The Floridan aquifer is the principal source of potable water for Duval County, Fla. In this area the aquifer is under artesian conditions, which means that water in the aquifer is confined under pressure and the water level in wells that penetrate the aquifer stands above the top of the aquifer. The level to which water will rise in a tightly cased well penetrating the aquifer represents an imaginary surface called the potentiometric surface. The potentiometric surface fluctuates in response to gains and losses of water to and from the aquifer. For example, if recharge exceeds discharge, the potentiometric surface rises. If discharge exceeds recharge, the potentiometric surface declines.

The principal method of discharge from the Floridan aquifer in Duval County is by hundreds of municipal, industrial, and privately owned wells which have been drilled into the aquifer to obtain water. As a result of population growth and industrial expansion, additional wells are drilled into the aquifer each year and thus discharge of water from the aquifer has steadily increased to meet increased demands. For example, Jacksonville municipal pumpage records show an increase from 10.9 Mgal/d (million gallons per day) in 1930 to 55.3 Mgal/d in 1977. Water-use data compiled by the U.S. Geological Survey show total withdrawals from the aquifer in Duval County exceeded 150 Mgal/d in 1977.

The amount of water withdrawn from the aquifer is constantly changing to meet the demands of the population and industry. Continuous records maintained by the City of Jacksonville of pumpage of municipal water show hourly, weekly, and seasonal variations in withdrawal because of variations in demand. For example, water use varies considerably because of seasonal changes in rainfall and temperature. More water is used for irrigation, cooling, swimming pools, and domestic consumption during warm, dry periods than during cool, wet periods.

A comparison of the graphs in figure 1 shows the relation between municipal pumpage and rainfall at Jacksonville, and the water level in a well at Jacksonville during 1977. The water level was highest during the winter months when pumpage was at a minimum. The water level declined during the spring and early summer months in response to increased pumpage and lower monthly rainfall. It then rose during late summer and fall in response to higher rainfall and decreased pumpage. The seasonal variation of water level in this well during 1977 was about 4.2 feet.

In addition to seasonal variations of water level there has been a long-term decline in the potentiometric surface throughout Duval County. This decline is attributed primarily to the large increase in withdrawal from the aquifer and, to a lesser extent, to a long-term decline in average annual rainfall in the recharge areas. Recharge occurs primarily in areas where the aquifer is at or near the surface or is hydraulically connected to shallow aquifers or to lakes and streams. During periods of high rainfall, recharge to the aquifer increases and the potentiometric surface rises. Reduced pumpage during periods of high rainfall also causes the potentiometric surface to rise. Conversely, during periods of low rainfall the aquifer receives less recharge and the potentiometric surface declines. The lack of rainfall also causes pumpage to increase, which further lowers the potentiometric surface. For this reason it is difficult to separate the effect of rainfall from the effect of withdrawals on the potentiometric surface.

A comparison of the graphs in figure 2 shows the relation between municipal pumpage and rainfall at Jacksonville, and water levels in wells from 1960 to 1977. Jacksonville municipal pumpage increased from 34.8 Mgal/d in 1960 to 55.3 Mgal/d in 1977. Part of the increase after 1970 was due to the addition of privately-owned water utilities to the municipal system. Although most of these small utilities were in existence before 1970, the pumpage was not included in the municipal pumpage records.

The graphs in figure 2 show a general decline of about 8 feet in the water levels since 1960. The greatest decline occurred during periods of below average rainfall. The water levels rose during periods when pumpage remained about constant and rainfall was above normal. The water level graphs also show that during some years the seasonal variation was greater than the 18-year trend. For example, in well D-115, the seasonal variation during 1960 and 1962 was about 8.5 feet, one foot greater than the 18-year decline of water level in that well.

The decline of water levels in wells in the Floridan aquifer is reflected by the potentiometric surface. Figure 3 shows the potentiometric surface of the Floridan aquifer in Duval County during January–February 1960 (modified from Leve, 1961, fig. 5) and in May 1977 (Laughlin and Hayes, 1977) and a profile of the potentiometric surface through the county, along section A-A′ for both times. The potentiometric map and the profiles show a general decline in the potentiometric surface during the 18-year period. The greatest decline was in the south-central part of the county where large ground-water withdrawals caused a depression in the potentiometric surface. Declines within the depression ranged from about 10 feet near the edge to more than 20 feet in the center. The size of the depression has increased with time, particularly on the western side. In the western part of the county, the potentiometric surface declined less than 5 feet.

The 1960 potentiometric map was constructed from measurements made in January and February during seasonal high water levels, and the 1977 map was made from measurements made in May during seasonal low water levels. Thus, the potentiometric map and the profiles show extreme conditions and the decline would have been much less had the data been collected during the same season.

Figure 4 shows the areal distribution of water-level changes throughout Duval County. The smallest decline was in the western part of the county, away from areas of heavy withdrawals from the aquifer. The greatest decline was within and adjacent to the depression in the potentiometric surface, particularly on the western flank of the depressed area where the hydraulic gradient into the area has expanded and has been lowered by increased withdrawals. The decline in the northeastern part of the county reflects the expansion of a very deep depression in the potentiometric surface centered about 20 miles north of Jacksonville at Fernandina Beach. The decline is caused by withdrawals from the aquifer by industrial wells. Other declines along the coast reflect increased withdrawals by municipal wells at Jacksonville Beach and Atlantic Beach.

REFERENCES

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Leve, G.W., 1961, Preliminary investigation of the ground-water resources of northeast Florida: Florida Geological Survey Information Circular No. 27, 28 p.

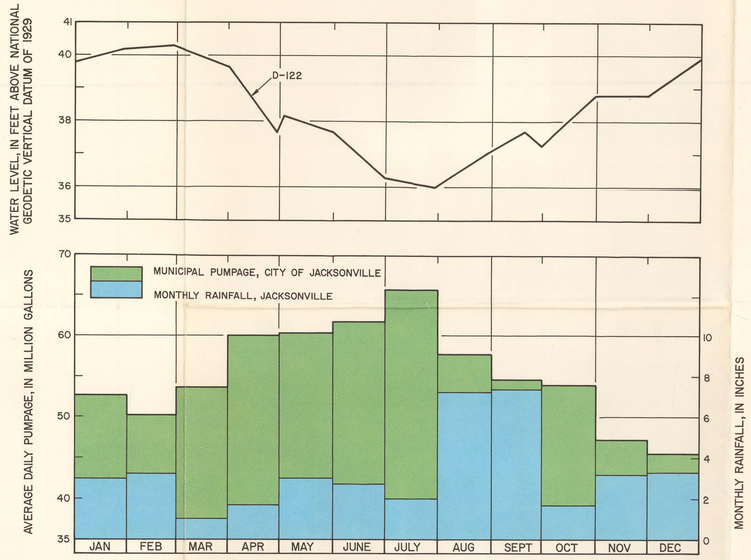

Figure 1.—Water level in well D-122, municipal pumpage, and monthly rainfall at Jacksonville, 1977.

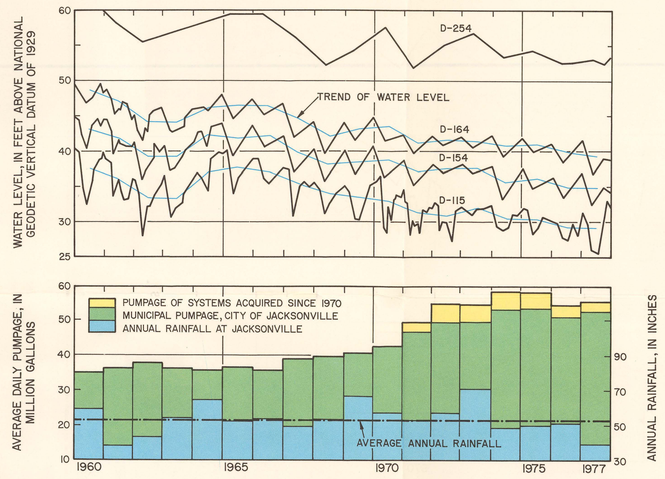

Figure 2.—Water levels in wells, municipal pumpage, and annual rainfall at Jacksonville, 1960–77.

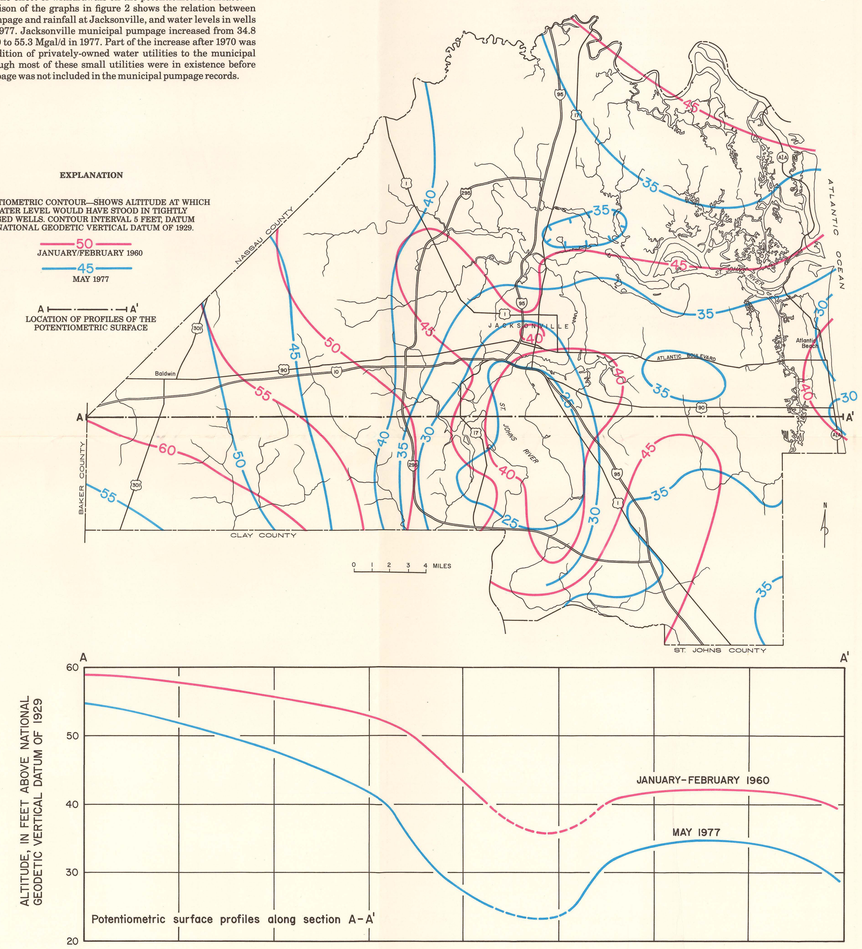

Figure 3.—Potentiometric surface of the Floridan aquifer in Duval County, January–February 1960, and May 1977.

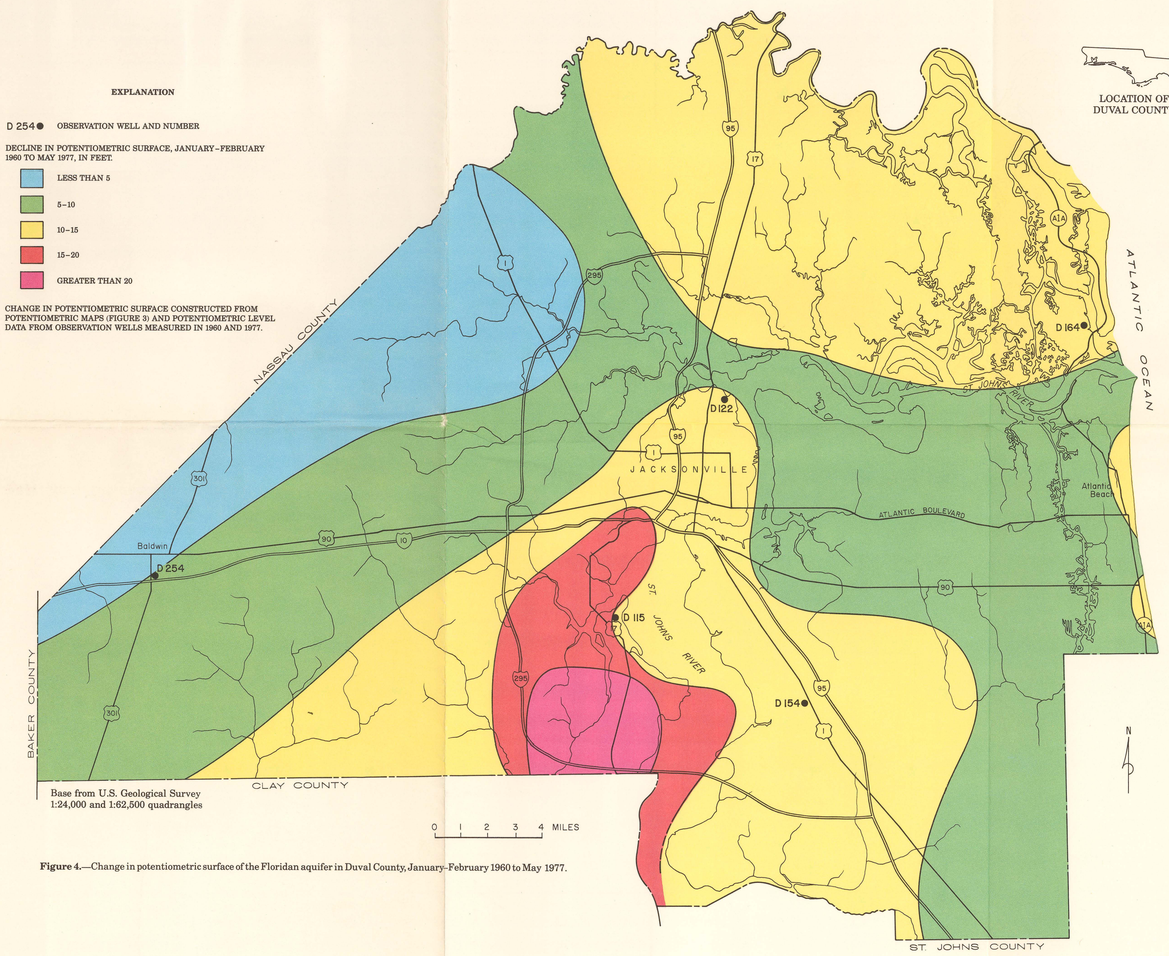

Figure 4.—Change in potentiometric surface of the Floridan aquifer in Duval County, January–February 1960 to May 1977.

SEASONAL AND ANNUAL VARIATIONS IN THE POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER IN DUVAL COUNTY, FLORIDA, 1960–77.

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