MAP SERIES NO. 149

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
published by FLORIDA GEOLOGICAL SURVEY

Potentiometric Surface of the Upper Floridan Aquifer in Florida, May 2000

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Prepared by the
U.S. GEOLOGICAL SURVEY
in cooperation with the
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
Tallahassee, Florida
2004
ISSN 0085-0624

INTRODUCTION

This report is the seventh in a series of map reports describing the potentiometric surface of the Floridan aquifer system in Florida (Healy, 1962, 1975, 1982; Barr, 1987, 1992; Mahon and others, 1997), but it differs from these earlier reports, because it emphasizes the highly permeable Upper Floridan aquifer. Data were collected as part of a continuing program that monitors ground-water resources in Florida in cooperation with the Florida Department of Environmental Protection, the state water management districts, and local government agencies. Many of the general hydrologic conditions associated with water levels and flow in the Floridan aquifer system were previously described by Miller (1986 and 1990).

This report illustrates and describes the potentiometric surface of the Upper Floridan aquifer based on water levels from more than 1,200 wells measured in May 2000 (mostly in Florida). Discussions regarding water levels or water-level changes in 2000 refer to those measured in May 2000; similarly, 1995 water levels refer to May and June 1995. The potentiometric surface is a spatial representation of the levels in which water would rise in tightly cased wells open to the Upper Floridan aquifer. The potentiometric surface was developed from the altitude of water levels in the wells and is represented on maps by contours that connect points of equal altitude above mean sea level. To depict the dynamic condition of the aquifer, this report includes a map of changes in water levels between 1995 and 2000 (fig. 1) and hydrographs from five wells across the State with long-term records (fig. 2).

UPPER FLORIDAN AQUIFER

The Floridan aquifer system is a thick, hydraulically connected sequence of limestone and dolomite of Tertiary age that is present in the subsurface and at land surface throughout Florida and in parts of southern Alabama, Georgia, and South Carolina (Miller, 1986, 1990). Although the system varies laterally and vertically in permeability throughout Florida, it is subdivided vertically into the Upper and Lower Floridan aquifers that are separated by the less permeable middle confining and semiconfining units. Miller (1986) based the subdivision of the system on permeability contrasts between the units and reported that the contact between adjacent units may or may not coincide with formation boundaries or time-stratigraphic breaks.

The Upper Floridan aquifer is confined or poorly confined beneath most of the State, but is unconfined and crops out in about a 50-mile-wide band from Hillsborough to Wakulla County and in an area south of the southeastern corner of Alabama in parts of Holmes, Jackson, and Washington Counties (from Miller, 1990, fig. 55). As shown in previously published maps by Miller (1986), the altitude of the top of the Upper Floridan aquifer in north-eastern Florida ranges from less than 100 feet below sea level to more than 500 feet below sea level. In the extreme northwestern part of the State (Escambia and Santa Rosa Counties), the top of the Upper Floridan aquifer dips steeply from an altitude of 100 feet above sea level to more than 1,800 feet below sea level. In an area along the Gulf Coast and in peninsular Florida between latitudes 28° N and 30° N, it occurs at an altitude near or slightly above sea level; south of latitude 28° N, it dips southward and decreases from near sea level to more than 1,200 feet below sea level.

Various environments of deposition, karst development, and other geologic processes have resulted in large variations in Upper Floridan aquifer thickness (Miller, 1986, pl. 28). Thickness in the Florida Panhandle ranges from less than 100 feet in northern Escambia County near the updip limit of the aquifer, to greater than 2,300 feet in southern Wakulla County. Thickness in peninsular Florida ranges from less than 100 feet in eastern Collier and southeastern Hendry Counties to greater than 1,900 feet in northwestern Marion County. Thicknesses greater than 1,400 feet occur in southern Manatee, northern Sarasota, and western Lee Counties.

POTENTIOMETRIC SURFACE

Data used to construct the May 2000 map of the potentiometric surface were obtained from published reports (Baker and others, 2000; Duerr, 2001; Knowles, 2001) and from the ground-water database of the Suwannee River Water Management District (Ron Ceryak, written commun., 2001). Potentiometric contours on the large map may differ slightly from these documents due to the availability of more recent data as well as differences in data interpretation near water management district boundaries. In Escambia and northwestern Santa Rosa Counties and for the area generally south of latitude 27° N, no interpretation was made because of the lack of water-level data from wells open only to the Upper Floridan aquifer. Interpretations of the potentiometric surface in reports prior to this map series for this area used water-level measurements that are now considered to represent composite heads of the Upper Floridan aquifer and overlying aquifer systems.

Water levels in the Upper Floridan aquifer are influenced by precipitation, recharge rates, hydraulic characteristics of the aquifer and confining units, and by large annual ground-water withdrawals. Depressions in the potentiometric surface, which occur in response to ground-water withdrawals, continue to exist below sea level in large coastal areas ranging from Santa Rosa to Gulf County, and in parts of Hillsborough, Manatee, and Sarasota Counties. Depressions in smaller areas are readily discernible in numerous counties. An estimated 4,020 million gallons per day (Mgal/d) was withdrawn from the Floridan aquifer system in Alabama, Florida, Georgia, and South Carolina during 2000 (Marella and Berndt, 2005) with Florida accounting for 78 percent (3,125 Mgal/d) of the total. More than 90 percent of the water withdrawn in Florida from the Floridan aquifer system is obtained from the Upper Floridan aquifer (Sepulveda, 2002).

Potentiometric-surface maps of the Upper Floridan aquifer for May-June 1995 and May 2000 were compared to determine net changes in head throughout Florida. Net water-level declines in wells are chiefly the result of (1) decreased recharge caused by below normal rainfall between 1995 and 2000, and (2) increased ground-water withdrawals caused by below normal rainfall during 2000, in addition to an increase in demand due to population growth and tourism between 1995 and 2000. Changes in head between the maps were calculated by computer techniques to determine head differences at well locations and at the intersection of drawn potentiometric-surface contour lines. Although small to moderate changes (declines of less than 10 feet) may have occurred in most of the State, three areas reflect more than 10 feet of change between 1995 and 2000. These areas are located in or around Okaloosa, Leon, and Hardee Counties (fig. 1). Although additional areas greater than 10 feet of change occurred, they are not presented on the map because (1) they were localized and, therefore, are not required to be identified on a regional scale; (2) uncertainties resulted from interpolations made during construction of the potentiometric-surface maps; (3) gaps existed in the well network on one or both of the maps; and (4) inconsistency existed in the wells selected for measurement and map construction between 1995 and 2000.

A large depression in the potentiometric surface is centered in southern Okaloosa County and extends into southeastern Santa Rosa County and a small part of central Walton County where heads declined more than 10 feet between 1995 and 2000 (fig. 1). This decrease in water levels is a result of increased ground-water withdrawals and below normal rainfall during the spring of 2000. The long-term trend of the Upper Floridan aquifer as shown in figure 2A indicates that water levels have been declining in southern Okaloosa County since the early 1950's. Ground-water withdrawals increased from 11 Mgal/d to 32 Mgal/d between 1965 and 2000 (Marella, 2004). Nearly all withdrawals in Okaloosa County are obtained from the Upper Floridan aquifer, mostly in the southern part of the county. In addition, public-supply withdrawals in May 2000 were 5.5 Mgal/d greater than May 1995, primarily a result of an increase in lawn irrigation caused by below normal rainfall during April and May of 2000. Rainfall at the Niceville weather station for April and May of 2000 totaled 2.5 inches, more than 5.1 inches below normal (National Oceanic and Atmospheric Administration, 2001).

Net water-level declines greater than 10 feet have also occurred in relatively large parts of Leon and parts of Gadsden and Jefferson Counties (fig. 1). These declines are similarly attributed to increased ground-water withdrawals and below normal rainfall between 1995 and 2000, as well as an accumulative rainfall deficit for the 12-month period between June 1999 and May 2000. Between July 1995 and June 2000, accumulative rainfall at the Tallahassee weather station totaled more than 60 inches below normal, and for the 12-month period between June 1999 and May 2000, rainfall totaled 41 inches, more than 24 inches below normal (National Oceanic and Atmospheric Administration, 2000 and 2001). Between January and May of 2000, rainfall totaled 8.4 inches at the Tallahassee station, more than 16 inches below normal (National Oceanic and Atmospheric Administration, 2001). Tallahassee's public water-supply system recorded their highest monthly water usage in June 1998 and May 2000 (1,380 and 1,330 million gallons, respectively); nearby Lake Jackson went dry during September of 1999 and remained dry throughout all of 2000 *(http://www.dep.state.fl.us/geology/programssections/jacksonsink.htm)*.

Net water-level declines greater than 10 feet also occurred between 1995 and 2000 in Hardee County and extended into parts of Hillsborough, Manatee, and Polk Counties (fig. 1). Most of the decrease is a result of higher than normal water withdrawals caused by below normal rainfall during the spring of 2000. Ground-water withdrawals for irrigation in Hardee, Hillsborough, Manatee, and Polk Counties increased by 165 Mgal/d between 1995 and 2000 (Marella, 2004) even though irrigated acreage in these counties remained nearly unchanged between 1995 and 2000. Rainfall for the months of March, April, and May of 2000 recorded at the Wauchula weather station (Hardee County) totaled 2.25 inches, which was 7 inches below normal (National Oceanic and Atmospheric Administration, 2001). During a 53-day span April 17 to June 8, 2000, no rainfall was recorded at the Wauchula station. In Hardee County, about 90 percent of the water withdrawn for irrigation is obtained from the Upper Floridan aquifer (Sepulveda, 2002). The effects of seasonal withdrawals can be seen in the ROMP 60 observation well data (fig. 2E) when water-levels dropped dramatically during the spring months as irrigation peaked, then recovered to near normal levels as irrigation decreased and rainfall increased. This seasonal pattern has occurred in this well since the early 1960's.

For all five hydrographs, water levels for 2000 are lower than those 40 to 50 years earlier. In some cases (figs. 2D and 2E), water levels have remained stable or even recovered somewhat over the past 10 to 20 years; in other cases (figs. 2A, 2B, and 2C) water levels continue to decline. Alternative water sources (including the Lower Floridan aquifer) are being developed due to a steady increase of withdrawals from of the Upper Floridan aquifer.

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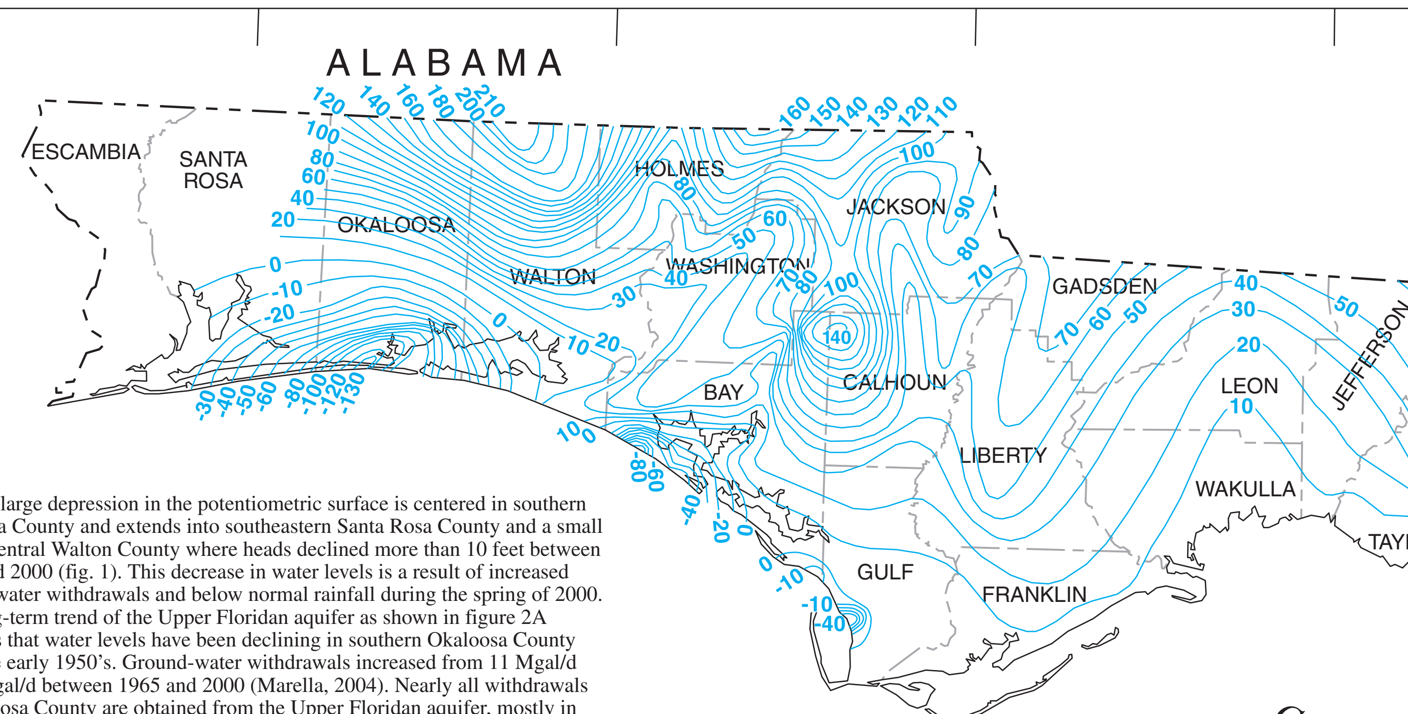
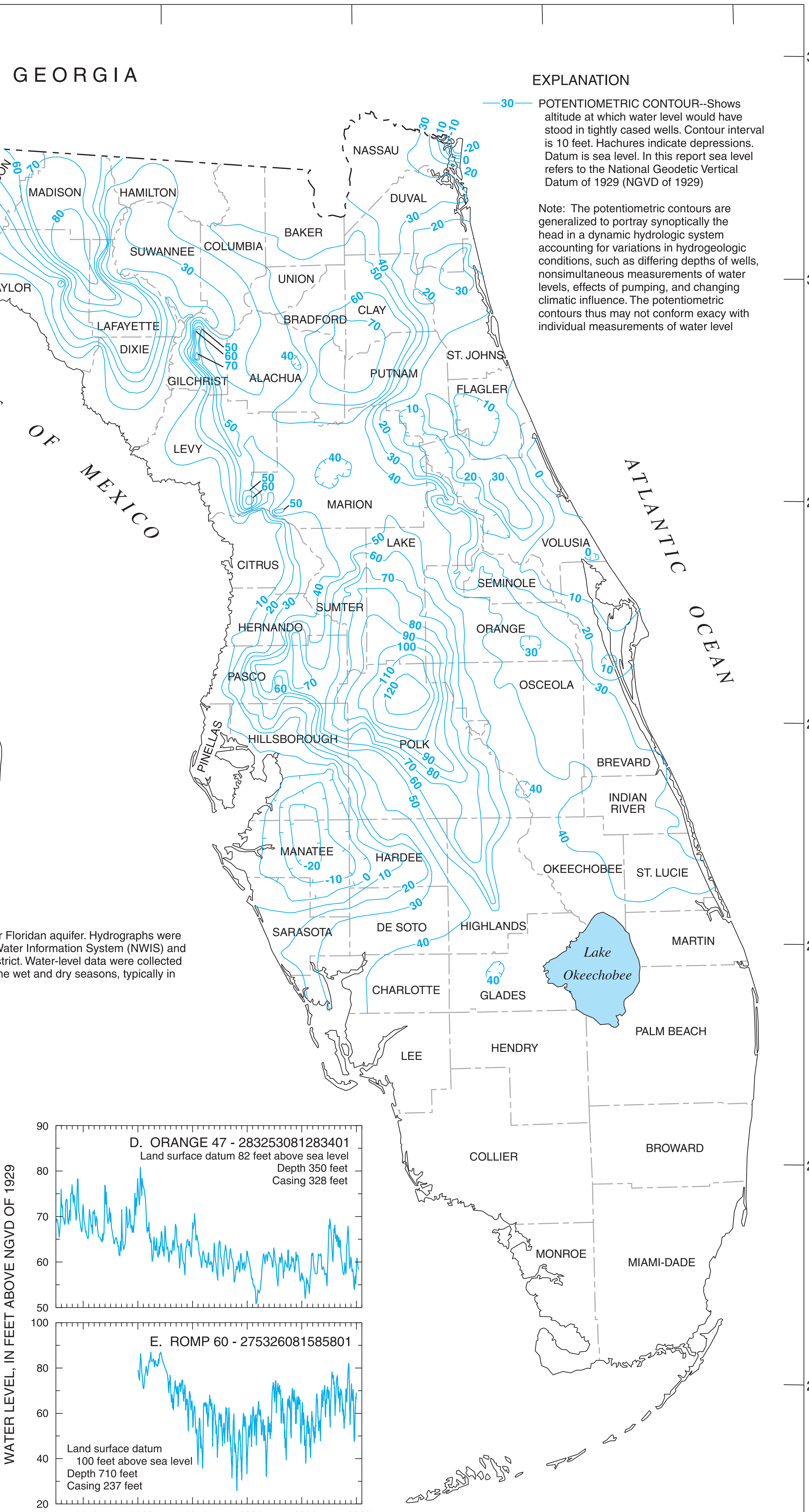

EXPLANATION

30 POTENTIOMETRIC CONTOUR--Shows altitude at which water level would have stood in tightly cased wells. Contour interval is 10 feet. Hachures indicate depressions. Datum is sea level. In this report sea level refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)

Note: The potentiometric contours are generalized to portray synoptically the head in a dynamic hydrologic system accounting for variations in hydrogeologic conditions, such as differing depths of wells, nonsimultaneous measurements of water levels, effects of pumping, and changing climatic influence. The potentiometric contours thus may not conform exacy with individual measurements of water level

Figure 1 – Generalized net change in the potentiometric surface of the Upper Floridan aquifer between May/June 1995 and May 2000.

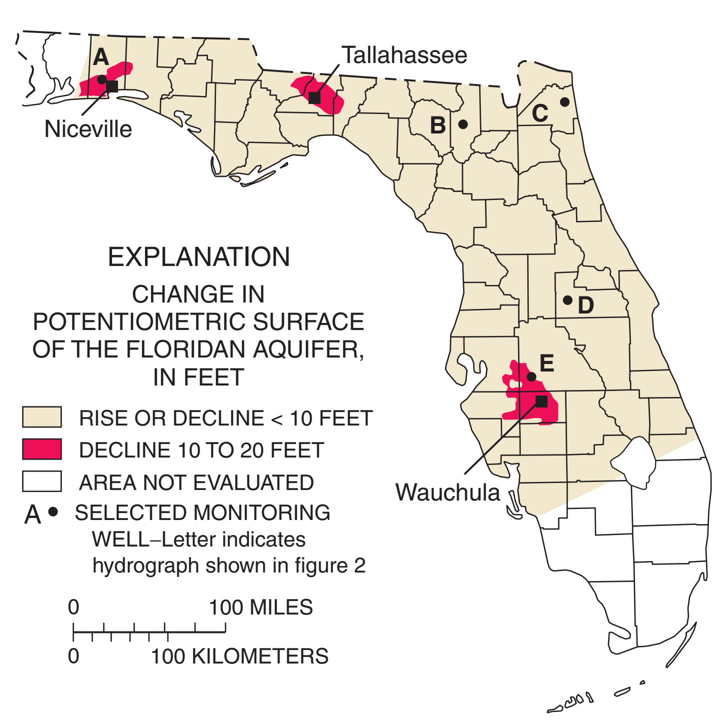

Figure 2 – Fluctuations of ground-water levels in selected wells in the Upper Floridan aquifer. Hydrographs were constructed using available data from the U.S. Geological Survey National Water Information System (NWIS) and the ground-water database of the Northwest Florida Water Management District. Water-level data were collected and plotted as monthly means and miscellaneous measurements made in the wet and dry seasons, typically in May and September. General location of well is shown in figure 1.