U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

HYDROLOGY OF THE UNCONFINED KIRKWOOD-COHANSEY AQUIFER SYSTEM, FORKED RIVER AND CEDAR, OYSTER, MILL, WESTECUNK, AND TUCKERTON CREEK BASINS AND ADJACENT BASINS IN THE SOUTHERN OCEAN COUNTY AREA, NEW JERSEY, 1998-99

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ABSTRACT

The Atlantic Coastal study area consists of 21 surface-water drainage basins and the underlying unconfined Kirkwood-Cohansey aquifer system. A map of water levels in the unconfined Kirkwood-Cohansey aquifer system, constructed from water-level measurements made during May and June 1998 at 56 wells and at 126 stream sites, shows that water levels ranged from the National Geodetic Vertical Datum of 1929 (NGVD 29) to 160 feet above NGVD 29. Seasonal fluctuations of water levels in two observation wells were as great as 6.6 feet. The horizontal hydraulic conductivities determined from aquifer tests in and near the study area range from about 131 to 200 feet per day and the transmissivities range from 1,370 to 24,902 feet squared per day.

Approximately 51 percent of the land in the study area (excluding the area of the bays and barrier islands) is forested, 31 percent is wetland, 12 percent is urban, 4 percent is water, less than 2 percent is barren, and less than 0.3 percent is used for agriculture. Approximately 54 percent of the land on the barrier islands is wetland, 32 percent is urban land, and 14 percent is designated as barren, consisting predominantly of beaches. The Atlantic Coastal study area is 331.3 square miles.

Base-flow-separation techniques were used to divide total surface-water discharge into base-flow and direct-runoff components for Cedar, Oyster, and Westecunk Creeks. Mean annual base flow of Cedar Creek at Lanoka Harbor, N.J., was 89.7 ft^3/s (cubic feet per second), or 83.4 percent of total flow, during water years 1933-58 and from late 1970 to 1971. (A water year is the 12-month period from October 1 through September 30 and is designated by the calendar year in which it ends.) Mean annual base flow of Oyster Creek near Brookville, N.J., was 26.3 ft^3/s, or 91.3 percent of total flow, during water years 1966-84. Mean annual base flow of Westecunk Creek at Stafford Forge, N.J., was 29.7 ft^3/s, or 93.3 percent of total flow, during water years 1974-88. In addition, low-flow-correlation analyses were made, and mean annual discharge and base flow for nine low-flow partial-record gaging stations were estimated.

Water-quality analysis of samples from 10 ground-water sites and 3 surface-water sites distributed throughout the study area were compiled and analyzed to document the quality of surface water and unconfined ground water. Data from sites that may be affected by known sources of contamination were not reported. The predominant cations in the 10 ground-water and 3 surface-water samples were sodium and potassium; the predominant anion in the samples was chloride. The U.S. Environmental Protection Agency secondary maximum contaminant level for iron of 300 micrograms per liter was exceeded in two ground-water samples. The Kirkwood-Cohansey aquifer system contains dilute (low ionic strength), acidic waters that have little buffering capacity and contain low concentrations of nutrients. The surface water has similar chemical characteristics. The pH of the surface-water samples ranged from 4.4 to 4.5 units, and the pH of the ground-water samples ranged from 4.8 to 6.4.

Ground-water withdrawals from the Kirkwood-Cohansey aquifer system totaled almost 2,735 Mgal (million gallons) (7.5 Mgal per day) in 1999: 1,608 Mgal for public supply, 1,077 Mgal for private domestic-water supply, 26 Mgal for commercial use, 9 Mgal for thermoelectric use, 6 Mgal for irrigation, 4 Mgal for use at sewage-treatment facilities, 4 Mgal for industrial use, and 1 Mgal for mining.

Mean annual precipitation in the study area was 44.7 inches per year during water years 1986-95. Actual evapotranspiration was estimated to be 23.4 inches per year during the same period. A water budget calculated for the mainland portion of the study area shows that ground-water recharge derived from precipitation in the study area is estimated to be 17.5 inches per year, or about 39 percent of mean annual precipitation. The water budget indicates that ground water flows into the study area from adjacent drainage basins.

INTRODUCTION

In 1986, the U.S. Geological Survey (USGS), in cooperation with the New Jersey Department of Environmental Protection (NJDEP), began to compile data about selected ground- and surface-water systems in New Jersey. These systems coincide with Regional Water Resource Planning Areas, which are single drainage basins or groups of drainage basins delineated in the New Jersey Statewide Water Supply Plan (New Jersey Department of Environmental Protection, 1996b).

The Kirkwood-Cohansey aquifer system in the New Jersey Coastal Plain is predominantly unconfined, although perched water tables and semiconfined conditions caused by the presence of clay units are found locally. Ground water is the principal source of potable water in the Atlantic Coastal study area, and withdrawals from this aquifer system are expected to increase with increasing population in the study area. Water demand in the study area is expected to grow from 12 Mgal/d in 1990 to 27 Mgal/d in 2040 (New Jersey Department of Environmental Protection, 1996b). (Definitions of abbreviations and conversions for units used in the text are shown in table 1-1.) Detailed information about this aquifer system and the surface-water systems that are hydraulically connected to it was needed as the basis for decisions that will ensure that the increasing demand for water from this aquifer will be met as the population grows.

Purpose & Scope

This report presents the results of a study conducted during 1998-99 to investigate the hydrology of the unconfined Kirkwood-Cohansey aquifer system and the surface-water system of 21 drainage basins in the New Jersey Coastal Plain. The combined areas of these 21 basins, referred to in this report as the "Atlantic Coastal study area," formerly corresponded to Regional Water Resource Planning Area number 19 in the New Jersey Statewide Water Supply Plan (New Jersey Department of Environmental Protection, 1996b) but currently (2000) are included in Regional Water Resource Planning Area number 13 (New Jersey Department of Environmental Protection, 1997). The extent of hydrogeologic units in the study area was approximated from published maps and reports. Data in this report include the results of (1) water-level measurements in 57 wells and at 126 surface-water sites; (2) chemical analyses of water samples from 10 wells and 3 surface-water sites, and of stream-bottom samples from 6 sites, for selected inorganic and organic constituents; (3) base-flow-separation analyses of discharge measurements at three streamflow-gaging stations and low-flow correlations of streamflow records from nine low-flow partial-record stations in the study area; and (4) a water-budget analysis, including measurements of precipitation and stream discharge and estimates of water use and evapotranspiration. The water budget is used to estimate recharge in the study area.

Previous Investigations

Results of county-wide studies of the geology and ground-water resources in the study area were reported by Anderson and Appel (1969) for Ocean County and Rush (1968) for Burlington County. Harriman and Voronin (1984) presented water-quality data for approximately 160 wells screened in the unconfined Kirkwood-Cohansey aquifer system in Ocean County and a small adjacent part of Monmouth County. Harriman and Sargent (1985) evaluated the ground-water quality of the unconfined and confined aquifers in Ocean County. Zapecza (1989) described the hydrogeologic framework of the Coastal Plain, and Martin (1998) provided an analysis of ground-water flow in the Coastal Plain.

Other reports on the hydrology of the unconfined aquifer system in areas adjacent to this study area are available. Watt and others (1994) described the hydrology of the unconfined aquifer system in the Toms River drainage basin, north of the study area; Watt and others (2003) described the hydrology of the unconfined system in the area of the Rancocas Creek drainage basin, northwest of the study area; and Johnson and Watt (1996) described the hydrology of the unconfined aquifer system in the Mullica River drainage basin, west of the study area.

Well-Numbering System

The well-numbering system used in this report is based on the system used by the USGS in New Jersey since 1978. It consists of a county-code number and a sequence number of the well within the county. County codes used in this report are those for Burlington County (5) and Ocean County (29). For example, well number 29-719 represents the 719th well inventoried in Ocean County. Construction details for wells with this type of identifier are stored in the USGS Ground-Water Site Inventory (GWSI) database (available at the USGS office in West Trenton, N.J.).

Description of the Study Area

The Atlantic Coastal study area (fig. 1-1) consists of 21 surface-water drainage basins that range in size from less than 1 to nearly 57 mi^2 (fig. 1-2) and that together make up an area of 331.3 mi^2. Most of the study area is in Ocean County, but 78.4 mi^2 is in Burlington County. This area encompasses all or part of 16 municipalities (fig. 1-3), and includes the bays and barrier islands that are part of these municipalities. The study area and basin boundaries can be defined by either topographic divides or surface-water-drainage divides, which nearly are coincident in most of the study area. Elevation of land surface ranges from more than 200 ft in Manchester Township to the National Geodetic Vertical Datum of 1929 (NGVD 29) in coastal areas.

Land Use

For the purpose of land-use analysis (fig. 1-4), the study area was divided into three sections: (1) the mainland, (2) the barrier islands, and (3) the bays, which are mostly water. The area of the mainland is approximately 235.7 mi^2; approximately 51 percent is forested, 31 percent is wetland, 12 percent is urban land, 4 percent is water, less than 2 percent is barren land, and 0.3 percent is used for agriculture (table 1-2). The area of the barrier islands is approximately 15.1 mi^2; approximately 54 percent is wetland, 32 percent is urban, and 14 percent is barren, predominantly beaches (table 1-2). Land-use designations are based on the updated NJDEP 1986 Integrated Terrain Unit Geographic Information System (GIS) Resource Data with 1995/97 color-infrared imagery and delineated areas of change (New Jersey Department of Environmental Protection, 2000).

Most of the forested land is in the western part of the study area and is part of an area designated as the New Jersey Pinelands. The New Jersey Pinelands is a regional recharge area that provides freshwater flow to coastal areas (Harriman and Sargeant, 1985, p. 67). The Pinelands area is characterized by hardwood swamps of red maple and black gum, and Atlantic white cedar swamps, along with pitch pine in lowland areas and oak forests (Tiner, 1985). Urban areas are scattered over the study area, but are concentrated along the coast. Wetlands are located in the coastal areas and along the tributaries of the many streams on the mainland. Barren land includes beaches and altered, transitional, and mining land. Agricultural land use is negligible. Industrial development in the study area always has been limited (Rivkin Associates, Inc., 1976).

Contaminated Sites

The proximity of the unconfined aquifer system to land surface causes it to be susceptible to contamination. The NJDEP's comprehensive contaminated site list (New Jersey Department of Environmental Protection, 1996a) includes 47 known contaminated sites (table 1-3) and 4 sites contaminated from unknown sources (table 1-4) that, on the basis of street address, are within the study area. Contaminated sites are found most commonly in coastal or urban areas, but some are inland in barren land.

Geologic and Hydrogeologic Units

The study area lies in the Coastal Plain physiographic province of New Jersey. The New Jersey Coastal Plain is a seaward-dipping wedge of unconsolidated sediments of Cretaceous to Quaternary age that extends from the Fall Line to the Atlantic Ocean and Delaware Bay (fig. 1-1). The Fall Line is the boundary between older, resistant, consolidated rocks to the northwest and younger, unconsolidated sediments to the southeast. Coastal Plain sediments thicken from a featheredge at the Fall Line to more than 2,000 ft at the southeasternmost extent of the study area and overlie consolidated Precambrian and Paleozoic bedrock. The Coastal Plain sedimentary wedge forms a complex ground-water system in which the sands and gravels function as aquifers and the silts and clays function as confining units (fig. 1-5). A detailed discussion of the hydrogeologic framework and the principal aquifers and confining units of the New Jersey Coastal Plain is given in Zapecza (1989).

The Kirkwood-Cohansey aquifer system is part of the Coastal Plain of New Jersey, but consists only of sediments of middle Tertiary to Quarternary age. A stratigraphic column of the principal geologic units and associated hydrogeologic units in the Coastal Plain of New Jersey is shown in table 1-5. A hydrogeologic unit consists of one or more geologic units or parts of geologic units with similar water-bearing and water-transmitting characteristics. Where ground water is present in sand and gravel that is not overlain by a confining unit and the sand and gravel is sufficiently thick to provide useful quantities of water, that hydrogeologic unit is considered an unconfined aquifer. Where ground water is present in silt or clay, the hydrogeologic unit can be referred to as a confining unit.

Two hydrogeologic sections were constructed from electric and gamma-ray geophysical logs to show the interpreted contacts between the aquifers and confining units in the study area. The locations of the wells from which the logs were obtained are shown in figure 1-3. The lateral continuity of the principal aquifers and confining units in the study area in the downdip direction and from south to northeast are traced in sections A-A' (fig. 1-6) and B-B' (fig. 1-7), respectively.

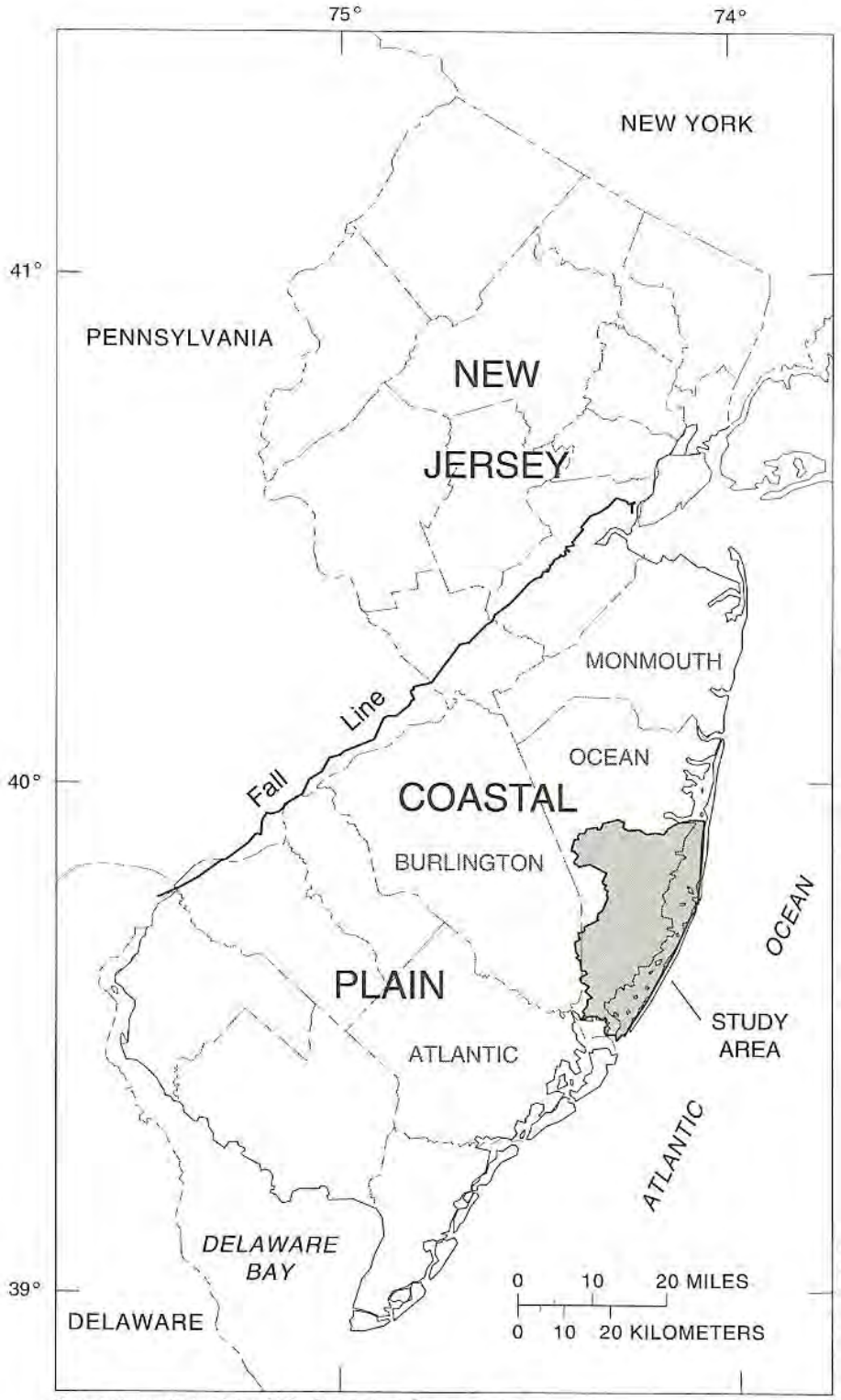
The Kirkwood-Cohansey aquifer system is predominantly unconfined, although local clay beds cause perched water tables and semiconfined conditions. In the study area, the aquifer system consists predominantly of the Kirkwood Formation and Cohansey Sand. The Kirkwood Formation is the oldest formation in the aquifer system and does not crop out in the study area. Along the coast, the Kirkwood Formation consists of areas of thick clay beds with interbedded zones of sand and gravel (Zapecza, 1989). In the subsurface updip from the coast, fine to medium quartz sand and silty sand are common (Zapecza, 1989). A regionally extensive clay unit, which is in the lower part of the Kirkwood Formation, forms the base of the Kirkwood-Cohansey aquifer system. The Cohansey Sand is composed of medium- to coarse-grained quartz sand with some gravel and silt. Thin, interbedded clay layers are common locally.

The updip limit of a thick confining unit that underlies the Kirkwood-Cohansey aquifer system and overlies the Atlantic City 800-foot sand is shown in figures 1-8 and 1-9. West of this feature, the basal surface of the Kirkwood-Cohansey aquifer system is the top of the clay unit in the lower part of the Kirkwood Formation (Zapecza, 1989), which is the updip extension of the confining unit underlying the Atlantic City 800-foot sand (table 1-5). East of this feature, the basal surface of the Kirkwood-Cohansey aquifer system is the top of a thick, diatomaceous clay unit that overlies the Atlantic City 800-foot sand (table 1-5) (Zapecza, 1989). A thin confined aquifer, the Rio Grande water-bearing zone, is found near the middle of the confining unit (fig. 1-5). This confining unit is absent in the northern part of the study area (fig. 1-5). The difference in these two basal surfaces of the Kirkwood-Cohansey aquifer system is shown in fig. 1-5. In the study area, southeast of this feature the basal surface of the Kirkwood-Cohansey aquifer system ranges in altitude from less than 140 to greater than 280 ft below NGVD 29 (fig. 1-9) and the thickness of the Kirkwood-Cohansey aquifer system ranges from about 200 to more than 300 ft (fig. 1-8). The altitude of the base of the Kirkwood-Cohansey aquifer system in the northern part of the study area ranges from about 100 to more than 350 ft below NGVD 29 (fig. 1-9). The thickness of the aquifer north of the updip limit of the confining unit overlying the Atlantic City 800-foot sand ranges from 200 to 400 ft (fig. 1-8).

Hydraulic Properties of the Kirkwood-Cohansey Aquifer System

Hydraulic properties of the Kirkwood-Cohansey aquifer system in the study area were compiled from results of aquifer tests conducted in or near the study area. An aquifer test is the withdrawal of measured quantities of water from, or the addition of water to, a well and the measurement of the resulting changes in water levels at nearby locations in the aquifer both during and after the period of withdrawal or addition (Fetter, 1994). The parameters typically reported from aquifer-test results are transmissivity, hydraulic conductivity, and storage coefficient or specific yield. Locations of aquifer-test sites are shown in figure 1-3.

Reported values of the horizontal hydraulic conductivity of the Kirkwood-Cohansey aquifer system in and near the study area range from 131 to 200 ft/d (table 1-6). These values are typical of a well-sorted sand (Freeze and Cherry, 1979, p. 29). Reported transmissivities (aquifer thickness multiplied by hydraulic conductivity) in and near the study area range from 1,370 to 24,902 ft^2/d (table 1-6). Specific yield is the storage term for an unconfined aquifer. It is a dimensionless value that repesents the volume of water an aquifer will release per unit surface area per unit decrease in water level (Freeze and Cherry, 1979). When a well tapping an unconfined aquifer is pumped, water is withdrawn largely from storage in the vicinity of the well. The pumping effect is transmitted to other parts of the aquifer, resulting in a decrease in the altitude of the water table as a result of gravity drainage. Typical specific yields for unconfined aquifers are from 0.01 to 0.3 (Freeze and Cherry, 1979, p. 61). The specific yield reported by Barksdale and others (1958) for the Kirkwood-Cohansey aquifer system near the study area is 0.23 (or 2.3×10^{-1}). The storage coefficient, also a dimensionless value, is the storage term used for a confined aquifer. It generally is much smaller than the specific yield of an unconfined aquifer. Reported storage coefficients for the Kirkwood-Cohansey aquifer system in and near the study area range from 7.0×10^{-4} to 2.2×10^{-3} (table 1-6). Therefore, the Kirkwood-Cohansey aquifer system, which is considered to be under unconfined conditions, appears to be under semiconfined conditions in some locations. This condition probably results from the presence of discontinuous layers of silt and clay in the Cohansey Sand.



County boundaries from U.S. Geological Survey digital line graph files, 1:24,000; State boundaries from U.S. Geological Survey digital line graph files, 1:2,000,000

Figure 1-1. Location of the Atlantic Coastal study area, New Jersey.

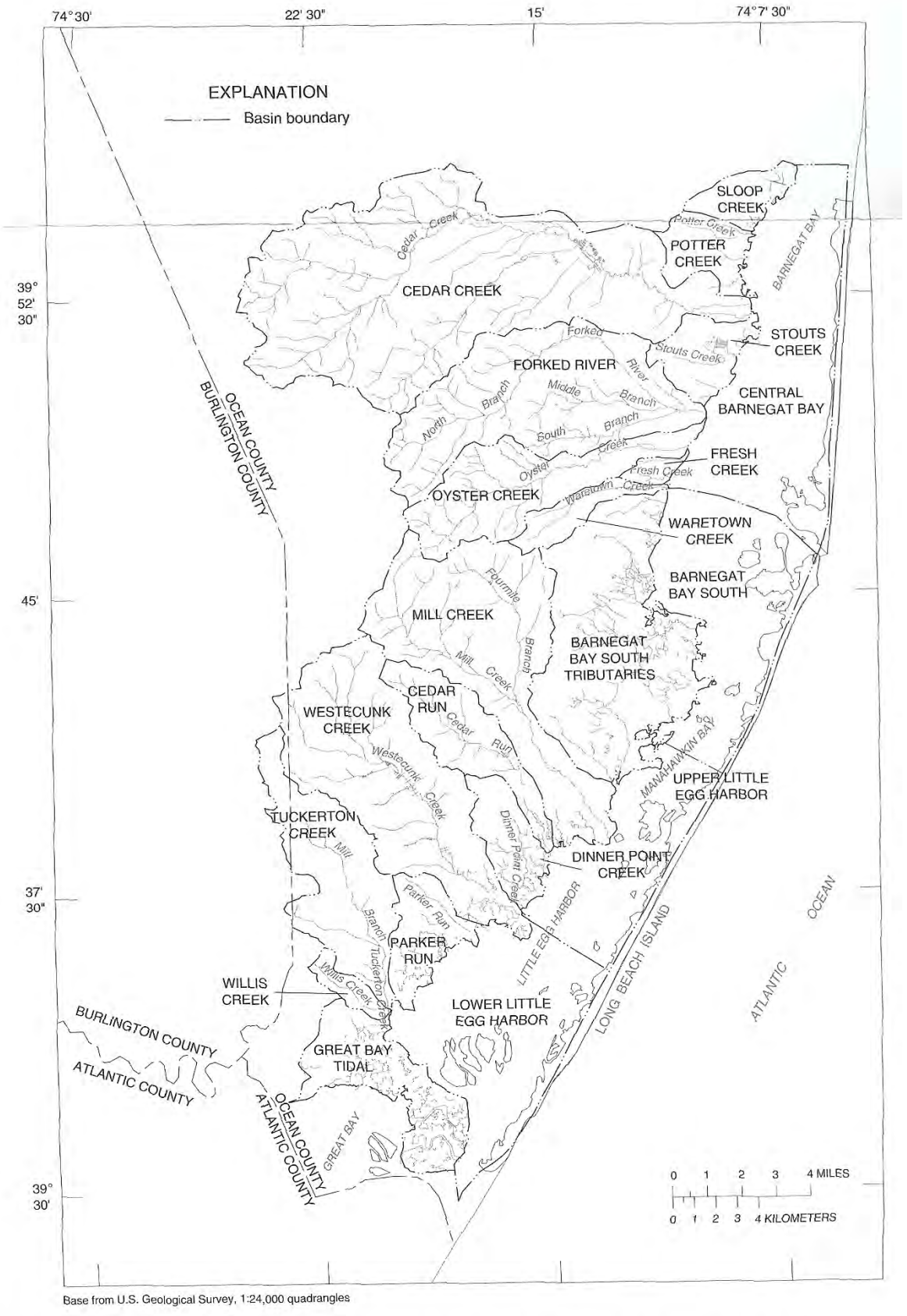


Figure 1-2. Surface-water drainage basins in the Atlantic Coastal study area, New Jersey.

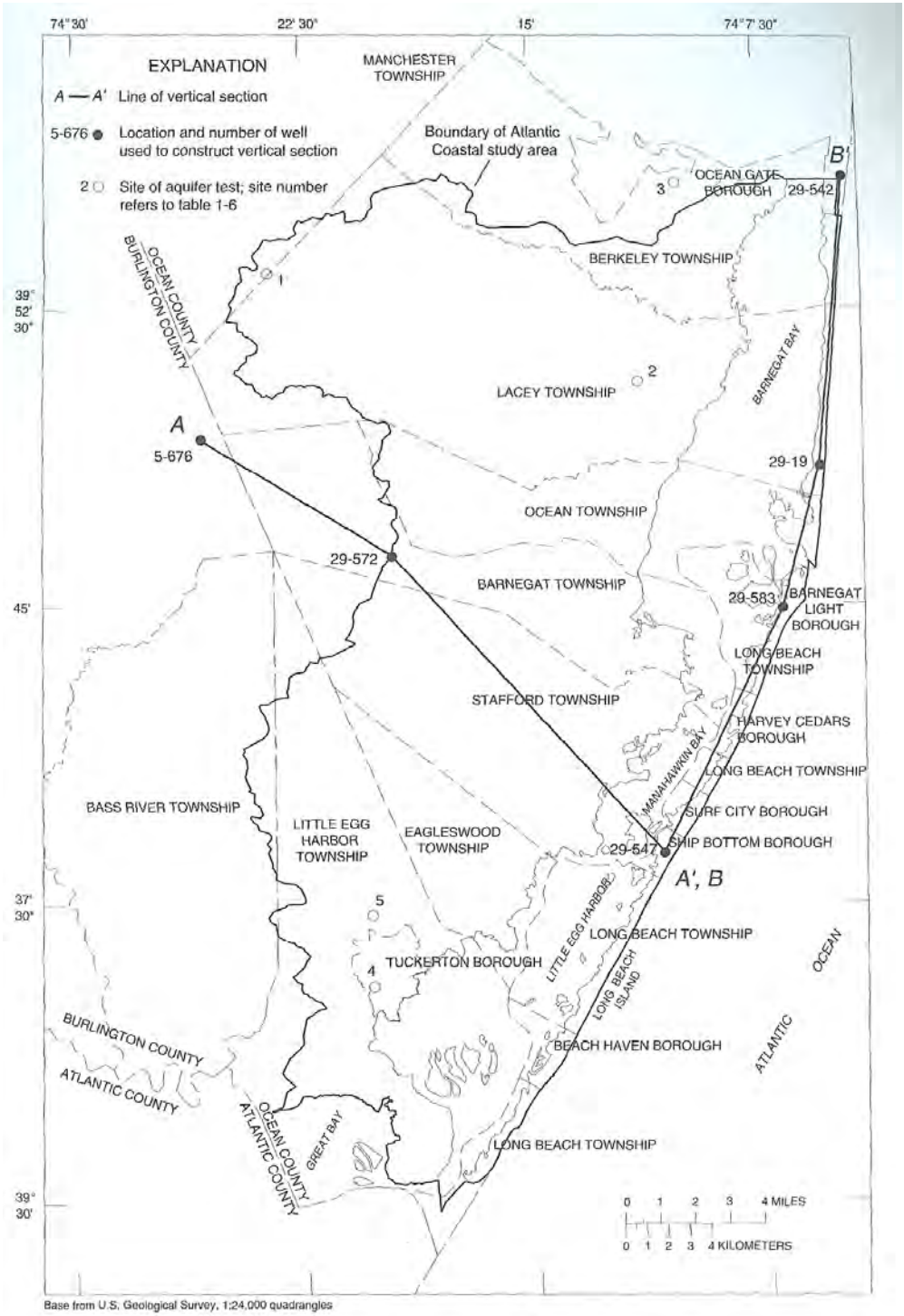


Figure 1-3. Municipalities, locations of vertical sections *A-A'* and *B-B'*, and locations of aquifer-test sites in the Atlantic Coastal study area, New Jersey.

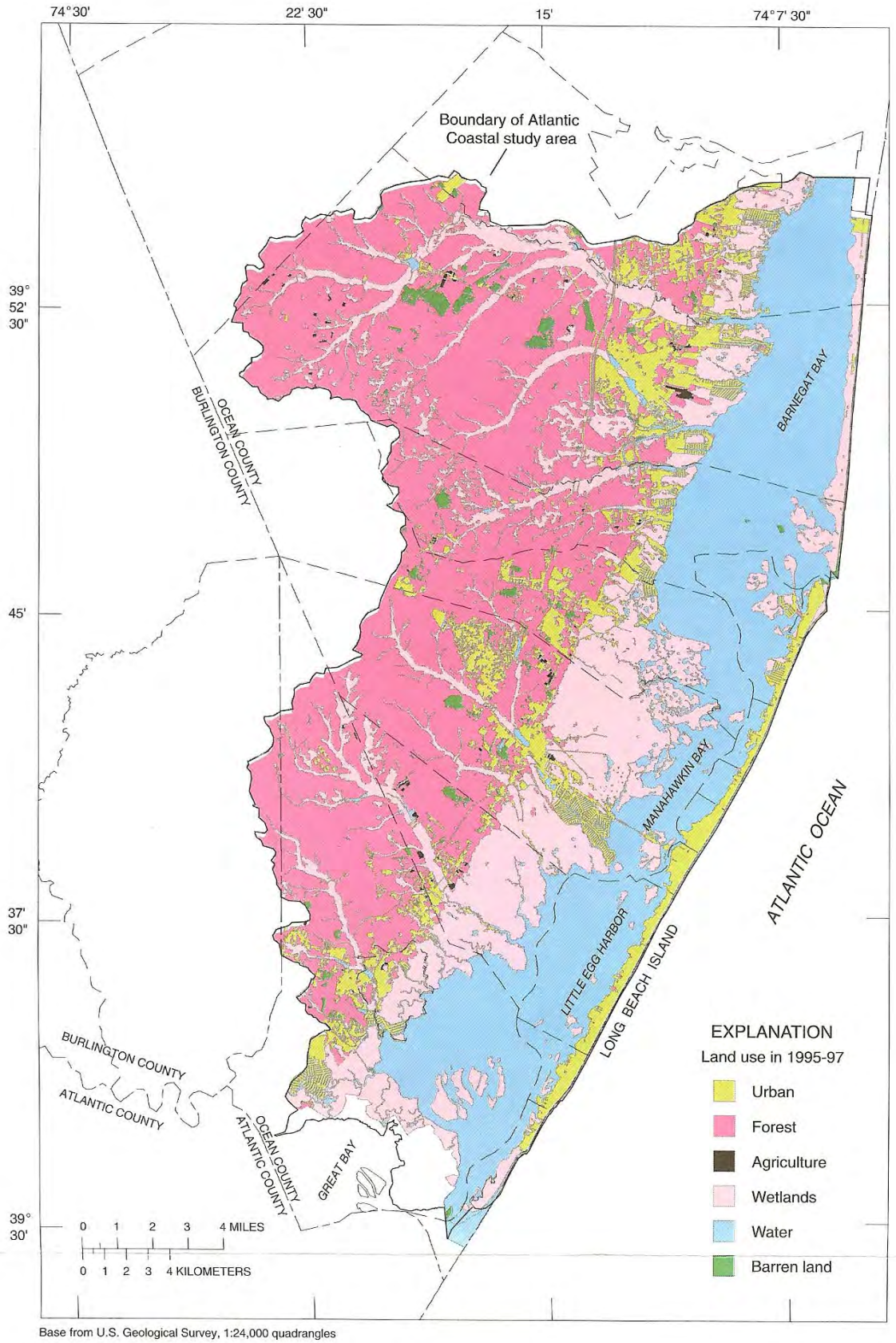


Figure 1-4. Land use in the Atlantic Coastal study area, New Jersey, 1995-97. (Land-use data from New Jersey Department of Environmental Protection, 2000.)

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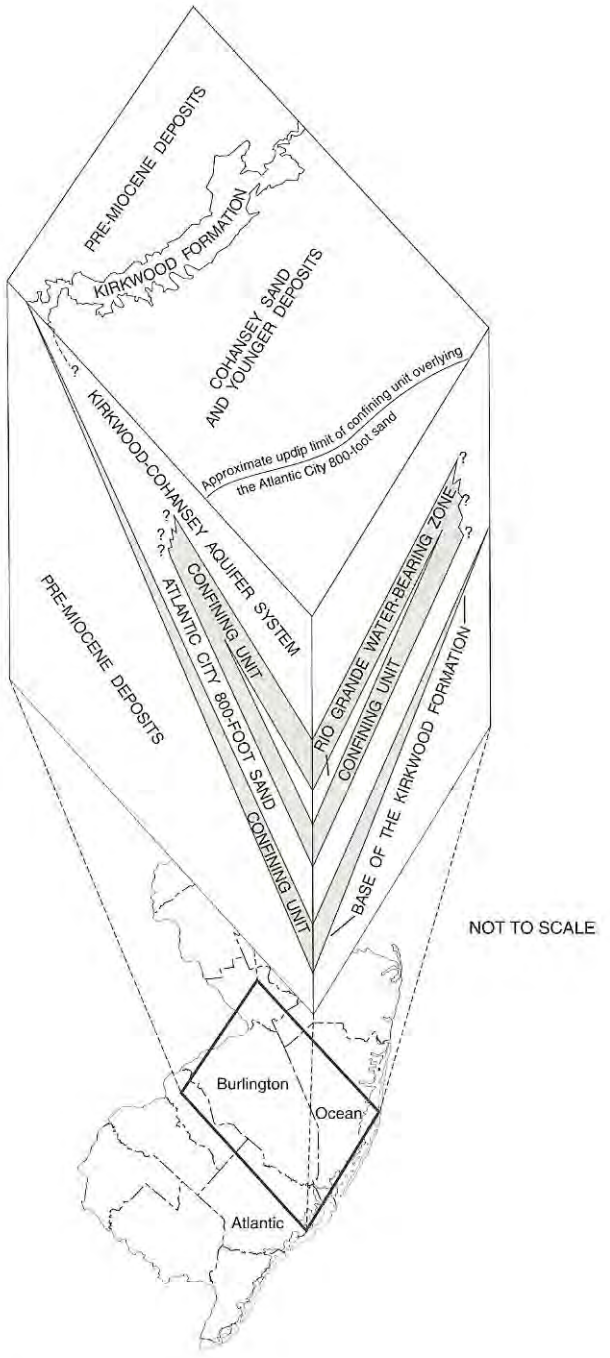


Figure 1-5. Relation of the Kirkwood-Cohansey aquifer system to confined aquifers within the Kirkwood Formation, southern New Jersey. (Modified from Zapecza, 1989, fig. 5.)

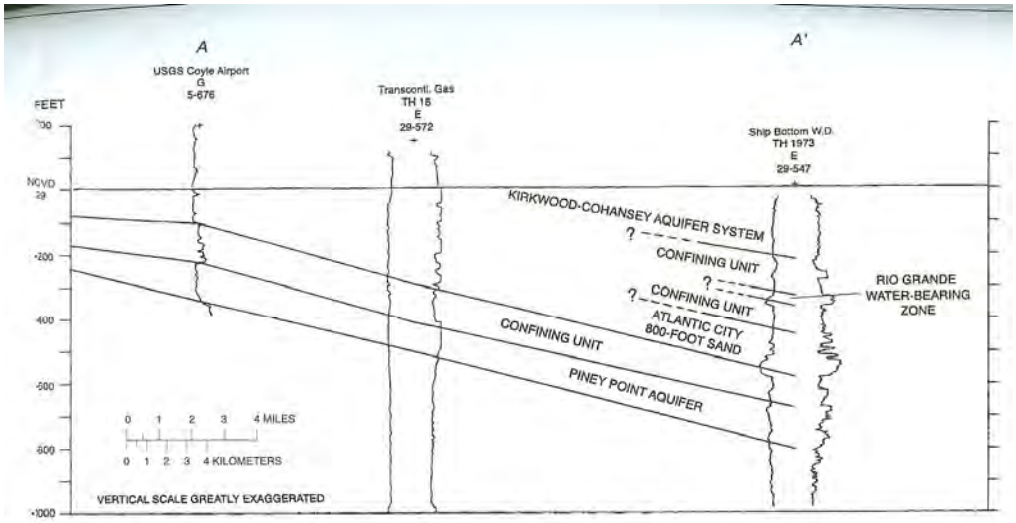


Figure 1-6. Vertical section *A-A'* through the Atlantic Coastal study area, New Jersey, based on gamma-ray and electric logs. (Modified from Zapecza, 1989, pl. 4; well locations shown in fig. 1-3.)

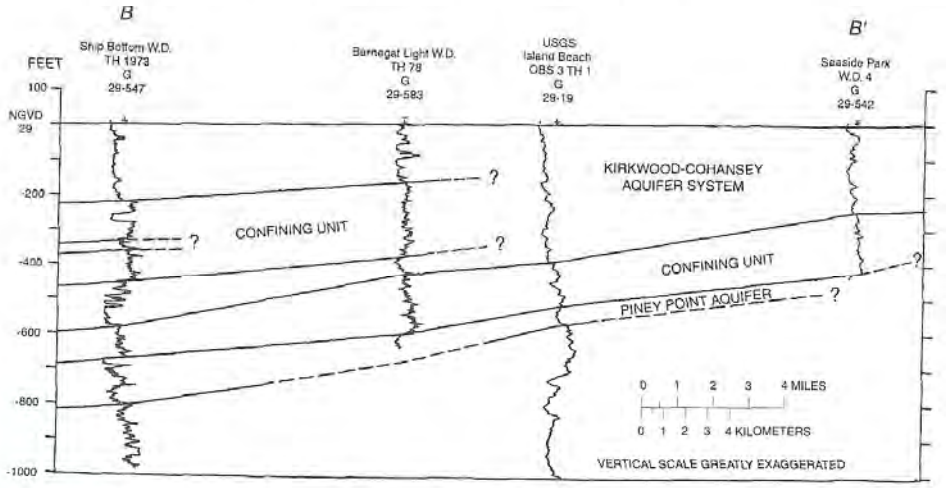
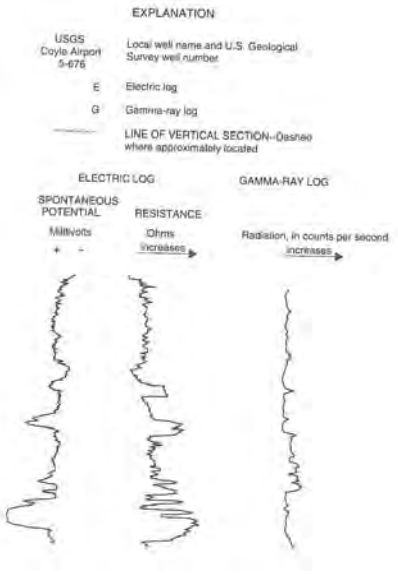
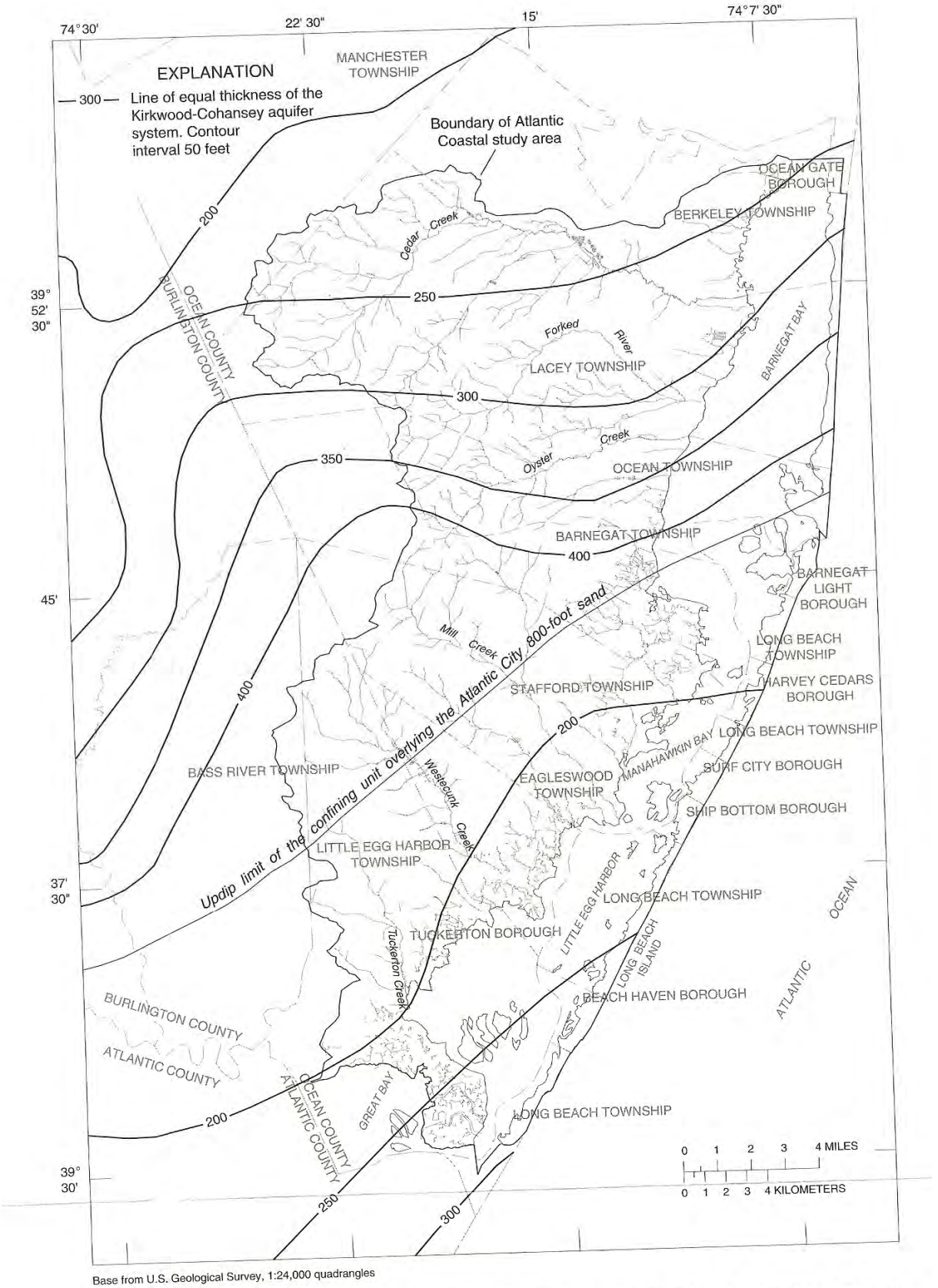


Figure 1-7. Vertical section *B-B'* through the Atlantic Coastal study area, New Jersey, based on gamma-ray logs. (Modified from Zapecza, 1989, pl. 5; well locations shown in fig. 1-3.)





Base from U.S. Geological Survey, 1:24,000 quadrangles

Figure 1-8. Thickness of the Kirkwood-Cohansey aquifer system in the Atlantic Coastal study area, New Jersey. (Hydrogeology from Zapecza, 1989, pl. 24.)

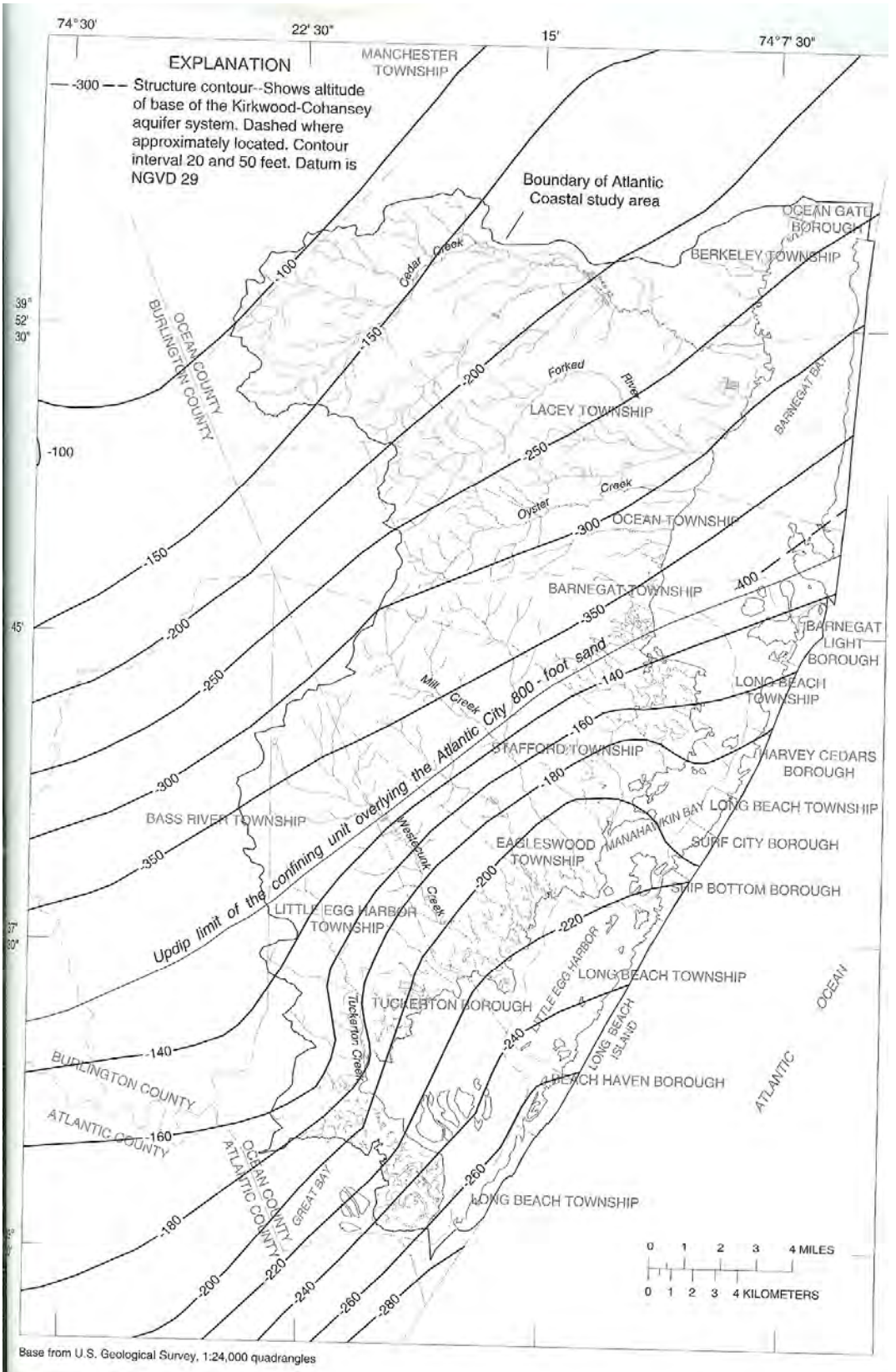


Figure 1-9. Altitude of the base of the Kirkwood-Cohansey aquifer system in the Atlantic Coastal study area, New Jersey. (Hydrogeology from Zapecza, 1989, pl. 23.)

Table 1-1. Conversion factors and vertical datum

Multiply	by	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
foot per mile (ft/mi)	0.1894	meter per kilometer
	Area	
acre	4.047	square meter
square mile (mi^2)	2.590	square kilometer
	Volume	
million gallons (Mgal)	3.785	cubic meter
	Flow	
inch per year (in/yr)	2.54	centimeter per year
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
gallon per minute (gal/min)	0.06308	liter per second
gallon per day (gal/d)	0.003785	cubic meter per day
million gallons per day (Mgal/d)	0.04381	cubic meter per second
	Transmissivity	
foot squared per day (ft^2/d)	0.09290	square meter per day
	Hydraulic conductivity	
foot per day (ft/d)	0.3048	meter per day

Temperature conversion formula: $^{o}F = 1.8 \times {}^{o}C + 32$

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Table 1-2. Land-use areas in the Atlantic Coastal study area, New Jersey

[Land-use data from New Jersey Department of Environmental Protection, 2000]

Land use	Area in mainland[1] (square miles)	Percent of mainland area	Area in barrier islands (square miles)	Percent of barrier islands area	Total area (square miles)	Percent of total area
Urban	27.7	11.8	4.8	31.8	32.5	9.8
Forest	120.6	51.2	0	0	120.6	36.4
Agriculture	.8	.3	0	0	.8	.2
Wetlands	73.6	31.2	8.2	54.3	81.8	24.7
Water	9.2	3.9	0	0	89.7	27.1
Barren land[2]	3.8	1.6	2.1	13.9	5.9	1.8
TOTAL	235.7	100	15.1	100	331.3	100

[1]Does not include area of barrier islands and water in bays.

[2]Barren land includes altered lands, extractive mining locations, transitional areas, and beaches.

Table 1-3. Contaminated sites with known source(s) of contamination in the Atlantic Coastal study area, New Jersey, 1995

[From New Jersey Department of Environmental Protection, 1996a]

Site name[1]	Street location
Burlington County	
Bass River Township	
Gulf Service Station	Route 9
Sears Trailer	Greenbush Road E
Ocean County	
Barnegat Light Borough	
Inlet Marine Sales	Bayview Avenue
U.S. Coast Guard Station Barnegat Light	6th Street & Bayview Avenue
Beach Haven Borough	
Howe Marina	Delaware Avenue
Morrisons Seafood Corporation	2nd Street & Bay Avenue
Berkeley Township	
A. Kurnel & Sons	Route 9
Bayville William Penn	Route 9 & Station Road
Denzer & Schafer X-Ray Company	Hickory Lane
Shell Service Station	Route 9
Eagleswood Township	
Eagleswood Township Sanitary Landfill	Stafford Forge Road
Harvey Cedars Borough	
Harvey Cedars Borough Garage	Long Beach Boulevard & Salem Avenue
The Boat Yard	Bay Terrace
Lacey Township	
Coraluzzo Trucking	Lacey Road
Exxon Service Station	Lacey Road
Garden State Parkway Forked River Service Area	Garden State Parkway MM 76
Lacey Township Sanitary Landfill	Lacey Road
Pugliese Realty	Lacey Road
Little Egg Harbor Township	
Fish Factory	Great Bay
Great Bay Plaza	Mathistown Road
Little Egg Harbor Atlantis Section	Saint Andrews Drive
Texaco Service Station	Radio Road & Dyke Place
Ocean Township	
Grand Bay Harbor Marina Condominiums	Washington Road & Pacific Avenue
Southern Ocean Sanitary Landfill	Route 532 & Brookville Road
Sunoco Service Station	Route 9 & Main Street
Ship Bottom Borough	
Amoco Service Station	17th Street & Long Beach Boulevard
Brennan Gas and Go Corporation	8th Street
Exxon Service Station	8th Street & Long Beach Avenue
Gulf Service Station	Central Avenue
Mobile Service Station	8th & Central Avenue
Sunoco Service Station	8th Street
Stafford Township	
Acme Oil Company	Stafford Avenue
G. Anderson Agency	Route 72 E
Lakeside Condo Incorporated	Bay Avenue
Manahawkin Baptist Church	Hilliard Boulevard & Beach Avenue
NJDOT Manahawkin Maintenance Facility	Route 72
Shell Service Station	Route 72 & Mill Creek Road
Stafford Township Department of Public Works	Recovery Road
Stafford Township Landfill	Recovery Road
Sunoco Service Station	Route 72 & West Street
Surf City Borough	
Walt Smiths Garage	19th Street & Long Beach Boulevard
Tuckerton Borough	
Cedar Cove Marina	South Green Street
Getty Service Station	West Main Street
Seacrest Village Nursing Home	Center Street
Shell Service Station	Main Street
Tuckerton Coal Gas (JCP&L)	Wool Street
Ultima Cove Marina Incorporated	Green Street

[1]The use of industry or firm names in this report is for location purposes only and does not inpute responsibility for any present or potential effects on the natural resources.

Table 1-4. Contaminated sites with unknown source(s) of contamination in the Atlantic Coastal study area, New Jersey, 1995

[From New Jersey Department of Environmental Protection, 1996a]

Site name	Street location
Ocean County	
Berkeley Township	
Butler Boulevard Ground-Water Contamination	Butler Boulevard
Lacey Township	
Constitution Drive Ground-Water Contamination	Constitution Drive
Lake Barnegat Drive North Ground-Water Contamination	Lake Barnegat Drive N
Lanoka Harbor Ground-Water Contamination	Lanoka Harbor

Table 1-5. Principal Oligocene to Holocene geologic and hydrogeologic units in the New Jersey Coastal Plain

[Modified from Zapecza, 1989, table 2]

SYSTEM	SERIES	GEOLOGIC UNIT	LITHOLOGY	HYDROGEOLOGIC UNIT	HYDROLOGIC CHARACTERISTICS
Quaternary	Holocene	Alluvial deposits	Sand, silt and black mud.	Undifferentiated	Surficial material, commonly hydraulically connected to underlying aquifers. Locally, some units may act as confining units. Thicker sands are capable of yielding large quantities of water.
		Beach sand and gravel	Sand, quartz, light-colored, medium-to coarse-grained, pebbly.		
	Pleistocene	Cape May Formation	Sand, quartz, light-colored, heterogeneous, clayey, pebbly.		
Tertiary	Miocene	Pennsauken Formation		Kirkwood-Cohansey aquifer system	A major aquifer system. Ground water occurs generally under (water-table) conditions.
		Bridgeton Formation			
		Beacon Hill Gravel	Gravel, quartz, light-colored, sandy.		
		Cohansey Sand	Sand, quartz, light-colored, medium-to coarse-grained, pebbly, local clay beds.		
		Kirkwood Formation	Sand, quartz, gray and tan, very fine to medium-grained, micaceous, and dark-colored diatomaceous clay.	Confining unit	Thick, diatomaceous clay bed occurs along coast and for a short distance inland. A thin water-bearing sand is present in the middle of this unit.
				Rio Grande water-bearing zone	
				Confining unit	
				Atlantic City 800-foot sand	A major aquifer along the coast.
	Oligocene	Piney Point Formation / Shark River Formation	Sand, quartz and glauconite, fine- to coarse-grained.	Composite confining unit	Poorly permeable sediments.
				Piney Point aquifer	Yields moderate quantities of water.

Table 1-6. Hydraulic properties of the Kirkwood-Cohansey aquifer system in southern Ocean County, New Jersey

[ft/d, foot per day; ft^2/d, foot squared per day; --, missing data]

Site number (fig. 1-3)	Site location	Date of test	Method of evaluation	Horizontal hydraulic conductivity (ft/d)	Transmissivity (ft^2/d)	Specific yield or storage coefficient (dimensionless)	Reference
1	Webb Mills, Lacey Township	07/05/1975	Stallman and Papadopulos	131	10,200	[1]0.23	Kam, 1978
2	Boox St. wellfield, Lacey Township	05/04/1990	Hantush and Jacob	200	24,902	.00223	[2]Database file number 168
3	Berkeley Township	01/13/1998	Papadopulos and Cooper	--	1,370	--	[2]Database file number 169
4	Tuckerton Borough	02/23/1998	--	--	4,644	.00222	[2]Database file number 189
5	Little Egg Harbor Township	09/03/1999	Hantush and Jacob	--	5,990	.0007	[2]Database file number 210

[1]Value of specific yield is given in Barksdale and others, 1958.

[2]New Jersey Geological Survey Hydroparameters Database System: unpublished data on file at the New Jersey Department of Environmental Protection, New Jersey Geological Survey, Trenton, N.J.