MAP SERIES NO. 65

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FLORIDA DEPARTMENT OF NATURAL RESOURCES
published by BUREAU OF GEOLOGY

THE OBSERVATION-WELL NETWORK OF THE U. S. GEOLOGICAL SURVEY IN FLORIDA

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Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with
FLORIDA DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY
Tallahassee
1974

DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY

This pubic document was promulgated at a total cost of $430.00 or a per copy cost of $.29 for the purpose of disseminating hydrologic data.

INTRODUCTION

An observation-well network has been established throughout Florida to evaluate the status of ground-water resources in each aquifer. The network provides basic documentation of the effects of natural variations and the effect of man on the ground-water resource. The network also provides the data by which the potential of the ground-water resources can be determined. The observation-well network is part of the statewide hydrologic monitoring network used to evaluate the total water resources of the State. (This hydrologic network has been described by Conover and others, 1965.)

The purpose of this water atlas is to acquaint the reader with the overall operation and extent of the observation-well network in Florida, the distribution of wells, and the frequencies and types of observation as a means of demonstrating the systematic approach used by the U.S. Geological Survey in cooperation with State, local, water-management districts, and other Federal agencies in evaluating and appraising the ground-water resources of the State.

Management of the network is dynamic: the network is constantly being revised in response to the varying needs brought about by water-resource problems and application of new hydrologic techniques. The statewide network began in 1930 when the 1929 State Legislature enacted a law, applicable to the Gulf-bordering Counties of Sarasota, Manatee, and Charlotte regulating the drilling and operation of wells and the conservation of ground water. To administer the new law successfully, acquisition of more information relating to the availability of ground water of that region, as well as other sections of the State where ground-water problems existed, proved necessary. As a result, in 1930 the State Geologist of Florida arranged for a cooperative program with the U.S. Geological Survey to make water-level measurements in selected wells in Sarasota County and in the Jacksonville area where ground-water data were badly needed.

From the modest beginning of the observation-well network in Sarasota and Duval Counties, the water-level measurement program was, by 1935, extended into Manatee, Orange, Duval, Pinellas, Seminole, Hillsborough, and Charlotte Counties because of the urgent need for information on the potential of the ground-water reservoirs, or aquifers, in those counties. By 1939, the U.S. Geological Survey had set up observation-well networks in southeast and northwest Florida and in other areas in west-central Florida. The network was gradually expanded as ground-water problems became more acute; by January 1974, the network consisted of 1,211 observation wells. In addition, a large number of observation wells are measured to collect hydrologic and water quality information as part of the water-resources project investigations in Florida.

The purpose of the program is to systematically acquire hydrologic data on representative wells in an area. Data from these wells are used to determine the hydrologic characteristics of the aquifer, the cause and effect relations of fluctuations that occur, and the trends of water levels in the aquifer. The observation-well program must have as its basis therefore the selection of those wells that are representative of the many wells in any given area. Commonly, in an area in which there may be as many as several tens of wells tapping a given aquifer, information from ten wells or less, all carefully selected for measurement, will supply most of the information needed to evaluate the aquifer's response to hydrologic stress (Healy, 1964).

By analyzing the data from a limited number of observation wells in an area, the ground-water regimen for that area can become known, and the network then becomes an important part of the overall hydrologic investigation of the area. For example, with other hydrologic parameters, the network can be used to: (1) show the rate and direction of ground water movement; (2) define the past, present, and future trends of water levels in aquifers; (3) estimate or forecast the base flow of streams and the relation between streamflow and ground-water levels; (4) indicate where water levels are near land surface and water logging may occur; (5) show where levels are declining toward optimum limits of economic lift or impairment of water of good quality; (6) provide data for evaluating the effectiveness of land-management and water-conservation programs; (7) provide records to show the effects of natural and man-induced forces that act on an aquifer; and (8) furnish data for use in basic research.

FUNDING OF THE PROGRAM

The observation-well program in the State of Florida is supported in part by local Florida governmental agencies and by various state and federal agencies.

As of January 1974, the network was maintained and operated by the U.S. Geological Survey in cooperation with the Florida Bureau of Geology, the Central and Southern Florida Flood Control District, the Southwest Florida Water Management District and other state and Federal agencies, counties and municipalities (table 1).

DISTRIBUTION OF WELLS

The distribution of wells used in the ground-water monitoring network as of January 1974 is shown on the map. A major factor affecting the distribution of observation wells in a given area is the extent to which ground-water pumping is heavy because of the increasing demand by municipalities, industries, and agriculture. Indirectly, demographic factors also control the distribution of observation wells. For example, because much of the southern coastal areas contain a large segment of the State's population, these areas exhibit an attendant increased use of water. Also, industrial demand for water tends to concentrate in specific areas where an abundant supply of raw materials exist. An example of this is central Polk County where phosphate mining is prevalent.

Observation wells are needed in areas where actual or potential critical water problems have developed or may develop. The tendency of both people and industry to cluster produces a decidedly non-uniform distribution of water development. This situation is most likely to cause such problems as water shortages or deterioration in water quality such as salt-water intrusion. The more critical the problem the more detailed must be the field data used to delineate and interpret the problem. Thus, more observation wells are required to provide these data in problem areas than in areas where comparatively little water development has taken place. Major problem areas and potential problem areas of major water use and development include most of southeast coastal Florida from Palm Beach County to and including most of Dade County; the Tampa-St. Petersburg area in Pinellas, Hillsborough and Pasco Counties; DeSoto, Hardee, and Polk Counties in south-central peninsular Florida; the Orlando area in Orange County; Collier, Lee, Sarasota, and Manatee Counties; and the Fernandina-Jacksonville area in Nassau and Duval Counties. Observation wells in the network are concentrated in these problem areas.

Thirteen counties each with 20 or more observation wells have 64 percent of the total number of wells in the network. The number of wells in individual counties range from one well each in Bradford, Columbia, Gulf, Hamilton, and Manatee Counties to 267 wells in Dade County.

The numbers of wells tapping the principal aquifer in the state are listed in Table 1. The Floridan aquifer underlies most of the State and is the principal source of water for municipal, industrial, and agricultural use (see fig. 1). Other aquifers include: the Biscayne aquifer which underlies about 3,500 square miles in Dade, Broward, and Palm Beach Counties; the shallow-sand aquifer and others which underlie part of the southwest coast, south-central Florida and the eastern coast of Florida from Martin County into St. Johns County; and the sand-and- gravel aquifer which underlies 2,000 square miles in Escambia, Santa Rosa, and part of Walton Counties.

TYPES OF DATA COLLECTED

Water-level measurements are made on a continuous or periodic basis. The frequency of measurement is determined primarily by the use of the record. Measurements are made over a period of time to delineate trends and fluctuations caused by man or by nature. Some of the events that can cause short-term fluctuations in level are: precipitation, earthquakes, barometric pressure changes, earth tides, pumping or recharging activities, and evapotranspiration. Long-term fluctuations or trends of ground-water level are caused by seasonal and gradual climatic change and continual pumping. Generally, such changes affect the aquifer over a large area.

Periodic measurements are primarily used to determine seasonal, annual, and long-term trends in water-level fluctuation. Types of periodic measurements include annual, semiannual, quarterly, bimonthly, monthly, weekly, daily, and intermittent or irregular (table 1).

Annual measurements are used to identify year-to-year changes; semiannual measurements depict seasonal highs and lows; bimonthly measurements show seasonal trends; monthly and weekly measurements reveal month-to-month trends in water levels. Knowledge of trends is of great importance, for example, to city water superintendents, as a guide in setting up pumping schedules involving several separate well fields.

In addition to the water-level monitoring network, an extensive quality-of-ground-water network is maintained by the U.S. Geological Survey in Florida. Water samples were being collected for chemical analyses from 509 wells in 34 counties as of January 1974 (table 1). The type of analysis is dependent upon the purpose for which the analysis will be used.

The chemical-quality monitoring of ground-water is used to: (1) establish a base for chemical characteristics of waters or to type the water in each aquifer and area; (2) signal by changes in composition the movement of salt water into an aquifer with subsequent deterioration in quality; (3) detect the presence of man-made pollutants; and (4) monitor short and long-term changes in water quality.

The chemical constituents of water usually analyzed are: silica, calcium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, fluoride, nitrate, nitrite, hardness, noncarbonate hardness, alkalinity, strontium, specific conductance, dissolved solids, temperature, color, and pH. Under special circumstances, analyses may include: phosphate, boron, aluminum, iron, manganese, copper, lead, zinc, bromide, iodide, organic compounds, insecticides, herbicides, and radiochemicals.

Frequencies of sampling of wells for chemical analyses are similar to those of measuring water levels (table 1). Sampling frequencies range from annual to continuous. Chemical analyses range in detail from complete analyses annually, to partial analyses in which only one or a few constituents such as chloride and specific conductance are determined. The temperature of water from wells in some areas is also measured and recorded. Continuous analyses are made by recorders that automatically analyze and record several chemical constituents simultaneously.

AVAILABILITY OF THE RECORDS

All records obtained from the observation well-program in Florida since the inception of the program in 1930, are available to the public. Measurements made in 1930-31 in Sarasota County were published in the Florida State Geological Survey's Twenty-third and Twenty-fourth Annual Reports, in 1933. Measurements made in 1930-34 in other parts of Florida were published in U.S. Geological Survey Water-Supply Paper 773-C. Records of water levels in wells in the statewide data-collection network, including records for 1933-36, were first published in Water-Supply Paper 817.

As of January 1974 records of water level in selected wells in Florida were available in Water-Supply Papers for 1933-68 and in Florida Bureau of Geology Information Circulars for 1960-70. Table 2 lists the serial numbers of both publications for each of the given years of record. The Water-Supply Papers containing these records are entitled, "Ground- Water Levels in the United States," in 6 parts by geographical sections of the county. Records for wells in Florida are in "Part 2, Southeastern States." Parts were not designated before 1940. Formerly an annual series, the current publication program provides for 5 years of record in one volume for each geographical section. The calendar years 1956 to 1960 span a transition period whereby 4 of the volumes do not contain 5 years of record. Each Information Circular of the Florida Bureau of Geology contains 2 years of record, as shown in Table 2. These reports are entitled, "Water Levels in Artesian and Nonartesian Aquifers in Florida." Records generally duplicate those published in the Water-Supply Papers.

In addition to this published material, a list of water levels in selected wells in Florida is compiled monthly, in duplicated form. Copies of these lists, as well as data collected as part of project investigations, are available from the District Chief, U.S. Geological Survey, 325 John Knox Rd., F-240, Tallahassee, Florida 32303.

SELECTED REFERENCES

Conover, C.S.
1965 (McKichan, K.A., and Pride,R.W.) *The water mapping, monitoring and research program in Florida*: State Board of Conserv., Florida Geol. Survey, Spec. Pub. 13.

Healy, H.G.
1964 *Two-variable linear correlation analyses of water-level fluctuations in artesian wells in Florida:* Research, U.S. Geol. Survey Prof. Paper 501-D, p. D199-D202.

Pride, R.W.
1973 *Estimated water use in Florida:* Florida Dept. Nat. Resources, Bur. Geol. Inf. Circ. 82.

Table 1.–Frequency of measurement and sampling source, aquifer, and ownership of observation wells.

WATER LEVELS		SAMPLING FOR CHEMICAL ANALYSIS		AQUIFER		OWNERSHIP	
Frequency	Number of wells	Frequency	Number of wells	Name	Number of wells	Category	Number of wells
Continuous	261	Continuous	3	Floridan	551	U.S.G.S.	582
Annual	176	Annual	83	Biscayne	366	Privately owned	257
Semi-annual	302	Semi-annual	252	Sand & gravel	13	Municipalities	180
Bi-monthly	288	Bimonthly	63	Nonartesian	167	Corporations & Companies	88
Other (includes weekly, quarterly, intermittently, monthly, daily)	184	Other (includes quarterly, monthly, intermittently)	108	Other (includes Caloosahatchee, Citronelle, Hawthorn, Hawthorn-Tampa, Tamiami	114	State & Gov't Agencies	54
						County	43

Table 2.–Serial numbers of publications of the U.S. Geological Survey and the Florida Bureau of Geology containing records of water level in selected wells in Florida for each year, 1933-70 (WSP, U.S. Geological Survey Water Supply Paper; IC, Florida Bureau of Geology Information Circular).

Year	Number WSP	Number IC	Year	Number WSP	Number IC	Year	Number WSP	Number IC
1933-1936	*777	–	1947	1097	–	1959	1803	–
1937	817	–	1948	1127	–	1960	1803	33
1938	840	–	1949	1157	–	1961	1803	48
1939	845	–	1950	1166	–	1962	1803	48
1940	886	–	1951	1192	–	1963	1803	52
1941	907	–	1952	1222	–	1964	1978	52
1942	937	–	1953	1266	–	1965	1978	61
1943	945	–	1954	1322	–	1966	1978	61
1944	987	–	1955	1405	–	1967	1978	68
1945	1017	–	1956	1538	–	1968	1978	68
1946	1024	–	1957	1538	–	1969	–	73
	1072	–	1958	1538	–	1970	–	73

*A brief description of projects and availability of measurements before 1936 is given on p. 40-42 of WSP 777.

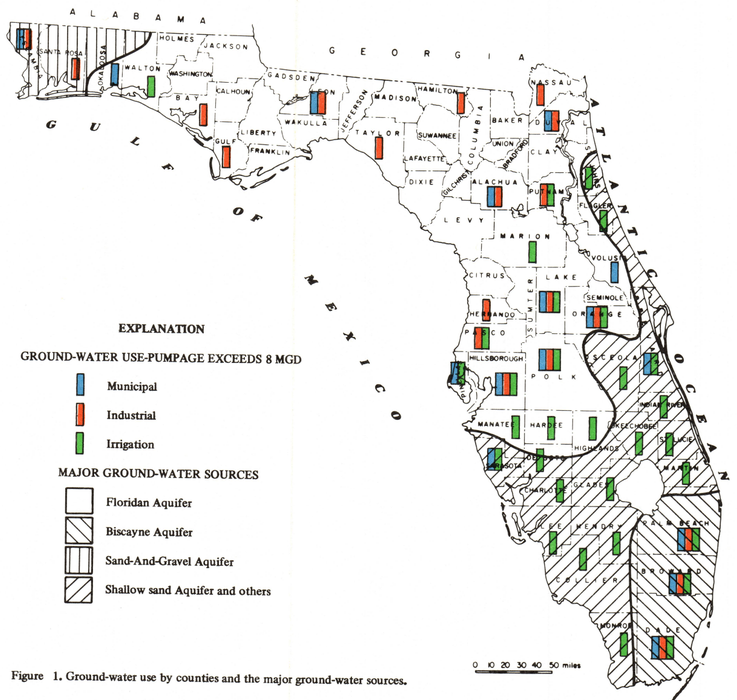

Figure 1. Ground-water use by counties and the major ground-water sources.