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SPECIAL REPORT NO. 27

GEOLOGY AND GROUND-WATER RESOURCES
OF THE
RAHWAY AREA, NEW JERSEY

Prepared in cooperation with
United States Department of the Interior
Geological Survey

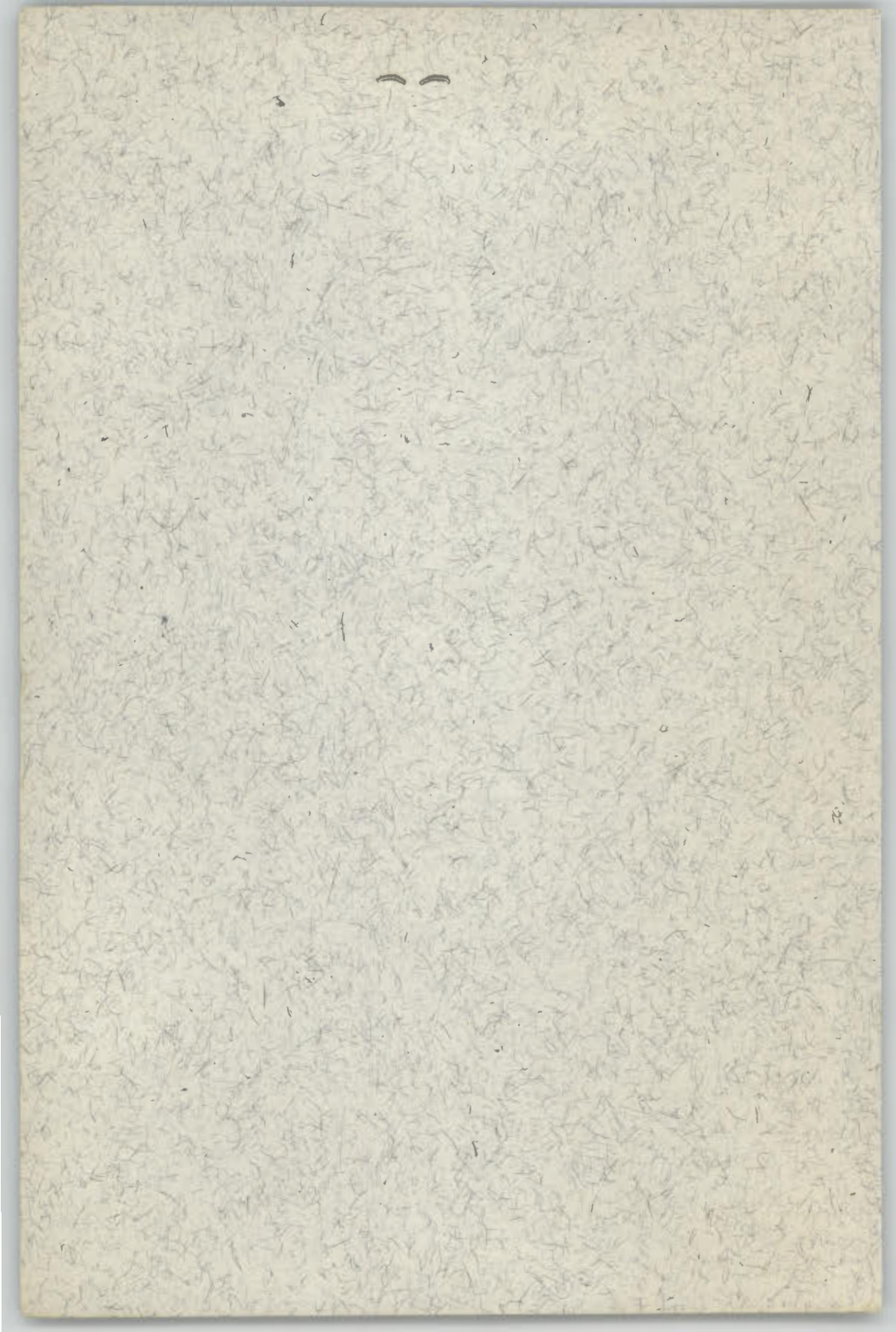
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**GEOLOGY AND
GROUND-WATER RESOURCES
OF THE
RAHWAY AREA, NEW JERSEY**

By

HENRY R. ANDERSON

Geologist, U. S. Geological Survey

SPECIAL REPORT NO. 27

1968

Prepared by the U. S. Geological Survey
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LETTER OF TRANSMITTAL

HONORABLE ROBERT A. ROE
Department of Conservation
and Economic Development

Dear Sir:

I am transmitting herewith a report entitled "The Geology and Ground Water Resources of the Rahway Area, New Jersey," which presents the results of an investigation that has been completed by the Ground-Water Branch, Water Resources Division, U. S. Geological Survey in cooperation with the Division of Water Policy and Supply.

The report discusses the quantity and quality of the ground water occurring in aquifers available in Rahway and adjacent areas in Union and Middlesex Counties.

This report provides investigation data which will be of value to this area as its economy develops. I therefore recommend that it be published as a special report of the Division of Water Policy and Supply.

Respectfully submitted,
George R. Shanklin
Director and Chief Engineer

January 8, 1968

**GEOLOGY AND GROUND-WATER RESOURCES OF THE
RAHWAY AREA, NEW JERSEY**

ABSTRACT

The Rahway area occupies 67 square miles of the Piedmont Plateau and Coastal Plain physiographic provinces in northeastern New Jersey. Lowlands, from less than 10 feet to 80 feet in altitude, constitute most of the area. A terminal moraine of Wisconsin age forms uplands that range in altitude from 100 to 240 feet. The Rahway River, the principal stream, follows a preglacial drift-filled channel through the city of Rahway, and flows into the Arthur Kill.

The Brunswick Shale of Triassic age which underlies the report area is a massive, fractured shale containing sandstone beds. It is more than 6,000 feet thick. The shale strikes N. 50° E. and dips about 9° to 12° NW. The Raritan Formation of Cretaceous age overlies the Brunswick unconformably in the southeast corner of the area. The Raritan Formation is a series of clays and sands of about 100 feet in thickness in the outcrop area. It strikes about N. 45° E. and dips less than 1° SE.

Wisconsin glacial drift, ranging in thickness from several feet on hilltops to 100 feet in the terminal moraine, blankets the Brunswick Shale and Raritan Formation.

About 6 mgd (million gallons of water per day) is pumped from the Brunswick Shale, which yields water from fracture openings and from pore spaces in the interbedded sandstone. As depth increases, the fractures become smaller and fewer in number and hence yield less water. Recharge to the Brunswick occurs through the hydraulically continuous overlying drift. Interference between wells in the Brunswick is greatest where wells are aligned along the strike of the formation and least where wells are aligned perpendicular to the strike. Both water-table and artesian conditions exist in the Brunswick Shale. Artesian conditions occur generally at depths greater than 100 feet; water-table conditions occur at shallower depths. The average yield of 150 industrial, public-supply, and domestic wells is 75 gpm (gallons per minute). The average specific capacity is 2.2 gpm per foot of drawdown and the average well depth is 218 feet. All industrial and public-supply wells in the Brunswick Shale having a specific capacity of less than one are in the southeastern half of the area.

Ground water from the Brunswick Shale is locally high in sulfate, dissolved solids, and hardness. This is owing to solution of gypsum and calcite in the formation. Concentrations of these constituents increase with depth.

Brackish water is contained in the Brunswick Shale along the tidal reach of the Rahway River and northward along the Arthur Kill. South of the Rahway inlet, the Raritan fire-clay, locally the basal member of the Raritan Formation, overlies the Brunswick Shale and retards seawater inflow from the Arthur Kill.

About 1 mgd is pumped from the Farrington Sand Member of the Raritan Formation in the report area. Twelve industrial wells have an average yield of 96 gpm, an average specific capacity of 9.5 gpm per foot of drawdown, and an average depth of 60 feet. The Farrington Sand Member is hydraulically separated from the Brunswick Shale by the basal Raritan fire-clay. Salt water is encountered in wells in the outcrop area adjacent to the Arthur Kill.

A stratified-drift deposit having an average thickness of 30 feet underlies the city of Rahway. More than a million gallons per day is pumped from four wells tapping both the drift and the underlying Brunswick Shale. The average yield of the wells is 370 gpm, and the average specific capacity is 15.3 gpm per foot.

INTRODUCTION

PURPOSE AND SCOPE

The ground-water study of the Rahway area, New Jersey, is part of a statewide program of water-resources investigations conducted by the U. S. Geological Survey in cooperation with the New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply. Earlier drafts of a report on this area were prepared by Henry C. Barksdale and John M. Birdsall, with later contributions by S. M. Lang, all of the Geological Survey, before the writer began work in 1960 under the general direction of Allen Sinnott, then district geologist.

The purpose of the study has been to make an appraisal of the ground-water resources of the area. It includes a description of the geologic features and their control on ground-water occurrence, together with an evaluation of the availability and quality of ground water.

The report includes descriptions of the geologic formations, a summary of the general geology and geologic history of the area, discussions of the water-bearing characteristics of the formations, and the quality of the ground water. In addition, the report includes tables of chemical analyses, well records and logs, and maps of the geology, bedrock configuration, and piezometric surface.

PREVIOUS INVESTIGATIONS

Detailed investigations of the Newark Group of Triassic age in New Jersey were first made by Kümmel. He described their petrology and occurrence in the annual reports of the State Geologist of 1896, 1897, and 1898. Lewis (1906) discussed the origin of the Newark sediments and their relation to the Triassic igneous rocks. Darton, Bayley, Salisbury, and Kümmel (1908) reported on the geography and the descriptive, structural, and economic geology of the area. Woollard (1941) compiled the results of geophysical surveys made in the State. McLaughlin (1946) studied the continuity and correlation of these rocks in Pennsylvania and New Jersey. A doctoral thesis by Sturm (1957) describes the mineralogy and petrology of the Newark Group. The paleotectonic folio of the Triassic (McKee and others, 1959) contains sections and maps of the paleogeology, lithofacies, and thicknesses of the Newark Group. Boch (1959) reported on the vertebrate fauna and their value in correlating the Newark Group.

Cretaceous sediments, which crop out in the southeastern part of the report area, were studied by Clarke (1892) and Weller (1904). Clarke published on their lithology and occurrence, and Weller on their paleon-

tology. Ries, Kümmel, and Knapp (1904) investigated the Raritan clays and the clay industry in the Woodbridge area. Recent works on the stratigraphy of the coastal plain are by Johnson and Richards (1952) and Spangler and Peterson (1950).

The Pleistocene deposits of the area were studied by Salisbury (1902). Hawkins (1910) believed that deformation of Cretaceous clays in the report area was caused by glaciation.

A description of the geology and geologic history of the State of New Jersey was presented by Kümmel (1940).

Vermeule (1894) published data on streamflow, precipitation, evaporation, and quality of surface waters of the State. He included discharge data and chemical analyses of the Rahway River. Surface-water chemical analyses were published also by Collins and Howard (1928). Chemical analyses of water samples from wells owned by the Plainfield-Union and Rahway water companies were published by Collins (1923), Collins, Lamar, and Lohr (1932) and Lohr and Love (1954). Barksdale and others (1943) reported on ground-water investigations in Middlesex county. The water-bearing characteristics of the Brunswick Shale and the coastal-plain formations in nearby areas were discussed by Barksdale and others (1958). In addition, Barksdale discussed ground-water depletion in the Rahway River drainage basin (1949). Langbein and others (1947) tabulated the topographic characteristics of the drainage basin.

Stream-discharge data collected by the Water Resources Division of the U. S. Geological Survey are available for the St. George Avenue bridge station (1908-15, 1921-63) on the Rahway River and for the Milton Lake station on Robinson Branch (1939-63).

Ground-water level records are available for the Hatfield Wire and Cable Company well in Rahway (1959-63) and for two wells in Kenilworth, north of the report area, at Union County Park (1943-63) and White Laboratories (1952-63). Surface-water and ground-water data are published annually in U. S. Geological Survey Water-Supply Papers.

ACKNOWLEDGMENTS

Cooperation by the New Jersey Division of Water Policy and Supply, and the office of the New Jersey State Geologist, for allowing access to files, is greatly appreciated.

Acknowledged also are the Rahway Water Department, the Plainfield-Union Water Company, and the many industries and local governments who cooperated in the collection of well information and water samples.

Special thanks are extended to Professor Allen C. Tester, State University of Iowa, for his valuable assistance during the preparation and writing of an earlier version of this report submitted as partial fulfillment of the requirements for the degree of Master of Science.

NUMBERING SYSTEM

Wells and test holes are assigned numbers according to the New Jersey topographic grid system. The first segment of the location number indicates the New Jersey State Atlas sheet number, the second designates a 6-minute quadrangle on the Atlas sheet, the third refers to one of nine 2-minute quadrangles into which each 6-minute quadrangle is divided, and the fourth and fifth segments refer similarly to further nine-fold subdivisions. The nine-fold divisions are numbered 1 through 9, left to right, beginning in the upper left-hand corner. If more than one well lies in the smallest subdivision (330 by 440 yards), an "A," "B," or "C," etc. is added to the well number. The subdivisions of the State topographic Atlas sheets are described in detail by Kümmel (1912). Most of the report area lies within Atlas sheet 26 except the west edge, which is in sheet 25. A diagrammatic explanation of the numbering system is shown in figure 1.

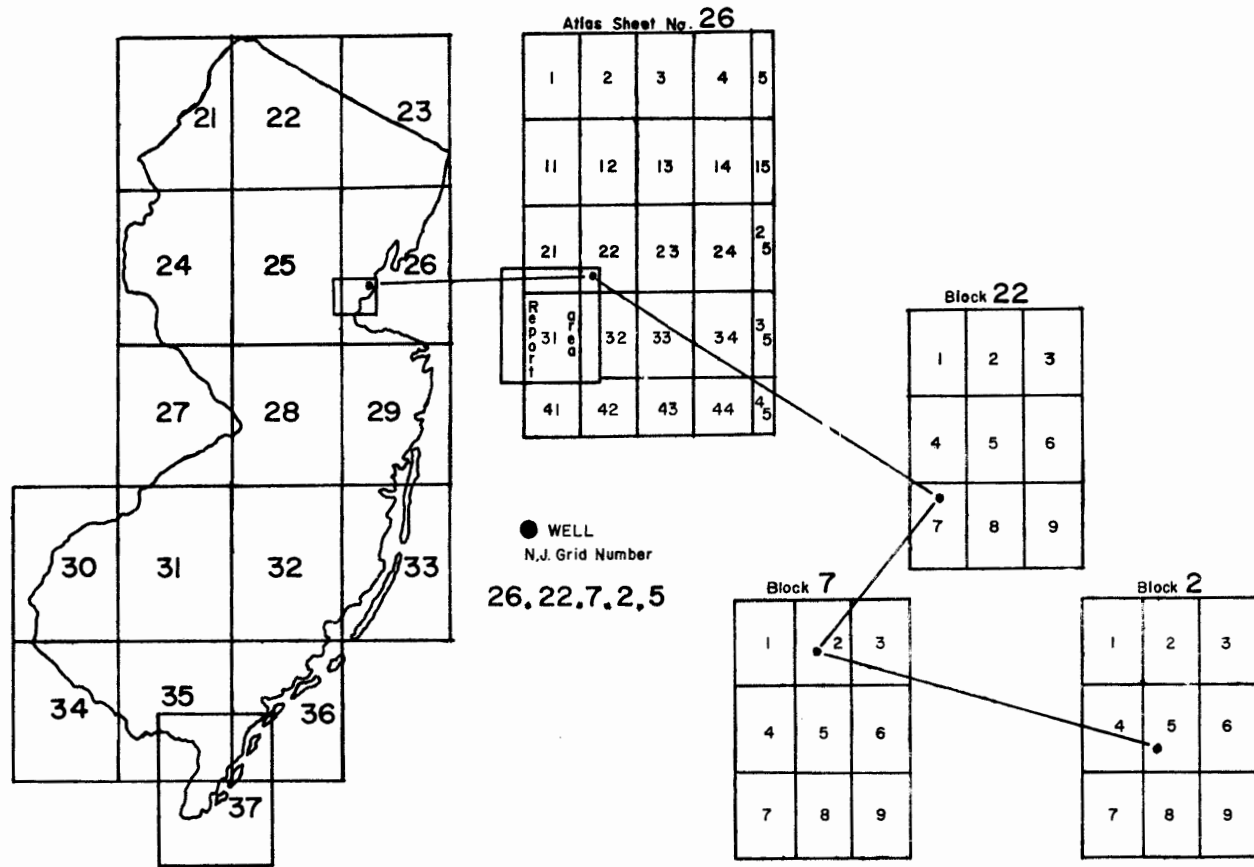


Figure 1.—Location of the Rahway area and method of numbering wells.

GEOGRAPHY

LOCATION AND EXTENT OF AREA

The Rahway area is in northeastern New Jersey (fig. 1). It is an area of 67 square miles between latitudes $40^{\circ}32'$ N and $40^{\circ}40'$ N and longitudes $74^{\circ}12'$ W and $74^{\circ}22'$ W (fig. 2); the Staten Island, New York, area is not included in this report. The city of Rahway is located in the geographic center of the report area. All or parts of the following towns and cities are included in the area: Carteret, Edison, Metuchen, Perth Amboy, and Woodbridge in Middlesex County and Clark, Elizabeth, Garwood, Linden, Rahway, Roselle Park, Scotch Plains, and Westfield in Union County (fig. 2). The area comprises parts of the following U. S. Geological Survey $7\frac{1}{2}$ -minute topographic quadrangle sheets, Arthur Kill, Elizabeth, Perth Amboy, and Roselle.

TOPOGRAPHY AND DRAINAGE

The Rahway area is largely in the Piedmont Plateau physiographic province. The present topography is that of a southeastward sloping preglacial surface modified by the deposition of drift of Wisconsin age. Drift blankets the entire area to varying depths. The upland area is dominantly terminal moraine of Wisconsin age (fig. 9) that forms a curved ridge from Perth Amboy northwestward to Metuchen and north to Westfield. Altitudes on the moraine range from 100 feet at Metuchen to 240 feet near Westfield. The surface of the terminal moraine is characterized by many knolls, hills, depressions, and ponds.

Lowlands lying northeast of the terminal moraine constitute most of the report area and form a gently undulating southeasterly sloping plain, decreasing in altitude from 80 feet above sea level in the north near Cranford to less than 10 feet above sea level at the Arthur Kill.

In general, the Rahway area is well drained except for swamps adjoining the terminal moraine in the Ash Brook and Menlo Park areas. The lowland is drained by perennial streams which follow approximately preglacial buried river channels. The Rahway River is the principal stream, and it meanders southeastward over a buried river channel. Robinson Branch begins in Ash Brook Swamp and flows eastward to join the Rahway River at Rahway. South Branch has its source in the terminal moraine near Roosevelt Park and flows northeastward to join the Rahway River about one mile south of the Robinson Branch junction. Other streams draining the area flow into the southward-flowing Arthur Kill that borders the report area to the east. Tide affects the Arthur Kill and parts of all streams flowing into it. Tidal conditions are found in the Rahway River up to the city of Rahway.

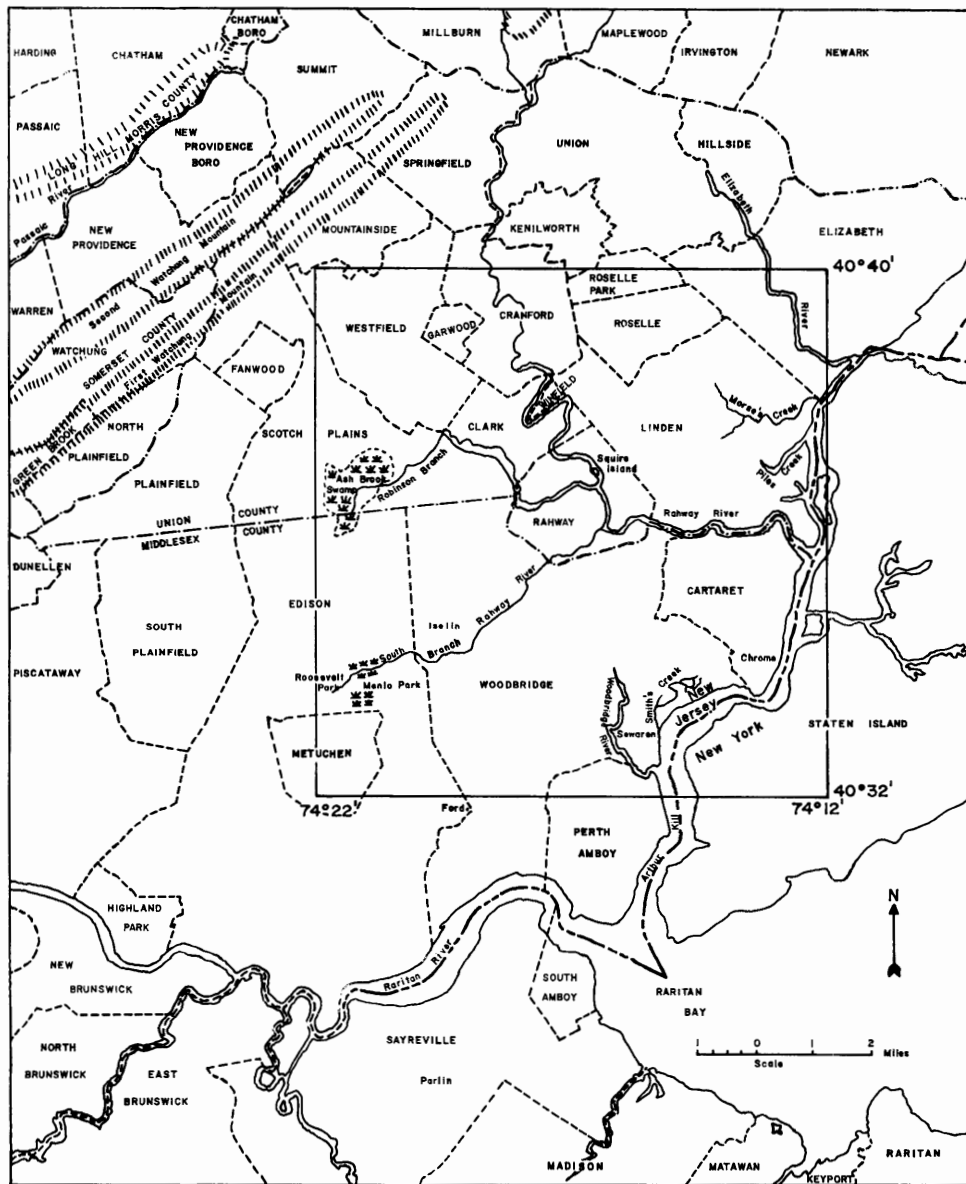


Figure 2.—Location of places named in this report.

According to Langbein and others (1947) the Rahway drainage basin has a stream density of 2.02 linear miles of stream per square mile of land area, a principal stream gradient (Rahway River) of 19.9 feet per mile, a tributary stream gradient average of 114 feet per mile, a principal stream length of 19 miles, a mean land altitude of 204 feet, and a surface-water area of 0.2 square mile. The average flow (1921 to 1966) of the Rahway River draining an area of 40.9 square miles is 43.3 cfs.

CLIMATE

The climate of the area is humid, typified by moist, warm summers, and moderately cold winters. Climatological data have been collected at a station in Elizabeth (latitude 40°40' N, longitude 74°14' W, altitude 33 feet) by the U. S. Weather Bureau since 1894. A summary of the climatological information is as follows:

The average annual precipitation is 48 inches, which includes a 4-inch water equivalent for 30 inches of snowfall. The annual average temperature is 53°F, which is also the average temperature of ground water at depths less than 100 feet. The average growing season or frost-free period is 187 days, extending from April 19 to October 23.

Evaporation at a Weather Bureau Class A evaporation station in Runyon was 8 percent greater than the precipitation during the growing season from 1932-42 (Barksdale, 1943).

GEOLOGY

STRATIGRAPHY AND STRUCTURE

The Rahway area is on the east edge of the northeast-southwest trending downfaulted Newark basin. The basin contains 15,000 to 20,000 feet of Triassic nonmarine shales, arkosic sandstones, conglomerates, and basic igneous rocks that make up the Newark Group (fig. 3). They unconformably overlie the schist and gneiss of the Wissahickon Formation of Early Paleozoic(?) age. The attitude of the Newark Group varies, but strikes N. 50° E., and dips 9° to 12° NW. The structure is complicated by extensive block faulting and fracturing.

Kümmel (1897) divided the Newark Group, from oldest to youngest, into the Stockton Formation, the Lockatong Formation, and the Brunswick Shale. The Brunswick Shale underlies the Rahway area.

Three basalt flows, each 500 to 800 feet thick, and an intrusive diabase sill about 1,000 feet thick are interbedded with the Triassic sediments. These resistant rocks form the Watchung Mountains, Hook Mountain, and the Palisades of New Jersey and New York.

The Raritan Formation of Late Cretaceous age ranges from 0 to more than 100 feet in thickness in the report area. It is the basal unit of the coastal-plain sequence, and it crops out in a belt extending from Salem to Perth Amboy, N. J. In the report area, the Raritan Formation consists of continental sands and clays overlying unconformably a beveled edge of the Brunswick Shale. The formation strikes N. 45° E. and dips less than 1° SE.

The Brunswick Shale and Raritan Formation are mantled by till and stratified drift of Pleistocene age up to 100 feet thick. The drift is thickest in the terminal moraine, which borders the area on the south and west. Locally, the Brunswick Shale is overlain by high terrace gravel and sand of the Pensauken Formation of Pleistocene age. The average thickness is about 25 feet.

Recent deposits which cover only a small area include river alluvium, and swamp, salt marsh, and eolian deposits.

The stratigraphic units in the Rahway area and their geologic and hydrologic character are given in table 1.

GEOLOGIC HISTORY

Interpretations of the geologic history of northern New Jersey are general and incomplete. The following summary is based largely on interpretations by Kümmel and Lewis (1940) and includes only the geologic history of the report area, from the Triassic to Recent.

During the late Triassic Period, part of the Piedmont Plateau underwent normal downfaulting that produced a series of northeast-southwest

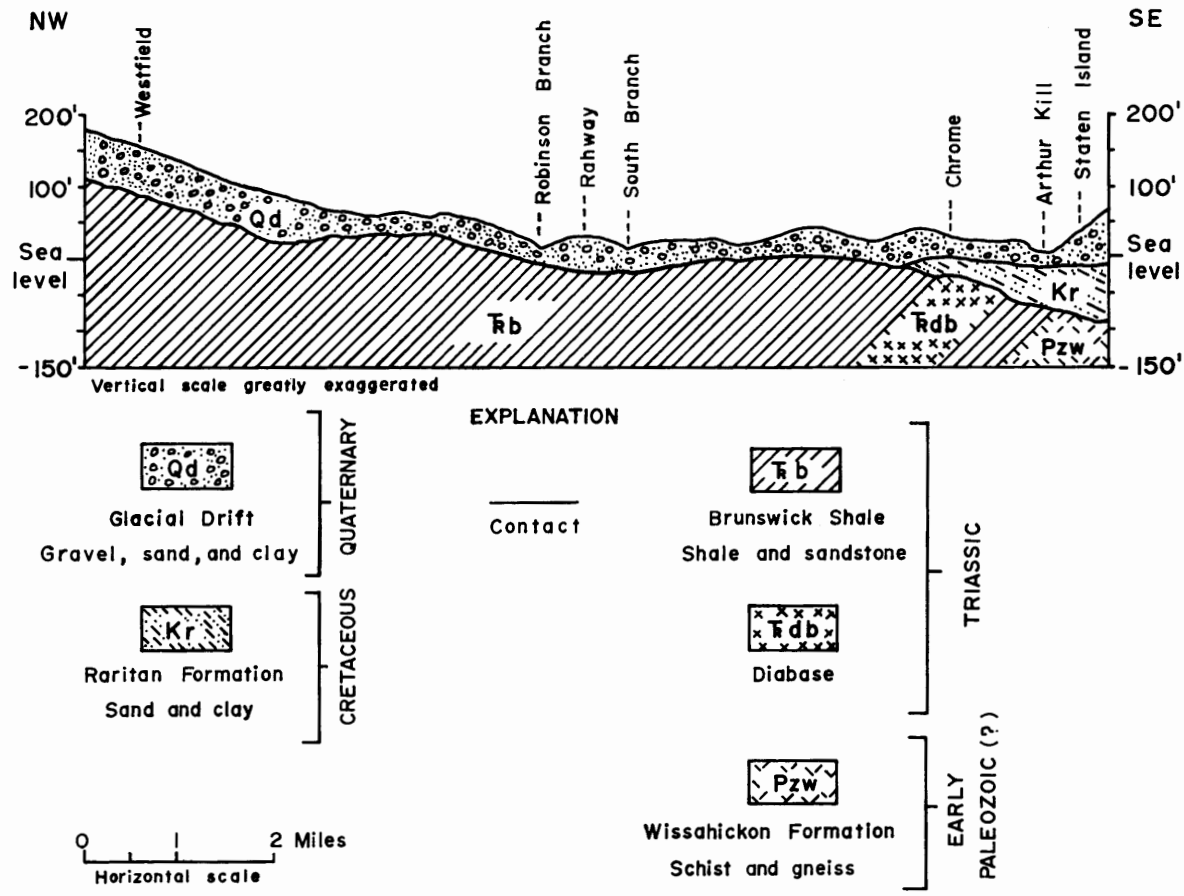


Figure 3.—Generalized geologic cross section through the Rahway area.

Era	Period	Epoch	Unit	Geologic characteristics	Hydrologic characteristics	
CENOZOIC	Quaternary	Recent	Alluvium	Muds and sands deposited in river channels and estuaries; 0 to 50 feet thick.	Muds are relatively impermeable and serve to retard seepage between rivers and the ground-water reservoir, and most important, to retard flow of saline water through river beds.	
			Eolian deposits	Sand, white, forming dunes along the Arthur Kill. Less than 10 feet thick.	Deposits lie above water table but transmit water readily to underlying sediments because of high infiltration capacity and permeability.	
		Pleistocene	Till	Clay, sand, and gravel, reddish-brown, unstratified, and unsorted. Forms most of the surficial ground and terminal moraine deposits; 0-100 feet thick. Deposited directly by glacier.	Not an important source of ground water because of low permeability and small thickness which lies below the water table. Yields water to dug domestic wells.	
			Stratified drift	Sand and gravel, sorted and stratified, occurring as fill in bed-rock channels and interbedded with till in the terminal moraine; 0-50 feet thick. Deposited by water.	Important as an aquifer only in the city of Rahway where wells tap both the Brunswick Shale and stratified drift and induce recharge from the Rahway River. Average well yield 370 gpm. Quality of water is good.	
			Pensauken Formation	Sand and gravel; chiefly quartz. Some pebbles and cobbles of shale, sandstone, quartz and crystalline rocks.	Yields no water to wells.	
MESOZOIC	Cretaceous	Late Cretaceous	Raritan Formation	Unconformity Sayreville Sand Member	Sand, fine to coarse, white, micaceous; contains clay and arkosic sand beds. Locally crossbedded. 0-40 feet thick.	Not an important source of water north of the Raritan River as much of it lies above the water table. At Sayreville, N. J. the specific yield ranges from 32 to 39 percent and the coefficient of permeability ranges from 30 to 500 gpd per sq. ft.
				Woodbridge clay	Upperbeds — clay, black lignitic; contains siderite, pyrite, and interbedded sand lenses. Lowerbeds — clay, varicolored and locally sandy. Total thickness 0-60 feet.	Confining bed.
				Farrington Sand Member	Sand, fine to very coarse, light colored; contains interbedded arkosic sand and clay. 0-80 feet thick.	Yields moderate amounts of good quality water. Average transmissibility 10,000 gpd per ft. Average well yield is 96 gpm. Salt water encountered in wells adjacent to the coast. Permeabilities at Parlin, N. J. range from 210 to 3,500 gpd per sq. ft. Specific yield ranges from 25 to 36 percent.
				Raritan fire clay	Clay, varicolored blue, brown, gray, or red. Reddish-brown at basal contact with Brunswick Shale. 2-35 feet thick.	Confining bed.
	Triassic	Late Triassic	Newark Group	Igneous intrusive	Buried diabase sill in southeastern part of report area that forms Palisades where it crops out on Staten Island.	Dense and relatively impermeable. No wells tap the sill.
				Brunswick Shale	Shale, reddish-brown, fractured; contains interbedded sandstone. Underlies glacial drift and Raritan Formation in the Rahway area. Altered to hornfels adjacent to diabase. 6,000 to 9,000 feet thick. Strikes N. 50° E. Dips 9-12° NW.	Most intensely developed aquifer in area. Yields small to moderate quantities of water from primary openings in sandstone and from secondary openings which decrease with depth in shale and sandstone. Water locally high in sulfate, total dissolved solids, and hardness. Both water table and artesian conditions exist. Interference is greatest between wells aligned along strike of formation. Average transmissibility 16,000 gpd per ft. Yield range 2 to 660 gpm. Average yield 75 gpm. Saline water encountered at depth (800 ft) and adjacent to the coast.

trending basins from Nova Scotia to South Carolina. West and east of the Newark basin, uplift occurred. Along the west margin of the basin, fan-shaped conglomerates (fanglomerates) were deposited throughout Late Triassic time. According to Carlston (1946), these fanglomerates indicate the drainage courses that existed during the Triassic. Within the Newark basin, sandstone, argillite, and shale of the Stockton, Lockatong, and Brunswick Formations were deposited in a continental environment.

Kümmel (1897) originally named the formations and considered them distinct lithologic units successively deposited under changing environmental conditions. Thus, each formation represents a distinct time-rock unit. However, the interpretation of McLaughlin and Willard (1949) differs: they suggest that the three formations were deposited contemporaneously and are actually different facies of a single formation. These facies result from changes in source areas of the sediments. Recent work by Boch (1959) on Triassic correlations in the northeastern United States supports Kümmel's interpretation of distinct time-rock units deposited in sequence.

Three periods of igneous flow and at least one intrusion occurred during the deposition of the Triassic sediments. The three basalt flows, two in the upper Brunswick Shale, compose the first and second Watchung and Hook Mountains. The intrusive rock is a diabase sill which forms the Palisades along the Hudson River.

The characteristic reddish-brown color of the Triassic sediments is caused by iron-bearing minerals which were oxidized to a hematitic clay as repeated wetting and drying of the sediments occurred during deposition.

At the close of the Triassic Period, the Newark Group was downfaulted on the northwest.

No sediments of Jurassic age occur, and erosion may have been the dominant process during this period. During the Cretaceous Period, according to Kümmel (1940), the area was tilted along an axis coinciding with the present shoreline. The landward side experienced uplift. Deposition near the coast in rivers and lakes produced a sequence of alternating clays, sands, and gravels that compose the Raritan Formation. Throughout the Tertiary Period, Cretaceous sediments on the Piedmont Plateau were eroded to approximately their present positions (fig. 4).

Evidence of Kansan and/or Illinoian Glaciation occurs as isolated patches of highly leached till south of the Wisconsin terminal moraine. These pre-Wisconsin age deposits cannot be differentiated in the field and are collectively mapped as the Jerseyan Till. Wisconsin Glaciation has removed or covered older glacial deposits north of the terminal moraine.

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HYDROLOGY

Water falls to the earth's surface as precipitation. Part is intercepted by vegetation, pavements, and buildings before reaching the ground and is evaporated. Part infiltrates the ground to become soil moisture, capillary water, and ground water. The remainder of the water runs off the land surface to the streams. Evaporation and transpiration take place during these processes, returning to the atmosphere moisture which eventually becomes precipitation again.

OCCURRENCE OF GROUND WATER

Water that percolates to the zone of saturation is ground water. The water table is the upper surface of the zone of saturation and separates that zone from the overlying zone of aeration. The moisture content of the zone of aeration ranges from saturation to a dry state.

Ground water in the Rahway area is stored in and transmitted through pore spaces of unconsolidated sediments such as glacial drift and the Raritan Formation. Joints and other fractures store and transmit the water in the consolidated rocks of Triassic age.

Water-table, or unconfined, ground-water conditions exist when the top of the zone of saturation is at atmospheric pressure. Such conditions occur in the stratified drift in Rahway, in the outcrop area of the Raritan Formation, and at shallow depths in the Brunswick Shale.

Artesian, or confined, conditions occur where ground water is under hydrostatic pressure greater than atmospheric pressure. Pumping from a confined aquifer quickly lowers the artesian pressure and water levels drop rapidly in nearby wells penetrating the same aquifer. Artesian conditions are found in the deeper parts of the Brunswick Shale and in the Raritan Formation beneath the Woodbridge clay. Several artesian wells in the Brunswick Shale flow; these are aligned northeast-southwest along the South Branch of the Rahway River. These wells probably tap a common fracture or fault system which trends northeast-southwest through the area.

MOVEMENT OF GROUND WATER

Ground water moves from points of high ground-water head to points of lower ground-water head. The generalized water-level contour map of the area (fig. 5) shows the altitudes of ground-water levels at the time of well completion. As water-level highs generally coincide with topographic highs, ground water flows generally in the same direction as overland surface flow. Ground-water movement is toward the Rahway River and its branches and through the gravel-filled valley extending from Rahway to the Arthur Kill. Hydraulic gradients range from less than

10 feet per mile, in the Rahway lowland, to more than 80 feet per mile in the southwest half of the area, where the greatest topographic relief occurs.

RECHARGE, DISCHARGE, AND WATER-LEVEL FLUCTUATIONS

Recharge to the zone of saturation occurs primarily from precipitation that infiltrates the soil and percolates to the water table. The amount of precipitation that reaches the water table varies throughout the year and depends on the vegetative cover, soil moisture and permeability, temperature, and the type, duration, and intensity of precipitation.

Ground-water recharge may occur also along streams and lake banks by influent seepage from surface-water bodies after heavy rainfalls. The river or lake level rises faster from direct precipitation and surface runoff than does the water table. The slope of the water table is temporarily reversed and surface water seeps into the aquifer. This water is bank storage and is returned to the stream or lake once the surface-water level falls below the water table.

When the amount of water reaching the zone of saturation exceeds the amount being withdrawn by natural and artificial discharge, the water table rises. As shown in figure 6a, the rise in water levels indicates recharge exceeds discharge from the end of October to the middle of April, during the time when evapotranspiration is lowest.

Discharge of ground water occurs both naturally and artificially. Discharge by natural means includes effluent seepage to perennial streams, lakes, and tidal areas; transpiration by plants whose roots extend to the water table or the overlying capillary fringe; and evaporation where the water table is near the land surface. Ground water is discharged artificially by the pumping or flowing of wells. Discharge from flowing wells in the Rahway area is slight. The amount removed by pumping, however, is significant and is about 8 mgd, of which about 5 or 6 mgd are from the Rahway River watershed area.

The decline in water level in the hydrograph of observation well 26.21.5.4.6 (fig. 6a) shows that discharge exceeds recharge to the water table during the growing season, April through October. The decline in ground-water levels is accompanied by a decrease in stream runoff, April through October (fig. 6b). Stream runoff declines partly because as the water-table gradient decreases, ground water discharge to the streams decreases. Overland flow to streams also decreases during the spring-summer period because most precipitation either evaporates or infiltrates the soil, where it is transpired by plants. It is apparent from figure 6c that evapotranspiration is at its peak and exceeds precipitation

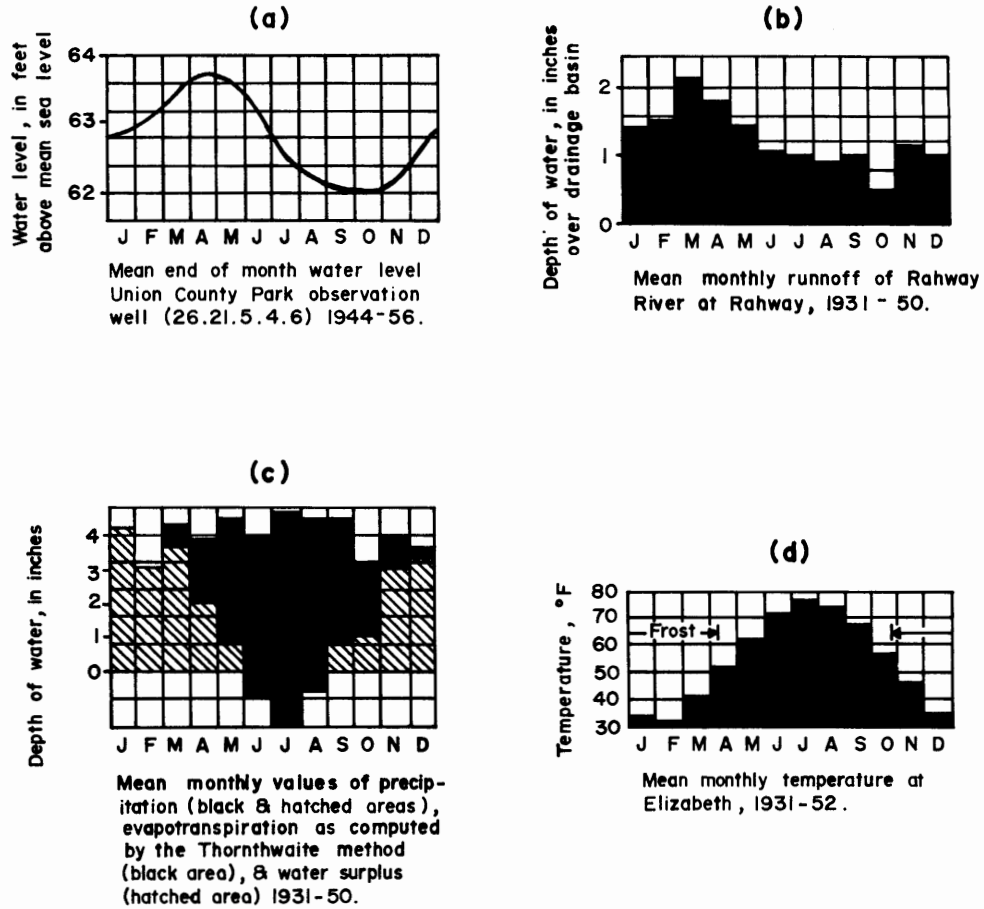


Figure 6.—Graph showing mean monthly values of (a) ground-water levels, (b) runoff, (c) precipitation, evapotranspiration, water surplus, and (d) temperature.

in June, July, and August. As no water surplus occurs during these months, little or no water percolates to the water table. After September, although a water surplus occurs, water levels continue to decline, and stream runoff continues to decrease as soil moisture is being replenished.

The soil controls to a degree the amount of precipitation that becomes surface runoff and ground-water recharge after the growing season. When soil moisture is near field capacity (usually after the first frost, fig. 6d), water percolates to the zone of saturation, recharge then exceeds discharge, and water levels rise until the beginning of the next growing season.

The hydrograph for the Union County Park observation well (fig. 7) shows that water levels in the area dropped abruptly after the early part of 1953. This change in water level, which has been noted also in other wells in the area, does not appear to be related to changes in precipitation but is probably a result of increased pumpage.

DEFINITIONS OF GROUND-WATER TERMS

The *coefficient of permeability* is the rate of flow of water in gallons per day through a cross section of one square foot under a unit hydraulic gradient. The standard coefficient is defined for water at a temperature of 60°F. The field coefficient is defined in terms of the prevailing water temperature.

The *coefficient of transmissibility* is the rate of flow of water, in gallons per day, at the prevailing water temperature, through each vertical strip of the aquifer one foot wide having a height equal to the saturated thickness of the aquifer and under a unit hydraulic gradient.

The *coefficient of storage* of an aquifer is the volume of water it releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface; it is expressed as a decimal fraction. For water-table aquifers, this essentially equals the specific yield.

Specific capacity is the discharge of a well per unit of drawdown, generally gallons per minute per foot.

The *specific yield* of a rock or soil, with respect to water, is the ratio of (1) the volume of water which, after being saturated, it will yield by gravity to (2) its own volume.

QUALITY OF GROUND WATER

The mineral content of ground water is related closely to the composition of the soil and rocks through which the water percolates. Concentrations of the dissolved constituents depends on temperature and pressure

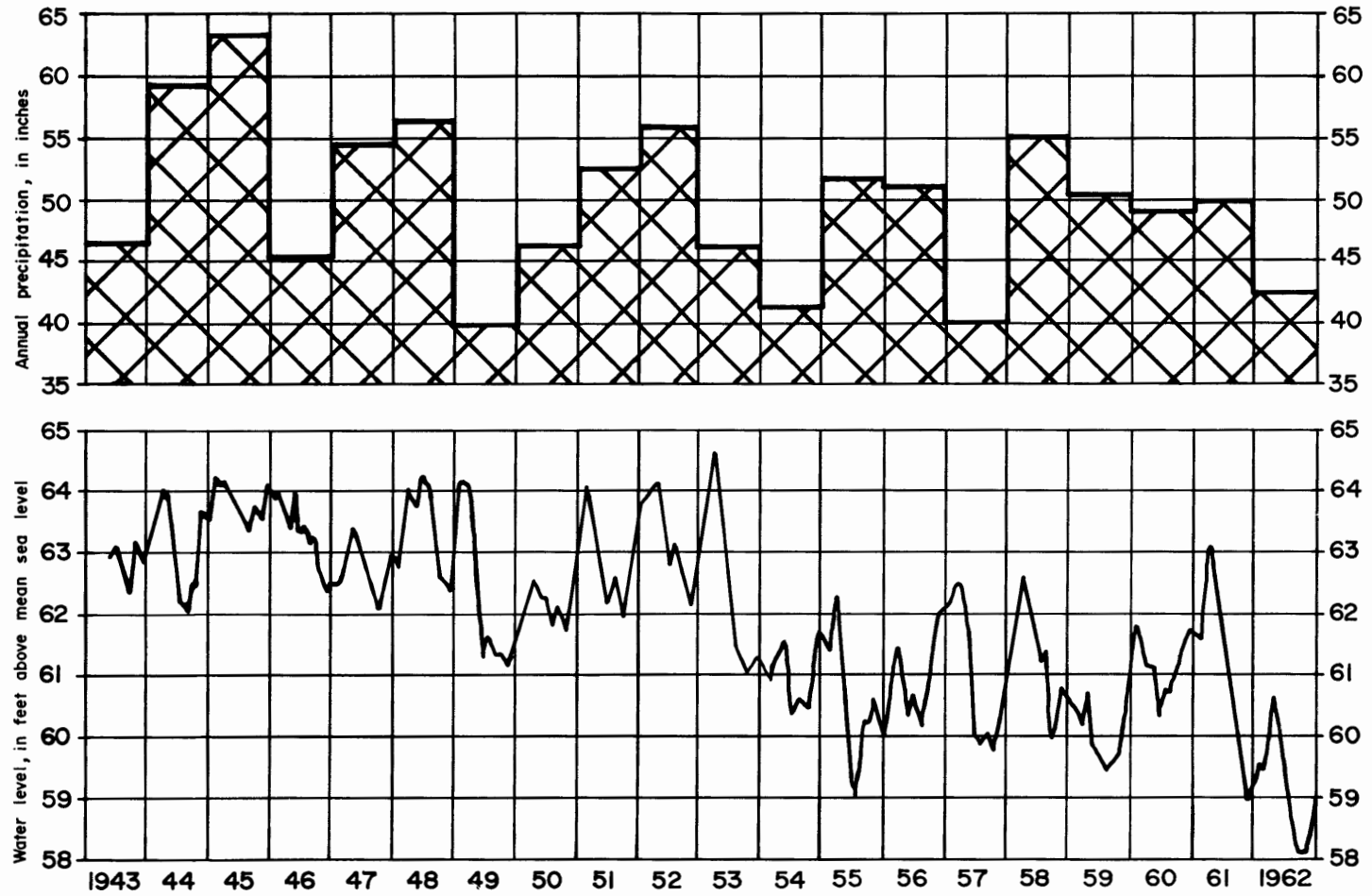


Figure 7.—Hydrograph of Union County Park observation well (26.21.5.4.6) and precipitation at Elizabeth, (1943-62).

of the water, hydrogen-ion and carbon dioxide concentration of the water, the length of time the water is in contact with rock, and the quantity and solubility of the minerals in the rock or soil. The analyses of water samples from the report area show no unusually high or harmful concentrations of mineral matter except for high sulfates and calcium in water from the Brunswick Shale, and high chlorides in water from the Raritan Formation adjacent to the Arthur Kill. Samples for this investigation (table 4) were collected in the summer of 1960 and analyzed at the U. S. Geological Survey laboratories in Philadelphia. Also analytical results were obtained from well owners during the course of the study. Mineral constituents are reported in parts per million by weight.

The specific conductance of water is a measure of the water's ability to conduct an electric current and is dependent upon the concentration of dissolved solids in the water. It is reported in micromhos per centimeter at 25°C. Maximum concentrations of mineral constituents recommended by the U. S. Public Health Service (1962) are given in table 2. Moore (1940) lists tolerances for industrial use (table 3).

Table 2.—Recommended maximum concentrations of mineral constituents in drinking water.

(U. S. Public Health Service, 1962)

	<i>Parts per million</i>
Iron	.3
Manganese	.05
Magnesium	125.0
Chloride	250.0
Sulfate	250.0
Total dissolved solids	500.0
	(when no better water is available) 1,000.0
Nitrate	45.0

The Water Resources Division, U. S. Geological Survey, classifies hardness in parts per million as:

0- 60	soft
61-120	moderately hard
121-180	hard
greater than 180	very hard

TABLE 3.—SUGGESTED WATER-QUALITY TOLERANCES FOR INDUSTRIAL USE

Allowable limits in parts per million. Source of data E. W. Moore. (1940) P. indicates that potable water conforming to U. S. Public Health Service standards is necessary
Iron as Fe limit given, applies to both iron alone and the sum of iron and manganese

Industry or use	Turbidity	Color	Hardness as CaCO ₃	Iron as Fe	Manganese as Mn	Total solids	Alkalinity as CaCO ₃	Odor and taste	Hydrogen sulfide	Other requirements
Air conditioning				0.5	0.5			Low	1	No corrosiveness, slime formation
Baking	10	10		.2	.2			Low	.2	P.
Boiler feed										
Brewing:										
Light beer	10			.1	.1	500	75	Low	.2	P. NaCl less than 275 ppm (pH 6.5-7.0).
Dark beer	10			.1	.1	1,000	150	Low	.2	P. NaCl less than 275 ppm (pH 7.0 or more)
Canning:										
Legumes	10		25-75	.2	.2			Low	1	P.
General	10			.2	.2			Low	1	P.
Carbonated beverages	2	10	250	{.2 .3}	.2	850	50-100	Low	.2	P. Organic color plus oxygen consumed less than 10 ppm.
Confectionery				.2	.2	100		Low	.2	P. pH above 7.0 for hard candy
Cooling	50		50	.5	.5				5	No corrosiveness, slime formation.
Food General	10			.2	.2			Low		P
Ice	5	5		.2	.2			Low		P. SiO ₂ : less than 10 ppm.
Laundrying			50	.2	.2					
Plastics, Clear, uncolored	2	2		.02	.02	200				
Paper and pulp:										
Groundwood	50	20	180	1.0	.5					No grit, corrosiveness.
Kraft pulp	25	15	100	.2	.1	300				
Soda and sulfite	15	10	100	.1	.05	200				
High-grade light papers	5	5	50	.1	.05	200				
Rayon (viscose)										
Pulp production	5	5	8	.05	.03	100	Total 50; hydroxide 8			Al ₂ O ₃ less than 8 ppm. SiO ₂ less than 25 ppm. Cu less than 5 ppm.
Manufacture	.3		55	.0	.0					pH 7.8 to 8.3.
Tanning	20	10-100	50-135	.2	.2		Total 135; hydroxide 8			
Textiles; General	5	20		.25	.25					
Dyeing	5	5-20		.25	.25	200				Constant composition. Residual alumina less than 0.5 ppm.
Wool Scouring		70		1.0	1.0					
Cotton bandage	5	5		.2	.2			Low		

WITHDRAWAL OF WATER

Approximately 8 to 10 mgd of water is withdrawn by industry and public water-supply companies from aquifers in the Rahway area. Most industries obtain water from wells, but those near salt-water contaminated areas or those requiring exceptionally large amounts of water, such as Merck Chemical Co. or Esso Standard Oil Co., purchase water from public water-supply companies.

Three public water-supply companies obtain all or part of their water from within the report area. The Plainfield Division of the Elizabethtown Water Co. owns several wells that tap the Brunswick Shale near Westfield. The Middlesex Water Co. obtains water from wells most of which are located outside of the Rahway area and from surface water from Robinson Branch. The Rahway Water Department obtains its water from the Rahway River and four wells adjacent to the river. Water diversion from the report area by these companies in 1966 was as follows:

	Pumpage from the Rahway area (mgd) in 1966	
	<i>Ground water</i>	<i>Surface Water</i>
Plainfield Division of the Elizabethtown Water Co.	1.83	
Middlesex Water Co.	.04	3.8
Rahway Water Dept.	1.4	3.7

GEOLOGIC FORMATIONS AND THEIR HYDROLOGIC CHARACTERISTICS

TRIASSIC SYSTEM

Brunswick Shale

Geology

The Brunswick Shale is the youngest formation of the Newark Group, which consists of the Stockton Formation, Lockatong Formation, and the Brunswick Shale. The Brunswick Shale has the most extensive outcrop area and is composed of 6,000-8,000 feet of fractured reddish-brown shale and locally interbedded sandstone. Sandstone beds increase in abundance northeastward, becoming predominant in the northernmost part of the outcrop area in New Jersey. Along the northwest edge of the outcrop, the Brunswick grades into a conglomerate. According to Boch (1959), the red color originates from reworked hematite, which comprises 5 to 10 percent of the formation. Although red predominates, some purple, green, yellow, and black layers occur in the lower 2,000 feet of the Brunswick.

In the Rahway area, the characteristic reddish-brown shale constitutes most of the formation, although interbedded sandstone and green and black shale also occur. Glacial drift blankets the Brunswick in most of the area, but exposures can be seen at Iselin and Menlo Park. Shale intruded by the Palisade Diabase is altered into a spotted hard slate that is dark green to gray in color.

The Brunswick Shale strikes N. 50° E. and dips 9° to 12° NW in the report area. The predominant system of fractures strikes about N. 45° E. and is vertical. A second, less prominent, system strikes N. 75° W. and is nearly vertical.

The presence of ripple marks, mudcracks, raindrop impressions, reptile footprints, and plant, reptile, and fish fossils indicates that the Brunswick Shale was deposited in a shallow-water continental environment.

The source of the sediments is generally considered to be Precambrian or early Paleozoic(?) metamorphic and igneous rocks to the southeast. The occurrence of detrital micas and feldspars support this.

The Brunswick Shale conformably overlies and is interfingered with the Lockatong Formation. In northern New Jersey, where the Lockatong is absent, the Brunswick overlies the Stockton Formation.

On exposure to weathering, the shale disintegrates readily into blocky and nodular-shaped fragments and chips that flake off along the bedding planes (fig. 8). The shale ultimately disintegrates into a hard clay.

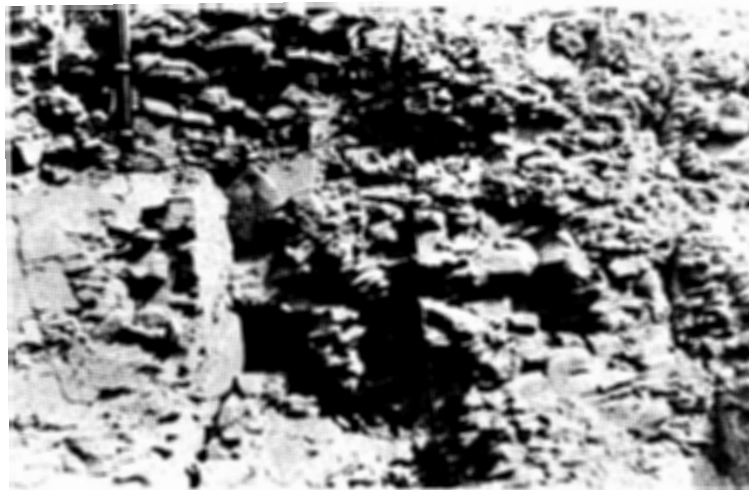


Figure 8.—Photograph of exposure of the Brunswick Shale on the north shore of the Raritan River at Perth Amboy, showing the secondary fractures and nodular-shaped weathering fragments.

HYDROLOGIC CHARACTERISTICS

More ground water is obtained from the Brunswick Shale than from any other formation in the Rahway area. Approximately 90 percent of the wells in the report area tap the Brunswick, and they yield a total of more than 6 mgd. The remaining 10 percent of the wells obtain water from the Raritan Formation or glacial drift.

Water is stored and transmitted primarily in the secondary fracture openings that formed after the deposition of the sediments. The primary opening or pores between the particles in the shale are too small to transmit water readily. Locally, the fracture openings are widened by percolating ground water that dissolves material from the walls of the fractures. The size of the fracture openings generally decreases, with depth, because the weight of overlying rock increases.

Cavities formed by the solution of calcite and gypsum may be common locally, but are not considered an important source of ground water.

The Brunswick Shale and the overlying glacial drift are hydraulically continuous in most areas. Infiltrated precipitation percolates directly through the till or stratified drift and into the fracture openings of the shale.

Ground water occurs under both water-table and artesian conditions in the Brunswick Shale. If the fractures have nearly vertical dips and

are hydraulically continuous with permeable drift, ground water is unconfined and water-table conditions prevail. This condition is found commonly in wells less than 100 feet deep. A decline in the water level in a water-table well indicates that part of the aquifer has been dewatered.

Where the fracture openings do not extend upward to permeable drift or where permeable sandstone layers are interbedded with impermeable shale, ground water is confined under artesian pressure. The lowering of the water level in an artesian well reflects changes in pressure within the aquifer and does not indicate dewatering of the aquifer. Wells penetrating the Brunswick Shale are uncased below the glacial drift, so both water-table and confined zones may be intercepted in a single well.

The observation well at Hatfield Wire and Cable Co. (26.31.2.3.5) responds as an artesian well. The water level in this well lies below the regional water table and drops about 6.4 feet in 2 hours when an air-conditioning well (26.31.2.5.3.) 3,500 feet to the southwest begins pumping. The two wells are aligned parallel to strike and probably penetrate the same system of bedding-plane fractures or sandstone beds. Other wells nearly at right angles to a line connecting these two and only a few hundred feet distant from the pumping well show a smaller drop in water levels. This suggests that water levels in wells aligned perpendicular to the strike of the Brunswick Shale interfere less with one another than wells aligned parallel to the strike.

The Brunswick is not a homogenous isotropic aquifer as the permeability varies greatly from one area to another as well as with direction at any one locality. In most cases, the drawdown rate in an observation well is greatest when the observation well and the pumped well are aligned parallel to the strike of the formation. Data obtained by Herpers and Barksdale (1951) from pumping tests in Newark, New Jersey, demonstrated similar conditions.

Wells that tap the Brunswick Shale range in yield from 2 to 660 gpm, and the average is 75 gpm. Yields of wells larger than 6 inches in diameter (non-domestic use) average 140 gpm.

Specific capacities of all Brunswick Shale wells range from 0.1 to 25 gpm per foot of drawdown and average 2.2. For wells larger than 6 inches in diameter, the average specific capacity is 3.6 gpm per foot of drawdown. Wells 26.21.8.2.9A and 26.31.1.3.1B (table 5) in the northwestern half of the area, penetrate sandstone beds and have specific capacities greater than 7. All industrial and public-supply wells with a specific capacity of less than one occur southeast of a diagonal line extending from Metuchen to Elizabeth. Hence, specific capacities are, on the average, greater in the northwestern than in the southeastern half of the area.

Depths of wells in the Brunswick Shale range from 60 to 1,566 feet and average 218 feet. For wells larger than 6 inches in diameter, the average depth is 340 feet.

Quality of water

The quality of water in the Brunswick Shale varies greatly with locality and depth. The ground water in some areas is highly mineralized, averaging more than 500 ppm of dissolved solids. Locally, it contains excessive amounts of sulfate.

Mineralization of ground water generally increases with depth. This relation is illustrated by the Merck well (26.31.2.6.7B), which is 1,108 feet deep. Water samples from the Merck well contained 1,795 ppm sulfate and 280 ppm calcium. Ground water from the Squire Island (26.31.2.6.4) 300-foot well and the Milton Lake (26.31.2.7.4) 301-foot well, contain 1,358 and 883 ppm sulfate, 279 and 198 ppm calcium, and 2,660 and 1,445 ppm dissolved solids, respectively. The Security Steel well (26.31.5.9.4), which is 614 feet deep, yields water with only 162 ppm sulfate, 67 ppm calcium, and 528 ppm dissolved solids. The unusual concentrations of sulfate and calcium may be from solution of calcite and gypsum layers within the formation.

The tidal reaches of the Rahway River and Arthur Kill also have high concentrations on these constituents but low chloride concentrations in the well samples indicate that salt-water intrusion is not the cause of the high mineralization.

The average temperature of water in the Brunswick Shale is about 55°F. Temperatures are generally lowest near the water table and increase with depth. The Standard Oil Company well (26.32.1.1.8) drilled in May 1920 to a depth of 1,556 feet encountered water which increased in temperature from 70° to 90°F below 800 feet in depth.

Salt-water contamination

Because the Brunswick Shale has at least a partial hydraulic connection with the Arthur Kill, whose water has a chloride concentration greater than 15,000 ppm, an interface is developed between the salt water of the estuary and the less dense, fresh ground water in the aquifer. According to the Ghyben-Herzberg principle (Drabbe and Ghyben, 1889 and Herzberg, 1901) the hydrostatic pressure at the base of a 41-foot column of fresh water of density 1.000 equals the hydrostatic pressure at the base of a 40-foot column of salt water with an average density of 1.025. Applying this relation to coastal aquifers such as the Brunswick Shale, salt water theoretically occurs 40 feet below sea level where the ground-water head in a well is one foot above sea level. Consequently, if ground-water levels are allowed to decline to below sea

Consequently if ground-water levels are allowed to decline below sea level, the fresh ground water will be replaced eventually by sea water.

Brackish water is contained in the Brunswick Shale along the tidal reach of the Rahway River and northward along the Arthur Kill. South of the Rahway inlet, the Raritan fire-clay overlies the Brunswick and retards sea-water inflow.

CRETACEOUS SYSTEM

Raritan Formation

Geology

The Raritan Formation of Late Cretaceous age covers about 9 square miles in the southeast part of the Rahway area. Most of the formation is overlain by glacial drift, but is exposed at the surface where commercial clay and sand pits have been developed. The Raritan Formation was named by T. A. Conrad in 1869 who described its lower clay members exposed along the Raritan River.

The Raritan Formation consists of light-colored alternating sands, clays, and gravels of continental origin, interbedded with tongues of marine sediments. The upper and lower parts of the formation are predominantly sand, the lower sands being coarser and more arkosic than the upper. The middle of the formation contains white clays which weather to red, and also dark lignitic clays that grade laterally and vertically into white or red non-carbonaceous clays. The sands are characteristically well sorted, medium to coarse grained, and micaceous; they are locally cross-bedded. The clays are massive, plastic, and contain pyrite, lignite, and carbonized material which imparts a bluish or gray color.

The thickness of the Raritan changes locally because the materials were deposited on an irregular surface of Triassic, Precambrian, and early Paleozoic(?) rocks. In outcrop, the thickness ranges from 150 to 300 feet. Downdip to the southeast, it thickens to more than 1,000 feet.

A variety of fossil fauna and flora which have been found include brackish water and marine pelecypods, dicotyledons related to modern flora, and dinosaur footprints. The Raritan is considered to be Late Cretaceous in age.

Kümmel (Ries, Kümmel, and Knapp, 1904) divided the Raritan in Middlesex County into seven members according to lithology. The members were later renamed by Barksdale and others (1943), from oldest to youngest, (1) Raritan fire clay, (2) Farrington Sand Member, (3) Woodbridge clay, (4) Sayreville Sand Member, (5) South Amboy fire clay, (6) Old Bridge Sand Member, (7) Amboy stoneware clay. Because of their lenticular nature, the members are not traceable outside the

county. The four lower units crop out in the report area and will be discussed as Kummel described them.

The Raritan fire clay is a white, light blue, or spotted red clay that grades downward into a reddish-brown color toward the underlying Brunswick Shale. It ranges from 2 to 35 feet in thickness and is found mostly in depressions in the Brunswick Shale where it grades almost imperceptibly into the Brunswick. The top of the clay is undulatory and is overlain by the Farrington Sand Member of the Raritan Formation or by glacial drift.

The Farrington Sand Member is mostly an angular quartz sand containing, locally, thin beds of gravel and seams of clay. The upper part is a medium- to fine-grained sand, and the lower 10 to 20 feet are light-gray to light-yellow, coarse, arkosic sand containing rounded quartz and black chert pebbles 6 to 50 mm in diameter. The maximum thickness of the sand in Middlesex County is 80 feet, but it is thinner in the Rahway area.

The Woodbridge clay overlies the Farrington Sand Member. The Woodbridge ranges in thickness from 50 to 80 feet but it is eroded to 20 feet in some exposed areas. It ranges from a fire clay at the base to a black laminated lignitic clay at the top. The thickness of the upper bed ranges from 30 to 60 feet where it is not eroded. The basal fire clay is light blue to gray or mottled red in color and has an average thickness of about 20 feet. The average quartz sand content of the fire clay is about 5 percent; however, the bottom and top parts contain as much as 50 percent sand. The base of the fire clay is undulatory. Its upper surface is irregular where glaciers have scoured away some of the top material.

The Sayreville Sand Member is an irregular channel-fill deposit composed of a feldspar sand and a kaolin sand. The sands are lenticular and do not occupy definite stratigraphic horizons. The feldspar sand contains subrounded quartz grains, kaolinized feldspar, and clay pellets. The kaolin sand is a micaceous, very fine-grained white quartz sand containing white clay. At Sayreville, 8 miles southwest of Woodbridge, the Sayreville Sand Member is predominantly medium to coarse grained.

Hydrologic Characteristics

The Raritan Formation, unlike the Brunswick Shale, yields water primarily from the intergranular pore spaces. The Raritan lies almost wholly outside the Rahway River watershed. Its aquifers are separated hydraulically from the underlying Triassic shale by the basal Raritan fire clay. In the outcrop areas of the sands of the Raritan Formation, ground water is unconfined. Downdip where the sands underlie clay beds, confined or artesian conditions exist.

The Sayreville Sand Member is discontinuous laterally and much of it lies above the water table; therefore, it is not an important source of water north of the Raritan River. Laboratory analyses of samples from exposures in Sayreville showed specific yields ranging from 32 to 39 percent and coefficients of permeability ranging from 30 to 500 gpd per square foot. The two clay members, the Raritan fire clay and the Woodbridge clay, do not yield water and act as aquicludes for the Farrington Sand Member.

Barksdale and others (1943) estimate that about 1.9 mgd was pumped from the Farrington north of the Raritan River in the 1930's and early 1940's. However, salt water, drawn in by the pumping of wells along the Arthur Kill, forced many industries to obtain water from inland public-water supply companies so that at present, only about 1 mgd is pumped from the Farrington Sand for a few large industries in the Rahway area.

Most wells tapping the Raritan have water levels that are less than 10 feet above sea level. Hence, north of the Raritan River, the aquifer has little potential yield because lowering water levels to sea level will eventually result in replacement of fresh ground water by salt water.

Results of 15 pumping tests conducted at the California Oil Company (26.31.8.8.9) in October 1950 showed a range in transmissibility from 7,000 to 14,000 gpd per foot and an average of 10,000 gpd per foot. The coefficient of storage ranged from 0.003 to 0.00001, indicating artesian conditions.

The coefficient of transmissibility of the Farrington at Parlin, which is south of the report area, is several times greater than that at the California Co. site because the aquifer is thicker there. Transmissibilities computed from pumping tests in the Parlin area are as high as 100,000 gpd per foot; the average is 50,000 gpd per foot—five times the value of the California Company tests. At Parlin, the aquifer is 80 feet thick, which is about twice as thick as it is at the California Co. site. Laboratory determinations of the coefficient of permeability of the Farrington Sand Member at Parlin range from 210 to 3,500 gpd per square foot and average 1,650 gpd per square foot. Specific yields range from 25 to 36 percent and average 31 percent.

Yields of 12 industrial wells range from 6 to 300 gpm and average 96 gpm. Specific capacities range from 1.9 to 39 and average 9.5 gpm per foot of drawdown. Wells tapping the Raritan Formation in the report area range in depth from 40 to about 120 feet, the greater depths occurring downdip. The average depth is about 60 feet.

Quality of water

The quality of the water from the Raritan Formation is very good for most uses. It rarely contains excessive amounts of sulfate or dissolved solids, and it is not as hard as water from the Brunswick Shale. Total dissolved solids range from 154 to 384 ppm. The temperature of the water averages about 54°F.

Salt-water contamination

Salt-water encroachment has occurred in areas where there are heavily pumped wells adjacent to the Arthur Kill. However, 1 mile or more inland there is generally sufficient fresh-water head to allow, indefinitely, present rates of withdrawal with safety. If encroachment were to occur inland, salt water probably would flow laterally into the Farrington outcrop from Woodbridge Creek and the Arthur Kill near Sewaren. Encroachment in an updip direction from the Raritan River is possible also, as discussed by Barksdale and others (1943).

QUATERNARY SYSTEM

Pleistocene Series

Pensauken Formation

The oldest deposit of Pleistocene age in the Rahway area is the Pensauken Formation, which forms the high terrace in the southwestern corner of the area. The Formation consists chiefly of quartz sand and gravel. In addition, pebbles and cobbles of shale, sandstone, quartzite, and crystalline rocks are present. So far as known, no wells obtain water from the Pensauken Formation.

Glacial Drift

Geology

Glacial drift mantles the Brunswick Shale and the Raritan Formation (fig. 9) and forms the land surface of the report area. The drift has an average thickness of about 25 feet, but ranges in thickness from a few feet on bedrock hilltops to 100 or more feet in the terminal moraine. Till, which is poorly sorted unstratified drift, occurs as ground or terminal moraine. It was deposited directly by the ice sheet. Till in the report area is characteristically a reddish-brown clay, derived from the Brunswick Shale, and contains pebbles and boulders of resistant gneiss, quartzite, sandstone, quartz, and diabase derived from rocks north of the terminal moraine. Pebbles of the Brunswick Shale are rare because the material disintegrates readily into small particles.

Stratified drift, which was deposited by glacial melt waters, occurs in lowland areas north and south of the terminal moraine, as well as

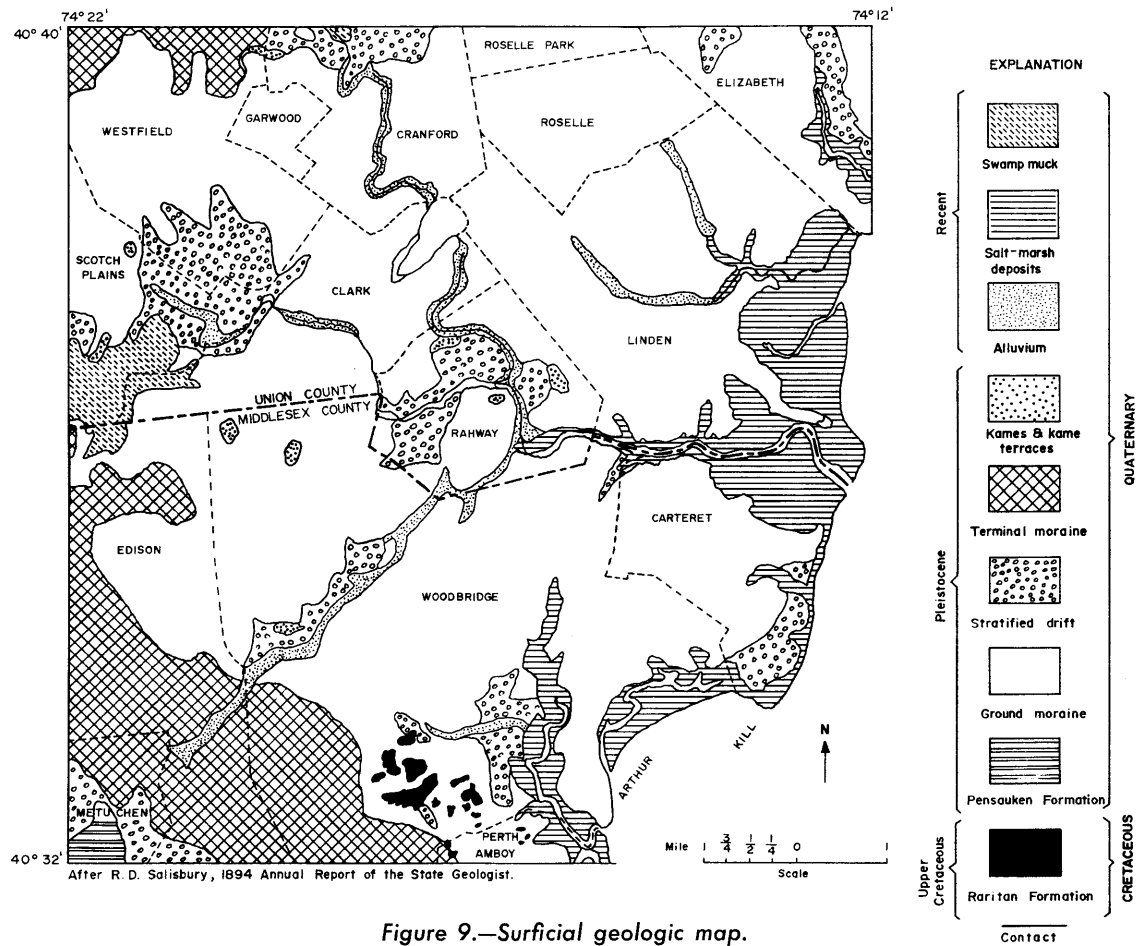


Figure 9.—Surficial geologic map.

interbedded with till in the terminal moraine. The sand and pebbles are similar in mineralogy to those in the till, but the stratified drift contains very little clay.

The most important water-bearing drift deposit is that underlying the city of Rahway. It is predominantly a sand, containing interbedded gravels and till, that fills a preglacial stream valley. The stratified drift has a maximum thickness of 50 feet near the confluence of the Rahway River and Robinson Branch; the average thickness is about 30 feet. The lithology and general character of this deposit are variable (fig. 10).

In well drained areas, the glacial drift is leached and oxidized to a depth of 2 to 3 feet. The upper 6 to 10 inches is a dark-red-brown soil.

Hydrologic characteristics

The stratified drift filling the buried valley in Rahway is the only important aquifer of Pleistocene age in the report area. The Rahway Water Department withdraws more than a million gallons of water a day from four wells that are screened 15 feet in the stratified drift and penetrate 25 to 50 feet into the underlying Brunswick Shale. The water is obtained from both stratified drift and the Brunswick Shale. The wells are near the Rahway River, and much of their yield is water induced into the aquifers from the river. The average yield of the four 10-inch diameter wells is 370 gpm. The average specific capacity is 15.3 gpm per foot. A 6-inch observation well in the well field which taps only the drift has a yield of 125 gpm, and a specific capacity of 6.2 gpm per foot.

Aquifer-test data are lacking for the stratified drift at Rahway, but some indication of its water-bearing capacity may be inferred from grain-size distribution of eight samples taken from two test wells drilled in Rahway. Laboratory coefficients of permeability for water-yielding materials having size distributions similar to the drift at Rahway are in the order of 1,000 gpd per sq ft or greater (Wenzel, 1942, p. 13). Accordingly, if the drift at Rahway has a saturated thickness of 30 feet, its coefficient of transmissibility is probably about 30,000 gpd per ft or greater. The coefficient of storage is probably between 0.1 to 0.2.

Till is not an important source of ground water in the report area because it has a low permeability, and much of it lies above the zone of saturation. In river valleys, 30 to 40 feet of till may lie below the water table. However, on bedrock hilltops capped with till the water table may be in the underlying Brunswick Shale.

An important function of glacial drift is to absorb, store, and transmit water to the underlying fractured shale wherever they are hydraulically connected. The transmissibility of the stratified drift in Rahway is ap-

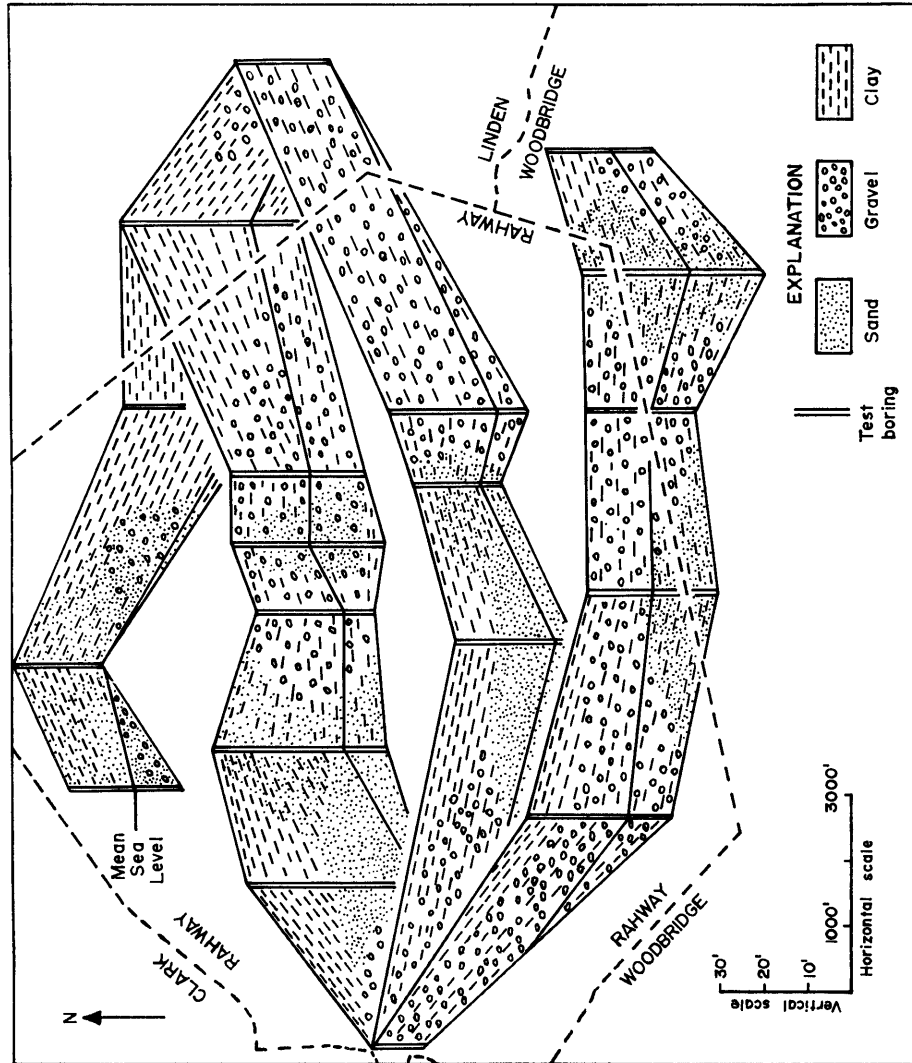


Figure 10.—Schematic fence diagram of the glacial drift underlying the city of Rahway.

proximately twice that of the underlying shale and can readily transmit water from storage or from induced river recharge to wells in the Brunswick Shale. Usually, where the drift cover is thickest, as in river valleys, the yields of wells in the underlying Brunswick are greatest.

Generally, ground water in the glacial drift is unconfined. However, where stratified drift is overlain by clay lenses, such as in Rahway and the Ash Swamp area, artesian conditions occur.

Quality of water

The quality of water in the drift is generally good, and thus is satisfactory for most uses. Total dissolved solids for 5 samples collected in 1949 range from 200 to 355 ppm and hardness ranges from 110 to 210 ppm.

Salt-water contamination

Salt-water has not intruded the stratified drift beneath the city of Rahway as this deposit is several miles inland from a salt-water source. Salt-water contamination can occur, however, in the drift along the river banks during high tide if withdrawal of ground water from stratified drift and the Brunswick Shale should lower ground-water levels below river level. River water would, then, seep into the ground-water reservoir.

This potential threat of salt-water encroachment would be greatly increased during extended dry periods, or in the autumn after the growing season, when river and ground-water levels are lowest and high tides encroach farthest inland. Such a dry period occurred in 1949, when there was no flow in the Rahway River below the Rahway Water Department intake. Streamflow at the USGS gaging station 2,000 feet downstream was only 0.6 mgd, indicating that there was an average of only 300 gpd contributed by ground-water discharge per foot of stream length.

Recent Series

Recent deposits of alluvium occur in the river channels. Where the stream gradient is sufficiently low, as in tidal reaches, fine-grained matter is flocculated by the sodium in sea water and deposited. Muds high in organic matter have accumulated in the Arthur Kill estuary attaining a thickness of up to 50 feet in Raritan Bay. These deposits are relatively impermeable and protect the coastal aquifers by impeding the intrusion of salt water.

Windblown sand deposits occur in small patches along the Arthur Kill where vegetation is sparse. They are unimportant as a source of ground-water but are highly permeable and transmit water to underlying aquifers.

CONCLUSIONS

If additional large ground-water supplies are developed in the Rahway area, existing supplies would probably be reduced, and intrusion of salt water could result. In the Brunswick Shale, over-development would greatly lower water levels in the southeastern half of the area where water-bearing fractures and sandstone beds are least abundant. Wells aligned parallel to the strike of the Brunswick interfere with one another more than wells aligned normal to the strike. To insure a supply of fresh ground water in the Brunswick Shale, wells should be located where the piezometric surface is 20 feet or more above sea level. Salt water would not be expected at depths of less than about 800 feet in such areas, according to the Ghyben-Herzberg principle. However, the depth to salt water should be verified by test drilling prior to any additional large-scale development.

Further development of ground-water from the Farrington Sand Member of the Raritan Formation is limited by the danger of salt-water intrusion. The piezometric head near the Arthur Kill is less than 10 feet above sea level, and if it is lowered to below sea level by pumping, salt-water contamination will eventually result. Intrusion would follow a path southwestward from Sewaren where the Farrington Sand Member is exposed to the Arthur Kill.

The stratified drift in Rahway is a thin deposit of limited areal extent and consequently has a low storage capacity. Yields of 370 gpm from wells adjacent to the Rahway River are obtained from induced infiltration by the Rahway Water Department. Further development of this deposit would depend on additional induced infiltration of surface water into the aquifer.

The quality of water of the Raritan Formation and the Pleistocene drift is superior to that of the Brunswick Shale as deep wells in the Brunswick near the Rahway River commonly yield water high in sulfate, calcium, and dissolved solids.

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APPENDIX

TABLE 4.—CHEMICAL ANALYSES OF WATER FROM WELLS IN THE RAHWAY AREA, N. J.

Geologic source: Kr, Raritan Formation; Qd, Glacial drift; Trb, Brunswick Shale

Source of analysis: CO, California Oil Co.; M, Merck & Co.; RWD, Rahway Water Dept.; USG, U.S. Gypsum Co.; USGS, U.S. Geological Survey; USMR, U.S. Metal and Refining Co.

(Results in parts per million except as indicated)

Owner	New Jersey grid no.	Date of collection	Temperature (°F)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)		Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue at 180°C)	Hardness as CaCO ₃		Specific conductance (micromhos at 25°C)	pH	Geologic source	Source of analysis
									Total	Carbonate													
Merck & Co.	26.31.2.6.7B	6-28-44	--	--	.4	----	260	42	---	---	---	126	----	83	----	----	----	----	----	----	7.3	Trb	M
City of Rahway	26.31.2.7.2	1949	--	--	.03	----	---	----	---	---	---	---	58	9	----	----	210	142	---	----	7.3	Qd	RWD
City of Rahway	26.31.2.7.4	10-15-48	--	--	.01	----	90	70	121	---	---	95	659	8.7	----	----	1,570	512	---	----	7.4	Trb	RWD
City of Rahway	26.31.2.7.4	12-16-48	--	3	.03	----	198	66	180	---	---	95	883	10	.03	.04	1,445	765	---	----	7.6	Trb	RWD
City of Rahway	26.31.2.8.9	1949	--	--	.03	----	---	----	---	---	---	---	94	18	----	----	200	110	---	----	6.4	Qd	RWD
General Gum Products Co.	26.31.3.1.7	8-9-60	58	23	.09	.04	58	22	16	3.5	230	57	19	.1	.2		329	235	47	497	7.5	Trb	USGS
City of Rahway	26.31.5.1.9	1949	--	--	.80	----	---	----	---	---	---	---	32	20	----	----	255	144	---	----	6.6	Qd	RWD
City of Rahway	26.31.5.2.5	1949	--	--	.03	----	---	----	---	---	---	---	84	21	----	----	355	210	---	----	7.0	Qd	RWD
Security Steel Co.	26.31.5.9.4	8-1-60	55	35	3.6	.55	67	21	63	4	255	162	18	.1	.5		528	254	45	723	7.5	Trb	USGS
Natvar Co.	26.31.6.1.3	8-10-60	68	22	.17	.04	122	28	117	4.8	112	522	25	.3	10		922	420	328	1,220	7.2	Trb	USGS
Reading Railroad	26.31.6.8.9	7-28-60	55	19	.53	.04	43	8.8	27	1.1	123	79	13	.2	3.3		294	144	43	398	6.9	Kr	USGS
S. Futo	26.31.7.9.5	7-28-60	55	39	1.12	.41	36	7.9	25	2.9	163	36	7.9	.5	.0		268	123	0	339	7.4	Trb	USGS
California Oil Co.	26.31.8.8.9A	3-13-51	53	9.2	11	.13	34	8.3	10	1.4	144	13	7.1	----	.4		154	119	1	276	6.6	Kr	CO
California Oil Co.	26.31.8.8.9B	3-13-51	53	9.6	4.6	.11	39	6.9	10	1.7	150	17	6.6	----	.2		165	126	3	291	7.3	Kr	CO
Swift & Co.	26.31.8.9.1	7-28-60	54	24	11.03	2.2	55	15	12	2.4	0	210	8.5	.1	.3		384	199	199	525	---	Kr	USGS
U. S. Metals & Refining Co.	26.32.4.7.9A	11-4-55	--	26	1.7	----	184	29	---	---	---	128	315	221	----	----	----	580	---	----	7.1	Kr	USMR
U. S. Metals & Refining Co.	26.32.4.7.9B	11-4-55	--	25	.15	----	128	25	---	---	---	92	130	242	----	----	----	424	---	----	6.9	Kr	USMR

TABLE 4.—CHEMICAL ANALYSES OF WATER FROM WELLS IN THE RAHWAY AREA, N. J.

Geologic source: Kr, Raritan Formation; Qd, Glacial drift; Trb, Brunswick Shale

Source of analysis: CO, California Oil Co.; M, Merck & Co.; RWD, Rahway Water Dept.; USG, U.S. Gypsum Co.; USGS, U.S. Geological Survey; USMR, U.S. Metal and Refining Co.

(Results in parts per million except as indicated)

Owner	New Jersey grid no.	Date of collection	Temperature (°F)	Silica (SiO ₂)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids (residue at 180°C)	Hardness as CaCO ₃		Specific conductance (micromhos at 25°C)	pH	Geologic source	Source of analysis
																	Total	Carbo-nate				
Plainfield Union Water Co.	25.25.7.5.6	8-31-60	54	26	0.17	0.01	52	14	11	1.5	174	35	17	0.1	10	266	187	45	399	7.4	Trb	USGS
Oak Ridge Golf Course	25.35.1.9.1	8- 8-60	52	22	.29	.03	46	3.2	9	1.1	124	40	5.0	.1	8.4	210	128	27	293	7.9	Trb	USGS
Methodist Church	25.35.4.6.4	8- 1-60	59	24	.30	.03	54	4.9	12	.9	150	29	13	.0	16	266	155	32	348	7.4	Trb	USGS
State of New Jersey	25.35.7.6.3	7-26-60	51	23	.03	.03	33	8.4	12	1.7	97	50	10	.0	3.7	235	117	38	288	6.7	Trb	USGS
National Gypsum Co.	26.21.7.5.1	8-19-60	54	25	.18	.00	102	27	19	1.5	164	222	17	.1	8.3	511	366	231	711	7.3	Trb	USGS
A & M Karagheusian Inc.	26.21.8.2.9	8- 8-60	56	23	.08	.00	74	12	16	1.4	196	56	31	.1	10	339	234	74	523	7.3	Trb	USGS
Lampert Dairy Farms	26.21.9.6.4	8-18-60	55	15	.13	.00	28	11	124	1.4	189	209	13	.2	12	512	115	0	759	8.0	Trb	USGS
Hyatt Bearing Co.	26.31.1.3.1	8-31-60	53	31	.05	.05	167	25	43	1.4	144	454	11	.3	8	856	520	402	1,060	6.9	Trb	USGS
U. S. Gypsum Co.	26.31.1.3.2	1946	--	--	0	----	---	----	----	---	---	434	10	----	----	---	638	---	----	7.3	Trb	USGS
State of New Jersey	26.31.1.8.3	7-26-60	54	21	.26	.02	34	3	9.8	.9	52	43	24	.0	4.5	225	98	55	261	6.3	Trb	USGS
City of Rahway	26.31.2.4.3	11-22-48	--	3	.01	.04	262	22	67		54	503	210	.03	.30	1,255	746	---	----	7.4	Trb	RWD
City of Rahway	26.31.2.4.3	1949	--	--	.04	----	---	----	----	---	---	65	10	----	----	220	110	---	----	7.2	Qd	RWD
City of Rahway	26.31.2.6.4	11-12-48	--	--	----	----	266	71	178		95	1,204	11	----	.2	1,338	956	---	----	7.3	Trb	RWD
City of Rahway	26.31.2.6.4	11-23-48	--	4	.24	.15	279	69	216		95	1,358	10	.04	.12	2,660	980	---	----	7.3	Trb	RWD
City of Rahway	26.31.2.6.4	11-23-48	--	18	.08	----	502	68	154	---	90	1,710	10	----	----	2,640	1,530	---	----	7.6	Trb	RWD
City of Rahway	26.31.2.6.6	10-28-48	--	--	.03	----	39	7.4	13		55	86	16	----	----	232	129	---	----	6.1	Trb	RWD
Merck & Co.	26.31.2.6.7B	2-12-44	--	--	.2	----	280	42	---	---	120	1,795	82	----	----	----	----	---	----	7.3	Trb	M

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
25.25.7.4.3	C. F. Engle	160	265	27	135	1.6	8- -40	80	Brunswick Shale
25.25.7.5.3	Westfield Realty Co.	120	250	18	250	1.5	2-15-49	30	Brunswick Shale
25.25.7.5.5	Plainfield Union Water Co.	130	523	22	500	5.6	5-10-51	52	Brunswick Shale
25.25.7.5.6	Plainfield Union Water Co.	130	---	--	---	---	-----	--	Brunswick Shale
25.25.7.6.4	Safeway Stores	125	205	17	90	10.0	9-27-51	29	Brunswick Shale
25.25.7.7.7	A. Howarth	125	110	17	10	4.3	3-15-48	30	Brunswick Shale
25.25.7.9.8	H. Specht	110	130	12	5	1.7	9-12-52	60	Brunswick Shale
25.35.1.1.1	C. Spader	105	100	8	5	.4	6- 8-53	55	Brunswick Shale
25.35.1.3.3	B. Blado	75	150	12	25	3.1	10- 4-52	48	Brunswick Shale
25.35.1.6.4	City of Rahway	55	122	2	---	---	1922	70	Brunswick Shale
25.35.1.9.5	F. Lanza	90	75	10	10	.6	8-27-51	16	Brunswick Shale
25.35.4.1.2	E. A. Roberts	85	85	6	7	.4	4-10-52	35	Brunswick Shale
25.35.4.3.3	W. Holmes	110	98	25	5	.5	7-10-53	12	Brunswick Shale
25.35.4.3.4	C. Amhuster	130	76	14	---	---	1-16-51	18	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
25.35.4.3.5	L. Rahming	125	86	10	5	.7	10- 7-52	14	Brunswick Shale
25.35.4.3.6	L. W. Rhodcap	100	94	18	5	.4	8- 5-52	40	Brunswick Shale
25.35.4.3.8	M. McCann	110	108	24	5	.5	5- 7-53	26	Brunswick Shale
25.35.4.5.6	W. Comar	135	90	22	6	.2	9-29-51	23	Brunswick Shale
25.35.4.5.9	W. Patrusnick	130	120	23	4	.2	7-29-52	20	Brunswick Shale
25.35.4.6.4	New Dover Methodist Church	120	111	41	6	.1	8- 3-55	--	Brunswick Shale
25.35.4.6.5	J. Farmkas	125	88	12	7	.3	3-25-52	30	Brunswick Shale
25.35.4.6.6	R. Slaskeures	110	87	6	7	.5	5-19-52	37	Brunswick Shale
25.35.4.6.7	T. J. O'Toole	120	80	28	5	0.2	9- 9-51	22	Brunswick Shale
25.35.4.6.8	F. E. Marsh	130	105	28	4	.2	6- 4-53	21	Brunswick Shale
25.35.4.6.9	R. Ladado	115	87	25	5	.3	4-16-53	34	Brunswick Shale
25.35.4.7.5	J. Erdo	160	95	30	7	.5	10-14-51	47	Brunswick Shale
25.35.4.8.1	R. Galaida	120	103	25	10	.8	8-26-55	36	Brunswick Shale
25.35.7.4.4	I. Lundy	143	143	40	10	1.0	7-24-48	126	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

<i>New Jersey grid no.</i>	<i>Owner or name</i>	<i>Altitude (feet)</i>	<i>Total depth (feet)</i>	<i>Depth to static water level (feet)</i>	<i>Yield (gpm)</i>	<i>Specific capacity (gpm/ft)</i>	<i>Date of test</i>	<i>Depth to bed- rock (feet)</i>	<i>Aquifer</i>
25.35.7.5.5	Middlesex Water Co.	100	610	flows 7 gpm	167	1.0	7- 3-53	53	Brunswick Shale
25.35.7.6.3	State of New Jersey Veterans' Home	70	305	flows 10 gpm	75	.8	1932	50	Brunswick Shale
25.35.7.7.5	Costa Ice Cream Co.	105	275	25	125	---	4-14-37	45	Brunswick Shale
25.35.7.9.4	E. Paszamant	115	200	20	12	2.4	1- 2-53	94	Brunswick Shale
26.21.7.5.1A	National Gypsum Co.	85	136	--	175	---	1913	--	Brunswick Shale
26.21.7.5.1B	National Gypsum Co.	85	188	33	175	2.6	12- 5-45	--	Brunswick Shale
26.21.7.5.1C	National Gypsum Co.	85	236	14	300	7.5	1- -34	34	Brunswick Shale
26.21.7.5.1D	National Gypsum Co.	85	380	28	350	3.0	11-29-45	43	Brunswick Shale
26.21.7.9.8	Fibro Corporation	75	250	19	75	2.5	9- 1-57	50	Brunswick Shale
26.21.8.2.7	Gibson Associates	80	271	12	274	3.0	6-17-56	23	Brunswick Shale
26.21.8.2.9A	A & M Karagheusian Inc.	75	164	13	183	14.0	4-19-31	26	Brunswick Shale
26.21.8.2.9B	A & M Karagheusian Inc.	75	173	--	113	---	11-14-28	33	Brunswick Shale
26.21.8.3.4	Plainfield Union Water Co.	85	509	28	457	4.1	9- -57	29	Brunswick Shale
26.21.8.4.5	Construction Specialties Co.	80	200	--	60	---	12-24-57	--	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.21.8.5.6	A. Topalian	70	109	21	44	4.0	10- -54	40	Brunswick Shale
26.21.8.6.7	Food Fair Corp.	70	304	33	150	1.5	8-27-51	--	Brunswick Shale
26.21.9.1.4	E. A. Lavin	80	107	15	10	.2	6- 9-53	10	Brunswick Shale
26.21.9.6.4A	Lampert Dairy Farms	20	263	9	30	.2	4- 9-55	8	Brunswick Shale
26.21.9.6.4B	Lampert Dairy Farms	30	803	26	12	.1	7- -59	8	Brunswick Shale
26.21.9.8.6	Helsmuth Tool and Die Co.	30	292	18	60	.7	6- -59	--	Brunswick Shale
26.21.9.9.3	United Laboratories	20	202	9	60	1.7	10-20-55	30	Brunswick Shale
26.21.9.9.5	Eastern Packing Co.	20	400	11	---	---	8- -50	--	Brunswick Shale
26.22.7.1.5	J. Waldo	50	150	28	12	.5	4-30-53	30	Brunswick Shale
26.22.7.1.8	J. E. Bryan	50	255	8	60	1.2	3-21-50	10	Brunswick Shale
26.22.7.4.6	Volupte, Inc.	20	400	15	24	.1	11- 8-52	5	Brunswick Shale
26.22.7.5.5	M. Marcus	15	600	21	80	1.3	12-12-52	--	Brunswick Shale
26.22.7.7.3	Park Plastic Co.	20	255	7	60	1.0	5-27-50	15	Brunswick Shale
26.31.1.1.2	W. McCollum	65	111	20	8	---	3-18-48	44	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.31.1.1.5	C. A. Cumady	58	116	29	10	1.0	12-21-47	54	Brunswick Shale
26.31.1.1.8	J. Amberg	55	200	12	40	7.0	7-28-51	65	Brunswick Shale
26.31.1.3.1A	Hyatt Bearing Division, General Motors Corp.	70	500	29	450	4.1	3- -40	38	Brunswick Shale
26.31.1.3.1B	Hyatt Bearing Division, General Motors Corp.	65	504	41	660	14.0	1-21-53	26	Brunswick Shale
26.31.1.3.1C	Hyatt Bearing Division, General Motors Corp.	65	505	40	500	25.0	12-30-44	28	Brunswick Shale
26.31.1.5.1	J. Wyzynski	55	92	15	10	.2	11- 8-51	42	Brunswick Shale
26.31.1.5.4	D. E. Brewer	85	94	--	20	---	11-20-51	45	Brunswick Shale
26.31.1.5.6	H. Nuhn	100	208	60	5	.2	9-28-35	70	Brunswick Shale
26.31.1.7.4	J. J. Symko	70	78	20	15	.1	7- 1-52	25	Brunswick Shale
26.31.1.7.5	A. Bunkowski	90	85	8	5	.7	10-21-52	17	Brunswick Shale
26.31.1.7.6	L. Kupka	105	90	26	8	1.0	4-15-53	42	Brunswick Shale
26.31.1.7.8	F. Sieger	90	82	12	5	.2	2-15-52	40	Brunswick Shale
26.31.1.7.9	H. W. Monenft	90	84	15	5	.4	10-17-52	14	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.31.1.8.3	State of New Jersey Highway Department	90	150	35	10	.4	5-17-52	42	Brunswick Shale
26.31.1.8.9	D. S. Randolph	90	100	10	5	.3	4-23-52	30	Brunswick Shale
26.31.1.9.4	E. F. Gill	60	89	15	5	.5	7-15-53	17	Brunswick Shale
26.31.1.9.8	L. J. Hiclicke	60	90	28	5	.2	12-10-51	10	Brunswick Shale
26.31.2.3.5A	Hatfield Wire and Cable Co.	40	175	8	40	.3	10- -58	18	Brunswick Shale
26.31.2.3.5B	Hatfield Wire and Cable Co.	40	356	11	325	7.7	4- -59	25	Brunswick Shale
26.31.2.3.5C	Hatfield Wire and Cable Co.	40	350	5	323	4.3	3- -59	32	Brunswick Shale
26.31.2.3.7	Tingley Rubber Co.	40	240	--	100	---	1932	--	Brunswick Shale
26.31.2.4.3A	City of Rahway	15	20	4	25	---	9-13-49	20	Glacial drift
26.31.2.4.3B	City of Rahway	15	52	2	355	12.7	1-21-52	23	Brunswick Shale and glacial drift
26.31.2.4.3C	City of Rahway	15	51	flows	350	10.0	1-21-52	26	Brunswick Shale and glacial drift
26.31.2.4.3D	City of Rahway	15	30	1	125	6.2	1-21-52	25	Glacial drift
26.31.2.4.3E	City of Rahway	---	76	6	355	10.4	12- 3-53	38	Brunswick Shale and glacial drift

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.31.2.4.3F	City of Rahway	---	127	37	425	28.0	11-24-54	78	Brunswick Shale and glacial drift
26.31.2.5.3	Koos Furniture Store	25	350	25	200	2.6	5- 8-53	40	Brunswick Shale
26.31.2.5.4	National Grocery Co.	35	300	22	122	1.5	2- -57	45	Brunswick Shale
26.31.2.5.7	W. Mershen	25	101	19	15	---	1904	40	Brunswick Shale
26.31.2.6.4	City of Rahway	10	300	flows 1 gpm	286	1.8	11-23-48	11	Brunswick Shale
26.31.2.6.7	D. Ryan	15	84	--	15	---	1909	36	Brunswick Shale
26.31.2.6.7	Merck Chemical Co.	25	1106	17	120	.5	8- -41	--	Brunswick Shale
26.31.2.6.8A	Quinn and Boden Co.	20	253	13	82	.7	8- 1-34	18	Brunswick Shale
26.31.2.6.8B	Quinn and Boden Co.	20	357	17	150	1.2	11-27-44	30	Brunswick Shale
26.31.2.7.2A	City of Rahway	25	18	4	12	---	8-25-49	--	Glacial drift
26.31.2.7.4	City of Rahway	20	301	flows 1 gpm	12	.1	10-14-48	17	Brunswick Shale
26.31.2.8.3	Rahway Theatre	20	349	10	100	.5	9- 8-48	25	Brunswick Shale
26.31.2.9.2	R. Jensen	15	100	5	5	---	7-26-52	40	Brunswick Shale
26.31.3.1.4	General Gum Products Co.	35	316	16	100	2.4	10-20-53	27	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.31.3.1.5	Linden Ice Co.	35	550	19	70	.8	3- -59	30	Brunswick Shale
26.31.3.1.7	General Gum Products Co.	35	310	15	90	2.6	3-12-57	35	Brunswick Shale
26.31.3.1.8	Nesco Steel Barrel Co.	30	266	25	25	.2	8-23-49	35	Brunswick Shale
26.31.3.1.9	Nesco Steel Barrel Co.	30	208	15	50	---	7- -37	35	Brunswick Shale
26.31.3.3.1	M. Sand	25	155	45	8	.2	9-12-49	16	Brunswick Shale
26.31.3.3.2A	Automotive Products	25	245	23	31	3.9	5- -57	15	Brunswick Shale
26.31.3.3.2B	Hollywood Drive-In	20	170	19	20	3.4	12-10-50	--	Brunswick Shale
26.31.3.3.7	J. W. Martin	20	110	12	15	1.9	8-15-53	25	Brunswick Shale
26.31.3.4.2	Layne, New York	30	308	20	30	.3	2- 8-55	30	Brunswick Shale
26.31.3.4.6	W. Melenchuk	30	96	12	5	---	8- 2-52	40	Brunswick Shale
26.31.3.5.2A	Distillers Co.	25	316	5	65	.6	1934	34	Brunswick Shale
26.31.3.5.2B	Distillers Co.	25	307	3	23	.2	1934	35	Brunswick Shale
26.31.3.5.8	Babb Co.	20	300	5	80	.8	4-30-50	--	Brunswick Shale
26.31.4.1.1	J. Lech	90	85	22	7	.3	9-20-51	32	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.31.4.1.2	C. Onellett	75	88	12	5	.5	4-23-52	18	Brunswick Shale
26.31.4.1.4	W. Ferman	80	86	8	5	.5	4-27-52	39	Brunswick Shale
26.31.4.1.9	V. Spence	115	102	26	6	.3	12-15-51	17	Brunswick Shale
26.31.4.2.3	D. K. Flemer	100	108	10	21	.5	3-12-49	16	Brunswick Shale
26.31.4.2.7	F. C. Fyke	110	102	27	5	.2	10- 1-52	12	Brunswick Shale
26.31.4.3.1	F. Boris	85	94	25	4	.4	7-19-53	12	Brunswick Shale
26.31.4.3.7	A. Albrecht	80	102	25	5	5.0	8-29-51	44	Brunswick Shale
26.31.4.4.3	C. D. Blair	120	112	30	7	.4	5- 3-52	12	Brunswick Shale
26.31.4.4.6	J. Fessee	105	87	15	5	.3	9- 9-52	12	Brunswick Shale
26.31.4.4.8	W. Stark	120	91	20	6	.9	7-23-53	12	Brunswick Shale
26.31.4.5.1	Texas Oil Co.	90	145	33	10	1.0	6-28-51	30	Brunswick Shale
26.31.4.5.4A	Caswell-Strauss Co.	80	350	22	65	2.0	4- -55	30	Brunswick Shale
26.31.4.5.4B	J. Kaiser	90	90	20	8	1.6	11- 4-51	16	Brunswick Shale
26.31.4.5.7	J. Holden	80	95	28	8	.7	10-17-51	14	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.31.4.5.9	S. Bloomfield	50	75	4	10	---	8-14-52	33	Brunswick Shale
26.31.4.6.3	Colonia Country Club	40	612	27	80	.4	3- -57	4	Brunswick Shale
26.31.4.7.4	F. Southard	120	100	26	5	.5	6-23-52	6	Brunswick Shale
26.31.4.8.5	A. Kalinch	---	160	8	2	---	10-10-47	120	Brunswick Shale
26.31.5.1.9	City of Rahway	10	24	4	10	2.0	1949	24	Glacial drift
26.31.5.2.3	C. Hill	15	109	10	10	.6	7-25-52	26	Brunswick Shale
26.31.5.2.4	Pennsylvania Railroad	15	30	8	---	---	10- 7-45	25	Glacial drift
26.31.5.2.5	City of Rahway	10	21	1	10	---	8-30-49	21	Glacial drift
26.31.5.2.9	P. J. Harper	20	75	10	5	.3	1-10-52	30	Brunswick Shale
26.31.5.3.3A	Mac Lac Co.	10	150	7	91	3.0	4- 9-25	23	Brunswick Shale
26.31.5.3.3B	Mac Lac Co.	15	151	flows	135	---	4- 7-23	18	Brunswick Shale
26.31.5.3.7	Bloomfield Iron and Scrap	20	105	22	10	.2	9-14-48	5	Brunswick Shale
26.31.5.3.9A	State of New Jersey Reformatory	20	206	--	95	---	3-28-35	25	Brunswick Shale
26.31.5.3.9B	State of New Jersey Reformatory	20	200	16	44	.4	5-22-34	--	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.31.5.4.9	C. Johnson	85	115	12	5	.3	10-18-52	60	Brunswick Shale
26.31.5.5.4	W. Chapman	60	120	55	17	1.7	7- 1-48	6	Brunswick Shale
26.31.5.6.3	State of New Jersey Reformatory	20	504	flows 9 gpm	55	.5	2- -34	--	Brunswick Shale
26.31.5.6.7	Philadelphia Quartz Co.	65	500	20	16	---	11-10-19	--	Brunswick Shale
26.31.5.7.1	S. W. Barkarsi	90	115	75	6	---	8-15-53	18	Brunswick Shale
26.31.5.7.6	C. Walsh	70	93	25	5	.3	7-12-52	17	Brunswick Shale
26.31.5.7.8	Walter Reade Theatre	80	300	10	70	.2	9- -56	30	Brunswick Shale
26.31.5.9.2	Pike and Pal Realty	40	204	11	---	---	6- -55	40	Brunswick Shale
26.31.5.9.4	Security Steel Corp.	30	614	22	34	.1	2- -57	--	Brunswick Shale
26.31.6.1.2	A. Sfalanga	25	60	25	15	.8	10-18-51	46	Brunswick Shale
26.31.6.2.4	National Varnish Co.	20	405	15	30	.2	1-11-49	50	Brunswick Shale
26.31.6.2.5	S. Mezley	20	108	8	5	.3	2-23-52	40	Brunswick Shale
26.31.6.4.3	State of New Jersey Reformatory	15	505	32	60	.4	2- 4-50	27	Brunswick Shale
26.31.6.5.1	Kagan-Dixon Wire Co.	25	210	14	60	2.2	9- -56	--	Brunswick Shale

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

New Jersey grid no.	Owner or name	Altitude (feet)	Total depth (feet)	Depth to static water level (feet)	Yield (gpm)	Specific capacity (gpm/ft)	Date of test	Depth to bed-rock (feet)	Aquifer
26.31.6.8.9A	Reading Railroad	20	41	13	45	1.9	5-12-48	57	Raritan Fm.
26.31.6.8.9B	Reading Railroad	20	41	8	60	2.0	4-22-48	--	Raritan Fm.
26.31.7.1.6	State of New Jersey Highway Department	80	100	6	5	.1	4-16-52	70	Brunswick Shale
26.31.7.3.3	T. Jackson	80	100	6	5	.5	10-13-52	55	Brunswick Shale
26.31.7.4.1	State of New Jersey Veterans' Home	80	240	flows 4 gpm	150	2.0	2- -32	30	Brunswick Shale
26.31.7.6.3	Maple Hill Dairy Farm	125	312	150	40	2.6	1936	--	Brunswick Shale
26.31.7.9.5	S. Futo	150	302	130	10	.1	11-27-54	170	Brunswick Shale
26.31.8.6.8	M. D. Valentine	50	151	15	71	.9	9-14-42	50	Brunswick Shale
26.31.8.8.3	Clover Green Dairy	45	68	9	120	---	1936	--	Raritan Fm.
26.31.8.9.1A	Swift Ice Cream Co.	35	78	10	300	---	1956	75	Raritan Fm.
26.31.8.9.1B	Swift Ice Cream Co.	30	70	11	75	15.0	6-20-51	--	Raritan Fm.
26.31.8.9.1C	New Jersey Wood Finishing	35	77	14	275	39.0	2-27-42	77	Raritan Fm.
26.31.8.9.2	American Cyanamid Co.	15	80	7	120	3.8	1-31-47	75	Raritan Fm.

TABLE 5.—RECORDS OF SELECTED WELLS IN THE RAHWAY AREA, N. J.

<i>New Jersey grid no.</i>	<i>Owner or name</i>	<i>Altitude (feet)</i>	<i>Total depth (feet)</i>	<i>Depth to static water level (feet)</i>	<i>Yield (gpm)</i>	<i>Specific capacity (gpm/ft)</i>	<i>Date of test</i>	<i>Depth to bed- rock (feet)</i>	<i>Aquifer</i>
26. 32. 1. 1. 8	Standard Oil Co. of New Jersey	20	1556	22	---	---	5- -20	15	Brunswick Shale
26. 32. 1. 6. 7	General Aniline Film Co.	10	80	3	30	---	1- 5-38	80	Raritan Fm.
26. 32. 4. 7. 9A	United States Metals and Refining Co.	15	42	10	55	2.5	6 ¹ -22-54	--	Raritan Fm.
26. 32. 4. 7. 9B	United States Metals and Refining Co.	15	40	15	50	2.5	6-25-54	--	Raritan Fm.
26. 32. 4. 8. 2	American Agricultural Chemical Co.	10	65	6	20	---	6-12-42	65	Raritan Fm.
26. 32. 4. 8. 4	Chrome Steel Co.	10	58	10	6	---	1906	90	Raritan Fm.

TABLE 6.—LOGS OF TEST HOLES AND WELLS

U. S. Geological Survey Test Hole		
1959		
N. J. grid no: 25.35.1.4.4		
Surface Altitude 70 feet		
	<i>Thickness</i>	<i>Depth</i>
	<i>(feet)</i>	<i>(feet)</i>
Pleistocene:		
Drift of Wisconsin age:		
Sand, reddish-brown, clayey and gravelly	5	5
Clay, reddish-brown, sandy and gravelly	20	25
Clay, reddish-brown, sandy	15	40
U. S. Geological Survey Test Hole		
1959		
N. J. grid no: 25.35.1.5.3		
Surface Altitude 70 feet		
Pleistocene:		
Drift of Wisconsin age:		
Sand, reddish-brown, fine, clayey	10	10
Clay, reddish-brown, sandy	67	77
City of Rahway Test Well		
1922		
(Log by Layne and Bowler Co.)		
N. J. grid no: 25.35.1.6.4		
Surface Altitude 55 feet		
Pleistocene:		
Drift of Wisconsin age:		
Soil	10	10
Sand, water-bearing	15	25
Clay, reddish brown	18	43
Gravel, coarse, water-bearing. Water level rose to within foot of surface	21	64
Shale, soft or hardpan	5	69
Sand, water-bearing. Water level rose 4 feet above surface	2	71

Table 6.—Logs of test holes and wells—Continued

	<i>Thickness</i> (feet)	<i>Depth</i> (feet)
Triassic:		
Brunswick Shale:		
Shale, porous	14	85
Shale, hard	16	101
Shale, hard, non-porous. Water level 2 feet below surface	21	122
Middlesex Water Co. 1933 (Log by W. Stothoff Co., Inc.) N. J. grid no: 25.35.7.5.5 Surface Altitude 100 feet		
Pleistocene:		
Drift of Wisconsin age:		
Clay	8	8
Sand and gravel	20	28
Clay, reddish-brown	25	53
Triassic:		
Brunswick Shale:		
Shale, reddish-brown	182	235
Shale, blue	35	270
Shale, reddish-brown	20	290
Shale, red and blue	20	310
Shale, reddish-brown	300	610
N. J. Home for Disabled Veterans 1932 (Log by J. Reilly, Driller) N. J. grid no: 25.35.7.6.3 Surface Altitude 70 feet		
Pleistocene:		
Drift of Wisconsin age:		
Clay, red, soft	10	10
Clay, hard	13	23
Sand	22	45

Table 6.—Logs of test holes and wells—Continued

	<i>Thickness</i> (feet)	<i>Depth</i> (feet)
Triassic:		
Brunswick Shale:		
Shale, reddish-brown, soft to hard. Water flowed 1 gpm	47	92
Shale, reddish-brown, hard. Water flowed 2 gpm	26	118
Shale, reddish-brown, soft to hard. Water flowed 3.5 gpm	24	142
Brownstone, hard	18	160
Shale, blue, soft	12	172
Brownstone, hard. Water flowed 5 gpm	15	187
Brownstone, soft	28	215
Shale, blue	5	220
Shale, reddish-brown, very hard	6	226
Shale, blue, hard	10	236
Brownstone. Water flowed 7 gpm	4	240
Shale, blue, hard	14	254
Brownstone, hard	33	287
Shale, blue	2	289
Brownstone. Water flowed 10 gpm	4	293
Brownstone, soft	9	302
Shale, blue, hard or diabase	3	305

City of Rahway

1949

N. J. grid no: 26.31.2.4.3A

Surface Altitude 15 feet

Pleistocene:

Drift of Wisconsin age:

Gravel, sand, and clay	4	4
Gravel and clay	4	8
Rock, sandy	4	12
Sand, medium	2	14
Sand, fine to medium	4	18
Shale rock, sandy	2	20

Table 6.—Logs of test holes and wells—Continued

Hyatt Bearing Division, General Motors Corp.

1944

N. J. grid no: 26.31.1.3.1C

Surface Altitude 70 feet

	<i>Thickness (feet)</i>	<i>Depth (feet)</i>
Pleistocene:		
Drift of Wisconsin age:		
Clay and gravel	28	28
Triassic:		
Brunswick Shale:		
Shale, reddish-brown, sticky	162	190
Sandstone, reddish-brown, fine, argillaceous	128	318
Shale, reddish-brown	100	418
Sandstone, reddish-brown, fine, argillaceous with interbedded shale beds	42	460
Shale, reddish-brown	45	505

U. S. Geological Survey Test Hole

1959

N. J. grid no: 26.31.1.2.1

Surface Altitude 58 feet

Pleistocene:		
Drift of Wisconsin age:		
Clay, reddish-brown	5	5
Clay, reddish-brown, sandy	5	10
Clay, reddish-brown, sandy and gravelly	24	34

A. & M. Karagheusian, Inc.

1928

(Log by W. Stothoff Co., Inc.)

N. J. grid no: 26.21.8.2.9B

Surface Altitude 45 feet

Pleistocene:		
Drift of Wisconsin age:		
Gravel	2	2
Sand and clay	15	17
Clay hardpan	16	33

Table 6.—Logs of test holes and wells—Continued

	<i>Thickness</i> (feet)	<i>Depth</i> (feet)
Triassic:		
Brunswick Shale:		
Shale, reddish-brown	54	87
Sandstone, reddish-brown	2	89
Shale, reddish-brown	71	160
Sandstone, reddish-brown	13	173
National Gypsum Co. 1945 (Log by W. Stothoff Co., Inc.) N. J. grid no: 26.21.7.5.1D Surface Altitude 85 feet		
Pleistocene:		
Drift of Wisconsin age:		
Clay and gravel	32	32
Triassic:		
Brunswick Shale:		
Shale, reddish-brown, soft	11	43
Shale, reddish-brown, hard	127	170
Shale, reddish-brown, soft, sticky	80	250
Shale, reddish-brown, hard calcareous at 295 feet ..	129	379
(Water-bearing zones at 100, 165, 295, and 360 feet)		
Union County Park Test Hole 1951 (Log by A. J. Conolly, Inc.) N. J. grid no: 26.31.2.4.3D Surface Altitude 15 feet		
Pleistocene:		
Drift of Wisconsin age:		
Clay and silt	8	8
Sand and gravel	1	9
Sand, coarse; fine gravel	7	16
Sand and gravel	4	20
Clay	3	23
Triassic:		
Brunswick Shale:		
Shale, reddish-brown, soft	7	30

Table 6.—Logs of test holes and wells—Continued

City of Rahway Test Hole
N. J. grid no: 26.31.2.4.5A
Surface Altitude 15 feet

	<i>Thickness</i> (feet)	<i>Depth</i> (feet)
Pleistocene:		
Drift of Wisconsin age:		
Clay, reddish-brown, sandy, sand grains coarser downward	15	15
Clay and sand, reddish-brown, sand grains rounded and fractured	10	25
Sand, pinkish-brown, medium to coarse, predominantly angular to rounded quartz grains. Also some clayey gravel	5	30
Sand, medium to coarse; gravel to 8 mm, coated with pinkish-brown clay; predominantly angular to subrounded quartz grains	10	40
Sand, medium to coarse; fine gravel; predominantly quartz grains coated with pinkish-brown clay; pebbles of Brunswick Shale	5	45

City of Rahway Test Hole

N. J. grid no: 26.31.2.4.5B

Surface Altitude 15 feet

Pleistocene:

Drift of Wisconsin age:

Clay with coarse sand and fine to medium gravel, reddish-brown; predominantly angular to subrounded quartz with pebbles of shale and a dark mineral	5	5
Sand, fine to medium, reddish-brown, clayey	10	15
Clay, reddish-to-pinkish brown, containing angular to rounded sand and gravel, plastic	5	20
Sand, reddish brown, with gravel to 8 mm; grains angular to rounded; clayey	5	25

Table 6.—Logs of test holes and wells—Continued

	<i>Thickness</i> (feet)	<i>Depth</i> (feet)
Sand, medium to coarse, and gravel to 18 mm; grains coated with pinkish-brown clay. Sand is predominantly quartz, angular to rounded. Dark minerals present	10	35
Sand, fine to coarse, and gravel to 8 mm; grains coated with pinkish-brown clay. Predominantly rounded to subrounded quartz	5	40
Sand, medium to coarse, with gravel to 14 mm; grains pinkish-brown clay; predominantly subrounded to rounded quartz; dark minerals and shale pebbles present	5	45

City of Rahway Test Hole

1949

N. J. grid no: 26.31.2.8.9

Surface Altitude 23 feet

Pleistocene:

Drift of Wisconsin age:

Clay	8	8
Sand, coarse	4	12
Rock, sandy	5	17
Sand, coarse	3	20
Sand, fine, dry	4	24
Sand, medium, dry	4	28

U. S. Geological Test Hole

1959

N. J. grid no: 26.31.2.9.6

Surface Altitude 25 feet

Pleistocene:

Drift of Wisconsin age:

Clay, reddish-brown	5	5
Clay, reddish-brown; contains gravel and mica flakes	5	10
Clay, reddish-brown; contains gravel	29	39

Table 6.—Logs of test holes and wells—Continued

Layne-New York Co.
1955
(Log by Layne-New York Co.)
N. J. grid no: 26.31.3.4.2
Surface Altitude 30 feet

	<i>Thickness (feet)</i>	<i>Depth (feet)</i>
Pleistocene:		
Drift of Wisconsin age:		
Clay, hard	30	30
Triassic:		
Brunswick Shale:		
Shale, reddish-brown	25	55
Shale, reddish-brown, sandstone streaks	30	85
Shale, reddish-brown	25	110
Shale, reddish-brown; sandstone streaks	5	115
Shale, reddish-brown	10	125
Shale, reddish-brown; sandstone streaks	40	165
Shale, red and purple	143	308

General Motors Corp. Test Boring

N. J. grid no: 26.31.3.5.4

Surface Altitude 25 feet

Pleistocene:		
Drift of Wisconsin age:		
Soil and sand	5	5
Sand and clay	10	15
Clay and gravel	14	29
Triassic:		
Brunswick Shale:		
Shale	6	35
Sandstone, reddish-brown, soft	4	39

Table 6.—Logs of test holes and wells—Continued

City of Rahway Test Hole		
1949		
N. J. grid no: 26.31.5.2.5		
Surface Altitude 15 feet		
	<i>Thickness</i>	<i>Depth</i>
	<i>(feet)</i>	<i>(feet)</i>
Pleistocene:		
Drift of Wisconsin age:		
Clay	8	8
Clay, sand and gravel	8	16
Sand, coarse, water-bearing	4	20
Reading Company well 2		
(Log by W. Stothoff Co. Inc.)		
N. J. grid no: 26.31.6.8.9A		
Surface Altitude 20 feet		
Cretaceous:		
Raritan Formation:		
Clay	20	20
Clay and gravel	14	34
Sand, water-bearing	5	39
Clay, green	12	51
Sand and clay	6	57
Stephan Futo		
1954		
(Log by F. J. Markewicz, Principal Geologist, State of New Jersey)		
N. J. grid no: 26.31.7.9.5		
Surface Altitude 150 feet		
Pleistocene:		
Drift of Wisconsin age:		
Clay, silt and fine to coarse sand, with shale pebbles, calcareous	20	20

New Jersey State Library

Table 6.—Logs of test holes and wells—Continued

	<i>Thickness</i> (feet)	<i>Depth</i> (feet)
Sand, angular to subangular quartz, subrounded shale grains containing dark-green minerals (hypersthene?), and magnetite grains	10	30
Sand, pale-red, fine to coarse, clayey arkosic, calcareous	20	50
Cretaceous:		
Raritan Formation:		
Sand, fine, pale-brown, arkosic, slightly clayey	10	60
Sand, yellowish-brown, fine to medium, of angular to subangular ironstained quartz, with magnetite, ilmenite, mica, and green minerals, clayey	10	70
Sand, yellowish-brown, fine to medium, slightly clayey, arkosic	10	80
Sand, grayish-orange, fine to medium; angular to subangular and some subrounded iron-stained quartz, and magnetite, ilmenite, tourmaline, green minerals, and slightly clayey feldspar	20	100
Sand, dusky yellowish-brown, fine to medium, earthy	10	110
Clay, grayish-pink, micaceous; contains large amount of coarse angular ironstained quartz, pyrite, magnetite, 6 mm pebbles of ironstone, chert and diabase	10	120
Sand, medium dark-gray, fine to medium and silt, lignitic, some coarse grains present	15	135
Clay, dark-gray, sandy, micaceous, lignitic. Fine to coarse sand grains	5	140
Silt, clayey and sand, dark-gray, fine, medium, micaceous, lignitic	13	153
Sand, yellowish-gray, fine to very coarse, poorly sorted	4	157
Clay, red	13	170
Triassic:		
Brunswick Shale:		
Shale, dusky-red, micaceous, slightly calcareous . .	132	302

Table 6.—Logs of test holes and wells—Continued

	<i>Thickness</i> (feet)	<i>Depth</i> (feet)
No sample	12	12
Pleistocene:		
Drift of Wisconsin age:		
Clay, red, sandy	5	17
Clay, red with small pebbles constituting 50 percent of sample	33	50
Triassic:		
Brunswick Shale:		
Clay, gray; fragments of baked shale	3	53
Shale, light-gray, baked	10	63
Shale, dark-gray, hard	23	86
Slate, blue	65	151
N. J. grid no: 26.31.8.7.8		
Surface Altitude 145 feet		
Pleistocene:		
Drift of Wisconsin age:		
Clay, reddish-brown, sandy	15	15
Sand and boulders, brown	15	30
Clay, yellow, sandy	10	40
Cretaceous:		
Raritan Formation:		
Clay, gray	10	50
Clay, black	15	65
Clay, white, sandy	13	78
Sand, white, fine, muddy	4	82
Clay, black	13	95
Sand, gray, muddy	5	100
Sand, coarse, gray	8	108

Table 6.—Logs of test holes and wells—Continued

California Refining Co.		
1949		
N. J. grid no: 26.31.8.8.9		
Surface Altitude 50 feet		
	<i>Thickness</i> <i>(feet)</i>	<i>Depth</i> <i>(feet)</i>
Pleistocene:		
Drift of Wisconsin age:		
Clay	40	40
Cretaceous:		
Raritan Formation:		
Sand, lignitic	20	60
Sand, very fine	20	80
Sand, very fine to fine, clayey	14	94
Sand, white, fine to medium, contains lignite and pyrite	3	97
Sand, fine, clayey	23	120
Clay, white, sandy	10	130
Sand, fine, clayey	9	139
N. J. Wood Finishing Co.		
1942		
(Log by W. Stothoff Co. Inc.)		
N. J. grid no: 26.31.8.9.1C		
Surface Altitude 35 feet		
Pleistocene:		
Drift of Wisconsin age:		
Clay, sand and gravel, reddish-brown	40	40
Sand, pink, medium to coarse; contains rounded pebbles of shale	5	45
Cretaceous:		
Raritan Formation:		
Sand, white, medium to coarse; contains fine gravel	19	64
Clay, light-gray, sandy	1	65
Triassic:		
Diabase:		
Diabase, decomposed	10	75
Diabase, dark-green	2	77

Table 6.—Logs of test holes and wells—Continued

American Cyanamid Co.		
1947		
(Log by W. Stothoff Co. Inc.)		
N. J. grid no: 26.31.8.9.2		
Surface Altitude 20 feet		
	<i>Thickness</i>	<i>Depth</i>
	<i>(feet)</i>	<i>(feet)</i>
Pleistocene:		
Drift of Wisconsin age:		
Sand and gravel, reddish-brown; rounded shale pebbles to 25 mm; clayey	18	18
Sand and gravel, reddish-brown; pebbles to 35 mm; clayey	15	33
Clay and sand, reddish-brown	11	44
Cretaceous:		
Raritan Formation:		
Sand, medium to coarse; reddish-brown gravel; clayey. Gravel to 18 mm. Sand, predominantly quartz	10	54
Clay, light-gray	8	62
Sand, medium to coarse, clayey; predominantly quartz	3	65
Sand, coarse, quartz; fragments of greenish-gray baked shale	10	75
Second Reserve Terminal Inc.		
1958		
N. J. grid no: 26.31.9.3.8		
Surface Altitude 5 feet		
Recent:		
Fill and muck	20	20
Cretaceous:		
Raritan Formation:		
Clay, gray	10	30
Sand, fine	15	45
Sand, brown and gravel	10	55
Sand, white	7	62
Clay, gray	9	71
Clay, greenish-gray	35	106
Triassic:		
Diabase, gray	62	168

Table 6.—Logs of test holes and wells—Continued

U. S. Metals Refining Co.		
1954		
(Log by W. Stothoff Co. Inc.)		
N. J. grid no: 26.32.4.7.9B		
Surface Altitude 20 feet		
	<i>Thickness</i>	<i>Depth</i>
	<i>(feet)</i>	<i>(feet)</i>
Pleistocene:		
Drift of Wisconsin age:		
Clay	3	3
Clay, red and gravel	11	14
Cretaceous:		
Raritan Formation:		
Sand, red, fine	10	24
Sand, gray, fine	4	28
Sand, gray, coarse	12	40
Clay, gray		

RECEIVED

47
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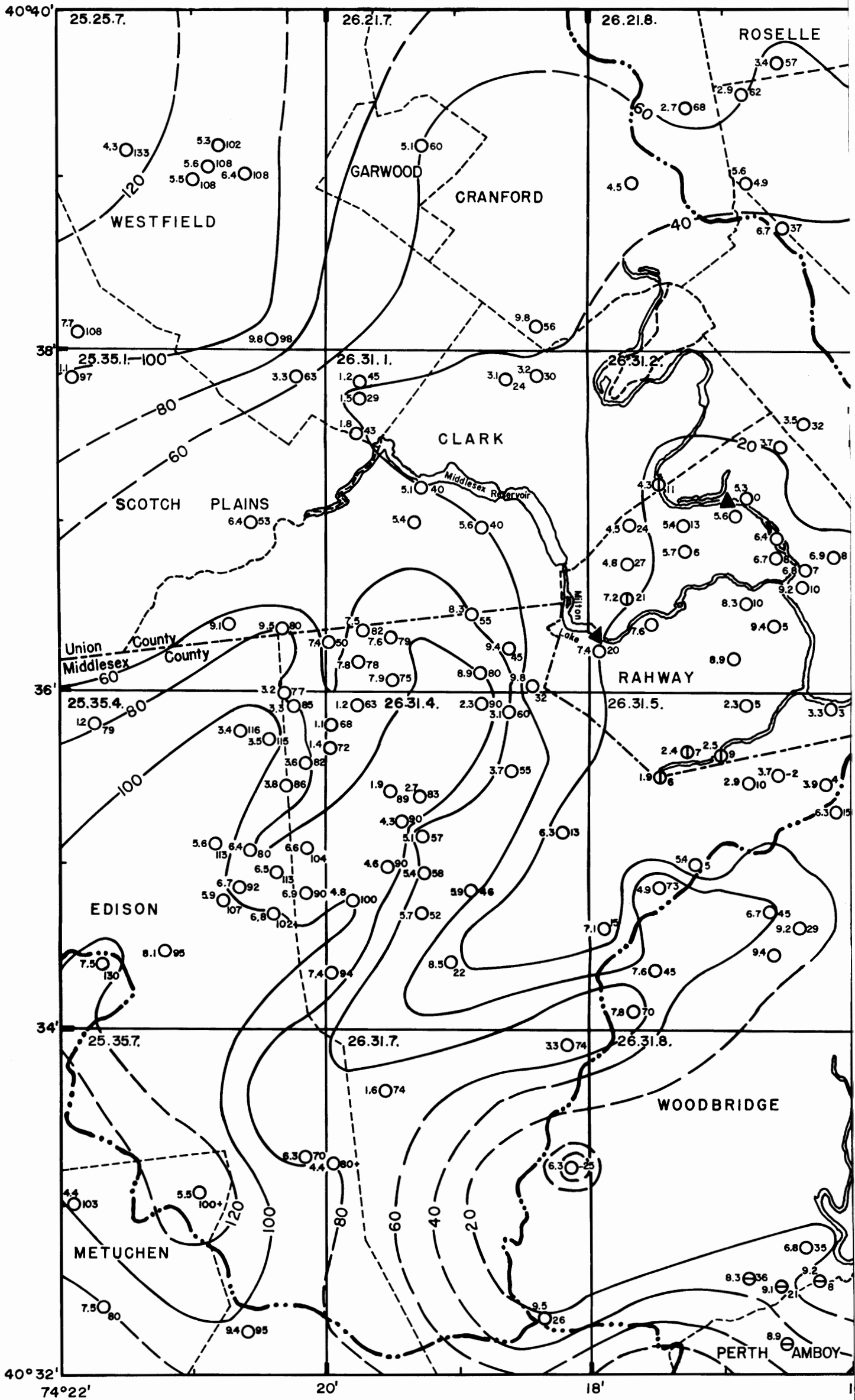
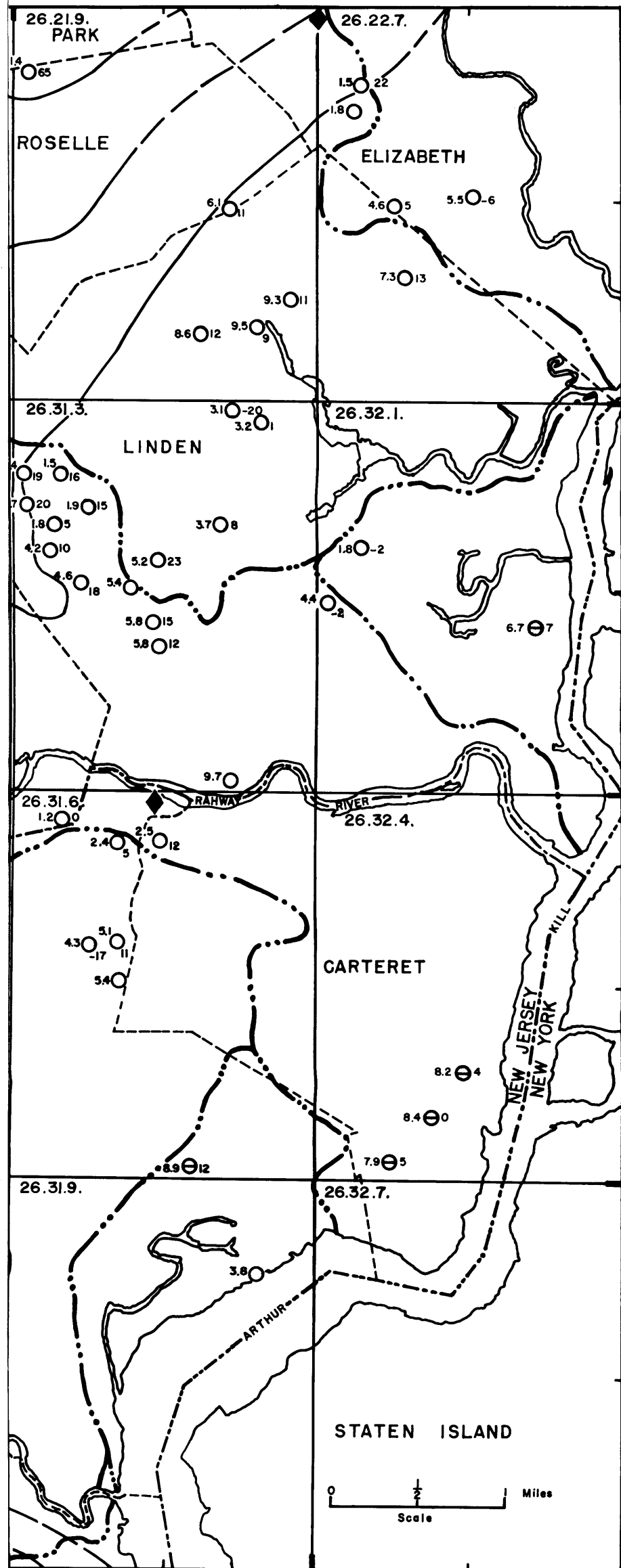





Figure 5.--Water level contour map showing location of wells in to




EXPLANATION

 60
Water-level contour
 Shows altitude of water level at time of well completion. Dashed where uncertain. Contour interval 20 feet. Datum is mean sea level.


Topographic drainage divide

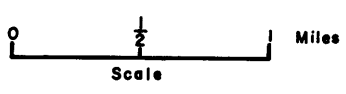

U.S. Geological Survey stream gaging station


U.S. Weather Bureau Climatological Station

26.31.5.
New Jersey grid number

9.3○9
Well in Brunswick Shale
 7.9⊖5
Well in Raritan Formation
 9.4⊕5
Well in Glacial Drift

Well number (separated by dot) on left is last two digits of New Jersey grid location. Number on right is water-level altitude in feet above mean sea level.



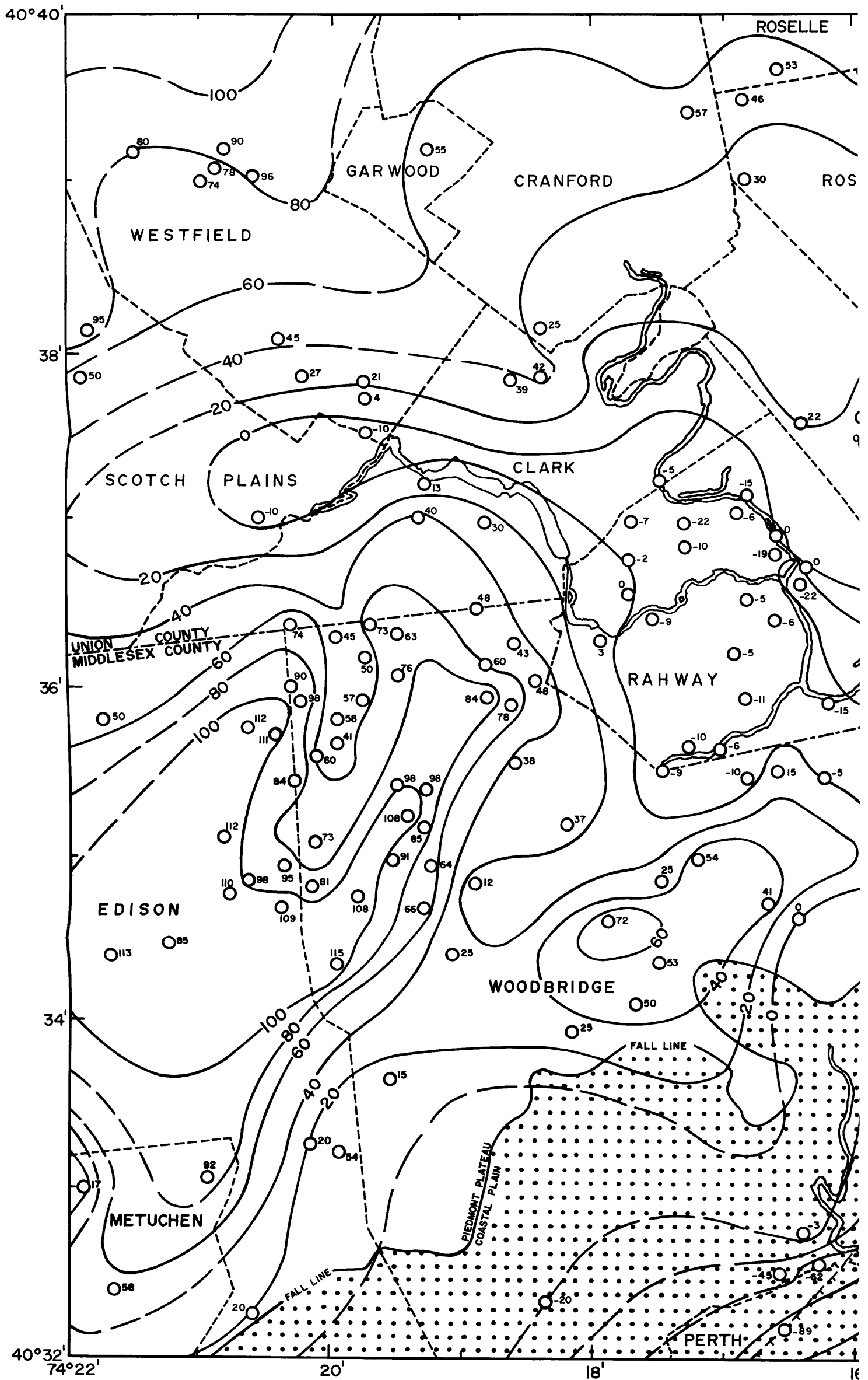
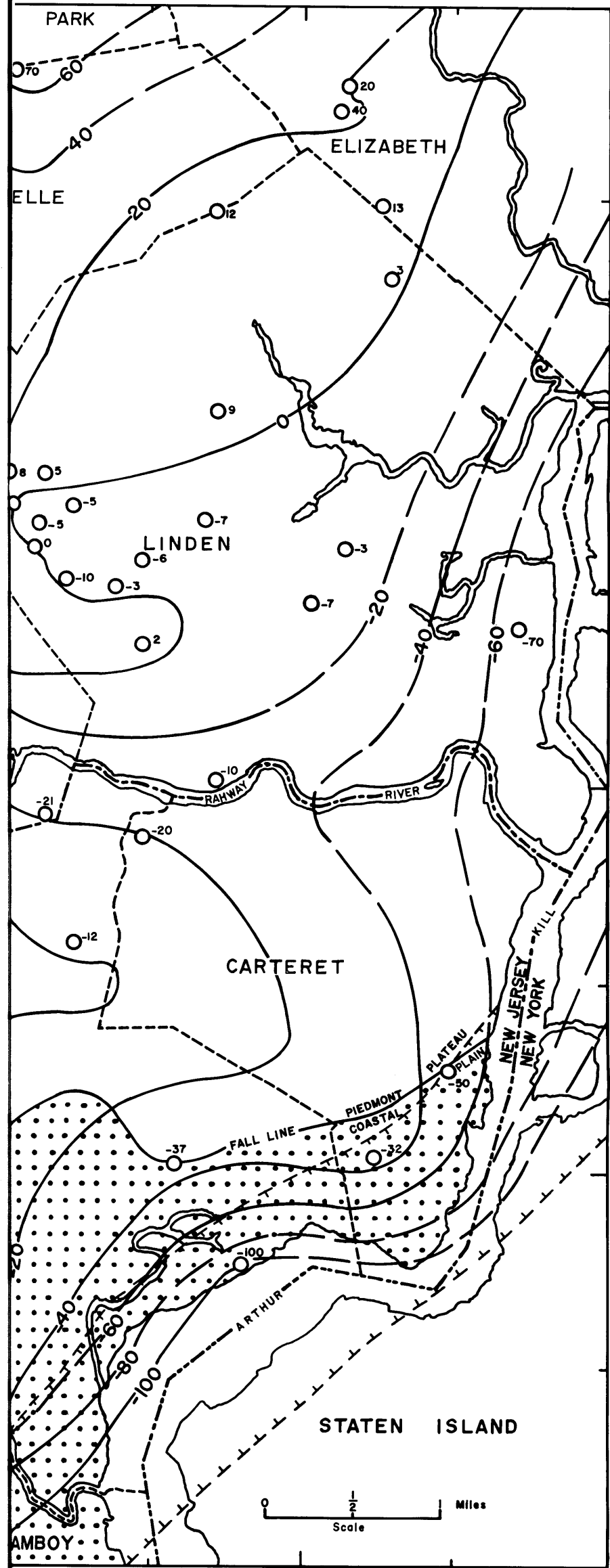
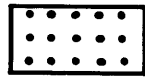


Figure 4.-- Bedrock Geologic map showing contours on the top



EXPLANATION



RARITAN FORMATION

Light-colored sands & clays. Yields moderate amounts of good quality water.



BRUNSWICK SHALE

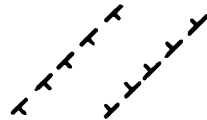
Reddish-brown fractured shale & interbedded sandstone. Yields small to moderate quantities of water primarily from fracture openings. Water locally high in sulfates, dissolved solids, & hardness.



Well or test hole. Number is bedrock altitude in feet above or below (-) mean sea level.



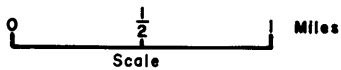
Structure contour
Shows altitude of top of Brunswick Shale. Dashed where uncertain. Contour interval 20 feet. Datum is mean sea level.



Trace of buried diabase ridge.



Contact
Coincides with fall line



14' 74°12'

of the Brunswick Shale.