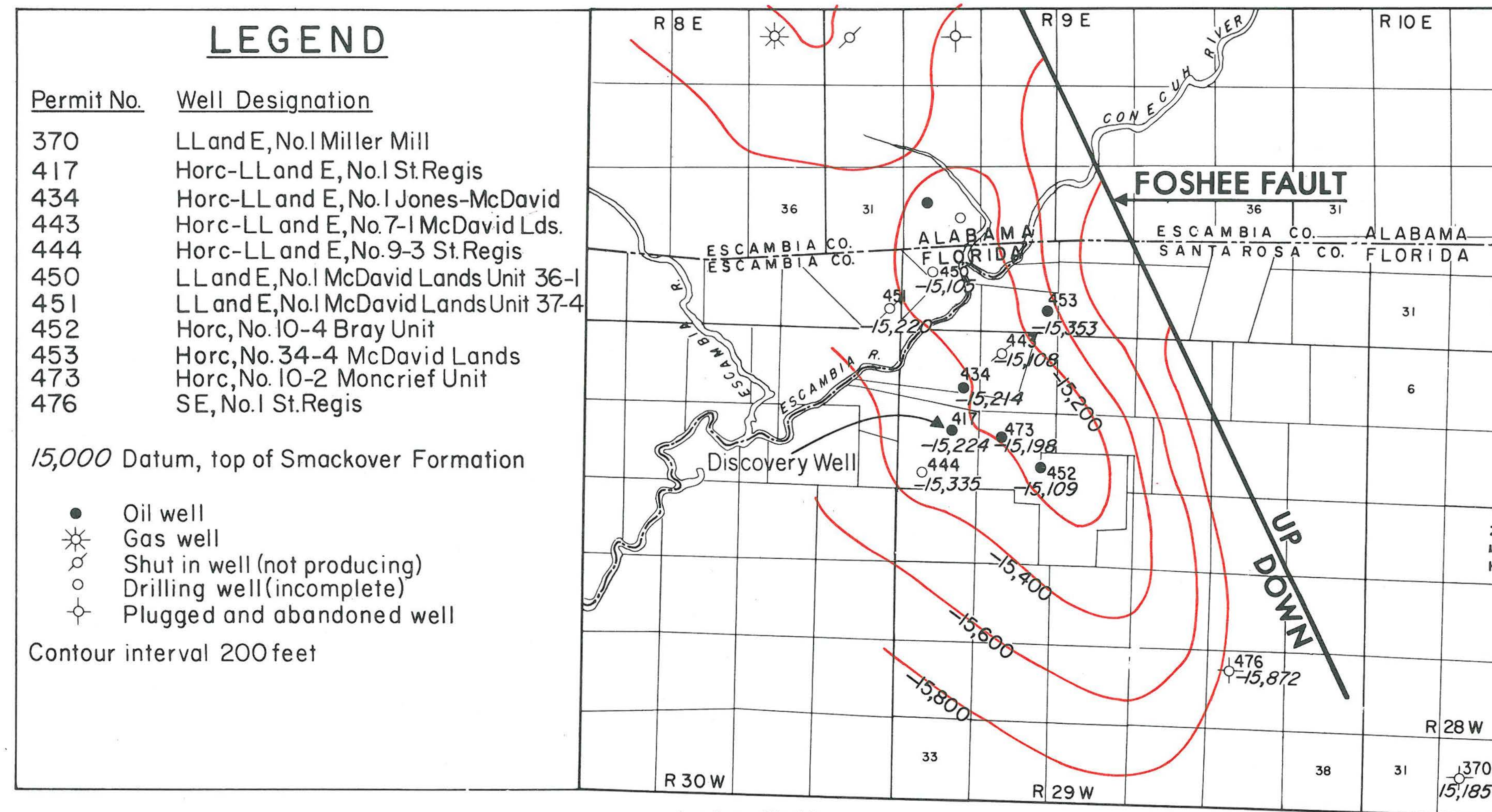
ENVIRONMENTAL PROTECTION BY THE DEPARTMENT OF NATURAL RESOURCES

Because of the relatively late start of the oil industry in Florida, it has avoided the environmental problems which resulted from the exploratory and development activities in some of the early oil states. The Florida oil industry has been characterized by a slow but continuous pace of development from the time of its inception in 1943 to 1970 when Jay field was discovered.

NEW RULES AND REGULATIONS

For the past two years, the Department of Natural Resources has been involved in the compilation of a very complete and up-to-date revision of our Rules and Regulations. Both industry and various conservation groups have made valuable contributions to this code, which should become effective in the first quarter of 1972.

These new Rules and Regulations will help to protect Florida's environment and also contribute to a stable regulatory climate for industry. They will also facilitate the systematic accumulation of information to be used by the Executive Board of Government given decision-making responsibilities for the formulation of oil and gas policies. Four Oil and Gas Coordinators have been employed to enforce the proposed Rules and Regulations. Two will be located in the Fort Myers area and two in Jay, Florida.

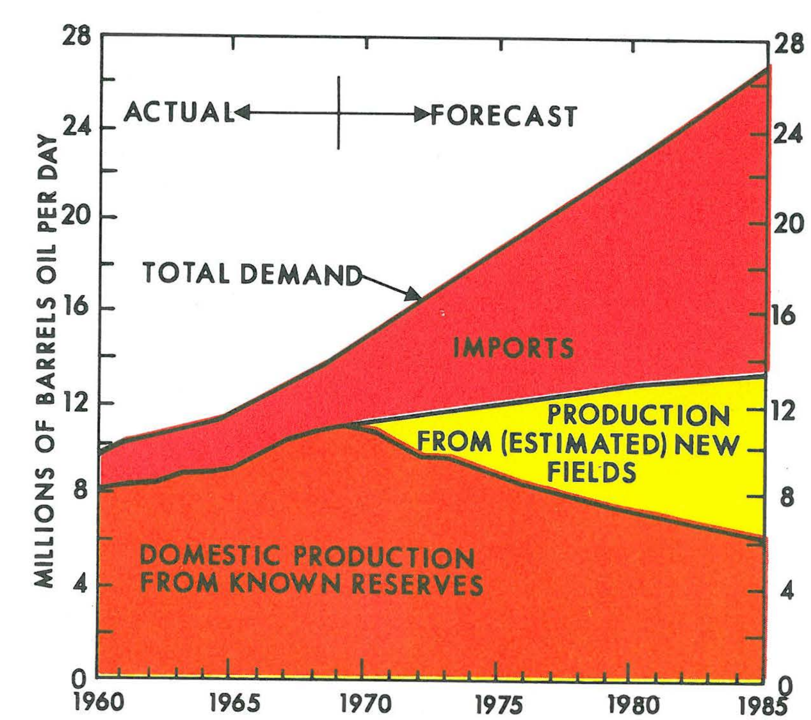


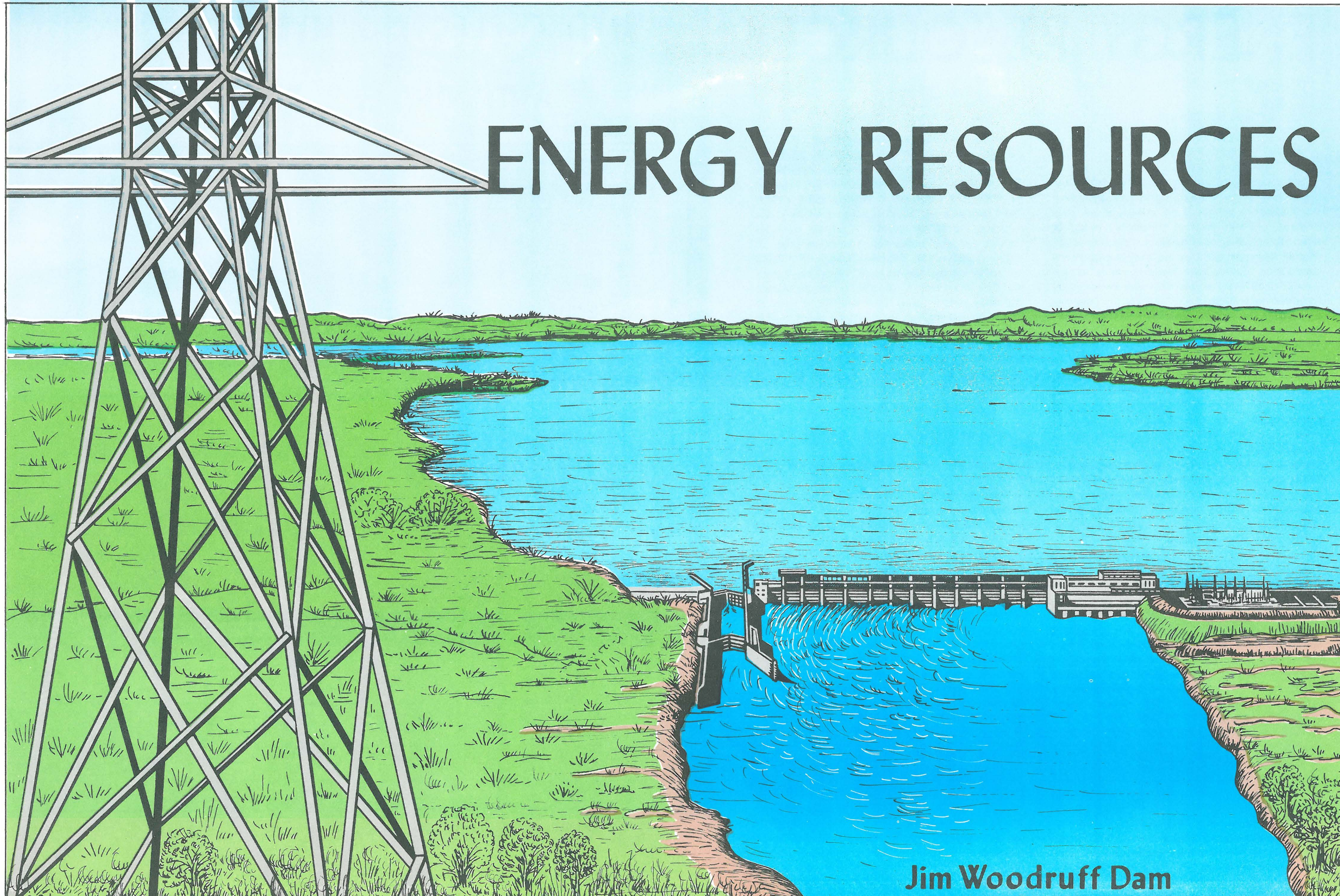
Jay Area, Florida.

TABLE 1. PRODUCTION STATISTICS AND OTHER DATA ON ALL FLORIDA FIELDS

Discovery Date	Oil Field	Operator	No. Of Wells	1970 Production (barrels)	Cumulative Production as of Aug. 31, 1971 (barrels)
Southern Florida:					
1943	Sunniland	Humble Oil Co.	17	722,534	13,071,065
1964	Sunoco-Felda	Sun Oil Co.	20	688,635	5,451,723
1966	West Sunoco-Felda	Sun and Humble	23	1,473,016	3,787,202
1968	Lake Trafford	Mobil Oil Corp.	1	25,806	63,397
1970	Lehigh Acres	Humble Oil Co.	2	81,542	187,574
NW Florida (Santa Rosa County):					
1970	Jay	Humble, LL and E, Amerada Hess, Sun et al	1	6,819[A]	379,183[B]
				2,998,352	22,940,144

Footnotes: Jay figures are limited to test production through the 2,000-BOPD capacity separator plant. An additional 12,000-BOPD plant should come on stream early in 1972.
[A] 1970 production was test yield from 1 well
[B] Cumulative production, Aug. 31, 1971, was test yield from 4 wells.




ENERGY RESOURCES
Jim Woodruff Dam
D.P. Jarson

ENERGY RESOURCES: HYDRO-ELECTRIC, HYDROCARBONS, AND NUCLEAR FISSION

1. PRESENT ENERGY DEMANDS
(WHAT WE HAVE)

Tallahassee owns its own electric generating and distributing system. The excess generating capacity of the Tallahassee system is 50 percent above peak demand. This highly favorable ratio of reserve-to-operating capacity enabled the City to sell 40,000 kilowatts per hour to the Florida Power Corporation during peak demand hours in the summer of 1971. By contrast the major private utility companies operating in southern Florida have less than 10 percent reserve capacity. The desirable safe level of reserve capacity is 20 percent.

The hydro-electric plant at Jim Woodruff Dam in Gadsden County has a rated capacity of 30,000 kilowatt hours per hour at peak load. This dam and its power generating facilities were constructed with federal funds under an R.E.A. program to make power available to rural areas of Leon, as well as Gadsden and Wakulla Counties. Talquin Electric Co-op is the R.E.A. distributor in the tri-county area. Tallahassee will add a standby gas turbine peaking unit of this same capacity to its system next summer. The municipal electric system is connected to the national power network, from which it could draw reserve energy in an emergency.

About a half century ago, the hydro-electric generating plant at Jackson Bluff was designed and the Ochlocknee River dam constructed. In 1926 this facility went into operation using water from Lake Talquin as outfall energy. The rated peak capacity of this facility was 8,000 kilowatt hours per hour, which was intended to furnish enough power to supply the needs of Tallahassee and Quincy until 1970. Much of the equipment was worn out and needed replacing a half century later, so in 1970, Florida Power Corporation made a gift to the State of its dam, lake bottoms and 20,000 upland acres. Tallahassee alone needed 30 times the peak load capacity of the Jackson Bluff generating system. The cessation of the water-powered turbines at Jackson Bluff marked the end of an ara: It was the last commercial domestically available energy in Leon County. A century ago, all of Leon County's energy needs could be fulfilled by wood or charcoal, available within the county. Today this material furnishes heat for special occasions, such as barbecue cook-outs, but is not considered a commercial energy source.

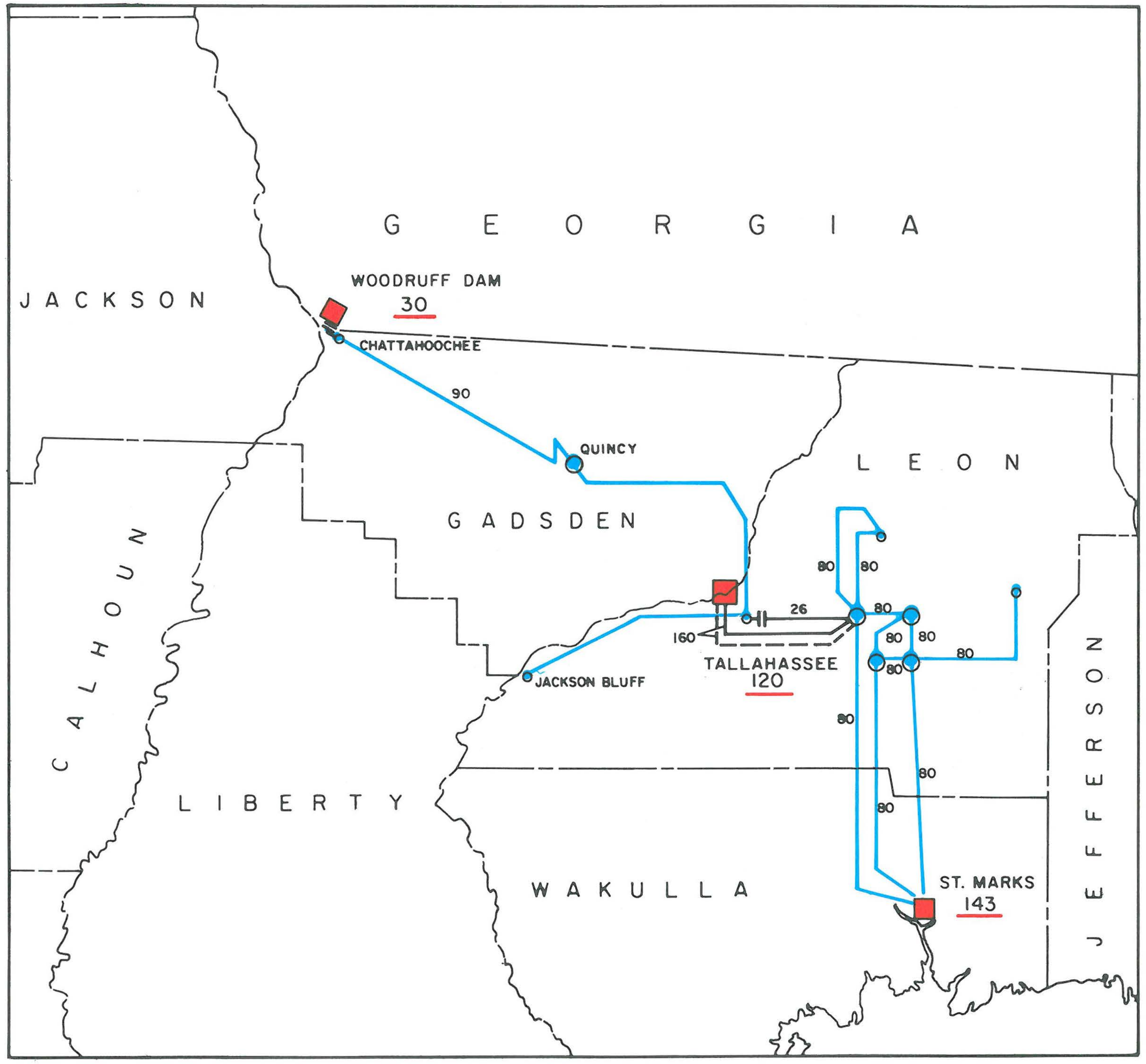
During the fiscal year ending October 31, 1971, the City of Tallahassee purchased about 20 billion cubic feet of gas from the Florida Gas Corporation. The municipally owned electric generating plants at St. Marks and the Arvah B. Hopkins plant west of Tallahassee required about 8 billion cubic feet; the remaining 12 billion cubic feet of gas was sold through the city-owned gas distribution lines. In addition, about 150 thousand barrels (6,300,000 gallons) of residual fuel oil were used to supplement the fuel requirements of the municipal electric generating system during the year 1971. In terms of energy equivalents, gas furnished 80×10^{11} BTU compared to about 9.5×10^{11} BTU available from the fuel oil. If gas were unavailable, approximately 1.25 million barrels of residual fuel oil would be required to produce the 765,000,000 kilowatt hours of electricity which were generated by the City of Tallahassee during the past fiscal year.

SOURCES OF ENERGY SUPPLY

Intrastate Sources:

The oil fields of Florida are located in the Sunniland trend east of Fort Myers and in the extreme northwestern portion of the Panhandle at Jay. Jay Field is primarily an oil field as defined by its gas-oil ratio which ranges from 800:1 to 3000:1. This means 800 to 3000 cubic feet of gas are produced per barrel (42 gallons) of oil. In terms of energy equivalents, crude petroleum averages nearly 6,000,000 BTU per barrel whereas natural gas (dry) provides about 1,000,000 BTU per thousand cubic feet. The crude oil at Jay is worth about $3.35 per barrel and the natural gas about 30 cents per thousand cubic feet, at the well head. Therefore the 1:6 ratio of energy equivalent obtained by comparing BTU values of 1000 cubic feet of gas to 1 barrel of oil should logically fix the price of 1000 cubic feet of gas at 56 cents, or nearly double the actual well head price.

The field allowables will probably be fixed at 1000 barrels per well per day at Jay plus 1,000,000 cubic feet of associated gas. The gas furnishes reservoir energy which causes the wells to flow, and therefore gas is conserved in the reservoir to the extent possible. It seems probable that Jay Field will produce oil and gas from 60 wells when fully developed, providing 60,000 barrels of oil and 60,000



80 Transmission line and Substations. Superscript indicates line capacity in kilovolts.

30 Electric Generating Plant - Superscript indicates plant capacity in kilowatt hours/hour.

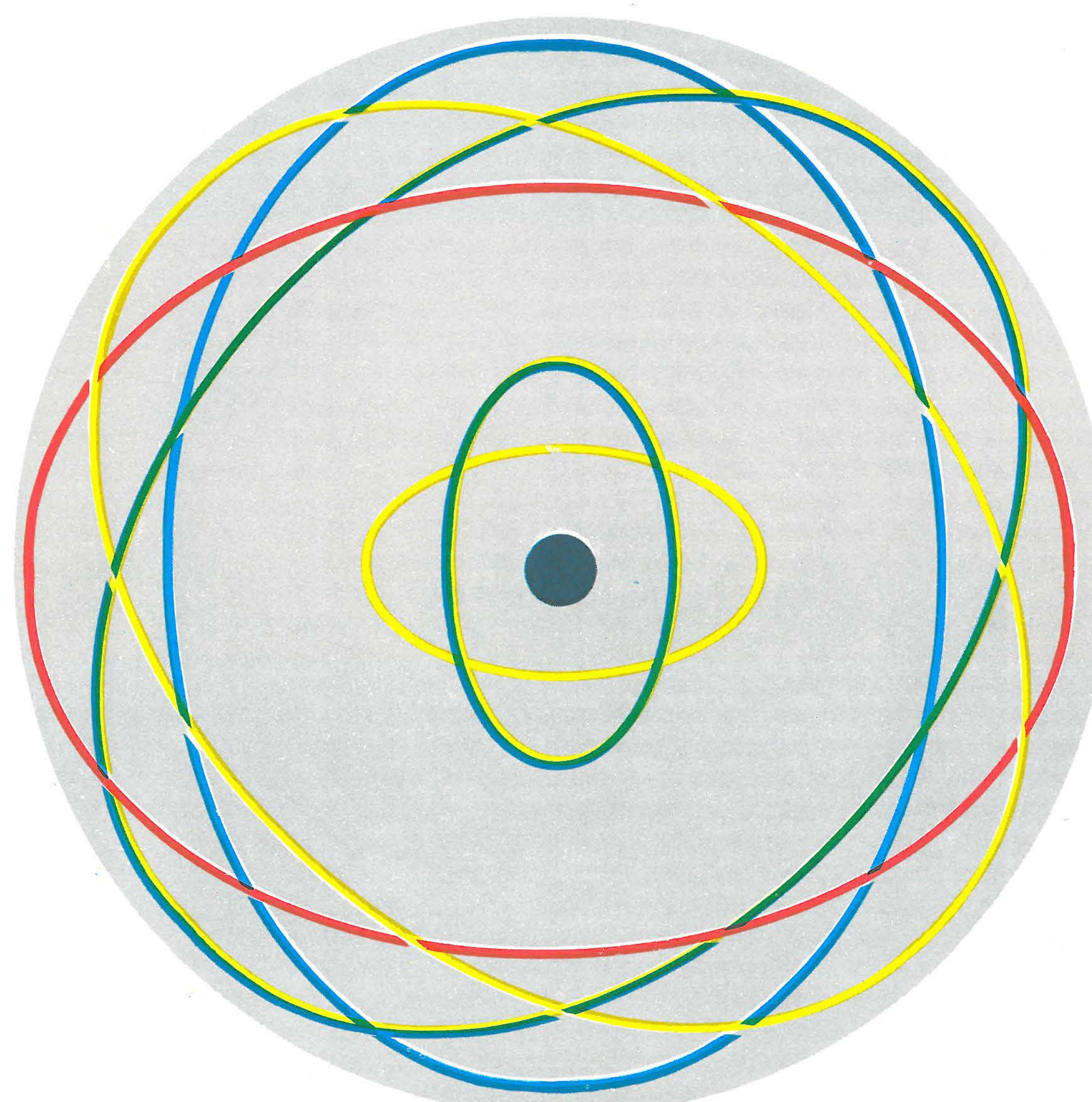
MCFG (thousand cubic feet of gas) per day. The indicated recovery rate of gas at Jay is, therefore, 22 billion cubic feet of gas annually, which is 10 percent more than Tallahassee purchased last fiscal year, but considerably less than the growing demand for gas in this one medium-sized city (71,763 persons at last census). There is no other gas produced in commercial quantities in the State of Florida at present. The oil wells in southern Florida are all on pump with average gas-oil ratio less than 100:1, which is not enough to operate the field pumps on a sustained basis.

The petroleum production at Jay may achieve a rate of 22 million barrels per year in 1973. The high gravity crude from Jay should yield at least 20 gallons of gasoline perbarrel, or a total of 440 million gallons of gasoline per year. Florida's gasoline consumption is more than 3 billion gallons annually, but Jay Field could supply nearly 8 times the annual consumption of gasoline in Leon County (51.5 million gallons). Residual fuel oil, derived from crude petroleum, at an average rate of yield of 7.3 percent would provide 1.6 million barrels per year. This would suffice to power the steam turbine generators for Tallahassee's electric plants and leave a third of a million barrel surplus, at present generating rates. The average yield in the United States of kerosene per refined barrel of crude petroleum was 7.7 percent at last report. Jay Field production would provide about 71 million gallons of kerosene annually, whereas Leon County sales only totalled 2.5 million gallons last year, hence we should be adequately supplied with fuel, if Tallahassee could obtain first claim to production from Jay Field and had a static population.

During 1970, the fields in the Sunniland trend of southern Florida produced about 3 million barrels of intermediate gravity crude oil from 60 wells. The United States requires nearly 5 times this amount every day (about 3 gallons per capita daily). At this rate of consumption, the fields of south Florida provide almost enough crude oil to suffice the population of Immokalee (3200), a Collier County farm center which is located near the hub of oil production in the Sunniland trend.

FUTURE ENERGY DEMANDS

The most important factors affecting future energy requirements are growth rates in population and in the gross national product. Environmental considerations, comparative costs of fuel and convenience factors, though unrelated to GNP also affect fuel demands. Examples of such qualitative considerations are: Increased motor fuel consumption due to exhaust control equipment. Heating of residences by electricity rather than by direct thermal conversion in home fuel burners. (The loss here is on the order of 3:1, due to thermal inefficiency of power generators.) A prolonged national fuel shortage would require rationing the consumption of petroleum and natural gas among higher quality uses. Electricity must be generated by coal, water power and, increasingly, by nuclear fission. In his message of June 4, 1971, President Nixon directed new standards



of insulation be required for F.H.A. insured homes. This would conserve fuel for heating, as well as cooling, by as much as one-third.

The growth rate for Tallahassee during the decade of the sixties was 49 percent, nearly 4 times the national average of 13.3 percent. If, during the next two decades Tallahassee's population continues to grow as forecast, it will attain 160,000 by 1990, more than double the present population. Even if there were no increase in the per capita rate of energy consumption, which is not the case, our requirements for energy would double in less than 20 years. Floridians are no more fecund nor long-lived than the rest of the nation. In fact our population increase due to the net gain in births-over-deaths in the sixties was a modest 10.0 percent, as compared to the national average of 11.7 percent. On the other hand, Florida had a net in migration of 1.3 million during the past decade, wheras the total national immigration was only 3 million, or slightly more than double that of our state alone.

The per capita consumption of electricity doubles every 9 years in Florida as compared to the national doubling rate of 10 years. The projected peak demand for electricity in Tallahassee by 1990 will, therefore, be 8.5 times the peak consumption rate of 1971, which was 175,000 kilowatt hours per hour. We will need electric generating capacity of 1.5 million kilowatt hours per hour (equal to 1500 million watts electric) plus a 20 percent reserve safety factor of 300,000 kilowatt hours per hour. In 1990, the Tallahassee municipal generating system will require the energy equivalent of 10.5 million barrels of residual fuel oil.

During the 20 year interval from 1949 to 1969, gasoline consumption in the United States increased from 37.5 to 88.6 billion gallons, or 136 percent. The consumption of gasoline in Florida during this interval rose from 782 million to more than 3 billion gallons, nearly 384 percent. Florida's population increase was 4.3 times the national average during this period, while our gasoline consumption only increased 2.8 times the national average. This may indicate that in-migrants tend to become relatively immobile, once they get here. The reduced rate of increase in gasoline consumption of Floridians, compared to other U.S. materials, is a bright spot in otherwise gloomy statistics.

SOURCES OF FUEL REQUIREMENTS OF THE FUTURE

Intrastate Petroleum Supply:

At its peak production rate Jay Field could supply one sixth the residual fuel oil which will be needed in 1990 to generate electricity for Tallahassee. Although production from this field will have declined by 1990, it is probable that other large oil fields will be discovered in the same producing trend of northwest Florida. There is however, little likelihood that Florida will ever approach self-sufficiency in petroleum from on-shore fields. However, prospects for the discovery of large accumulations of petroleum in that half of the Florida platform which is submerged beneath shallow waters off the Gulf of Mexico are rather good.

Domestic And Imported Petroleum Supply

The United States demand for petroleum products is about 15 million barrels (630,000,000 gallons) per day. This demand will double by 1990. The U.S. is now dependent on imports for 23 percent of its petroleum needs. More than half of these imports, which totalled a billion barrels in 1969, were refined products, the bulk of it residual fuel oil used in industry including electric power generating plants. Canada and Venezuela together provided more than 60 percent of our crude petroleum imports. Nearly all of the imported residual fuel oil originated in Venezuela and the Caribbean region. Unfortunately, Venezuelan production seems near its peak as is that of the United States. Canada might be able to furnish another hundred million barrels a year to us if required, while our own domestic reserve capacity totals 365,000,000 barrels annually. The two together are less than 10 percent of the 5.5 billion barrels of petroleum we consume.

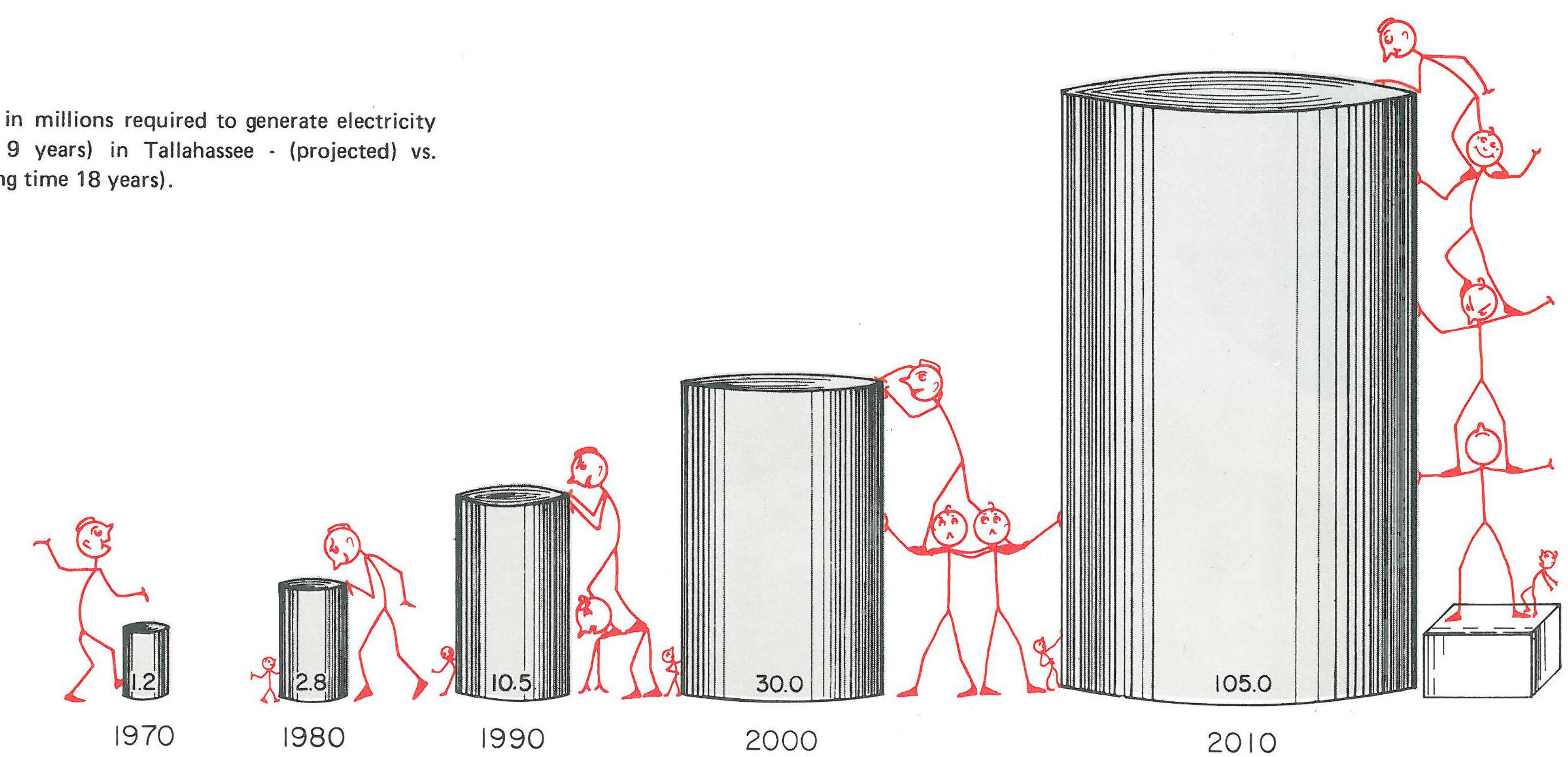
In the next 20 years, while our domestic supply declines and our imports rise we must rely increasingly on the Middle East and Africa, where 83 percent of the proven free world petroleum supplies are located. Western Europe now obtains more than 60 percent of its petroleum requirements (13 million barrels per day) from these sources. In the event the supply lines are cut by war or insurrection we shall have to furnish oil to our NATO allies. We could send them 2 million barrels per day by cutting our non-essential travel. However, by 1990, we shall ourselves be as dependent on the Middle East and Africa for petroleum as Europe is today unless alternate supplies of liquid fuels can be developed. Sources such as oil shales, tar sands, coal-derived oil and gas, plus exotics such as liquid hydrogen should be developed now. Our pipe-line and refinery patterns and techniques cannot be shifted in a matter of months or years - it would require decades to redesign and re-equip this industry to handle the half billion gallons plus per day we need at present.

Intrastate Sources of Uranium:

The phosphate deposits of Florida contain associated uranium which should be recovered during phosphate processing. In a 1969 report prepared for and published by the U.S. Atomic Energy Commission entitled "Uranium in the Southern United States," the following paragraph is quoted from page 65:

> "An amazing quantity of uranium is being wasted each year during current mining operations (of phosphate in Florida). If the phosphate pebble and other phosphate minerals mined are included, the uranium wasted is on the order of 6,000 tons of U_3O_8 per year, of which approximately 2000 tons could be recovered. It is unfortunate that economic pressures should destroy such a precious resource."

Barrels of residual fuel oil in millions required to generate electricity consumed (doubling time 9 years) in Tallahassee - (projected) vs. population increase (doubling time 18 years).



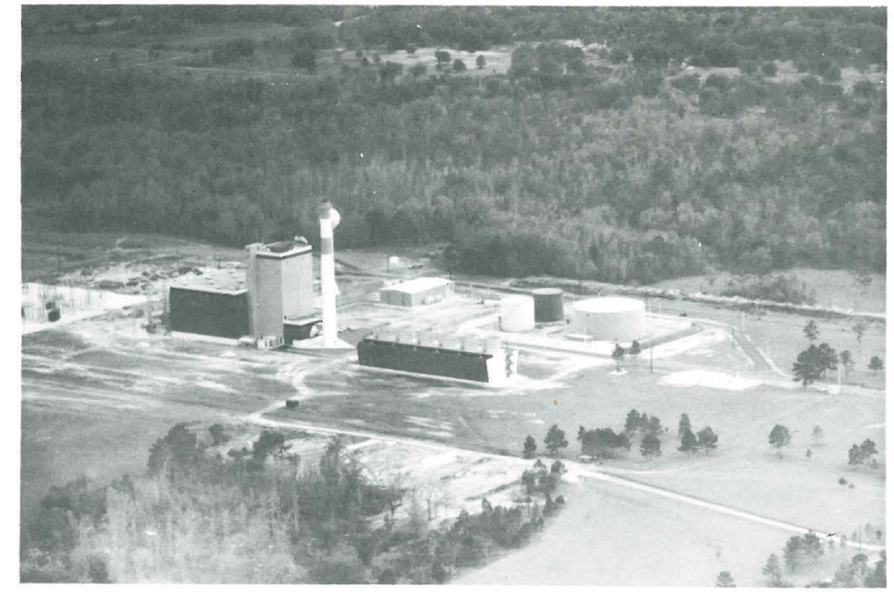
The reason that only a third of the 6,000 tons of uranium oxide wasted annually in Florida is recoverable rests on variation in method of processing phosphate ore. Of the 30 million tons processed in Florida annually, about 1/3 is converted to phosphoric acid by the wet process method, using sulfuric acid, as opposed to the electric furnace method. Recovery of the uranium oxide associated with the phosphate ore is feasible only when the wet process method is employed.

The uranium oxide reserves of the free world are estimated at 1.6 million short tons, recoverable at a price of $8 to $10 per pound, with an additional 1.4 million tons recoverable at a price between $10 - $15 per pound. It is further estimated the free world requirements for uranium used in nuclear reactors generating electricity will have totaled 3 million tons by the end of the century. In view of the fact that uranium oxide associated with phosphate in Florida can profitably be extracted at $10 to $15 per pound and considering that the free world supply available at a price below $15 will be exhausted within 30 years, why do we allow it to be wasted? The argument that this is in response to economic necessity like the deliberate flaring of natural gas in the early part of the present century is unfounded. The difference is that prior to 1930 there were no pipe lines and no known techniques for gas storage in most oil producing areas; either the gas had to be flared or the oil would remain in the ground. In the case of uranium associated with mineable phosphates - the uranium should be extracted concurrently with phosphate from the matrix clays, and the cost should be subsidized by tax write-offs and direct payments, if needed.

The estimated 600,000 tons of uranium oxide in Florida represents one fifth the entire free world supply recoverable at less than $15 per pound. At an average price of $12.50 per pound, this uranium oxide is worth 15 billion dollars.

Florida will have 4 nuclear powered electric plants in operation by the end of 1972. The combined output of these plants will be 3000 Megawatts (3 million kilowatts) capacity. By 1980 the estimated nuclear powered generating plants in the United States will have a combined capacity of about 160,000 Mwe. Fuel requirement approximates 3 kilograms of U235 per day to generate each 1000 Mwe (million watts electric). The combustion of U235 yields 7.76×10^6 Btu per gram, the energy equivalent of 12 1/3 barrels of residual fuel oil. Therefore, 37,000 barrels per day of residual fuel oil would be required to generate the same amount of power as is available from 3 kilograms of U235.

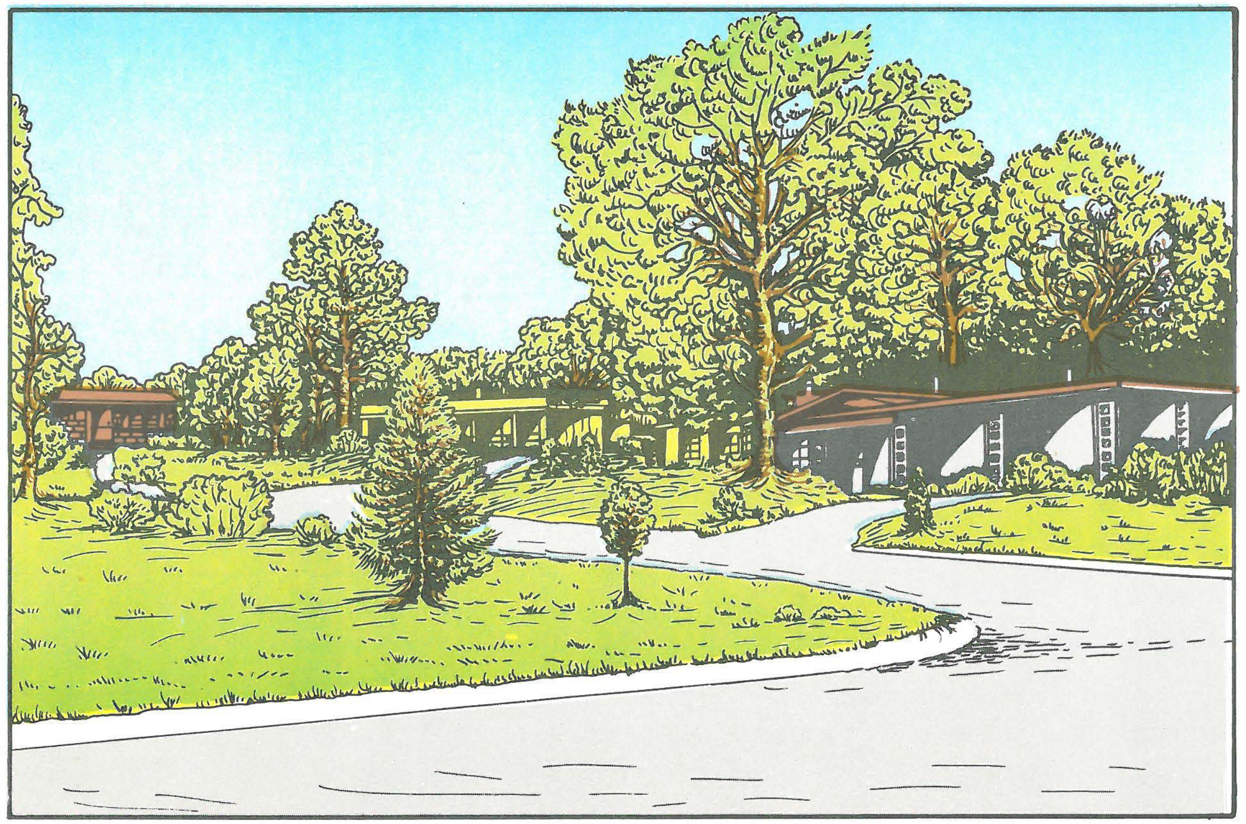
As hitherto indicated Tallahassee will need 1.5 million (1500 Mwe) kilowatts capacity by 1990. In lieu of burning 10.5 million barrels of residual fuel oil, 3600 lbs of U235 could be substituted in a nuclear power plant. Approximately 250 tons of uranium oxide could be processed to yield the necessary 3600 lbs of U235. That is one-eighth the amount of uranium oxide lost annually in connection with wet process phosphate processing. When breeder reactors are commercially available and U238 can be converted to fissionable plutonium, the energy available from uranium oxide will be increased 140-fold. The 2000 tons of uranium oxide wasted annually in Florida could fuel nuclear power reactors generating 1,680,000 million watts electric, which is more than a thousand times the electricity requirements of Tallahassee as projected for 1990.



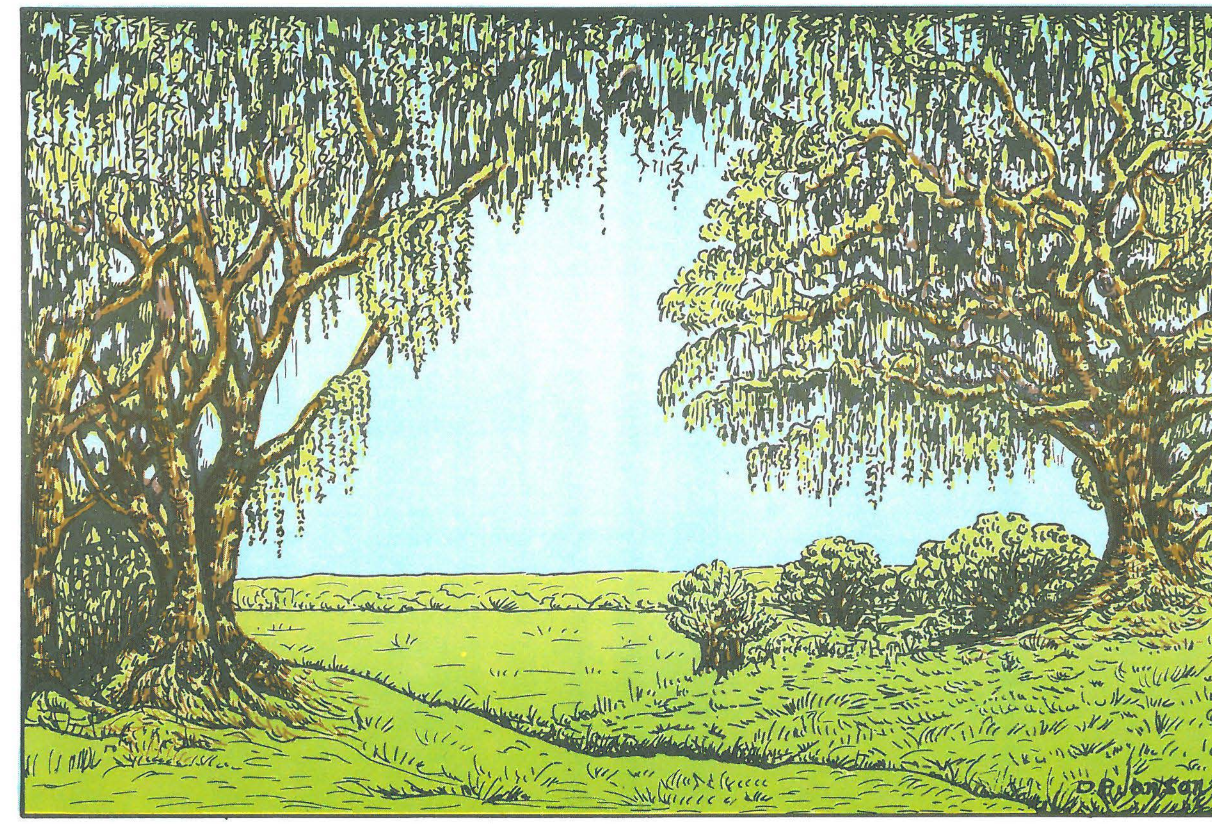
Arvah B. Hopkins Plant.

At full load, 440 gal./minute of groundwater is used to cool the steam generator power plant. Water is cooled in 6-towered cooling system shown in foreground.

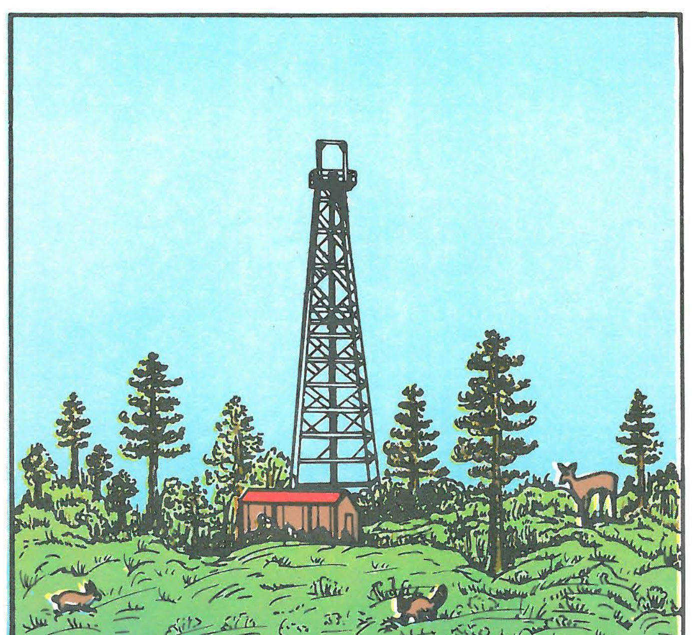
LAND USE



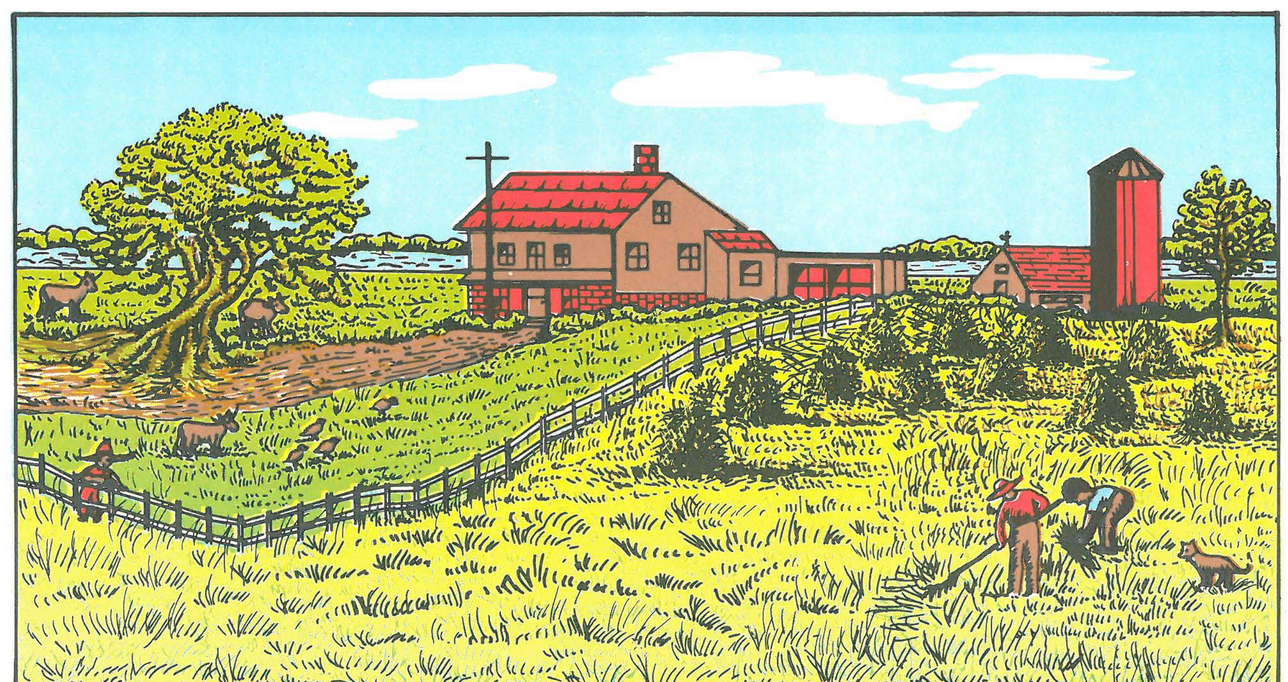
URBAN



OPEN SPACE



MINERAL RESOURCES



AGRICULTURE

RECREATION

PRESENT LAND USE

Present land use in the Tallahassee area reflects the geology and physiography of the area. Rapid suburban development is spreading northward into the rolling wooded physiographic subdivision known as the Tallahassee Hills. Industry occupies land that is less desirable physically and consequently less expensive. Certain attributes of the land have been important in the selection of institutional sites. Agricultural areas in Tallahassee directly reflect the physical characteristics of the land such as soil type and topography. The designation of recreational areas is also dependent on the physical setting. Water bodies, forests and rolling hills are the natural assets of the Tallahassee area recreational lands.

A clear understanding of the geology and physiography of the area is essential to optimum land development. When environmental factors are not considered as an integral phase of planning, problems arise. Construction problems related to physical conditions such as flooding and subsidence point up the need for geologic and hydrologic information as a basis for land development.

The desirability of a land area for a particular use may be evident to the casual observer, but the suitability of the land for that use must be determined by environmental study.

URBAN

Urban Tallahassee encompasses a large portion of the land within the study area and centers around major highway intersections. The Tallahassee city limits include 26.14 square miles of residential, industrial and commercial properties. The limited industrial areas are located in the south and west sections of town in proximity to transportation facilities.

SUBURBAN

Large suburban areas are found north and east of the City. Three recent residential developments include Killearn, Winewood and Killearn Lakes. The construction of I-10 is in progress north of Tallahassee and will no doubt precipitate further suburban growth in that area.

INSTITUTIONAL

One of the notable features of Tallahassee is the preponderance of institutional land use. Two state universities, a community college and various state buildings give a distinct character to the city. A correctional institute is found east of urban Tallahassee. Land maintenance and beautification generally accompany institutional use.

WOODLANDS

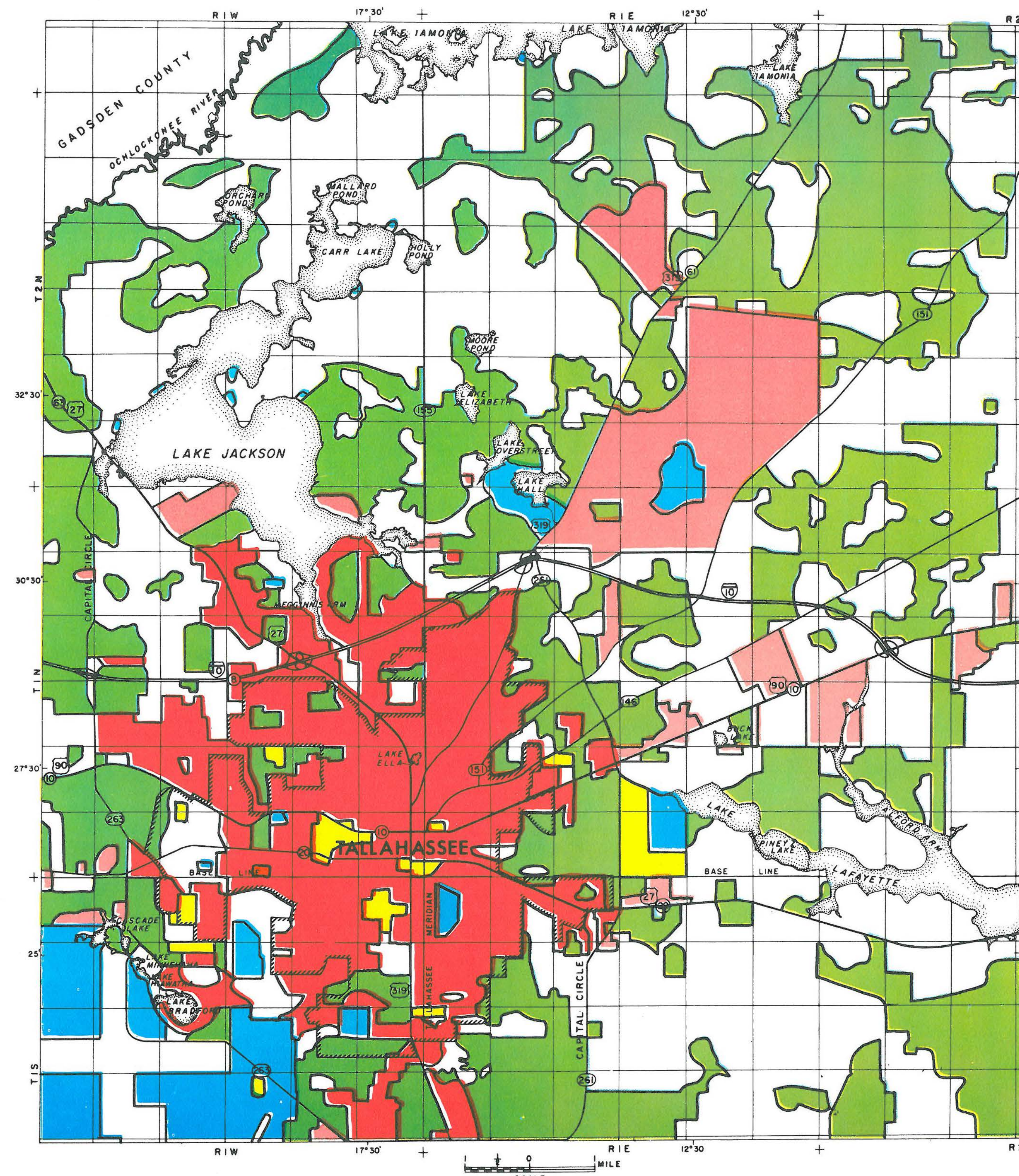
Much of the total surface area is taken up by natural and planted woodlands. These include pine flatwoods, hardwood forests, mixed pine and hardwoods, tree crops and planted pines.

RECREATIONAL

Recreational lands within the area include part of the Apalachicola National Forest, two state parks, golf courses and assorted parks and boat landings.

AGRICULTURE AND OTHER USES

Agricultural land uses include horse farms, dairy farms, pasture land, etc. . . The remainder of the land is idle, unimproved, or swamp.



FUTURE LAND USE
TALLAHASSEE AREA INTERIM LAND USE PLAN, 1971-1995

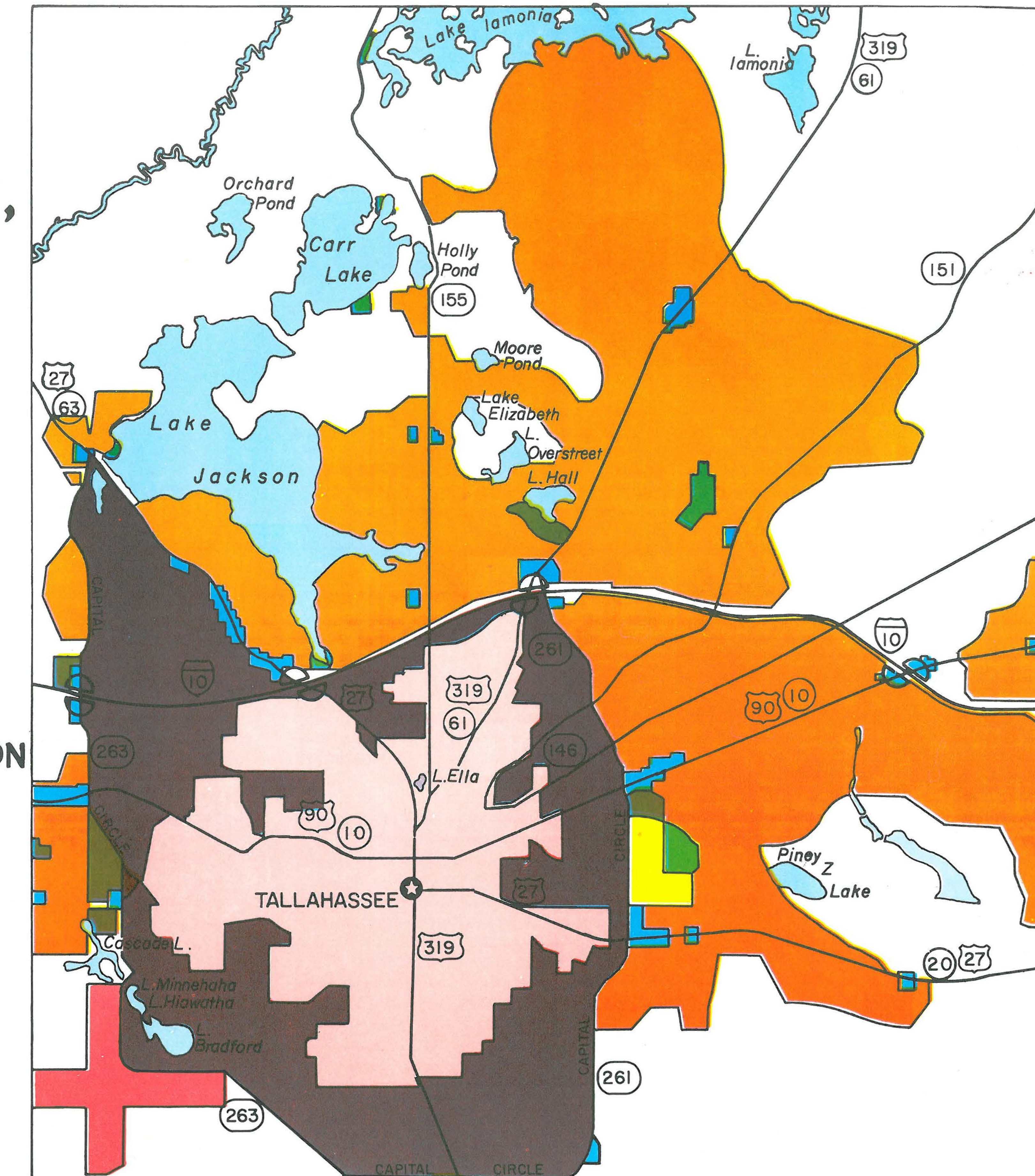
As the population of Tallahassee grows and urbanization spreads to suburban as well as rural areas, competition for space will require efficient land use planning. The populace will need more land for work, play, travel, and space for disposal of the wastes they generate.

Compatible coexistence between urban spread and the physical environment will require that those responsible for future land use planning will need basic geologic information. Therefore, this study is directed toward presenting basic facts about the physical environment of the area which will aid in planning for future urban spread.

This work is not to be considered as the ultimate or end in itself, but rather a beginning. It brings together at this moment in time the most accurate data available. As additional data becomes available through research the picture will become more definitive and for this reason, environmental geological studies of this nature should be continuously used for the improvement of our environment.

EXPLANATION

- CITY LIMITS
- URBAN AREA
- RESIDENTIAL
- RECREATIONAL
- TRANSPORTATION
- COMMERCIAL
- INDUSTRIAL
- INSTITUTIONAL
- UNDEVELOPED



GEOLOGIC CONDITIONS

Affecting Solid–Waste Disposal

The problem of solid-waste disposal is becoming more acute as the population increases. In a survey of solid-waste practices in Florida it is shown that presently Floridians are generating over five million tons of refuse per year or over five pounds per day per person. By 1990, as the population increases, this figure could reach twenty-two million tons per year or twelve pounds per person per day. Under the present methods of solid-waste disposal, new sanitary landfills will be needed to accomodate this increase, and the selection of proper sites is an important factor in the disposal problem. The American Society of Civil Engineers defines the Sanitary Landfill as: "A method of disposing of refuse on land without creating nuisances or hazards to public health or safety, by utilizing the principles of engineering to confine the refuse to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with a layer of earth at the conclusion of each day's operation, or at such more frequent intervals as may be necessary."

As rainwater passes through the refuse in the landfill, chemicals derived from the decomposing material are taken into solution thus creating leachate, a pollution potential to the groundwater and surrounding surface water. Also, in landfills where refuse is placed below the water table or is subjected to flushing by a fluctuating water table, the solid waste will produce leachate.

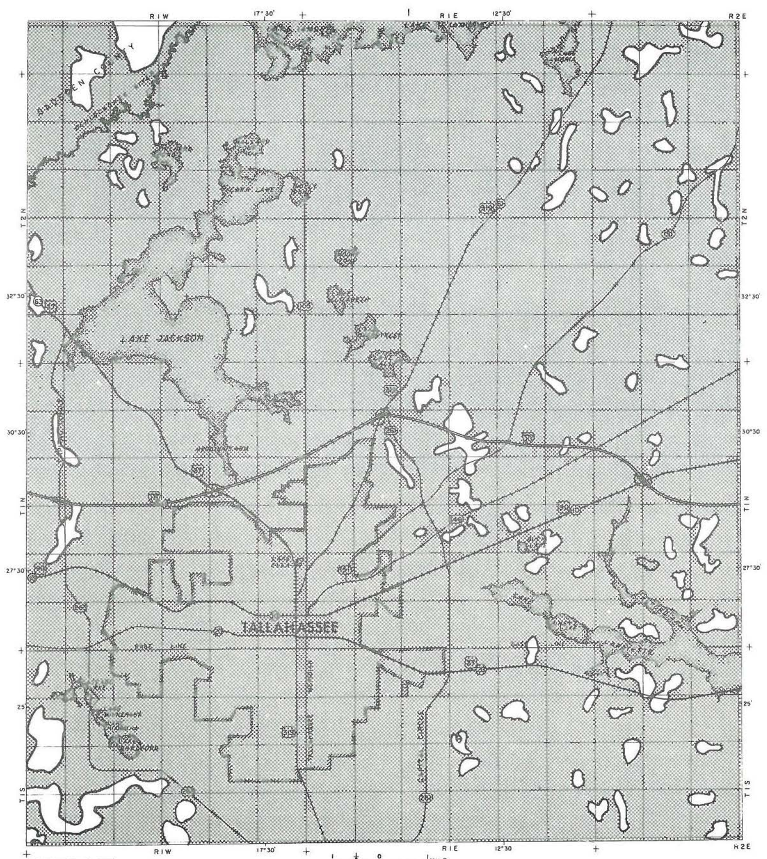
Landon defines leachate as "a liquid, high in biological and chemical oxygen demand and dissolved chemicals (particularly iron, chloride and sodium) and hardness."

To reduce the groundwater-pollution potential of a sanitary landfill, the geologic and hydrologic factors should be considered. Sanitary landfills should be placed in areas where earth material underlying the site is composed of clay, clayey silts, or silts. These relatively impervious earth materials retard the downward movement of leachate and ideally would remove the contaminants by filtration and adsorption. Many investigators consider that 25 to 30 feet of relatively impervious earth material should be present below the base of the landfill.

The following are areas that should be avoided for sanitary landfill sites: (1) Areas that are underlain by sands of high permeability; (2) Areas such as swamps, flood plains and marshes that are flood prone; (3) Sinkholes because of the possibility of the contaminants moving through solution cavities directly into groundwater systems; (4) Slopes that are too steep for stabilization or that are subject to surface runoff; (5) Areas immediately underlain by limestone in which caverns and fractures occur, as the direction and rate of groundwater movement in such material may not be readily determined.

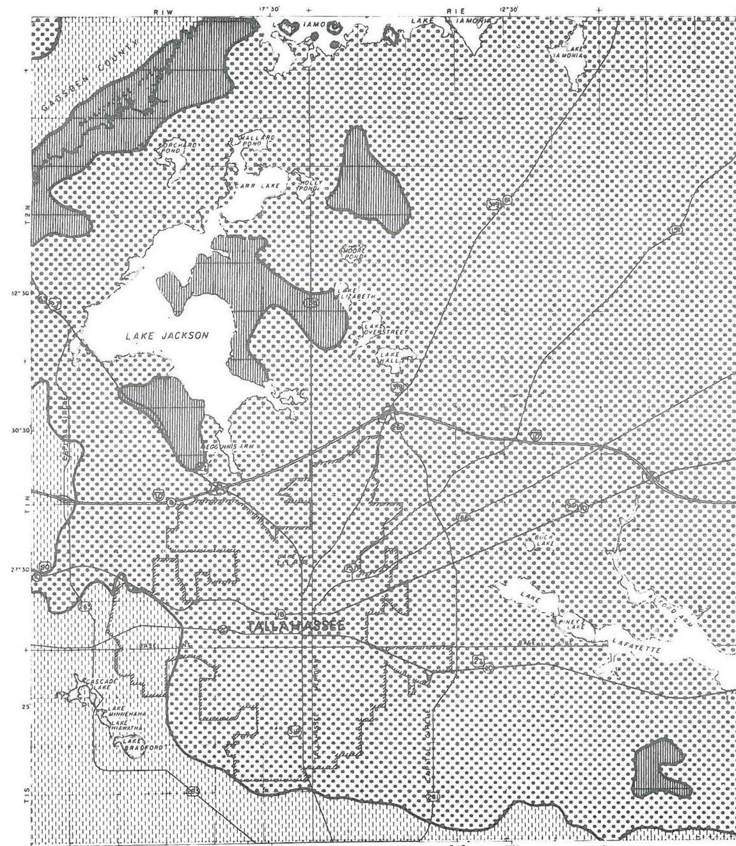
The greater the depth to the water table below the base of the sanitary landfill the less risk there is of pollution. The States of Alabama and Illinois suggest that the depth to the water table be 30 to 40 feet. It is also suggested that sites should be several miles down gradient from areas where there are large withdrawals of groundwater.

To reduce the amount of rainfall infiltrating the sanitary landfill, a fine-grained earth material should be compacted and used as a cover. However, if the fine-grained material is predominantly clay it may be difficult to work when wet. Also it may crack excessively when dry, thereby permitting rainfall to enter the landfill.



A. Area includes physical obstructions and preempted regions.

No physical obstructions nor preempted regions.

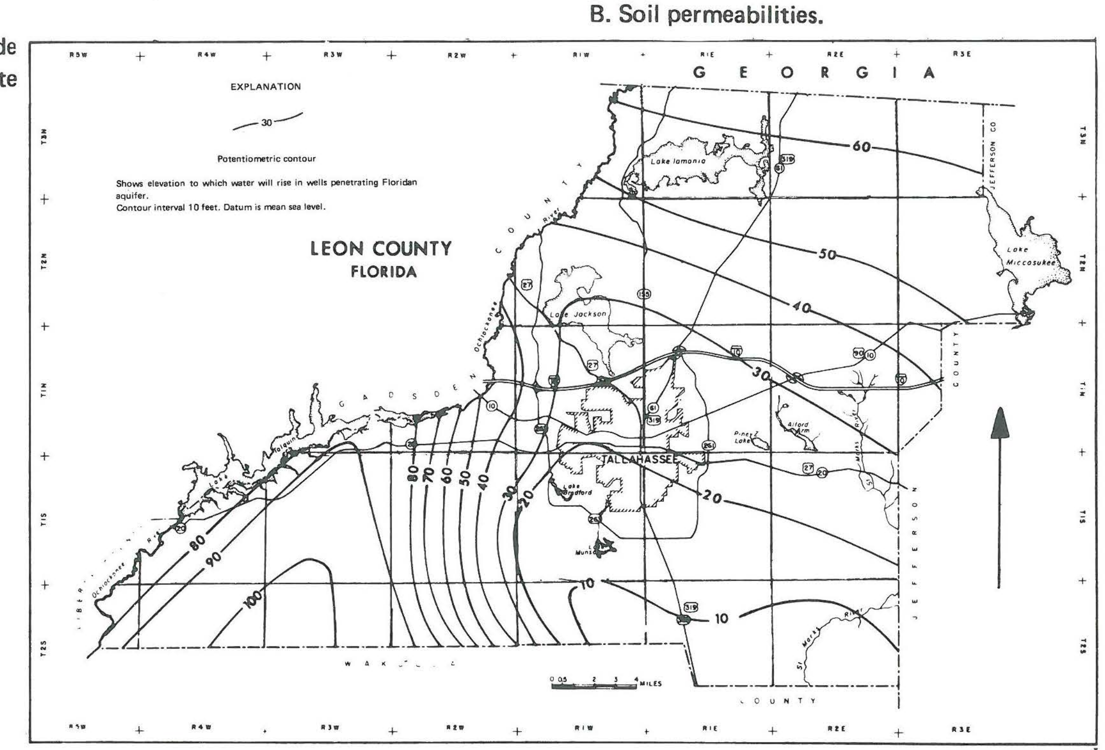


Rapid | Moderate | Moderately Slow

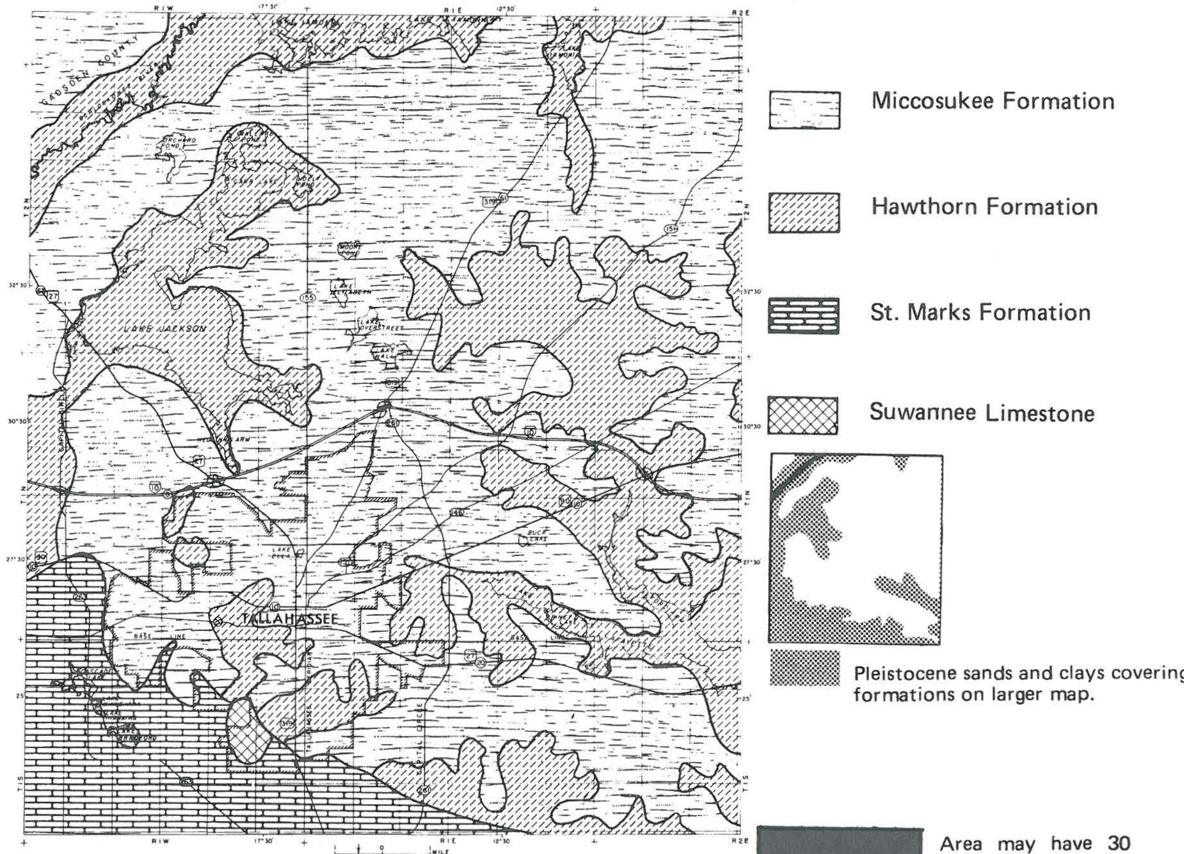
B. Soil permeabilities.

The following set of criteria is suggested as a guide in evaluating the suitability of a sanitary landfill site in the Tallahassee area.

1. The bottom of the landfill site should be underlain by at least 30′ of clay or other low permeable material.
2. The site area should not be prone to flooding.
3. The water table should be 30 feet below land surface.
4. The site area should not display sinkholes or other karst features that may indicate the underlying limestone is highly permeable.
5. Site areas in swamps and steep terrains should be avoided.
6. Site areas should be at least several miles down gradient from large withdrawals of ground water.



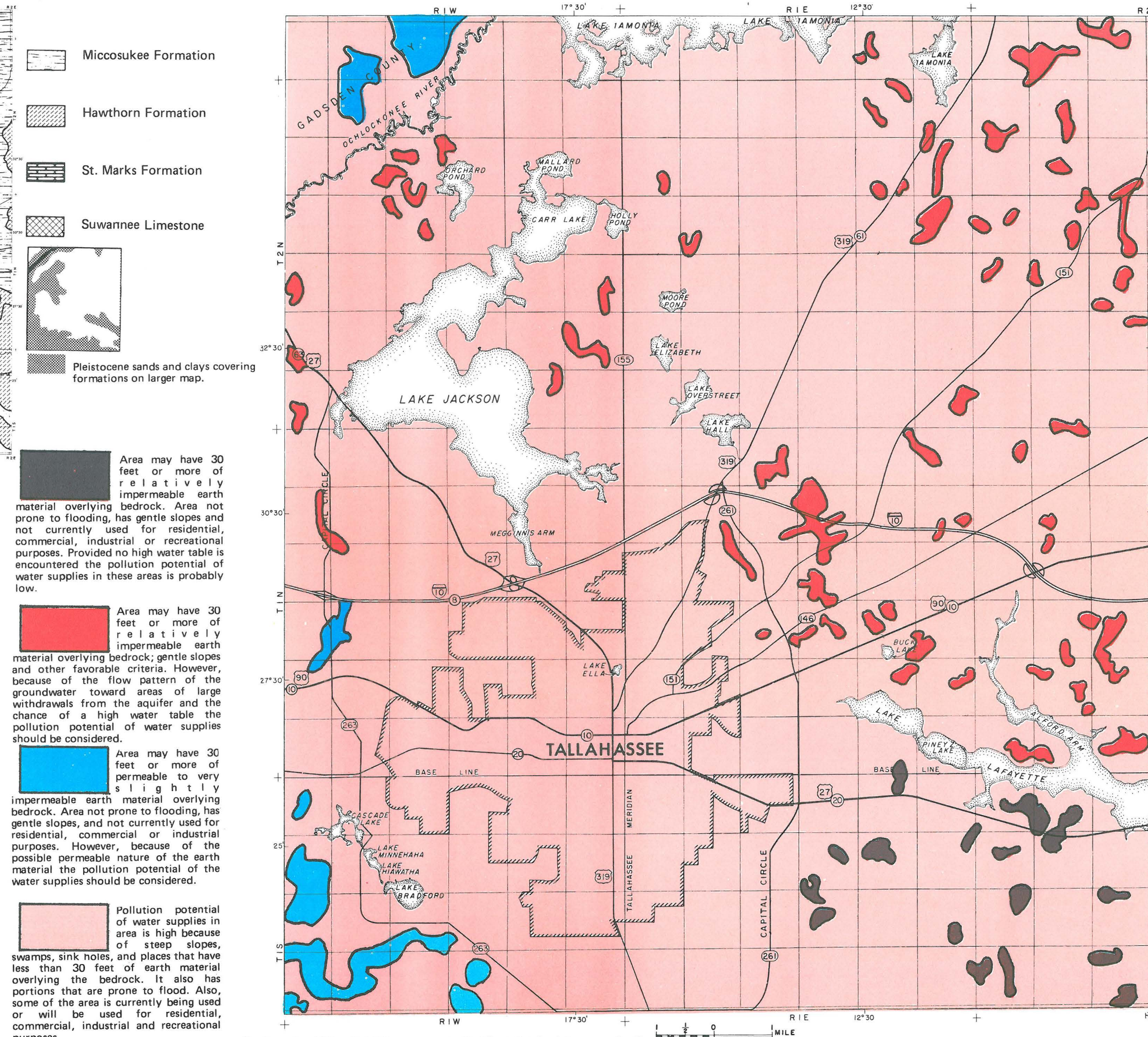
C. Potentiometric surface of Floridan Aquifer.



D. Geologic map.

The land-use map showing potential sanitary landfill sites in this publication was compiled using these criteria. However, it is presented only as a preliminary guide for planning sites; the map does not show the exact character of the geologic (earth) materials overlying the bedrock, nor the precise groundwater conditions. Each potential sanitary landfill site should be investigated and evaluated before being put into operation.

It should be pointed out the position of the water table in the four quadrangles has not been delineated. However, in the northern half of Leon County, discontinuous sand lenses occur in the Miccosukee and Hawthorn Formations forming perched aquifers that may occur as high as 200 feet above sea level. In the southern part of Leon County the water table is essentially the same as the potentiometric surface of the Floridan aquifer.



Sanitary landfill suitability map compiled from basic data maps A–D.

GEOLOGIC CONDITIONS

Affecting Construction

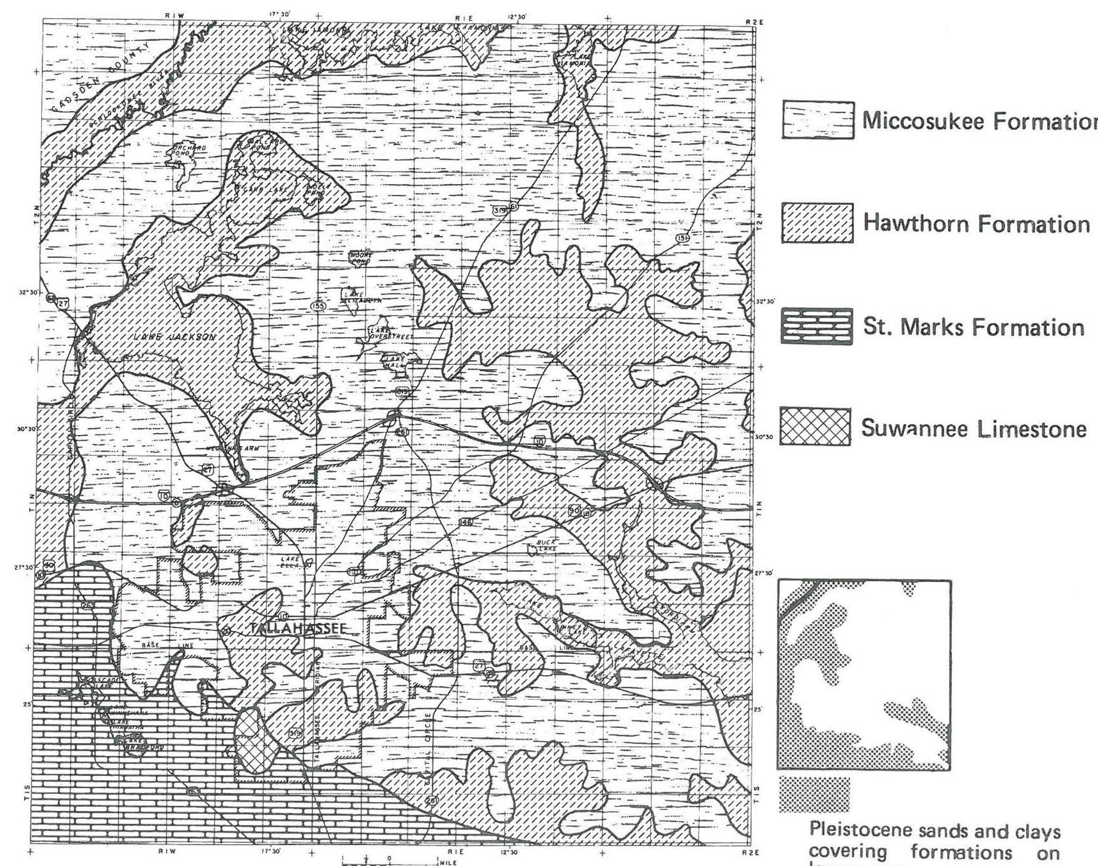
In preparing a land-use plan for general construction, factors such as slope, subsurface geology, and soil conditions should be considered. Stream flood plains and topographically low areas should be avoided, as they may have a high fluctuating water table and may be subject to periodic flooding.

The earth materials occurring in the topographically high areas are composed of heterogeneous mixtures of clays, silts and sands (Miccosukee Formation) which are generally suitable as construction sites. However, perched water tables occur locally; so subsurface investigations should be conducted for larger buildings.

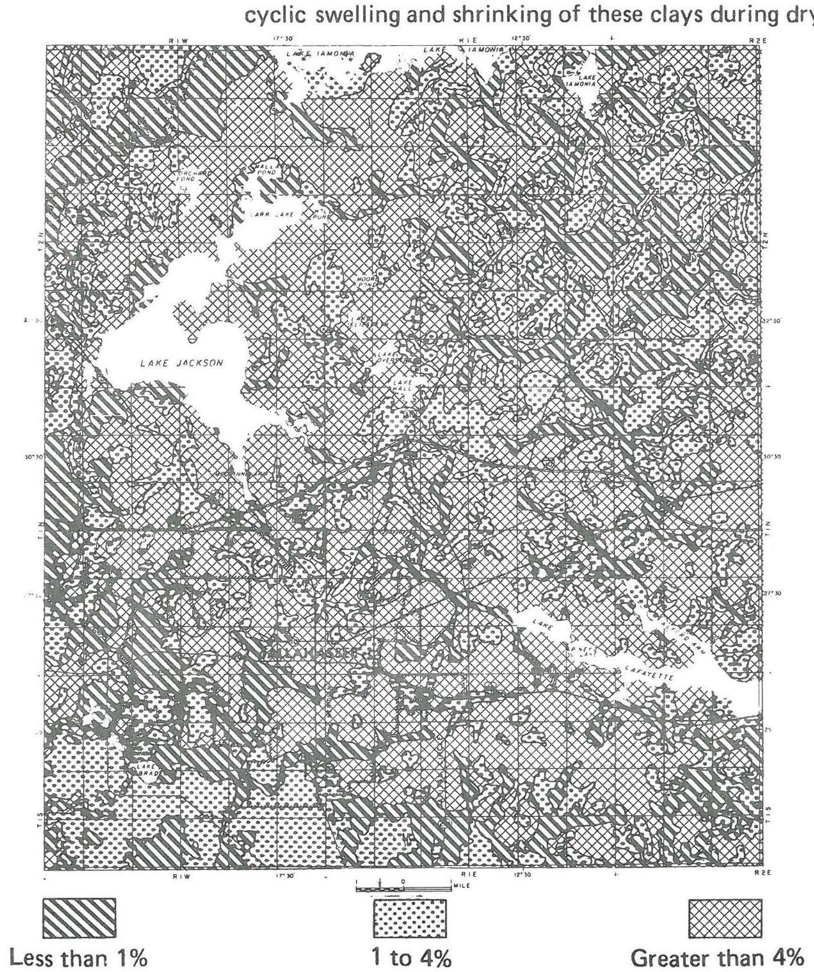
The Hawthorn Formation contains bedded clays that are plastic and will swell upon wetting. The cyclic swelling and shrinking of these clays during dry and wet seasons can be detrimental to stable foundation conditions. When saturated with water the clays provide a sliding surface that can result in slippage along slopes. Subsurface investigations are recommended before building in these areas.

In the southern portion of the area, porous sands overlie limestone, which being soluble lends itself to the formation of caverns with subsequent sinkhole activity. Though sinkholes are not abundant nor frequently formed, those planning to use this area should be aware that such conditions may exist.

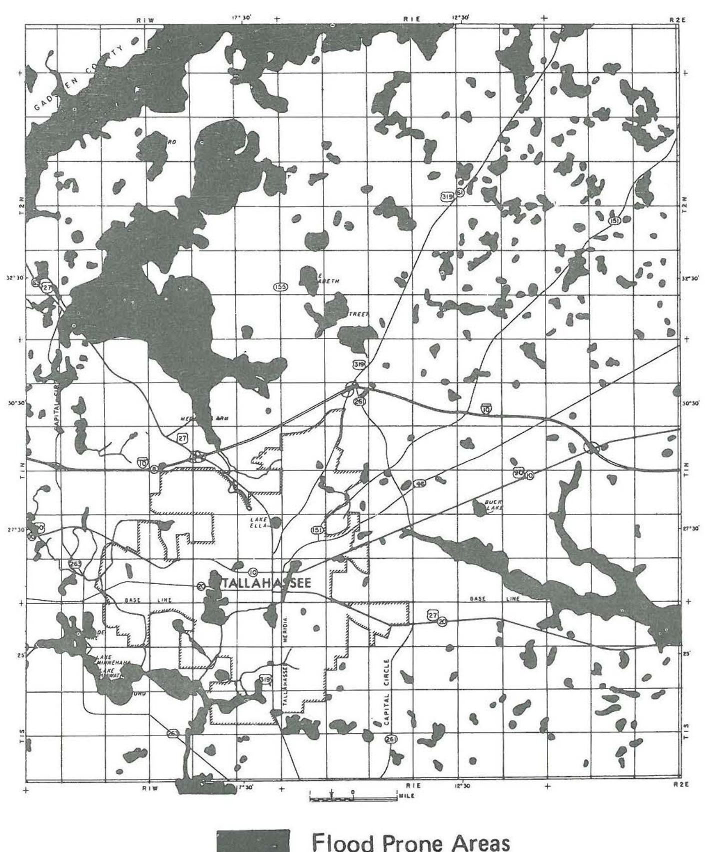
In much of the area, the slopes are moderate to gentle and offer no particular problem to construction. However, along some valley walls the slopes are steep and if plastic clays of the Hawthorn Formation are present slumping as well as sliding may occur.



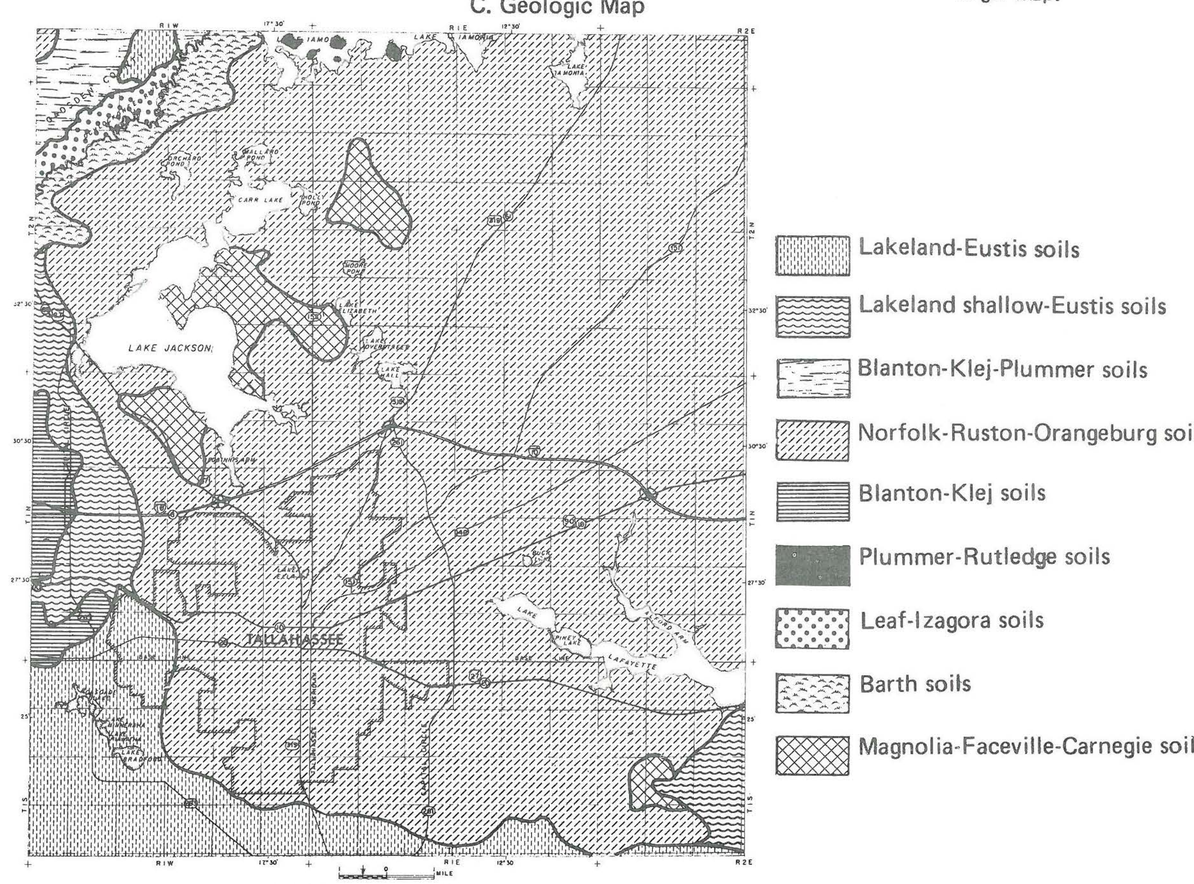
C. Geologic Map



A. Slopes



B. Flood Prone Map



D. Soil Associations

PLEISTOCENE

Area covered by sands in excess of 42 inches that overlie limestone at depth. Slopes vary from less than one to four percent. Soils are well drained, the infiltration rate is rapid and some flooding occurs in low flat areas. Sinkholes are numerous and may occur in the area.

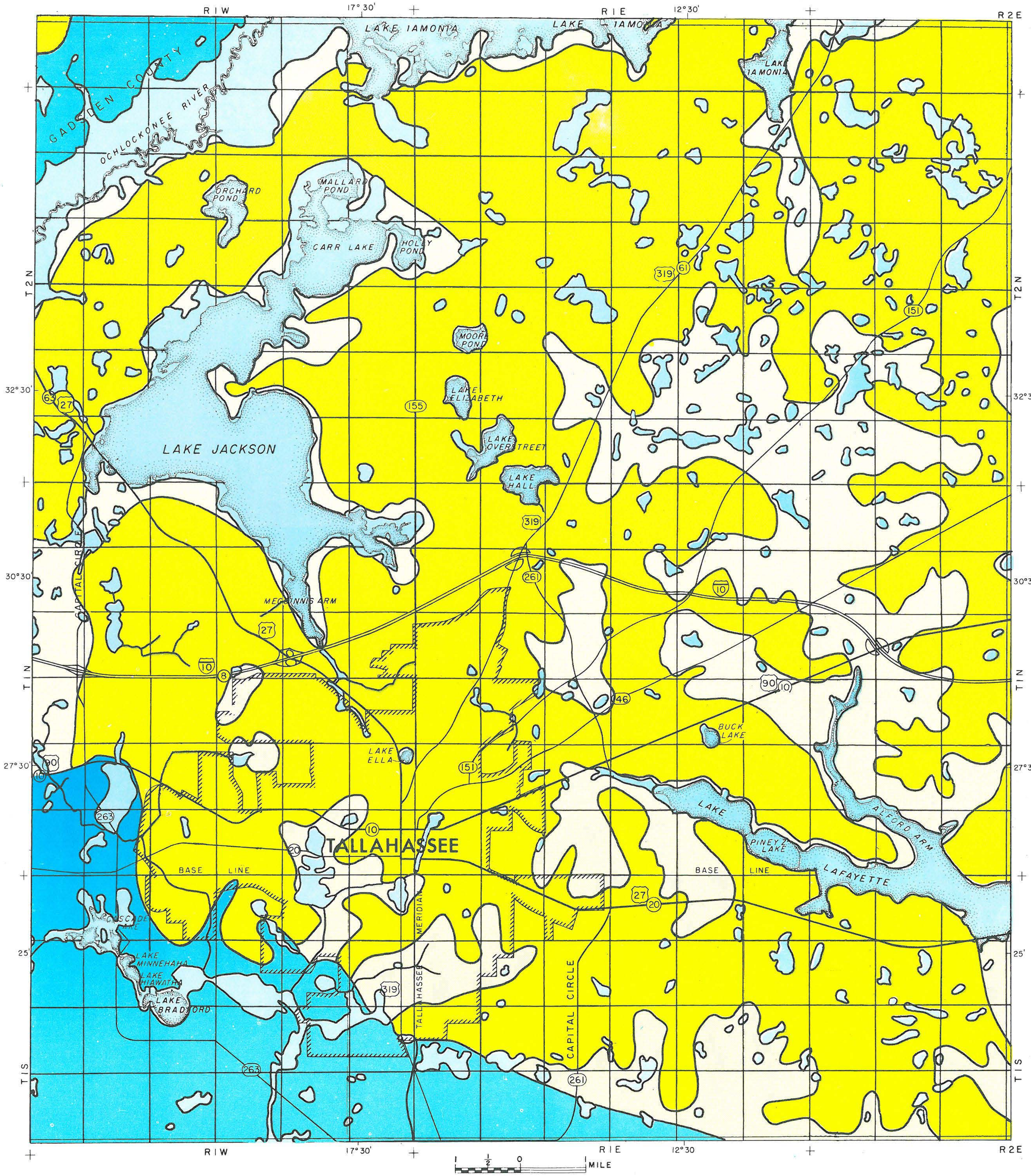
MICCOSUKEE FORMATION

Area underlain by thick deposits of sands, silts, and clays. Generally earth materials in this area present very few foundation problems. However, clay beds can occur at shallow depth and although these clays are not generally plastic they should be considered in foundation preparation. Soils generally well drained but wet weather ponds, and lakes are present in the area. Infiltration rate of the soil is moderate to moderately slow in some areas. Locally perched sand aquifers may occur. The area is characterized by hilly topography with slopes ranging from less than one percent to greater than ten percent along stream valleys. Some of the hills have tops that are almost level.

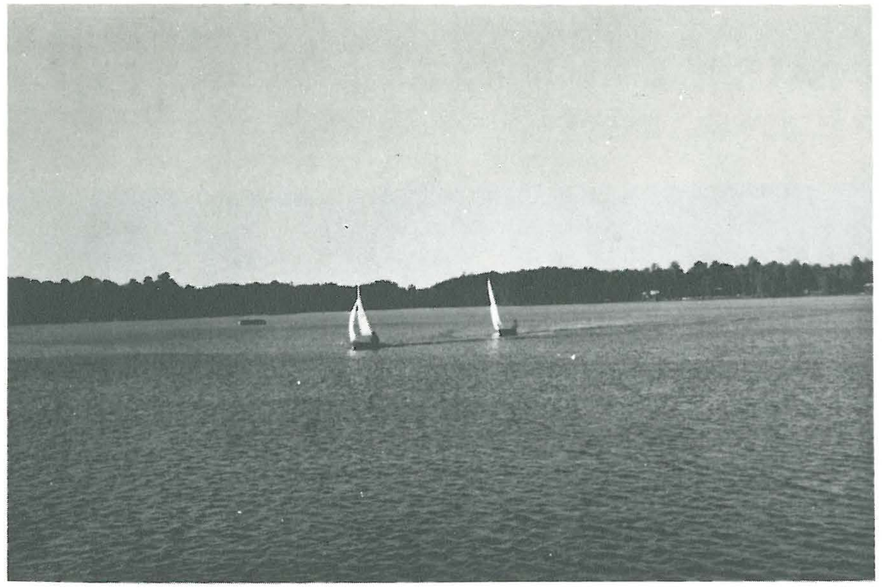
HAWTHORN FORMATION

Areas underlain by sands, clays, and limestone at depth. The topography of the area varies from hilly to level with slopes ranging from less than one percent to greater than 10 percent. Some of the areas are subject to periodic flooding. In areas where clays are shallow the infiltration rates may be slow to moderately slow. Bedded clays encountered at shallow depths generally become plastic and swell upon wetting. The continual swelling and shrinking of the clays as they dry may be detrimental to foundations.

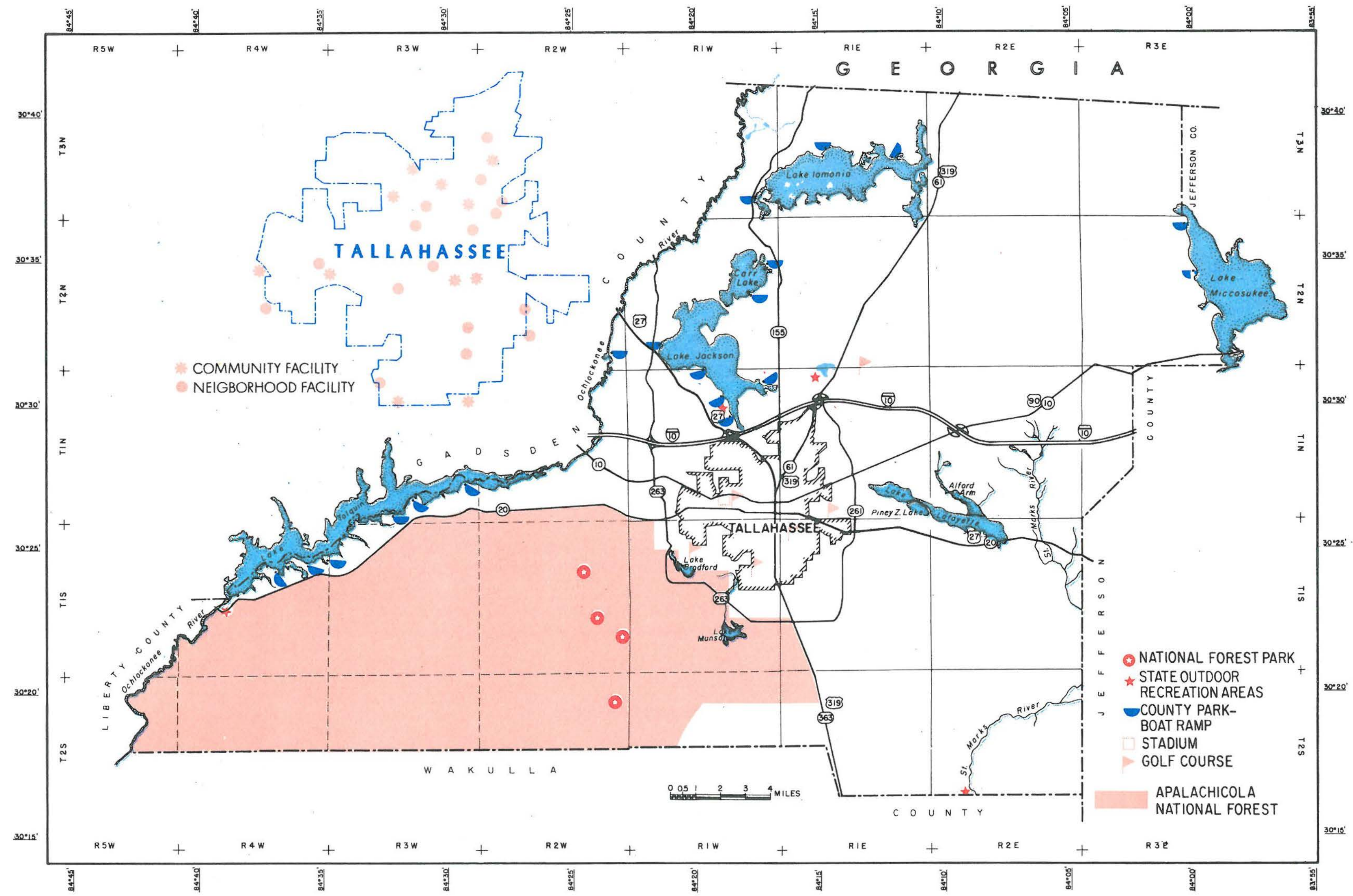
Area subject to flooding, but the chance that the entire area will be inundated in any given year is about 1 in 100. Lowlands, immediately adjacent to streams, swamps, and lakes may be flooded every year, but not to the limits as shown in red. Lakes and stream channels are shown in red. However, flooding only applies to the lake or stream flood plains.



Construction suitability map compiled from basic data maps A—D.



RECREATION



Natural forces have been continually changing and modifying the face of the earth for billions of years. Even today these forces continue to shape the earth's surface and we see the manifestation of these changes in the natural beauties all about us.

The area around Tallahassee reflects some of these wonders of nature that have been focal points for recreational use. The rolling hills (Tallahassee Hills) and valleys in the Tallahassee area are the remnants of an ancient highland that has been partitioned by erosion occurring over thousands of years. This beautiful hill and valley topography provides excellent sites for the golf courses found in the Tallahassee area. Lying cradled in the hills are Lakes Iamonia, Jackson, Lafayette, and Miccosukee. These large lakes are geologic features formed by solution of the underlying limestone over a period of thousands of years and provide people of the area, as well as many visitors, excellent fishing and water fowl hunting areas. Lake Hall, located in the Tallahassee Hills is a popular recreational area for water sports. McClay Gardens, one of the most beautifully landscaped parks in Florida, is located on the shore of the lake.

South of the Tallahassee Hills occurs an essentially flat ancient marine plain which is divisable into two areas. A portion of the plain lies almost entirely within the limits of the Apalachicola National Forest. It is characterized by a flat sandy surface containing many densely wooded swamps.

The nature of the region and the occupational restrictions imposed by the U.S. Forest Service has left the area essentially in its natural state. Several camping sites in the area are maintained by the U.S. Forest Service for recreational use.

Joining the above area on the east is the other portion of the ancient marine plain. This area is characterized by thin deposits of sand overlying a limestone substrata that has resulted in a sinkhole topography. The clear deep sinks occurring here are popular with swimmers and scuba divers.

Several recreational areas are developed around the many lakes that occur on this geologic feature. Lake Bradford provides water-oriented recreational facilities for the residents who live around the lake, for Florida State University students (at a University camp), and for the general public. Silver Lake and Dog Lake are located in the Apalachicola National Forest where recreational facilities for camping, swimming, and fishing are made available to the public by the U.S. Forest Service.

The Ochlockonee River in its journey to the Gulf of Mexico has for thousands of years been carving a valley along the western side of Leon County. Many boat landings occur along the Ochlockonee River and many citizens use these facilities annually for fishing in the river. Lake Talquin, a man made lake, occupies a portion of the broad valley carved out by the Ochlockonee River. Lake Talquin plays a major role in the recreational facilities in the Tallahassee area. A State Park is located along the eastern shores of Lake Talquin in Leon County. Many public and private boat landings found along its shore provide citizens access to some excellent fishing areas.

The St. Marks River, at Natural Bridge, in the southern portion of Leon County, is an area of natural beauty. The river is much wider there than to the north because of the addition of water from the springs in the area. The springs, the State Park, and the scenic splendor of the Natural Bridge area provides the aesthetic qualities for anyone interested in enjoying the great outdoors.

Wakulla Springs, located near Tallahassee, one of the deepest springs in the world, is an interesting geologic feature. Natural scenic areas around the spring are available for the nature lovers and hikers.

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