PREPARED IN COOPERATION WITH THE
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Lacombe, P.J., and Rosman, Robert, 1995, Hydrology of the unconfined aquifer system in the upper Maurice River basin and adjacent areas in Gloucester County, New Jersey, 1986-87

GROUND WATER

This sheet shows the altitude and configuration of the water table in the Kirkwood-Cohansey aquifer system in autumn 1986. Hydrographs from five water- level observation wells and the hydraulic characteristics of the aquifer and underlying confining unit are included. Results of a small-scale survey to measure the shallow ground-water flow into the Maurice River are presented.

Ground water in the Kirkwood-Cohansey aquifer system is found in the openings, or pore spaces, between the sediment grains that make up the aquifer. Ground water moves very slowly under normal conditions, typically from inches per day to feet per day. In an unconfined aquifer, water moves from areas of recharge, which typically are dry and elevated, to areas of discharge, such as swamps, rivers, lakes, ponds, and springs. Figure 2-1 is a water-table map that shows the altitude of the top of the Kirkwood-Cohansey flow system during the autumn of 1986, when the altitude of the water surface in 91 wells and at 90 stream sites in the study area was measured. Ground- water flow is perpendicular to the contour lines, as shown by the arrows in figure 2-1.

The gradient of the water table in the Maurice and Great Egg Harbor River basins generally is between 5 and 10 ft/mi; the gradient of the water table in the four river basins that drain into the Delaware River generally is 20 to 40 ft/mi. The water table generally is less than 30 ft below land surface, but typically is deeper below hilltops and along the basin divides.

In the study area, the ground-water divides generally coincide with the topographic divides. In the southern part of Washington Township, however, the ground-water divide is as much as 0.75 mi south of the topographic divide. The water-table map shows that ground water in 3-mi^2 area of the Maurice River basin, which previously was assumed to flow southward from the topographic divide, is in fact flowing northward into tributaries of Mantua Creek and Big Timber Creek basin. Stream-discharge records at partial-record stations 01474950, 01474970, 01475000, and 01411456 (shown on sheet 3) confirm this finding. Stations 01474950, 01474970, and 01475000, in basins north of the topographic divide, each have a 7-day, 10-year base flow that is greater than the calculated flow based on the basin size. Station 01411456, south of the topographic divide, has a 7-day, 10-year base flow that is less than the calculated flow for other basins of similar size. The stream-discharge data, in conjunction with the water-table map, indicate that ground water is moving into the Mantua Creek and South Branch of Big Timber Creek basins from an area that previously was considered to be part of the Maurice River basin as defined by the topographic divide (unpublished drainage-divide maps in USGS files, West Trenton, N.J.).

Aquifer Properties

The hydraulic characteristics of the Kirkwood-Cohansey aquifer system, based on aquifer tests and well-acceptance tests, have been reported by Rhodehamel (1973) and are available in NJDEP well-record files. Figure 2-2 and table 2-1 show the locations and results of the nine aquifer tests that have been conducted since 1951. The horizontal hydraulic conductivity ranges from 90 to 250 ft/d, which is typical of a clean, coarse sand. The transmissivity, which is calculated by multiplying hydraulic conductivity by aquifer thickness, ranges from 4,300 to 20,000 ft^2/d [1]. The storage coefficient ranges from 3.0×10^{-4} to 4.4×10^{-2}, which is typical of semiconfined to confined aquifers. Many of the aquifer tests were conducted for only 8 to 12 hours, and the effects of local clay layers probably have affected the test results so that the wells appeared to be screened in a confined aquifer. If each aquifer test had been continued for 72 hours or more, the local clay layers probably would have had less influence on the drawdown; therefore, the storage coefficients probably are much larger than the results of the aquifer tests indicate. Larger storage coefficients would be consistent with wells screened in the water-table aquifer. On the basis of Darcy's Law, the parameters listed above, and the gradient shown on the water-table map, it is calculated that ground water flows out of the Maurice River basin at a rate of 1 ft^3/s.

The results of four soil tests to determine the hydraulic character of the underlying confining unit are shown in table 2-1. The vertical hydraulic conductivity of the confining unit underlying the Kirkwood-Cohansey aquifer system determined in laboratory tests ranges from 2.0×10^{-5} to 6.0×10^{-5} ft/d, which is typical of silt or mixtures of sand, silt, and clay. On the basis of the hydraulic character of the underlying confining layer and data from Martin (1990), the leakance of the confining layer is about 0.1 in/yr.

[1] Transmissivity is reported as $[(ft^3/d)/ft^2]$ cubic foot per day per square foot per foot of aquifer. This formula reduces to $[ft^2/d]$ foot squared per day. This reduced form is used in this report.

Water Levels

No long-term hydrographs of water levels in the Kirkwood-Cohansey aquifer system in the study area are available; however, the USGS maintains five water-level observation wells adjacent to the study area (fig. 2-3). Water- level records for two of these wells have been collected since 1962; for the other three wells, water-level records have been collected since 1972 (figs. 2-4 to 2-8). These records show that seasonal fluctuations of the water table typically are between 1 and 3 ft. Water-table altitudes have fluctuated as much as 8 to 10 ft during the 15- to 25-year period of record. Water levels in wells 1-256, 11-141, 11-42, and 11-162, which are located in an area that has undergone limited residential and commercial development during the periods of record, have remained relatively consistent. Water levels in well 7-503, however, which is located in an area that has undergone significant increases in both residential and commercial development during the period of record, show a declining trend from 1972 through 1986. The water-table decline could be the result of increased pumpage from the aquifer or a decrease in aquifer recharge resulting from the regional network of stormwater and sewer lines, which carry potential recharge water out of the area.

Table 2-1.--Results of aquifer tests and soil tests in the study area

[ft/d, foot per day; $(gal/d)/ft^2$, gallon per day per foot squared; ft^2/d, foot squared per day; (gal/d)/ft, gallon per day per foot; cm/sec, centimeter per second; Theis, Theis equilib, Theis equilibrium method; Theis non-eqi, Theis non-equilibrium method; Theim, Theim equation; Jacob semilog, Jacob Semilog method; --, value not calculated; NJDEP, New Jersey Department of Environmental Protection, Trenton, New Jersey; Schultes, W.C. Services., Inc., Woodbury, N.J.]

Aquifer test

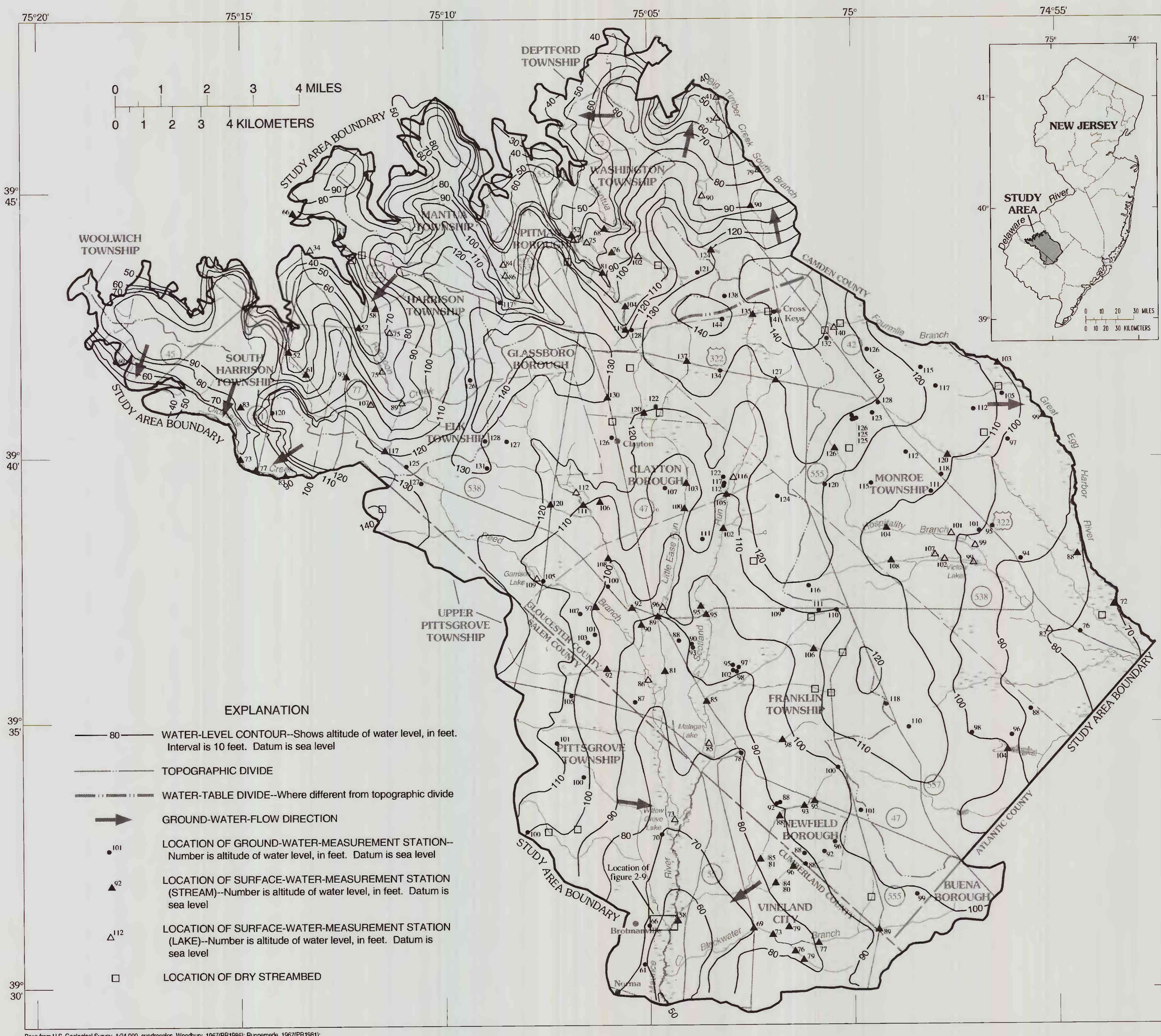
Test number	Location	Date	Evaluation method	Hydraulic conductivity (ft/d)	Hydraulic conductivity $((gal/d)/ft^2)$	Transmissivity (ft^2/d)	Transmissivity ((gal/d)/ft)	Storage coefficient	Reference
1	ViChem Water	1986	Theis equilib	--	--	9,100	68,300	4.0×10^{-4}	F.C.Hart Inc. (1986)
			Cooper Jacoh	--	--	10,500	78,800	3.4×10^{-4}	F.C.Hart Inc. (1986)
2	Vineland	1963-64	Theim	170	1,300	10,000	77,000	--	Rhodehamel (1973)
3	Clayton City	8/7/57	Jacob semilog	250	1,885	7,500	56,500	--	Rhodehamel (1973)
4	Williamstown #4	11/12/51	Jacob semilog	90	660	8,300	62,000	--	Rhodehamel (1973)
5	Monroe Twp #7	1979	Jacob semilog	--	--	6,700	50,600	--	Schultes files(1978)
6	Williamstown	1978	Jacob semilog	--	--	6,300	47,000	8.4×10^{-3}	NJDEP files
7	Cecil Fire	1982	Jacob semilog	--	--	5,900	44,000	1.4×10^{-2}	NJDEP files
8	Brotmanville	1966	Theis non-eqi	150	1,130	20,000	150,000	4.4×10^{-2}	Rhodehamel (1973)
9	Paulaitis	11/59	Theim	150	1,100	4,300	32,000	3.0×10^{-4}	Rhodehamel (1973)

Soil test

Test number	Soil location	Evaluation method	Hydraulic conductivity (ft/d)	Hydraulic conductivity (cm/sec)	Reference
10	Sheppards Mill Pond #3	Laboratory test	3.1×10^{-5}	8.17×10^{-3}	Nemickas and Carswell (1976)
11	Vocational High School #3	Laboratory test	5.2×10^{-5}	1.37×10^{-2}	Nemickas and Carswell (1976)
12	Gloucester Solid Waste Site	Laboratory test	6.0×10^{-5}	1.58×10^{-2}	Converse Cons. (1985)
13	Bostwich Lake 3	Laboratory test	2.0×10^{-5}	5.27×10^{-3}	Nemickas and Carswell (1976)

Table 2-2.--Observation wells for hydrographs in figure 2-3 through 2-8

Well number	Latitude	Longitude	Township	Local well identifier	Well depth
01-256	393333	0744426	HAMILTON	SCHOLLER BROS OBS 1	250
07-503	394440	0745931	WINSLOW	WINSLOW W C 5 OBS	76
11-042	392732	0750929	DEERFIELD	CUMBERLAND COUNTY VOCAT SCH 2	47
11-141	392219	0750113	MILLVILLE	MILLVILLE W D ORANGE ST OBS 1	49
11-162	392526	0750643	MILLVILLE	CUMBERLAND CO. FAIR GROUNDS 2	82



Base from U.S. Geological Survey, 1:24,000, quadrangles. PR - Photo Revision

Figure 2-1. Altitude of the water table in the study area, Autumn 1986.

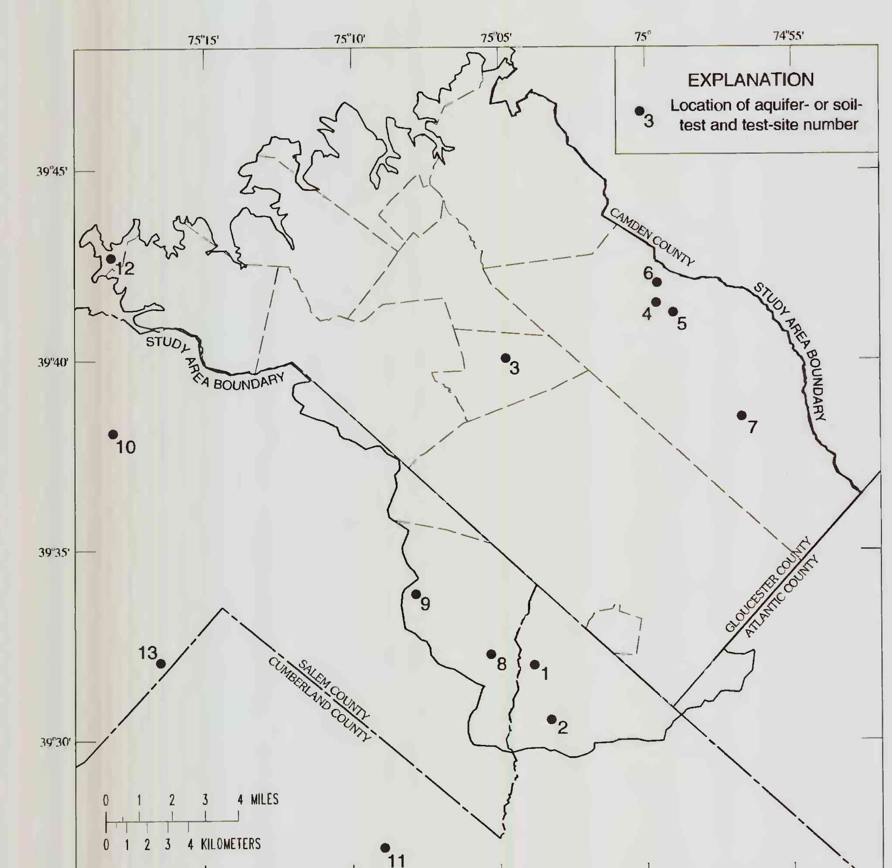


Figure 2-2. Locations of aquifer- and soil-test sites. (Data are listed in table 2-1.)

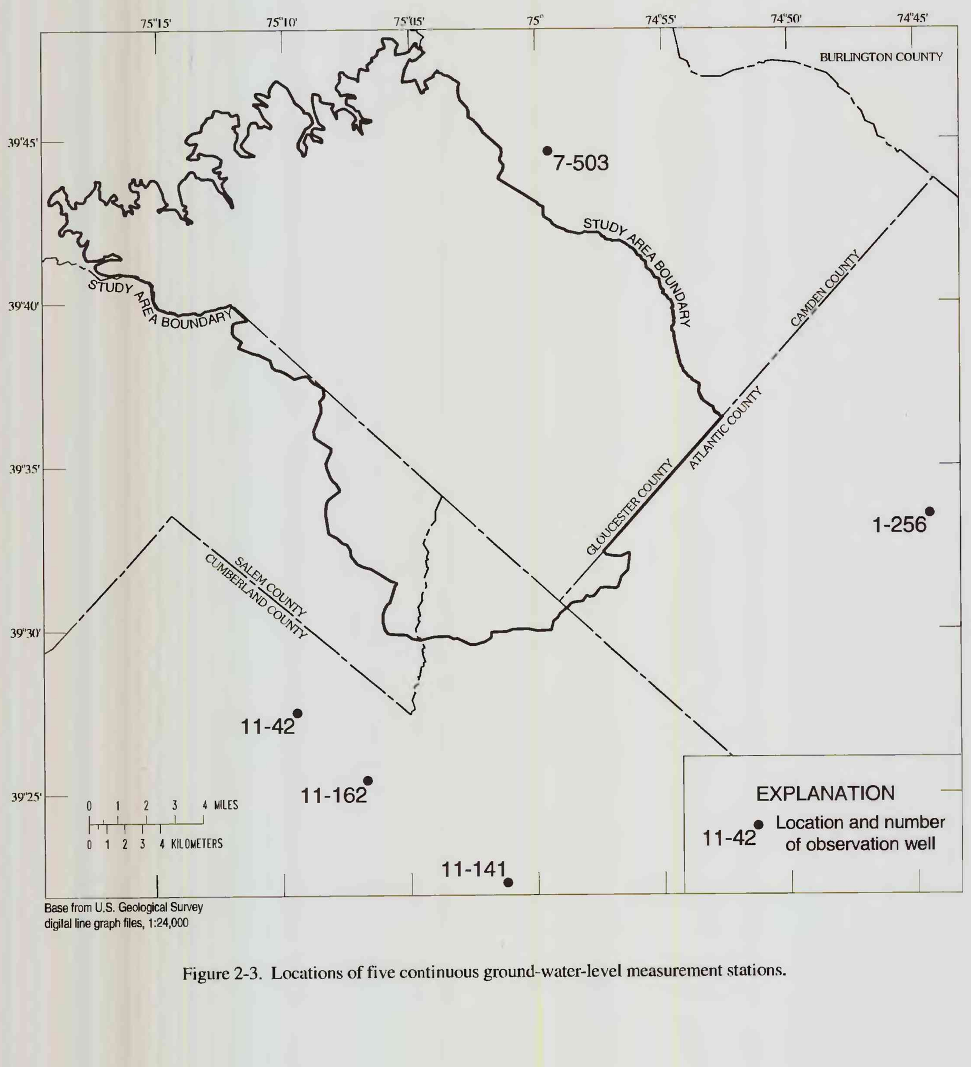


Figure 2-3. Locations of five continuous ground-water-level measurement stations.

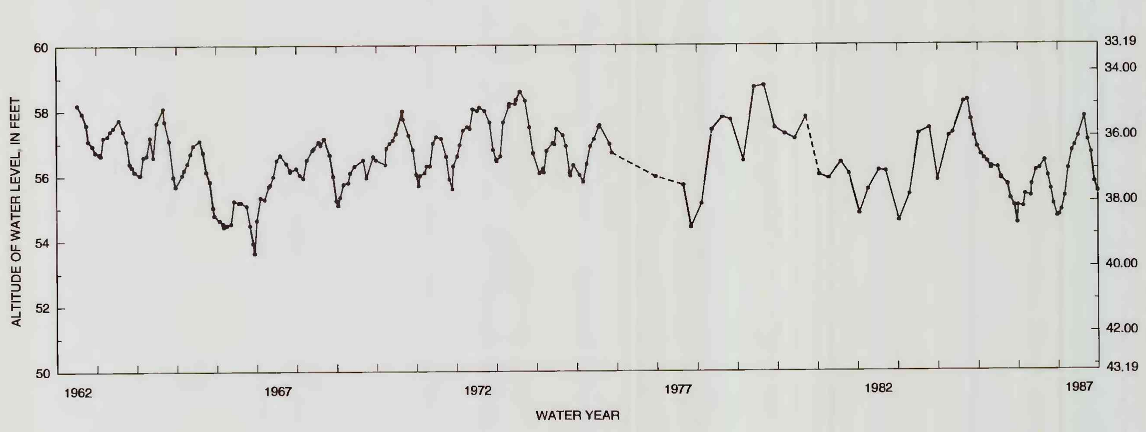


Figure 2-4. Hydrograph of ground-water level in observation well 01-256, 1962-87.

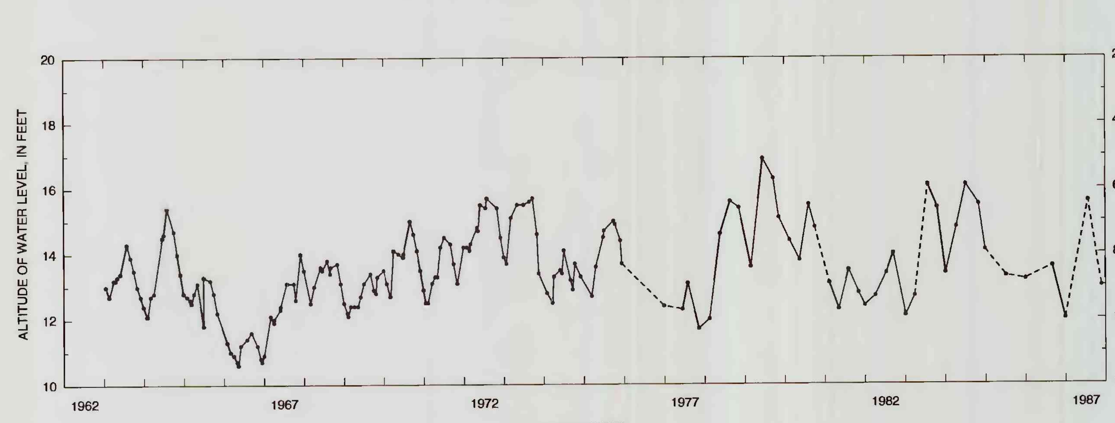


Figure 2-5. Hydrograph of ground-water level in observation well 11-141, 1962-87.

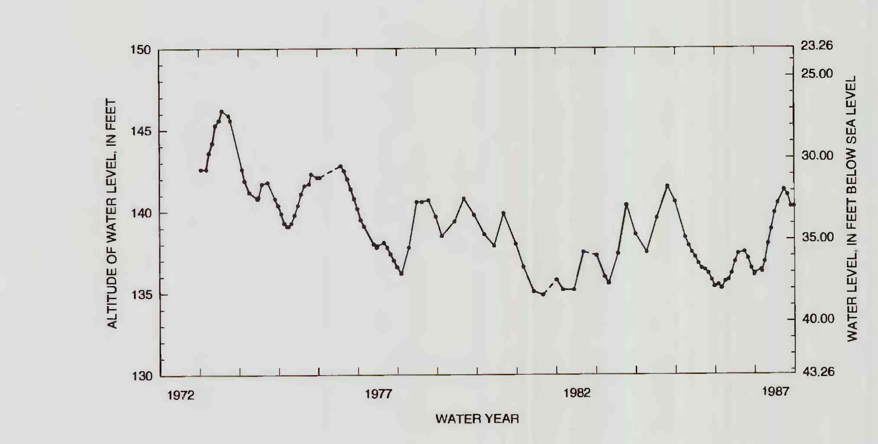


Figure 2-6. Hydrograph of ground-water level in observation well 07-503, 1972-87.

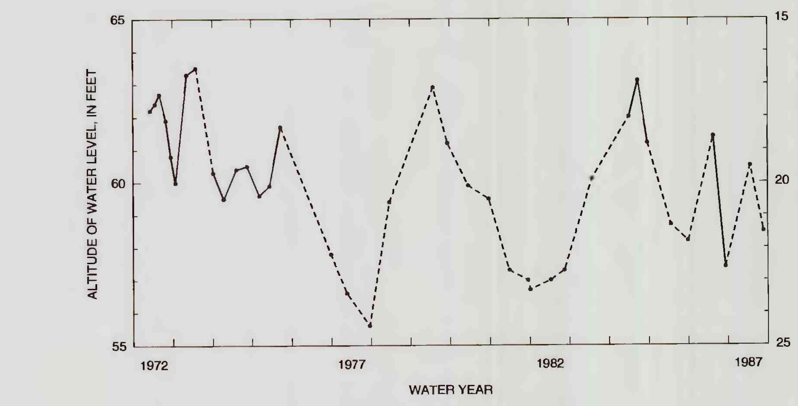


Figure 2-7. Hydrograph of ground-water level in observation well 11-162, 1972-87.

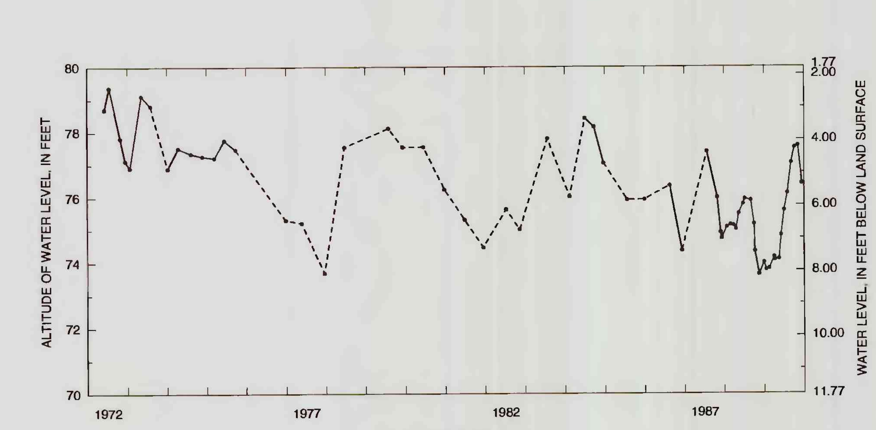


Figure 2-8. Hydrograph of ground-water level in observation well 11-042, 1972-89.

Depth of Shallow Flow System

An investigation to determine the relation between ground water and surface water in the study area was conducted during September 1987. Three temporary 2-in.-diameter drive-point wells with 18-in. screens were installed to measure the water level in the aquifer at the centerline of the channel, along the bank, and in the floodplain of the Maurice River east of Brotmanville (fig. 2-9). Each well was driven to discrete intervals below the stream or land surface, and then was pumped until the water was clear and had a constant temperature. Water samples were collected and the temperature, pH, and specific conductance of the water were measured. The hydraulic head at this interval was also measured. The drive point then was driven an additional 1, 2, or 5 ft below the stream or land surface, and temperature, pH, specific conductance, and head were measured again. This process was repeated until further penetration was difficult or, in the case of the well on the floodplain, no further significant change in head with depth was measured.

The hydraulic head, temperature, pH, and specific-conductance data are shown in figure 2-10. Heads in wells driven into the stream show that ground water from as deep as 55 ft below the river was flowing upward. At a depth of 55 ft, the head in the aquifer increased to 0.27 ft above the stream surface, indicating that ground water was discharging into the river. Heads in wells driven into the streambank were variable, but suggest the presence of a small upward flow component at depths less than 15 ft below land surface. This shallow upward flow suggests that shallow ground water is discharged into the stream. Heads in wells driven into the floodplain showed no change with depth, indicating that ground water did not discharge upward into the floodplain at the time of the test.

The greatest change in ground-water temperature was measured in the upper 5 ft below the stream surface. Temperature data (fig. 2-10) indicate that ground water at a depth greater than 10 ft beneath the stream surface was 14 to 14.5°C. Beneath the stream, pH ranged from about 4.5 to 5.5, and specific conductance ranged from 37 to 40 microsiemens per centimeter at 25°C.

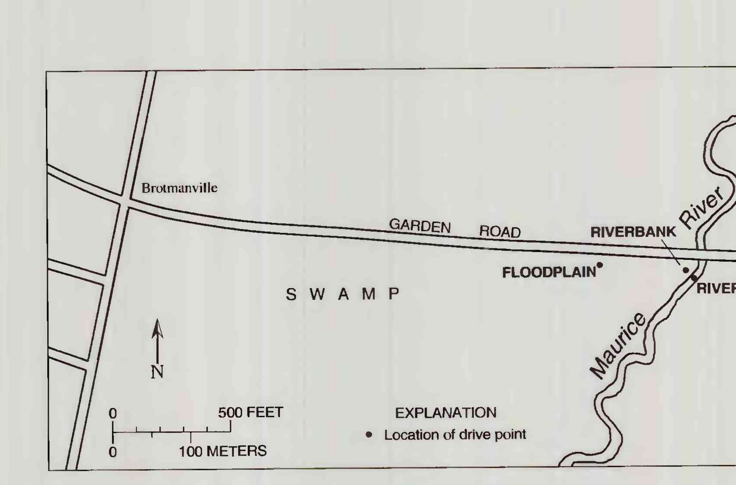


Figure 2-9. Location of the three drive-point sites in the center and on the banks of the Maurice River near Brotmanville, New Jersey.

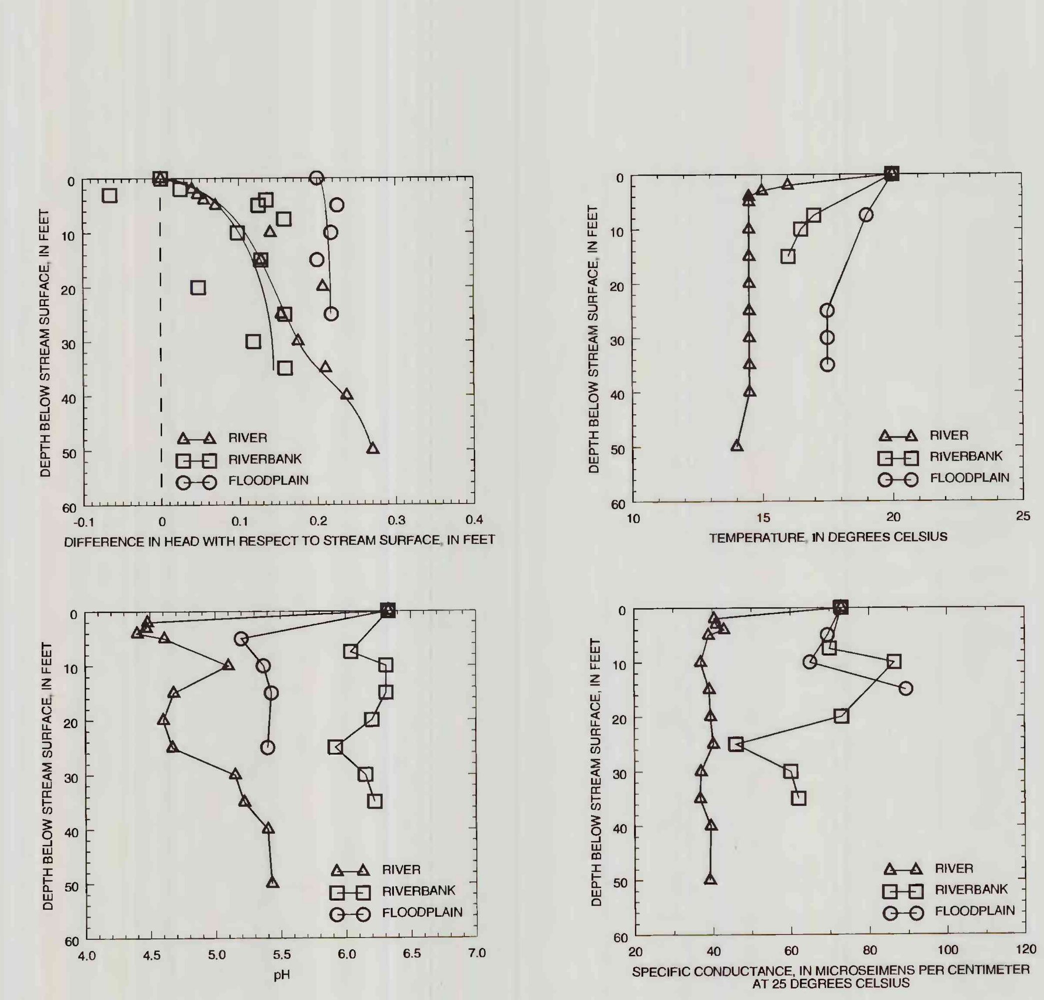


Figure 2-10. Variations of head, temperature, pH, and specific conductance with depth.

HYDROLOGY OF THE UNCONFINED AQUIFER SYSTEM IN THE UPPER MAURICE RIVER BASIN AND ADJACENT AREAS IN GLOUCESTER COUNTY, NEW JERSEY, 1986-87

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1995