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THE SHALLOW AQUIFER OF SOUTHWEST FLORIDA

By
Howard Klein

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INTRODUCTION

An extensive shallow aquifer underlies the Big Cypress Swamp and adjacent areas of southwest Florida (fig. 1). This aquifer represents a principal factor in the present and future growth and development in southwest Florida. The shallow aquifer beneath the west part of the Big Cypress Swamp is the source of municipal and irrigation water for most of that area. The section of aquifer beneath the central part of the Big Cypress will probably be the prime potential source of water for future municipal demands along the **rapidly** urbanizing coastal and adjoining interior areas. Important as the Biscayne aquifer is to the hydrologic system in southeast Florida, equally important is the shallow aquifer to the hydrologic system in southwest Florida and the future growth of the area. The purpose of this report is to describe pertinent hydrologic aspects of the shallow aquifer determined from data collected during 1 year of investigation in the central part of the Big Cypress Swamp and from data collected during several years in perimeter areas of the Big Cypress Swamp. The data contained in the report were obtained in cooperation with the Florida Department of Natural Resources and Collier County.

The Big Cypress Swamp comprises nearly all of Collier County and parts of southern Hendry and western Monroe counties. (See fig. 1.) It is a prime source of water supply to maintain the aquatic biologic communities of the northwest part of the Everglades National Park and the adjoining estuaries, and it is also a potential area from which fresh water for the expanding urban area of the lower Gulf coast will be obtained. The seasonal southward overland flow through the east and central parts of the Big Cypress Swamp nourishes the Park estuaries, which are nursery grounds and feeding areas for many marine animals (Klein and others, 1970, p. 12).

Acknowledgment is extended to the Florida Department of Transportation, Tallahassee, for granting permission to drill exploratory holes along the Everglades Parkway, and to the G.A.C. Corporation, who gave permission to drill on its property in central and western Collier County.

GEOLOGIC ASPECTS

The prime source of fresh-water supplies in Collier County and adjoining parts of Lee and Hendry counties is the shallow aquifer. According to McCoy (1962, p. 24-25), the shallow aquifer has a maximum thickness of about 130 feet in western Collier County, where it comprises the Pamlico Sand and the Anastasia Formation of Pleistocene age, and limestone of the Tamiami Formation of Miocene age. The aquifer thins eastward, and it wedges out near the Dade and Broward county boundary. The patterns in figure 1 show, approximately, the areal extent of the shallow aquifer within and adjacent to the Big Cypress Swamp and the areas where limestone of the aquifer is within 10 feet of the land surface.

The approximate areal extent of the aquifer was determined from well logs and well inventory work by Klein and others (1964, Table 8) in Hendry County, and from McCoy (1962, p. 61-82) in Collier County. Information concerning the approximate depth to the top of the limestone of the shallow aquifer was obtained from well logs and drillers' reports, from exploration holes along roads traversing Collier County, and from inspection of spoil material along canals and roads.

During 1969-70, exploratory rotary holes were drilled along the Everglades Parkway from the Collier County east boundary westward nearly to Naples. The locations of those holes and other exploratory drill holes are shown in figure 1. They were drilled to determine the areal extent, continuity, depth and thickness of limestone sections and the relative permeability of the limestone in the shallow aquifer in the central part of the Big Cypress Swamp area. The hydrologic and geologic data obtained from those holes are shown graphically in figure 2.

Although the shallow aquifer is nonartesian, it contains beds and lenses of sandy clay and fine sand of low permeability, which tend to retard the circulation of water within the aquifer (McCoy, 1962, p. 24-31). Generally, the limestone parts of the aquifer are the important water-yielding sections because they are solution riddled and, therefore, are highly permeable. However, nearly everywhere the upper part of the limestone section is hard and dense and of lower permeability than the lower part. The low permeability of the upper part is important in that it affects the ability of shallow canals to drain water from aquifer storage.

Most of the interbedded sand and sandy clay of low permeability within the shallow aquifer is in the west, north, and east-central parts of the Big Cypress Swamp. In the central and south parts, generally south of the Everglades Parkway, the aquifer is composed predominately of nearly continuous sections of limestone to depths ranging from 60 to **at least** 85 feet. The lithologic logs in figure 2 show that a continuous section of limestone ranging in thickness from 40 feet to more than 80 feet occurs along the Everglades Parkway from the Turner River Canal westward nearly 20 miles. At test hole 5, (west of the intersection of the Barron River Canal) the limestone is at least 80 feet thick. In this test hole, it is a continuous section, the top of which is immediately below the land surface. Limestone sections south of the Everglades Parkway generally range in thickness from about 55 feet to 70 feet. Klein (1964, p. 44) indicated that at the Collier County boundary east of Immokalee the top of the permeable limestone of the shallow aquifer is 22 feet below the land surface and extends at least to 54 feet in well 131 (fig. 1). The limestone is similar in character to that penetrated along the Everglades Parkway.

The uppermost 100 feet or more of sediments in the vicinity of Immokalee are particularly nonuniform in character (McCoy, 1967, p. 7-12), and they are generally of low permeability, except for isolated thin sections of coarse sand and gravel of relatively high permeability. Most wells having yields of 100 gpm (gallons per minute) or more are deeper than 150 feet and are finished in limestone. Because of the dissimilarity of the shallow sediments near Immokalee to the sediments of the surrounding areas, the area shown underlain by the shallow aquifer in figure 1 did not include the vicinity of Immokalee.

The shallow aquifer is underlain by material of low permeability, the base of which extends to depths ranging from about 400 feet to more than 700 feet. This thick section also is the confining layer for the underlying artesian Floridan aquifer, which yields brackish water by **natural flow to wells throughout the Big Cypress Swamp.**

HYDROLOGIC ASPECTS

The shallow aquifer in southwest Florida is replenished primarily by the infiltration of local rainfall. Therefore, during the rainy season, June through October, ground-water levels are high, and by May, the usual end of the dry season, water levels normally reach annual lows. The seasonal fluctuations and long-term trend of water levels are shown in the hydrograph of well 131 (fig. 3), 8 miles east of Immokalee and near the north end of the Big Cypress Swamp. The total annual rainfall at Lake Trafford is shown for comparison. The level in well 131 was lowest in the spring of 1962, as a result of the 1961 rainfall deficiency. The level was highest at the peaks of the 1959 and 1960 rainy seasons. The maximum range of fluctuation was 6.5 feet. Except for the normal response of ground-water levels to the wet and dry seasons, the 17-year water-level record in figure 3 shows no long-term trend.

As the rainy season begins, usually in June, ground-water levels rise correspondingly. In the central and eastern parts of the watershed, where drainage is poor to nonexistent, levels generally continue an upward trend until the water rises above the land surface; thereafter, further replenishment to the aquifer is rejected, and southward overland flow occurs. Large-scale inundation is generally continuous through February or March, but the southward flow through outlets along U.S. Highway 41 stops generally at the end of December or January. By May most of the Big Cypress Swamp is dry except for the perennially wet strands and sloughs. The hydrographs for wells 131 and 380 (fig. 4) show the seasonal fluctuation of ground-water levels in the Big Cypress Swamp and the flow in the Barron River Canal for 1970 and the dry season of 1971.

The differences between the levels in well 131 in the north part of the watershed and the levels in well 380 in the south part (see fig. 5 for locations) indicate that an average southward hydraulic gradient of 18 feet in 35 miles (0.5 foot per mile) sustains during the dry as well as the wet season through the central part of the watershed. Figure 4 also shows the close relation between the flow of the Barron River Canal and the fluctuation of level in the two wells. Widespread inundation and high ground-water levels during the rainy season cause large gradients toward the Barron River Canal, which result in increased sheet flow and ground-water contribution to the canal and, therefore, in increased canal discharge. During prolonged drought, sheet flow stops, the gradients toward the canal are low, and correspondingly low canal discharge results.

Record low water levels in southwestern Florida occurred near the end of the dry seasons of 1961-62 and 1970-71. The contour map in figure 5 shows the configuration of the water table in the shallow aquifer in early May 1971. The pattern of the contours shows that water levels were highest in northern Collier and southwestern Hendry counties and that ground water flows generally southward and southwestward. Water levels in the southwest part of the area are strongly affected by the Golden Gate Canal and the Fahka Union Canal. Ground-water levels in the vicinity of the Barron River and Turner River canals are only mildly affected because the canals are shallow and generally are cut into the surface limestone of relatively low permeability. The effectiveness of drainage by the Golden Gate Canal, as compared with the Barron River Canal, is indicated by their flows: the highest daily flow of record of the Golden Gate Canal is 2,390 cfs (cubic feet per second), whereas the highest daily of the Barron River Canal is 292 cfs.

Observations during the rotary drilling of the exploratory 6-inch holes, whose locations are shown in figure 1, furnished information on the permeability changes within the area and with depth in the aquifer and the differences in yield of wells. The rotary machine utilized compressed air through the drill stem to bring rock cuttings to the surface. Increasing quantities of water were picked up as the aquifer was penetrated and the water and cuttings were forced to the surface. The differences in the amount of water returned indicated differences in permeability. The largest quantities of water were returned from wells drilled in the area between well 2 and well 7 along the Everglades Parkway. The amount of water returned to the surface from each well in that area exceeded 500 gpm. Designations of relative permeability along the Everglades Parkway are shown in figure 2.

Five 30-foot rotary exploratory holes were drilled along the Henderson Creek Canal, each within 200 feet of the canal, from the Everglades Parkway southward to U.S. Highway 41, to determine the shallow geology, the approximate yield of wells, and the general quality of the shallow ground water. The holes penetrated sand, shelly sand, and limestone. In November 1970 the wells were tested by pumping at 200 gpm, and water levels were measured in the pumping wells to determine drawdowns (McCoy, 1972); also water samples were collected at the beginning and end of pumping. Specific capacity of the wells ranged from 910 gpm to 35 gpm per foot of drawdown. The specific **capacity for** the north wells was the greatest, indicating good interconnection between the aquifer and the canal near the Everglades Parkway. The water samples collected at that time from each of these five wells ranged in chloride content from about 150 mg/l (milligrams per liter) to more than 365 mg/l, suggesting that the area of shallow mineralized ground water inland from Naples, described by Sherwood and Klein (1961, p. 32-34), also extends southward toward U.S. Highway 41.

Scattered data from specific-capacity tests on other exploratory wells and from aquifer tests show that the transmissivity of the shallow aquifer differs widely in Collier and southern Hendry counties. Klein and others (1964, p. 40-58) showed that the transmissivity of the shallow aquifer in southern Hendry County ranges from about 250,000 gpd per foot to about 1,000,000 gpd per foot; the highest value was computed from a test at the Collier-Hendry boundary in the vicinity of well 131, east of Immokalee. From specific-capacity tests on wells in the vicinity of the Everglades Parkway and Fahka Union Canal, McCoy (1972) indicated that the transmissivity of the aquifer there ranges from about 500,000 to 800,000 gpd per foot. The shallow aquifer underlying the area eastward to the Turner River Canal would be expected to be within about the same range, on the basis of the geologic data shown in figure 2. These transmissivities are markedly greater than those determined by McCoy (1962, p. 40-41), about 60,000 gpd per foot, 5 miles northwest of Immokalee, and by Sherwood and Klein (1961, p. 36-39), ranging from 80,000 to 185,000 gpd per foot near Naples.

The water in the shallow aquifer is a typical limestone type, hard, and high in bicarbonate. It generally meets the standards of the U.S. Public Health Service (1962) for potable water supplies, except from areas east of Naples, indicated by Sherwood and Klein (1961, p. 28-34), and areas along the coast and tidal channels affected by sea-water intrusion. The ground water in the interior part of the Big Cypress Swamp generally contains less than 40 mg/l chloride and less than 440 mg/l dissolved solids.

In view of the good water quality, the relatively large areal extent of permeable limestone, the perennially high water levels, and the high yield to wells, the shallow aquifer in the central part of the Big Cypress Swamp represents a potential source of potable water capable of serving much, if not all, the expected urban growth along west and south coasts, provided that good management practices are followed, overdrainage is prevented, and pollution is minimized in the central Big Cypress Swamp area.

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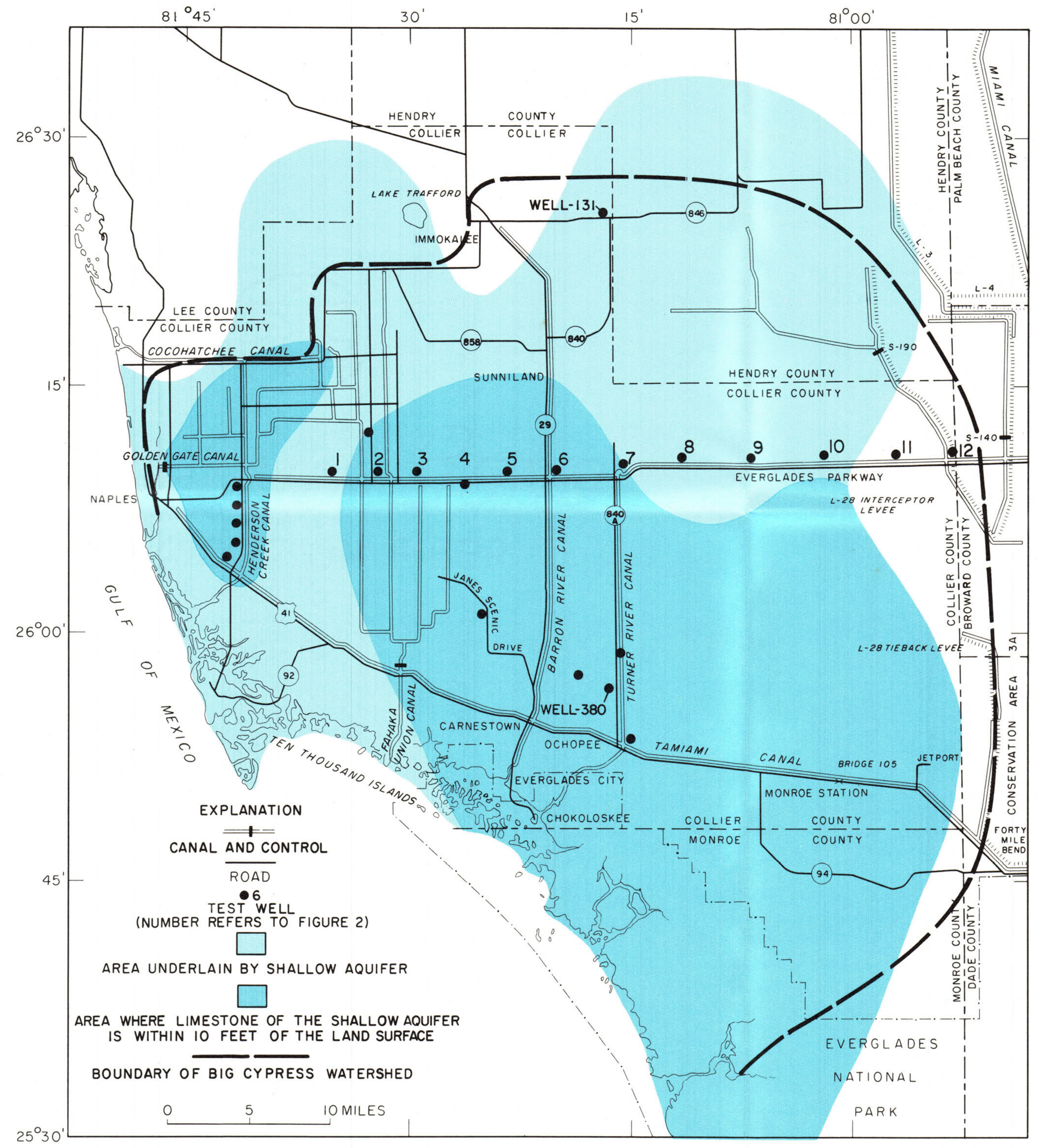


Figure 1. Approximate areal extent of the shallow aquifer and the area where limestone is within 10 feet of the land surface.

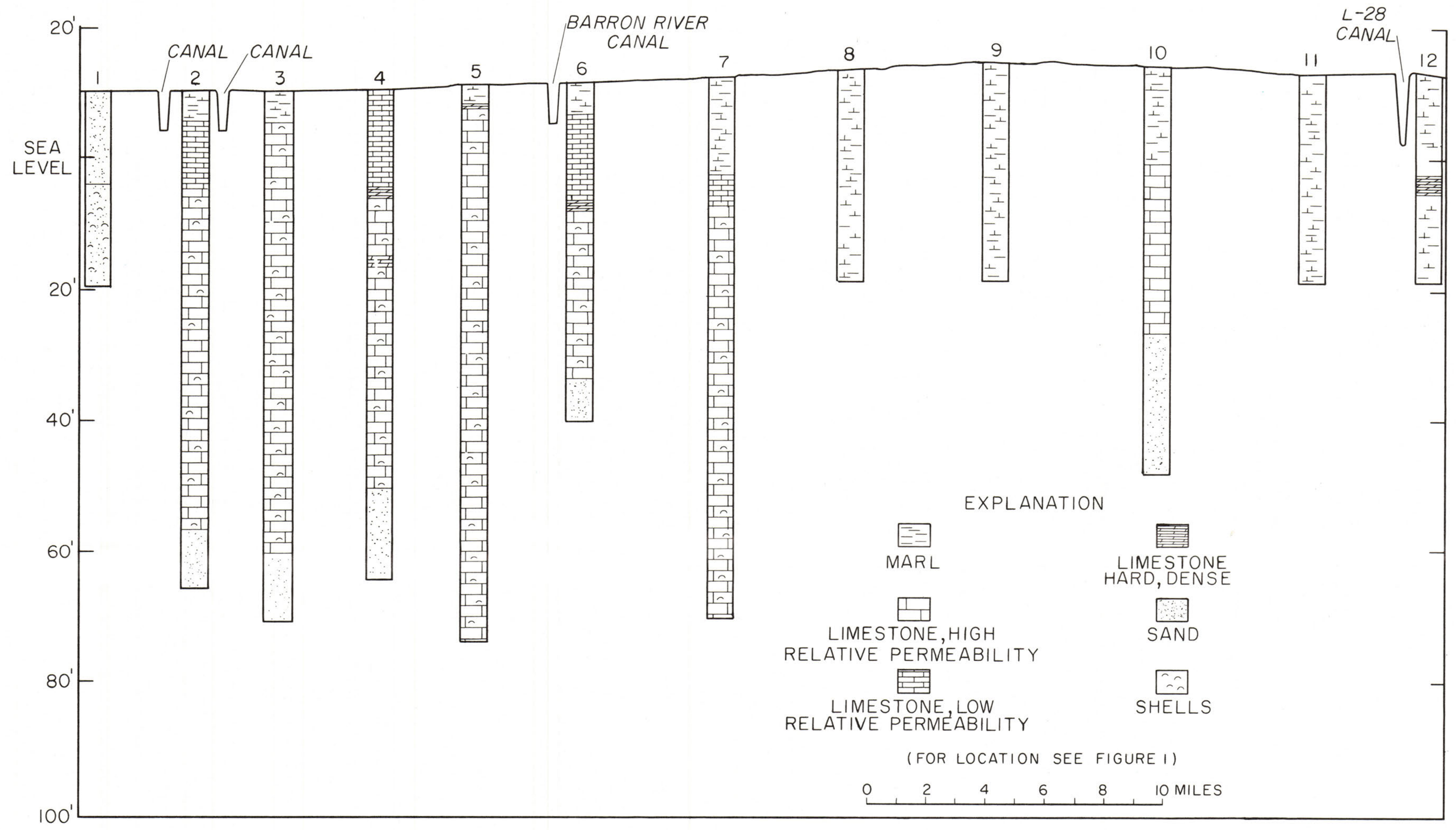


Figure 2. Hydrogeologic data obtained along the Everglades Parkway.

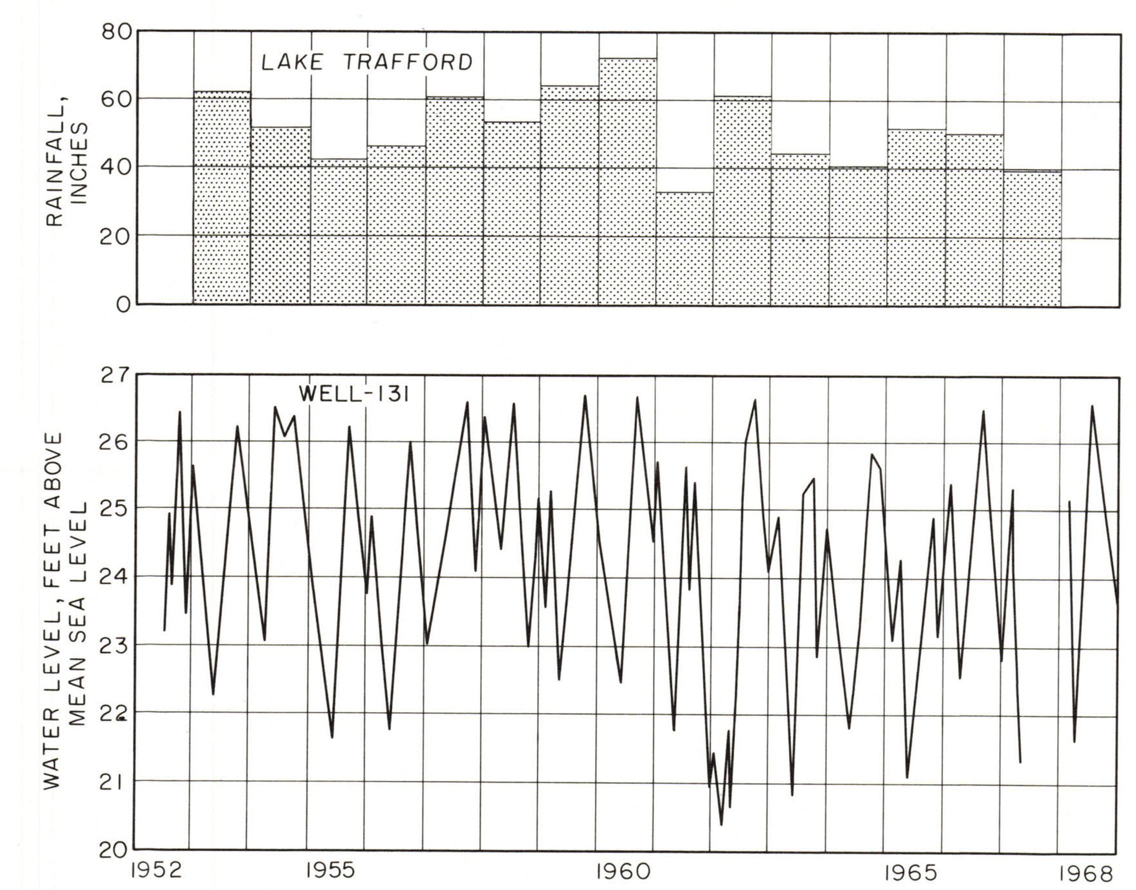
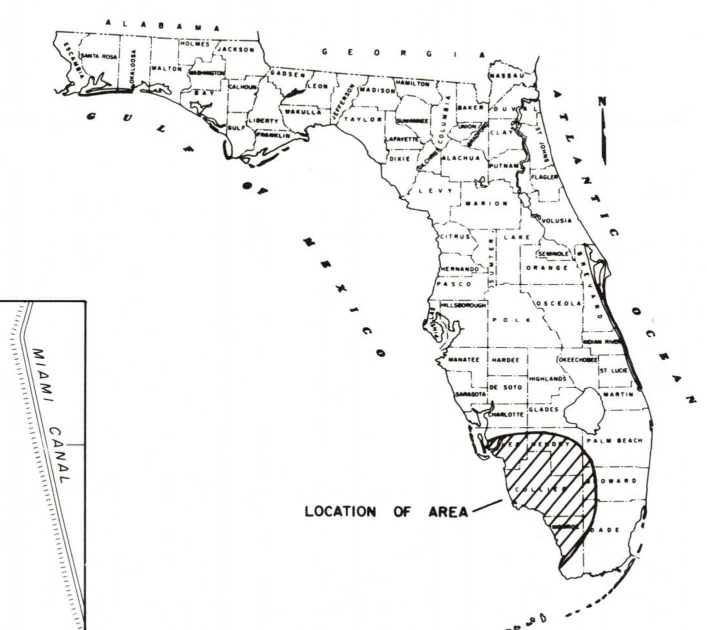


Figure 3. Hydrographs of well 131 for 1952-68 and rainfall at Lake Trafford, 1953-67.



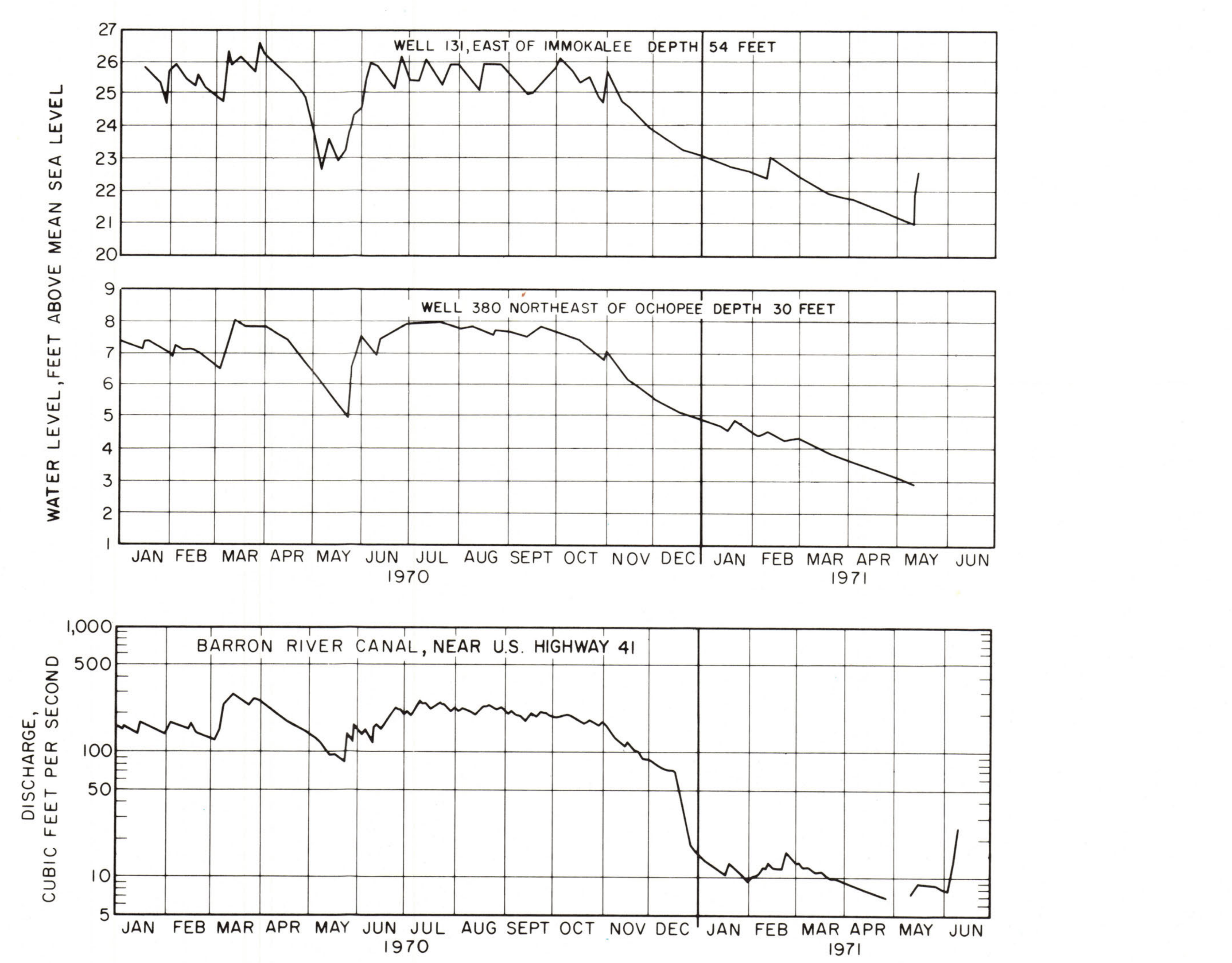


Figure 4. Hydrographs of wells 131 and 380 and the discharge of the Barron River Canal for 1970 and early 1971.

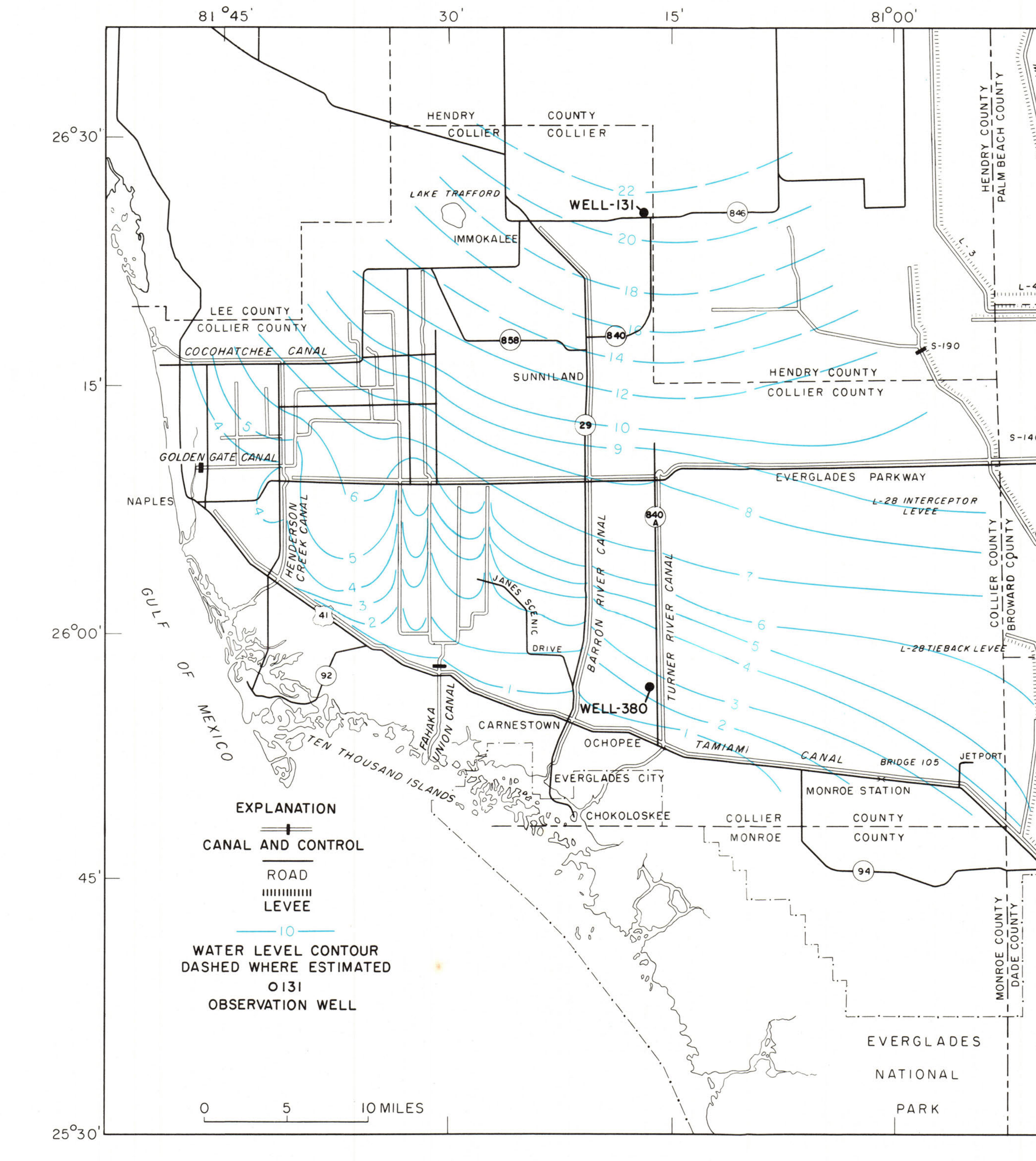


Figure 5. Low water-level contours for early May 1971.