INTRODUCTION

Lake Padgett and Saxon Lake are about 15 miles north of Tampa in southern Pasco County in west-central Florida. Outflow from the lakes is south and east to Cypress Creek, then south to the Hillsborough River. The proximity of the lakes to the growing Tampa Bay area has resulted in exensive residential development around the lakes, and dredged material from the lake bottoms has been used to increase the amount of waterfront property for development.

ncurrent with area development has been increasing demand on ground water of Pasco County to supply the county and the Tampa Bay area. To assure that present and future development in housing and ground-water withdrawals do not adversely affect the lakes and their hydrologic environs, the relation of the lakes to the climate, hydrology, hydrogeology, and residential development must be understood. As part of a broad cooperative program with the Southwest Florida Water Management District (SWFWMD), the U.S. Geological Survey has undertaken a series of annual hydrologic investigations of lakes within the District's jurisdiction. These investigations provide information necessary or comprehensive planning and management of water resources throughout west-central Florida. Increased knowledge of the lakes will enable responsible agencies to deal with existing hydrologic problems and to avert potential problems in the future. Lake Padgett and Saxon Lake and their hydrologic environs are the subjects of the 12th investigation conducted as

part of this cooperative program. The study area for this investigation is Lake Padgett, Saxon Lake, the surface-water drainage basins of the lakes, and nearby well fields in south Pasco County. Existing hydrologic and climatic data as well as field observations obtained between October 1979 and August 1980 are used in this report. Hydrology of the Lake Padgett and Saxon Lake drainage basins is described and the relation between the lakes and the ground-water system evaluated using preliminary results of ground-water computer models. Lake-bottom contours covering areas of extensive dredging were determined from bathymetric data collected on the two lakes. Chemical constituent and biological data collected since 1965, and as part of this inrestigation, were used to evaluate some of the effects that development along the lake shorelines and surrounding area has had on the water quality of the lakes. Results of water-quality analyses by Pasco County and preliminary work done by the University of South Florida on the algae pop-

ulation of the lakes were helpful in evaluating the quality of water in the There have been several previous investigations conducted by the Geological Survey on the hydrology and geology in the general area of Lake water table is higher than the potentiometric surface in the Floridan of Florida was described by Cherry and others (1970). A geohydrologic reconnaissance of Pasco and southern Hernando Counties was conducted by Wetterhall (1964). Well-field pumpage from the Cypress Creek well field and its effect on ground-water levels in the area was evaluated using a digital model by Ryder (1978). Sinclair (1974) described the hydrogeologic character for the Floridan aquifer is lowest, generally during the spring and early sum-Murphy and others (1982) included Lake Padgett in a report on 1979 flooding in northwest Hillsborough and south Pasco Counties. Hutchinson and others (1981) developed a regional ground-water model to simulate ground-water flow in a well-field area that includes Lake Padgett and Saxon

Other government agencies and private consulting firms have also report ed on the hydrology and geology of the area around Lake Padgett and used to construct a contour map of the lake bottoms. Stage-volume and Saxon Lake. The Southwest Florida Water Management District (1975) evaluated the environmental effects of the Cypress Creek well field and proposed flood detention project. The U.S. Army Corps of Engineers and everal consultants have conducted investigations on the hydrogeologic and hydraulic properties of the surficial aquifer of the area. Seaburn and Robertson, Inc., and Biological Research Associates (1977) conducted several investigations on the effects of pumpage from the Cypress Creek well field The Geological Survey publishes annual reports, "Water Resources Data

AREA DESCRIPTION

Lake Padgett and Saxon Lake are in south-central Pasco County in an area of gentle topographic relief that contains many small lakes and cypress ponds (fig. 1). As part of the residential development that began about 1967, Lake Padgett and Saxon Lake were connected by a dredged canal and culvert. The altitude of the land surface in the area ranges from about 70 feet above NGVD of 1929 in the small cypress swamps to about 90 feet above NGVD of 1929 in citrus groves east of Saxon Lake. East of the groves, the land slopes downward to altitudes of about 50 feet above NGVD of 1929 and surface runoff flows directly to the poorly defined channel of Cypress Creek, thence to Hillsborough River and Tampa Bay. The headwaters of Anclote River drain the land west of the lakes. The drainage basin for Lake Padgett and Saxon Lake is elongated in the north-south direction and is about 5.4 mi² in size (fig. 1). Residential development is least in the northern part of the basin and increases southward to the intensely developed land adjacent to the lakes. Small lakes and cypress swamps north of State Road 583 drain pasture and citrus groves. Water from the lakes and swamps flows southward through a series of lakes, culverts, and swamps to King Lake, 1 mile north of Lake Padgett. Drainage from King Lake and that part of the basin west of U.S. Highway and also increased the potential for downward leakage from the lake. However, there are insufficient data to quantify the effects of dredging. 41 is through culverts to Bell Lake and then to the northwest corner of Lake Padgett. Lake Joyce (formerly Hog Lake) and East Lake (formerly Cow Lake) drain through canals and culverts to the north side of Saxon Lake (fig. 2). Outflow from the basin occurs at the south end of Lake Padgett and continues south and east for about 5 miles through a series of lakes and cypress swamps to Cypress Creek (fig. 1).

areas of Florida. Pasco County's population more than doubled in size each those recorded for Lake Padgett. Field observations in 1980 indicate that emands on its water resources. In the past, land use in the area of the lakes was devoted primarily are unknown. o citrus groves, interspersed with pasturelands, homes, and wetlands.

Residential development was generally limited to a narrow corridor along U.S. Highway 41 and to a few lakefront homes. While citrus groves still occupy much of the basin, citrus acreage has decreased since 1965, with esidential developments replacing groves. Lakeshore development in the area began in about 1967. In the area bordered by Lake Padgett, Saxon Lake, East Lake, and Bell Lake (fig. 2), the occurring on May 14, 1976. The maximum daily stage for this period was number of homes increased from about 20 in 1967 to more than 300 by 1974. Private wells are used by residents in this area for water supply, and septic tanks are used for wastewater disposal. Further development east and north of Saxon Lake occurred during 1972-80, and a county taxing

and a wastewater treatment plant. Future development is planned for areas Concurrent with development, demands for freshwater by Hillsborough and Pinellas Counties are rapidly increasing. In 1973, South Pasco well field, about 3.5 miles southwest of Lake Padgett and Saxon Lake (fig. 1), was greatest in September as a result of heavy summer rainfalls. The range of developed by the city of St. Petersburg to augment ground-water supplies from well fields in Pinellas and northwest Hillsborough Counties. Cypress Creek well field, about 7 miles northeast of Lake Padgett and Saxon Lake (fig. 1), began production in 1976. By 1979, a total of about 41 Mgal/d was being pumped from these two well fields (fig. 3). Cross Bar Ranch well field. about 10 miles north of the lakes, began production in early 1980. The need for evaluating the relation of the lakes to the ground-water system and the other aspects of the hydrologic cycle became apparent as residential and

district was established in this area in 1973 to manage public supply wells

well-field development continued to expand.

The general climate of the Lake Padgett and Saxon Lake area is one of nild winters and warm, rainy summers. The average annual temperature is 72°F; the average monthly temperatures range from 60°F in January to 1976) was used in determining this curve. Data used in the analysis include 82°F in August. Rainfall in the winter months is generally a result of cold annual maximum stages for 1970-80 and a historical peak (1960). Annual fronts moving through the area and is more uniform and less intense than

maximum stages are for the climatic year beginning June 1 and ending May the late afternoon thunderstorms in the summer months. Frost-free days

31. A stage of 71.6 feet above NGVD of 1929 is expected to be exceeded on average more than 340 per year, making the area ideal for citrus crops and the average of about once every 5 years. year-round water sports.

The normal annual rainfall in the Lake Padgett and Saxon Lake area is estimated to be 53.12 inches, based on the average of rainfall records for 941-70 at the three National Oceanic and Atmospheric Administration IOAA) rainfall stations nearest to the lakes — Tampa, Tarpon Springs, and St. Leo (U.S. Department of Commerce, 1941-80). The Tarpon Springs rainfall station is 19 miles west of the lakes, and the Tampa and St. Leo stations are 16 miles from the lakes in the southwest and northeast directions, respectively. Rainfall data shown in figure 3 for 1965-72 are based on the surficial aquifer, and downward leakage to the Floridan aquifer. The comaverage of rainfall recorded at these three NOAA stations. Rainfall data for 1973-80 are from a SWFWMD-Geological Survey rainfall station 0.6 mile northeast of Lake Padgett. The average annual rainfall at the three NOAA stations is within 1 percent of that recorded at the Lake Padgett station for the period of coincident record. Rainfall during the 4-month period June-September averages 31 inches

per year and represents almost 60 percent of the normal annual rainfall for the study area. Rainfall during October-May averages only about 2.8 inches per month. Monthly rainfall is generally greatest in July and lowest during November, averaging 8.74 inches and 1.86 inches, respectively Annual rainfall was less than the normal for the study area for 12 of the 16 years shown in figure 4. The cumulative rainfall deficit for 1965-77 was about 80 inches. Above-normal rainfall in 1978 and 1979 reduced the rainfall deficit for the 16-year period to 72 inches. Lake evaporation in the study area was based on evaporation maps prepared by NOAA (formerly the National Weather Service) and on evaporation from a class A pan at the discontinued NOAA station at Bay Lake, 9 miles south of Lake Padgett. Kohler and others (1959, plate 2) estimated lake evaporation in the study area to be 50 inches per year, based on evaporation data for 1946-55. Pan evaporation at the Bay Lake station averaged 64.63 inches per year during the 15 years of data collection (U.S. Department of Commerce, 1952-66). Dividing the estimated 50 inches of lake evaporation by the average pan evaporation at Bay Lake yields a pan coefficient of 0.77. This agrees with the estimate of average class A pan coefficients by Kohler and others (1959, plate 3) Monthly estimates of evaporation from Lake Padgett and Saxon Lake

were based on average monthly values of pan evaporation at the Bay Lake evaporation station. Monthly pan coefficients were adjusted from those determined for Lake Okeechobee, Fla. (Kohler, 1954, p. 128), so that the annual pan coefficient would be 0.77. Values of monthly pan coefficients ranged from 0.67 for February to 0.88 for August. The greatest monthly evaporation occurs in May and averages about 6.2 inches (fig. 5). Evaporation from the lakes decreases steadily from May to an average of about 2.3 inches in January. Estimated annual evaporation from the lakes exceeded rainfall for 10 of the 16 years during 1965-80.

that determine their relation with the ground-water system. The uppermost Sources of precipitation and evaporation data used in the water-balance unit is a layer of sand and clay re 2 to 25 feet in thickness (Ryder, 1978). This unit acts as a confining bed determine downward leakage as the residual component. between the overlying surficial aquifer and underlying carbonate rock for
Results of analyses indicate downward leakage has a much greater effect changes that can affect the lakes include increased nutrient enrichment mations of an extensive artesian aquifer. These underlying formations are on lake stages than does lateral flow to or from the surficial aquifer. The from agricultural runoff, wastewater, and urban runoff and the introduction principally limestone with some dolomitic zones and are known collectively rate of downward leakage was greatest each spring during 1975-77 and as the Floridan aquifer. These solution-riddled limestone formations comprise the major water-bearing formations for ground-water withdrawals in was about 0.07 ft³/s. Computations indicate that the rate of downward the area. Figure 6 is a generalized geologic section showing approximate leakage in April-May 1975 was slightly greater than that in 1976 or 1977.

The surficial aquifer consists of fine to very fine quartz sand, clayey sand, and sandy clay. The clay content generally increases with depth with a sponding decrease in permeability (Sinclair, 1974). Water is supplied to the surficial aquifer by rainfall, lateral movement of water from the lakes, septic tank drain fields, and irrigation. In the area east of the basin, near Cypress Creek, upward leakage from the Floridan aquifer supplies water to the surficial aquifer (Ryder, 1978). Water loss from the sand and clay unit is by evapotranspiration, lateral movement from the area or to the lakes, or by downward leakage through the underlying clay layer to the Floridan aquifer. A few domestic wells tap the surficial aquifer, but they generally produce highly colored water with objectionable iron concentrations (Wetterhall, 1964, p. 12). The lakes are contiguous with the water table of the surficial aquifer (Yobbi and others, 1980). Depending on the relative altitudes between water

in the lakes and in the aquifer, the lakes either receive water from or supply water to the surficial aquifer. The relatively high water table north, east, and northwest of the lakes creates a gradient toward the lakes and, therefore, water flows to the lakes from those areas. Water moves laterally from the lakes toward the south and west. where this layer is thin or absent. Underlying the surficial aquifer and clay layer is a series of highly per-

that this layer was absent at 12 of 59 test sites (Sinclair, 1974). Vertical exchange of water between the surficial and Floridan aquifers is increased ed in this term. The accuracy of computed downward leakage, however, is difference between the lakes is indicated in the 1968 data, collected before meable limestone formations known collectively as the Floridan aquifer. estimated using pan evaporation data from each of the five closest NOAA These formations range in age from Miocene to Eocene and extend to more stations for the 30-day period beginning April 27. These evaporation rates nutrients, and trace metals in water samples from Lake Padgett and Saxon than 1,000 feet below land surface. The uppermost formation is the Tampa ranged from 2.16 ft³/s to 1.69 ft³/s. Thus, the computed downward leakage Limestone, followed in descending order by the Suwannee, Ocala, Avon rate for the period conceivably could range from 0.88 ft³/s to 1.35 ft³/s. is evaluated. Present and potential effects of well-field pumpage on the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Park, and Lake City Limestones (Ryder, 1978). Residential wells near the Pa lakes are generally less than 200 feet deep and extend into the Suwannee stage of about 0.2 foot per month. In comparison, average lake evaporation Dissolved nitrate has not been detected in samples from Lake Padgett since Limestone or the upper part of the Ocala Limestone. Public supply wells, induring the April-May period would cause lake stages to decline about 0.5

1968. There is insufficient data to identify possible causes of change in these cluding those in the Cypress Creek and South Pasco well fields, are about foot per month. The decline in stage of Lake Padgett and Saxon Lake two constituents. Results of analyses for other nutrient species in 1980 do 600 feet deep and are finished in the Avon Park Limestone. Two major during April-May 1975 was typical of stage declines for other lakes in the not show any appreciable changes from previous concentrations. Results of cavernous zones in the Avon Park Limestone, at altitudes of about 400 and vicinity. 500 feet below NGVD of 1929, are the major water-bearing formations During April and May 1975, the average stage of Lake Padgett and within the expected range for surface waters in the area. Of the trace metals (Ryder, 1978). Estimates of transmissivity in the Floridan aquifer un- Saxon Lake was about 68.4 feet above NGVD of 1929. The altitude of the sampled in both lakes, only iron and manganese show concentrations derlying the study area average about 40,000 ft²/d (Ryder, 1978). The vertical movement of water between the aquifers depends on the datum, resulting in a head differential of 9.2 feet. If this head differential 1980 samples for both lakes are relatively high compared with other surface permeability of the sand and clay units and the altitude of water in the surwas diminished by 1 foot, either by lowered lake stage or higher altitude of waters in the area, but are not a cause for concern. The source of these ficial aquifer relative to the potentiometric surface in the Floridan aquifer. the potentiometric surface, downward leakage would decrease propor-Throughout the Lake Padgett and Saxon Lake basin, the altitude of the tionately, or about 11 percent. aquifer. Water, therefore, moves downward from the surficial aquifer to

LAKE CHARACTERISTICS

recharge the Floridan aquifer. Although both vary in altitude seasonally,

surface in the Floridan aquifer. The head differential and subsequent down-

the water table remains from 3 to 10 feet higher than the potentiometric

Hydrologic characteristics of Lake Padgett and Saxon Lake were evaluated by analysis of bathymetric, stage, and flow data. Bathymetric data were stage-area relations for both lakes were also determined. Lake-stage data were analyzed to determine stage-duration and stage-frequency curves.

Bathymetric data were collected to define bottom contours of natural and for Florida," that contain lake-stage and water-quality data for Lake dredged areas of the lake (fig. 2). Depths were recorded by echo sounder and Padgett and many other surface-water sites. Ground-water data for sites verified by rod and line soundings. All depths are referenced to the mean near the lakes and throughout the SWFWMD area are also contained in stage of the lakes, 69.76 feet above NGVD of 1929. Depth contours for these reports. The Geological Survey, in cooperation with SWFWMD, also areas of extensive dredging represent the generalized contours of the highly collects local rainfall data at a Lake Padgett rainfall station. Semiannual irregular dredge holes. As shown in figure 2, Saxon Lake has been dredged reports showing the altitude of the potentiometric surface in the surficial more extensively than Lake Padgett. The lake has been enlarged by comand Floridan aquifers are published as part of the cooperative program with pletion of a connecting canal to Lake Padgett and extension northward of a atural shoreline reentrant. The deepest dredge holes sounded were about 30 feet. The deepest of several natural depressions in the lakes was 25.3 feet below mean stage and is located in the southwest corner of Lake Padgett. Maximum natural depth in Saxon Lake prior to dredging was probably about 20 feet.

Stage-area curves for Lake Padgett and Saxon Lake are shown in figure . Bathymetric data and Geological Survey topographic maps were used to letermine areas and were verified by controlled aerial photographs. The abrupt change in slope of the stage-area curves near the mean stage of 69.76 feet above NGVD of 1929 occurs because of inundation of low-lying swampy areas adjacent to the lakes. At mean stage, Lake Padgett has an area of 180 acres. Comparison of topographic maps for 1974 and 1943 shows that Saxon Lake was enlarged from about 79 acres to its present area of 83 acres. The area and shoreline length of Lake Padgett were unchanged, but he shoreline length of Saxon Lake at mean stage was increased by 30 percent, from 2.7 miles to 3.5 miles. Dredge-and-fill operations significantly altered the shape and the volume of Saxon Lake, but caused little change in Lake Padgett. Stage-volume curves for Lake Padgett and Saxon Lake are shown in figure 8. The mean depth of the lakes — the ratio of volume to area at mean stage — is 11.0 feet for Lake Padgett and 12.0 feet for Saxon Lake. Removal of extensive bottom material from Saxon Lake increased the depth and volume of the lake

Stage Variations Stage data discussed in this report are from the gage located on Lake Padgett. As long as the lakes are hydraulically connected by the canal be-Lake Padgett and Saxon Lake are in one of the most rapidly growing tween them, stages of Saxon Lake should be approximately the same as of the last two decades and future growth rates are expected to be similar sand in the connecting culvert would cause separation of the lakes below a University of Florida, 1979). As the Tampa Bay area continues to expand stage of about 68.5 feet. The stage of Saxon Lake below this elevation, northward, the area will attract new residents that will place increasing however, should be closely approximated by stages of Lake Padgett. Fluctuations of Saxon Lake prior to construction of the connecting canal in 1967

Collection of periodic stage data for Lake Padgett was begun by the Geological Survey in January 1965. Continuous lake-stage data have been collected since February 1970. Month-end stages for Lake Padgett are presented in figure 3 for the period 1965-80. The average stage for the period March 1970-February 1980 is 69.76 feet above NGVD of 1929. The minimum daily stage for this period was 67.93 feet above NGVD of 1929. 71.81 feet above NGVD of 1929 recorded on May 9, 1979, following a 15inch rainfall in a 24-hour period. The maximum known stage of Lake Padgett since at least 1960 was 73.6 feet above NGVD of 1929 and probably occurred as a result of Hurricane Donna in March 1960 (Florida Department of Transportation, 1961). Maximum, mean, and minimum monthly stages for Lake Padgett and years of occurrence are shown in figure 9. The mean monthly stage for May

is the lowest at 69.39 feet above NGVD of 1929. This is a consequence of the typically low rainfall during the spring. Mean and maximum stages are monthly extremes is greatest in August, 2.82 feet, and least in January, Duration curves of daily mean stages for 1970-80 are shown for Lake Padgett in figure 10. These curves indicate the percentage of time that a particular lake stage was equaled or exceeded during the period of record. The intermediate curve is based on all days, whereas the upper and lower curves are based on records for September and May, respectively. The May curve exceeds the intermediate and September curves about 3 percent of the time, as a result of the unusually heavy rainfall on May 8, 1979, that caused

the maximum stage for the 10-year period of record. The mean stage of

69.76 feet above NGVD of 1929 was exceeded about 50 percent of the time

for all days of record. The stage of Lake Padgett was within 1.0 foot of the mean stage for about 85 percent of all days. A stage-frequency curve for Lake Padgett is shown in figure 11. The log-Pearson Type III frequency distribution (U.S. Water Resources Council,

The water balance of Lake Padgett and Saxon Lake consists of several components. Sources of inflow include rainfall, surface-water inflow, and ground-water inflow from the surficial aquifer. Upward leakage from the Floridan aquifer does not occur at the lakes. Water leaves the lakes by ponents of flow that cause changes in lake volume are related by the

Change in volume	=	Precipi- tation	-	Evapora- tion	+	Surface- water inflow	-	Surface- water outflow
	+	Ground- water inflow	-	Ground- water outflow	_	Down- ward leakage		
		analyses		conducte	ed f	or seven	low-flo	w period

during 1972-80. Data limitations prevented a continuous water balance, primarily because of unknown surface flow. By selecting periods when lake stages were less than 69.4 feet above NGVD of 1929—the stage at which surface-water outflow begins - surface-water outflow was zero. Surfacewater inflow, based on inflow-outflow relations, was zero or assumed to be negligible. Rainfall was generally light during these seven periods, so computational errors due to errors in precipitation were minimized. These relatively dry periods generally occurred during late spring when the lake stage and potentiometric surface of the Floridan aquifer were at or near the annual minimums, and the difference between the two was greatest. Downward leakage is greatest during such periods and decreases lake stages more than at any other time of year. The computed amount of downward leakage for these dry periods, therefore, represents the probable maximum downward leakage during the year. Average downward leakage throughout the year would be less.

Exchange of water between the lakes and the shallow aguifer was estimated by using Darcy's law, which states that the quantity of flow through porous materials is the product of the hydraulic conductivity of the material, the water-table gradient, and the cross-sectional area through which the flow occurs. A hydraulic conductivity of 13 ft/d was used based on aquifer data from northwest Hillsborough County (Sinclair, 1974). Water-table gradients were estimated from existing water-level data and from water levels in the surficial aquifer determined in June 1980. Maximum inflow gradients, about 10 feet per 1,000 feet, were on the eastern ide of Saxon Lake. Maximum outflow gradients for both lakes were about 6 feet per 1,000 feet towards the south. The thickness of each of several flow sections around the lakes was estimated as the difference in elevations of Lake Padgett and Saxon Lake are underlain by three hydrogeologic units the water table at the section and the bottom of the lakes. analyses were discussed in the section on climate. Changes in lake volum ranges from 10 to 50 feet in thickness throughout the lake basin and were determined from lake-stage records and stage-volume data. By averages about 40 feet in thickness in the vicinity of the lakes. Underlying estimating ground-water inflow and outflow and choosing periods when natural and cultural factors. Climate, lake size, drainage basin size and the surficial aquifer is a layer of dense clay that ranges, where present, from surface flow is negligible, the water-balance equation can be solved to runoff characteristics, and the geologic setting of the lake are among the

30-day period beginning April 27, 1975, are as follows:

water water inflow or Downward leakage = 0.92 ft³/s

Average thickness of the clay is about 5 feet in the vicinity of the lakes. ground-water terms because of their small magnitude relative to the temporary condition. Test borings in northwest Hillsborough and south Pasco Counties indicated residual. The change-in-volume term is a product of surface area and stage maximum probable range of downward leakage, lake evaporation was re-slight chemical difference between the lakes is not known.

IMPACTS OF DEVELOPMENT The Lake Padgett and Saxon Lake area is between two major well fields in south Pasco County. Lakes in other areas of west-central Florida have experienced lowered water levels as a result of increased downward leakage nduced by ground-water withdrawals from nearby well fields. Other public supply wells and irrigation wells near the lakes could also affect the potentiometric surface of the Floridan aquifer beneath the lakes. With demands on the ground-water supply increasing, water managers realize the need for evaluating potential effects of ground-water withdrawals in the future. The quality of water in Lake Padgett and in Saxon Lake may be affected by existing and future well-field withdrawals and by residential and agricultural developments. If lake levels are lowered by ground-water withdrawals, their ability to maintain high quality and assimilate pollutant loads crease as new residential and agricultural developments occur. Assessment of impacts of development on the lakes must therefore take into account both the quantity and quality of water in the lakes.

Water-Level Declines

The levels of Lake Padgett and Saxon Lake could be affected by pumpage from Cypress Creek, South Pasco, and Cross Bar Ranch well fields (fig. 1), as well as by pumpage from other public supply and irrigation wells near the lakes. Ground-water withdrawals from Cypress Creek well field averaged 30 Mgal/d during 1979 (fig. 3). Average pumpage from South Pasco well field was 11.6 Mgal/d during 1979 (Duerr and Trommer, 1981). Public supply wells of the taxing district adjacent to the lakes pumped an average of less than 0.2 Mgal/d. Hutchinson and others (1981) estimated that total irrigation pumpage within about 3 miles of the lakes was approximately 4 Mgal/d. Permitted rates of pumping were determined from records of SWFWMD. Currently, the Cypress Creek and Cross Bar Ranch well fields are each permitted to pump, on the average, 30 Mgal/d. The South Pasco well-field permit allows average withdrawals of 16.9 Mgal/d. SWFWMD monitors obthe lake (Dr. B. Cowell, University of South Florida, oral commun., August servation wells within and near the South Pasco well field and establishes 6, 1980).

minimum water-level altitudes that must be maintained regardless of pumping rates. The taxing district adjacent to the lakes is permitted an average pumpage of 4.3 Mgal/d, and irrigation wells within a 3-mile radius of the lakes are permitted combined pumpage of more than 5 Mgal/d. Water levels in two wells finished in the Floridan aquifer are presented in figure 3. Pasco deep well 207 is midway between the South Pasco well field detrimental effects of such development can be reduced if waterand the Lake Padgett and Saxon Lake area (fig. 1). The increasing water levels in this well after mid-1977 reflect decreased pumpage in the South hydrology of the lakes and surrounding areas. Documentation of past and in 1978-79. Cypress Creek deep well 3 is 6 miles northeast of the lakes in the Cypress Creek well field. Water levels in this well have shown a steadily declining trend since 1977 (fig. 3).

the 60- and 70-foot contour lines east of the lakes represents lower altitudes in the potentiometric surface along Cypress Creek. The relatively high aquifer transmissivity in this area and upward leakage to the surficial aquifer are the original causes of this trough (Ryder, 1978). Pumpage from Cypress Creek well field has lowered water levels in the Floridan aquifer near the well field and caused the trough to extend farther northward (Wolansky and others, 1978; Yobbi and others, 1980). Pumping from South Pasco well field began in March 1973, and the altitude of the potentiometric surface at the well field declined as much as 15 feet between March and June 1973. Gradients in the potentiometric surface between the well field and the lakes increased, and water levels in Pasco deep well 207 and Woodward deep well (fig. 1) declined 6.5 and 4.2 feet, respectively, between March and June. Water levels in other wells in the study area that were not affected by pumping declined between 1.8 and 3.8 feet during this 3-month period. The average decline in water levels in these wells was about 2.5 feet during this period. This would indicate that about 1.7 feet of the 4.2-foot decline in the potentiometric surface at Woodward well could have been caused by pumping from the South Pasco well field. The head differential between water levels in the lakes and in Woodward well increased from an average of 6.4 feet in 1972 to an average of 8.5 feet for 1973-77. This head differential also averaged 6.4 feet for 1978-80 after pumping from South Pasco well field decreased and above average rainfall

Using aquifer hydraulic characteristics determined in pump tests, digital computer models can be used to estimate the extent and degree of drawdown of the potentiometric surface caused by pumpage. Ryder (1978) developed a two-dimensional digital model to evaluate the hydrogeology of Cypress Creek well field. The 120-mi² area of the model borders on Lake Padgett and Saxon Lake. After calibration of the model to observed hydrologic conditions in September 1974, a withdrawal of 30 Mgal/d from Cypress Creek well field was simulated. Because the model is twodimensional, computed drawdowns represent the minimum drawdown expected. Results of the simulated withdrawal indicated that lowering of the potentiometric surface of the Floridan aquifer in the area of Lake Padgett and Saxon Lake would not occur. Water levels in wells approximately 3 miles northeast of the lakes have not declined since pumping began at ypress Creek well field in 1976, substantiating model computations ne Geological Survey, in cooperation with SWFWMD, has also developed a two-dimensional model for simulating regional ground-water flow in a 932-mi² area of municipal well fields north of Tampa (Hutchinson and others, 1981). The model area includes Lake Padgett and Saxon Lake, as well as other lakes and the surrounding well fields. After calibrating the model to match the average potentiometric surface for September 1976 to May 1977, all pumpage was removed from the model input data and a verification simulation was run. This simulated potentiometric surface was compared with an actual-estimated potentiometric surface mapped by Johnston and others (1980) that represents predevelopment conditions.

Comparison of the simulated potentiometric surface with the actual predevelopment conditions was considered sufficient to verify the model Subsequent predictive model runs used this simulated predevelopment potentiometric surface as the starting condition to estimate drawdown caused by pumpage within the model area. Because the water table is held at a constant level during model simulations, computed drawdown of the tentiometric surface represents the minimum drawdown for a given pumping rate. Although developed to simulate regional rather than specific-site conditions, the model can provide insight into possible effects of groundwater withdrawals on the potentiometric surface in the area of Lake Padgett and Saxon Lake. The model was used to compute approximate drawdowns of the poten-

ometric surface for maximum permitted pumping rates at Cross Bar Ranh, Cypress Creek, and South Pasco well fields and for maximum permitted pumping from the irrigation and public supply wells near the lakes. Model imulations indicate that pumping 30 Mgal/d from Cross Bar Ranch well field would not affect the potentiometric surface beneath the lakes. The drawdown of the potentiometric surface at the lakes caused by simulated pumping of 30 Mgal/d from Cypress Creek well field was about 0.1 foot ne model simulations indicated that South Pasco well field would cause a minimum drawdown at the lakes ranging from 0.5 to 0.9 foot if pumping was set at 16.9 Mgal/d. The combined effect of simulated pumping at the permitted rates of 4.3 Mgal/d from the public supply wells adjacent to the lakes and 3.8 Mgal/d from nearby irrigation wells would be a drawdown ranging from 0.5 to 1.0 foot beneath the lakes. The total computed drawdown of the potentiometric surface beneath Lake Padgett and Saxon Lake from all permitted pumping langed from 1.3 to 1.6 feet in the four model-grid nodes that include the lakes.

Model simulations indicate that increased pumping at either Cypress Creek or Cross Bar Ranch well fields would have little effect on the potentiometric surface of the Floridan aquifer beneath Lake Padgett and Saxon Lake. Simulation runs at twice the permitted rates for both well fields indicated that drawdown of the potentiometric surface beneath the lakes would be about 0.3 foot. Increasing the average head difference between the lake surface and the potentiometric surface by lowering the potentiometric urface 0.3 foot would increase downward leakage by less than 5 percent. The potentiometric surface of the Floridan aquifer at the lakes could be drawn appreciably by increasing the permitted pumping from South Pasco well field, nearby irrigation wells, or the public supply wells of the taxing district adjacent to the lakes. Model simulations indicate minimum drawdown of the potentiometric surface at the lakes would range from 1.0 to 1.9 feet if pumping from South Pasco well field was doubled. If pumping rates for the public supply and irrigation wells near the lakes were twice the presently permitted rates, minimum drawdown of the potentiometric surface would range from 1.0 to 2.0 feet at the lakes. The combined drawdown of the potentiometric surface at the lakes would probably exceed 4 feet if all pumping rates were doubled.

The quality of water in Lake Padgett and Saxon Lake is affected by many natural features that can influence the water quality of lakes. Cultural of pesticides or industrial chemicals. Table 1 presents results of analyses for physical and chemical characteristics for samples collected from Lake Padgett and Saxon Lake in 1965thickness of each unit and its altitude relative to other hydrogeologic units,

Components of the water-balance equation, in cubic feet per second, for the

by the Geological Survey for the period 1972-80. Saxon Lake was sampled for field parameters and alkalinity only once prior to 1980.

Specific conductance of water in Lake Padgett has been the only waterquality characteristic measured on a regular basis. The plot of specific conductance for Lake Padgett is presented in figure 12. A definite increase in specific conductance is evident after 1975. The average of 26 measurements of specific conductance prior to 1976 was 137 micromhos per centimeter at 25°C (μmho/cm). Specific conductance averaged 183 μmho/cm for the 27 measurements since early 1976. Specific conductance values exhibited little correlation with antecedent rainfall, lake volume, or time of year, although the decreasing conductance between April 1979 and January 1980 was probably caused by the unusually heavy rainfalls between May and September 1979. Whereas deficient rainfall of the preceding years would tend to concentrate dissolved solids, development in the lake basin has probably played a major role in the increased specific conductance readings in Lake The analyses in table 1 for samples collected in 1980 show higher concen-

trations for hardness, alkalinity, dissolved solids, and calcium in Lake Padgett waters than those of previous years. Lack of data during 1971-79 The residual term includes the errors associated with each of the components in the water-balance equation, as well as the actual value of down-The layer of dense clay underlying the surficial aquifer is probably the ward leakage. The computed value of downward leakage would not be increase in specific conductance shown in figure 12, however, suggests that result of weathering of the underlying limestone (Carr and Alverson, 1959). significantly affected by errors in precipitation, surface-water terms, or the change in hardness, alkalinity, dissolved solids, and calcium is not a Results of analyses indicate that Saxon Lake exhibits higher concentrations of alkalinity, hardness, and dissolved solids than Lake Padgett. The

highly dependent on the estimate of lake evaporation. To evaluate the the present change in chemical characteristics in the lakes. The cause of this Table 2 presents results of analyses for carbon species chlorophyll Lake. Historical water-quality data for Saxon Lake are not available. analyses for 1980 water samples for nutrients show concentrations to be potentiometric surface in the Floridan aquifer was about 59.2 feet above the greater than 3 micrograms per liter (µg/L). Manganese concentrations in the manganese concentrations is unknown. Samples of bottom sediments were collected to determine their pesticide and polychlorinated biphenyl content (table 3). Herbicides and insecticides are generally insoluble in water and analyses of sediment material provide a better indication of their presence than would analyses of the lake water.

Results of analyses show that only DDE and chlordane were present at

letectable levels. The concentrations for both of these compounds were less

Bacteriological analyses of samples collected in Lake Padgett and Saxon

Lake in May and August 1980 resulted in coliform bacteria counts below

the statistically acceptable range for determination (analyses based on

nonideal colony counts). The Department of Public Works, Environmental

than 5 micrograms per kilogram (µg/kg).

Control Division, Pasco County, has conducted periodic sampling of bacteriological conditions in Lake Padgett, Saxon Lake, Lake Joyce, and East Lake. In August and September 1979, fecal coliform bacteria exceeded 1,000 colonies per 100 milliliters (col/100 mL) of sample from Lake Padgett and 2,500 col/100 mL of sample from Saxon Lake (T. Feldman, written commun., February 18, 1980). Florida statutes limit fecal coliform bacteria to Estimates of the quantity of water exchanged between the lake and the will diminish. Pollutant loads to the lakes are expected to significantly inpropagation and management of fish and wildlife (Florida Department of ironmental Regulation, 1979, Rule 17-3). High nutrient levels can cause an overabundance of aquatic vegetation in lakes. Undeveloped shoreline areas of Lake Padgett and Saxon Lake are generally dominated by cattails (Typha spp.) and maidencane (Panicum hemitomon Schult.). Nuisance levels of torpedograss (Panicum repens L.) and hydrilla (hydrilla verticillata Royle) impede swimming at many water ront homesites. The many species of aquatic plants in the littoral zone of the lakes can provide a beneficial environment for game fish, but some areas of Lake Padgett and Saxon Lake have a vegetation density that may outweigh any beneficial characterist High nutrient levels can also result in undesirable concentrations of algae in the lakes. Phytoplankton samples collected from Lake Padgett and Saxon Lake in 1977 by Biological Research Associates indicate that Merismopedia sp. and Microcystis sp. are the dominant organisms during summer months (Seaburn and Robertson, Inc. and Biological Research Associates, 1977). reliminary results of an investigation on the algae of Lake Padgett by the

University of South Florida indicate that minor blooms of these blue-green

will probably limit algal blooms to a level not detrimental to game fish in

algae are possible during warm months. Nutrient uptake by aquatic plants

Residential development and ground-water withdrawals are expected to continue to increase in the Lake Padgett and Saxon Lake area. Any management activities are based upon a thorough understanding of the the future in a manner that will benefit area residents Ground-water withdrawals and dredging of Lake Padgett and Saxon Lake have not had a noticeable effect on water levels in the lakes. Although Contour lines of the altitude of the potentiometric surface of the Floridan stage data for the lakes prior to dredging are incomplete, available data aquifer during May 1980 are shown in figure 1 (Yobbi and others, 1980). The do not indicate declining trends in stage. Ground-water withdrawals trough in the potentiometric surface shown by the northward curvature of primarily from South Pasco well field—have caused some lowering of the potentiometric surface of the Floridan aquifer underlying the lakes. At presently permitted rates of pumping, however, the increase in downward leakage due to a lowered potentiometric surface will not cause a decline in lake stages. Large increases in ground-water withdrawals from South Pasco well field, the public supply and irrigation wells near the lakes, and, possibly, from Cypress Creek well field would lower the potentiometric surface of the Floridan aquifer enough to increase substantially the downward leakage from the lakes. Water-quality data for Lake Padgett for 1965-80 indicate an increase in organic nitrogen concentrations and specific conductance during this period. Historical water-quality data are not available for Saxon Lake, but analysis of samples collected in 1980 indicate that concentrations of nitrogen and phosphorus species in both lakes are within the expected range of Class III surface waters in west-central Florida. Dissolved constituent data indicate a slight chemical difference between Saxon Lake and Lake Padgett, but the causes of this difference are unknown. Concentrations of fecal coliform bacteria in the lakes have occasionally exceeded State limits for Florida surface

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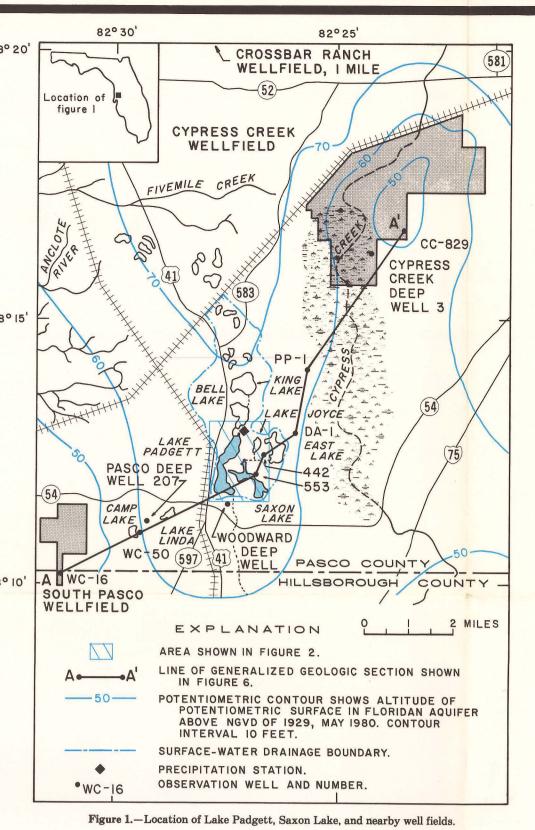
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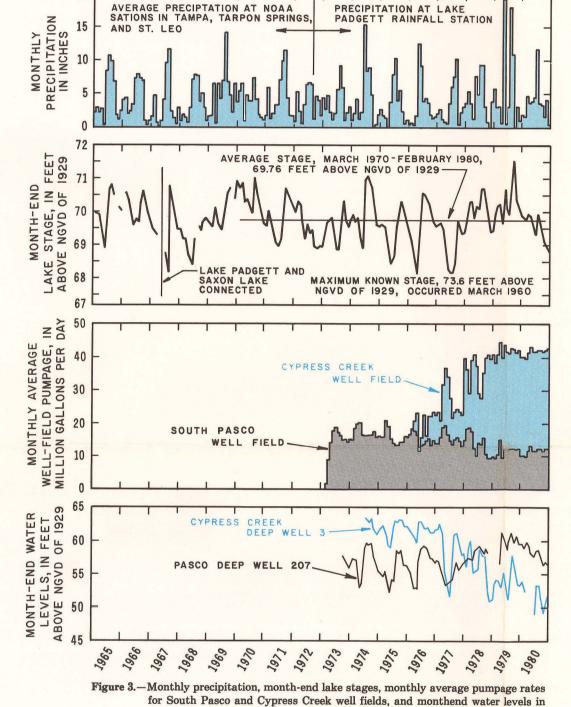
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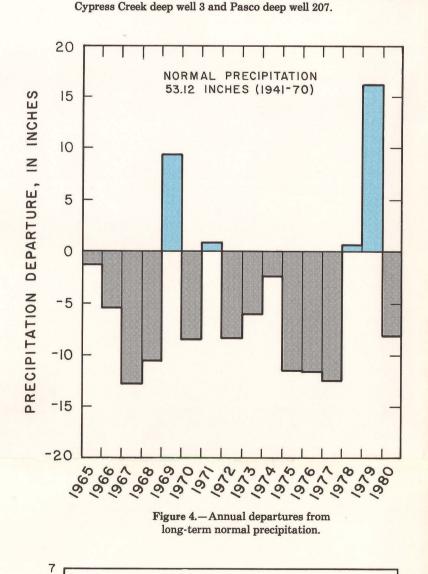
ABBREVIATIONS AND CONVERSION FACTORS Factors for converting inch-pound units to International System

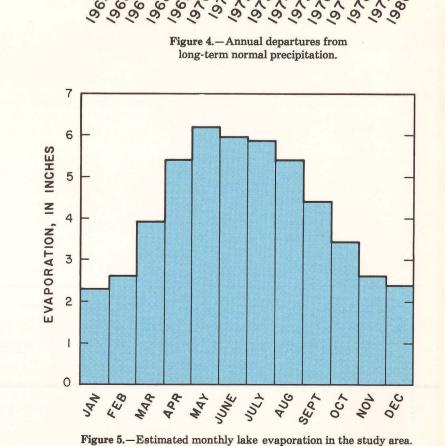
of units	(SI) and abbreviation of	funits
Multiply	By	To obtain
inch (in)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
foot per day (ft/d)	0.3048	meter per day (m/
square foot per day (ft²/d)	0.0929	square meter per day (m²/d)
cubic foot per second (ft³/s)	0.02832	cubic meter per second (m³/s)
gallon (gal)	0.003785	cubic meter (m³)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m³/s)
degree Fahrenheit (°F)	(°F-32)/1.8	degree Celsius (°C)
National Geodetic Vertical		

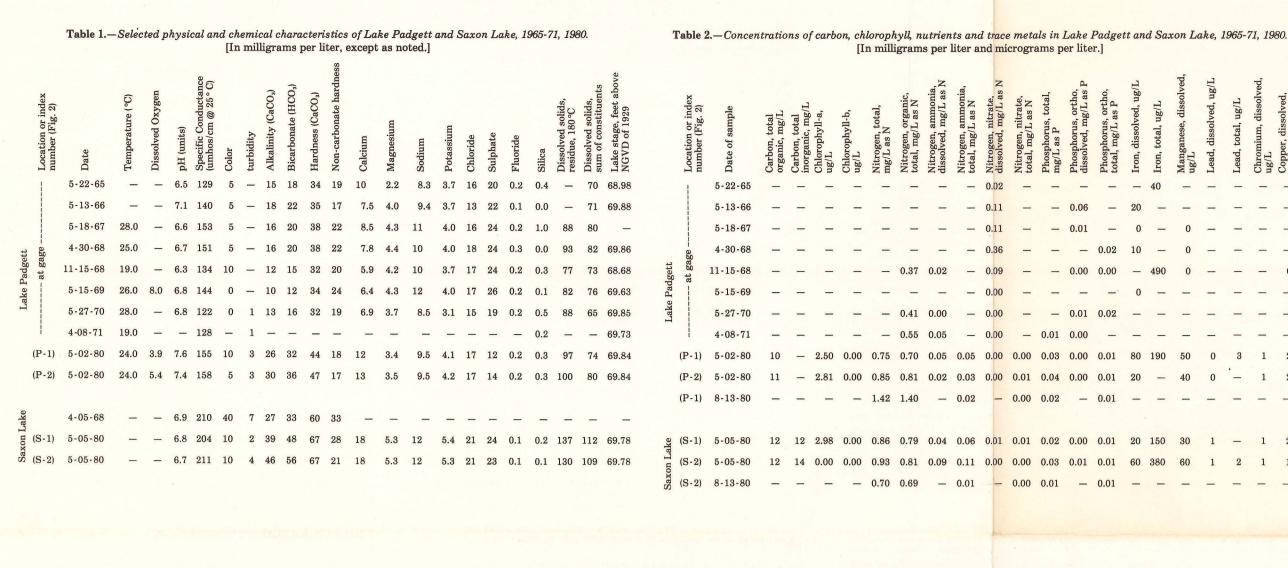
both the United States and Canada, formerly called mean sea level.

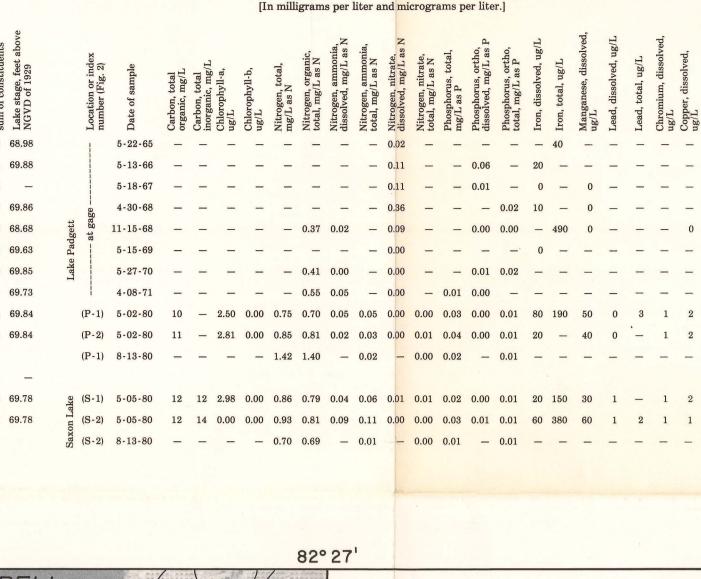


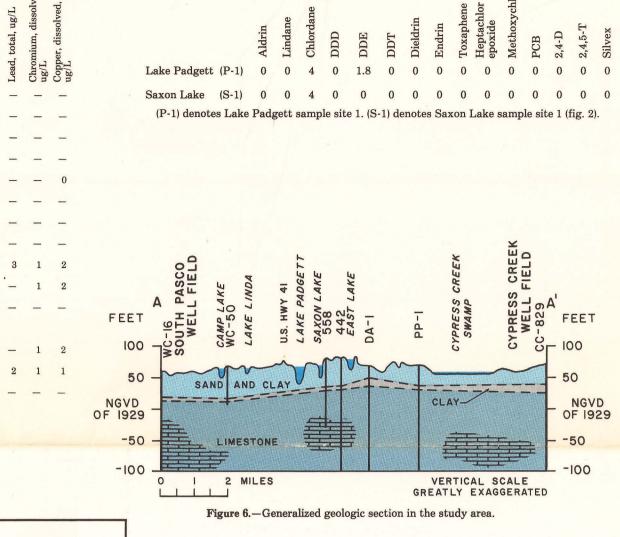












SAXON LAKE __ LAKE PADGETT_

- AREAS AT MEAN STAGE

(69.76 FEET)

500

200 300 400

Table 3.—Concentrations of pesticides and polychlorinated biphenyls in bottom material

of Lake Padgett and Saxon Lake, May 1980.

[In micrograms per liter.]

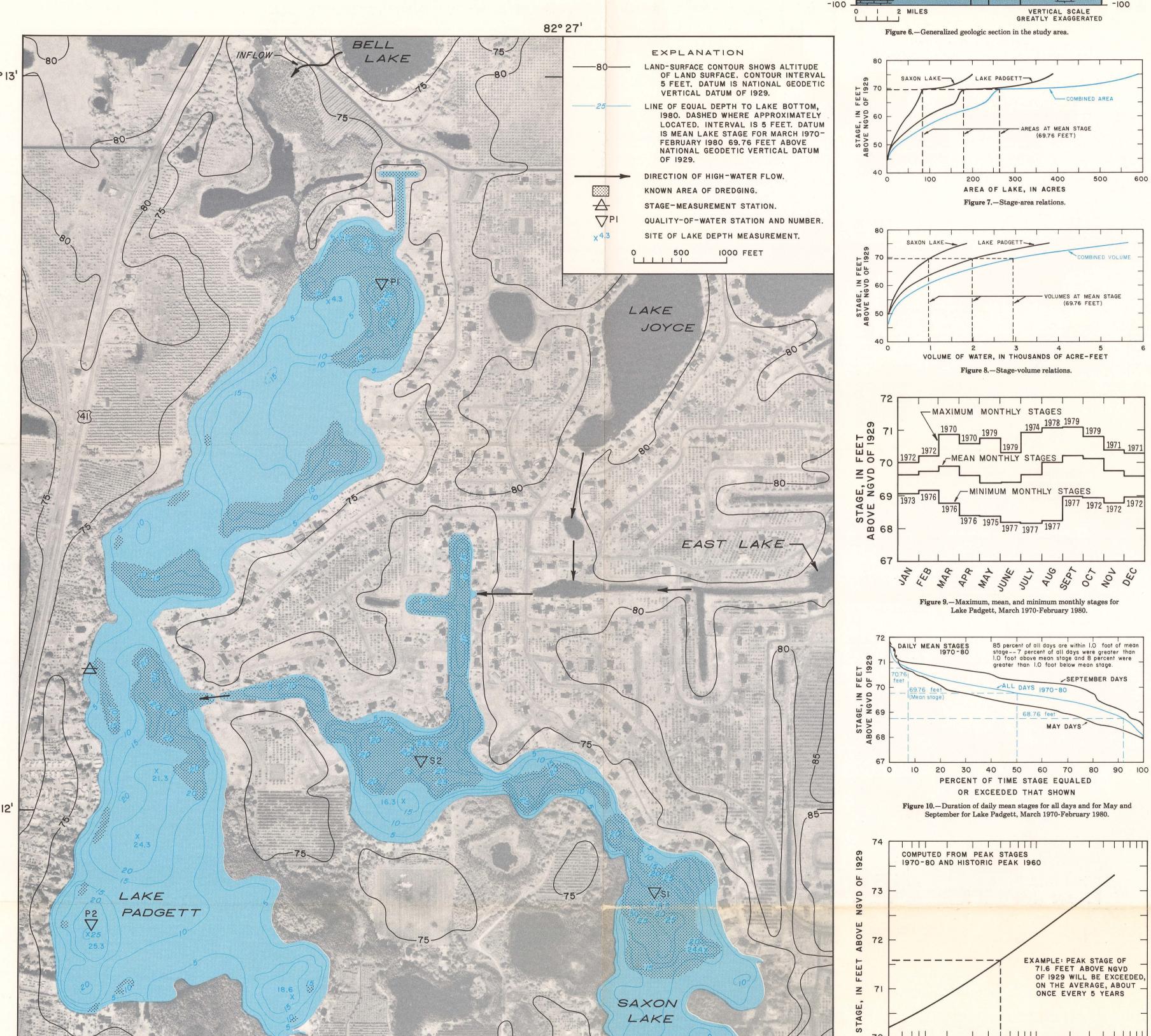
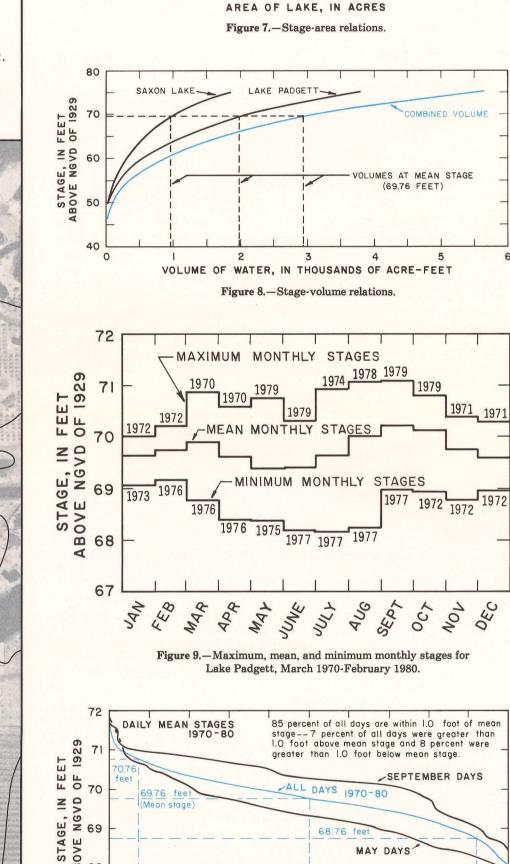
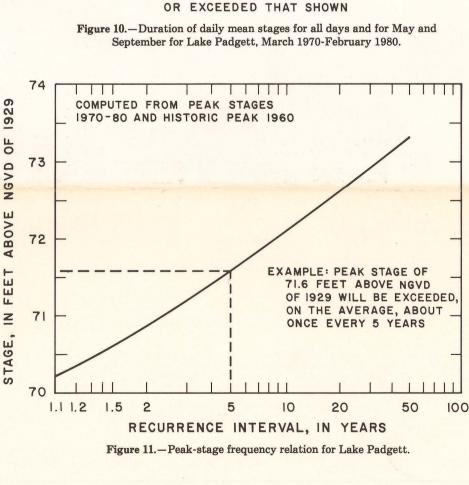


Figure 2.—Aerial photograph of the Lake Padgett and Saxon Lake area.





PERCENT OF TIME STAGE EQUALED

