Prepared in cooperation with the
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

INTRODUCTION

Lake Butler, at the town of Windermere in western Orange County (fig. 1), is in the headwaters of the Kissimmee River which flows south to Lake Okeechobee. Although major developments such as Walt Disney World and other recreational facilities have been built in the vicinity of Lake Butler in recent years, development in the Lake Butler drainage basin has been largely confined to construction of single-family homes.

Land within the lake drainage basin is used primarily for citrus groves and residential development. These land uses, because of septic tanks, fertilization, pest control, and vehicular traffic, may cause undetermined quantities of nutrients, pesticides, and other chemical constituents to enter the lake.

The lake is used primarily for recreation, such as sailing, waterskiing, motorboating, fishing, and swimming, and for lawn irrigation. Also, the lake has an esthetic value for those residents living within view of the lake.

In 1981, the U.S. Geological Survey, in cooperation with the South Florida Water Management District, began a study of Lake Butler and its environment. The objective of the study was to describe generally the hydrology of Lake Butler and its contributing drainage basin. The study scope included collection of new data on lake stage, water quality, and lake bathymetry as well as compilation and analysis of existing data on the hydrology of the lake. New and existing data were included on water quality of ground water and lake water, chemical constituents and pesticides in lake-bottom sediments, rainfall, lake stage, streamflow, ground-water levels for the surficial (water table) and Floridan aquifers, lake bathymetry, soils, geology, and geomorphology. Table 1 lists all U.S. Geological Survey data sites and gives their location, station type, and data type.

PHYSICAL SETTING

Geology

The topography of the Lake Butler drainage basin is characterized by rolling hills that range from approximately 100 to 190 feet above sea level. The topographic features seen today are the result of geologic processes that include solution, tectonic, fluvial, and shoreline activity. Because the area is underlain by soluble limestone, the basin exhibits karst topography typified by numerous sinkholes and solution depressions. Fluvial processes of erosion and deposition also have further modified the local topography. During Pleistocene glacial activity, coastal processes formed a shoreline in the Lake Butler area. This occurred during the Sangamon Interglacial period when the Wicomico sea level was nearly 100 feet above the present level. The Lake Butler chain of lakes may represent a relict lagoon between the shore and an eastern relict beach ridge or offshore bar (White, 1970).

The surficial materials of the Lake Butler drainage basin generally consist of fine-grained, well sorted sand interbedded with lenses of clay. Soils in the basin are moderately to somewhat excessively drained. The surficial materials are underlain by the Hawthorn Formation of Miocene age which contains sand mixed in varying proportions with clay and interspersed with clay lenses of variable thickness and lateral extent. The Hawthorn Formation is underlain by limestone and dolomite of upper and middle Eocene age (Ocala Limestone and Avon Park Formation). The top of the Eocene limestone ranges from about 25 feet above sea level in the central part of the drainage basin to about 25 feet below sea level in the eastern part of the basin (Lichtler and others, 1968).

Bottom Configuration

The lake bathymetric (depth) map for April 1981 (fig. 2) was prepared from data collected during numerous lake traverses in a boat equipped with a chart-recording fathometer and a supplementary nonrecording depth finder. The depth contour lines closely resemble the December 1961 map by Kenner (1964) with a few minor exceptions. Numerous deep holes (greater than 40 feet), because of their location, shape, and proximity to lakefront development, were assumed to be caused by sand dredging for beach fill and are not shown in figure 2. Other depressions in the lake bottom suggest sinkhole origin. These depressions have very uniform side slopes and are generally cone-shaped. The irregular bottom of the lake is typical of relict karst features formed during lower stages in sea level.

HYDROLOGY

The hydrologic cycle of Lake Butler generally contains eight interacting elements. Elements that may cause lake levels to rise are rainfall, surface-water inflow, and ground-water seepage. Elements that may cause levels to decline are surface-water outflow, seepage from the lake for lawn irrigation or other uses, evaporation from the lake surface, transpiration, and seepage from the lake into the surficial aquifer. Rainwater in the drainage basin may enter the lake directly, may enter the lake as surface-water runoff, or may infiltrate into the surficial aquifer. From the surficial aquifer it may either recharge the Floridan aquifer, seep into the lake, or return to the atmosphere by evaporation or by plant transpiration.

Lake water use, other than recreation, is mostly for residential lawn irrigation. Water use by other sources within the drainage basin consists mainly of citrus grove irrigation and domestic water supply. Water for citrus grove irrigation and domestic use is supplied primarily from the Floridan aquifer by wells that range in depth from 100 to more than 1,000 feet. The effect of lake water use on lake level is minimal compared to the effects of other elements of the hydrologic cycle.

Ground Water

Ground water in the study area is obtained from two aquifers—the surficial aquifer and the Floridan aquifer. The surficial aquifer is composed of sand imbedded with minor amounts of clay. The water table in this aquifer generally follows the land surface, and during the study was about 10 feet below land surface. However, under some isolated hills, the water table is more than 40 feet below land surface, but above the levels of nearby lakes.

The top of the Floridan aquifer is 50 to 100 feet below the land surface in the study area. The aquifer consists of about 2,000 feet of limestone and dolomite. Water in the Floridan aquifer is under pressure (artesian) so that the potentiometric surface (the level to which water will rise in tightly cased wells) is within 10 to 30 feet of the land surface in the vicinity of Lake Butler (Lichtler and others, 1968, p. 106-108).

Because the potentiometric surface of the Floridan aquifer in the vicinity of Lake Butler is below the lake surface, a potential for the lake to recharge the Floridan aquifer exists. Water also moves from the surficial aquifer to the Floridan aquifer when the water table is higher than the potentiometric surface of the Floridan aquifer. The rate of movement is dependent on the head and the hydraulic properties of the aquifers and intervening strata (Lichtler and others, 1968).

Surface Water

Lake Butler's drainage area of approximately 14.5 square miles is comprised of subbasins draining into Lakes Cypress, Crescent, Whitney, Ebes, Bessie, Down, and several unnamed lakes (fig. 3). Surface outflow from Lake Butler is generally southward into a chain of lakes that flows into Cypress Creek, a tributary of the Kissimmee River.

The lakes within the Lake Butler drainage basin, except landlocked Lake Bessie, drain into Lake Butler through surface channels during wet periods. The normal direction of flow in the surface channels is shown by arrows in figure 3. Lake Down, Wauseon Bay, Lake Butler, and the lakes downstream from Lake Butler comprise the "Butler chain of lakes" and are connected by navigable channels that tend to equalize the lake levels in the chain. Flow may reverse in the channels due to variable rainfall in the Cypress Creek basin, to prevailing wind, and possibly to lake stage differences caused by change in net seepage. If the net seepage varies among lakes, the variation may be due partly to the gradient of the potentiometric surface from southwest to northeast in the vicinity of the lake chain. Uneven distribution of rainfall with resultant large differences in surface inflow is the most likely cause of flow reversal in the channels.

Rainfall and Lake Stage

The average annual rainfall at Isleworth in the southeast part of the drainage basin (site 9, fig. 3) for the period 1933-81 is 53.16 inches, with annual rainfalls ranging from 35.33 inches in 1954 to 78.78 inches in 1953 (fig. 4).

Average monthly rainfall totals show (fig. 5) that approximately 60 percent of the annual rainfall generally occurs during the 4 months from June through September. Average monthly rainfall ranges from 1.73 inches in November to 8.06 inches in July. Also shown in figure 5 is the average monthly lake evaporation (from Lichtler and others, 1968, p. 75) and the difference between rainfall and lake evaporation. The average annual difference between rainfall and lake evaporation is 2.16 inches, with evaporation greatly exceeding rainfall during the months of April and May, and rainfall greatly exceeding evaporation from June through September.

The extremes in lake stage for the period of record from 1933 through 1981 are 94.67 feet on June 23, 1961, and 101.78 feet on September 13, 1960 (fig. 4). A comparison of the graphs in figure 4 shows a relation between rainfall and lake stage, particularly during extreme wet or dry periods. For example, during the below-average rainfall period of 1954-56, the lake stage declined, whereas during the wet years of 1953, 1957, and 1969, the lake stage increased. The general decline indicated by the hydrograph from the extremely high lake stage in 1960 through 1981 can be attributed initially to high surface outflow and subsequently to below-average rainfall in most years since 1960.

The percentage of time that a lake stage is exceeded was calculated from average monthly values for the period 1933-81 (fig. 6). The curve indicates that the median (50 percentile) lake stage is 99.28 feet above sea level. That is, 50 percent of the time the lake stage is about 99.3 feet or above and 50 percent of the time it is about 99.3 feet or below. The curve also indicates that the range in stage is greater for periods of low water (75 percentile or more) than for periods of high water (25 percentile or less). This is typical of lakes with a surface outflow because when the stage is above the outflow channel, invert and downstream conditions are favorable and outflow from the lake will attenuate the rise in lake stage.

Relations Among Hydrologic Components

Weekly rainfall totals, daily water levels in a well tapping the Floridan aquifer, the stage of Lake Butler, and daily discharge of Cypress Creek for calendar year 1957 are shown in figure 7. The calendar year 1957 was selected because of the variation in hydrologic conditions that occurred during that year. The cumulative effect of rainfall on both the potentiometric surface and lake stage is indicated by the gradual increase in levels through the wet season (May through September). Although ground-water levels increase more rapidly than lake stage, they also fall more quickly as is illustrated by the dry months (October through February). During the dry season and during drought conditions, the potential for recharge from the lake to the Floridan aquifer is greatest because of the increased difference between lake level and potentiometric surface of the aquifer.

The discharge record for Cypress Creek at Vineland indicates that surface flow from the Butler chain of lakes ceases when the stage of Lake Butler falls below about 99.3 feet, which is the median stage of Lake Butler and the apparent altitude of the highest point along the creek bottom between the chain of lakes and the gaging station. Thus, drainage from the Butler chain of lakes is totally to the Floridan aquifer about 50 percent of the time. The net surface discharge in the Butler-Louise canal is not known, but when the level of the lake chain is high enough to cause surface outflow, it is a part of the discharge at the Cypress Creek at Vineland station (about 7 miles downstream). Lake Butler's drainage basin makes up about 48 percent of the drainage area of the Cypress Creek basin at the Vineland station. Unless the level of the Butler chain of lakes is at or above median stage (about 99.3 feet), the flow at Vineland reflects the impact of rainfall on an area thought to be less than 2 square miles, the area between the high point along the creek bottom and the gaging station. Thus, when the lakes are above median stage, the effect of a given amount of rainfall on the flow of Cypress Creek is much greater than when the lakes are below median stage.

PHYSICAL, CHEMICAL, AND BIOLOGICAL QUALITY OF THE LAKE

Water Quality

Quality of water in a lake is affected by the geology of the area, climate, land use, and the activities of man within the drainage basin. Various measurements can be made that indicate the suitability of the water for water supply, recreation, or other uses. Collection of data over a period of time may yield information about trends or changes in the water quality and their causes. Even when considering changes and their causes, naturally occurring processes in lakes must be considered as well as the effects of man's activities.

Water-quality data from samples collected from Lake Butler from 1962 to 1981 by the U.S. Geological Survey, Florida Game and Fresh Water Fish Commission, and Orange County Pollution Control Department were used for this study. Table 2 is a statistical summary of all available data for major inorganic ions, nutrients, trace metals, and other physical and chemical properties for the lake at site 7A.

The statistical summary indicates that lake water is slightly acidic (maximum pH measured was 6.8 units) and soft (the range for soft water is 0-60 mg/L (milligrams per liter) hardness (Swenson and Baldwin, 1965). The maximum Secchi disc transparency measured was 240 inches (20 feet) (Orange County Pollution Control Department, written commun., 1973-80). Lake Butler is low in color (mean equals 6.0 units) and turbidity (mean equals 2.0 units), indicating that only small quantities of suspended solids and organic materials are present. Specific conductance is often used to indicate the dissolved solids concentration in water by multiplying specific conductance values by a factor ranging from 0.55 to 0.75 (Hem, 1970). Using a factor of 0.65 (mean specific conductance, the dissolved solids concentrations of the lake water range from 98 to 214 mg/L.

Dissolved oxygen (DO) concentrations vary with light and temperature, and thus, vary with location in the lake, time of year, and time of day. Concentrations during a day are generally highest during daylight hours in areas of aquatic plant growth due to photosynthesis, and lowest during the dark hours. The mean value of 8.3 mg/L (table 2) for the center of the lake is representative of the dissolved oxygen concentration in most of the lake but may vary in weedy areas because of differing rates of photosynthesis. Typical DO concentrations for unpolluted waters are between 5 and 10 mg/L, with 3 to 5 mg/L accepted as a lower limit for support of fish life (Swenson and Baldwin, 1965).

Major Inorganic Ions

Water types (major constituents that comprise the bulk of dissolved solids) for several sites (locations shown in figs. 1 and 3) are represented in the diagrams in figure 8.

Bulk precipitation (rainfall plus dry fallout) at Lake Hope near Maitland (site 8) is primarily a calcium sodium bicarbonate water (Irwin and Kirkland, 1980). The type of water in the surficial aquifer near Lake Butler is variable. For example, although shallow wells at sites 3 and 4 are both located about 100 feet from the edge of Lake Butler and near citrus groves, water samples show the waters in the wells are not the same type. The well at site 4 taps highly organic material (approximately 15 feet below land surface and the well at site 3 taps a more silty layer. In water at site 3, nitrate and magnesium dominate, but at site 4 calcium and sulfate dominate. Water from wells at sites 4 and 5 are similar, with the exception of the presence of bicarbonate and nitrates at site 5. Cations are similar in proportion to each other at sites 1, 2, and 4. Sulfate is a dominant anion in all the surficial aquifer wells, with the exception of site 3, in which nitrate dominates the anions. Water from the Floridan aquifer is a calcium bicarbonate type due to the dissolution of these constituents from the limestones that compose most of the aquifer. The water type of the lake does not resemble precisely any one of the potential sources shown in figure 8, and therefore the chemical composition is likely controlled by a combination of input to the lake from several sources.

Nutrients, Metals, and Pesticides

The Florida Department of Environmental Regulation (DER) has not established any criteria but indicates in its water-quality standards that nutrient concentrations shall not "be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." (Florida Department of Environmental Regulation, 1983, Chapter 17-3.091 (20)). Phosphorus concentrations found in Lake Butler are generally less than 0.025 mg/L (25 µg/L (micrograms per liter)), below the criterion of 50 µg/L established by the U.S. Environmental Protection Agency (1976, p. 188) for eutrophication control. Analysis of samples collected in April 1981 from the north and south sites (sites 6 and 8, respectively) showed that most of the nitrogen present in Lake Butler is in the organic form, with nitrate, nitrite, and ammonia levels being low in comparison. The low levels of these latter forms of nitrogen suggest that they are being used by aquatic plants.

Dissolved trace metals in water usually occur in low concentrations, generally less than 1 mg/L (Hem, 1970, p. 179). Many are essential plant nutrients but may be toxic to plants and other aquatic life if above certain concentrations. Metals at both sampling locations were below criteria established by the Florida DER (table 3).

Pesticides in water-column samples taken at sites 6 and 8 were all below detectable limits, except for Diazinon (0.16 µg/L) at the northern site. Certain pesticides (such as chlorinated hydrocarbons) are mostly insoluble in water. These pesticides are often not detected in water but they may accumulate in bottom material.

Bottom Sediments

Bottom sediment samples at two sites (sites 6, north site; and 8, south site) collected in April 1981, were analyzed for pesticides, metals, nutrients, and major chemical constituents. Results indicated that the two sites differed in concentrations of pesticides. This difference is probably attributable to the different land uses near the sampling sites. Land use near the northern site is primarily residential, whereas that near the southern site is agricultural.

The specific pesticides found at the southern site include chlordane, PCB, DDD, and DDE (all chlorinated hydrocarbons). Chlorinated hydrocarbons are persistent in the environment, sometimes requiring 10 years or more for half of the original substance to become inert. DDT, which was banned by the U.S. Environmental Protection Agency in 1972 (Nebel, 1981, p. 382), breaks down partially into DDD and DDE. The presence of these products of DDT in the bottom sediments attests to the longevity of pesticides in the environment.

Concentrations (in micrograms per kilogram of bottom material) of pesticides found in the bottom sediment of the two samples are as follows:

Site	Chlordane	PCB	DDD	DDE
North	<1.0	<0.01	<0.01	<0.01
South	36.0	11.0	15	35

Concentrations of pesticides in the sediments at the north site were all below detection limits. The most probable sources of pesticides are runoff from citrus groves to the south of the lake and runoff from lawns to the north. To date (1983), Florida DER or U.S. Environmental Protection Agency criteria have not been established for pesticides in bottom sediments.

Biological Characteristics

Water samples from Lake Butler have been collected and analyzed for phytoplankton by the Orange County Pollution Control Department. Phylums identified include Cyanophyta (blue-green algae), Chlorophyta (green algae), and Chrysophyta (yellow-green algae). Phytoplankton are present in low density, typically less than 100 cells/mL (cells per milliliter) (Orange County Pollution Control Department, written commun., 1973-80). Chlorophyll a concentrations were usually less than 5 ug/L in the lake. This level of chlorophyll a is comparable to levels in lakes categorized as oligotrophic by Shannon and Brezonik (1972). Wanielista (1978, p. 343) refers to a lake with a level of chlorophyll a less than 10 mg/m³ (milligram per cubic meter) (ug/L) as oligotrophic.

Bacteriological analyses for Lake Butler indicated that fecal and total coliform bacteria counts were below the criteria for recreation established by the Florida DER of 200 (fecal) and 1,000 (total) colonies per 100 mL of sample (monthly average). Values for fecal coliform generally ranged from less than 10 to less than 100 colonies per 100 mL and values for total coliform ranged from less than 20 to less than 100 colonies per 100 mL, but high counts (500, 250, and 970 colonies per 100 milliliter have been recorded (Orange County Pollution Control Department, written commun., 1973-80).

Vegetation in Lake Butler is typical of a soft-water scalic lake. Emersed plant varieties within the lake include species of the following: Nymphaeaceae (watershield, yellow waterlily), Umbelliferae (water pennywort), Pontederiaceae (pickerelweed), and shoreline genera, including Typhaceae (cattails), Gramineae (grasses), Cyperaceae (sawgrass, bulrush), and Salicaceae (willows). Submersed plant varieties include Lentibulariaceae (bladderwort), Mayacaceae (bogmoss), Alismataceae (arrowhead), and Elocharis (hairgrass) (Orange County Pollution Control Department, written commun., 1980). Populations and species may vary with time.

Comparison to Lakes in North-Central Florida

Eutrophication is the enrichment of lakes by nutrients. Three basic stages are generally associated with the eutrophication process. The oligotrophic stage is characterized by high concentrations of dissolved oxygen at all depths, low concentrations of dissolved materials, and low nutrient levels. Plant and animal life are restricted by the low nutrient and dissolved material concentrations.

The mesotrophic stage is characterized by an increase in plant nutrients and dissolved materials, thus causing an increase in plant and animal population over the oligotrophic stage. Plant production is not so great that the dissolved oxygen levels are depleted.

The eutrophic stage, the last in the eutrophic process, is characterized by depletion of oxygen with depth, high concentrations of dissolved solids and plant nutrients, excessive amounts of phytoplankton, and a reduction in the number of different species of animal and plant life. Animal and plant life are restricted to species that are able to tolerate low dissolved oxygen concentrations caused by decomposition of organic matter. Fishkills result when dissolved oxygen levels drop lower than tolerance levels. Plant nutrients which contribute to a lake's decline come from various sources including animal and human wastes, and fertilizers. Thus, the natural process of the aging of lakes may be accelerated by man.

A study of 55 lakes in north-central Florida categorized the lakes into trophic-state groups according to selected water-quality characteristics (Shannon and Brezonik, 1972). Total organic nitrogen and total phosphorus concentrations in Lake Butler were between those in lakes categorized as oligotrophic and mesotrophic by Shannon and Brezonik. Other constituents concentrations indicate that Lake Butler nearly always falls into or just borders the oligotrophic category. However, specific conductance and the cation ratio (calcium plus magnesium to sodium and potassium) are more characteristic of eutrophic lakes. The Orange County Pollution Control Department (1980) indicates that the quality of the water in Lake Butler is excellent based on bacteria count, algae count, dissolved oxygen levels, diverse aquatic organism and vegetation communities, the presence of indicator organisms (intolerant to organic pollution) in bottom samples, and physical characteristics (turbidity, color) (Orange County Pollution Control Department, written commun., 1980).

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ABBREVIATIONS AND CONVERSION FACTORS

For those readers who may prefer to use metric units (SI) rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply	*By*	*To obtain*
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
acre	4,047	square meter (m^2)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows: °F=1.8(°C)+32

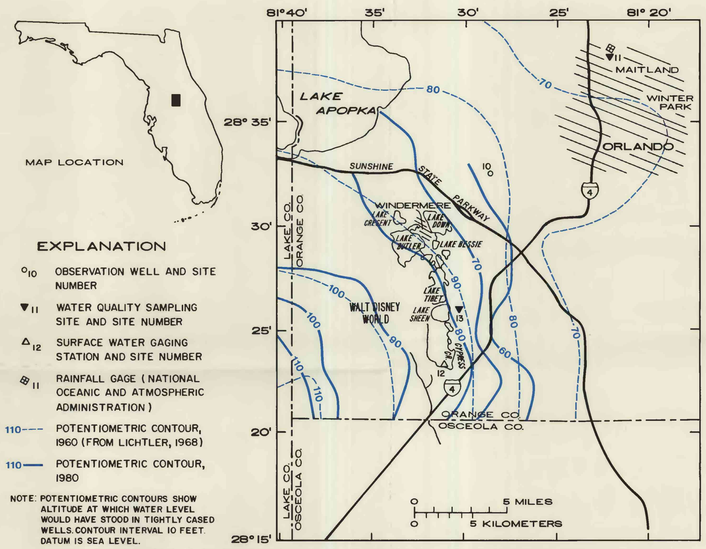

Figure 1.—Study area, location of selected data sites, and potentiometric surface of the Floridan aquifer during high (1960) and low (1980) water conditions.

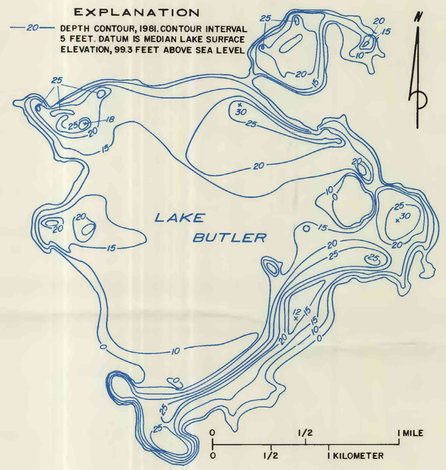

Figure 2.—Depth of Lake Butler.

Table 2.—*Summary of major ions, nutrients, metals, and physical and chemical properties for center of Lake Butler, site 7A*

[75 to 90 percent of samples collected and analyzed by Orange County Pollution Control Department; total concentrations in milligrams per liter, except as noted]

	Maximum	Minimum	Mean	No. of observations
Major inorganic ions (dissolved)				
Calcium (Ca)	12	5.6	9	84
Magnesium (Mg)	11	3.4	10	86
Sodium (Na)	17.0	11.0	14.8	87
Potassium (K)	9.0	3.9	7.6	87
Bicarbonate (HCO_3)	14.0	4.0	6.4	9
Sulfate (SO_4)	66.0	34.0	41.1	15
Chloride (Cl)	36.0	18.0	28.1	98
Nutrients				
Nitrate (NO_3-N)	.27	.00	.06	105
Nitrite (NO_2-N)	.03	.001	.01	53
Ammonia (NH_4-N)	.27	.00	.06	100
Organic nitrogen (N)	.83	.11	.36	96
Orthophosphate (P)	.08	.003	.01	66
Phosphorus (P)	.12	.009	.02	98
Trace metals				
Iron (Fe) (dissolved)	.07	.00	.05	78
Copper (Cu) (dissolved)	.05	.01	.01	71
Physical and chemical properties				
Alkalinity (as $CaCO_3$)	11	1	2	100
Hardness (as $CaCO_3$)	48	36	46	17
Specific conductance (umho/cm at 25°)	329	150	231	117
pH (units)	6.8	5.2	5.9	103
Temperature (°C)	33	9.0	23	104
Dissolved oxygen	10.9	7.0	8.3	96
Turbidity (Jackson turbidity units)	6.8	.40	2.0	23
Color (platinum cobalt units)	20	0	6	10
Secchi disk transparency (inches)	240	9.0	147	31

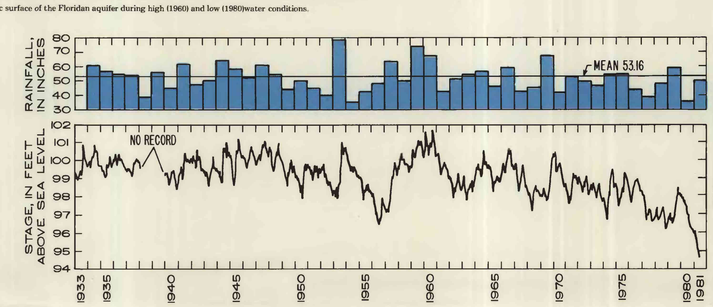

Figure 4.—Annual rainfall at Isleworth NOAA station, and stage of Lake Butler, 1933-81.

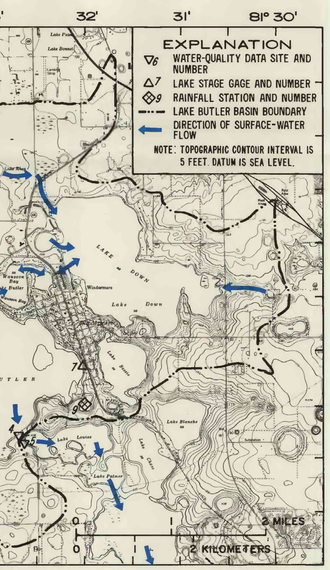

Figure 3.—Lake Butler drainage area and selected data-collection sites.

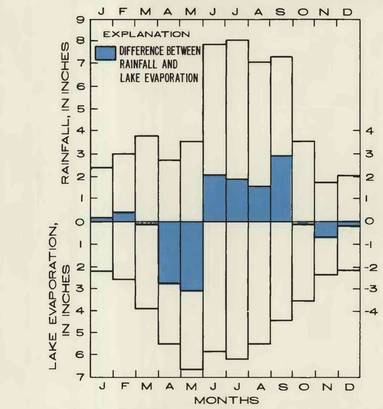

Figure 5.—Average monthly rainfall, lake evaporation, and difference for 1933-81.

Table 1.—*Data-site information*

[See figures 1 and 3 for locations]

Map No.	USGS site identification No.	Site name	Latitude	Longitude	Station type	Data type
1	282752081332301	Butler shallow well 5	282752	0813323	Surficial aquifer	Quality
2	282600081332501	Butler shallow well 6	282600	0813325	do.	Do.
3	282111081332101	Butler shallow well 4	282811	0813321	do.	Do.
4	282842081324001	Butler shallow well 3	282842	0813240	do.	Do.
5	282838081323801	Butler shallow well 7	282838	0813238	do.	Do.
6	282948081330001	Lake Butler, north	282948	0813300	Surface water	Do.
7	02263900	Lake Butler, at Windermere	[1]282926	[1]0813204	do.	Stage
7A	do.	Lake Butler, center			do.	Quality
8	282818081331401	Lake Butler, south	282818	0813314	do.	Do.
9	282900081320001	Isleworth	282900	0813200	Rainfall	Quantity
10	283253081283401	USGS observation well OR47	283253	0812834	Floridan aquifer	Water level
11	283824081221502	Lake Hope nr. Maitland	283824	0812215	Rainfall	Quality
12	02264000	Cypress Creek at Vineland	282325	0813111	Surface water	Discharge
13	282556081302402	82513002 24528EO3	282556	0813024	Floridan aquifer well	Quality

[1]Latitude and longitude are included for the lake stage site but not for the water-quality site.

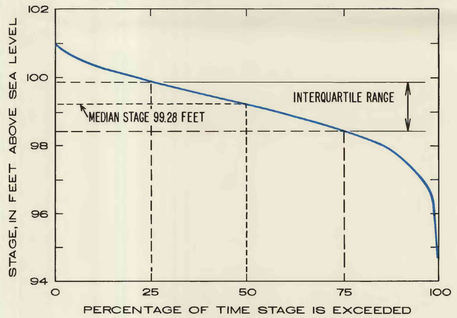

Figure 6.—Stage-exceedance curve for Lake Butler.

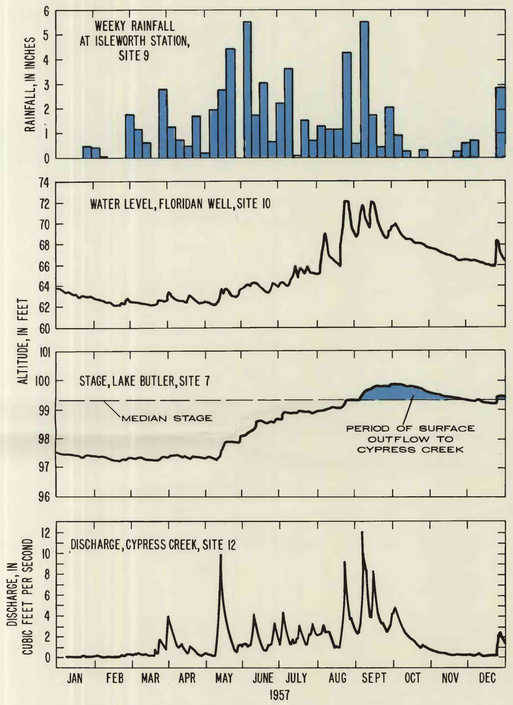

Figure 7.—Hydrographs, calendar year 1957, of weekly rainfall, in inches, at Isleworth station; daily water level in a well tapping the Floridan aquifer; daily stage, Lake Butler; and daily discharge, Cypress Creek.

Table 3.—*Concentrations of metals at two sampling locations in Lake Butler, and Florida Department of Environmental Regulation criteria for Class III waters (except where noted)*

[Concentrations in micrograms per liter]

Constituent	Florida DER criterion	North, site 6 (282948081330001)	South, site 8 (282818081331401)
Barium (Ba)	[1]1,000	100	100
Cadmium (Cd)	0.8	0	0
Chromium (Cr)	50	30	10
Copper (Cu)	30	0	0
Iron (Fe)	1,000	140	60
Lead (Pb)	30	4	4
Manganese (Mn)	[2]100	10	10
Silver (Ag)	0.07	0	0
Zinc (Zn)	30	10	20

[1]From criteria for Class I-A waters.
[2]From criteria for Class II waters.

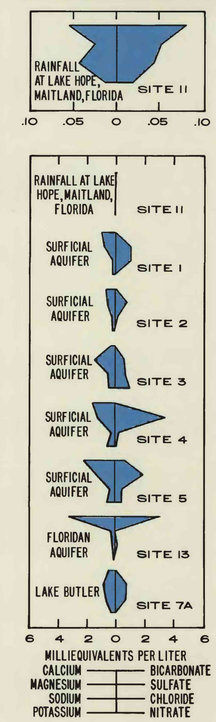

Figure 8.—Major dissolved constituents in water from selected sites and in rainfall.

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By
James L. Smoot and Donna M. Schiffer

1985