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POTENTIOMETRIC SURFACES OF THE UPPER GLACIAL AND MAGOTHY AQUIFERS AND SELECTED STREAMFLOW STATISTICS, 1943-72, ON LONG ISLAND, NEW YORK

By D. E. Vaupel, K, R. Prince, A. J. Koehler, and Mario Runco

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Syosset, New York

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FACTORS FOR CONVERTING ENGLISH UNITS OF MEASURE TO INTERNATIONAL SYSTEM (SI) UNITS

Multiply English units	by	To obtain SI units
inches (in)	25.4	millimeters (mm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
million gallons per day (Mgal/d)	3785	cubic meters per day (M^3/d)
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)

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ABSTRACT

A brief text describes the two major aquifers and the discharge pattern of major streams on Long Island. Four water-table maps for the years 1943, 1959, 1966, and 1972, an average water-table map for the period 1943-72 supplemented by five well hydrographs representing Kings, Queens, western Nassau, eastern Nassau, and Suffolk Counties, and three potentiometric-surface maps of the Magothy aquifer for the years 1959, 1966, and 1972 are included. A statistical summary of stream discharge presents average annual discharges, annual average discharges, and average 7-day, 10-year low-flow discharges for major streams.

INTRODUCTION

Ground water is the sole source of water supply for over 3 million people on Long Island, New York. Thus, it is extremely important for water managers to understand the occurrence of ground water and its movement.

The ground-water system or reservoir on Long Island consists of a group of wedge-shaped deposits of unconsolidated materials that thicken to the southeast. These deposits form three major aquifers--the upper glacial (water table), which is underlain by the Magothy, which, in turn, is underlain by the Lloyd. Generally, the Lloyd is separated from the Magothy by the Raritan clay. A more complete description of the hydrogeologic units of Long Island can be found in several publications; for example, Cohen and others (1968, p. 18) and McClymonds and Franke (1972, p. E3-E6).

The purpose of this report is to describe the occurrence of water in the upper glacial and Magothy aquifers on Long Island by presenting potential head data in the form of maps depicting the potentiometric surfaces of these two major aquifers. A potentiometric surface is determined by the altitude to which water would rise in tightly cased wells and represents the pressure head in an aquifer.

In addition, statistical streamflow data on most major Long Island streams are presented because streamflow on Long Island consists mostly of ground-water discharge and varied directly with ground-water levels.

Data in the report are presented in three formats: (1) maps depicting the water table in the upper glacial aquifer for the years 1943, 1959, 1966, 1972 and an average water level for the period 1943-72; (2) maps depicting the potentiometric surface in the Magothy aquifer for the years 1959, 1966, and 1972; and (3) a table of streamflow characteristics of most major Long Island streams. The 30-year period, 1943-72, was selected as the most appropriate period of record to conform with the May 1975 "Workplan and scope of services" (Nassau-Suffolk Regional Planning Board, 1975). The years 1943 and 1972 were selected to show water-level conditions at the beginning and end of the period, whereas 1959 and 1966 illustrate a year of relatively high water levels and a year of relatively low water levels, respectively.

In addition to describing the occurrence of water in the aquifers, each of the potentiometric-surface maps can be used to determine the direction of the horizontal component of flow. Also, by comparing a potentiometric-surface map of the upper glacial aquifer with one of the Magothy aquifer for the same year, one can determine the vertical component of flow, which, in turn, allows determination of the areas of water movement between the two aquifers.

POTENTIOMETRIC SURFACE OF THE UPPER GLACIAL AQUIFER

The upper glacial aquifer is the uppermost of the three aquifers and has as its potentiometric surface the water table--the upper surface of the zone of saturation in ordinary permeable soil or rock. The upper glacial aquifer is the second most heavily used aquifer on Long Island, with a public-supply pumpage rate of about 105 Mgal/d in 1973.

Plates 1-5 show the altitude of the water table. Plates 1-4 represent the shape and altitude of the water table during March-April of the selected years 1943, 1959, 1966, and 1972. Plate 5 depicts the average water-level altitude during 1943-72.

Plates 1-4 were prepared from water-level information collected by the U.S. Geological Survey and the Nassau County Department of Public Works. In addition, after each map was prepared, it was compared with existing water-table maps of different time periods for contour shape and general conformity. The map for 1943 (pl. 1) was based on 165 water-level measurements and a water-table map of Suffolk County (N.J. Lusczynski, written commun., 1947). The map for 1959 (pl. 2) was based on 210 water-level measurements; it was compared against a March 1970 water-table map (Kimmel, 1971), and an April 1968 water-table map (Soren, 1971). The map for 1972 (pl. 4) was based on 330 measurements; a comparison was made with a March 1970 water-table map (Kimmel, 1971), a March 1971 water-table map (Koszalka and Koch, 1974), and a March 1974 water-table map (Koszalka, 1975). Maps from other years were used to contour areas of plates 3 and 4 where little or no data for the study years existed. The maps used were those in which water-level altitudes were similar to those measured in the study years.

The 1943-72 average water-table map (pl. 5) was drawn only for areas where man's effects on the occurrence and movement of water in the upper glacial aquifer is minor; thus, the urban (western) part of Long Island, including about one-third of Nassau County, has been excluded.

The average water levels shown on plate 5 were determined by calculating an average annual water level for each year during 1943-72 and then calculating a mean annual average from the annual averages.

With the data obtained from well records, the following criteria were used to determine if water levels in a well were unaffected by man's activities: (1) that a reasonable comparison exists between water-level fluctuations and precipitation (when water-level fluctuations in a water-table well and precipitation do not show a direct relationship, it is quite probable that man's activities are affecting the water-level fluctuation); (2) that the difference between 1943 and 1972 water-levels in a single well, as projected by a linear regression using the lease squares method, does not exceed 20 percent; and (3) that withdrawal in the vicinity of the well was not sufficient to significantly affect the water level in the well (large withdrawal near the well could produce a localized cone of depression in the ground-water body, which would cause the water level in the well to be lower than the regional water level).

Figures 1-5 are hydrographs of wells K1236, Q1250, N1147, N1232, and S3530[1/]. These wells have an areal distribution that covers most of Long Island. These hydrographs illustrate the trends in water levels from 1943 to 1972 in the areas under discussion. Water levels in Suffolk and Nassau Counties (figs. 4, 5), excluding the southwest part of Nassau (1), showed little or no trend, (2) are in areas of lesser pumpage, and (3) show fluctuations directly proportional to the amount of precipitation. Water levels in the remaining areas of Kings County, Queens County, and the southwestern part of Nassau County (figs. 1-3) show changing trends and are in areas of greater pumpage. An average water level calculated from these data would be meaningless and was, therefore, excluded.

The shaded area on plate 5 indicates where water levels show a definite and continuous upward or downward trend; average water-level contours in these areas would be incorrect and therefore were not drawn.

[1/] These well numbers are assigned by the New York State Department of Environmental Conservation. Letter K, Q, N, or S preceding the number indicates Kings, Queens, Nassau, or Suffolk County. The numbers in each county are assigned chronologically at the time the well is drilled.

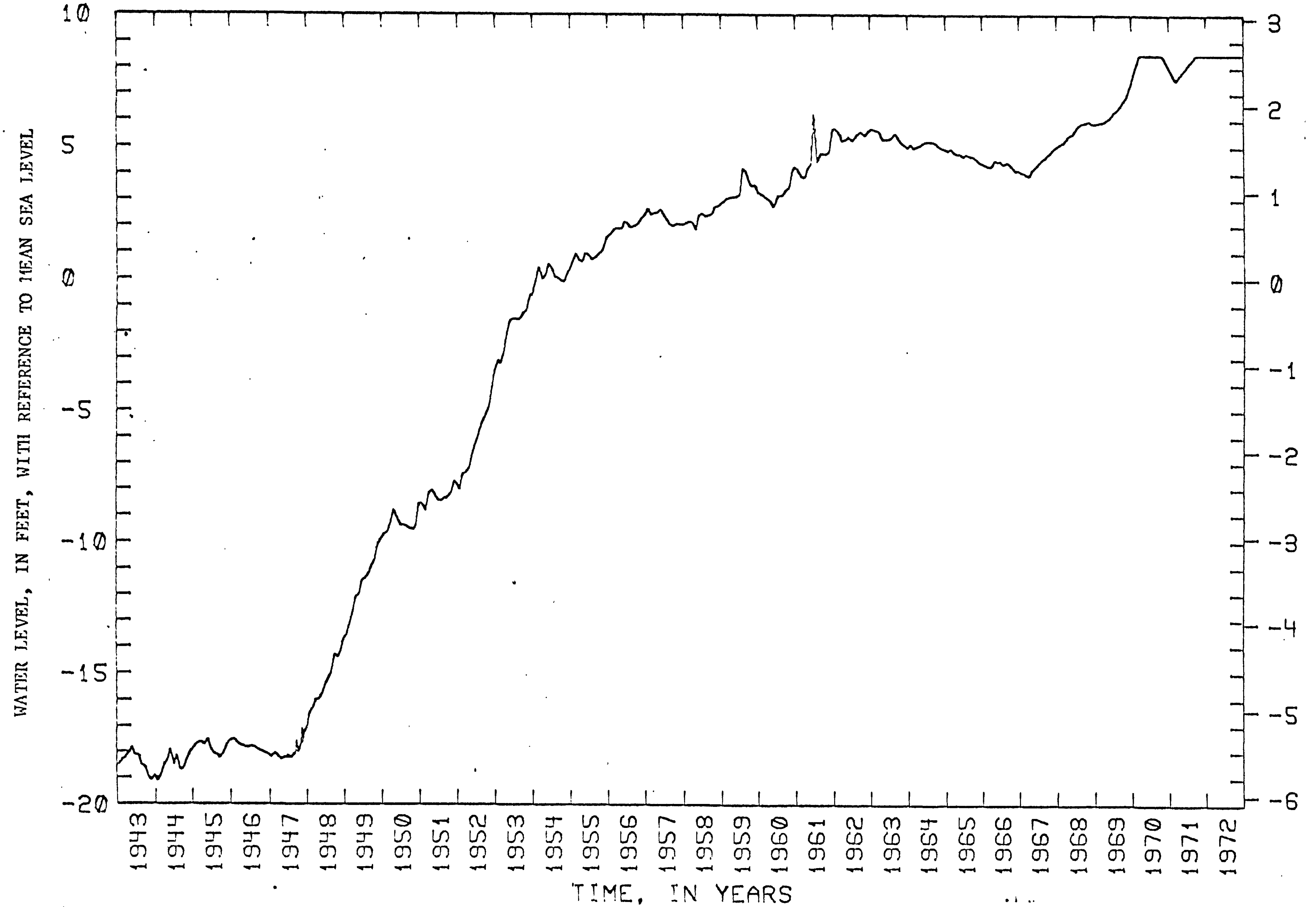

Figure 1.--Hydrograph of well K1236, Kings County, from January 1943 to December 1972.

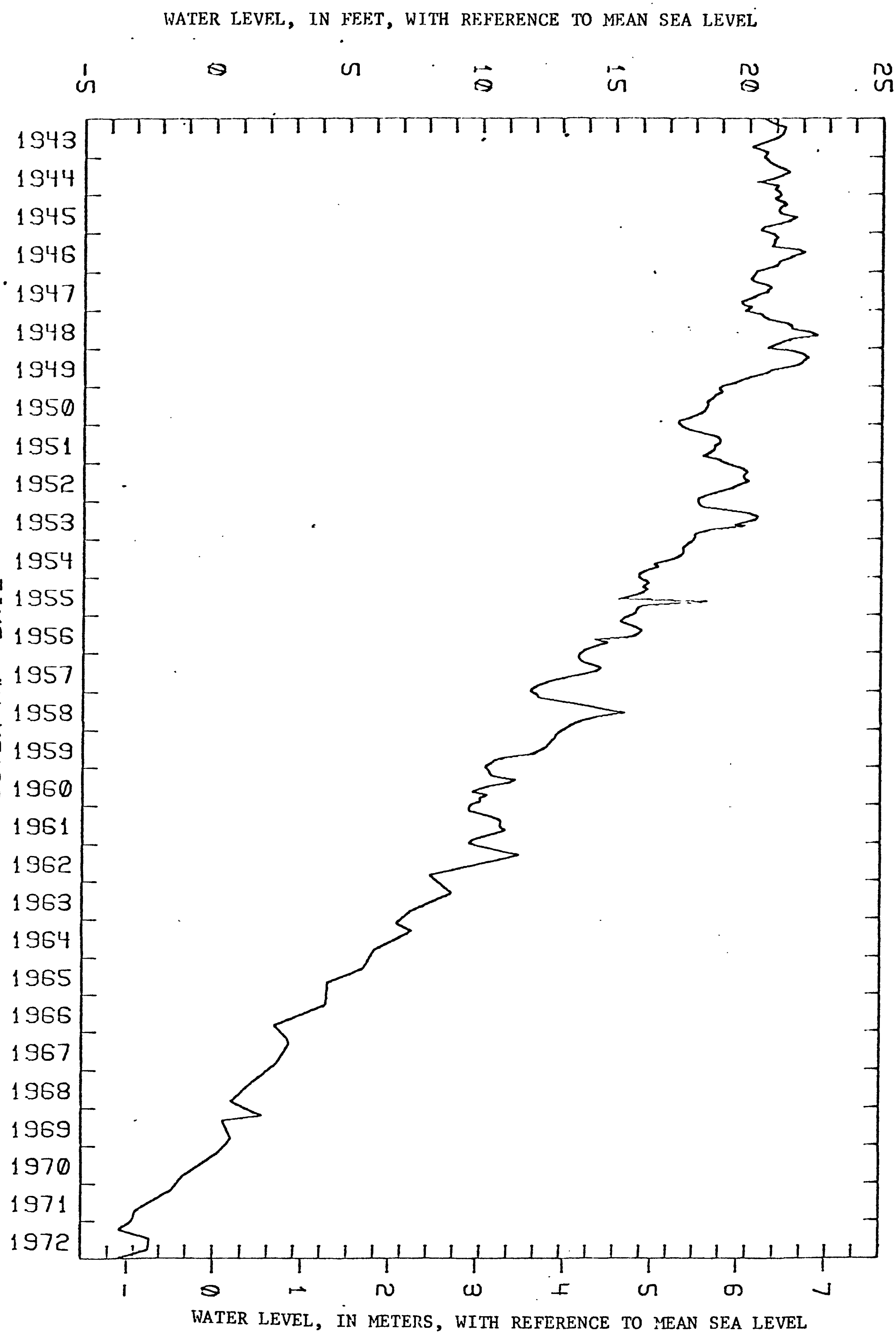

Figure 2.--Hydrograph of well Q1250, Queens County, from January 1943 to December 1972.

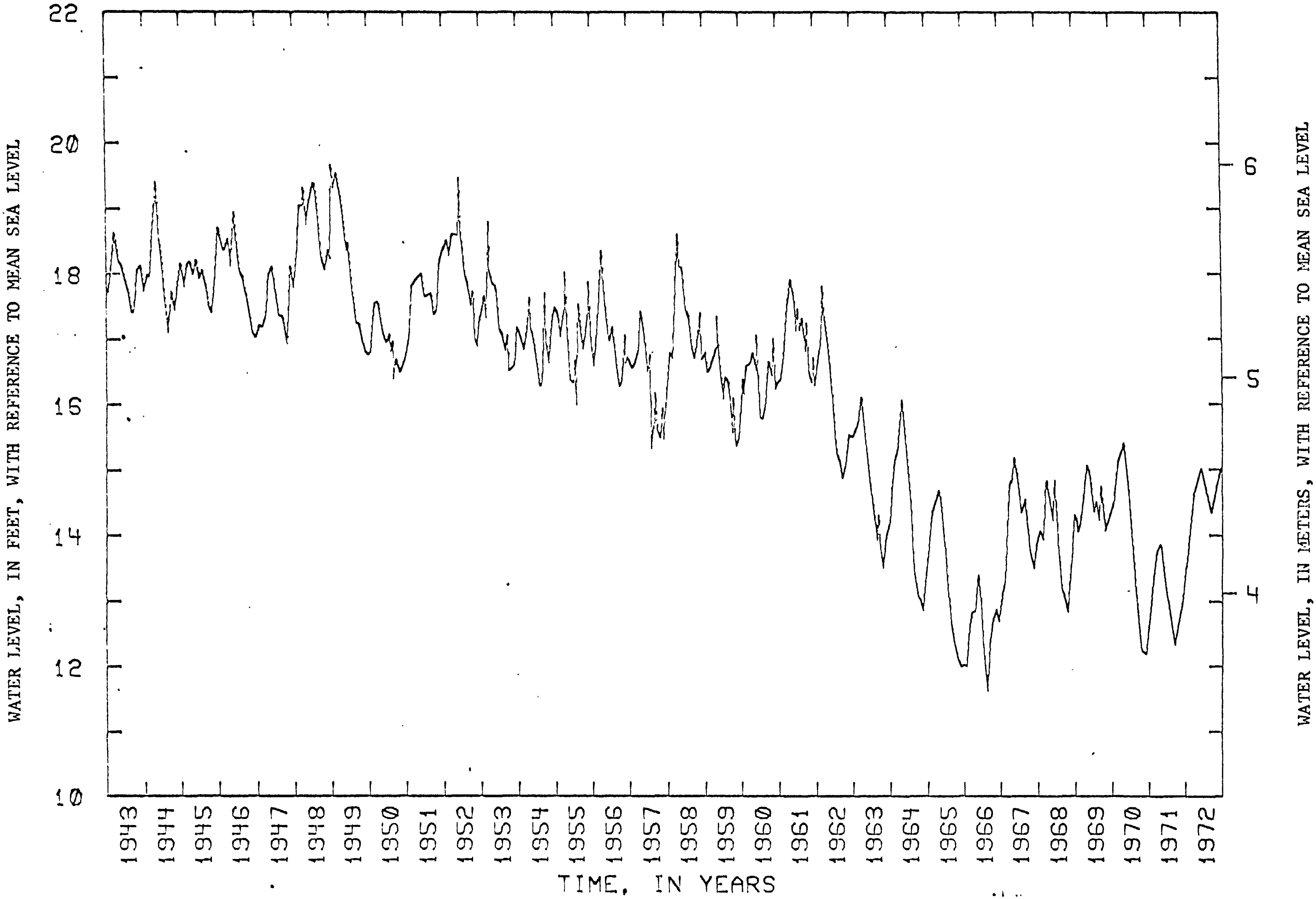

Figure 3.--Hydrograph of well N1147, southwestern Nassau County, from January 1943 to December 1972,

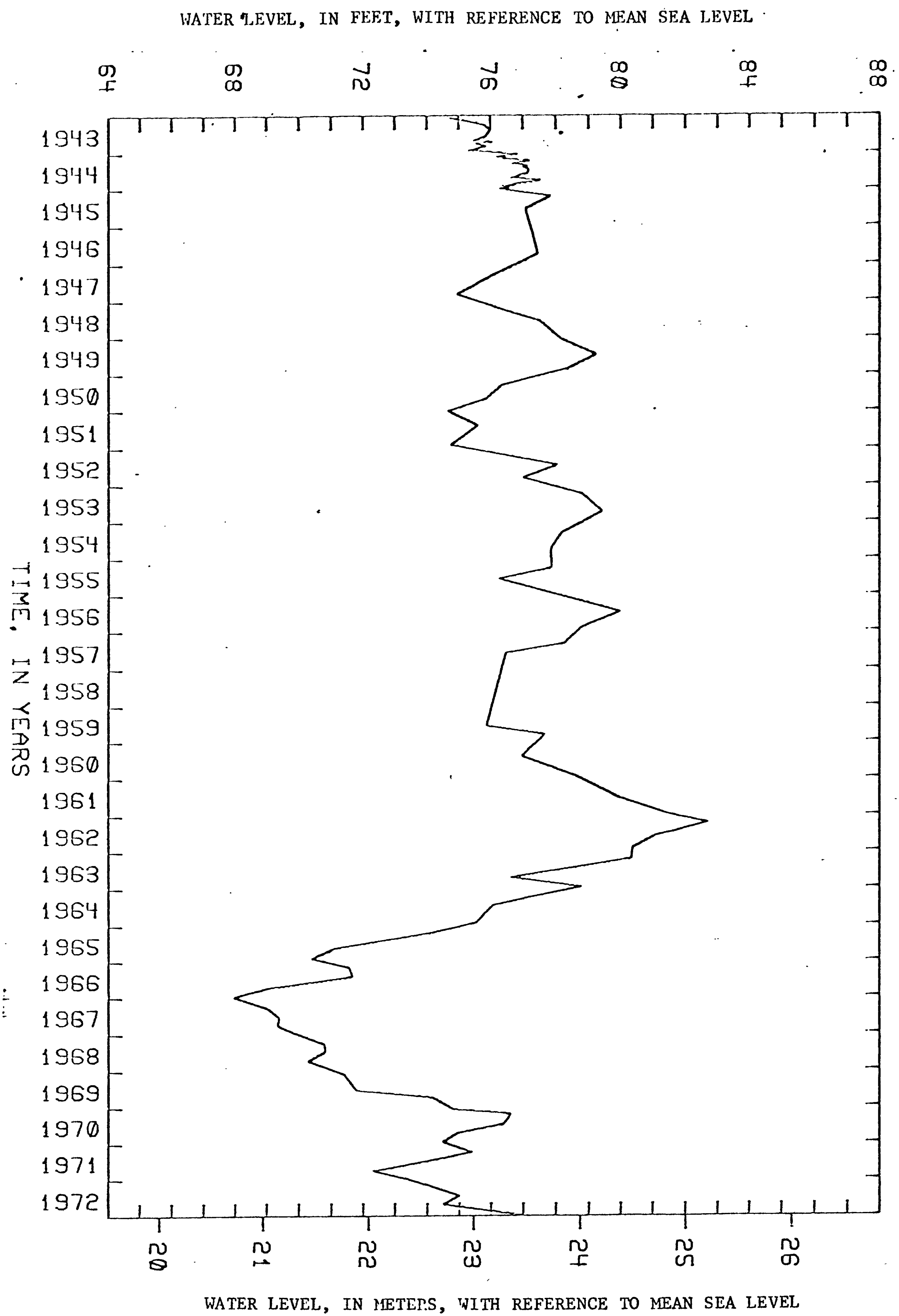

Figure 4.--Hydrograph of well N1232, eastern Nassau County, from March 1943 to December 1972.

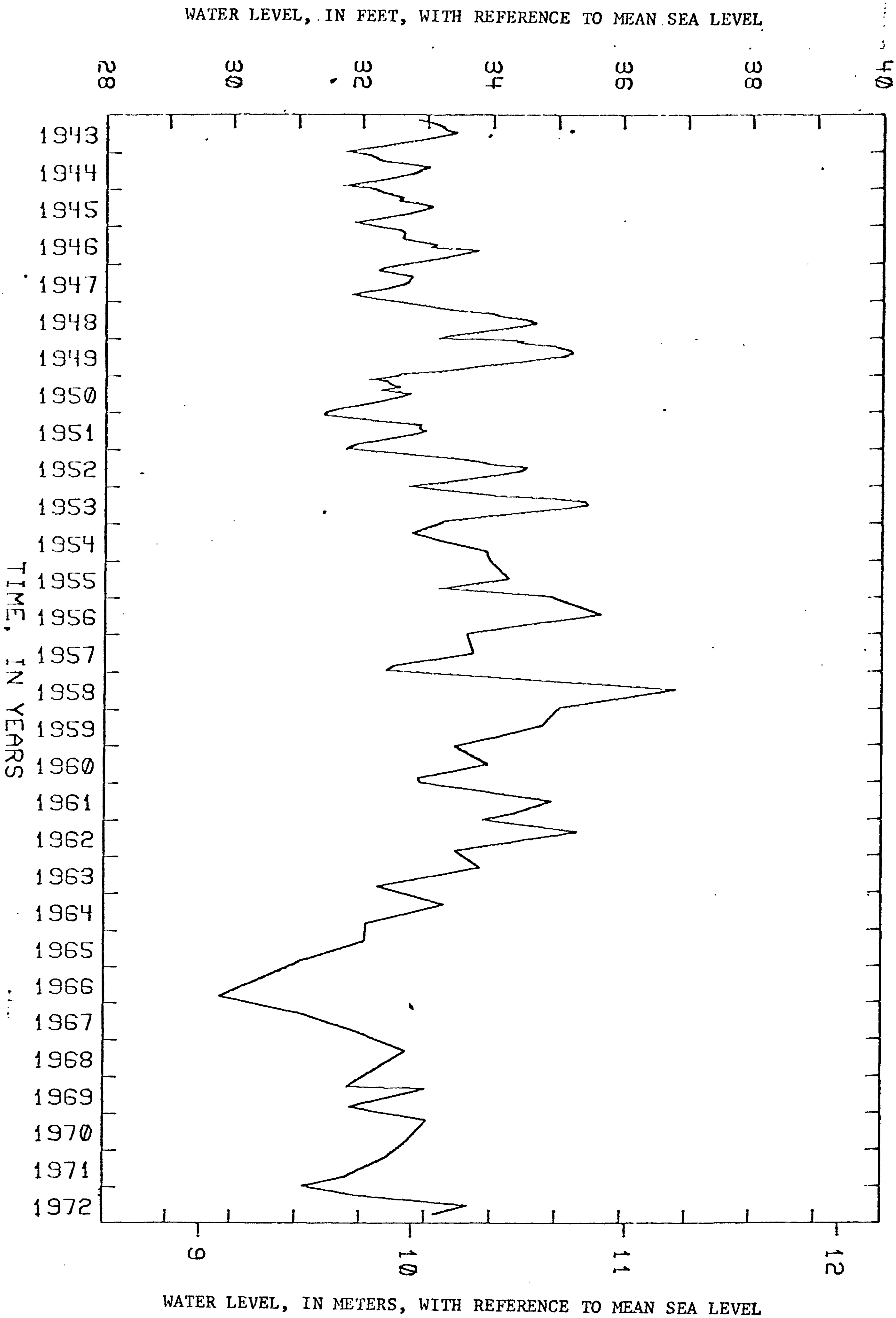

Figure 5.--Hydrograph of well S3530, Suffolk County, from March 1943 to October 1972.

POTENTIOMETRIC SURFACE OF THE MAGOTHY AQUIFER

The Magothy aquifer is the most heavily used aquifer on Long Island and had a public-supply pumpage of about 240 Mgal/d in 1973. Plates 6-8 show the potentiometric surface of the Magothy aquifer for the selected years 1959, 1966, and 1972.

The maps were prepared from data collected by the U.S. Geological Survey and the Suffolk County Water Authority. In addition, after each map was prepared, it was compared with existing potentiometric surface maps of the Magothy aquifer of the same or different time periods for contour shape and general conformity. The 1959 map (pl. 6) was based on 46 water-level measurements that were either measured in March and April 1959 or adjusted from measurements made during March and April of the years 1957-61 and from a published 1959 potentiometric-surface map (Kimmel, 1971). The 1966 map (pl. 7) was based on water-level measurements made in 83 wells during March-April 1964-67. Data from several consecutive years were used to compile these two maps because too few wells were measured during any one year. The time periods selected were those in which water-level changes were minimal. The 1972 map (pl. 8) was based on measurements made in 103 wells during March-April 1972 and from a 1972 potentiometric-surface map (Koch and Koszalka, 1973).

STREAMFLOW STATISTICS FOR SELECTED LONG ISLAND STREAMS

Except for Kings, Queens, and southwestern Nassau counties, where sanitary sewers have been constructed, ground-water discharge accounts for more than 90 percent of the flow in Long Island streams (Franke and McClymonds, 1972, p. F41); thus, variations in streamflow are a result of variations in discharge from the ground-water body.

Figure 6 shows the location of continuous-record stream gaging stations on Long Island streams. These 19 streams together represent approximately 50 percent of the streamflow on Long Island. The data recorded at each station show the variation in streamflow with time at that site. Because of the direct relationship between ground water and streamflow, streamflow in the areas significantly affected by man (shaded area on pl. 5) are influenced by changing ground-water levels in these areas.

Table 1 is a statistical summary of the data collected at the stream-gaging stations. The first two stream discharges given in table 1 are average annual stream-flow. These were obtained by calculating a mean of all annual averages for the appropriate period. The first average annual discharge is for the period of record, the second is for the study period, 1943-72. Where the period of record does not encompass the entire study period, estimates of annual average discharges were determined by correlating discharges with those of nearby streams.

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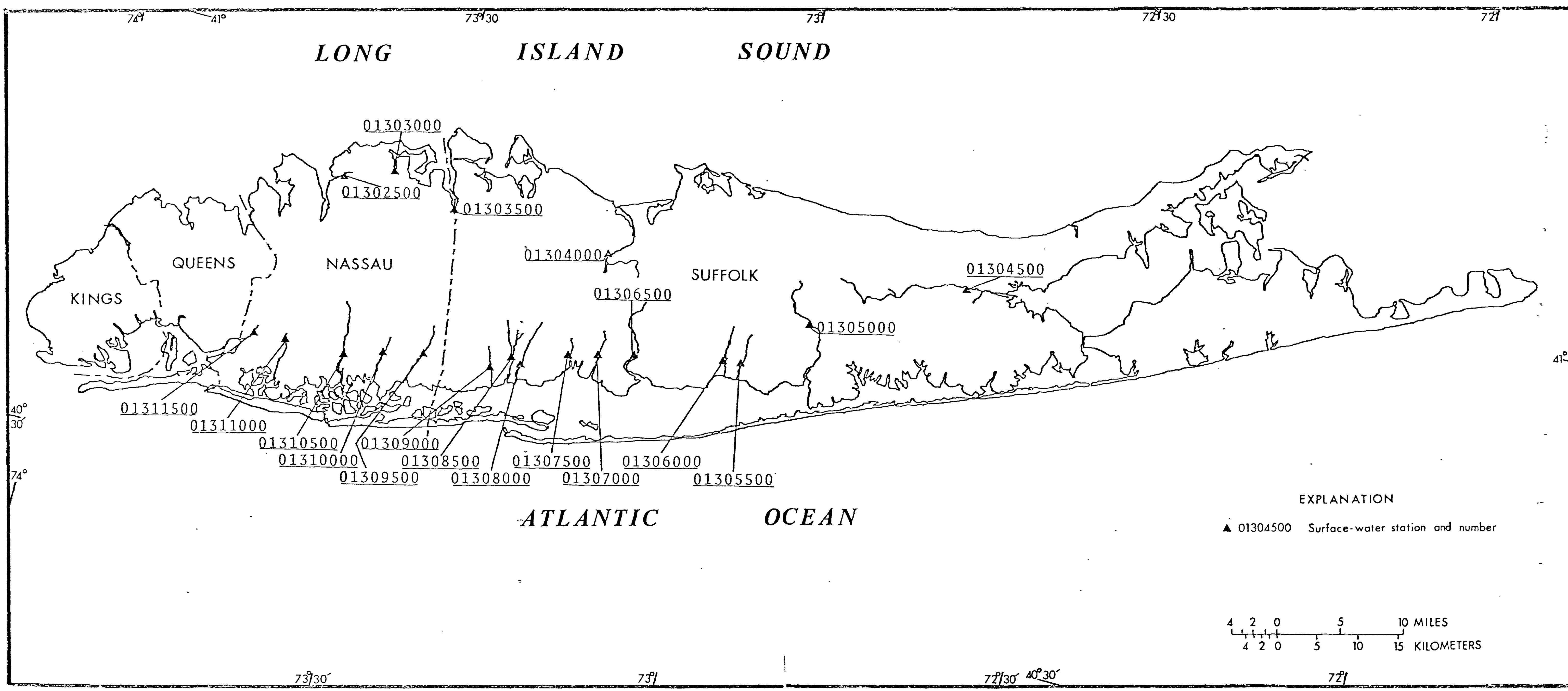

FIGURE 6.-- LOCATION OF STREAMFLOW DATA COLLECTION STATIONS

Station number	Station name	Average annual streamflow (ft3/s)			Annual average streamflow (ft3/s)				Average 7-day, 10-year low flow (ft3/s)	
		Period of record	Streamflow for period of record	Streamflow 1943-72	1943	1959	1966	1972	Period	Streamflow
01302500	Glen Cove Creek at Glen Cove	1939-75	6.8	6.6	7.1	7.3	4.2	5.7	1940-75	2.8
01303000	Mill Neck Creek at Mill Neck	1938-75	9.0	8.9	9.1	9.7	5.6	7.8	1939-75	4.8
01303500	Cold Spring Brook at Cold Sring Harbor	1951-75	2.4	2.4	2.6	3.4	0.8	2.6	1952-75	0.4
01304000	Nissequogue River nr. Smithtown	1944-75	41.0	40.0	41.0	44.0	27.0	36.0	1945-75	23.4
01304500	Peconic River at Riverhead	1943-75	35.0	34.0	29.0	53.0	16.0	34.0	1944-75	10.1
01305000	Carmans River at Riverhead	1943-75	23.0	22.0	22.0	31.0	13.0	18.0	1944-75	11.7
01305500	Swan River at Patchogue	1947-73	12.0	12.0	12.0	14.0	8.7	11.0	1948-75	7.7
01306000	Patchogue River at Patchogue	1946-69, '74, '75	20.0	20.0	20.0	24.0	15.7	18.0	1947-75	10.3
01306500	Connetquot River nr. Oakdale	1944-74	38.0	37.0	37.0	42.0	25.0	33.0	1945-74	21.6
01307000	Champlin Creek at Islip	1949-69	7.1	6.7	6.7	7.5	3.9	5.2	1950-69	2.8
01307500	Penataquit Creek at Bayshore	1946-75	6.3	6.2	5.7	6.1	4.1	6.7	1947-75	2.8
01308000	Sampawams Creek at Babylon	1945-75	9.5	9.3	8.4	10.0	5.8	9.1	1946-75	3.3
01308500	Carlls River at Babylon	1945-75	26.0	26.0	24.0	28.0	14.0	23.0	1946-75	9.9
01309000	Santapogue Creek at Lindenhurst	1948-69	4.2	4.0	3.4	4.2	1.3	3.1	1949-69	0.4
01309500	Massapequa Creek at Massapequa	1938-75	11.0	11.0	9.5	14.0	3.2	8.7	1938-75	2.5
01310000	Bellmore Creek at Bellmore	1938-75	11.0	11.0	7.5	15.0	3.6	11.0	1939-75	1.9
01310500	East Meadow Brook at Freeport	1938-75	15.0	15.0	16.0	18.0	2.5	7.5	1939-74	0.7
01311000	Pines Brook at Malverne	1938-75	4.1	4.0	5.3	5.0	0.5	1.2	1939-75	0.4
01311500	Valley Stream at Valley Stream	1956-75	2.7	4.7	6.3	5.2	1.2	0.7	1956-75	0.3

The next four discharges listed for each stream are annual average discharges for the years 1943, 1959, 1966, 1972, which were selected to correspond with the years of the potentiometric-surface maps (pls. 1-4 and 6-8). Annual average discharge for each stream is determined by obtaining the mean of the average daily discharges for the entire year. Here again, figures that are outside the period of record were derived by correlation.

The last discharge given for each stream in table 1 is the 7-day, 10-year low flow, which is the maximum mean daily flow expected during the 7 consecutive days of lowest flow in an average 10-year period.

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