WATER LEVELS, CHLORIDE CONCENTRATIONS, AND PUMPAGE IN THE COASTAL AQUIFERS OF DELAWARE AND MARYLAND

By Daniel J. Phelan

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CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who may prefer to use metric (International System) units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply inch-pound units	by	To obtain metric units
foot (ft)	0.3048	meter (m)
gallon (gal)	3.785	liter (L)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.59	square kilometer (km^2)

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows:

$$°F = 1.8°C + 32$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)---a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called " Sea Level Datum of 1929."

Chemical concentration and water temperature in this report are expressed in SI units. Chemical concentration is given in milligrams per liter (mg/L) or in micrograms per liter (ug/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weights of solute per unit volume of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations of less than about 7,000 mg/L, the numerical value is about the same as for concentration in parts per million.

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ABSTRACT

The freshwater aquifers that provide water to coastal Delaware and Maryland are susceptible to saltwater intrusion from (1) downward leakage from the ocean and bays, (2) upward leakage from the underlying St. Marys Formation, and (3) inland movement of offshore water.

The freshwater aquifers in the study area are, from bottom to top: the Manokin, Ocean City, Pocomoke, and unconfined (referred to as Pleistocene or Columbia aquifer in previous studies) aquifers. The three deeper confined aquifers are of Miocene deposits and the unconfined aquifer consists of Pleistocene deposits. Generally, ground water flows east-southeastward downdip in the study area under nonpumping conditions.

In the study area, the thickness of the Manokin aquifer ranges from about 50 to 150 feet, the Ocean City aquifer ranges from 30 to 150 feet, the Pocomoke aquifer ranges from near 0 to 90 feet, and the unconfined aquifer ranges from about 70 to 180 feet.

Municipal and industrial water systems comprise about 80 to 90 percent of all water use in the study area. In Delaware, the city of Lewes pumps from the subcrop area of the Pocomoke aquifer, while the city of Rehoboth Beach uses the unconfined aquifer as its source of water for both Rehoboth and Dewey Beach. Millsboro uses the unconfined and Manokin aquifers for water supply. Sussex Shores Water Company, 1.8 miles north of Bethany Beach, uses the Pocomoke aquifer. Bethany Beach uses the Ocean City and Manokin aquifers, while Sea Colony, just south of Bethany Beach, uses the Manokin aquifer. Fenwick Island does not have a municipal water system and uses private wells in the Pocomoke aquifer. In Maryland, the town of Ocean City uses the Ocean City and Manokin aquifers, but both Ocean Pines and Berlin use the unconfined aquifer for water supply.

Chloride concentrations in the Manokin aquifer range from 6 mg/L (milligrams per liter) at Millsboro, to 460 mg/L at Fenwick Island. Wells screened close to the bottom of the aquifer tend to have higher chloride concentrations than those screened in the upper part of the aquifer.

Chloride concentrations in the Ocean City aquifer range from 6 mg/L at Whaleysville, to 260 mg/L at 44th Street in Ocean City. Concentrations in production well WO Bh-28 at 44th Street increased steadily from 50 mg/L in 1976 to 200 mg/L in 1986, with no direct relationship to the amount of water pumped. Vertical movement of water from the saltier Manokin aquifer upward through the leaky confining unit is thought to be a reason for the increase in chloride.

Chloride concentrations measured in the Pocomoke aquifer range from 5 to 46 mg/L. No part of the Pocomoke aquifer in the study area was found to have significant increases in chloride concentrations since 1972.

Chloride concentrations measured in the unconfined aquifer range from 11.5 to 46 mg/L, but concentrations vary widely in areas along the coast and inland bays. Chloride concentrations as high as 9,500 mg/L have been documented at Fenwick Island, where the aquifer is unused.

Seasonal high water levels are affected more by total annual rainfall than by the effects of pumpage. Seasonal low water levels have generally declined most years in areas of heavy pumpage along the coast, but farther inland, water levels have not declined. Several

record low water levels recorded in 1986 were caused by extreme drought conditions in the study area, rather than by pumpage. No substantial areal declines in water levels due to pumping were found.

Seasonal water-level variations range from about 2 to 40 feet below spring high-water levels. Comparison of data for water levels, chloride, and pumpage shows that increased pumpage and lower water levels have not yet caused a corresponding increase in chloride concentrations in the confined aquifers, except in the Ocean City aquifer at 44th Street in Ocean City.

INTRODUCTION

Background

The Manokin, Ocean City, Pocomoke, and unconfined aquifers which provide freshwater to coastal Delaware and Maryland are susceptible to saltwater intrusion from (1) downward leakage from the ocean and bays, (2) upward leakage from the underlying Miocene St. Marys Formation, and (3) inland movement of offshore water.

Pumping water from a well lowers water levels in the aquifer surrounding the well. As larger quantities of water are pumped from the well, nearby water levels continue to decline, and the volume affected by the pumping increases. These lowered water levels cause ground water to move from other parts of the aquifer system toward the pumping well. Along the coast, the aquifer system may contain saltwater that could contaminate wells if substantial movement of water occurs.

Previous water-resources investigations in coastal Delaware and Maryland discussed the possibility of saltwater intrusion into the freshwater aquifer systems supplying water to coastal communities. Each of the investigations of this rapidly developing area focused on only one side of the Delaware-Maryland State line. Data collection from the most recent study ended in 1977. Because pumpage in one State affects water levels and the potential for saltwater intrusion in the other, a more comprehensive, updated analysis relying on a consistent and coordinated data-gathering effort in both Delaware and Maryland was necessary. To expand and update the data-collection network of those studies, a 2-year study was begun in 1985. This report presents the findings of the study done by the U.S. Geological Survey, in cooperation with the Delaware Geological Survey (DGS), the Delaware Department of Natural Resources and Environmental Control (DNREC), the Maryland Geological Survey (MGS), the Maryland Water Resources Administration (WRA), and the town of Ocean City, Maryland.

The study area (fig. 1) encompasses approximately 400 mi^2 (square miles) and includes southeastern Sussex County, Del., and northeastern Worcester County, Md. The area is bounded on the north by Lewes, Del.; on the west by Millsboro, Del., and Whaleysville, Md.; on the south by Assateague Island State Park; and on the east by the Atlantic Ocean.

Water containing more than 250 milligrams per liter (mg/L) chloride tastes salty to most people. In this report, a chloride concentration of 250 mg/L or more signifies saltwater as opposed to freshwater. As a comparison, ocean water chloride concentrations are about 18,000 mg/L (Woodruff, 1969, p. 3).

Purpose and Scope

The purpose of this report is to present current water levels, chloride concentrations, and pumpage data for the coastal freshwater aquifers of southeastern Sussex County, Del., and northeastern Worcester County, Md., and to compare them to historic data so that long-term changes can be documented. Data collection covered two annual pumping cycles--one from April 1985 to March 1986, and one from April 1986 to March 1987. Data included in this report cover all historical data, plus data from this project, up to September 30, 1986.

Water-level measurements were collected from 25 wells in Delaware and 21 wells in Maryland. Continuous water-level recorders were installed on 7 wells in Delaware and 11 wells in Maryland. Chloride analyses were made of water samples collected from 11 observation and 18 production wells in Delaware, and 17 observation and 15 production wells in Maryland.

Records of chloride concentrations from public-supply wells were obtained from the Delaware Division of Public Health (DDPH) and the Worcester County Sanitary Commission, and are presented in this report along with U.S. Geological Survey field and laboratory

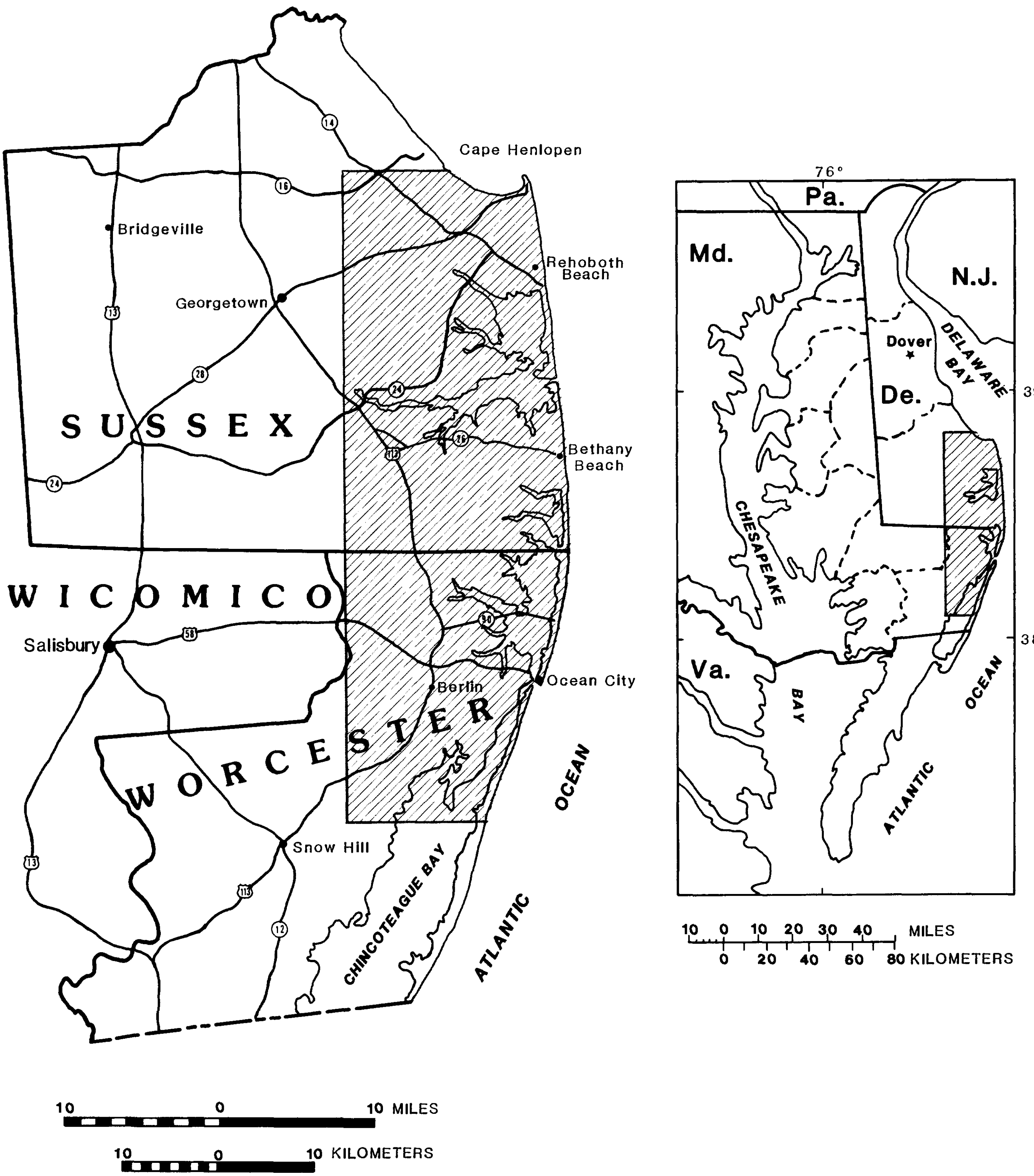


Figure 1.--Location of study area.

data. Pumpage data for the towns and industries given in table 1 were supplied by the Delaware Department of Natural Resources and Environmental Control, the Maryland Water Resources Administration, and the town of Ocean City, Md.

Previous Investigations

Publications pertaining to the geology of the Delaware portion of this report are by Andres (1986), Jordan (1962, 1963, 1964, and 1967), Spoljaric and Jordan (1966), Kraft and Maisano (1968), and Brown and others (1972). Reports on the hydrology of the Delaware area include Rasmussen and others (1960), who also discussed saltwater encroachment at Lewes; Parker and others (1964); Baker and others (1966); Rasmussen and others (1966); Sundstrom and Pickett (1969 and 1970); Miller (1971); Cushing and others (1973); Johnston (1973, 1976, and 1977); and Hodges (1984). Woodruff (1969) discussed occurrence of saline ground water in the Delaware aquifers and listed chloride concentrations of wells throughout Delaware.

In Maryland, Rasmussen and Slaughter (1955) prepared a comprehensive ground-water resource investigation for Somerset, Wicomico, and Worcester Counties. Slaughter (1962) discussed water supplies from Ocean City, Md., north to Rehoboth Beach, Del. Other reports include the results of an exploration well at Ocean City by Kantrowitz (1969), and a compilation of ground-water data for Worcester County by Lucas (1972). Cushing and others (1973) presented a comprehensive regional view of the hydrology of the Delmarva Peninsula, and Hansen (1981) discussed the unconformity between the Columbia and Miocene aquifers in eastern Maryland. Recent studies of the freshwater aquifer system in the Ocean City area are by Weigle (1974), and Weigle and Achmad (1982).

Acknowledgments

The author wishes to thank Scott Andres of the Delaware Geological Survey, who assisted in data collection in Delaware and helped identify aquifer boundaries.

Thanks are expressed to the following people and organizations in Delaware who assisted in collecting water samples throughout the study so that seasonal variations in chloride concentrations could be determined: William Reynolds and the Lewes Water Department, Howard Blizzard and the Rehoboth Beach Water Department, Phil Morse and the staff of the Indian River Inlet State Park, James Seabreeze and the Bethany Beach Water Department, John Sausman and the Sea Colony Water Department, Harry Adams from Quillens Point, and John Kearney and the Board of Directors of the Cape Windsor mobile home community near Fenwick Island.

Thanks are also expressed to the Ocean City Water Department, Maryland Water Resources Administration, Worcester County Sanitary Commission, Delaware Division of Public Health, and the Department of Natural Resources and Environmental Control, who made their records available and assisted in researching old records. The author thanks Lou Vlangas of Whitman, Requardt, and Associates, who assisted in water-level data collection in Ocean City and allowed the U.S. Geological Survey to use data collected during test drilling at 44th Street in Ocean City.

Towns or developments in Delaware that allowed their observation wells to be measured and sampled for this study included Lewes, Rehoboth Beach, Bethany Beach, Sea Colony, Frankford, and Millsboro. In Maryland, Ocean Pines, Mystic Harbor in West Ocean City, and Ocean City allowed use of their observation or unused production wells as observation wells.

HYDROGEOLOGIC SETTING

The study area is located entirely within the Atlantic Coastal Plain physiographic province. The province is underlain by a wedge of unconsolidated sediments comprised of layers of sand, silt, and clay that dip and thicken to the southeast. These sediments make up the aquifers and confining units addressed in this study.

An aquifer is a formation, group of formations, or part of a formation, that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs (Lohman and others, 1972). The aquifers addressed in this study are comprised mostly of sand.

Confining units are bodies of impermeable material stratigraphically adjacent to one or more aquifers. The confining units in this study area are mostly clay and silt with some interbedded sand. Confining units may protect aquifers from being contaminated by adjacent aquifers which contain high concentrations of salt, nitrates, iron, or other unwanted constituents. Some confining units in the Coastal Plain province are not impermeable; however, they are much less permeable than the surrounding aquifers and are, therefore, termed "leaky" confining units.

The freshwater aquifers in the study area are, from bottom to top: the Manokin, Ocean City, Pocomoke, and unconfined (referred to as Pleistocene or Columbia aquifers in previous studies) aquifers (fig.2). The unconfined aquifer consists of Pleistocene deposits, and the three deeper confined aquifers are of Miocene deposits.

The aquifer boundaries described in this report are consistent with previous publications, but may be oversimplifications of actual hydrologic conditions. There have been problems correlating aquifers along the coast, especially from Bethany Beach, Del., to north Ocean City, Md.. Andres (1986) conducted an extensive review of the aquifer identifications in southeastern Sussex County, Del., and some stratigraphic revisions were suggested.

Recharge to the unconfined aquifer occurs predominantly by direct infiltration and downward percolation of rainfall and snowmelt through the overlying deposits. Recharge to the underlying confined aquifers occurs primarily by downward leakage through the unconfined aquifer.

Ground water flows east-southeastward downdip in the study area under nonpumping conditions (Weigle and Achmad, 1982). Figure 2 shows a generalized geologic cross section and directions of steady-state ground-water flow.

The hydrology and geology of the study area are discussed in detail in the reports cited previously. The aquifer names used in this report are consistent with previous publications in Maryland and Delaware (Weigle, 1974; Hodges, 1984).

Manokin Aquifer

The Manokin aquifer is the deepest freshwater aquifer in the coastal areas of Delaware and Maryland (fig. 2) and underlies the entire study area. Thickness of the aquifer ranges from about 50 feet at Lewes to about 150 ft at Ocean City. The top of the Manokin aquifer is about 250 ft below sea level at Lewes and about 360 ft below sea level at the Ocean City Inlet.

The Manokin aquifer is confined below by the Miocene St. Marys Formation, and above by an unnamed locally leaky confining unit. The aquifer consists primarily of fine to very coarse sand, although beds of peat or lignite occur locally in the sand (Weigle and Achmad, 1982). Under nonpumping conditions along the coast, heads are higher in the Manokin aquifer than in the overlying Ocean City and Pocomoke aquifers, causing the Manokin to discharge to the overlying aquifers by upward vertical leakage (fig. 2). This process can be reversed locally in the summer near major pumping centers which use the Manokin aquifer.

Ocean City Aquifer

The Ocean City aquifer was originally considered to be a part of the Manokin aquifer (Rasmussen and Slaughter, 1955), but was later recognized as a separate aquifer by Weigle (1974). Separating the Ocean City from the Manokin aquifer is a confining unit, which in some areas is considered "leaky". In the Ocean City area, the Manokin and Ocean City aquifers are considered to act as one hydrologic unit (Weigle, 1974). Ground-water flow in the Ocean City aquifer is similar to that of the Manokin aquifer (fig. 2).

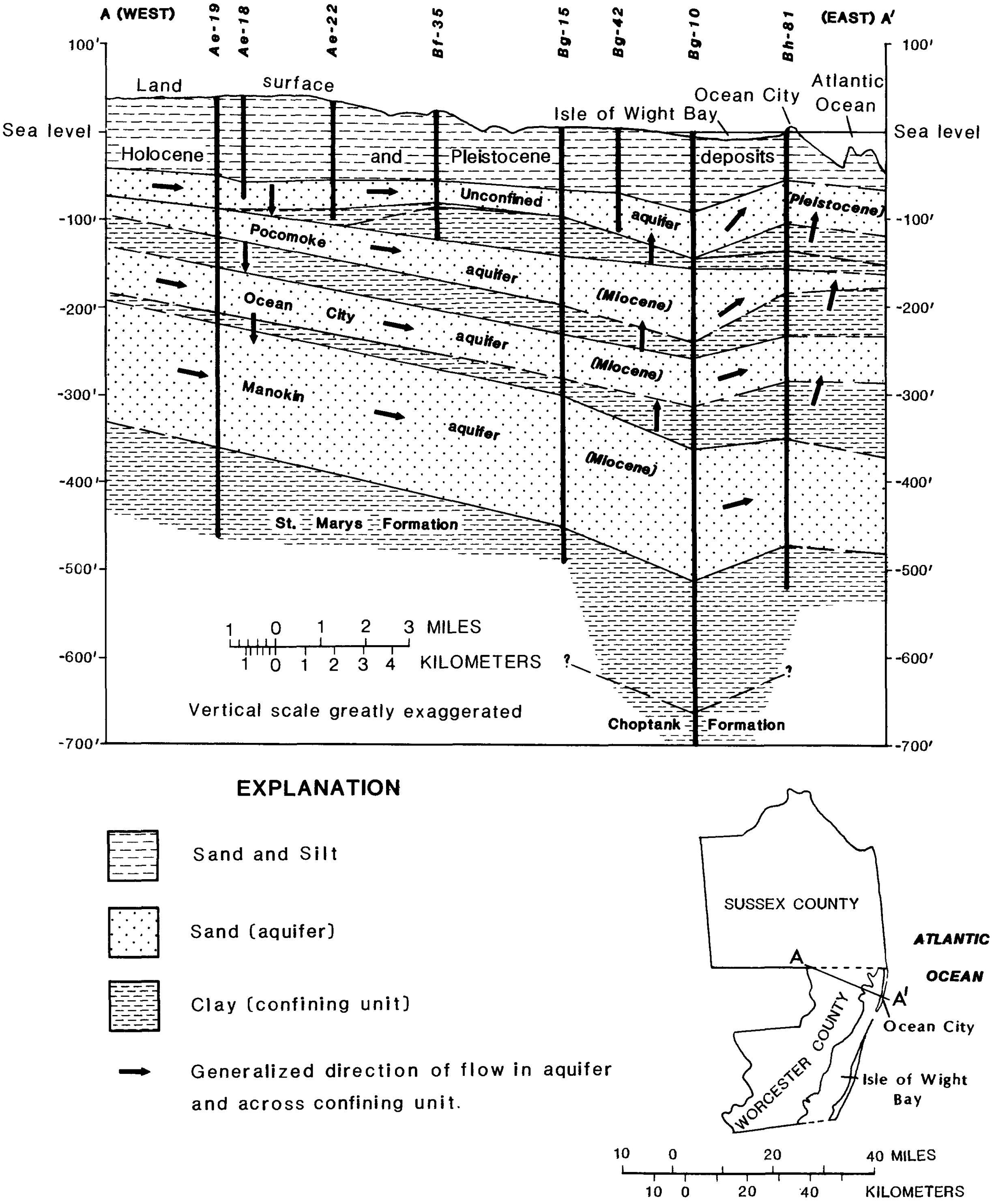


Figure 2.--Generalized geologic section trending east-southeastward across study area, and generalized directions of steady-state ground-water flow. (Modified from Weigle and Achmad, 1982, p.5.)

The Ocean City aquifer underlies all except the northwestern part of the study area and is composed chiefly of fine to very coarse sand. Thickness of the aquifer varies from 30 to 120 ft along the Maryland coast, and from 75 to 150 ft along the Delaware coast. The top of the aquifer is 160 ft below sea level at Lewes, Del., and 220 ft below sea level at the Ocean City Inlet.

Pocomoke Aquifer

The Pocomoke aquifer underlies all of the study area, but subcrops the unconfined aquifer in the Lewes area. Thickness of the aquifer in the Delaware portion of the study area reaches a maximum of 90 ft at Bethany Beach (Hodges, 1984). In the Maryland part of the study area, the Pocomoke aquifer is thickest near Berlin (about 80 ft), but generally ranges in thickness from 30 to 60 ft (Weigle and Achmad, 1982).

Hodges (1984) showed the thinning and the eventual absence of the confining unit between the Ocean City and Pocomoke aquifers west of a southwest-trending line from about 4 mi (miles) west of Lewes to about 3 mi east of Gumboro, Del. This was referred to by Hodges as the Gumboro-Lewes Line, and the combined aquifer to the west of this line was assumed to be the Pocomoke aquifer.

In the area of north Ocean City and Fenwick Island, geophysical logs and drill cuttings indicate discontinuous aquifers at depths that correlate with the Pocomoke aquifer. It is possible that the Pocomoke aquifer in Ocean City is not the same aquifer as the Pocomoke in Fenwick Island. It is also possible that there are interconnections between the Ocean City and Pocomoke aquifers near the Delaware-Maryland border and along the coast (Hodges, 1984; Woodruff, 1977). These speculations can only be confirmed by additional test drilling and geophysical logs in the area.

Unconfined Aquifer

The unconfined aquifer, which has also been referred to in previous studies as the Columbia or Pleistocene aquifer, is the uppermost aquifer throughout the study area. The stratigraphically complex Pleistocene deposits that make up the aquifer are the net result of cycles of erosion and deposition. Within the deposits are numerous discontinuous and nonparallel deposits (Weigle, 1974).

Thickness of the unconfined aquifer in the study area ranges from about 70 to 180 ft. Denver (1983) and Bachman and Wilson (1984) show maps and cross sections of the thickness of the unconfined aquifer for Delaware and Maryland, respectively. Hodges (1984) mapped the thickness of the confining unit between the unconfined aquifer and the deeper confined aquifers in both the Delaware and Maryland parts of this study area.

Detailed studies of the Pleistocene deposits in Delaware include Jordan (1964), Johnston (1973), and Denver (1983). In Maryland, Bachman and Wilson (1984) presented a comprehensive report on the hydrogeology of the Maryland section of the unconfined aquifer.

MUNICIPAL WATER SUPPLIES AND PUMPAGE

Municipal water-supply systems and industrial users listed in table 1 are the largest users of ground water in the study area and comprise about 80 to 90 percent of all water use. Table 1 shows the total amounts of ground water pumped by municipalities and selected industrial users from 1966 through 1986. Several municipalities pump water from two aquifers, and therefore chloride data from an individual aquifer cannot simply be related to total pumpage. This section describes the sources of water used by each major water-supply system and presents the total pumpage of each major user of ground water (those systems using more than 50,000 gal/d (gallons per day) as well as the amount withdrawn from each aquifer.

Table 1.--Total yearly use of ground water by municipalities and selected industrial users in the coastal areas of Delaware and Maryland from 1966 through 1986

[Pumpage, in million gallons per year. A dash indicates data not available.]

DELAWARE	1966[1]	1974[2]	1976[2,3]	1977[3]	1978[4]	1979[4]	1980[4]	1981[4]	1982[4]	1983[4]	1984[4]	1985[4]	1986[4]
<u>Municipal</u>													
Bethany Beach	13.668	38.581	36.966	39.566	39.665	42.522	44.414	71.982	76.019	81.165	84.591	91.767	101.895
Frankford	21.9	26.28	31.476	31.135	29.091	33.441	20.862	19.991	17.688	20.480	20.448	19.460	23.270
Lewes	521.95	443.11	366.0	491.180	459.155	448.72	448.189	442.865	-----	-----	362.492	388.893	363.472
Millsboro	26.28	36.5	38.43	-----	45.0	47.786	52.642	81.548	69.113	75.146	66.334	71.718	95.413
Rehoboth Beach	250.025	252.215	259.311	360.474	342.567	262.125	279.181	322.844	426.109	476.519	435.451	451.252	513.058
Sea Colony	-----	3.285	34.331	34.237	-----	55.411	56.895	52.239	59.294	51.582	75.368	66.986	63.477
Selbyville	-----	-----	103.541	107.894	95.856	106.063	87.090	88.191	90.224	83.782	85.036	96.467	103.752
Sussex Shores	7.3	23.689	32.391	27.521	27.840	26.995	39.245	68.980	41.544	37.402	22.344	32.579	29.307
<u>Industrial</u>													
Delmarva Power and Light (Indian River Plant)			11.606	50.881	54.454	86.134	140.465	156.923	119.623	120.479	141.613	145.728	----
Mountaire (Selbyville)			-----	42.336	109.616	205.984	298.759	323.196	354.151	363.210	384.584	487.039	----

MARYLAND[5]	1969	1970	1971	1972	1973	1974	1975	1976	1977
<u>Municipal</u>									
Ocean City									
Total	444.51	573.461	623.606	720.805	926.346	1009.156	1059.512	1257.643	1361.092
Gorman Ave. Plant	-----	-----	-----	-----	8.5	117.900	196.397	292.584	362.922
44th St. Plant	136.247	191.818	232.197	271.874	391.818	416.922	402.151	471.159	428.318
15th At. Plant	143.934	239.047	243.335	132.446	249.707	235.415	208.420	247.497	291.914
South Plant	164.329	142.596	148.074	316.485	276.321	238.919	252.544	246.404	277.938
Ocean Pines (Maryland Marine Utilities)	7.70	13.00	19.00	23.60	35.00	49.10	61.30	67.70	78.60
Berlin (estimated 1969-80)	150.	150.	150.	150.	150.	150.	150.	150.	150.
<u>Industrial</u>									
Chesapeake Foods (near Berlin)	182.5	260.0	350.0	416.3	282.2	257.0	185.1	194.1	245.4

MARYLAND	1978	1979	1980	1981	1982	1983	1984	1985	1986
<u>Municipal</u>									
Ocean City									
Total	1436.660	1485.736	1312.726	1274.474	1309.503	1411.022	1538.001	1636.720	1724.031
Gorman Ave. Plant	318.682	398.120	407.651	416.987	348.098	274.725	369.235	408.972	345.031
44th St. Plant	574.691	549.160	446.965	490.115	372.927	445.017	802.136	778.613	833.143
15th St. Plant	263.424	165.263	263.926	191.535	325.224	391.996	194.722	160.541	373.530
South Plant	279.863	373.193	194.184	175.837	263.254	299.284	173.908	288.594	171.888
Ocean Pines (Maryland Marine Utilities)	63.50	77.60	91.459	90.606	96.726	113.148	134.565	160.944	163.449
Berlin (estimated 1969-80)	150.	119.067	119.067	119.067	120.081	111.949	123.180	109.391	127.586
<u>Industrial</u>									
Chesapeake Foods (near Berlin)	203.8	193.9	136.0	147.0	149.4	142.9	138.4	140.8	125.4

1 The Availability of Ground Water in Eastern Sussex County, Delaware: Sundstrom and Picket, 1969.
2 Inventory and Use of Water In Delaware for 1974: Robertson, 1975.
3 Hydrology of the Manokin, Ocean City, and Pocomoke Aquifers of Southeastern Delaware: Hodges, 1984.
4 Data reported by the Delaware Department of Natural Resources and Environmental Control.
5 Data reported by the Maryland Water Resources Administration and the town of Ocean City, Maryland.

Lewes

The city of Lewes pumps water from five wells in the subcrop area of the Pocomoke aquifer. Total yearly pumpage by Lewes is presented in table 1. Annual pumpage reached a maximum of 491 Mgal (million gallons) in 1977, at which time the city began installing water meters on houses and businesses. Water use dropped steadily as more meters were installed (Howard Seymour, city of Lewes Water Department, oral commun., 1986). Total monthly pumpage during 1985 from the Pocomoke aquifer at Lewes, which reflects the seasonal water use of the city, is shown in figure 3.

Rehoboth Beach

The city of Rehoboth Beach uses seven wells in the unconfined aquifer as its source of water for both-Rehoboth Beach and Dewey Beach. Yearly pumpage increased from 252 Mgal in 1974 to 513 Mgal in 1986 (table 1). Total monthly pumpage at Rehoboth Beach from 1979 to 1986 is shown in figure 4, which reflects the seasonal distribution of pumping from the unconfined aquifer.

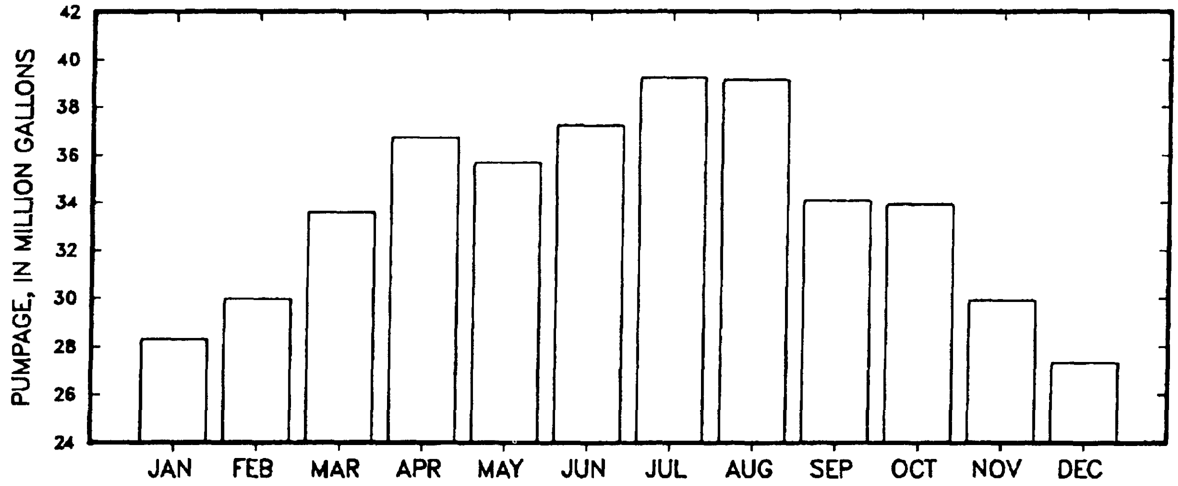


Figure 3.--Total monthly pumpage from the Pocomoke aquifer at Lewes, Delaware, 1985.

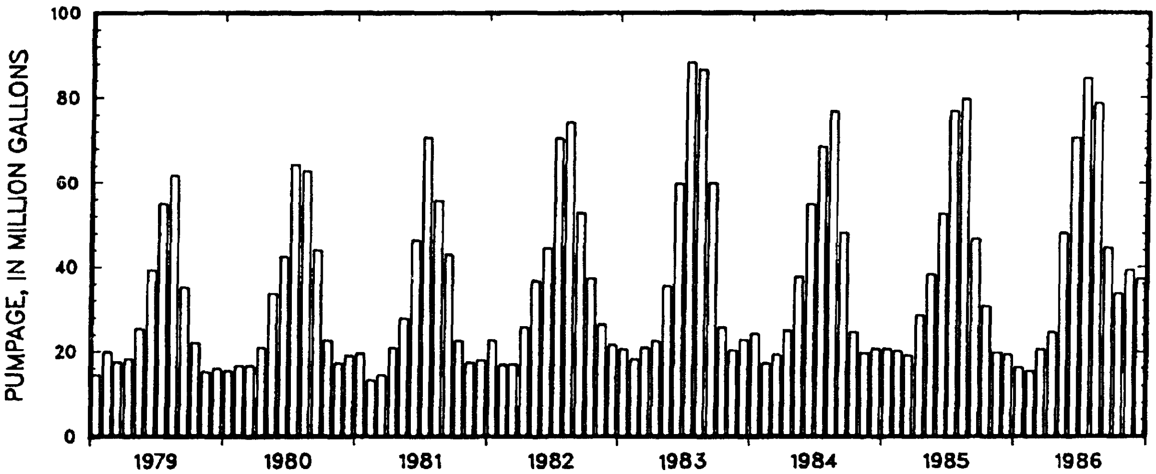


Figure 4.--Total monthly pumpage from the unconfined aquifer at Rehoboth Beach, Delaware, 1979-86.

Millsboro

The town of Millsboro withdraws water from two wells in the unconfined aquifer and one well in the Manokin aquifer. Total yearly pumpage is given in table 1. Total monthly pumpage by aquifer is shown in figure 5. Pumping at Millsboro varies less seasonally than the resort towns along the coast. The anomalously high pumpage from the Manokin aquifer in March and August 1981 is the result of system-maintenance procedures.

Sussex Shores

The Sussex Shores Water Company (1.8 mi north of Bethany Beach) supplies water to resort communities just north of Bethany Beach, and pumps from three wells in the Pocomoke aquifer. Traditional aquifer designations identify the three wells at Sussex Shores, screened between 163 and 184 ft below land surface, as being in the Pocomoke aquifer. New interpretations of data by the Delaware Geological Survey, however, indicate that the Pocomoke aquifer at Sussex Shores is hydraulically connected to, but not necessarily the same sandy interval as, the Ocean City aquifer at Bethany Beach (Andres, 1986).

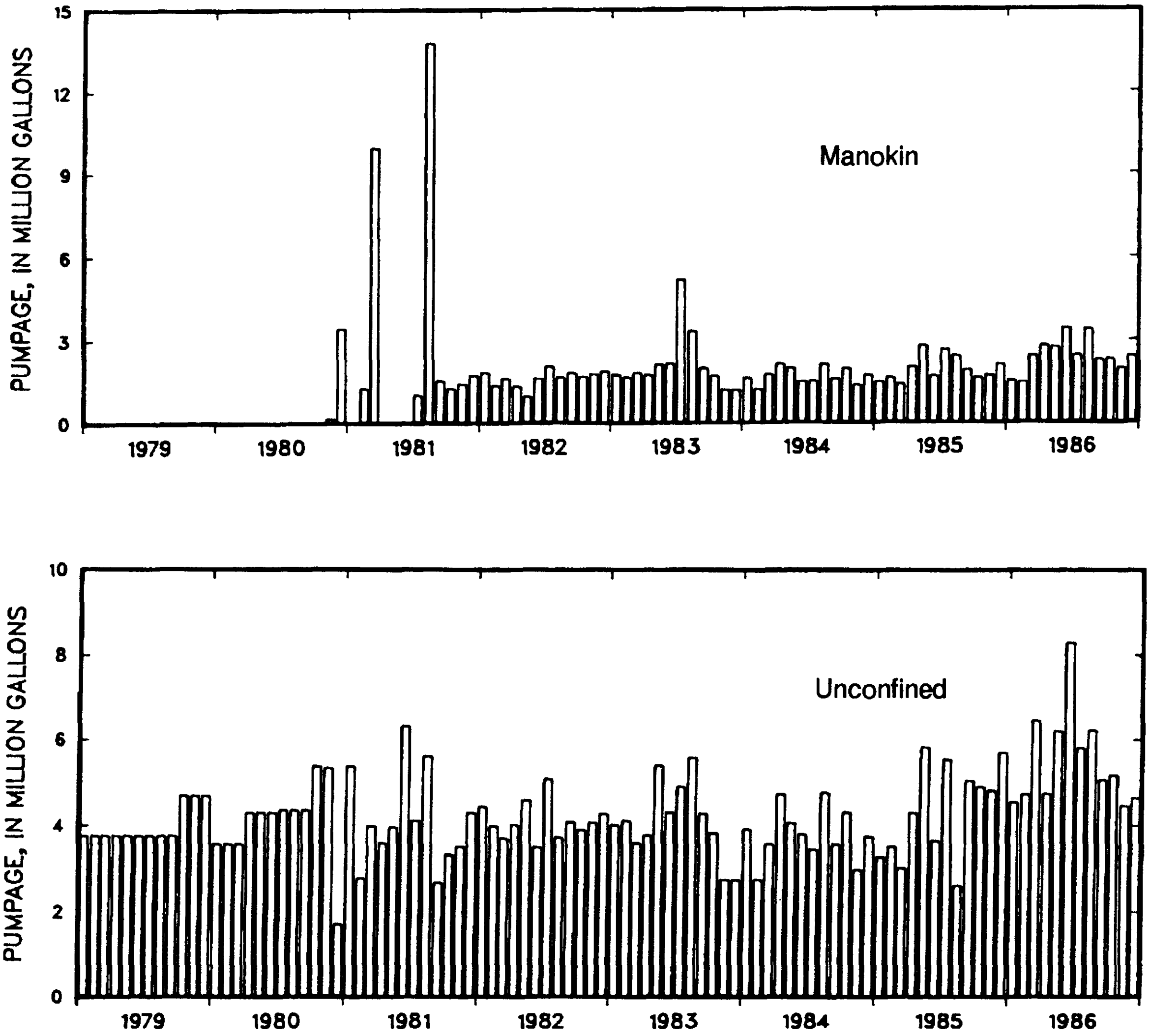


Figure 5.--Total monthly pumpage from the Manokin (1980-86) and the unconfined (1979-86) aquifers at Millsboro, Delaware.

Total monthly pumpage from the Sussex Shores water plant from 1979 to 1986 is shown in figure 6. Pumpage by the Sussex Shores Water Company and water use in the Sussex Shores area may differ slightly because interconnections between the water systems for Sussex Shores, Bethany Beach, and Sea Colony allow one system to shut down and obtain water from another system.

Bethany Beach

The town of Bethany Beach and the Sea Colony development are the largest water users in the Bethany Beach area. Bethany Beach pumps water from both the Manokin and Ocean City aquifers, and Sea Colony pumps only from the Manokin aquifer. Figure 7 shows the locations of observation and community production wells in the Bethany Beach area. Total monthly pumpage from the Ocean City and Manokin aquifers at Bethany Beach and Sea Colony is shown in figure 8. Except for 1983 and 1984, the Manokin aquifer withdrawals exceed Ocean City aquifer withdrawals in the Bethany Beach area.

South Bethany does not have a central public-supply system. Most individual wells in this area are screened in the unconfined or Pocomoke aquifers.

Fenwick Island

Fenwick Island does not have a central public-supply system. Most domestic and small public water systems in Fenwick Island use wells screened in the Pocomoke aquifer, usually between 180 and 220 ft below land surface.

Ocean City

The town of Ocean City has four well fields and utilizes both the Manokin and Ocean City aquifers. The well fields are at the Gorman Avenue (near 137th Street), 44th Street, 15th Street, and South water plants (fig. 9).

Total pumpage at Ocean City has more than doubled from 1972 to 1985 (table 1). The increase is apparent in figure 10, which presents total yearly pumpage from 1969 to 1986. Total monthly pumpage at Ocean City and monthly pumpage at each water plant are shown in figure 11.

The Gorman Avenue well field (fig. 9) has four production wells in the Manokin aquifer. Only wells WO Ah-33, -34, and -38 were used between 1973 and 1985; well WO Ah-39 began production in 1986. Production well screen depths range from 320 to 450 ft below land surface. Three observation wells in the Manokin aquifer (WO Ah-6, -36, and -37) and one observation well in the Choptank Formation (WO Ah-35) are located near the Gorman Avenue water plant. The locations of these observation wells are shown in figure 9. The Manokin observation well WO Ah-6 is located 24 ft east of the "A" production well (WO Ah-34), and observation wells WO Ah-35, -36, and -37 are located at the east end of 137th Street, two blocks east of the water plant (fig. 9).

Prior to June 1986, the 44th Street water plant consisted of four production wells in the Ocean City aquifer: WO Bh-28, -29, -41, and, -81 (fig. 9). Begining in June 1986, water from two wells (WO Bh-39 and -40) screened in the Ocean City aquifer at the Ocean City Convention Center at 40th Street was added to the

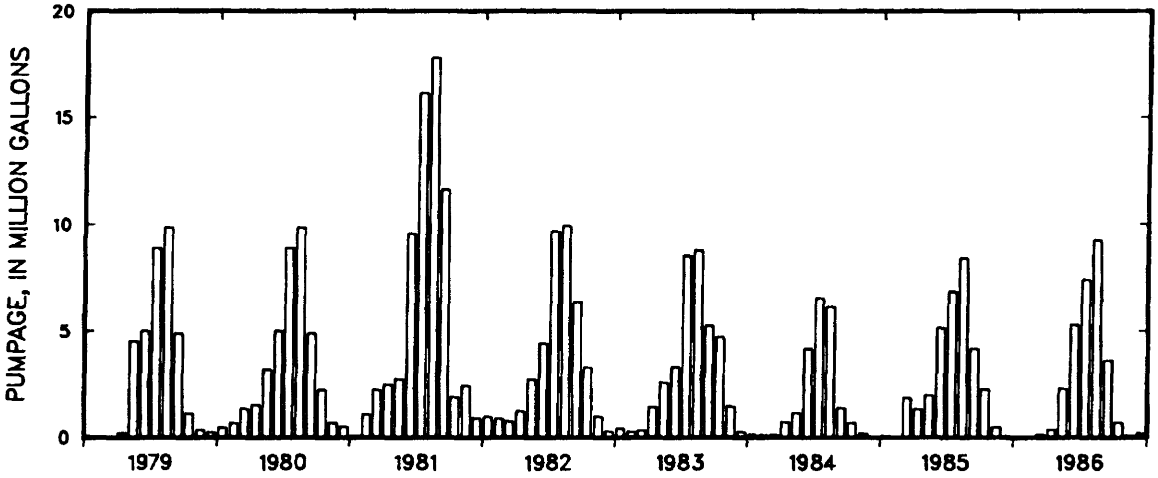


Figure 6.--Total monthly pumpage from the Pocomoke aquifer at Sussex Shores, Delaware (1979-86).

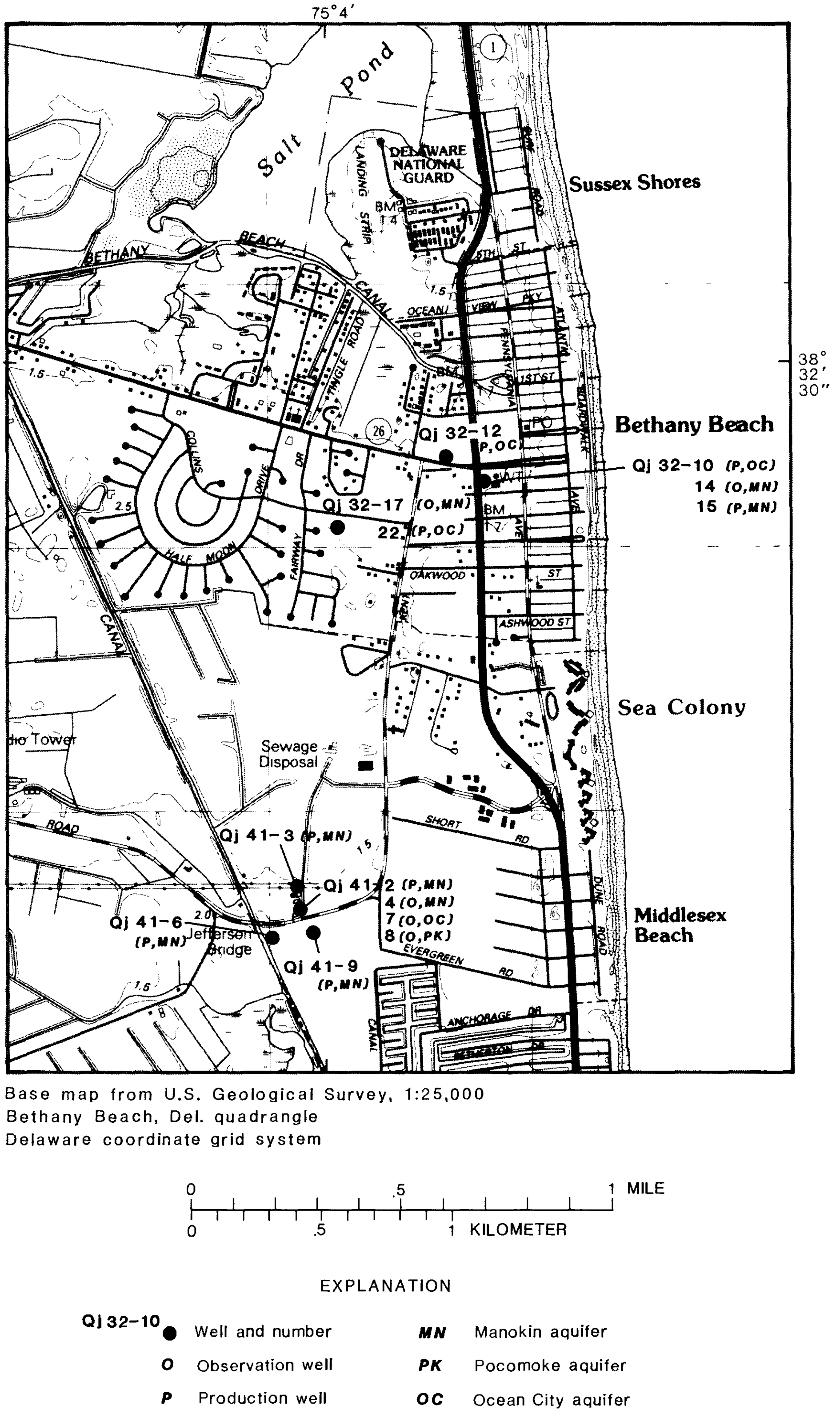


Figure 7.--Location of observation and production wells at Bethany Beach and Sea Colony, Delaware.

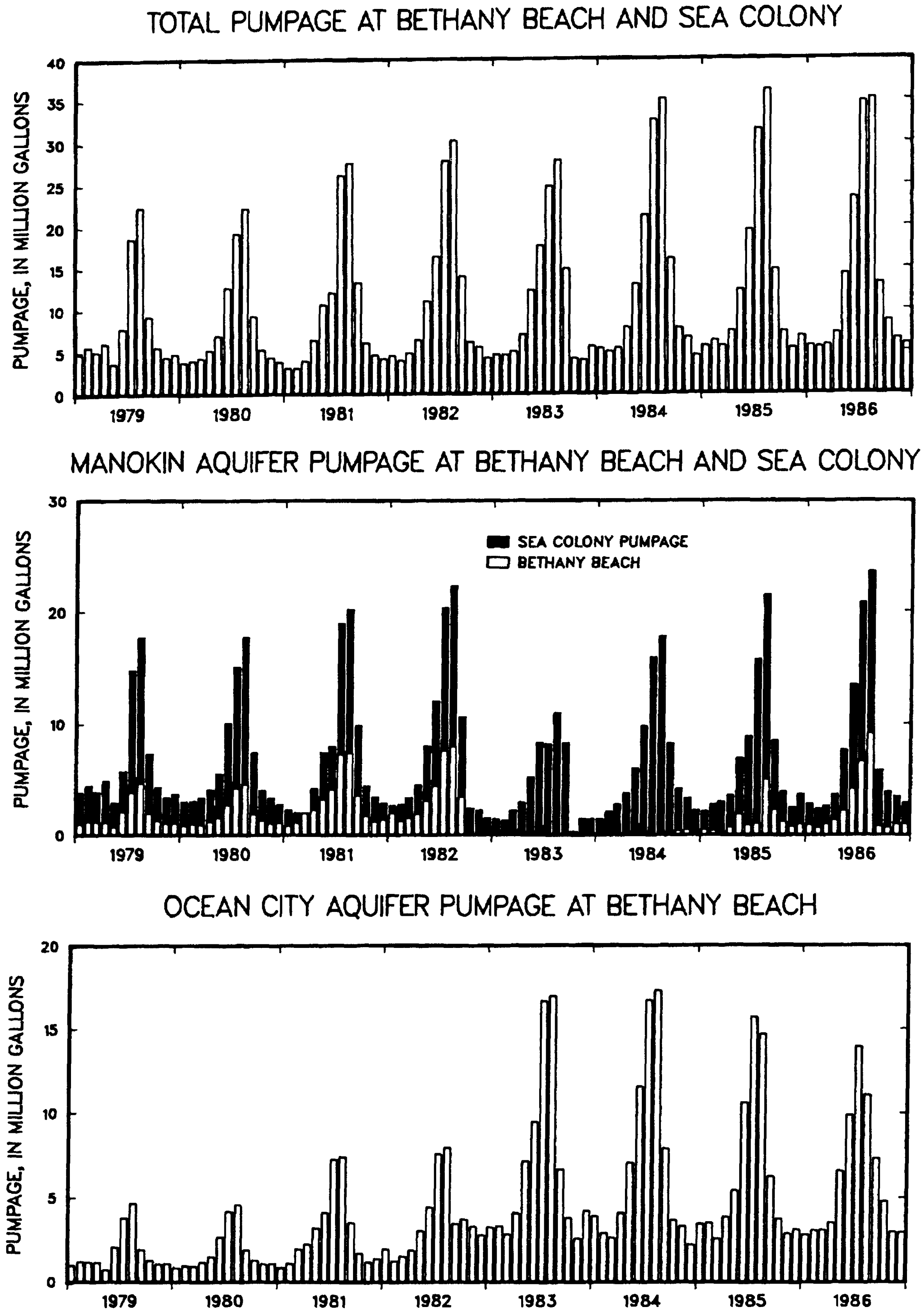


Figure 8.--Total monthly pumpage from the Manokin and Ocean City aquifers at Bethany Beach and Sea Colony, Delaware, 1979-86.

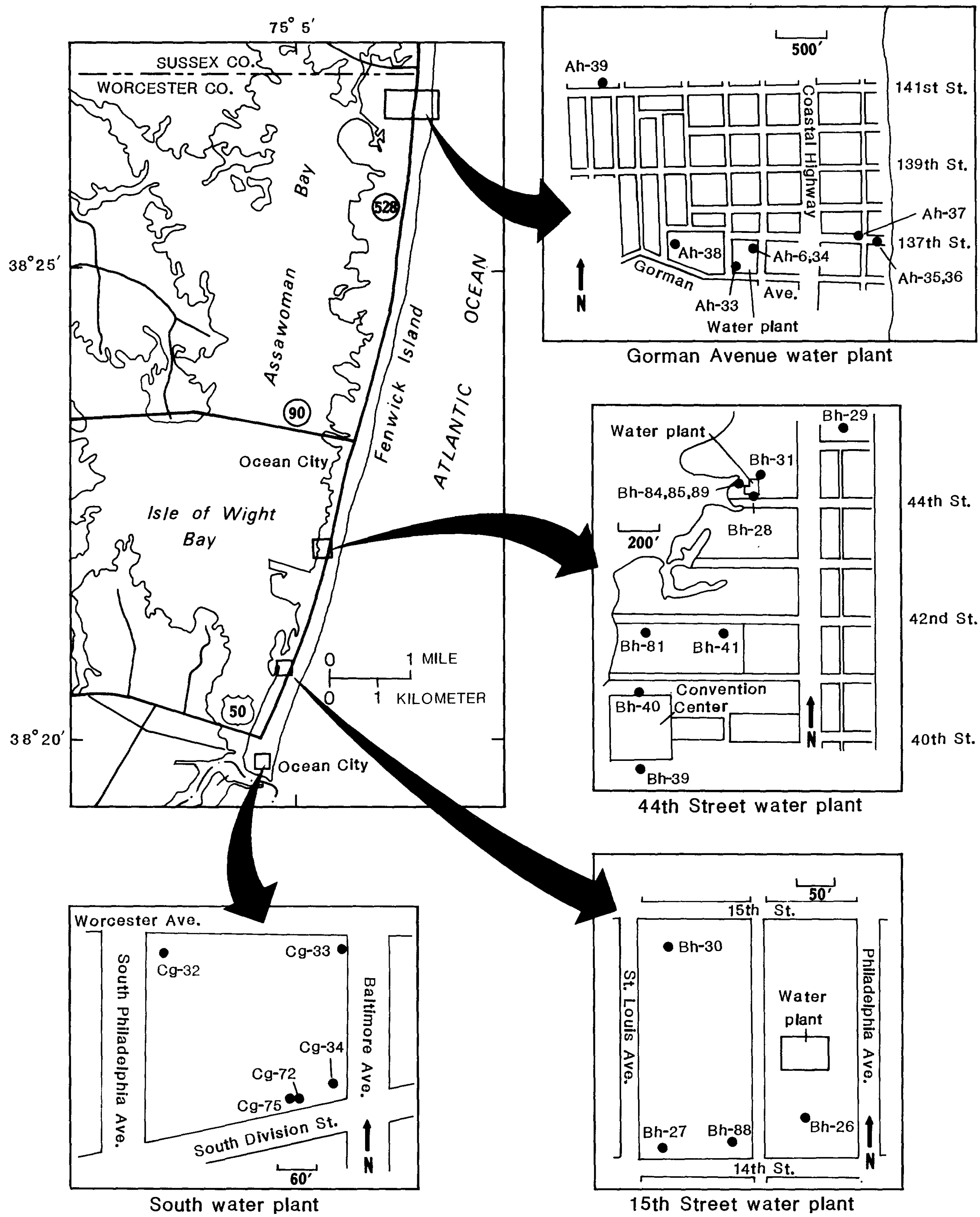


Figure 9.--Location of Ocean City, Maryland, well fields and observation wells. (Expanded views modified from Whitman, Requardt, and Associates-Engineers, 1985.)

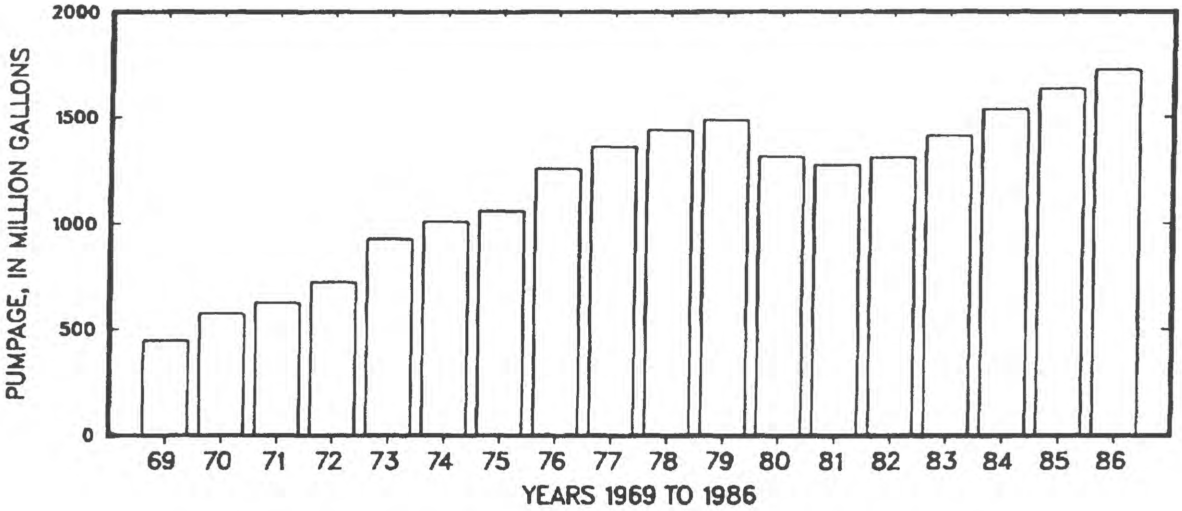


Figure 10.--Total yearly pumpage at Ocean City, Maryland,1969-86.

water plant. From 1970 to May 1986, water from these two wells was used only for the Convention Center's heating and cooling systems and then was discharged into the Isle of Wight Bay. To conserve water, the Convention Center's heating and cooling water was diverted to the 44th Street water plant in June 1986 for treatment and use for public water supply. Pumpage data from the Convention Center's wells prior to June 1986 are incomplete, but analysis of the partial records shows that the Convention Center pumped approximately 16 percent of Ocean City's total annual pumpage. Figure 11 shows the reported monthly pumpage for the 44th Street water plant. Pumpage shown in figures 10 and 11 does not reflect the Convention Center's pumpage prior to June 1986 because records of this pumpage are incomplete.

The 15th Street and South water plants (fig. 9) each use three Ocean City aquifer wells and one Manokin aquifer well for water supply. Pumpage has been reported only by water plant and not by aquifer. Pumpage by aquifer has been estimated by the Ocean City Water Department to be about 66 percent from the Ocean City aquifer and 34 percent from the Manokin aquifer from June to August, and 100 percent from the Ocean City aquifer from September to May for each water plant. Prior to 1984, all pumpage at both plants was from the Ocean City aquifer. Total monthly pumpage for the 15th Street and South water plants is shown in figure 11.

Ocean Pines

Ocean Pines is a private residential community across the Assawoman Bay from Ocean City, near Maryland Routes 90 and 589 (pl. 1). Pumpage started in 1969 and increased to 163 Mgal by 1986 (table 1). The Ocean Pines water supply is operated by Maryland Marine Utilities with four operating wells in the unconfined aquifer. Total yearly pumpage from 1969 to 1986 is presented in figure 12.

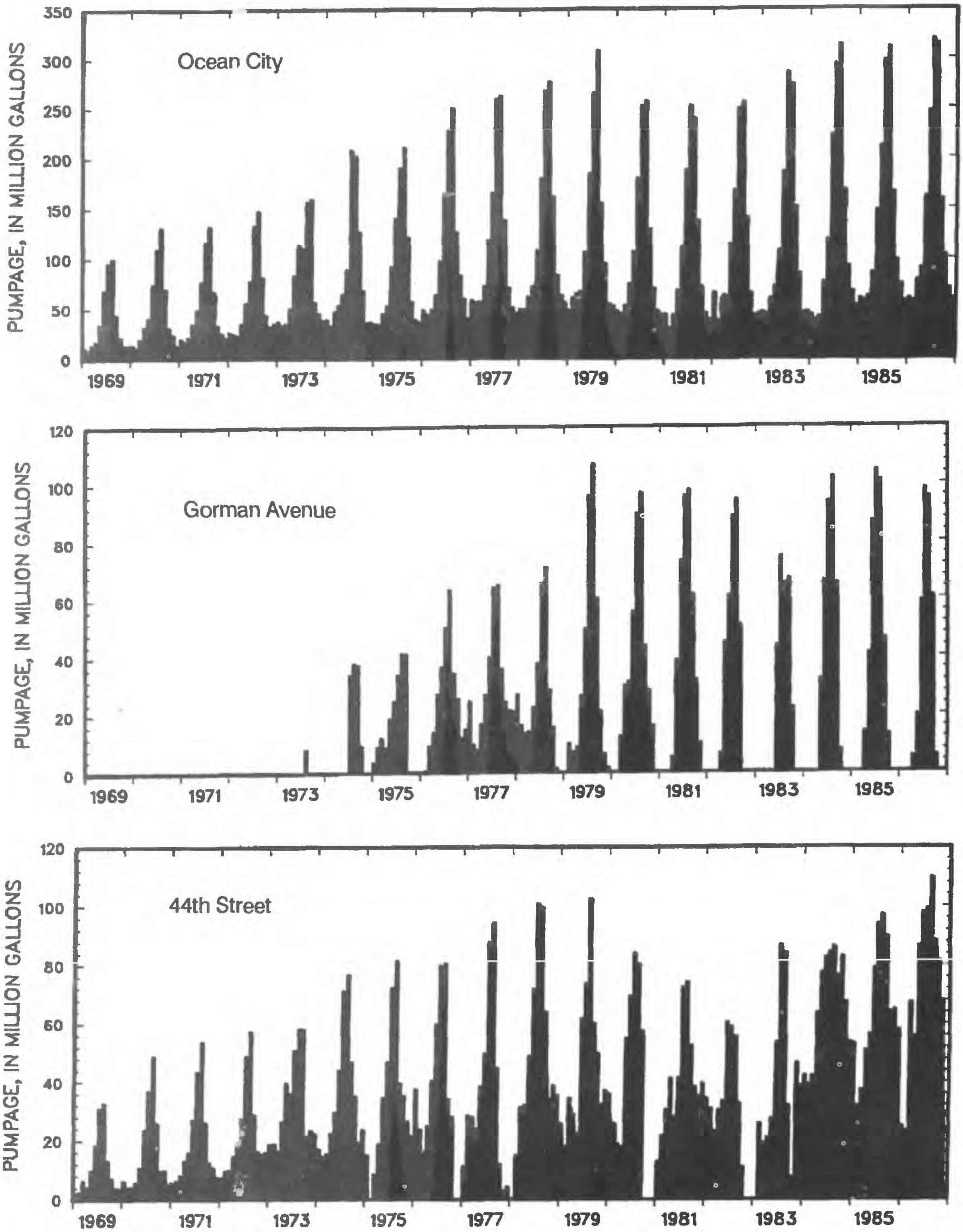


Figure 11.--Total monthly pumpage at Ocean City, Maryland, and the Gorman Avenue, 44th Street, 15th Street, and South water plants, 1969-86.

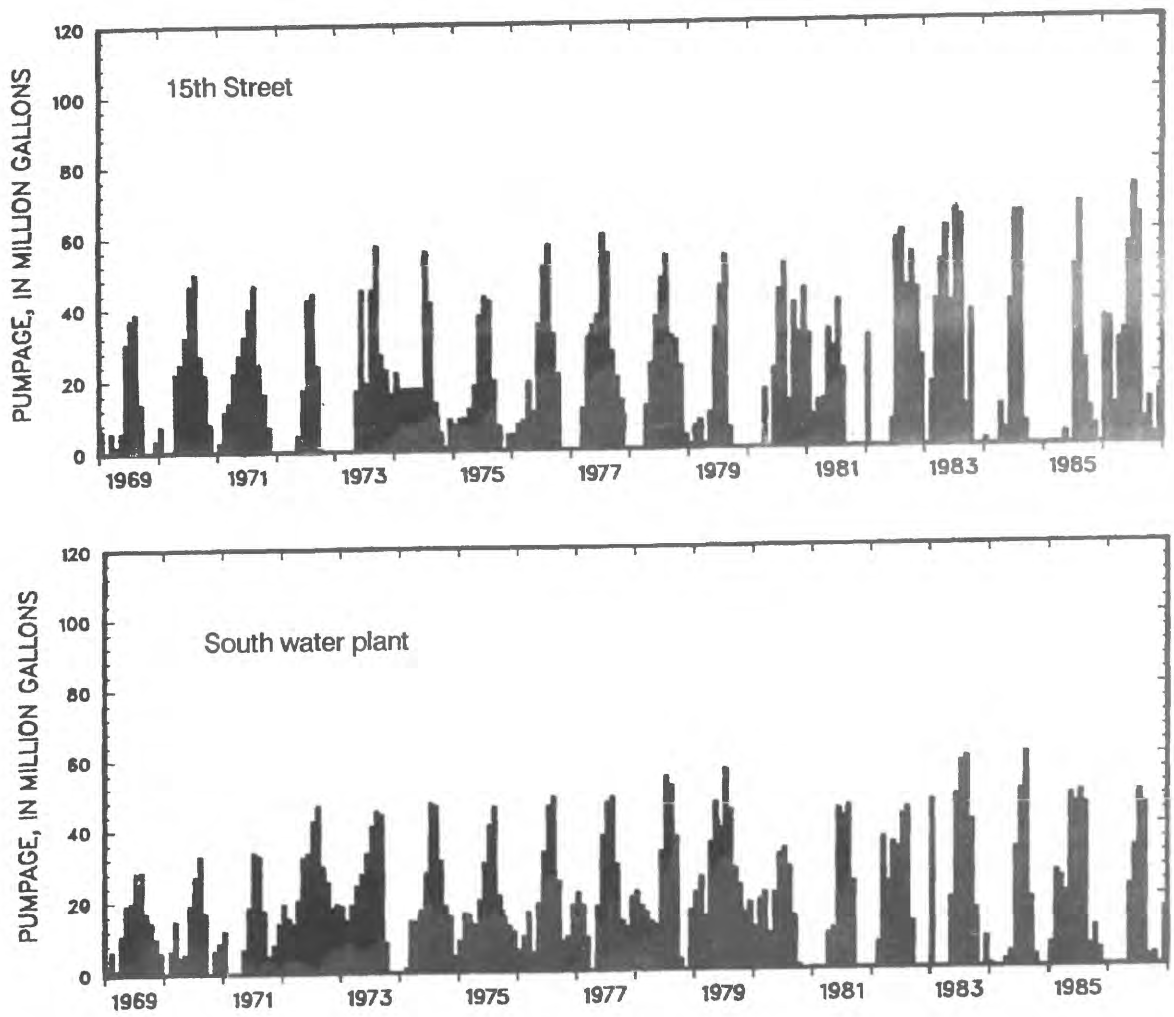


Figure 11.--Total monthly pumpage at Ocean City, Maryland, and the Gorman Avenue, 44th Street, 15th Street, and South water plants, 1969-86--Continued.

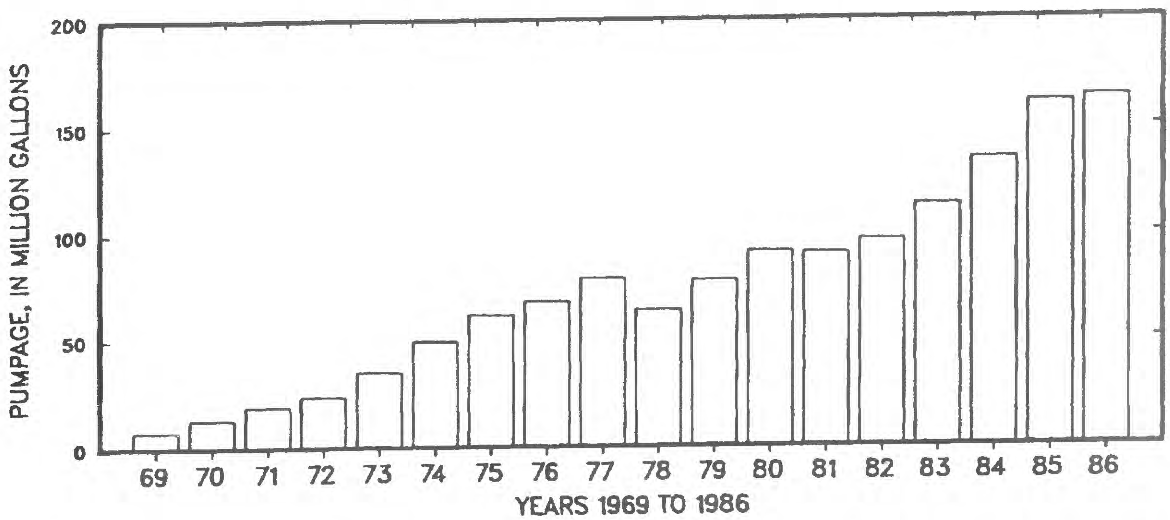


Figure 12.--Total yearly pumpage from the unconfined aquifer at Ocean Pines, Maryland, 1969-86.

DATA-COLLECTION NETWORK

A total of 79 wells was monitored during this study. The network of observation wells (those wells not used for water supply) consisted of 25 wells in Delaware and 21 wells in Maryland. Observation wells were selected based on location and availability. No test drilling was done as part of this study.

Water levels were measured at least monthly in the observation wells. Water-quality field parameters (pH, specific conductance, chloride concentration, and water temperature) were measured every 2 to 3 months in 11 of the Delaware observation wells and in 16 of the Maryland observation wells. Where observation wells were within a few hundred yards of production wells in the same aquifer, only the production wells were routinely sampled for water quality.

Eighteen production wells in Delaware were sampled periodically for chloride concentration. Eight of the wells were sampled at least every 2 to 3 months by U.S. Geological Survey personnel for field parameters. Seven local water-plant operators collected samples once a week during summer months from 17 of the wells. U.S. Geological Survey personnel received the samples and analyzed chloride concentrations monthly to detect any short-term variations during peak pumping periods.

The Worcester County Sanitary Commission tested each operating production well in Ocean City (up to 18 wells) weekly for chloride concentration. The results of those tests were forwarded monthly by the town of Ocean City to the U.S. Geological Survey. Field parameters were measured by U.S. Geological Survey personnel every 2 to 3 months on 4 of the 18 production wells.

Synoptic sampling for field parameters from 27 observation and 12 production wells occurred in October 1985, February, July, October, and November 1986, and February 1987. Synoptic sampling for U.S. Geological Survey laboratory analyses of major ions occurred in August and September 1985, and April, August, and September 1986. U.S. Geological Survey field and laboratory analyses through 1986 for Delaware and Maryland wells are presented in the Appendix.

In Delaware, pumpage data were collected from DNREC files for Lewes, Rehoboth Beach, Sussex Shores, Bethany Beach, Sea Colony, Millsboro, Frankford, Selbyville, Delmarva Power and Light near Millsboro, and Mountaire in Selbyville. In Maryland, pumpage data were collected from WRA files for Ocean .City, Ocean Pines, Berlin, and Chesapeake Foods near Berlin.

Manokin Aquifer

A total of 31 wells in the Manokin aquifer were monitored during this study, with 15 in Delaware and 16 in Maryland (pl. 1). Of the 15 wells in Delaware, 7 are production wells and 8 are water-level observation wells. Ten wells in Delaware were tested periodically for chloride concentrations (table 2). Of the wells monitored in Maryland, 5 are production wells and 11 are water-level observation wells; 12 wells were tested periodically for chloride concentrations (table 3).

Ocean City Aquifer

A total of 21 wells in the Ocean City aquifer were monitored during the study, with 6 in Delaware and 15 in Maryland (pl. 2). In Delaware, two of the wells monitored are production wells and four are observation wells; four of the six wells were tested periodically for chloride concentrations (table 4). In Maryland, where the Ocean City aquifer is more heavily utilized, 5 observation and 10 production wells were monitored; all 15 wells were tested periodically for chloride concentrations (table 5).

Pocomoke Aquifer

Twenty wells in the Pocomoke aquifer were monitored during this study, with 17 in Delaware and 3 in Maryland (pl. 3). Of the 17 wells in Delaware, 8 are production wells and 9 are observation wells; 12 of the 17 wells were tested periodically for chloride concentrations (table 6). All three wells monitored in Maryland are observation wells and were tested periodically for chloride concentrations (table 7).

The wells in the Lewes area (all "Ni" wells in table 6) are located in the subcrop area of the Pocomoke aquifer. Here, the Pocomoke and unconfined aquifers are hydraulically connected. These wells were designated as Pocomoke aquifer wells by Andres (1986) and will be so classified in this report. Previous publications (Johnston, 1973, and 1977) identified older wells of similar depths to be in the unconfined aquifer. Most wells are screened through the two aquifers, so identification of wells by aquifer is mostly arbitrary in that location.

Table 2.--Network of monitored wells in the Manokin aquifer in Delaware

Well No.	Location	Well type[1]	Elevation of land surface[2]	Screened interval[3]	Chloride concen-trations measured	Water levels measured[4]
Oh 54- 1	Angola	O	18	280-290	x	S
Oi 24- 6	Rehoboth Beach	O	26	230-250	x	R
Pg 53-13	Millsboro #3	P	22	205-255	x	
Pg 53-14	Millsboro	O	22	198-248		R
Qh 54- 4	Omar	O	28	324-328	x	S
Qj 32-14	Bethany Beach	O	6	350-370		S
Qj 32-15	Bethany Beach #1	P	6	353-383	x	
Qj 32-17	Bethany Beach	O	5	335-400		R
Qj 41- 2	Sea Colony #1	P	6	341-366	x	
Qj 41- 3	Sea Colony #2	P	6	331-366	x	
Qj 41- 4	Sea Colony	O	6	370-390		S
Qj 41- 6	Sea Colony #4	P	6	340-375	x	
Qj 41- 9	Sea Colony #3	P	6	335-370	x	
Rj 22- 5	Fenwick Island	O	5	450-455		S
Rj 31- 8	Cape Windsor	P	5	345-365	x	

Table 3.--Network of monitored wells in the Manokin aquifer in Maryland

Well No.	Location	Well type[1]	Elevation of land surface[2]	Screened interval[3]	Chloride concen-trations measured	Water levels measured[4]
WO Ae-23	Whaleysville	O	40	270-280	x	S
	Ocean City					
WO Ah- 6	Gorman Ave.	O	5	347-357		R
WO Ah-33	Gorman Ave."B"	P	5	346-450	x	
WO Ah-34	Gorman Ave."A"	P	5	350-450	x	
WO Ah-36	137th St.	O	13	420-430		S
WO Ah-37	137th St.	O	10	468-478		S
WO Ah-38	Gorman Ave."C"	P	5	330-430	x	
WO Bg-15	Ocean Pines	O	7	288-318	x	R
WO Bg-48	Isle of Wight	O	5	410-420	x	R
	Ocean City					
WO Bh-34	100th St.	O	4	337-353	x	R
WO Bh-88	15th St. "D"	P	5	365-445	x	
WO Bh-89	44th St.	O	5	388-408 413-423 433-443 464-474 495-500	x	R
WO Cg-72	South Plant	O	5	384-394 404-424 445-450		R
WO Cg-75	South Plant"D"	P	5	367-427	x	
WO De-36	Newark	O	30	320-330	x	S
WO Dg-21	Assateague St.Pk.	O	6	300-310	x	R

[1] O - Observation, P - Production.
[2] Land surface elevation, in feet above sea level.
[3] Screened intervals, in feet below land surface.
[4] S - Steel tape, R - Recorder.

Table 4.--Network of monitored wells in the Ocean City aquifer in Delaware

Well No.	Location	Well type[1]	Elevation of land surface[2]	Screened interval[3]	Chloride concentrations measured	Water levels measured[4]
Qh 41- 9	Frankford	O	35	178-225		S
Qh 54- 5	Omar	O	28	229-232	x	S
Qj 32-10	Bethany Beach #3	P	7	186-211	x	
Qj 32-22	Bethany Beach #4	P	5	200-250	x	
Qj 41- 7	Sea Colony	O	6	284-294	x	S
Rj 22- 6	Fenwick Island	O	5	290-295		S

Table 5.--Network of monitored wells in the Ocean City aquifer in Maryland

Well No.	Location	Well type[1]	Elevation of land surface[2]	Screened interval[3]	Chloride concentrations measured	Water levels measured[4]
WO Ae-24	Whaleysville	O	40	190-220	x	S
WO Bg-47	Isle of Wight	O	5	258-268	x	R
WO Bg-49	West Ocean City	O	10	233-243	x	R
	Ocean City					
WO Bh-26	15th St. "A"	P	6	245-281	x	
WO Bh-27	15th St. "B"	P	5	233-238	x	
				248-268		
				279-289		
WO Bh-28	44th St. "A"	P	5	248-294	x	
WO Bh-29	44th St. "B"	P	6	248-294	x	
WO Bh-30	15th St. "C"	P	6	232-237	x	
				240-270		
				282-292		
WO Bh-31	44th St.	O	5	263-278	x	R
WO Bh-41	44th. St. "C"	P	4	258-318	x	
WO Bh-81	44th. St. "D"	P	5	227-232	x	
				244-264		
				272-297		
WO Cg-32	South Plant "A"	P	4	245-280	x	
WO Cg-33	South Plant "B"	P	5	253-290	x	
WO Cg-34	South Plant "C"	P	5	226-231	x	
				240-260		
				270-280		
				284-294		
WO Cg-69	Mystic Harbor	O	10	215-235	x	R

[1] O - Observation, P - Production.
[2] Land surface elevation, in feet above sea level.
[3] Screened intervals, in feet below land surface.
[4] S - Steel tape, R - Recorder.

Table 6.--Network of monitored wells in the Pocomoke aquifer in Delaware

Well No.	Location	Well type[1]	Elevation of land surface[2]	Screened interval[3]	Chloride concen- trations measured	Water levels measured[4]
Ni 42-15	Lewes	O	16	142-152		S
Ni 51-26	Lewes #1	P	18	70-95	x	
Ni 51-28	Lewes #3	P	16	70-150	x	
Ni 51-29	Lewes #2	P	17	117-145	x	
Ni 51-30	Lewes	O	16	150-155		R
Ni 51-31	Lewes #4	P	16	100-150	x	
Ni 51-32	Lewes #5	P	16	85-135	x	
Ni 52-11	Lewes R.R. park	O	16	145-155	x	S
Oh 54- 2	Angola	O	18	179-189	x	S
Pj 41- 4	Indian R. Inlet	P	10	200-220	x	
PJ 51- 5	Quillens Point	P	5	195-215	x	
Qh 41-11	Frankford	O	35	100-140		S
Qh 54- 6	Omar	O	28	144-148	x	S
Qj 41- 8	Sea Colony	O	6	200-210	x	S
Rj 22- 7	Fenwick Island	O	5	180-185		S
Rj 22- 9	Fenwick Island	O	5	190-220		R
Rj 31- 7	Cape Windsor #2	P	5	150-200	x	

Table 7.--Network of monitored wells in the Pocomoke aquifer in Maryland

Well No.	Location	Well type[1]	Elevation of land surface[2]	Screened interval[3]	Chloride concen- trations measured	Water levels measured[4]
WO Ae-25	Whaleysville	O	40	108-118	x	S
WO Bg-46	Ocean Pines	O	10	164-194	x	S
WO Bh-85	Ocean City 44th St.	O	5	190-195	x	S

[1] O - Observation.
[2] Land surface elevation, in feet above sea level.
[3] Screen intervals, in feet below land surface.
[4] S - Steel tape, R - Recorder.

Unconfined Aquifer

Seven wells in the unconfined aquifer were monitored during this study, with five in Delaware and two in Maryland (pl. 4; tables 8 and 9). One production well (Oi 34-1) at Rehoboth Beach was sampled frequently throughout the study to observe fluctuations in chloride concentrations. Most municipalities, aware of the risk of chloride contamination, have changed from using shallow wells near the coast, to using wells pumping the deeper confined aquifers along the coast, or the shallow, unconfined aquifer farther inland, away from the possible sources of chloride contamination.

Table 8.--Network of monitored wells in the unconfined aquifer in Delaware

Well No.	Location	Well type[1]	Elevation of land surface[2]	Screened interval[3]	Chloride concentrations measured	Water levels measured[4]
Ni 52-12	Lewes R.R. Park	O	16	70-80	x	S
Oi 23-13	Breezewood	O	22	92-96		S
Oi 34- 1	Rehoboth #1	P	23	69-131	x	
Qh 54- 7	Omar	O	28	104-108	x	S
Rj 22- 8	Fenwick Island	O	5	110-115		S

1 O = Observation P = Production.
2 Land surface elevation, in feet above sea level.
3 Screened intervals, in feet below land surface.
4 S = Steel tape.

Table 9.--Network of monitored wells in the unconfined aquifer in Maryland

Well No.	Location	Well type[1]	Elevation of land surface[2]	Screened interval[3]	Chloride concentrations measured	Water levels measured[4]
WO Bg-45	Ocean Pines	O	10	56-77	x	S
WO Bh-84	Ocean City 44th St.	O	5	81-86	x	S

1 O = Observation.
2 Land surface elevation, in feet above sea level.
3 Screened intervals, in feet below land surface.
4 S = Steel tape.

METHODS OF DATA COLLECTION

Water Levels

Eighteen of the 46 observation wells in the study area were monitored by water-level recorders. The remaining 28 observation wells were measured by calibrated steel tape. Five recorders were graphic recorders and measurements from every fifth day were transcribed and replotted using a computer. The 13 digital recorders documented water levels every 15 minutes if the wells were near production wells, or once every hour if the well was not within 2,000 ft of a production well in the same aquifer. Mean daily values for those wells were recorded and plotted.

Water-level data collected during this study were combined with data from previous and current DGS and MGS studies and are displayed graphically in figures throughout this report so that long-term changes can be observed.

Chloride Concentrations

All chloride concentrations were determined by colorimetric titration. U.S. Geological Survey field and laboratory procedures use mercuric nitrate as the reagent, while the Delaware Division of Public Health and Worcester County Sanitary Commission use silver nitrate as the reagent.

When sampling observation wells, gas-powered suction pumps were used. Pumping rates varied from 10 to 75 gal/min, and averaged about 40 gal/min depending on water levels in the wells. All wells were pumped so that at least four times the volume of the well was removed before sampling. Specific conductance, pH, and water temperature were monitored every 10 minutes to ensure that equilibrium was reached before the sample was taken. Several samples were analyzed for chloride concentration during pumping to be sure that concentrations had stabilized.

Production wells were sampled from taps at the wellheads so that only untreated water was sampled. Wells were pumped for at least 5 to 10 minutes before each sample was collected. Usually the wells were operating prior to the time the samples were taken.

Current chloride data were obtained by sampling 61 wells throughout the study area (tables 2-9). Historical chloride data were obtained from previous publications, U.S. Geological Survey records, Delaware Division of Public Health, and the Worcester County Sanitary Commission.

The following water-supply plants in Delaware collected more frequent samples for U.S. Geological Survey field measurements so that chloride variations could be determined: Lewes, Rehoboth Beach, Indian River State Park, Bethany Beach, Sea Colony, Quillens Point, and Cape Windsor.

Chloride concentrations and other water-quality data collected by U.S. Geological Survey personnel are listed in the Appendix. Chloride data supplied by the Delaware Division of Public Health and the Worcester County Sanitary Commission are used in figures throughout this report, but are not listed in the Appendix. Chloride data from samples taken by towns for U.S. Geological Survey analysis are used in figures in the report, but are not listed in the Appendix.

Pumpage

In Delaware, major users of water (those using more than 50,000 gal/d) are required to report pumpage to the DNREC. Water-use data presented in this report were supplied by DNREC and local municipalities.

In Maryland, major users of water (those using more than 10,000 gal/d) are required to report pumpage to the WRA. Data presented in this report were supplied by the WRA and Ocean City.

Water-use data in this report include municipal and industrial water systems that average more than 50,000 gal/d.

WATER LEVELS, CHLORIDE CONCENTRATIONS, AND PUMPAGE

This section of the report describes the combined effects of pumpage and water levels on chloride concentrations in aquifers in the study area. Descriptions are arranged first by aquifer, then by location, generally from north to south.

Manokin Aquifer

Major users of the Manokin aquifer in the coastal areas in Delaware are the town of Bethany Beach, the development of Sea Colony, and the town of Millsboro. In coastal Maryland, Ocean City is the only major user of the aquifer. The aquifer is pumped more extensively at other locations west of the study area.

The St. Marys Formation underlies the Manokin aquifer (fig. 2). This formation is an effective confining layer that prevents or greatly retards movement of saltwater from the underlying Miocene Choptank Formation into the Manokin aquifer. Parts of the St. Marys Formation are known to contain saltwater (Weigle, 1974). Static heads are higher in the Choptank than in the Manokin aquifer, at least at 137th Street, Ocean City, where the only Choptank observation well in the study area is located. Because of these head differences, a potential for slowly increasing chloride concentrations in the bottom of the aquifer exists in areas of heavy pumpage from the aquifer. However, upward movement of salty water through the St. Marys Formation near pumping centers would probably be slow and would therefore not constitute a threat to the aquifer.

Chloride concentrations in wells in the Manokin aquifer range from 6 mg/L at Millsboro, to 460 mg/L at Fenwick Island. Wells screened close to the bottom of the aquifer tend to have higher chloride concentrations than those screened higher.

Delaware

Lewes-Rehoboth Beach area

Neither Lewes nor Rehoboth Beach pump water from the Manokin aquifer. Observation well Oi 24-6 (pl. 1) is screened in the Manokin aquifer and is located near Delaware Route 1 at the Lynch well field, Rehoboth Beach. Figure 13 shows water-level data for well Oi 24-6 from 1976 to 1982, and from 1985 to 1986. This well has the least amount of seasonal water-level variation in the study area because (1) the aquifer is confined, (2) the nearest pumpage from the aquifer is 12.5 mi away at both Millsboro and Bethany Beach, and (3) the observation well is updip of all major pumping centers in the aquifer. Chloride concentrations ranged from 8.8 mg/L on April 3, 1986, to 12 mg/L on July 7, 1986 (see Appendix).

The Manokin aquifer at Rehoboth Beach is presently an untapped source of water. It could provide Rehoboth Beach with a good backup water supply. The only undesirable characteristic of the water is that it is higher in dissolved iron than Rehoboth's present source of water (the unconfined aquifer), and any use of water from the Manokin aquifer may necessitate removal of the iron. Iron concentrations in the Manokin aquifer at well Oi 24-6 were 2 mg/L, as opposed to the 0.27 mg/L of iron in Rehoboth's production well 1 (Oi 34-1) in the unconfined aquifer.

Angola area

The nearest pumpage from the Manokin aquifer in the Angola area is at Millsboro, 8 mi southwest. Observation well Oh 54-1, screened in the Manokin aquifer, and observation well Oh 54-2, screened in the Pocomoke aquifer, are located near Angola at the intersection of Delaware Route 24 and State Route 277, 6 mi southwest of Rehoboth Beach (pls. 1 and 3). Water levels in these wells were measured monthly from 1977 until 1979 (Hodges, 1984). After 1979, measurement frequency was decreased to twice yearly until early 1985 when this study began.

Water levels in the Manokin aquifer showed a marked decrease at this location during 1985 and 1986. The seasonal range of water levels also decreased (fig. 14). Average water levels in the aquifer dropped from 9.81 ft above sea level (8.19 ft below land surface) during 1977 to 1979, to 7.44 ft above sea level (10.56 ft below land surface) during 1985 to 1986.

Water levels in wells Oh 54-1 and -2 seemed to reflect the decrease in precipitation that occurred during 1980 and 1981, and the increase in precipitation that occurred during 1982 and 1983 (fig.15). This relation between water levels and precipitation is evident throughout the study area in observation wells that are not in the immediate vicinity of production wells.

Water levels near Angola were usually higher in the Manokin aquifer than in the Pocomoke, indicating ground-water flow was probably upward from the

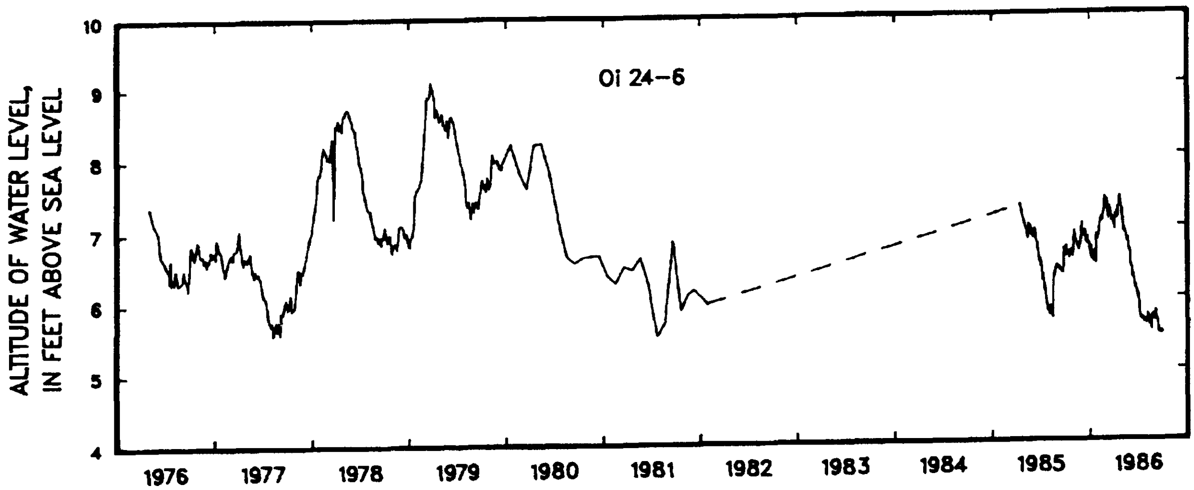


Figure 13.--Water levels in a well in the Manokin aquifer at Rehoboth Beach, Delaware, 1976-86.

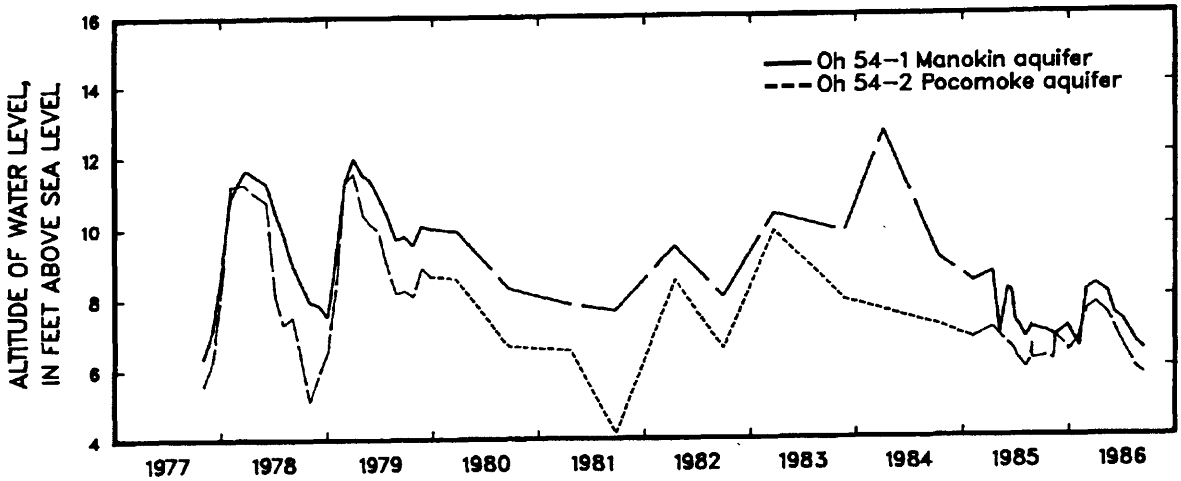


Figure 14.--Water levels in wells in the Manokin and Pocomoke aquifers near Angola, Delaware, 1977-86.

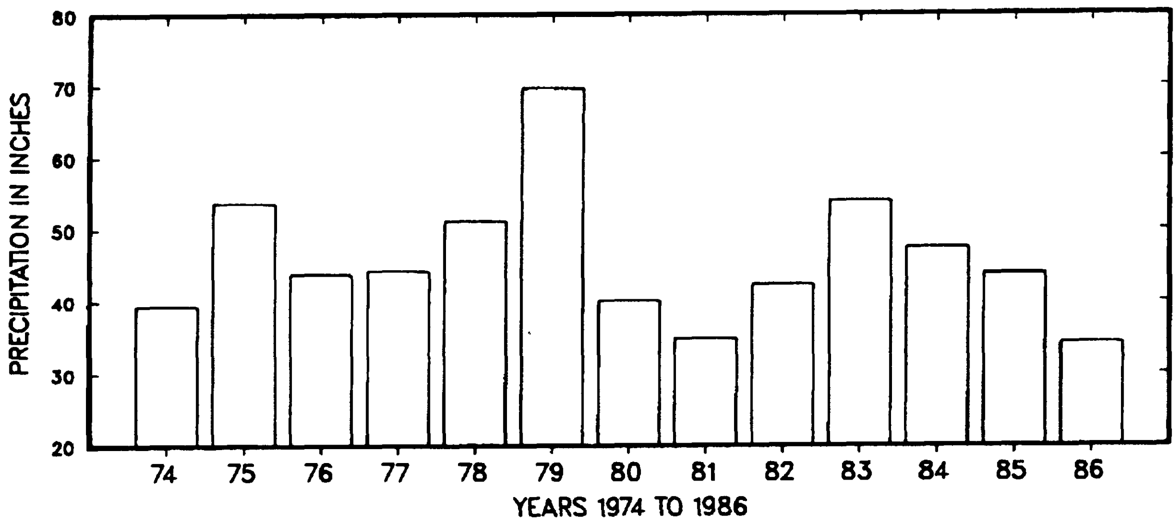


Figure 15.--Yearly precipitation at Salisbury, Maryland, 1974-86.

Manokin aquifer to the Ocean City aquifer, and from the Ocean City to the Pocomoke aquifer.

Chloride concentrations in the Manokin aquifer at well Oh 54-1 ranged from 7 mg/L on February 5, 1986, to 9.2 mg/L on August 26, 1985. This narrow range was probably due as much to analytical variation as it was to a decrease in chloride concentrations in the aquifer. These concentrations were among the lowest for the aquifer in the study area.

Millsboro area

The town of Millsboro has much less seasonal variation in pumping rates than the resort areas along the coast. These differences are readily apparent when Millsboro pumpage (fig. 5) is compared to pumpage at Rehoboth Beach (fig. 4) or Bethany Beach (fig. 8).

The only water-level monitoring well in the Manokin aquifer near Millsboro (Pg 53-14) is about 40 ft from Millsboro's production well 3 (Pg 53-13). Water levels were measured monthly in Pg 53-14 for one year (February 2, 1978, to March 1, 1979) after the well was drilled and before the production well was put into use in 1979. A water-level recorder monitored water levels from June 6, 1985, to the end of this study. Prepumping data (1978-79) show that a seasonal low water level occurred during November and December 1978. This was possibly due to delayed movement of ground water toward the cone of depression in the aquifer caused by seasonal pumpage at Bethany Beach, Sea Colony, and Ocean City. The 1985-86 water levels were affected by use of nearby production well Pg 53-13. Seasonal low water levels for this period occurred in August as they did in the other coastal areas. Seasonal high (altitude = 10 ft) and low (altitude = 0 ft) water levels did not change between 1978 and 1986 in well Pg 53-14.

Chloride concentrations in Manokin aquifer well Pg 53-13 ranged from 6 to 11 mg/L. Data presented in figure 16 show no trend to higher or lower chloride concentrations in the aquifer at Millsboro or any variation due to changes in annual pumpage.

Delaware Power and Light's Indian River power plant, 3 mi east of Millsboro, pumps water from both the Manokin and unconfined aquifers. Total ground-water pumpage at the plant is given in table 1. Manokin aquifer pumpage at the plant started in 1982 and averages 29 percent of the Manokin aquifer pumpage at Millsboro (based on 1983-85 pumpage totals from wells Pg 53-13 and Ph 51-20 at the power plant).

Omar Area

The nearest major withdrawals from the Manokin aquifer occur 6 mi away at Delmarva Power and Light's Indian River Power Plant, and 8 mi away at Millsboro and Bethany Beach. Observation wells Qh 54-4, -5, -6, and -7 are located 1.4 mi southeast of Omar, and 1.4 mi northwest of Roxana (pls. 1, 2, 3, and 4). These wells are screened in the Manokin, Ocean City, Pocomoke, and unconfined aquifers, respectively (tables 2, 4, 6, and 8), and are cased in the same borehole.

Water levels in all four wells were measured monthly during 1978 and 1979 and then twice yearly until early 1985 when monthly measurements were again instituted. Water levels in the Manokin and Ocean City aquifers were almost identical (fig. 17), indicating an ineffective confining unit between the two aquifers in this area.

Wells Qh 54-4, -5, -6, and -7, are 8 mi west of Bethany Beach and have not been affected by saltwater intrusion from the ocean or the inland bays. When well Qh 54-4 was first tested in 1978, the chloride concentration of the water was 33 mg/L. Five measurements taken during this study showed chloride concentrations ranging from 29 to 34 mg/L between August 1985 and August 1986. Chloride concentrations measured in water from these wells could be considered background concentration levels for these aquifers in southeastern Sussex County.

Bethany Beach area

Water levels in the Manokin aquifer near Bethany Beach were measured in three wells, Qj 32-14, Qj 32-17, and Qj 41-4 (fig. 7). Periodic water-level measurements were made from well Qj 32-14 from 1977 to 1982, and continuous records were obtained from May 1985 until January 1986. The water-level recorder was transferred from well Qj 32-14 to Qj 32-17 (2,200 ft to the west-southwest) in January 1986 due to mechanical problems. Observation well Qj 41-4 is located near the center of Sea Colony's four production wells (fig. 7), and is affected by Sea Colony's pumping (fig. 8). Figure 18 shows water levels in these three wells. Drawdowns at Qj 32-17 ranged only about 8 ft from high spring levels to the lowest summer levels. The lack of long-term water-level measurements from observation wells unaffected by pumping precludes assessment of long-term changes in areal water levels.

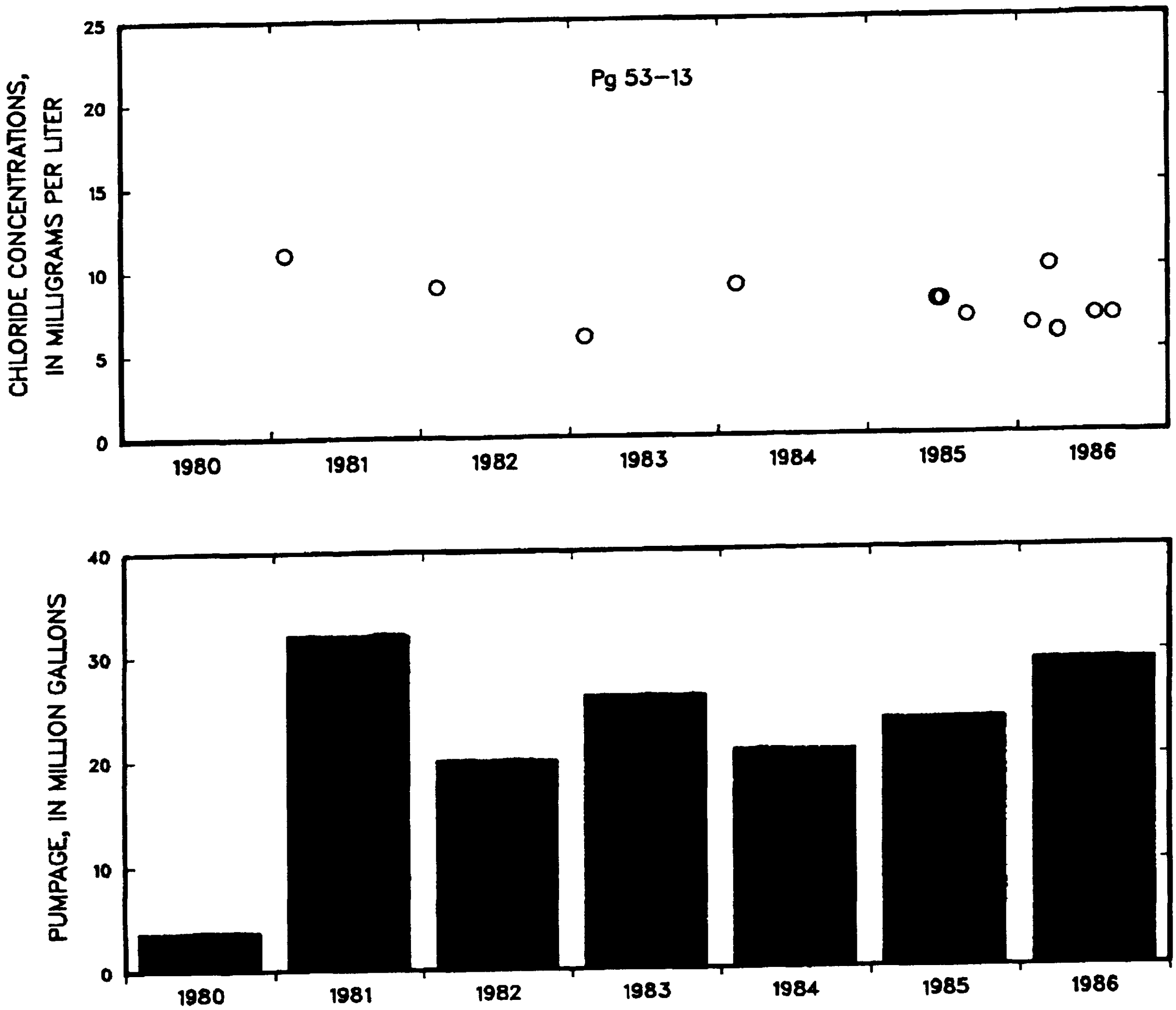


Figure 16.--Chloride concentrations and yearly pumpage from the Manokin aquifer at Millsboro, Delaware, 1980-86.

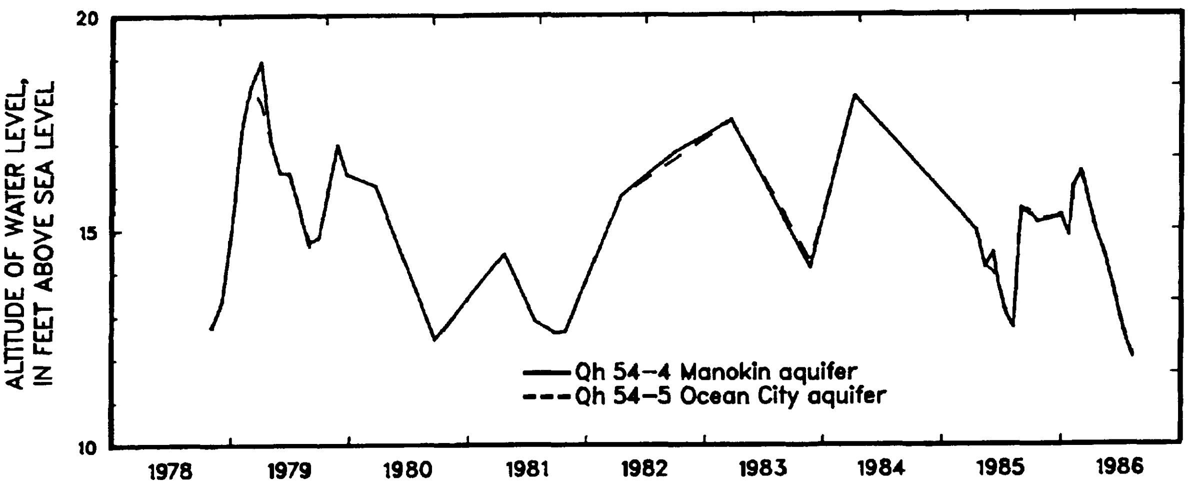


Figure 17.--Water levels in wells in the Manokin and Ocean City aquifers near Omar, Delaware, 1978-86.

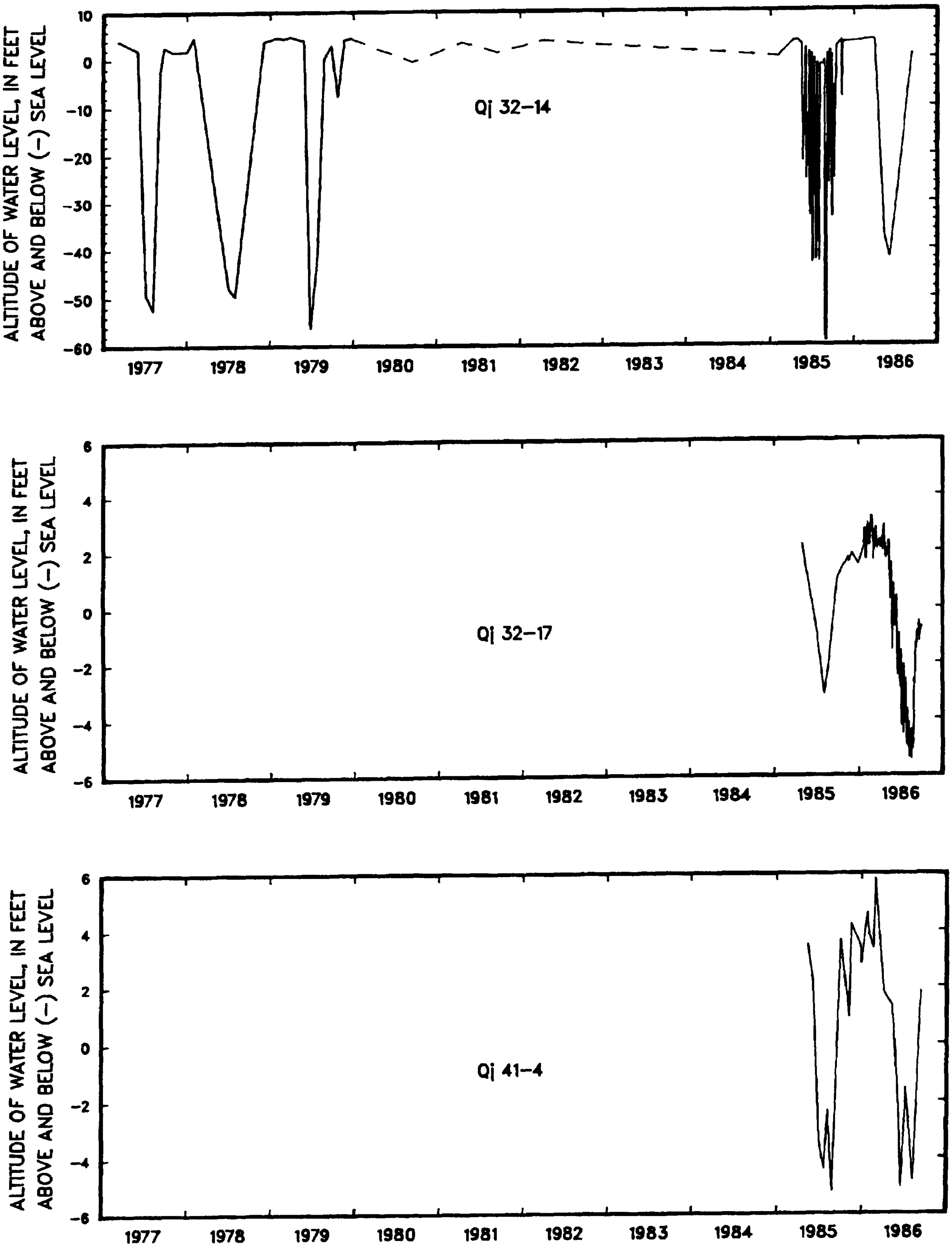


Figure 18.--Water levels in three wells in the Manokin aquifer at Bethany Beach, Delaware, 1977-86.

Chloride concentrations in the Manokin aquifer production wells near Bethany Beach ranged from 26 to 69 mg/L. Observation well Qj 32-17, which is screened to a greater depth than production wells at Bethany Beach, had chloride concentrations as high as 170 mg/L. Table 10 shows chloride concentrations in water from the Manokin aquifer wells near Bethany Beach and Sea Colony and the corresponding screened intervals of the wells.

Chloride concentrations did not vary directly with seasonal pumpage from the aquifer (fig. 8) and did not appear to increase since measurements from well Qj 32-15 were first recorded in 1979. Figure 19 shows chloride concentrations in water from three wells in the Manokin aquifer near Bethany Beach between 1979 to 1986.

Total yearly pumpage from the Manokin aquifer by Bethany Beach and Sea Colony is shown in figure 20. The changes in annual pumpage from the aquifer did not appear to affect chloride concentrations.

Fenwick Island area

There are no major production wells in the Manokin aquifer in Fenwick Island, Del. Water levels in the Manokin aquifer were measured in well Rj 22-5 (pl.1), which is screened near the base of the aquifer, and is located at the north end of Fenwick Island. Water levels in the Manokin aquifer at Fenwick Island seemed to be only minimally affected by the pumpage at Ocean City's Gorman Avenue water plant 2 mi to the south, and did not decline more than 5 ft below sea level between 1977 and 1986 (fig. 21). Water levels in the Ocean City aquifer at the same location (Rj 22-6) showed a close correlation to water levels in well Rj 22-5, indicating the leaky characteristic of the confining unit between the two aquifers.

Chloride concentrations in water from well Rj 22-5 were reported by Hodges (1984) as being 460 mg/L in 1977, and tests done in 1985 and 1986 showed concentrations to be 450 mg/L, indicating no increase in chloride concentrations in the base of the aquifer between 1977 and 1986.

Chloride concentrations in the Manokin aquifer at Cape Windsor (well Rj 31-8) 1.2 mi west of Fenwick Island, ranged from 32 to 35 mg/L (fig. 22), but this well is screened much higher than well Rj 22-5. Stratification of high chloride concentrations at the base of the

Table 10.--Chloride concentrations compared to screen depths in the Manokin aquifer in the Bethany Beach area, Delaware, from 1979 to 1986

[mg/L = milligrams per liter]

Well No.	Location or local name	Screen depth, in feet below land surface	Choride values, in mg/L		Number of samples
			Range	Mean	
Qj 32-15	Bethany Beach #1	353-383	60-69	62.5	10
Qj 32-17	Bethany Beach	335-400	123-170	146.5	2
Qj 41- 2	Sea Colony #1	341-366	49-62	53.0	11
Qj 41- 3	Sea Colony #2	341-366	49-60	56.0	8
Qj 41- 9	Sea Colony #3	335-370	26-38	35.0	6
Qj 41- 6	Sea Colony #4	340-375	26-37	34.0	12

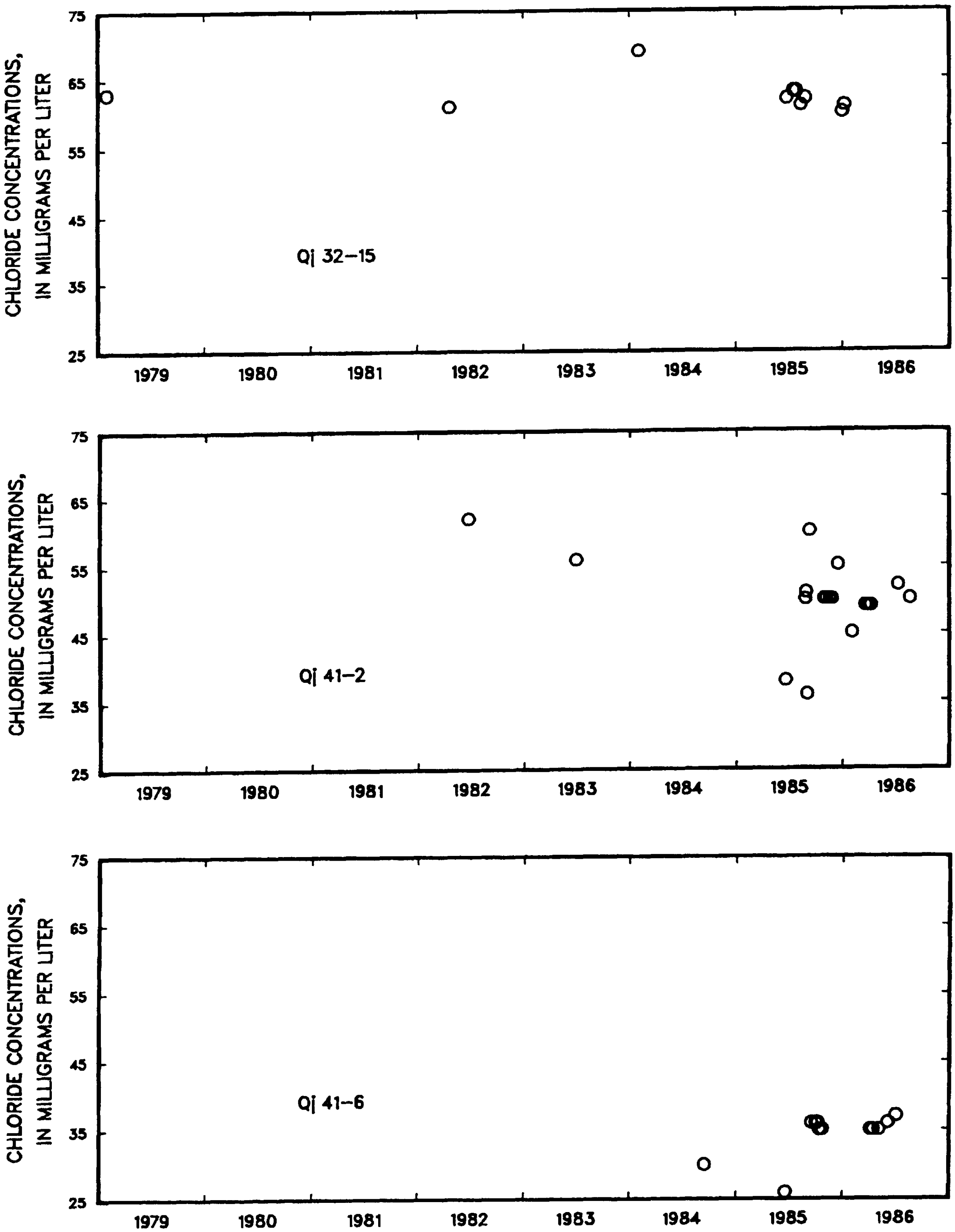


Figure 19.--Chloride concentrations in water from three wells in the Manokin aquifer in the Bethany Beach area, Delaware, 1979-86.

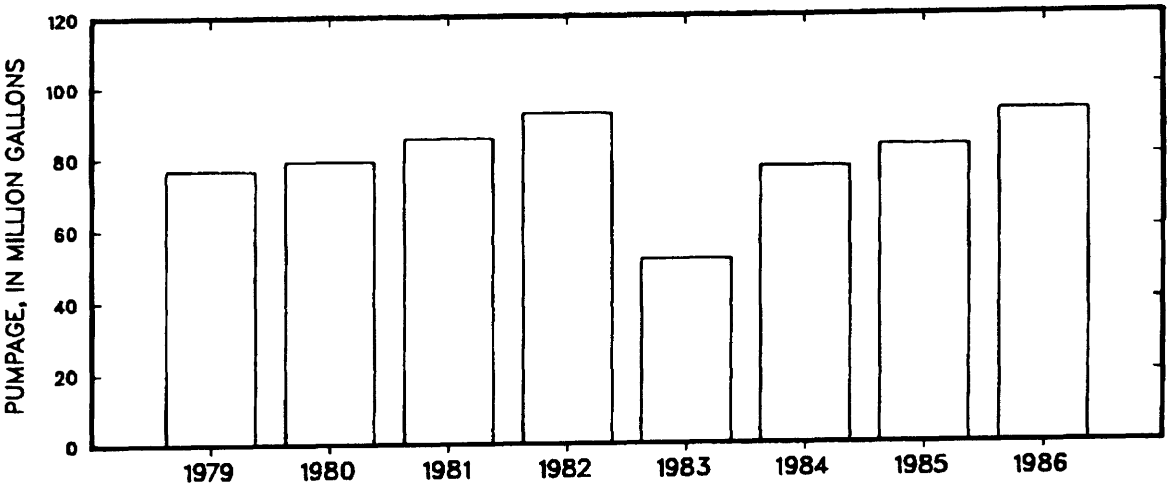


Figure 20.--Total yearly pumpage from the Manokin aquifer in the Bethany Beach area, Delaware, 1979-86.

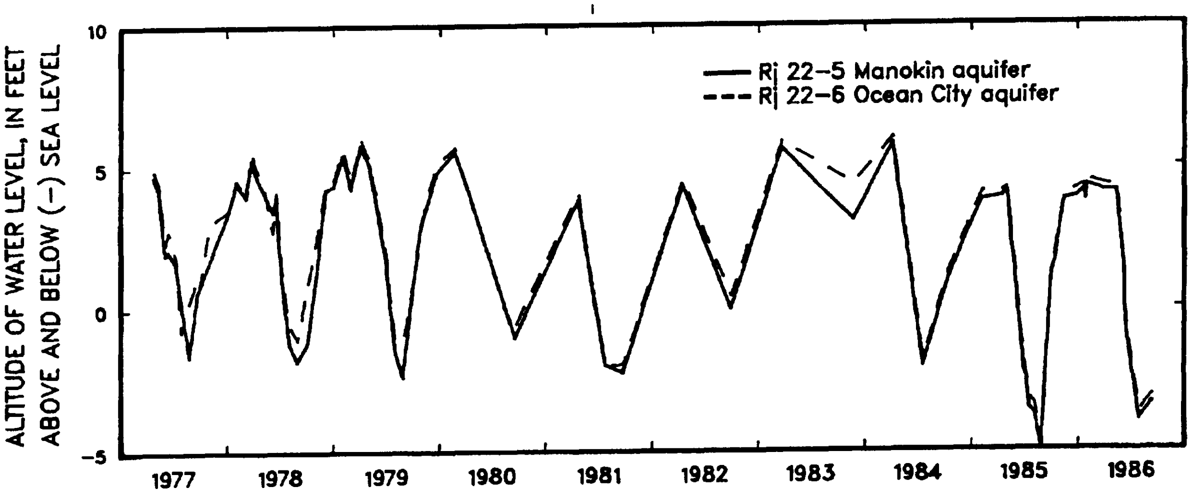


Figure 21.--Water levels in wells in the Manokin and Ocean City aquifers at Fenwick Island, Delaware, 1977-86.

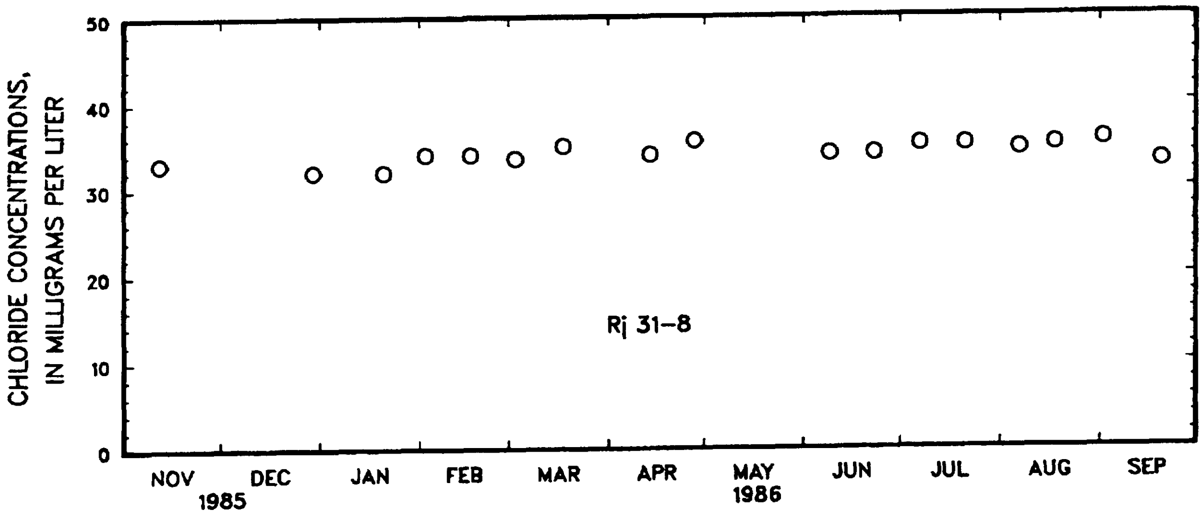


Figure 22.--Chloride concentrations in water from a well in the Manokin aquifer west of Fenwick Island, Delaware, November 1985 to September 1986.

Manokin aquifer was discussed by Weigle (1974) and may occur throughout the coastal sections of the study area. Results of tests from observation wells at Bethany Beach, Fenwick Island, and Ocean City show increasing chloride concentrations with increasing depth in the aquifer.

Maryland

Ocean City area

The Manokin aquifer at Ocean City is pumped at the Gorman Avenue, 15th Street, and the South water plants (see Municipal Water Supplies and Pumpage section). Observation wells in the Manokin aquifer are located at 137th Street, 44th Street, and the South water plant (pl. 1).

Gorman Avenue water plant.--Water levels in the Manokin aquifer and the underlying Choptank Formation at 137th Street are shown in figure 23. Observation well WO Ah-6 is located 24 ft east of production well WO Ah-34 (Gorman Avenue "A" well), and observation wells WO Ah-35 and -37 are located about 1,100 ft east of well WO Ah-34, at 137th Street (fig. 9). Well WO Ah-35 is screened in a saline aquifer in the Choptank Formation (716 to 726 ft below land surface) and water levels represent static pressure in that aquifer. Water levels were almost always higher in the Choptank Formation than in the Manokin aquifer in the 137th Street area. This relationship indicates a vertical hydraulic gradient upward through the St. Marys Formation toward the Manokin aquifer, causing chloride concentrations to be higher near the base of the aquifer.

Chloride concentrations in the production wells at the Gorman Avenue water plant and total yearly pumpage at the water plant are shown in figure 24. Wells WO Ah-34 and -38 had chloride concentrations ranging from 53 to 156 mg/L and 62 to 93 mg/L, respectively. Figure 24 shows only negligible increases in chloride concentrations in these two wells. Well WO Ah-33, located between the other two production wells, showed chloride concentrations increasing from 52 to 122 mg/L during the first 2 years of use, and then a gradual decline to a level of concentration similar to, but slightly higher than the other two wells. This is probably due to upconing of water from deeper in the formation since WO Ah-33 is near the center of the cone of depression caused by pumping from the Gorman Avenue water plant.

100th Street area.-- The Manokin observation well at 100th Street (WO Bh- 34) is 2 mi south of the nearest Manokin production well at the Gorman Avenue water plant. Figure 25 shows water levels in well WO Bh-34. Little water-level data are available for the well before the Gorman Avenue water plant began operation in 1973; however, water levels have declined since 1973. Water levels were not measured during late summer in 1978 and 1979, so reported extreme low water-level measurements for those years cannot be interpreted as having increased from the 2 previous years, as figure 25 indicates. Water levels in well WO Bh-34 recovered in the spring of each year shown, to near sea level or above, and were within about 5 ft of water levels in the aquifer before it was used for water supply.

Chloride concentrations in water from well WO Bh-34 ranged from 14 to 18 mg/L during 1985 and 1986. These concentrations are uncharacteristically low for the Manokin aquifer in Ocean City and suggest that the well (screened between 337 and 353 ft below land surface) may actually be screened in the bottom of the Ocean City aquifer rather than in the top of the Manokin aquifer. Earlier analyses are not available for the well.

44th Street water plant.--Well WO Bh-89 (fig. 9) was drilled in August 1986 as a Manokin test well for the town of Ocean City, and is screened intermittently between 388 and 500 ft below land surface (table 3). Examination of drill cuttings by U.S. Geological Survey and Whitman, Requardt and Associates personnel indicated little or no confining unit present between the Manokin and Ocean City aquifers. Near the end of August 1986, the lowest water level in the Ocean City aquifer observation well WO Bh-31 was 43 ft below sea level (48 ft below land surface). At the same time, the water level in well WO Bh-89, 50 ft to the west, was 38 ft below sea level (43 ft below land surface). These water levels were at least 20 ft lower than the Manokin aquifer water levels would have been if the aquifer was hydraulically separated from the Ocean City aquifer in that area. On October 3, 1986, a water-level recorder was installed on well WO Bh-89 and set to the same datum as observation well WO Bh-31. Figure 26 shows water levels from both wells for a 3-day and 21-day period. Water levels in the Ocean City aquifer (well WO Bh- 31) dropped within a few seconds after the nearby production well WO Bh-28 ("A" well) in the Ocean City aquifer commenced pumping. The effects of this pumping appeared in well WO Bh-89 in the Manokin aquifer about 10 minutes after the "A" well was turned on, and recovery began about 20 minutes after the "A" well was turned off.

Chloride concentrations in water from well WO Bh-89 were 440 mg/L during the pump test conducted on September 15, 1986. Chloride concentrations were stratified in this well also, with higher concentrations near the bottom screens. These high concentrations of

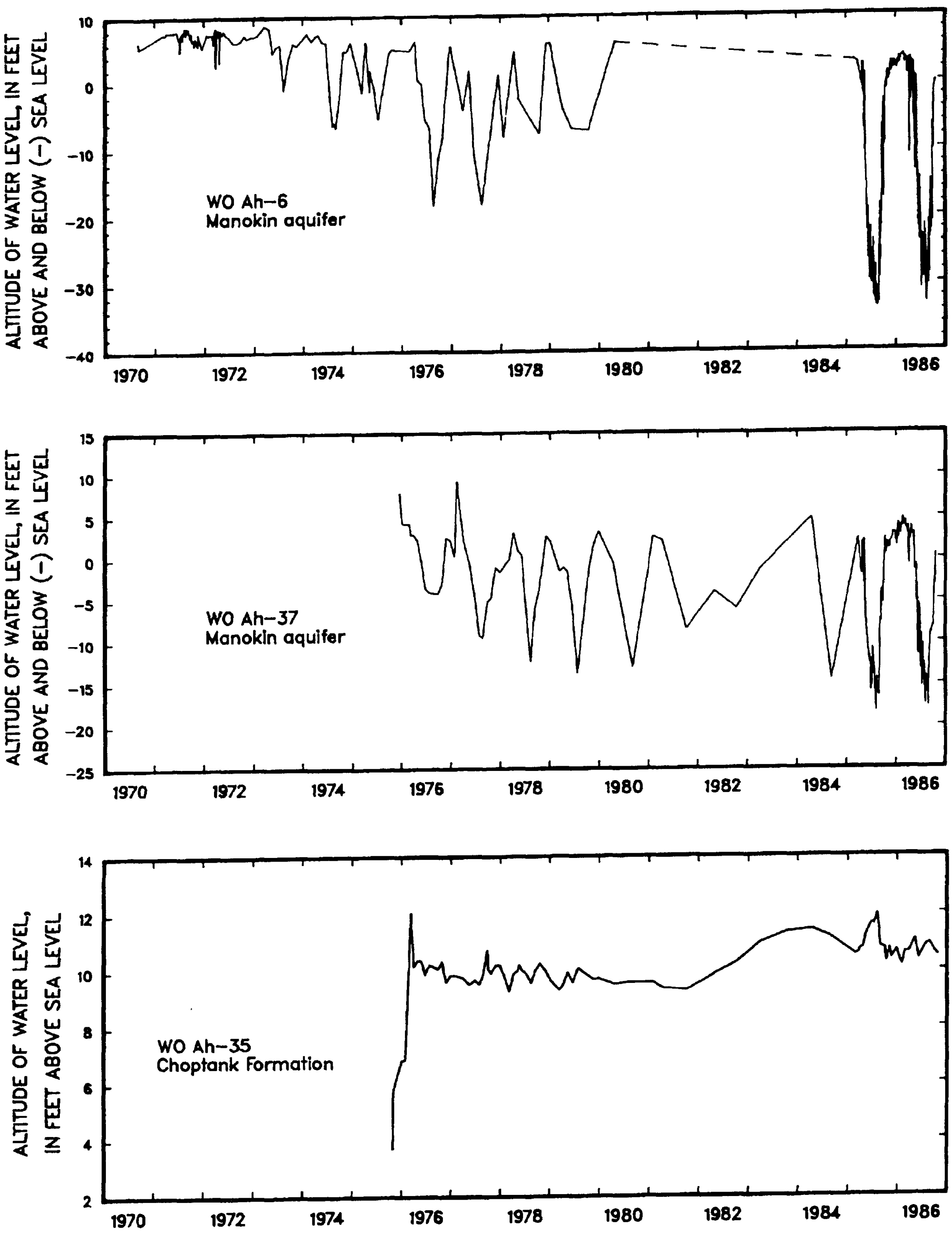


Figure 23.--Water levels in two wells in the Manokin aquifer and one well in the Choptank Formation at 137th Street, Ocean City, Maryland, 1970-86.

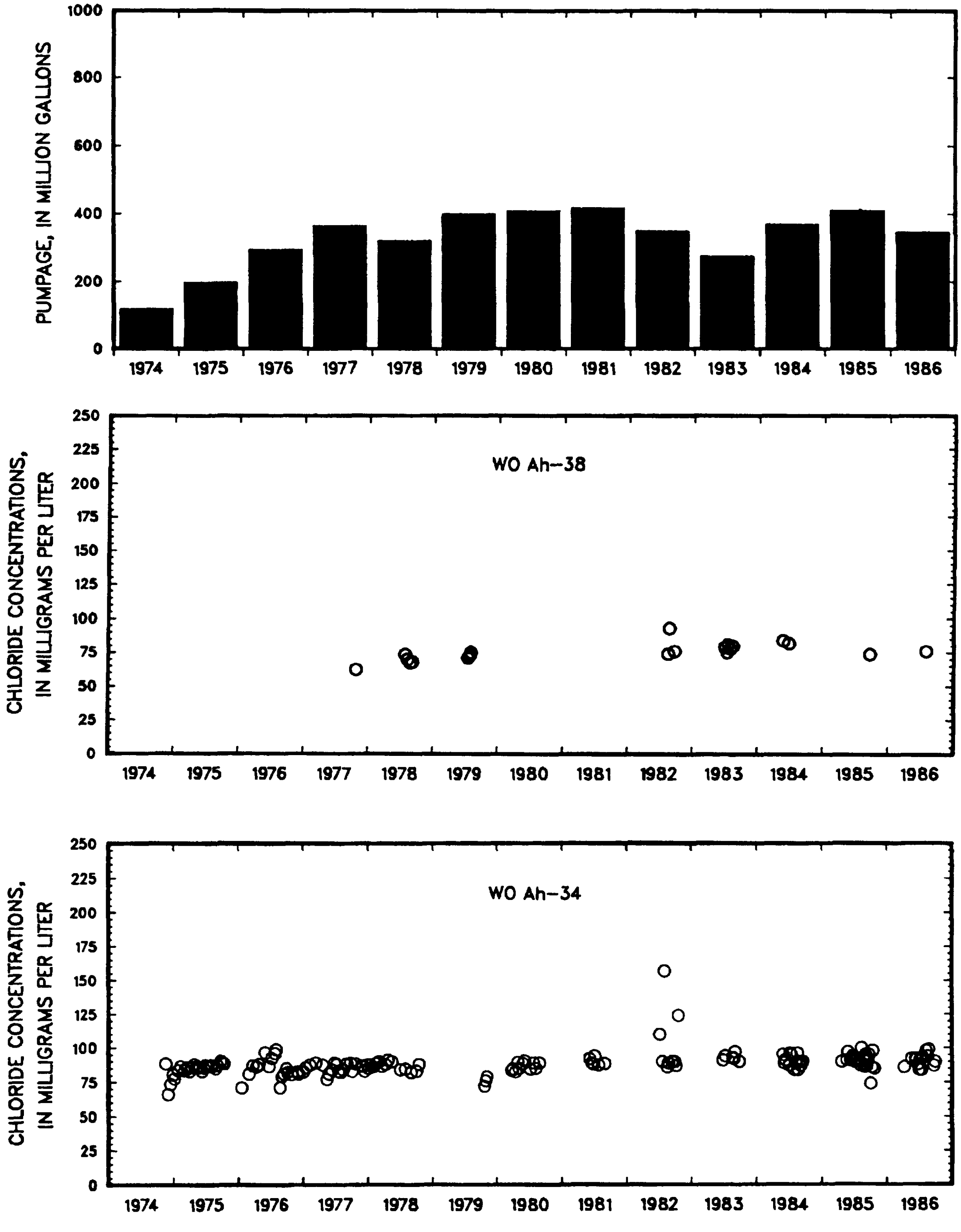


Figure 24.--Total yearly pumpage and chloride concentrations in water from three wells in the Manokin aquifer at the Gorman Aveune water plant, Ocean City, Maryland, 1974-86.

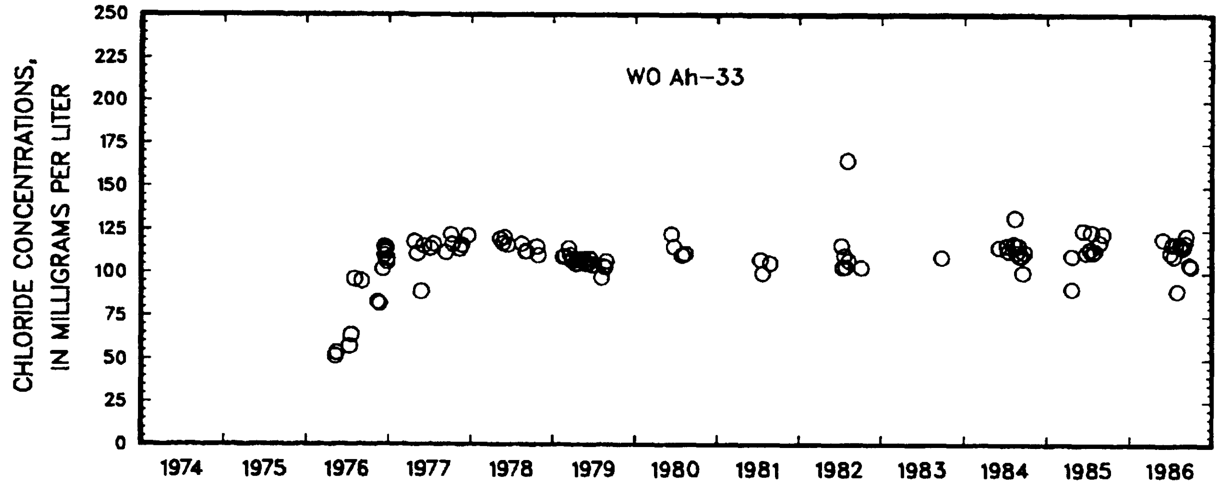


Figure 24.--Total yearly pumpage and chloride concentrations in water from three wells in the Manokin aquifer at the Gorman Avenue water plant, Ocean City, Maryland, 1974-86--Continued.

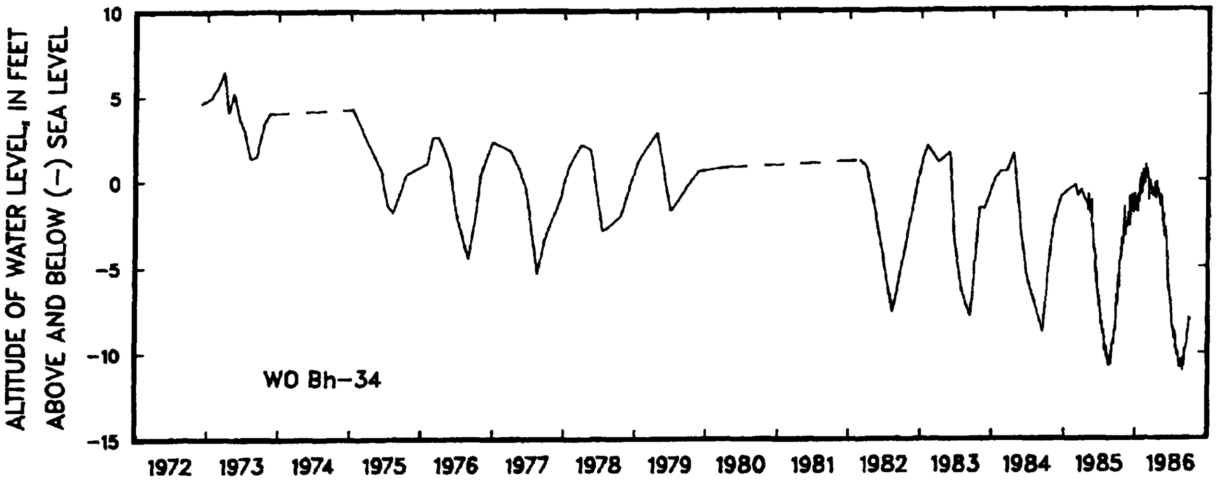


Figure 25.--Water levels in a well in the Manokin aquifer at 100th Street, Ocean City, Maryland, 1972-86.

chloride should preclude the use of the Manokin aquifer near 44th Street for public water supply.

Water-level and chloride data from the 44th Street vicinity indicate leakage of brackish water from the Manokin aquifer to the Ocean City aquifer occurs as a result of pumpage from the Ocean City aquifer.

15th Street water plant.--Water levels in the Manokin aquifer near 15th Street are not available since no observation well is nearby. Chloride concentrations in production well WO Bh-88 (15th Street "D" well), the only Manokin well at the water plant, ranged from 98 to 110 mg/L in 1985 and 1986 (fig. 27). Pumpage from the well, which began in 1985, has been estimated by the Ocean City Water Department to be approximately 33 percent of the total pumpage at the water plant during June, July, and August of each year. The well is used only in the summer months because iron concentrations are much higher in the Manokin than in the Ocean City aquifer.

South water plant.--Manokin observation well WO Cg-72 is located 12 ft from well WO Cg-75 (South water plant "D" well), the only Manokin production well at the

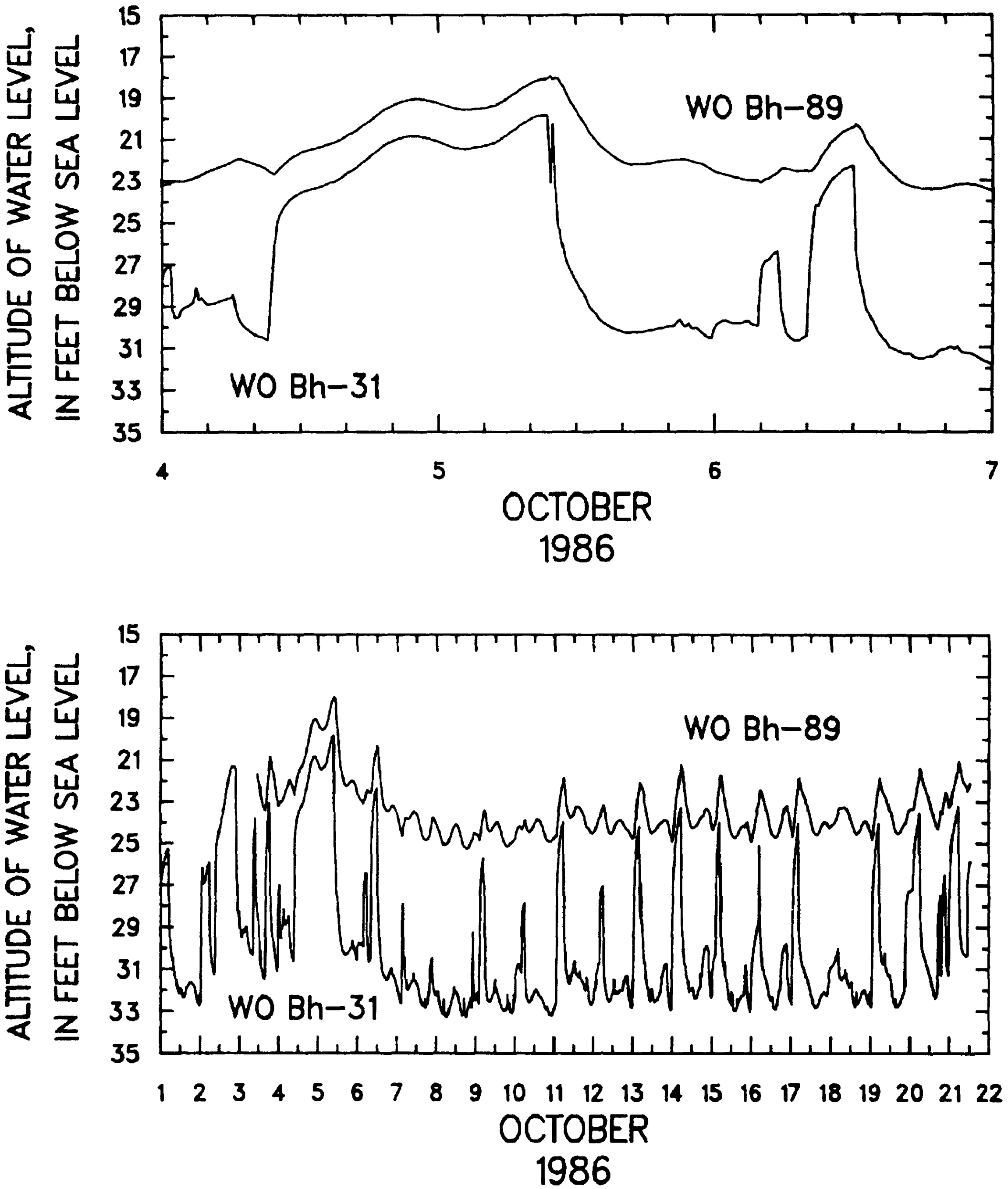
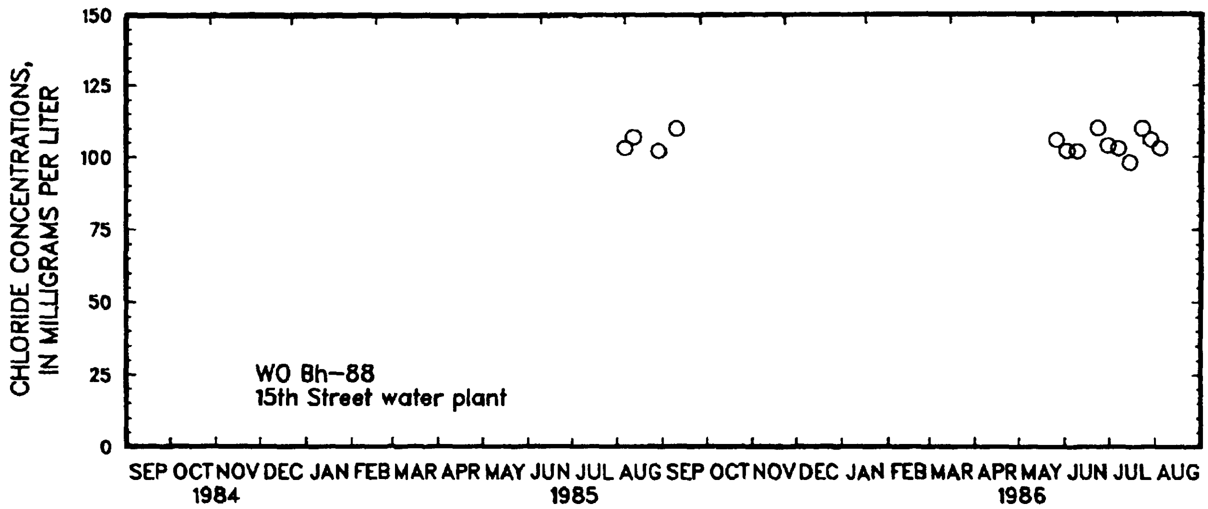


Figure 26.--Water levels in wells in the Manokin and Ocean City aquifers at 44th Street, Ocean City, Maryland, October 1986.



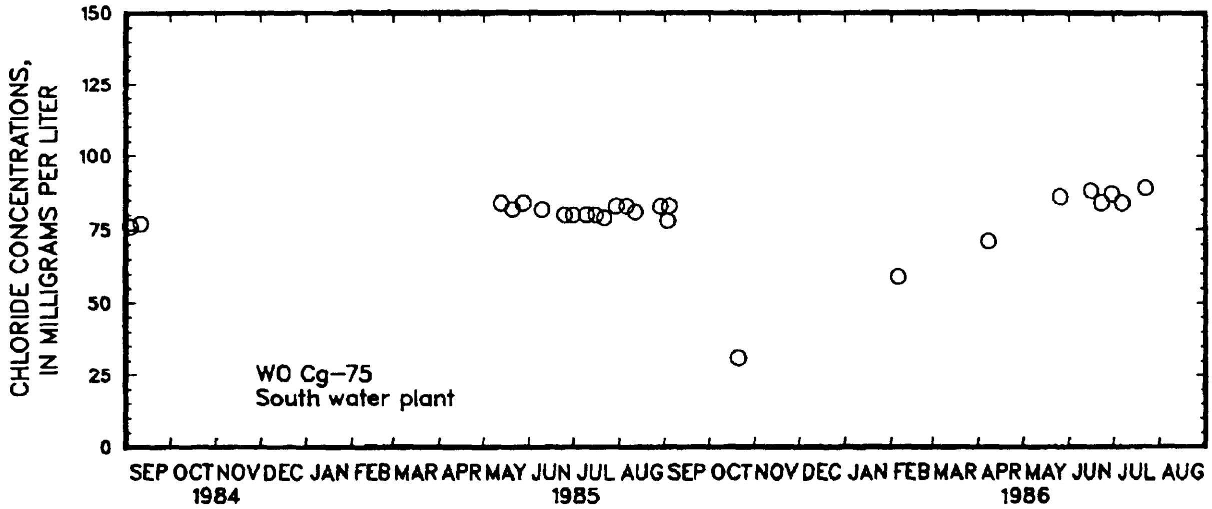


Figure 27.--Chloride concentrations in water from wells in the Manokin aquifer at 15th Street and South-water plants, Ocean City, Maryland, September 1984 to August 1986.

South water plant (fig. 9). Water levels in well WO Cg-72 are shown in figure 28.

In 1986, chloride concentrations in water from well WO Cg-75 ranged from 31 to 71 mg/L from September to May, and 76 to 89 mg/L from June to August (fig. 27).

Pumpage from WO Cg-75 is limited to the summer months because of high iron concentrations in the aquifer. Manokin aquifer pumpage has been estimated by the Ocean City Water Department to be approximately 33 percent of the South water plant's total pumpage during June, July, and August, with little or no pumping from September to May.

Ocean Pines area

Manokin observation well WO Bg-15 is located on the north side of Ocean Pines (pl. 1) and is not directly affected by pumpage from Ocean City. Water levels were usually near or above land surface (altitude = 7 ft) during the non-summer months (fig. 29), and were always at least 4 ft above sea level between 1970 and 1986. The nearest Manokin production well is 6 mi away at 15th Street; however, most of the drawdown in

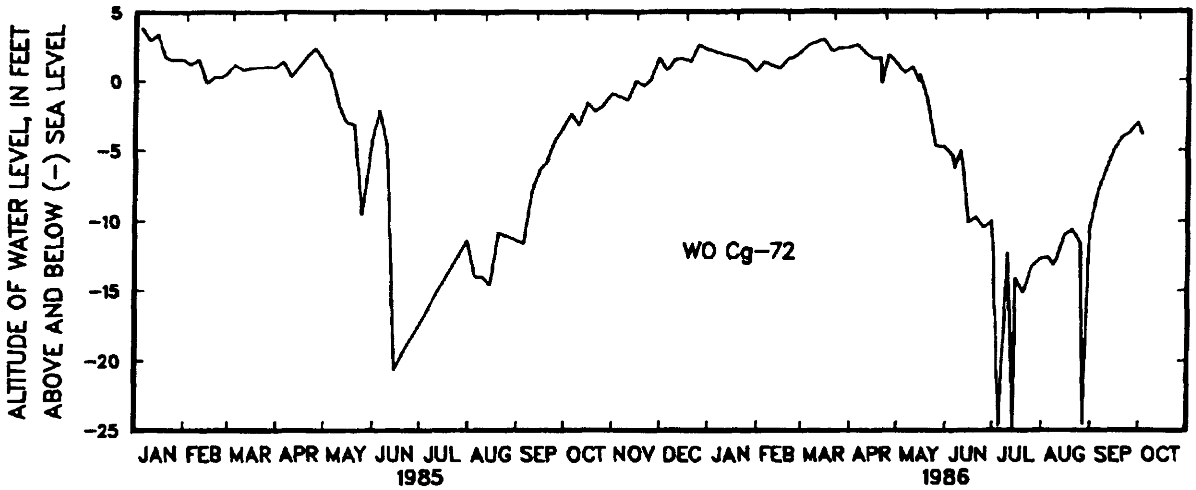


Figure 28.--Water levels in a well in the Manokin aquifer at the South water plant, Ocean City, Maryland, January 1985 to October 1986.

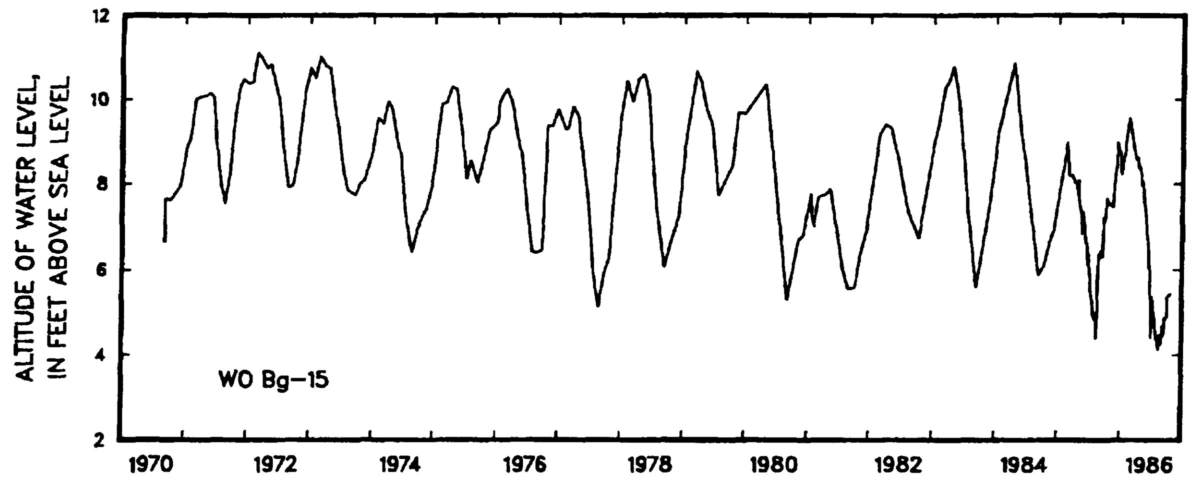


Figure 29.--Water levels in a well in the Manokin aquifer at Ocean Pines, Maryland, 1970-86.

this well was due to the Gorman Avenue water plant near 137th Street in Ocean City, 6.4 mi away, because most of the Manokin aquifer pumpage at Ocean City is from the Gorman Avenue water plant (fig. 9).

Chloride concentrations in water from well WO Bg-15, which is screened at the top of the Manokin aquifer, ranged from 20 to 26 mg/L in 1985 and 1986. No measurements of chloride concentrations were made before 1985.

Isle of Wight area

Observation wells WO Bg-47 and -48 are located on the Isle of Wight (pls. 1 and 2) and are screened in the Ocean City and Manokin aquifers, respectively. Figure 30 shows water levels in both wells from 1975 through 1986. Before 1980, when water-level data were available for both wells, levels were higher in the Manokin aquifer during winter and spring months, indicating potential discharge from the Manokin to the Ocean City aquifer during those periods. When pumpage at Ocean City increased during the summer, heads in both aquifers equalized, as indicated by the nearly identical water levels. After 1984, water levels during the non-summer months in both aquifers were usually equal, and during the summer, water levels in the Manokin aquifer dropped below those of the Ocean City aquifer (fig. 30).

Chloride concentrations in the Manokin aquifer at well WO Bg-48 ranged from 62 to 87 mg/L. Chloride measurements made in 1985 and 1986 ranged between 62 and 68 mg/L. The only measurement of 87 mg/L was in 1975, just after the well was completed. This decrease in chloride concentrations may be due to ground-water movement in the aquifer from inland toward the center of the cone of depression at Ocean City.

Whaleysville area

Observation wells WO Ae-23, -24, and -25 are located 3 mi north of Whaleysville and are screened in the Manokin, Ocean City, and Pocomoke aquifers, respectively (pls. 1, 2, and 3). These wells are not affected by any nearby pumping.

Figure 31 shows water levels from each of the three observation wells from 1975 through 1986. These levels indicate that in this part of the study area, ground-water flow in the aquifers is downward from the Pocomoke to the Ocean City, and from the Ocean City to the Manokin aquifer. Water-level elevations in the unconfined aquifer in this area are not available, but may be higher than heads in the Pocomoke aquifer since recharge to the Pocomoke is directly from the unconfined aquifer in the western part of the study area.

Chloride concentrations in the Manokin aquifer at well WO Ah-23 ranged from 5 to 7.5 mg/L from 1975 to 1986. These concentrations are normal background concentrations for the aquifer. Chloride levels generally increase as distance from the ocean decreases, and as screen depths approach the underlying St. Marys Formation.

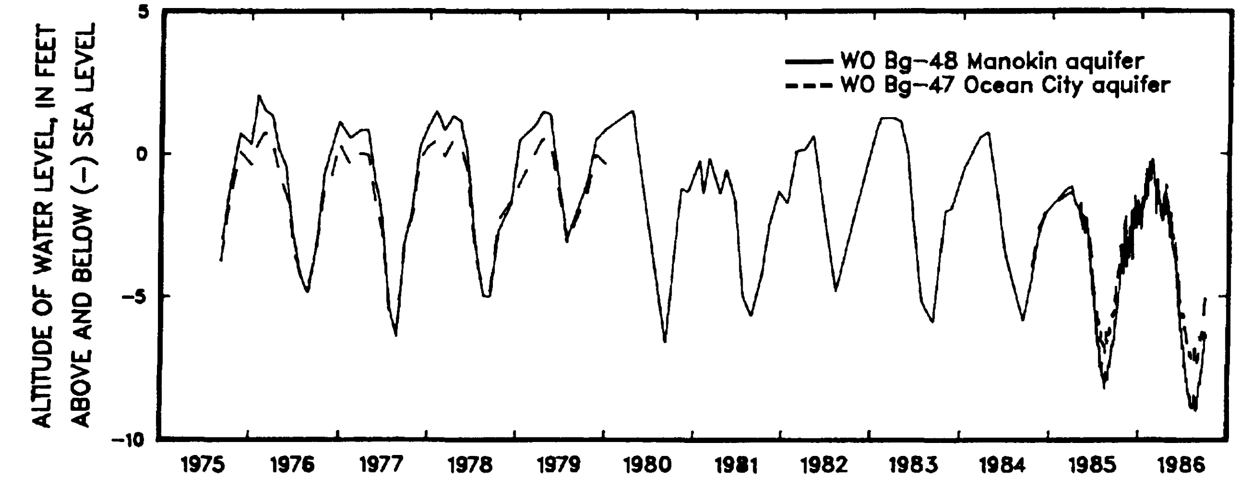


Figure 30.--Water levels in wells in the Manokin and Ocean City aquifers at the Isle of Wight, Maryland, 1975-86.

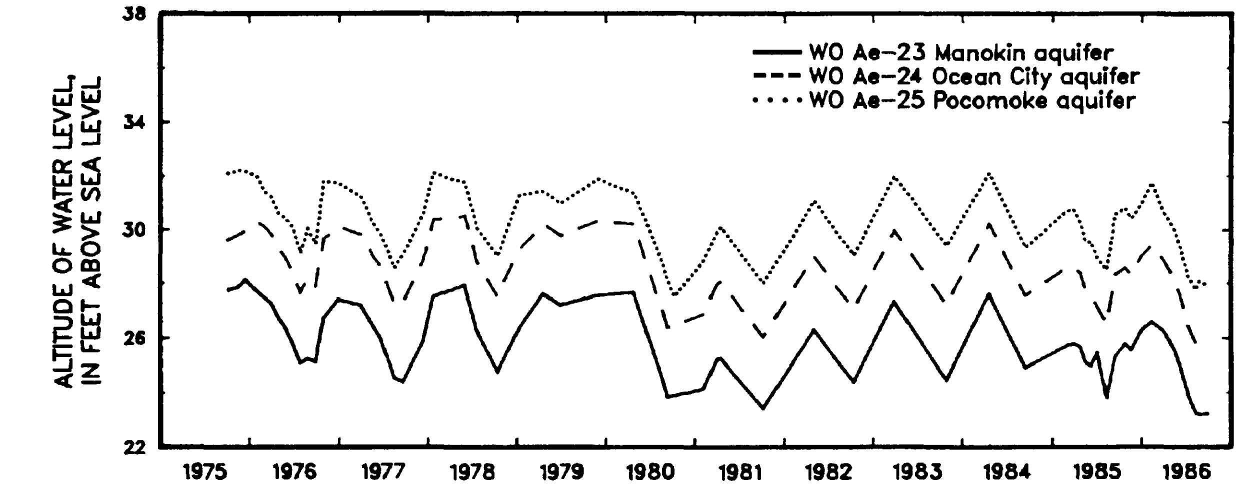


Figure 31.--Water levels in wells in the Manokin, Ocean City, and Pocomoke aquifers near Whaleysville, Maryland, 1975-86.

Assateague Island area

The Manokin aquifer is the source of the water supply for Assateague Island State Park and is also pumped at Ocean City, 6.3 mi north of the park. Summer water levels in the aquifer at the park have declined about 2.5 ft since water-level measurements in well WO Dg-21 began in 1975 (fig. 32). The record low water level of 1.11 ft above sea level (4.89 ft below land surface) on August 12, 1986, shows that head in the aquifer is still sufficient to prevent saltwater intrusion during the summer months. The record high water level of 6.66 ft above sea level (0.66 ft above land surface) on April 18, 1984, indicates that spring water levels continue to approach 1975 levels, depending on annual rainfall.

Chloride concentrations did not increase between 1975 and 1986 in water from well WO Dg-21. The initial measurement of 26 mg/L in 1975 is essentially the same as the maximum concentration of 25 mg/L determined during this study.

Newark area

The Manokin aquifer is not used for water supply in the Newark area. The nearest pumpage from the aquifer is at Ocean City, 12 mi northeast of Newark.

Manokin observation well WO De-36 is located at the southwest end of the study area (pl. 1). Water levels in this well declined an average of 2 ft between 1976 and 1986, possibly because of declines in rainfall in 1986 (fig. 33).

Chloride concentrations in water from well WO De-36 did not increase between 1975 and 1986. The chloride concentration of 9.3 mg/L in 1975 is about equivalent to the 8 mg/L measured in 1986.

Ocean City Aquifer

Major users of the Ocean City aquifer in the coastal area include Bethany Beach, Del., and Ocean City, Md. Chloride concentrations in the aquifer ranged from 6 mg/L at Whaleysville (well WO Ae-24), to 260 mg/L at Ocean City (well WO Bh-31).

Delaware

The town of Bethany Beach is the only major user of the Ocean City aquifer in the Delaware portion of the study area. The only available water- level observation wells in the Ocean City aquifer in the State are near Omar, Frankford, Bethany Beach, and Fenwick Island (pl. 2).

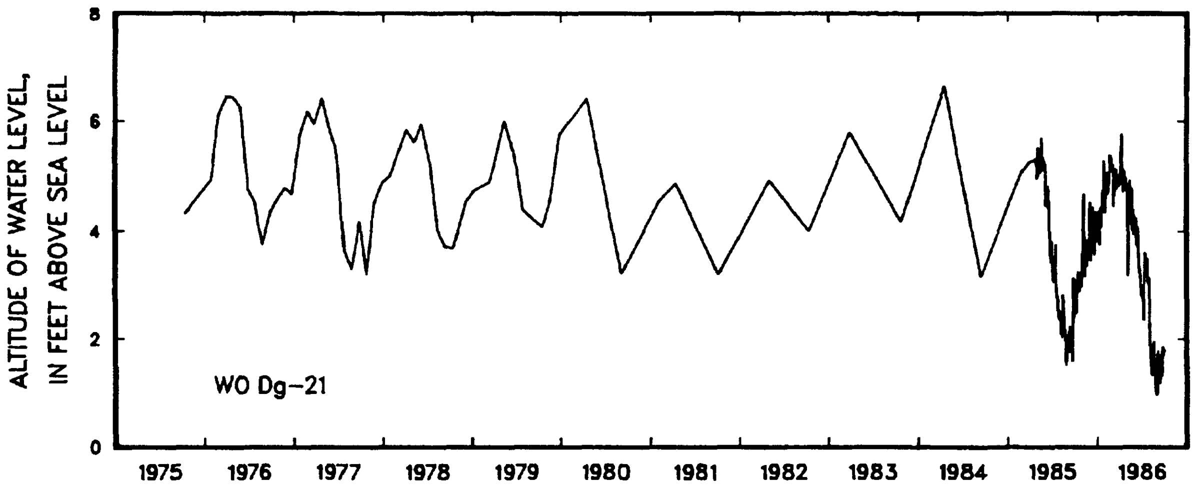


Figure 32.--Water levels in a well in the Manokin aquifer at Assateague Island State Park, Maryland, 1975-86.

Omar area

The nearest pumpage from the Ocean City aquifer is at Bethany Beach, 8 mi east of observation well Qh 54-5 (pl. 2).

Water levels in the Ocean City aquifer near Omar are shown in figure 17, along with levels from the Manokin aquifer. As discussed in the Manokin Aquifer section, water levels in the Ocean City aquifer well at this site (Qh 54-5) were nearly identical to those of the well screened in the Manokin aquifer (Qh 54-6).

Chloride concentrations in Ocean City aquifer well Qh 54-5 were 15 mg/L in 1978 when the well was first drilled. Chloride concentrations measured during this study ranged from 9.5 to 12 mg/L, indicating no increase in concentrations in the aquifer from 1978 to 1986.

Frankford area

The town of Frankford uses the Pocomoke aquifer for its water supply. The nearest major pumping from the Ocean City aquifer is at Bethany Beach, 10 mi east of Frankford.

Water levels were measured in observation wells Qh 41-9 and -11 at Frankford from May 1985 through October 1986 (fig. 34). These wells are screened in the Ocean City and Pocomoke aquifers, respectively.

Water levels in the Ocean City aquifer averaged about 5 ft lower than those in the Pocomoke aquifer at Frankford. The Ocean City aquifer in this area is recharged by the overlying Pocomoke aquifer and is indirectly recharged by the unconfined aquifer.

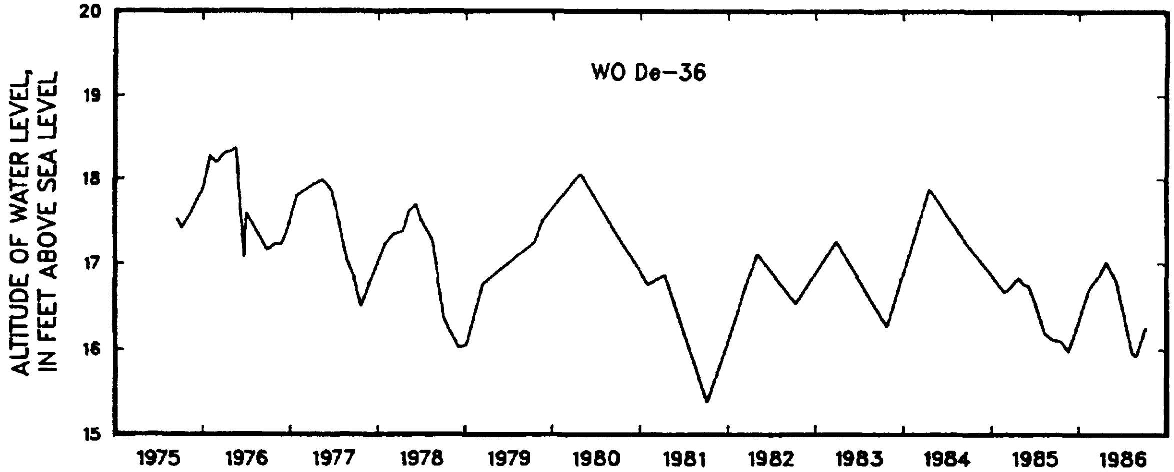


Figure 33.--Water levels in a well in the Manokin aquifer at Newark, Maryland, 1975-86.

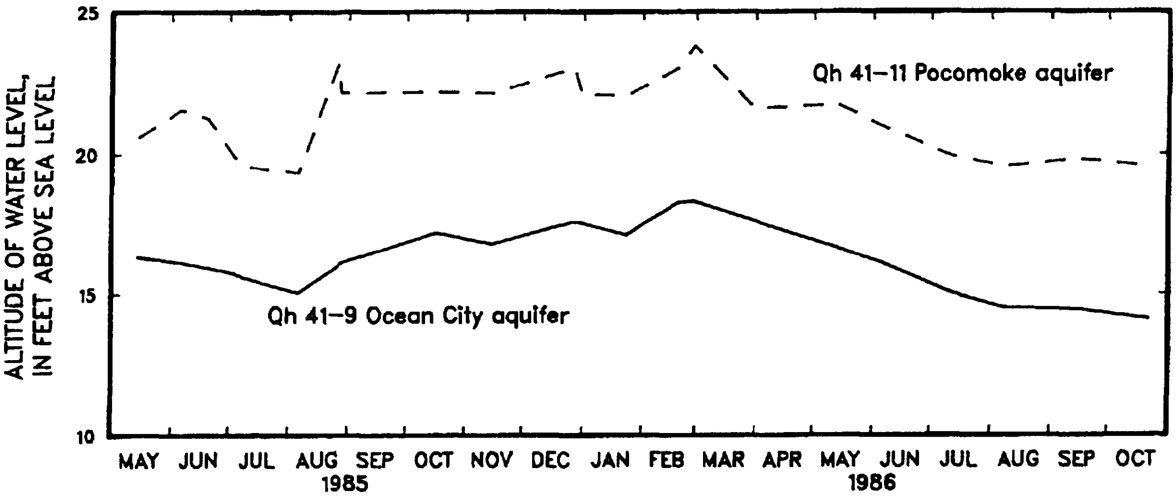


Figure 34.--Water levels in wells in the Ocean City and Pocomoke aquifers at Frankford, Delaware, May 1985 to October 1986.

Water-quality data were not available for either of the observation wells at Frankford.

Bethany Beach area

Bethany Beach has three production wells in the Ocean City aquifer--Qj 32-10, -12, and -22 (fig. 7). Water-level measurements in the Ocean City aquifer near Bethany Beach began in May 1985 in observation well Qj 41-7 at the Sea Colony water plant (fig. 7). Water levels in well Qj 41-7 show little effect from the Ocean City aquifer pumpage at Bethany Beach, about 0.9 mi to the north. Seasonal low water levels in well Qj 41-7 remained above sea level in 1985, but reached sea level the summer of 1986 during a period of drought. In February 1986, water levels were 0.22 ft above the land surface elevation of 5 ft (fig. 35).

Chloride concentrations in water from well Qj 41-7 ranged from 9 to 13 mg/L during this study. Chloride concentrations in production well 4 at Bethany Beach (Qj 32-22) ranged from 12 to 19 mg/L and are shown in figure 35. There is no trend of increasing chloride in the Ocean City aquifer at Bethany Beach. Total yearly pumpage from the aquifer is also shown in figure 35. The increase in pumpage from the aquifer between 1980 and 1984 did not affect chloride concentrations in water from well Qj 32-22. There are no data available to determine if the increased pumpage during 1983 and 1984 has resulted in decreased water levels in the aquifer.

Fenwick Island area

The nearest pumpage from the Ocean City aquifer is at Bethany Beach, 4.6 mi north of Fenwick Island, and at 44th Street, Ocean City, 7 mi to the south.

Water levels in Ocean City aquifer well Rj 22-6 at Fenwick Island are discussed in the Manokin Aquifer section, under the Fenwick Island subheading. Figure 21 shows the close correlation between water levels in wells in the Manokin (Rj 22-5) and Ocean City (Rj 22-6) aquifers.

Chloride concentrations in water from well Rj 22-6 were 21 mg/L when the well was drilled in 1977. Concentrations measured during this study were 14 mg/L in October 1985 and 13 mg/L in February 1986, apparently indicating a slight decrease of chloride concentrations in the aquifer at Fenwick Island.

Maryland

The major user of water from the Ocean City aquifer in Maryland is the town of Ocean City.

Ocean City area

The Ocean City aquifer is pumped at the 44th Street, 15th Street, and South water plants. The 44th Street water plant pumps more water from the Ocean City aquifer than the other water plants.

44th Street water plant.-- Observation well WO Bh-31 in the Ocean City aquifer is located about 100 ft northeast of well WO Bh-28 (production well "A") at the 44th Street water plant (fig. 9). Water levels in the observation well react quickly to pumping of well WO Bh-28, and much more gradually to the pumping of more distant production wells (WO Bh-29, -39, -40, -41, and -81). Water levels measured in well WO Bh-31 remained below sea level from 1970 when the well was drilled, through 1986 (fig. 36). Water-level measurements between 1979 and 1984 were too infrequent to adequately define the seasonal drawdown and recovery cycles; therefore, comparisons should be made between pre-1979 data and 1985-86 data. Late summer water levels in this well have declined from 20 ft below sea level in 1971 to over 40 ft below sea level in 1985-86. This decline in water level correlates with the increased pumpage from the 44th Street area shown in figure 37.

Chloride concentrations in production well "A" (WO Bh-28) increased steadily from 75 mg/L in 1977, to 200 mg/L in 1986 (fig. 37). The cause of the increasing chlorides is probably vertical movement of water from the saltier Manokin aquifer upward through the leaky confining unit to the Ocean City aquifer (see Manokin Aquifer, 44th Street section). The confining unit is probably more permeable near the "A" well because chloride concentrations in the other production wells in the area are not increasing as rapidly as in the "A" well (fig.37). Comparisons between the screen depths of wells and chloride concentrations in this area showed that the depth at which a well is screened in the Ocean City aquifer near 44th Street did not correlate with the chloride concentration in that well. Chloride concentrations increased toward the "A" well, however, regardless of the screen depth.

More water is pumped from the Ocean City aquifer at the 44th Street water plant than at any other location in the study area. Figure 37 shows total yearly pumpage from the aquifer at 44th Street from 1974 through 1986. These data do not reflect the pumpage from the Convention Center at 40th Street prior to 1986 (see Municipal Water Supplies and Pumpage section).

15th Street water plant.-- Water-level data in the Ocean City aquifer south of 44th Street are not available since there are no Ocean City aquifer observation

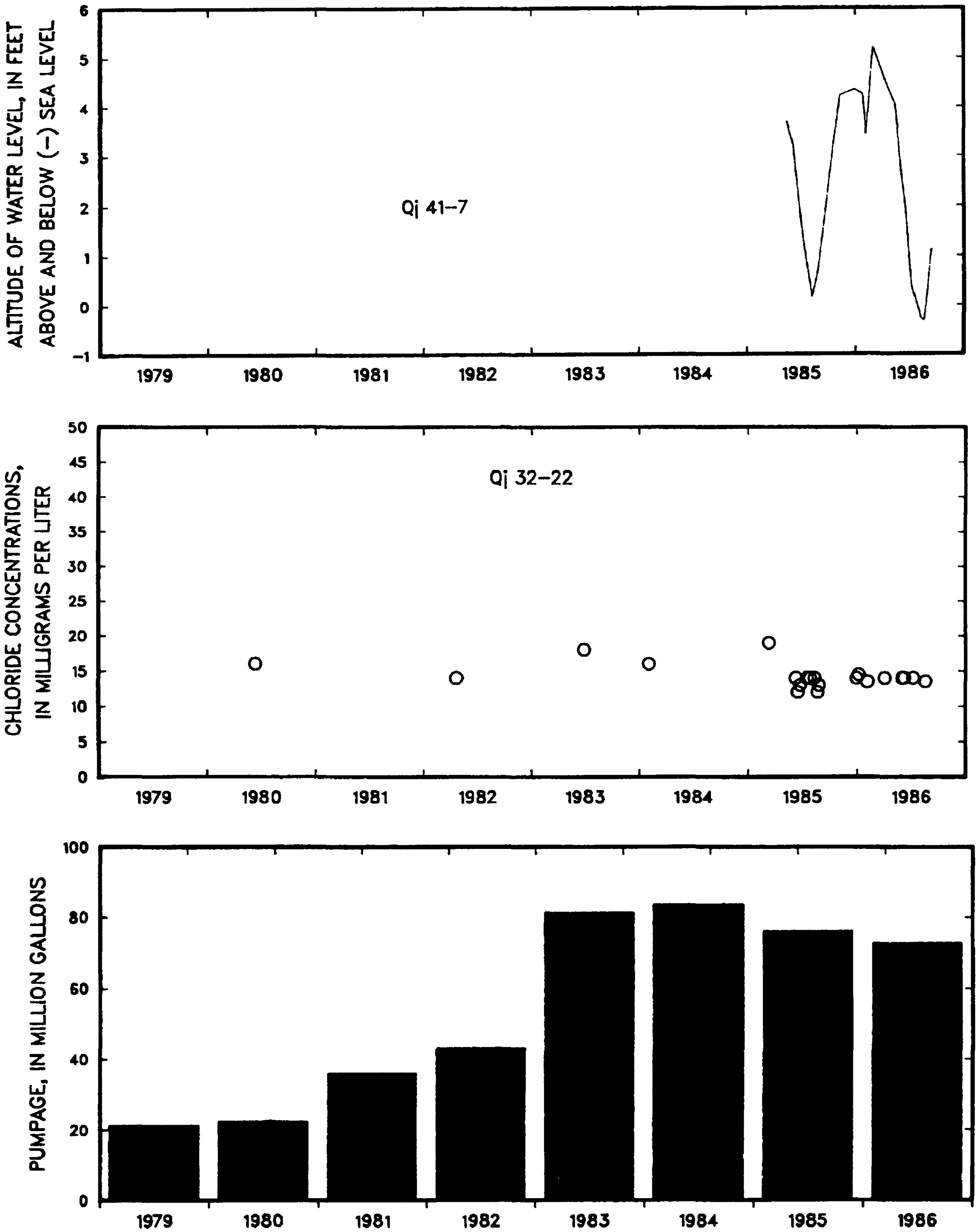


Figure 35.--Water levels, chloride concentrations, and total pumpage from wells in the Ocean City aquifer near Bethany Beach, Delaware, 1979-86.

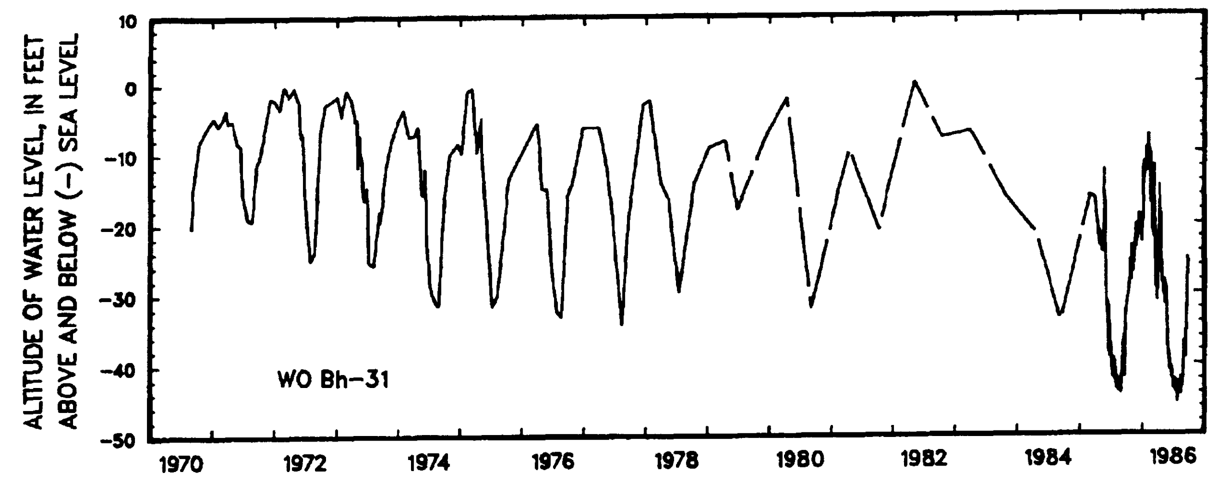


Figure 36.--Water levels in a well in the Ocean City aquifer at 44th Street, Ocean City, Maryland, 1970-86.

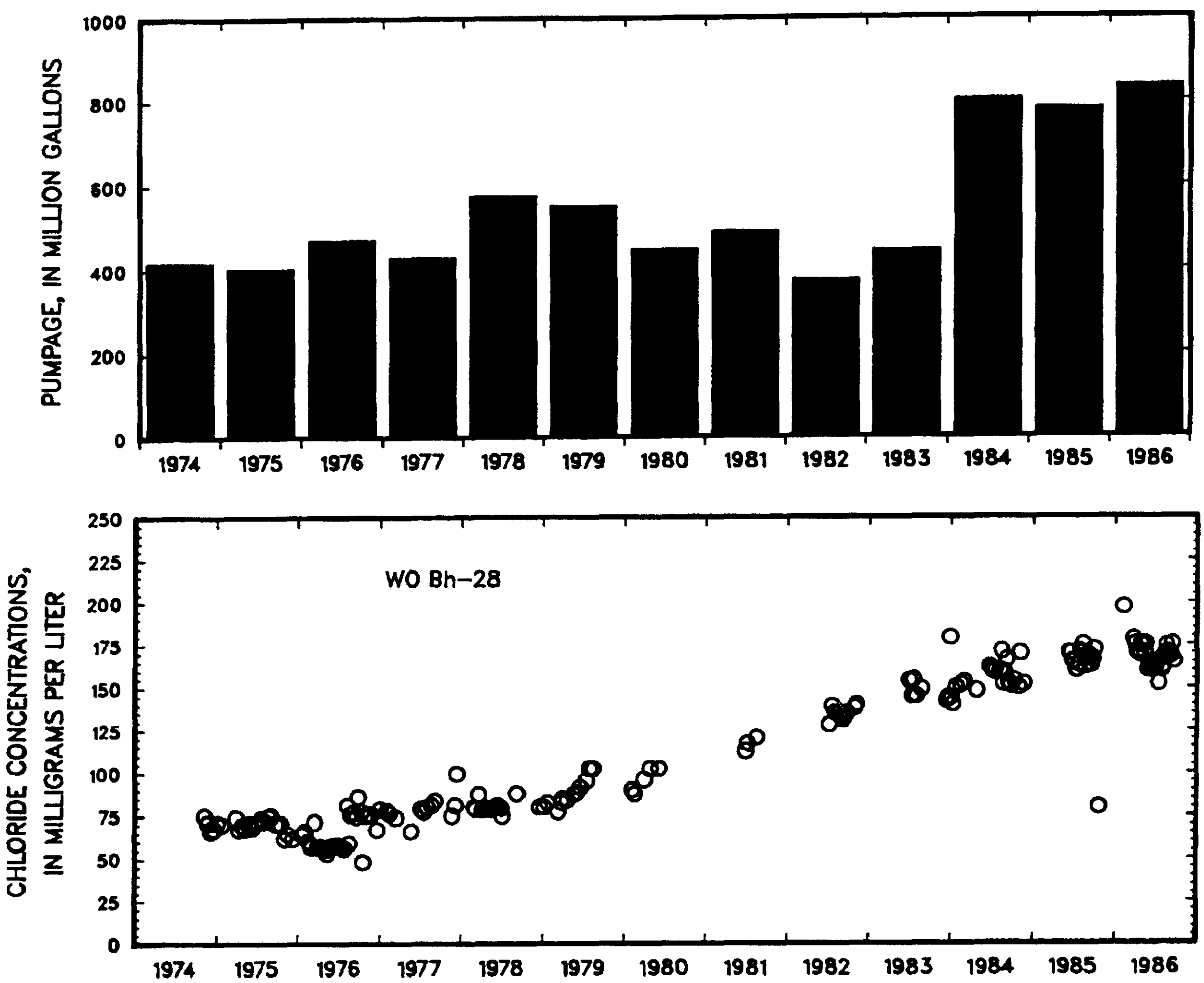
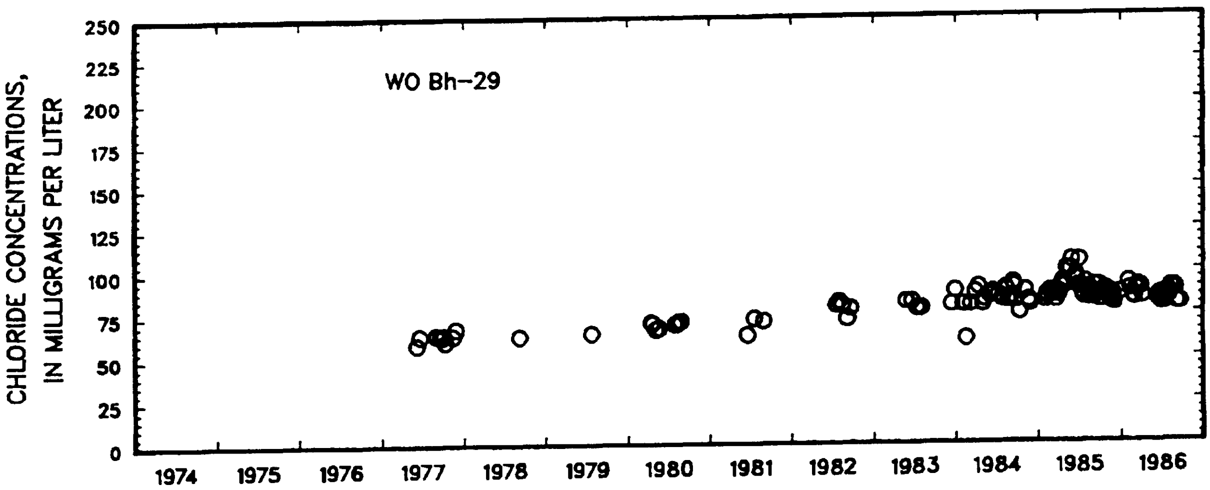
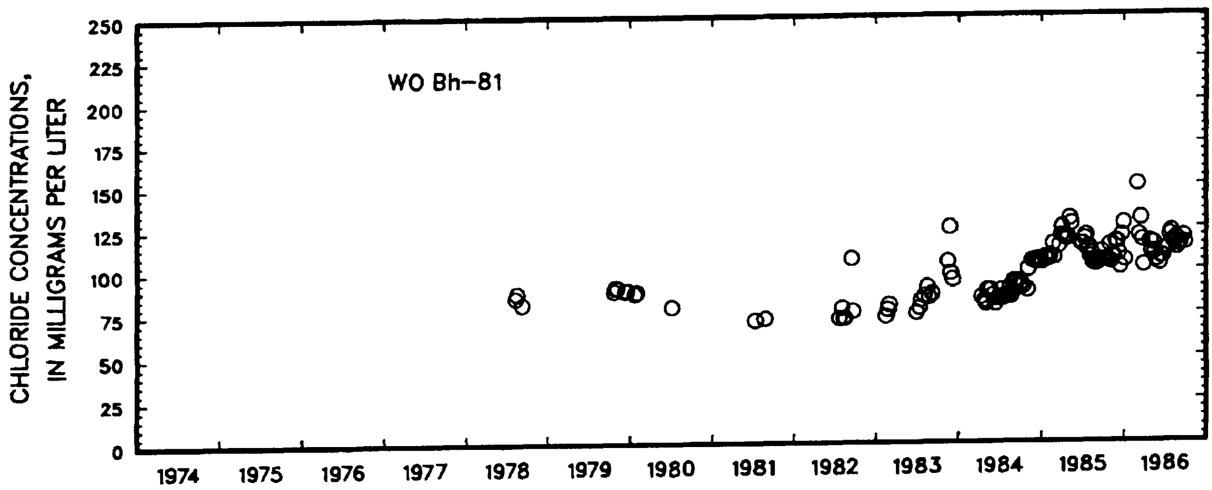


Figure 37.--Total yearly pumpage from the 44th Street water plant, and chloride concentrations in four production wells in the Ocean City aquifer at the water plant, Ocean City, Maryland, 1974-86.





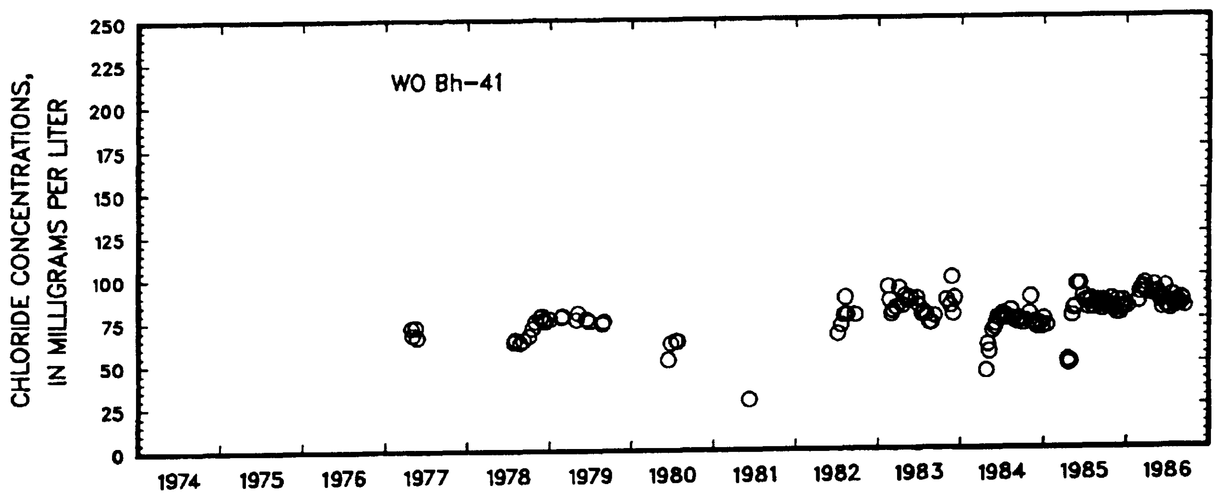


Figure 37.--Total yearly pumpage from the 44th Street water plant, and chloride concentrations in four production wells in the Ocean City aquifer at the water plant, Ocean City, Maryland, 1974-86--Continued.

wells between 44th Street and the Ocean City Inlet at the south end of Ocean City.

Chloride concentrations in the three Ocean City aquifer production wells (WO Bh-26, -27, and -30) at 15th Street ranged from 20 to 54 mg/L and showed a slight increase from 1977, when data were first available, to 1986 (fig. 38). These concentrations were much lower than chloride values in the Ocean City aquifer wells at the 44th Street water plant.

Pumpage from the 15th Street water plant averages about 200 Mgal/yr (million gallons per year) (fig. 38). Most of the pumpage at the plant is from the Ocean City aquifer (see Municipal Water Supply and Pumpage section).

South water plant.-- Chloride concentrations in the three Ocean City aquifer production wells (WO Cg-32, -33, and -34) generally resemble the chloride concentrations measured at 15th Street, 1.3 mi to the north (fig. 39). Chloride concentrations in the three wells ranged from 21 to 59 mg/L. As with the 15th Street wells, chloride concentrations increased slightly after 1977.

The total yearly pumpage shown in figure 39 is the combined Ocean City and Manokin aquifer pumpage. Prior to 1984, 100 percent of the pumpage at the South plant was from the Ocean City aquifer (see Municipal Water Supplies and Pumpage section).

West Ocean City area

Prior to 1986, the Ocean City aquifer in West Ocean City was not used for public water supply, with the possible exception of a few private wells.

Water levels in two observation wells in the Ocean City aquifer (WO Bg-49 and WO Cg-69) are shown in figure 40. These wells are 1.3 mi apart (pl. 2) and reflected the same spring high water levels. Well WO Bg-49 is closer to the 44th Street water plant than well WO Cg-69 and therefore summer drawdowns were usually between 1 and 3 ft greater in well WO Bg-49 than WO Cg-69, presumably because of this location difference.

Chloride concentrations in water from well WO Cg-69 ranged from 12 to 19 mg/L in 1985 and 1986. No values prior to 1985 are available for comparison. Chloride concentrations in water from well WO Bg-49 during 1985 ranged from 12 to 16 mg/L, compared to 17 mg/L measured in 1975.

Isle of Wight area

The nearest pumpage from the Ocean City aquifer is from the 44th Street water plant, 2.5 mi southeast of the Isle of Wight.

Water levels in the Ocean City aquifer at the Isle of Wight were discussed previously in the Manokin Aquifer section. Figure 30 shows the water-level data from observation well WO Bg-47.

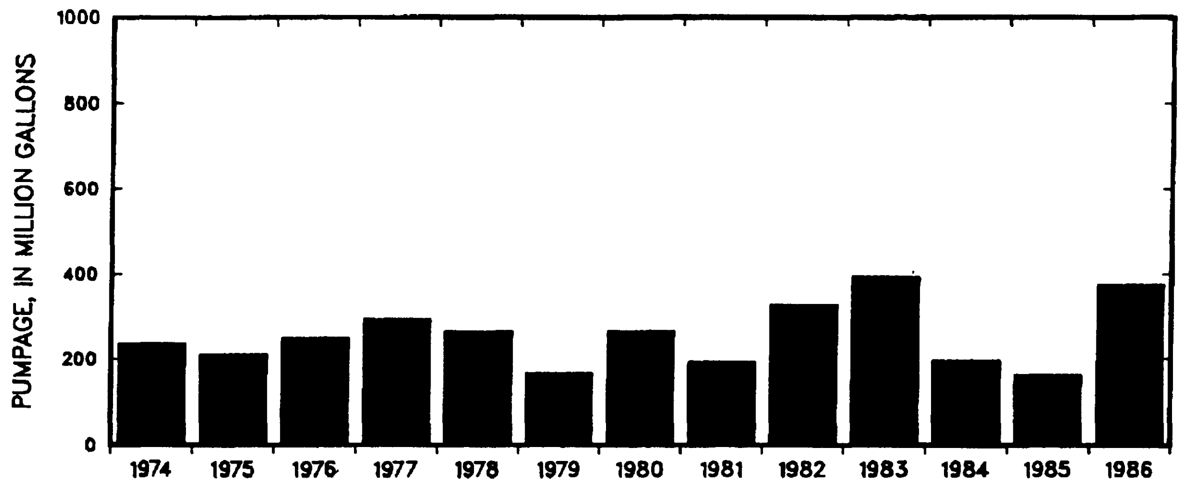


Figure 38.--Total yearly pumpage from the 15th Street water plant, and chloride concentrations in three production wells in the Ocean City aquifer at the water plant, Ocean City, Maryland, 1974-86.

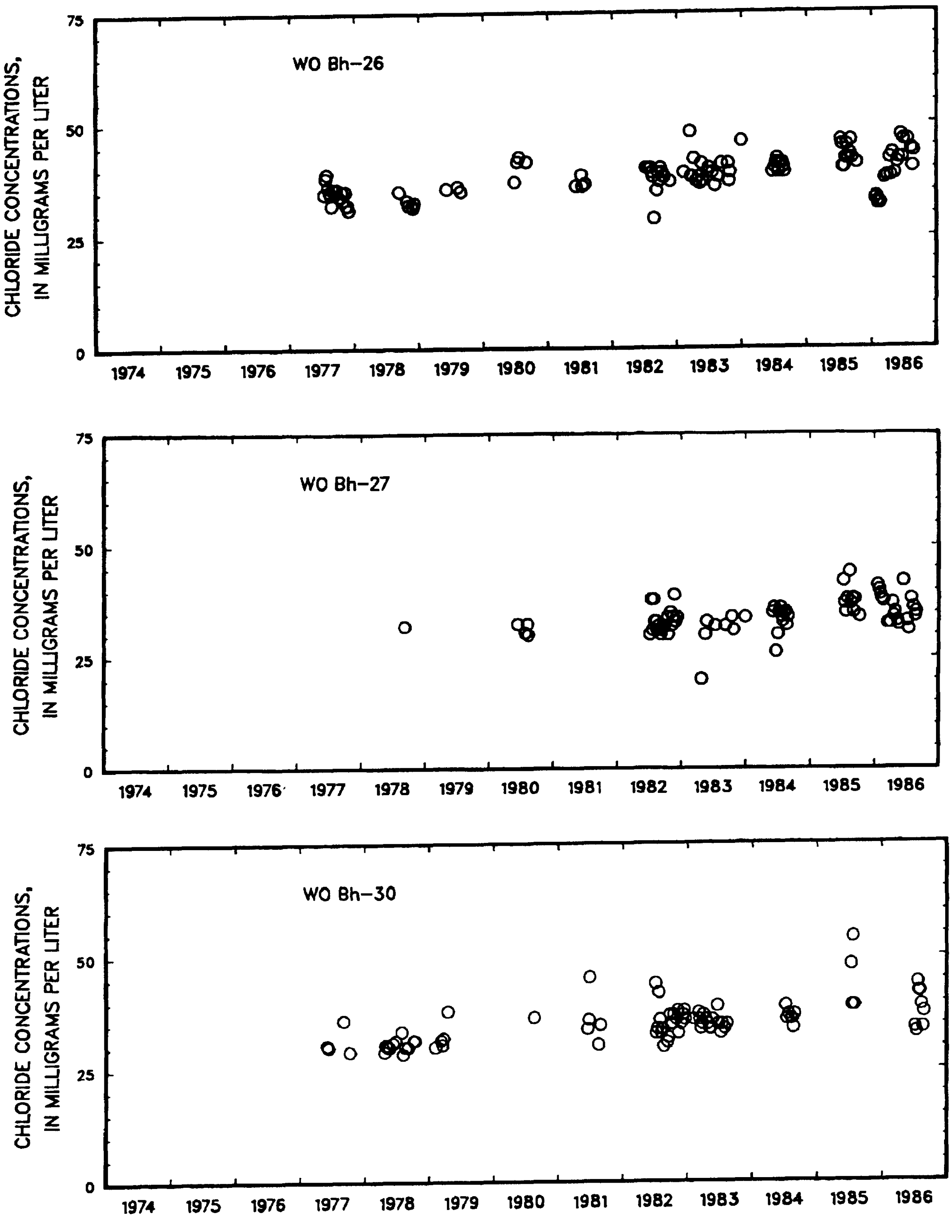


Figure 38.--Total yearly pumpage from the 15th Street water plant, and chloride concentrations in three production wells in the Ocean City aquifer at the water plant, Ocean City, Maryland, 1974-86--Continued.

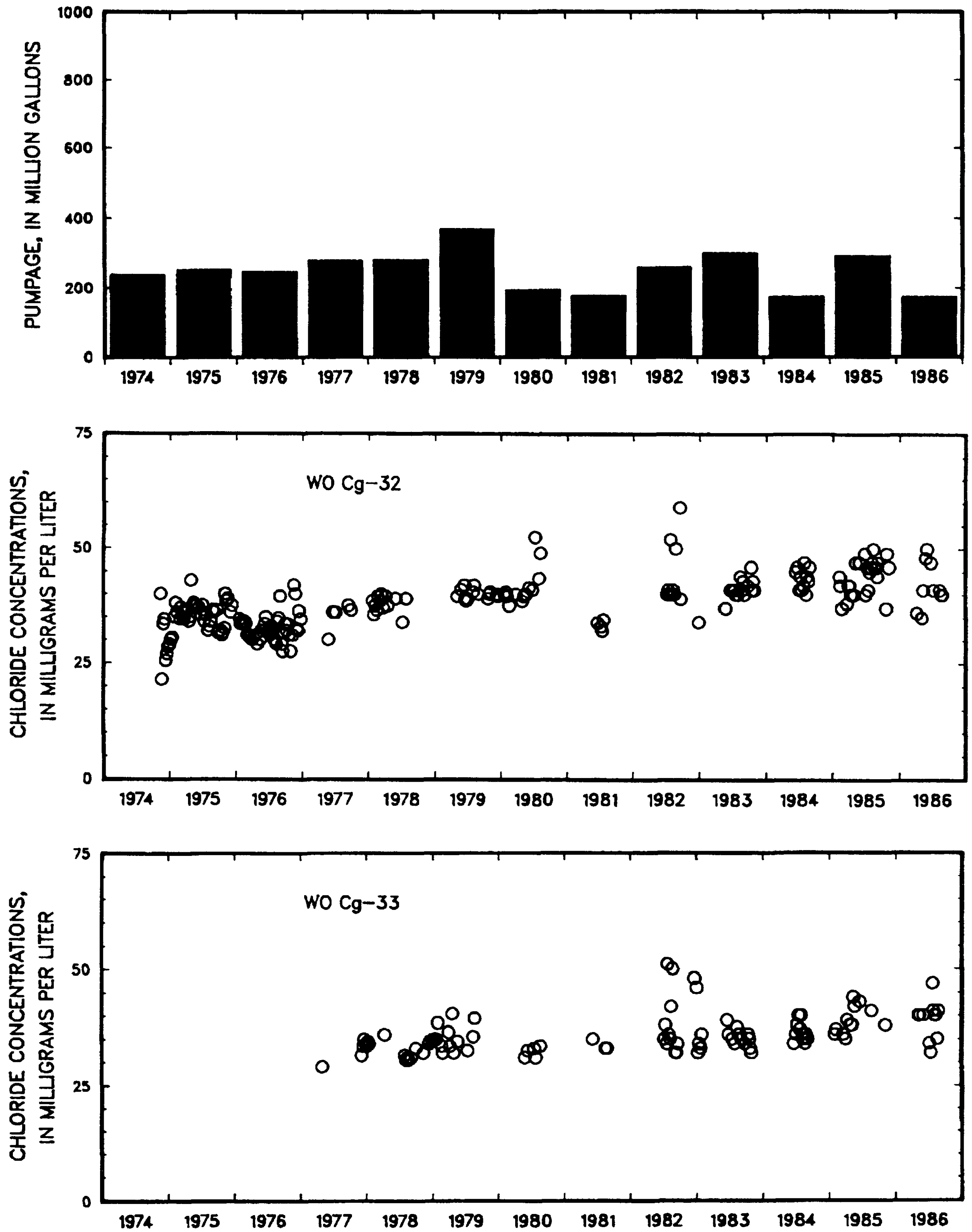


Figure 39.--Total yearly pumpage from the South water plant, and chloride concentrations in three production wells in the Ocean City aquifer in south Ocean City, Maryland, 1974-86.

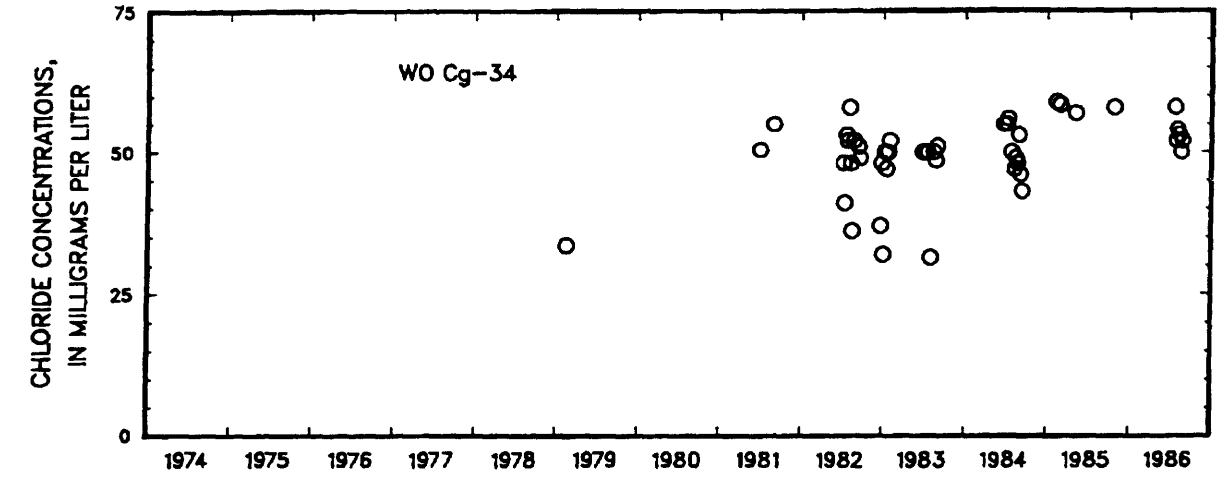


Figure 39.--Total yearly pumpage from the South water plant, and chloride concentrations in three production wells in the Ocean City aquifer in south Ocean City, Maryland, 1974-86--Continued.

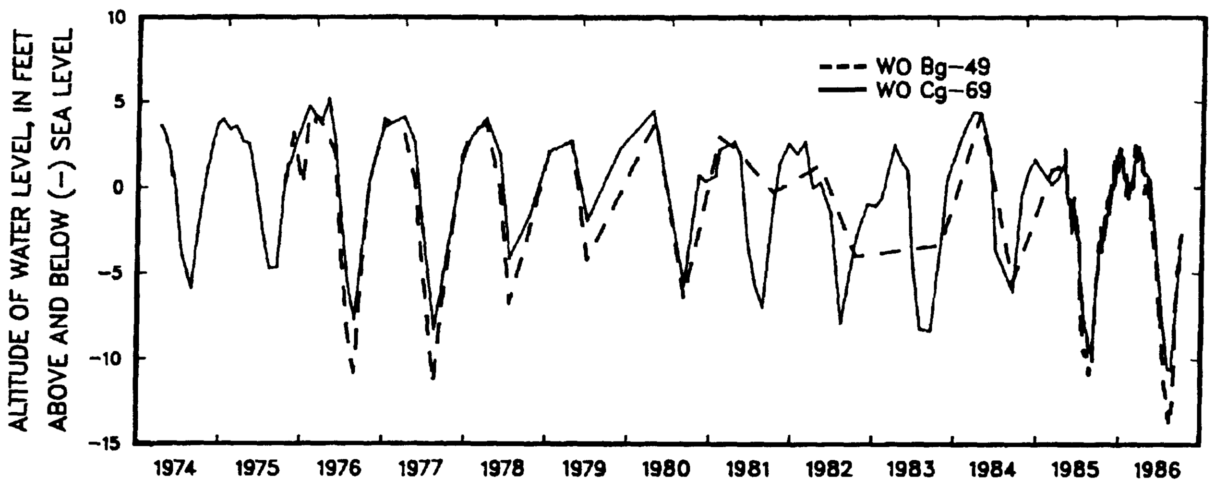


Figure 40.--Water levels in two wells in the Ocean City aquifer in West Ocean City, Maryland, 1974-86.

Chloride concentrations in the Ocean City aquifer at the Isle of Wight (observation well WO Bg-47) ranged from 49 to 53 mg/L during 1985-86. The only other chloride measurement available (1976) for this well was 68 mg/L. Chloride concentrations in the Ocean City aquifer may have decreased in this area because of movement of fresher ground water from inland toward the Ocean City well fields.

Whaleysville area

There are no production wells in the Ocean City aquifer in the Whaleysville area. Water levels in observation well WO Ae-24 are shown in figure 31 and were discussed previously in the Manokin Aquifer section.

Chloride concentrations in water from well WO Ae-24 ranged from 6 to 11 mg/L; no change occurred from 1975 to 1986. These values are background concentrations for the aquifer.

Pocomoke Aquifer

Chloride concentrations measured during this study in the Pocomoke aquifer range from 5 mg/L at Whaleysville (well WO Ah-25) to 46 mg/L at 44th Street in Ocean City (well WO Bh-85).

Delaware

Major users of the Pocomoke aquifer in coastal Delaware are the city of Lewes, Fenwick Island, and the Sussex Shores Water Company north of Bethany Beach. Lewes and Sussex Shores have municipal water systems, but Fenwick Island depends entirely on privately owned domestic and public supply wells for water.

Lewes area

Water levels from observation well Ni 51-30 in the Pocomoke aquifer at the Lewes well field are shown in figure 41. Extreme low water levels at Ni 51-30 occurred when nearby (about 120 ft away) production wells 4 and 5 (Ni 51-31 and -32) were in use. Water levels in observation wells Ni 52-11 and 42-15 show that heads in the aquifer nearer the coast are well above sea level year-round, reducing the threat of saltwater intrusion toward, or caused by the Lewes well field.

Chloride concentrations in the Pocomoke aquifer at the Lewes well field ranged from 14 to 23 mg/L during 1985 and 1986. Figure 42 shows chloride concentrations in production well 4 (Ni 51-31), about 200 ft from observation well Ni 51-30.

Pumpage data for Lewes are given in table 1, and figure 3 shows total monthly pumpage for 1985.

Angola area

The nearest major pumpage from the Pocomoke aquifer is at Lewes, 5.5 mi northeast of Angola. Since there is no confining unit between the Pocomoke and unconfined aquifers in this area, local pumping from the unconfined aquifer probably affects water levels in the Pocomoke aquifer.

Water levels in the Pocomoke aquifer near Angola (well Oh 54-2) are shown in figure 14, along with water levels in the Manokin aquifer. Water levels in the Pocomoke aquifer are lower than those in the underlying Manokin aquifer, indicating ground-water flow is probably from the underlying Manokin and Ocean City aquifers as well as from the overlying unconfined aquifer to the Pocomoke aquifer.

Water-level data from 1980 to 1984 are too incomplete to define changes during that period. Water levels in 1985-86 showed much less of a seasonal water-level variation than from 1977 to 1979, and a decline of 2 to 3 ft from 1977 to 1986. Pumpage from the unconfined aquifer in the area has increased since 1979, possibly reducing recharge to the Pocomoke aquifer, and the decrease in precipitation in 1986 also caused lower water levels than normal.

Chloride concentrations in the Pocomoke aquifer near Angola ranged from 7.1 to 9 mg/L in eight samples collected from 1977 to 1986, indicating no change in chloride concentrations in the aquifer during that time.

Indian River Inlet area

Water levels in the Pocomoke aquifer were measured by DGS in the Indian River Inlet area during nonpumping periods from production wells Pj 41-4 at the Indian River Inlet Marina, and Pj 51-5 at Quillens Point (Tally and Andres, 1987, p. 33-34). Water-level altitudes in Pj 41-4 remained between 4 and 7 ft above sea level in 1985-86. Altitudes in Pj 51-5 ranged from 0 to 3 ft below sea level during the same period.

Water samples were taken frequently from the same two production wells for chloride analysis. Chloride concentrations ranged between 25 and 32 mg/L in well Pj 51-5, and between 39 and 49 mg/L in well Pj 41-4. Figure 43 shows chloride concentrations in both wells for 1985-86. There are several small users of water from the Pocomoke aquifer in the area, but none are required to report pumpage to the DNREC.

Omar area

The nearest pumpage from the Pocomoke aquifer is at Frankford, 2.5 mi west of Omar.

Observation wells Qh 54-6 and -7 are located 1.4 mi southeast of Omar (pls. 3 and 4) and are screened in the Pocomoke and unconfined aquifers, respectively (see Manokin Aquifer section, Omar Area). Water levels from these wells are shown in figure 44. The nearly identical water levels in wells in the two aquifers indicate a permeable or ineffective confining unit in this area, and negligible net vertical ground-water movement between the two aquifers.

Analysis of eight water samples taken from well Qh 54-5 between 1978 and 1986 showed a chloride concentration range of 10 to 15 mg/L, with no apparent increase during that time.

Bethany Beach area

Water levels in the Pocomoke aquifer in the Bethany Beach area were measured in observation well Qj 41-8 at Sea Colony, Del. Water levels in well Qj 41-8 remained above sea level during 1985-86, and in the spring, rose to, or slightly above, land surface (6.67 ft above sea level) (fig. 45). Water levels for 1985-86 are

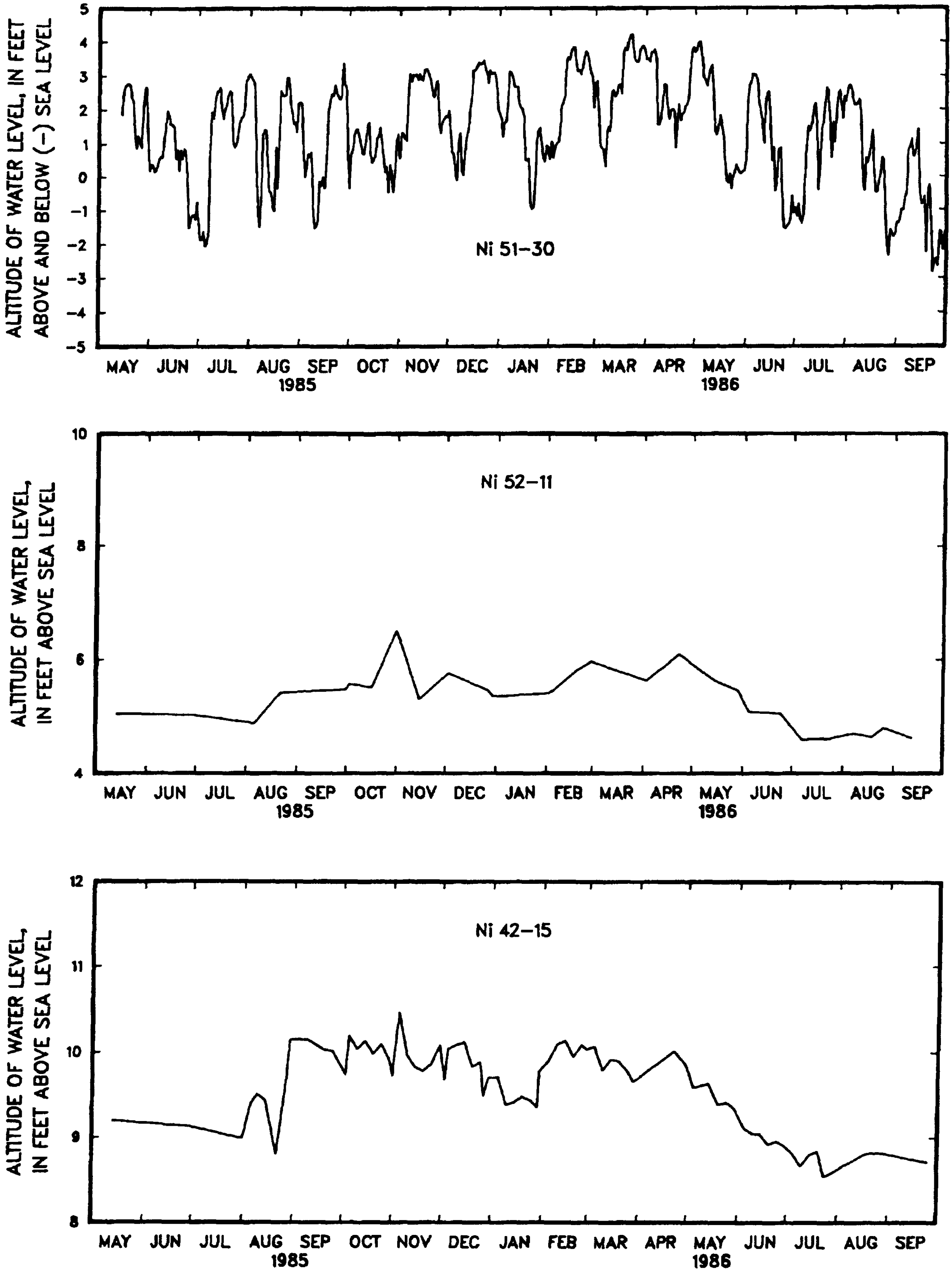


Figure 41.--Water levels in three wells in the Pocomoke aquifer at Lewes, Delaware, May 1985 to September 1986.

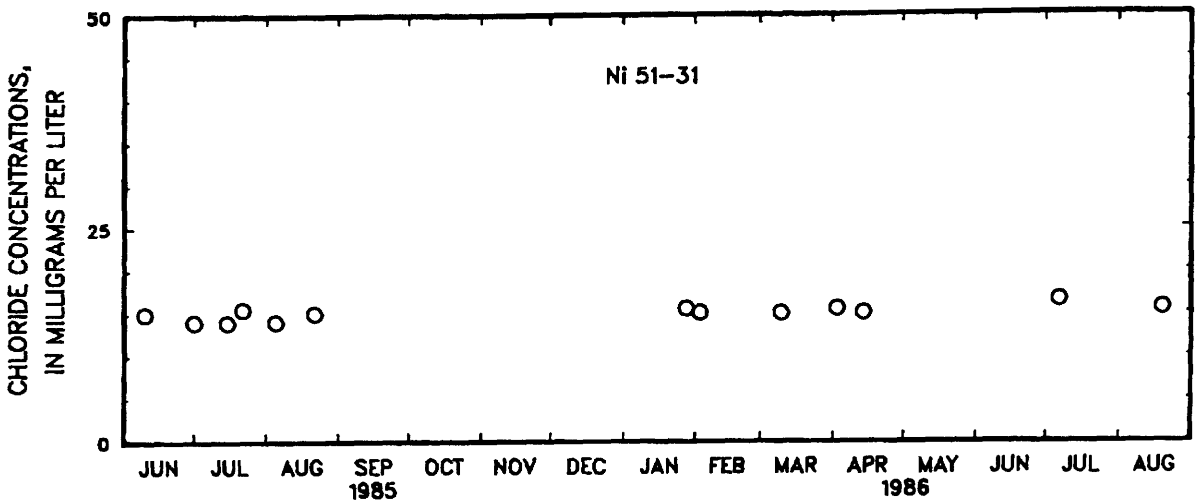


Figure 42.--Chloride concentrations in water from a well in the Pocomoke aquifer at Lewes, Delaware, June 1985 to August 1986.

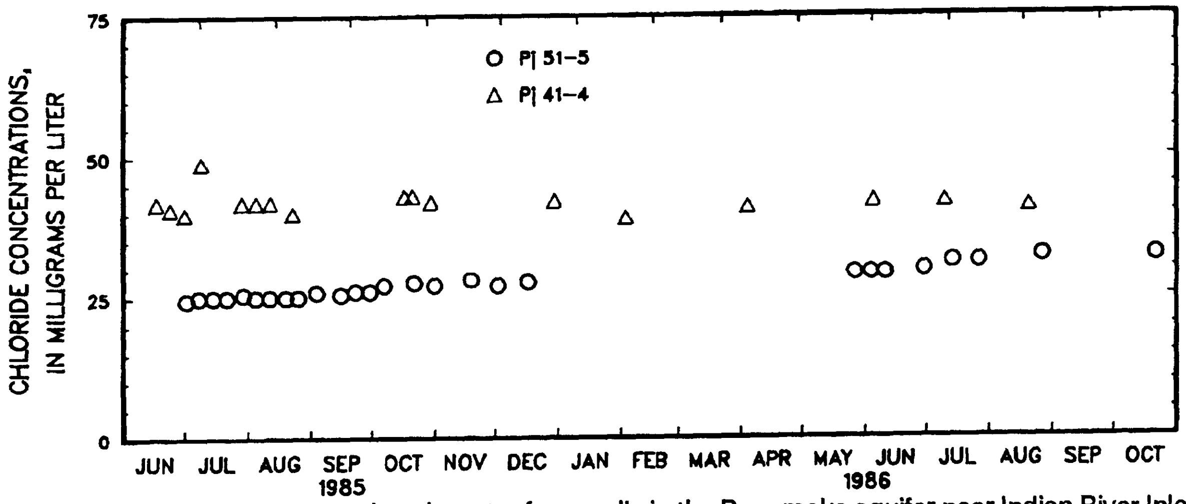


Figure 43.--Chloride concentrations in water from wells in the Pocomoke aquifer near Indian River Inlet, Delaware, June 1985 to October 1986.

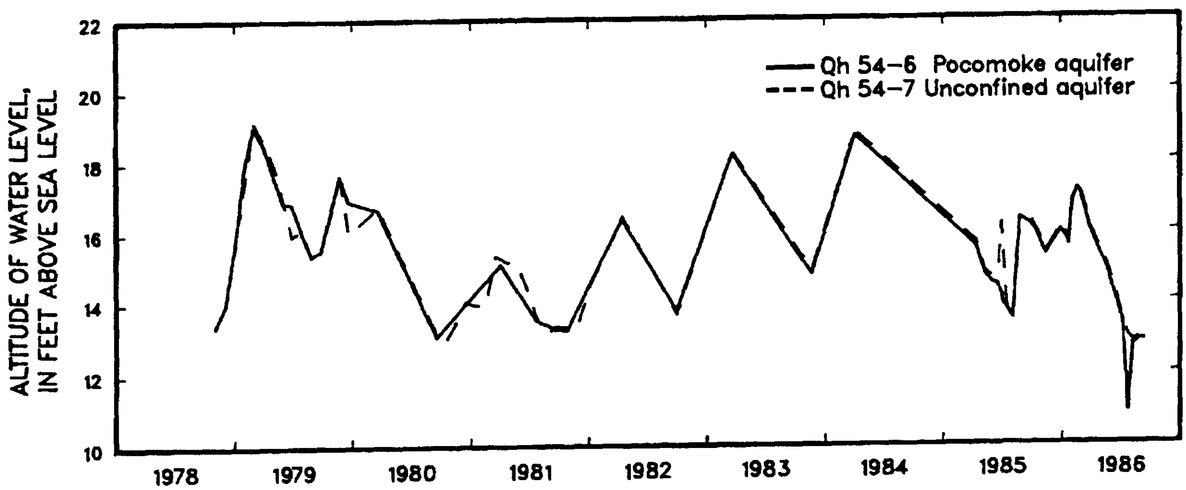


Figure 44.--Water levels in wells in the Pocomoke and unconfined aquifers near Omar, Delaware, 1978-86.

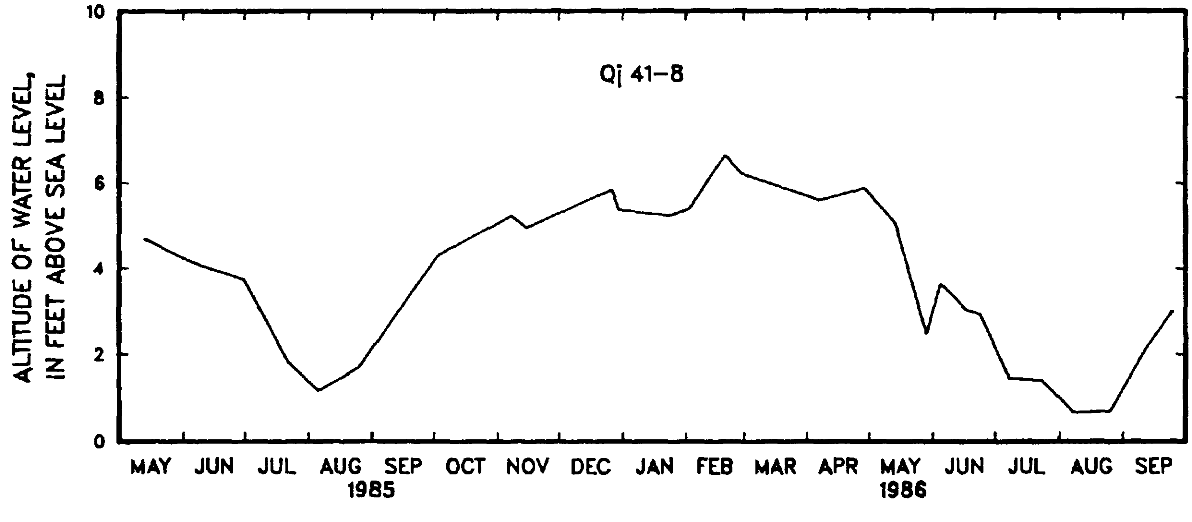


Figure 45.--Water levels in a well in the Pocomoke aquifer near Bethany Beach, Delaware, May 1985 to September 1986.

shown in figure 45. Chloride concentrations in water from well Qj 41-8 ranged from 12 to 13 mg/L in five samples collected during 1986.

Sussex Shores Water Company, 1.8 mi north of Bethany Beach, uses the Pocomoke aquifer as its source of water. Total yearly pumpage figures from Sussex Shores and chloride concentrations from production well 1 (Qj 22-1) are shown in figure 46. There have been no indications of increased chloride concentrations in the aquifer in this area since 1983.

Fenwick Island area

Fenwick Island does not have a municipal water-supply system. Most wells are screened in the Pocomoke aquifer, between 200 and 220 ft below land surface.

Water levels in the Pocomoke aquifer were measured in wells Rj 22-9 and -7 (pl. 3). Mean daily water levels from well Rj 22-9 are shown in figure 47. Periodic water-level measurements in wells Rj 22-7 and -8 in the Pocomoke and unconfined aquifers, respectively, are shown in figure 48.

Consistent differences between water levels in Rj 22-7 and -8 are not apparent. Neither aquifer seems to have a higher or lower average head than the other. Water levels in the Pocomoke aquifer were above sea level for about 9 months of each year, based on water-level data from Rj 22-7 and -9 for 1985-86.

Two water samples from a 220-ft deep well in the Pocomoke aquifer (1,000 ft south of Rj 22-7) had chloride concentrations of 20 and 14 mg/L in December 1985 and April 1986, respectively. Chloride analyses from untreated private wells in Fenwick Island were not available.

Chloride concentrations in water from a production well in the Pocomoke aquifer (Rj 31-7) at the Cape Windsor mobile home community, 1.2 mi west of Fenwick Island, are shown in figure 49. Chloride concentrations in water from well Rj 31-7 averaged 14 mg/L, with no apparent seasonal variation.

Estimates of pumpage from the Pocomoke aquifer for the Fenwick Island area were not available.

Frankford area

Water levels in well Qh 41-11 in the Pocomoke aquifer at Frankford are shown in figure 34. Even though Frankford uses the Pocomoke aquifer for water supply, water levels in this aquifer were higher than those in the Ocean City aquifer. This indicates that the Pocomoke aquifer recharges the Ocean City aquifer in this area.

Chloride concentrations from the Pocomoke aquifer at Frankford ranged from 13 to 30 mg/L from 1983 to 1986, according to Delaware Division of Public Health records. Yearly pumpage at Frankford is given in table 1.

Maryland

Major users of water from the Pocomoke aquifer in the Maryland part of the study area include Chesapeake Foods and Ross-Beatrice in Berlin, and the White Marlin Mall in West Ocean City, which began

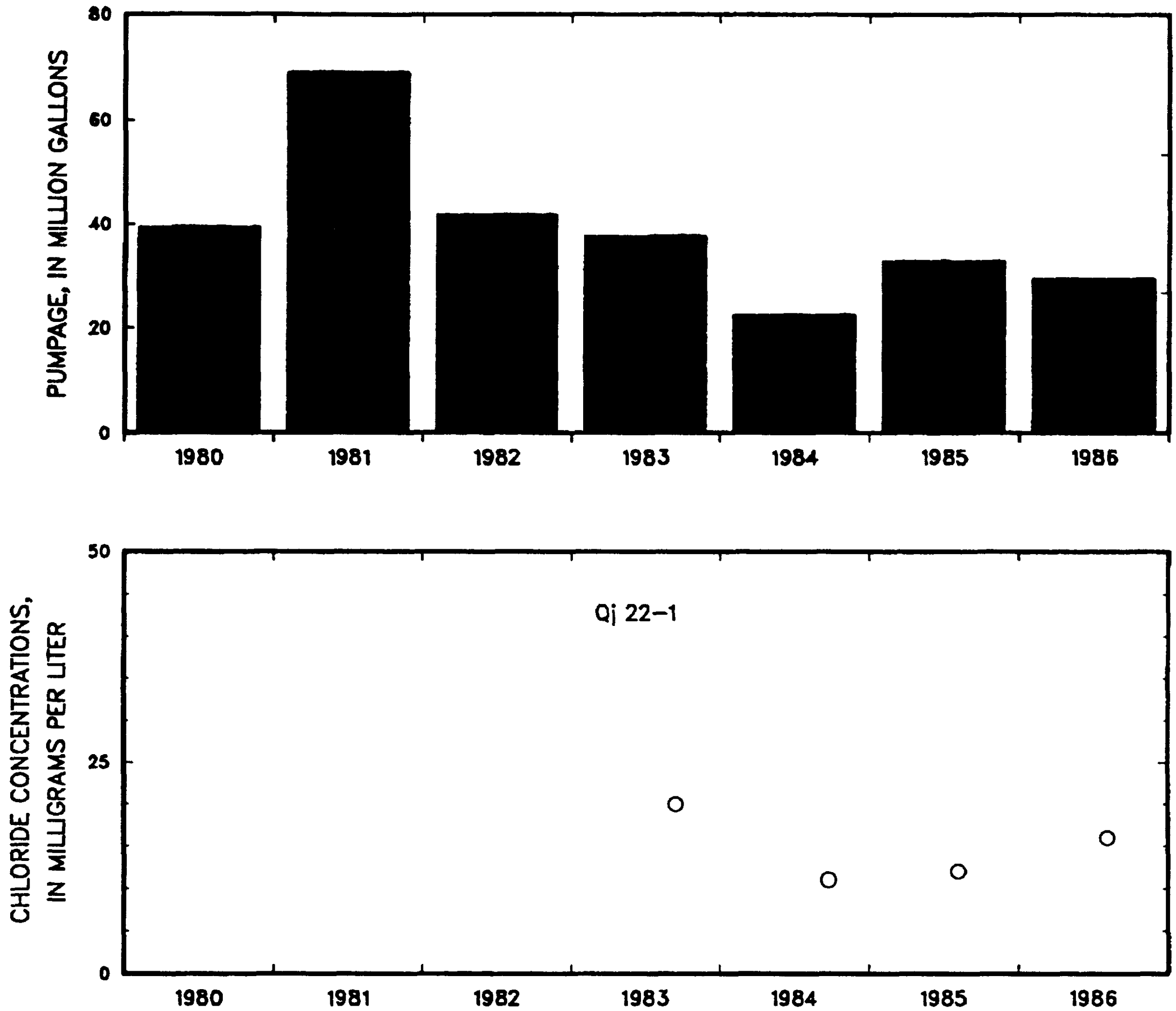


Figure 46.--Total yearly pumpage and chloride concentrations in water from a well in the Pocomoke aquifer at Sussex Shores, Delaware, 1980-86.

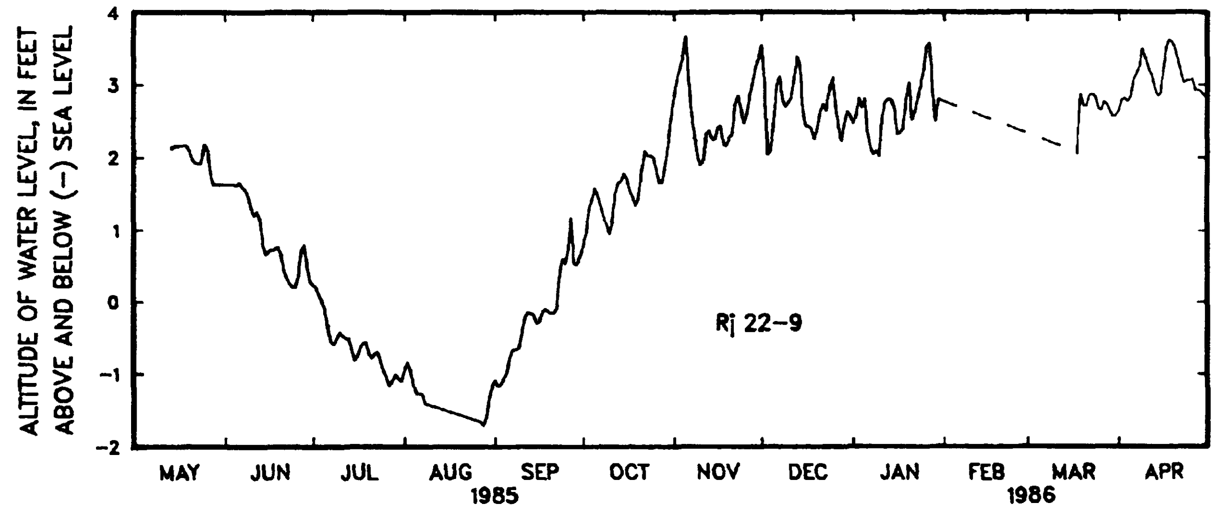


Figure 47.--Mean daily water levels in a well in the Pocomoke aquifer at Fenwick Island, Delaware, May 1985 to April 1986.

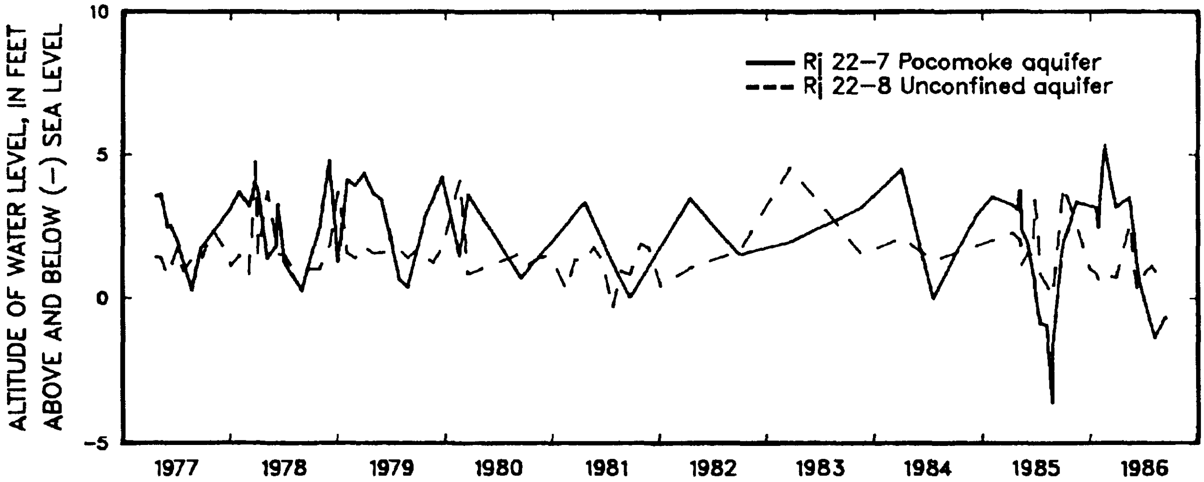


Figure 48.--Water levels in wells in the Pocomoke and unconfined aquifers at Fenwick Island, Delaware, 1977-86.

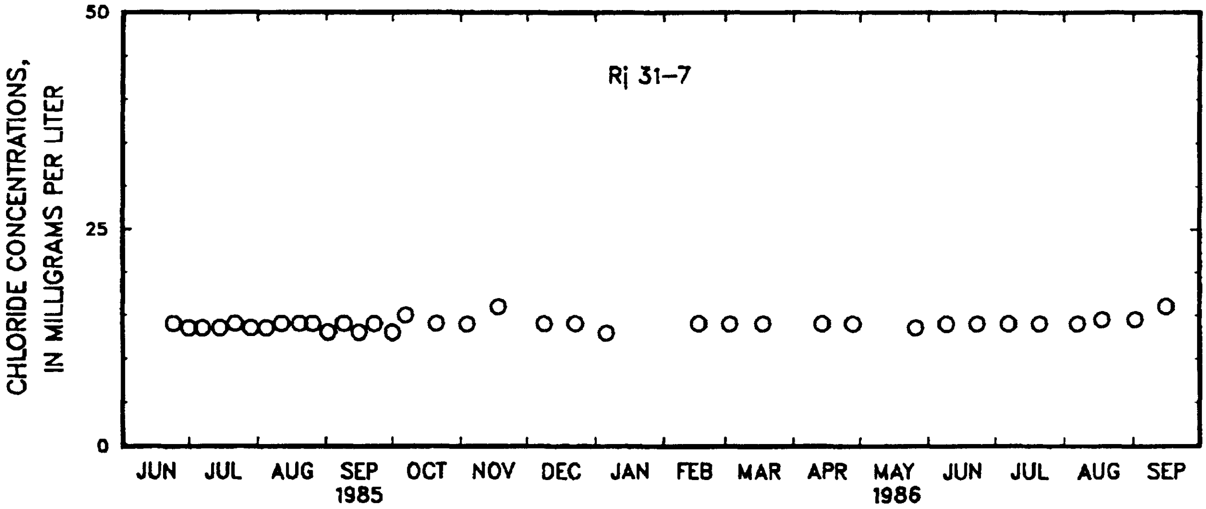


Figure 49.--Chloride concentrations in water from a well in the Pocomoke aquifer west of Fenwick Island, Delaware, June 1985 to September 1986.

operations in 1986. Several private wells use the aquifer, but data on water quality and pumpage in the coastal areas of Maryland are not available.

Ocean City area

Water-level variations in observation wells in the Pocomoke and unconfined aquifers at 44th Street in Ocean City are shown in figure 50. Well WO Bh-85 in the Pocomoke aquifer (pl. 3) showed a higher yearly variation in water level than well WO Bh-84 in the unconfined aquifer, but did not show a decreasing trend in water levels. Extreme low water levels in 1986 were probably caused by the drought that year, rather than by pumping.

Chloride concentrations in water from well WO Bh-85 did not change between 1973 and 1986. Concentrations ranged from 43 to 46 mg/L in 1985-86, compared to the original measurement of 46 mg/L on April 20, 1973.

Ocean Pines area

Water levels in the Pocomoke and unconfined aquifers (WO Bg-46 and -45, respectively) at Ocean Pines from 1970 to 1986 are shown in figure 51. Water levels were higher in the Pocomoke than in the unconfined aquifer at Ocean Pines, indicating potential recharge to the unconfined from the Pocomoke aquifer, or drawdown in the unconfined aquifer due to

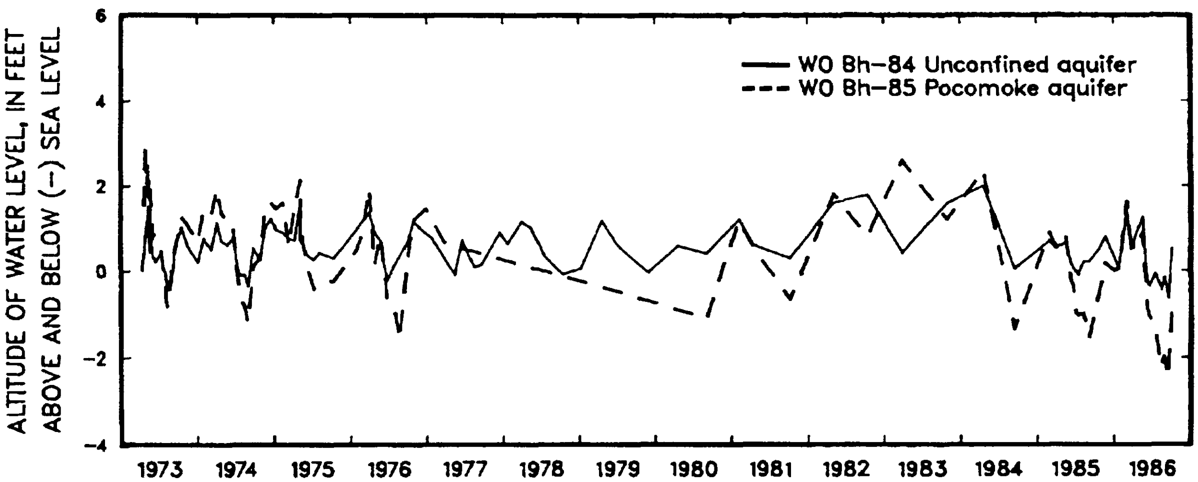


Figure 50.--Water levels in wells in the Pocomoke and unconfined aquifers at 44th Street in Ocean City, Maryland, 1973-86.

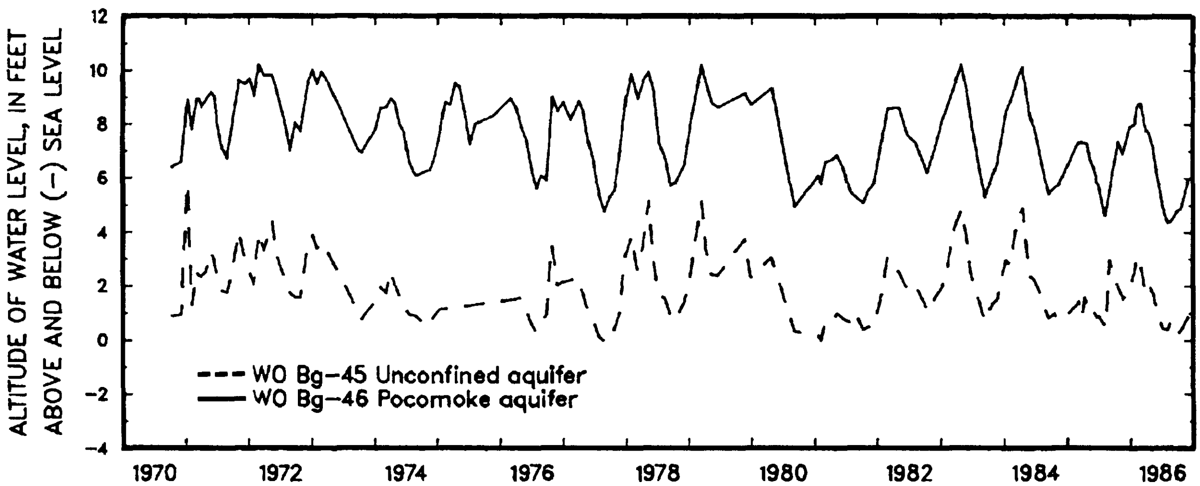


Figure 51.--Water levels in wells in the Pocomoke and unconfined aquifers at Ocean Pines, Maryland, 1970-86.

pumpage, or both. Water levels in WO Bg-46 declined slightly in 1985-86. This was probably due to a decrease in total annual rainfall from 1983 to 1986 (fig. 15), rather than from any increase in pumpage in the area.

Chloride data prior to 1985 for well WO Bg-46 were not available. Chloride concentrations ranged between 6 and 10 mg/L in five samples taken in 1986.

Whaleysville area

Water levels in well WO Ae-25 in the Pocomoke aquifer near Whaleysville are discussed in the Manokin Aquifer section and are shown in figure 31. Chloride concentrations did not increase in observation well WO Ae-25 between 1975 and 1986, and ranged from 8.5 to 12 mg/L. There are no major production wells in the Pocomoke aquifer in the area. Iron concentrations of 13 to 14 mg/L in well WO Ae-25 were particularly high, and any use of the aquifer in this area for water supply would require water treatment systems. The Maryland Department of Health's recommended drinking water limit for dissolved iron is 0.3 mg/L.

Unconfined Aquifer

Chloride concentrations in the unconfined aquifer vary widely in areas along the coast and inland bays. At some locations, freshwater lies only a few feet above unusable, saltier water. Detailed analysis of chloride concentrations in all areas of the unconfined aquifer is beyond the scope of this study. However, water-level and chloride-concentration data were collected where municipal supplies use the unconfined aquifer along the coast, and where observation wells were available.

Chloride concentrations measured in the unconfined aquifer during this study ranged from 11.5 mg/L at Omar, Del. (well Qh 54-7), to 46 mg/L at 44th Street in Ocean City, Md. (well WO Bh-84).

Delaware

Major users of water from the unconfined aquifer in coastal Delaware include Rehoboth Beach, Millsboro, and Delmarva Power and Light near Millsboro, as well as many commercial, residential, agricultural, and irrigation users throughout the study area. South Bethany is supplied by individual private wells in the unconfined and Pocomoke aquifers.

Lewes area

Pumpage from the Pocomoke aquifer affects water levels in the unconfined aquifer because of the lack of a confining unit in the subcrop area. The amount of water actually removed from the unconfined aquifer as compared to the Pocomoke aquifer at the Lewes well field is unknown. The two formations act as one hydrologic unit near Lewes.

Water levels in observation well Ni 52-12 in the unconfined aquifer at Lewes are shown in figure 52. This well is located about halfway between the Lewes well field and the Lewes-Rehoboth Canal (pl. 4). Water levels remained at least 4 ft above sea level during this study (1985-86). All older observation wells had been destroyed prior to this study, so comparisons with long-term data were not possible.

Chloride concentrations in water from well Ni 52-12 ranged from 23 to 25 mg/L during this study. These values closely resemble chloride concentrations in the Pocomoke aquifer at Lewes. This would be expected because the Pocomoke aquifer subcrops the unconfined aquifer in this area, and the aquifers are hydraulically connected.

Rasmussen and others (1960, p. 103) documented a case of saltwater intrusion into the unconfined aquifer at Lewes near well Ni 42-15 (pl. 3). In 1944, chloride concentrations increased to 1,420 mg/L in water from one production well (Ni 42-11) near the canal. The town then drilled new production wells farther inland and chloride concentrations began to decline in the older production wells as pumpage from the older wells ceased.

Rehoboth Beach area

Water levels in the unconfined aquifer near Rehoboth Beach were available from only one observation well (Oi 23-13), which is about 40 ft from Rehoboth's production well 7 (pl. 4). Levels in the observation well fluctuated rapidly in response to pumping and recovered to about 3 ft above sea level (19 ft below land surface) in the non-summer months (fig. 53). Data for other areas in the unconfined aquifer near Rehoboth Beach were not available, and well Oi 23-13 is not representative of the whole area because it is too close to a production well. The lack of long-term water-level data does not allow assumptions to be made as to whether water levels have declined in the area.

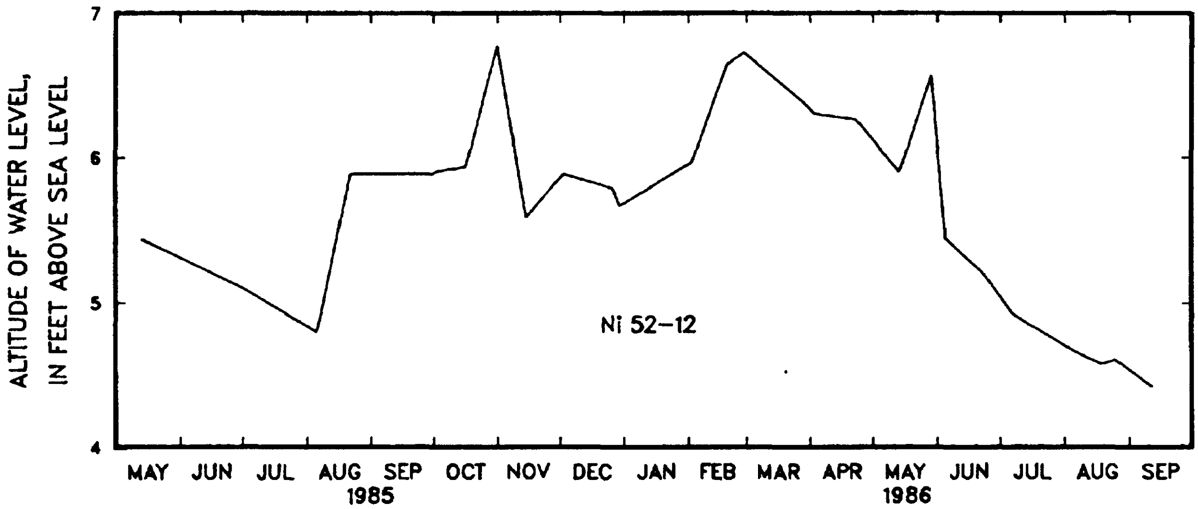


Figure 52.--Water levels in a well in the unconfined aquifer at Lewes, Delaware, May 1985 to September 1986.

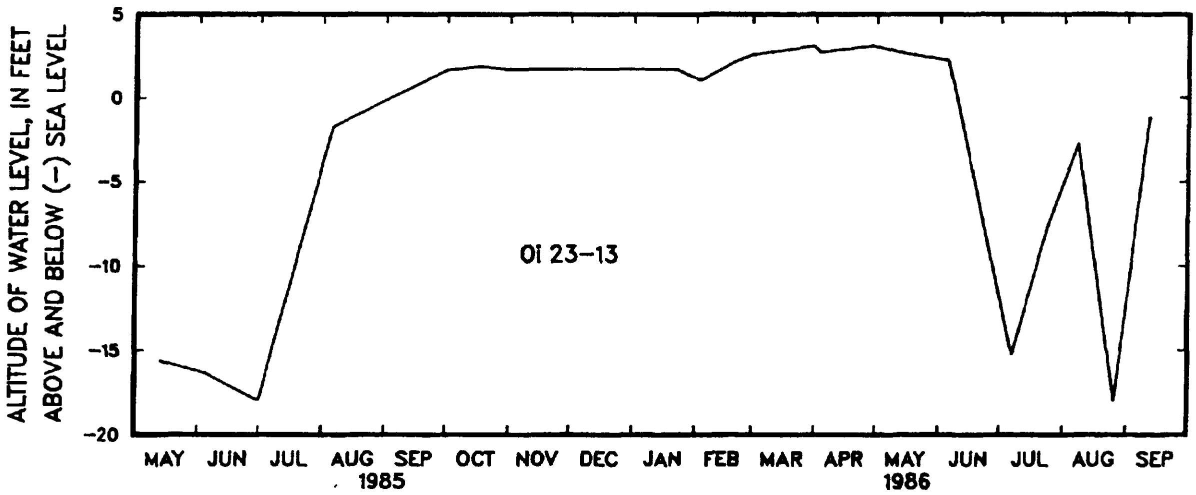


Figure 53.--Water levels in a well in the unconfined aquifer near Rehoboth Beach, Delaware, May 1985 to September 1986.

Figure 54 shows total yearly pumpage from Rehoboth Beach and chloride concentrations from production well 1 (Oi 34-1) from 1979 to 1986. Chloride concentrations in water from well Oi 34-1 showed no significant increase since the well was first measured in 1956. The chloride concentration in 1956 was 14 mg/L (Rasmussen and others, 1960, p. 79) compared to the range of 15 to 20 mg/L measured between 1979 and 1986. Results of chloride measurements indicate the well field appears to be far enough inland so that saltwater intrusion is not a problem.

Water use by the city of Rehoboth Beach has increased fairly steadily since 1979, when pumpage records were first reported to the DNREC, through 1986. As pumpage has increased, chloride concentrations have remained essentially the same in all of the production wells.

Millsboro area

Water levels in the unconfined aquifer near Millsboro were not available for this study. Chloride concentrations in water from Millsboro's production well 2 (Pg 53-12) in the unconfined aquifer are shown in figure 55. Concentrations ranged from 10 to 19 mg/L, with no apparent increase since the earliest available data.

Pumpage variations from the unconfined aquifer at Millsboro (fig. 5) are much less seasonal than at the resort areas, and pumpage changed little between 1979 and 1985 (fig. 55). Pumpage increased in 1986 due to increases in both commercial and residential development in the area.

Long Neck area

No data were collected from wells in the Long Neck area during the study, but the DDPH and the DNREC have reported many cases of saltwater intrusion in shallow wells along the bays. More study is needed to determine the extent of saltwater intrusion into the unconfined aquifer in this area.

Bethany Beach area

Water-level, chloride, and pumpage data for the unconfined aquifer are not available in the Bethany Beach area. South Bethany Beach does not have a community water supply and most houses originally had wells in the unconfined aquifer. According to the DNREC, saltwater intrusion into the unconfined aquifer in South Bethany Beach has forced more homeowners each year to drill to about 220 to 240 ft below land surface for a freshwater supply in the Pocomoke aquifer. As fewer wells withdraw water from the unconfined aquifer, the rate of saltwater intrusion may decrease in this area.

Fenwick Island area

Water levels in the unconfined aquifer at Fenwick Island were measured in well Rj 22-8 (pl. 4). With the exception of one measurement, water levels in the aquifer remained above sea level in this area (fig. 48).

The base of the unconfined aquifer in the Fenwick Island area is saline. One chloride concentration of 9,500 mg/L was determined near the base of the aquifer in well Rj 22-8 in 1977. This well no longer produces

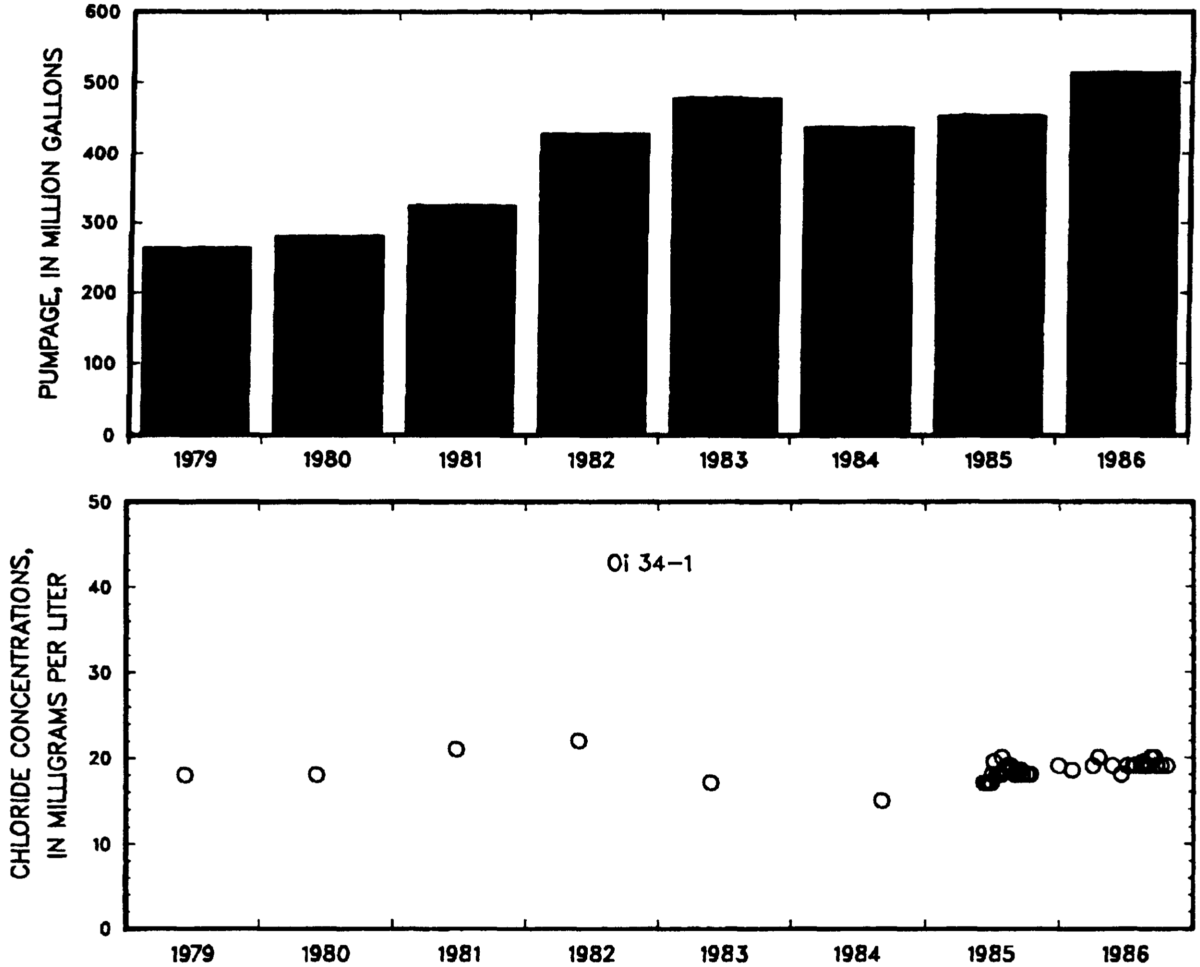


Figure 54.--Total yearly pumpage and chloride concentrations in water from a well in the unconfined aquifer at Rehoboth Beach, Delaware, 1979-86.

enough water to provide a representative sample for comparison with the 1977 chloride determination. Few shallow wells (less than 100 ft deep) are still being used in the unconfined aquifer at Fenwick Island because of saltwater intrusion. Since the mid-1970's, most new wells in this area are being screened in the Pocomoke aquifer.

Maryland

The major user of the unconfined aquifer in coastal Maryland is Ocean Pines, located on the Isle of Wight Bay west of Ocean City. The town of Berlin, 6 mi west of Ocean City, and Chesapeake Foods near Berlin also use the unconfined aquifer for water supply.

Ocean City area

There is no pumpage from the unconfined aquifer in Ocean City, with the possible exception of a few old domestic heat pumps. Only one observation well in the unconfined aquifer (WO Bh-84) is located in Ocean City (pl. 4). Well WO Bh-84 is located next to well WO Bh-85 in the Pocomoke aquifer at 44th Street (pl. 3). Figure 50 shows water levels in the two wells. Water levels in well WO Bh-84 dropped below sea level in 1974 and 1986, during years when rainfall was well below normal. Only two water-level measurements were made in 1981, and the water level may have declined below sea level in 1981 because of below-normal precipitation (fig. 15).

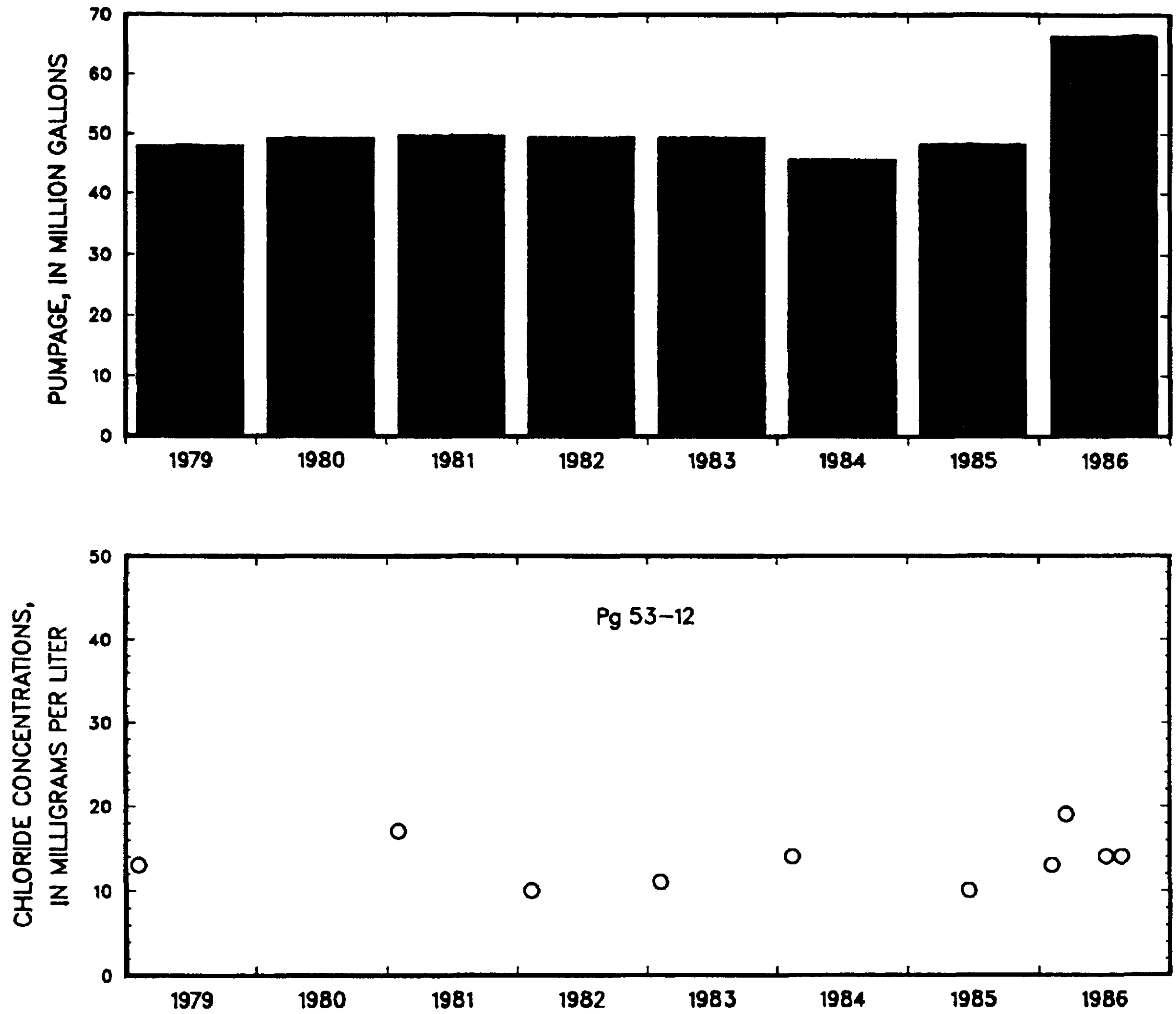


Figure 55.--Yearly pumpage from the unconfined aquifer and chloride concentrations in water from a well at Millsboro, Delaware, 1979-86.

Chloride concentrations in the unconfined aquifer, like those in the Pocomoke aquifer at the same location, did not change significantly from 1973 (when the wells were first drilled) to 1986. In 1973 and 1976, chloride concentrations of 39 mg/L in water from well WO BH-84 in the unconfined aquifer are about equal to the range of 37 to 46 mg/L measured in 1985-86.

Ocean Pines area

Water levels in the unconfined aquifer (well WO Bg-45) at Ocean Pines (fig. 51) dropped to near sea level during most summer months. Yearly precipitation (fig. 15) affected the water levels, as was evident during 1974, 1980, 1981, and 1986, when precipitation was deficient. Water levels did not appear to be affected by the increased pumpage from the unconfined aquifer at Ocean Pines (fig. 12), because, although pumpage tripled between 1974 and 1985, water levels have not shown a corresponding decline (fig. 51). The amount of precipitation available for recharge is the major factor that controls water levels in the unconfined aquifer in this area.

Measurements of chloride concentration before 1986 were not available for well WO Bg-45, nor were there chloride records for untreated water from the Ocean Pines production wells. In 1986, chloride concentrations of 13 to 15 mg/L were found in water from well WO Bh-45, and 11.5 and 13 mg/L in water from production wells 3 and 5, respectively. The relatively low summer water levels measured in well WO Bg-45 indicate that shallow wells close to the Isle of Wight Bay in this area could be susceptible to saltwater intrusion during periods of drought.

Total yearly pumpage from the unconfined aquifer at Ocean Pines is shown in figure 12. In 1985, total pumpage at Ocean Pines was about 10 percent of the total pumpage at Ocean City.

SUMMARY AND CONCLUSIONS

Ground water in the coastal freshwater aquifers of Delaware and Maryland is susceptible to saltwater intrusion from (1) downward leakage from the ocean and bays, (2) upward leakage from the underlying St. Marys Formation, and (3) inland movement of offshore water.

The freshwater aquifers in the study area are, from bottom to top: the Manokin, Ocean City, Pocomoke, and unconfined (referred to as the Pleistocene or Columbia aquifer in previous studies) aquifers. The three deeper confined aquifers are of Miocene deposits and the unconfined aquifer consists of Pleistocene deposits.

Chloride concentrations were determined and water-level measurements were made and compared to pumpage figures to determine if increased pumpage from the freshwater aquifer system is drawing down water levels and causing saltwater intrusion.

Generally, ground water flows east-southeastward downdip in the study area under nonpumping conditions. Ground-water recharge to the confined aquifers is through downward percolation from the overlying unconfined aquifer where the confined aquifers subcrop the unconfined aquifer and where confining units are locally absent.

Thickness of the Manokin aquifer ranges from about 50 ft at Lewes, Del., to 150 ft at Ocean City, Md. The Manokin aquifer is confined below by the saline Miocene St. Marys Formation.

Thickness of the Ocean City aquifer ranges from 75 to 150 ft along the Delaware coast, and from 30 to 120 ft along the Maryland coast. Thickness of the Pocomoke aquifer in the study area ranges from 0 to 90 ft in Delaware, and 30 to 80 ft in Maryland. Thickness of the unconfined aquifer ranges from about 70 to 180 ft in the study area.

Geophysical logs and drill cuttings indicated discontinuous aquifers at depths that correlate with the Pocomoke aquifer in the vicinity of the Delaware-Maryland State line near the coast. It is possible that the Pocomoke aquifer in Ocean City is not the same aquifer as the Pocomoke aquifer in Fenwick Island.

Municipal and industrial water systems comprise about 80 to 90 percent of all water use in the study area. Changes in chloride concentrations in production wells in individual aquifers cannot always be compared to changes in total pumpage from town or industrial users because many systems pump water from more than one aquifer. Pumpage can increase from one aquifer while decreasing from another.

The city of Lewes pumps from the subcrop area of the Pocomoke aquifer, whereas the city of Rehoboth Beach uses the unconfined aquifer as its source of water for both Rehoboth and Dewey Beach. Millsboro uses the unconfined and Manokin aquifers for water supply. Sussex Shores Water Company, 1.8 mi north of Bethany Beach, uses the Pocomoke aquifer. Bethany Beach uses the Ocean City and Manokin aquifers, whereas Sea Colony, just south of Bethany Beach, uses the Manokin aquifer. Fenwick Island does not have a municipal water system and uses private wells in the Pocomoke aquifer.

The town of Ocean City uses the Ocean City and Manokin aquifers for water supply. Locations of well fields are at 137th Street (Gorman Avenue plant), 44th Street, 15th Street, and near the Ocean City Inlet at the South water plant. The Gorman Avenue plant pumps from four wells in the Manokin aquifer. The 44th Street plant pumps from six wells in the Ocean City aquifer. The 15th Street and South water plants each use three wells in the Ocean City aquifer and one well in the Manokin aquifer. Ocean Pines and the town of Berlin each pump water from the unconfined aquifer.

Chloride concentrations in the Manokin aquifer range from 6 mg/L at Millsboro, to 460 mg/L at Fenwick Island. Wells screened close to the bottom of the aquifer tend to have higher chloride concentrations than those screened higher in the aquifer, and chloride levels generally decrease as distance from the ocean increases.

Increased pumpage from the Manokin aquifer at Millsboro and Bethany Beach did not cause increased chloride concentrations in the Manokin aquifer in those areas. Concentrations in the Manokin aquifer near 137th Street, Ocean City (well WO Ah-33), increased from 52 to 110 mg/L during 1976, when the well was first pumped, but remained steady between 1977 and 1986. The high concentrations in the Manokin aquifer at 44th Street were first discovered in 1986 when a test well was drilled. The aquifer is not pumped in this area and the reason for these high concentrations is not known. Concentrations in the Manokin aquifer at 15th Street average about 105 mg/L, and concentrations at south Ocean City average about 80 mg/L.

Water levels in the Manokin aquifer have declined several feet in north Ocean City since 1970. Spring high water levels usually were above sea level in most areas of Ocean City, but summer pumping rates caused water levels in observation wells to fall below sea level throughout the summer and fall.

Chloride concentrations in the Ocean City aquifer range from 6 mg/L at Whaleysville, Md., to 260 mg/L at 44th Street in Ocean City. As pumpage from the Ocean City aquifer at Bethany Beach doubled from 1982 to 1986, chloride concentrations remained essentially the same (about 15 mg/L). Concentrations in water from production well WO Bh-28 at 44th Street, Ocean City, increased steadily from 50 mg/L in 1976 to 200 mg/L in 1986, regardless of the amount of water pumped; the cause is probably vertical movement of water from the saltier Manokin aquifer upward through the leaky confining unit.

Chloride concentrations measured during this study in the Pocomoke aquifer range from 5 mg/L at Whaleysville, to 46 mg/L at 44th Street in Ocean City. No part of the Pocomoke aquifer in the study area was found to have significantly increased chloride concentrations, and no substantial areal decreases in water levels due to pumping were found.

Chloride concentrations measured during this study in the unconfined aquifer ranged from 11.5 mg/L near Omar, to 46 mg/L at 44th Street in Ocean City, but concentrations varied widely in areas along the coast and inland bays. Measurements from Rehoboth Beach production well 1 (Oi 34-1) showed no increase in chloride since the water was first analyzed in 1956. Chloride concentrations as high as 9,500 mg/L have been documented at Fenwick Island where the aquifer is unused. Problems of localized saltwater intrusion in the unconfined aquifer in South Bethany Beach and Long Neck, and in other areas using shallow wells directly adjacent to the inland bays, have been reported.

Seasonal high water levels were affected more by total annual rainfall than by the effects of pumpage. Seasonal low water levels generally declined during most years in areas of heavy pumpage along the coast, but, farther inland, the water levels did not decline. Several record low water levels recorded in 1986 were caused by drought conditions on the Delmarva Peninsula, rather than by pumpage.

Seasonal water-level variations ranged from about 2 to 40 ft below spring high water levels. Comparison of data for water levels, chloride, and pumpage showed that increased pumpage and lower water levels have not yet caused more than a minimal corresponding increase in chloride concentrations in the confined aquifers, except in the Ocean City aquifer at 44th Street in Ocean City.

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APPENDIX

WATER-QUALITY DATA

INDEX TO ABBREVIATIONS USED IN APPENDIX

Aquifer units:

UNCONFD	-	Unconfined aquifer
POCOMKE	-	Pocomoke aquifer
OCN CTY	-	Ocean City aquifer
MANOKIN	-	Manokin aquifer

DEG C	=	Degrees Celsius
MG/L	=	Milligrams per liter
GPM	=	Gallons per minute
US/CM	=	Microsiemens per centimeter at 25 degrees Celsius
UG/L	=	Micrograms per liter (1 mg/L = 1,000 ug/L)
MIN	=	Minutes
FT	=	Feet
IT-FLD	=	Incremental titration, field
TOT FLD	=	Total, field

A dash (--) indicates that no data are available for that specific parameter.

Water-quality data in this appendix include only data collected and analyzed by the U.S. Geological Survey.

APPENDIX
WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	DATE	TIME	AQUIFER UNIT	TEMPER-ATURE (DEG C)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLOW RATE, INSTAN-TANEOUS (GPM)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM)	PH (STAND-ARD UNITS)
Ni 51-31	08-22-85	1510	POCOMKE	14.0	10	--	121	114	5.30
	02-03-86	1150	POCOMKE	14.0	16	--	115	--	5.90
	04-03-86	0940	POCOMKE	14.0	11	--	108	104	5.60
	07-07-86	1050	POCOMKE	15.0	17	--	130	--	5.40
	08-20-86	0900	POCOMKE	14.5	15.5	--	120	--	5.70
	11-20-86	1000	POCOMKE	13.5	16	--	116	--	5.60
Ni 52-11	08-22-85	1420	POCOMKE	15.0	11	--	77	--	5.30
	10-17-85	1020	POCOMKE	14.5	12	22	68	--	--
	02-03-86	1055	POCOMKE	14.5	12	27	68	--	6.00
	04-03-86	1100	POCOMKE	15.0	13	50	70	--	5.85
	07-07-86	1005	POCOMKE	15.0	--	27	74	--	5.72
	08-19-86	0920	POCOMKE	15.0	12	24	71	--	--
	11-20-86	1120	POCOMKE	14.5	13	25	70	--	5.95
Ni 52-12	02-03-86	1115	UNCONFD	14.0	25	60	245	--	5.80
	04-03-86	1125	UNCONFD	14.0	25	60	255	--	5.65
	07-07-86	1025	UNCONFD	14.5	24	60	269	--	5.66
	08-19-86	0935	UNCONFD	14.0	23	60	240	--	--
	11-20-86	1200	UNCONFD	14.0	23	50	235	--	5.87
Oh 54-01	08-26-85	1145	MANOKIN	15.0	9.2	7.5	362	322	7.20
	02-05-86	1145	MANOKIN	15.5	7.0	3.0	320	--	--
	04-03-86	1545	MANOKIN	15.0	9.1	11	330	254	7.70
	07-07-86	1440	MANOKIN	16.0	9.0	11	355	--	7.75
	08-19-86	1255	MANOKIN	16.0	8.2	8.5	348	329	--
	10-18-86	1030	MANOKIN	16.0	8.0	8.0	325	--	--
	11-20-86	1350	MANOKIN	16.0	9.0	6.0	325	--	8.07
Oh 54-02	11-22-77	1145	POCOMKE	17.0	7.8	1.5	220	--	5.90
	08-28-85	1150	POCOMKE	14.0	8.0	15	62	57	5.50
	10-18-85	1100	POCOMKE	14.5	8.0	30	57	--	--
	02-05-86	1035	POCOMKE	14.5	9.0	20	54	--	--
	04-03-86	1630	POCOMKE	14.5	7.9	40	55	57	5.90
	07-07-86	1510	POCOMKE	15.0	9.0	58	61	--	5.58
	08-19-86	1335	POCOMKE	15.0	7.1	40	58	57	--
	11-20-86	1435	POCOMKE	14.5	9.0	40	59	--	5.83
Oi 24-06	08-23-85	1100	MANOKIN	14.0	11	50	84	77	--
	10-17-85	1135	MANOKIN	15.0	11	20	76	--	--
	02-05-86	1040	MANOKIN	14.5	12	45	78	--	7.50
	04-03-86	1400	MANOKIN	15.0	8.8	50	80	65	6.25
	07-07-86	1235	MANOKIN	15.0	12	37	85	--	5.93
	08-19-86	1105	MANOKIN	15.0	10	17	82	73	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	PH LAB (STAND-ARD UNITS)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	ALKA-LINITY TOTAL FIELD MG/L AS CACO3	BICAR-BONATE TOTAL FIELD MG/L AS HCO3	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)
Ni 51-31	5.90	58	--	--	--	2.70	--	--	<0.01
	--	--	--	--	--	--	--	--	--
	5.80	29	--	--	--	1.20	--	--	<0.01
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	8	--	--	--	--	--	--
Ni 52-11	6.60	39	--	--	--	<0.10	--	--	<0.01
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	11	--	--	--	--	--	--
Ni 52-12	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	9	--	--	--	--	--	--
Oh 54-01	7.60	19	--	--	--	<0.10	2.9	--	0.96
	--	--	--	--	--	--	--	--	--
	8.50	4.3	--	--	--	<0.10	3.0	--	0.98
	--	--	--	--	--	--	--	--	--
	7.80	--	--	--	--	<0.10	3.0	--	0.98
	--	--	--	--	--	--	--	--	--
	--	--	158	--	--	--	--	--	--
Oh 54-02	--	42	17	21	0.44	--	--	0.01	--
	6.10	55	--	--	--	0.50	--	--	<0.01
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	5.90	20	--	--	--	0.59	--	--	<0.01
	--	--	--	--	--	--	--	--	--
	6.20	--	--	--	--	0.57	--	--	<0.01
	--	--	95	--	--	--	--	--	--
Oi 24-06	6.20	--	--	--	--	0.11	--	--	<0.01
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.20	14	--	--	--	<0.10	--	--	<0.01
	--	--	--	--	--	--	--	--	--
	6.30	--	--	--	--	<0.10	--	--	<0.01

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	HARDNESS (MG/L AS CACO3)	HARDNESS NONCARB TOT FLD MG/L AS CACO3	HARDNESS NONCARBONATE (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PERCENT SODIUM	POTASSIUM, DISSOLVED (MG/L AS K)
Ni 51-31	21	15	21	5.1	2.0	11	1	51	1.6
	--	--	--	--	--	--	--	--	--
	18	12	18	4.4	1.7	12	1	57	1.4
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Ni 52-11	9	5	9	2.3	0.91	8.3	1	61	1.6
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Ni 52-12	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Oh 54-01	9	--	9	1.3	1.3	72	11	91	5.8
	--	--	--	--	--	--	--	--	--
	9	--	9	1.3	1.3	72	11	90	6.4
	--	--	--	--	--	--	--	--	--
	9	--	9	1.3	1.3	71	11	91	5.6
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Oh 54-02	12	0	12	3.5	0.8	7.7	1	55	1.4
	7	--	7	2.0	0.59	7.1	1	64	1.1
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	7	--	7	2.0	0.5	7.3	1	66	1.0
	--	--	--	--	--	--	--	--	--
	7	--	7	1.8	0.5	6.9	1	65	1.1
	--	--	--	--	--	--	--	--	--
Oi 24-06	10	--	10	2.1	1.2	8.0	1	56	2.8
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	11	--	11	2.3	1.3	8.4	1	55	2.8
	--	--	--	--	--	--	--	--	--
	10	--	10	2.1	1.2	7.7	1	55	2.8

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	SULFATE DIS-SOLVED (MG/L AS SO4)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)
Ni 51-31	7.1	<0.1	18	--	12	--	6	48
	--	--	--	--	--	--	--	--
	9.8	<0.1	19	--	55	--	10	74
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
Ni 52-11	3.8	<0.1	21	--	200	--	37	52
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
Ni 52-12	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
Oh 54-01	3.9	0.5	14	--	76	--	9	204
	--	--	--	--	--	--	--	--
	8.3	0.5	14	--	93	--	10	200
	--	--	--	--	--	--	--	--
	4.1	0.5	14	--	93	--	9	200
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
Oh 54-02	6.3	<0.1	22	790	320	40	40	79
	4.4	<0.1	21	--	300	--	2	63
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	3.7	<0.1	23	--	12	--	<1	50
	--	--	--	--	--	--	--	--
	3.2	<0.1	22	--	7	--	1	48
	--	--	--	--	--	--	--	--
Oi 24-06	4.5	<0.1	20	--	1900	--	23	55
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	4.7	<0.1	20	--	2000	--	23	46
	--	--	--	--	--	--	--	--
	4.4	<0.1	20	--	1900	--	22	61

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	SOLIDS, SUM OF CONSTIT-UENTS, DIS-SOLVED (MG/L)	ELEV. OF LAND SURFACE DATUM FT ABOVE SEA LEVEL	PUMP OR FLOW PERIOD PRIOR TO SAM-PLING (MIN)	DEPTH OF WELL, TOTAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH BELOW LAND SURFACE (WATER-LEVEL) (FT)	ALKA-LINITY LAB (MG/L AS CACO3)
Ni 51-31	58	16.0	--	150.00	100	150	--	6.0
	--	16.0	15	150.00	100	150	--	--
	63	16.0	--	150.00	100	150	--	6.0
	--	16.0	15	150.00	100	150	--	--
	--	16.0	15	150.00	100	150	--	--
	--	16.0	10	150.00	100	150	--	--
Ni 52-11	52	16.0	--	155.00	145	155	10.58	4.0
	--	16.0	25	155.00	145	155	10.49	--
	--	16.0	30	155.00	145	155	10.59	--
	--	16.0	20	155.00	145	155	10.37	--
	--	16.0	30	155.00	145	155	11.41	--
	--	16.0	30	155.00	145	155	11.37	--
	--	16.0	25	155.00	145	155	11.33	--
Ni 52-12	--	16.0	20	80.00	70	80	10.03	--
	--	16.0	25	80.00	70	80	9.70	--
	--	16.0	15	80.00	70	80	11.07	--
	--	16.0	15	80.00	70	80	11.42	--
	--	16.0	35	80.00	70	80	11.70	--
Oh 54-01	200	18.0	--	290.00	280	290	10.82	155
	--	18.0	65	290.00	280	290	11.47	--
	180	18.0	--	290.00	280	290	9.68	112
	--	18.0	50	290.00	280	290	10.73	--
	200	18.0	90	290.00	280	290	11.34	156
	--	18.0	20	290.00	280	290	11.03	--
	--	18.0	45	290.00	280	290	11.98	--
Oh 54-02	60	18.0	45	189.00	179	189	--	--
	50	18.0	--	189.00	179	189	11.77	9.0
	--	18.0	30	189.00	179	189	--	--
	--	18.0	30	189.00	179	189	11.16	--
	50	18.0	--	189.00	179	189	10.23	8.0
	--	18.0	30	189.00	179	189	11.47	--
	48	18.0	--	189.00	179	189	12.09	9.0
	--	18.0	40	189.00	179	189	12.69	--
Oi 24-06	59	26.0	--	250.00	230	250	19.61	13
	--	26.0	35	250.00	230	250	19.28	--
	--	26.0	45	250.00	230	250	19.03	--
	58	26.0	60	250.00	230	250	18.99	13
	--	26.0	30	250.00	230	250	20.12	--
	58	26.0	30	250.00	230	250	20.30	13

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	DATE	TIME	AQUIFER UNIT	TEMPER-ATURE (DEG C)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLOW RATE, INSTAN-TANEOUS (GPM)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM)	PH (STAND-ARD UNITS)	PH LAB (STAND-ARD UNITS)
Oi 34-01	02-13-56	1200	UNCONFD	14.0	14	--	112	--	5.80	--
	08-23-85	1220	UNCONFD	14.0	18	--	164	148	--	5.80
	02-05-86	1030	UNCONFD	14.0	18	--	160	--	6.20	--
	04-03-86	1300	UNCONFD	14.0	15	--	170	165	5.55	5.90
	07-07-86	1245	UNCONFD	14.5	19	--	170	--	5.58	--
	08-19-86	1040	UNCONFD	14.0	16	--	165	156	--	6.10
Pg 53-13	08-29-85	1100	MANOKIN	15.0	7.0	--	143	136	6.50	6.90
	02-06-86	1025	MANOKIN	14.5	6.5	--	127	--	--	--
	04-08-86	1010	MANOKIN	15.0	6.0	--	130	109	5.80	6.80
	07-08-86	0910	MANOKIN	16.0	7.0	--	133	--	6.48	--
	08-21-86	1113	MANOKIN	15.5	7.0	--	131	--	6.60	--
	08-21-86	1130	MANOKIN	15.5	5.9	--	131	108	6.60	6.90
	12-01-86	1000	MANOKIN	15.0	6.0	--	120	--	6.64	--
Pg 53-14	01-31-78	1200	MANOKIN	14.0	5.8	68	115	--	6.40	--
Pj 41-04	08-23-85	1340	POCOMKE	15.0	42	--	345	277	--	6.60
	10-17-85	1220	POCOMKE	--	43	--	305	--	--	--
	02-03-86	1240	POCOMKE	15.5	39	--	300	--	6.20	--
	04-04-86	1010	POCOMKE	15.5	42	--	E320	292	6.05	6.60
	07-10-86	1050	POCOMKE	18.5	42	--	295	--	6.03	--
	08-20-86	1000	POCOMKE	16.0	42	--	320	274	6.20	6.60
	11-21-86	1255	POCOMKE	15.0	41	--	300	--	6.82	--
Qh 54-04	11-03-78	1030	MANOKIN	15.5	33	12	360	--	6.30	--
	08-28-85	1520	MANOKIN	15.0	34	--	405	320	6.40	6.40
	10-18-85	1240	MANOKIN	15.5	29	10	390	--	--	--
	02-05-86	1440	MANOKIN	15.5	30	4.0	380	--	--	--
	04-07-86	1400	MANOKIN	15.0	32	--	375	339	6.30	6.60
	07-08-86	1050	MANOKIN	16.0	31	8.0	395	--	6.45	--
	08-22-86	0920	MANOKIN	15.5	33	12	378	320	6.50	6.60
	11-21-86	1435	MANOKIN	15.0	32	8.0	400	--	6.74	--
Qh 54-05	11-03-78	1145	OCN CTY	15.0	15	50	209	--	6.30	--
	08-28-85	1605	OCN CTY	14.0	15	--	222	140	6.60	6.10
	10-18-85	1250	OCN CTY	15.0	9.5	20	200	--	--	--
	02-05-86	1525	OCN CTY	15.5	11	4.0	202	--	--	--
	04-07-86	1445	OCN CTY	15.0	11	--	193	176	6.20	6.50
	07-08-86	1115	OCN CTY	15.0	10	23	205	--	6.31	--
	08-22-86	0955	OCN CTY	15.0	12	20	188	132	6.24	6.30
	11-21-86	1520	OCN CTY	15.0	10	12	190	--	6.57	--
Qh 54-06	11-03-78	1045	POCOMKE	15.0	14	20	211	--	6.30	--
	08-28-85	1700	POCOMKE	14.0	15	--	238	167	6.50	6.40
	10-18-85	1300	POCOMKE	15.0	10	28	210	--	--	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	CARBON DIOXIDE DIS- SOLVED (MG/L AS CO2)	ALKA- LINITY TOTAL FIELD MG/L AS CACO3	ALKA- LINITY, CARBON- ATE IT-FLD (MG/L - CACO3)	BICAR- BONATE TOTAL FIELD MG/L AS HCO3	NITRO- GEN, NITRATE DIS- SOLVED (MG/L AS N)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	PHOS- PHATE, ORTHO, DIS- SOLVED (MG/L AS PO4)	PHOS- PHORUS, TOTAL (MG/L AS P)
Oi 34-01	25	8	--	10	2.70	--	--	--	--
	--	--	--	--	--	--	5.00	0.46	--
	--	--	--	--	--	--	--	--	--
	44	--	--	--	--	--	5.20	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	<0.10	--	--
Pg 53-13	35	--	--	--	--	--	<0.10	0.74	--
	--	--	--	--	--	--	--	--	--
	120	--	--	--	--	--	<0.10	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	28	--	57	--	--	--	<0.10	--	--
	--	55	--	--	--	--	--	--	--
Pg 53-14	28	37	--	45	--	0.02	--	--	0.16
Pj 41-04	--	--	--	--	--	--	<0.10	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	119	--	--	--	--	--	<0.10	0.06	--
	--	--	--	--	--	--	--	--	--
	128	--	105	--	--	--	<0.10	--	--
	--	96	--	--	--	--	--	--	--
Qh 54-04	111	110	--	140	--	<0.10	--	--	0.32
	86	--	--	--	--	--	<0.10	1.0	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	111	--	--	--	--	--	<0.10	1.2	--
	--	--	--	--	--	--	--	--	--
	96	--	157	--	--	--	<0.10	0.83	--
	--	155	--	--	--	--	--	--	--
Qh 54-05	111	110	--	140	--	<0.10	--	--	0.15
	26	--	--	--	--	--	<0.10	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	62	--	--	--	--	--	<0.10	0.58	--
	--	--	--	--	--	--	--	--	--
	103	--	92	--	--	--	<0.10	0.03	--
	--	95	--	--	--	--	--	--	--
Qh 54-06	60	62	--	75	--	<0.10	--	--	0.19
	38	--	--	--	--	--	<0.10	--	--
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB TOT FLD MG/L AS CACO3	HARD-NESS NONCAR-BONATE (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM
Oi 34-01	--	19	11	--	--	--	--	--	--
	0.15	33	23	33	6.7	3.9	12	0.9	43
	--	--	--	--	--	--	--	--	--
	<0.01	41	33	41	7.5	5.3	13	0.9	40
	--	--	--	--	--	--	--	--	--
	<0.01	34	25	34	6.7	4.2	12	0.9	42
Pg 53-13	0.24	0	--	0	0.05	0.02	31	31	99
	--	--	--	--	--	--	--	--	--
	<0.01	19	--	19	4.3	2.0	14	1	58
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	<0.01	19	--	19	4.3	1.9	14	1	59
	--	--	--	--	--	--	--	--	--
Pg 53-14	--	21	0	21	5.4	1.8	13	1	55
Pj 41-04	<0.01	85	17	85	23	6.7	16	0.8	28
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.02	85	16	85	23	6.7	15	0.7	27
	--	--	--	--	--	--	--	--	--
	<0.01	63	--	63	17	4.9	24	1	43
	--	--	--	--	--	--	--	--	--
Qh 54-04	--	100	0	104	29	7.6	26	1	34
	0.33	91	--	91	25	6.9	25	1	36
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.39	90	--	90	25	6.8	26	1	37
	--	--	--	--	--	--	--	--	--
	0.27	100	--	103	34	4.4	37	2	43
	--	--	--	--	--	--	--	--	--
Qh 54-05	--	110	5	115	42	2.4	11	0.5	17
	<0.01	42	--	42	13	2.2	8.7	0.6	30
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.19	41	--	41	13	2.0	8.5	0.6	30
	--	--	--	--	--	--	--	--	--
	0.01	40	--	40	13	1.9	8.7	0.6	31
	--	--	--	--	--	--	--	--	--
Qh 54-06	--	54	0	54	19	1.7	11	0.7	30
	<0.01	54	--	54	19	1.7	9.1	0.6	26
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	SULFATE DIS- SOLVED (MG/L AS SO4)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	SILICA, DIS- SOLVED (MG/L AS SIO2)	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	IRON, DIS- SOLVED (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)	MANGA- NESE, DIS- SOLVED (UG/L AS MN)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)
Oi 34-01	--	4.0	--	--	80	--	--	--	--
	1.7	10	<0.1	16	--	27	--	3	105
	--	--	--	--	--	--	--	--	--
	1.5	16	<0.1	15	--	24	--	5	97
	--	--	--	--	--	--	--	--	--
	1.9	11	<0.1	16	--	17	--	4	99
Pg 53-13	0.5	3.6	<0.1	31	--	60	--	1	108
	--	--	--	--	--	--	--	--	--
	2.2	9.1	<0.1	32	--	7500	--	210	97
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	2.3	7.9	0.1	31	--	7600	--	220	89
	--	--	--	--	--	--	--	--	--
Pg 53-14	2.0	3.4	0.1	32	9300	9200	260	260	82
Pj 41-04	4.0	28	0.1	30	--	16000	--	170	184
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	3.6	5.3	<0.1	31	--	16000	--	170	178
	--	--	--	--	--	--	--	--	--
	4.3	1.0	0.1	37	--	9800	--	130	191
	--	--	--	--	--	--	--	--	--
Qh 54-04	4.2	9.2	0.1	33	17000	18000	160	170	246
	3.9	35	<0.1	33	--	21000	--	220	225
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	4.0	17	<0.1	34	--	21000	--	180	225
	--	--	--	--	--	--	--	--	--
	4.3	35	<0.1	38	--	20000	--	130	239
	--	--	--	--	--	--	--	--	--
Qh 54-05	1.5	7.7	0.1	45	13000	14000	180	190	222
	1.6	29	<0.1	33	--	21000	--	140	195
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	1.7	32	<0.1	32	--	20000	--	98	135
	--	--	--	--	--	--	--	--	--
	2.0	52	<0.1	33	--	21000	--	120	76
	--	--	--	--	--	--	--	--	--
Qh 54-06	1.5	8.3	<0.1	36	17000	17000	120	140	154
	1.1	21	<0.1	38	--	19000	--	120	148
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	NITROGEN, NITRATE DISSOLVED (MG/L AS NO3)	ELEV. OF LAND SURFACE DATUM FT ABOVE SEA LEVEL	PUMP OR FLOW PERIOD PRIOR TO SAMPLING (MIN)	DEPTH OF WELL, TOTAL (FT)	DEPTH TO TOP OF SAMPLE INTERVAL (FT)	DEPTH TO BOTTOM OF SAMPLE INTERVAL (FT)	DEPTH BELOW LAND SURFACE (WATER-LEVEL) (FT)	ALKALINITY LAB (MG/L AS CACO3)
Oi 34-01	--	12	23.0	--	131.00	69	131	--	--
	75	--	23.0	--	131.00	69	131	--	10
	--	--	23.0	--	131.00	69	131	--	--
	78	--	23.0	--	131.00	69	131	--	8.0
	--	--	23.0	--	131.00	69	131	--	--
	73	--	23.0	--	131.00	69	131	--	9.0
Pg 53-13	110	--	22.0	--	255.00	205	255	--	57
	--	--	22.0	--	255.00	205	255	--	--
	100	--	22.0	--	255.00	205	255	--	39
	--	--	22.0	--	255.00	205	255	--	--
	--	--	22.0	--	255.00	205	255	--	--
	100	--	22.0	--	255.00	205	255	--	43
	--	--	22.0	60	255.00	205	255	--	--
Pg 53-14	95	--	22.0	240	404.00	198	248	--	--
Pj 41-04	210	--	10.0	--	220.00	200	220	--	68
	--	--	10.0	--	220.00	200	220	--	--
	--	--	10.0	--	220.00	200	220	--	--
	180	--	10.0	--	220.00	200	220	--	69
	--	--	10.0	--	220.00	200	220	--	--
	180	--	10.0	15	220.00	200	220	--	67
	--	--	10.0	10	220.00	200	220	--	--
Qh 54-04	230	--	28.0	50	328.00	324	328	--	--
	250	--	28.0	--	328.00	324	328	--	112
	--	--	28.0	22	328.00	324	328	--	--
	--	--	28.0	65	328.00	324	328	12.03	--
	240	--	28.0	--	328.00	324	328	--	114
	--	--	28.0	28	328.00	324	328	15.35	--
	270	--	28.0	25	328.00	324	328	15.93	112
	--	--	28.0	25	328.00	324	328	16.00	--
Qh 54-05	210	--	28.0	45	232.00	229	232	--	--
	160	--	28.0	--	232.00	229	232	--	53
	--	--	28.0	10	232.00	229	232	--	--
	--	--	28.0	40	232.00	229	232	12.01	--
	150	--	28.0	--	232.00	229	232	--	51
	--	--	28.0	20	232.00	229	232	15.31	--
	170	--	28.0	30	232.00	229	232	15.89	49
	--	--	28.0	35	232.00	229	232	16.06	--
Qh 54-06	150	--	28.0	50	148.00	144	148	--	--
	160	--	28.0	--	148.00	144	148	--	62
	--	--	28.0	10	148.00	144	148	12.10	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	DATE	TIME	AQUIFER UNIT	TEMPER-ATURE (DEG C)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLOW RATE, INSTAN-TANEOUS (GPM)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM)	PH (STAND-ARD UNITS)
Qh 54-06	02-05-86	--	POCOMKE	--	13	1.0	177	--	--
	04-07-86	1530	POCOMKE	14.5	12	--	210	193	6.20
	07-08-86	1135	POCOMKE	15.0	13	50	225	--	6.45
	08-22-86	1020	POCOMKE	15.0	13	30	210	162	6.46
	11-21-86	1550	POCOMKE	14.5	12	35	205	--	6.67
Qh 54-07	11-03-78	1140	UNCONFD	15.0	13	33	309	--	6.30
	10-18-85	1315	UNCONFD	15.0	12	25	310	--	--
	02-05-86	1610	UNCONFD	15.5	13	10	303	--	--
	04-07-86	1620	UNCONFD	14.5	12	--	300	279	6.50
	07-08-86	1155	UNCONFD	15.0	13	60	328	--	6.60
	08-22-86	1055	UNCONFD	15.0	14	30	300	267	6.69
	11-21-86	1617	UNCONFD	14.5	13	40	290	--	6.84
Qj 32-22	08-23-85	1540	OCN CTY	14.0	14	--	315	265	--
	02-05-86	1135	OCN CTY	14.5	13	--	285	--	6.40
	04-04-86	1140	OCN CTY	15.0	13	--	285	266	6.15
	07-09-86	1155	OCN CTY	15.5	14	--	315	--	6.48
	08-20-86	1355	OCN CTY	15.5	14	--	290	267	6.80
	11-24-86	1215	OCN CTY	15.0	15	--	275	--	6.55
Qj 41-02	08-26-85	1050	MANOKIN	15.0	51	--	482	345	6.40
	04-07-86	1115	MANOKIN	16.0	49	--	400	396	5.85
	07-09-86	1130	MANOKIN	17.0	52	--	430	--	6.62
	08-20-86	1115	MANOKIN	16.0	50	--	430	395	6.70
	11-24-86	1040	MANOKIN	16.0	39	--	370	--	6.77
Qj 41-07	02-03-86	1415	OCN CTY	15.5	9.0	25	280	--	6.50
	04-07-86	1220	OCN CTY	15.5	12	50	288	--	6.40
	07-08-86	1330	OCN CTY	16.0	13	45	300	--	6.51
	08-20-86	1155	OCN CTY	16.0	13	40	290	--	6.80
	11-24-86	1105	OCN CTY	15.5	13	35	280	--	6.67
Qj 41-08	02-03-86	1450	POCOMKE	15.5	12	8.0	280	--	6.70
	04-07-86	1200	POCOMKE	15.0	12	10	290	--	6.00
	07-08-86	1350	POCOMKE	16.0	12	9.0	310	--	6.61
	08-20-86	1230	POCOMKE	16.0	13	9.0	287	--	--
	11-24-86	1135	POCOMKE	15.5	13	9.0	280	--	6.79
Rj 22-05	05-11-77	1530	MANOKIN	18.0	460	5.0	1720	--	7.00
	10-17-85	1455	MANOKIN	18.0	450	5.0	1900	--	--
	02-03-86	1630	MANOKIN	16.5	450	5.0	2000	--	7.30
Rj 22-06	05-11-77	1420	OCN CTY	17.5	21	5.0	230	--	6.30
	10-17-85	1525	OCN CTY	17.0	14	10	210	--	--
	02-03-86	1550	OCN CTY	16.0	13	10	210	--	6.20
Rj 22-07	05-11-77	1640	POCOMKE	--	60	0.3	420	--	6.80

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	PH LAB (STAND-ARD UNITS)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	ALKA-LINITY TOTAL FIELD MG/L AS CACO3	ALKA-LINITY, CARBON-ATE IT-FLD (MG/L - CACO3)	BICAR-BONATE TOTAL FIELD MG/L AS HCO3	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, TOTAL (MG/L AS P)
Qh 54-06	--	--	--	--	--	--	--	--	--
	6.50	77	--	--	--	--	<0.10	0.55	--
	--	--	--	--	--	--	--	--	--
	6.50	64	--	95	--	--	<0.10	0.06	--
	--	--	102	--	--	--	--	--	--
Qh 54-07	--	54	56	--	68	<0.10	--	--	0.21
	--	--		--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.70	73	--	--	--	--	<0.10	0.49	--
	--	--	--	--	--	--	--	--	--
	6.90	58	--	147	--	--	<0.10	0.4	--
	--	--	145	--	--	--	--	--	--
Qj 32-22	6.50	--	--	--	--	--	0.11	0.77	--
	--	--	--	--	--	--	--	--	--
	6.80	156	--	--	--	--	<0.10	0.61	--
	--	--	--	--	--	--	--	--	--
	6.90	41	--	135	--	--	<0.10	0.46	--
	--	--	134	--	--	--	--	--	--
Qj 41-02	6.60	84	--	--	--	--	0.10	0.86	--
	6.80	331	--	--	--	--	<0.10	0.4	--
	--	--	--	--	--	--	--	--	--
	6.90	56	--	145	--	--	<0.50	0.31	--
	--	--	145	--	--	--	--	--	--
Qj 41-07	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	135	--	--	--	--	--
	--	--	135	--	--	--	--	--	--
Qj 41-08	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	140	--	--	--	--	--
	--	--	138	--	--	--	--	--	--
Rj 22-05	--	33	170	--	210	<0.10	--	--	0.41
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Rj 22-06	--	66	68	--	83	0.05	--	--	0.16
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Rj 22-07	--	38	120	--	150	1.80	--	--	0.17

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB TOT FLD MG/L AS CACO3	HARD-NESS NONCAR-BONATE (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM
Qh 54-06	--	--	--	--	--	--	--	--	--
	0.18	54	--	54	19	1.6	8.7	0.5	25
	--	--	--	--	--	--	--	--	--
	0.02	29	--	29	9.3	1.4	47	4	77
	--	--	--	--	--	--	--	--	--
Qh 54-07	--	44	0	44	14	2.2	11	0.8	34
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.16	110	--	109	40	2.2	9.9	0.4	16
	--	--	--	--	--	--	--	--	--
	0.13	110	--	106	39	2.2	9.9	0.4	17
	--	--	--	--	--	--	--	--	--
Qj 32-22	0.25	100	--	103	31	6.3	11	0.5	18
	--	--	--	--	--	--	--	--	--
	0.20	110	--	105	32	6.2	11	0.5	18
	--	--	--	--	--	--	--	--	--
	0.15	100	--	105	33	5.4	11	0.5	18
	--	--	--	--	--	--	--	--	--
Qj 41-02	0.28	100	--	103	34	4.5	36	2	42
	0.13	110	--	105	35	4.3	36	2	42
	--	--	--	--	--	--	--	--	--
	0.10	100	--	101	33	4.5	36	2	42
	--	--	--	--	--	--	--	--	--
Qj 41-07	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Qj 41-08	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Rj 22-05	--	150	0	151	26	21	350	13	81
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Rj 22-06	--	63	0	63	18	4.4	20	1	39
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Rj 22-07	--	110	0	105	24	11	52	2	49

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	POTASSIUM, DISSOLVED (MG/L AS K)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	IRON, TOTAL RECOVERABLE (UG/L AS FE)	IRON, DISSOLVED (UG/L AS FE)	MANGANESE, TOTAL RECOVERABLE (UG/L AS MN)	MANGANESE, DISSOLVED (UG/L AS MN)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)
Qh 54-06	--	--	--	--	--	--	--	--	--
	1.2	29	<0.1	37	--	18000	--	94	152
	--	--	--	--	--	--	--	--	--
	1.6	45	<0.1	39	--	19000	--	120	140
	--	--	--	--	--	--	--	--	--
Qh 54-07	2.1	8.3	<0.1	32	20000	20000	140	140	144
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	1.1	18	<0.1	44	--	15000	--	170	220
	--	--	--	--	--	--	--	--	--
	1.4	23	<0.1	45	--	15000	--	160	219
	--	--	--	--	--	--	--	--	--
Qj 32-22	3.3	14	0.2	38	--	8700	--	120	190
	--	--	--	--	--	--	--	--	--
	2.9	16	<0.1	38	--	9000	--	130	191
	--	--	--	--	--	--	--	--	--
	3.1	20	0.1	39	--	9400	--	130	183
	--	--	--	--	--	--	--	--	--
Qj 41-02	3.9	14	0.1	37	--	8500	--	120	252
	3.4	16	<0.1	37	--	8400	--	140	239
	--	--	--	--	--	--	--	--	--
	4.2	7.6	0.1	36	--	8900	--	120	268
	--	--	--	--	--	--	--	--	--
Qj 41-07	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Qj 41-08	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Rj 22-05	18	54	0.2	26	3000	3100	60	60	1010
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Rj 22-06	3.5	4.4	0.1	35	8900	8700	150	150	144
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
Rj 22-07	9.5	8.0	0.2	33	4600	4600	110	140	263

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	SOLIDS, SUM OF CONSTIT-UENTS, DIS-SOLVED (MG/L)	ELEV. OF LAND SURFACE DATUM FT ABOVE SEA LEVEL	PUMP OR FLOW PERIOD PRIOR TO SAM-PLING (MIN)	DEPTH OF WELL, TOTAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH BELOW LAND SURFACE (WATER-LEVEL) (FT)	ALKA-LINITY LAB (MG/L AS CACO3)
Qh 54-06	--	28.0	5	148.00	144	148	11.24	--
	160	28.0	45	148.00	144	148	12.15	63
	--	28.0	15	148.00	144	148	14.65	--
	210	28.0	25	148.00	144	148	15.19	62
	--	28.0	20	148.00	144	148	15.40	--
Qh 54-07	140	28.0	43	108.00	104	108	--	--
	--	28.0	15	108.00	104	108	--	--
	--	28.0	30	108.00	104	108	11.17	--
	210	28.0	--	108.00	104	108	--	120
	--	28.0	15	108.00	104	108	14.60	--
	220	28.0	20	108.00	104	108	15.11	118
	--	28.0	17	108.00	104	108	15.32	--
Qj 32-22	190	5.0	--	250.00	200	250	--	112
	--	5.0	--	250.00	200	250	--	--
	200	5.0	--	250.00	200	250	--	114
	--	5.0	--	250.00	200	250	--	--
	200	5.0	15	250.00	200	250	--	114
	--	5.0	15	250.00	200	250	--	--
Qj 41-02	260	6.0	--	366.00	341	366	--	109
	260	6.0	--	366.00	341	366	--	121
	--	6.0	--	366.00	341	366	--	--
	250	6.0	20	366.00	341	366	--	120
	--	6.0	20	366.00	341	366	--	--
Qj 41-07	--	6.0	20	294.00	284	294	1.59	--
	--	6.0	20	294.00	284	294	0.42	--
	--	6.0	35	294.00	284	294	4.60	--
	--	6.0	25	294.00	284	294	5.33	--
	--	6.0	45	294.00	284	294	1.94	--
Qj 41-08	--	6.0	35	210.00	200	210	0.59	--
	--	6.0	40	210.00	200	210	0.4	--
	--	6.0	15	210.00	200	210	4.55	--
	--	6.0	35	210.00	200	210	5.30	--
	--	6.0	30	210.00	200	210	1.76	--
Rj 22-05	1100	5.0	45	455.00	450	455	--	--
	--	5.0	30	455.00	450	455	3.27	--
	--	5.0	20	455.00	450	455	0.7	--
Rj 22-06	160	5.0	45	295.00	290	295	--	--
	--	5.0	30	295.00	290	295	2.99	--
	--	5.0	25	295.00	290	295	0.51	--
Rj 22-07	280	5.0	45	185.00	180	185	--	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	DATE	TIME	AQUIFER UNIT	TEMPER-ATURE (DEG C)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLOW RATE, INSTAN-TANEOUS (GPM)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM)	PH (STAND-ARD UNITS)
Rj 22-08	05-11-77	1230	UNCONFD	16.0	9500	5.0	23000	--	6.70
	02-03-86	1600	UNCONFD	16.0	--	1.0	>50000	--	6.60
Rj 31-07	08-29-85	1205	POCOMKE	15.0	14	--	245	208	6.50
	02-05-86	1445	POCOMKE	16.0	14	--	220	--	6.40
	04-04-86	1350	POCOMKE	15.5	12	--	230	211	6.10
	07-09-86	1330	POCOMKE	17.0	14	--	245	--	6.47
	08-21-86	1340	POCOMKE	16.0	13	--	225	208	6.56
	11-24-86	1410	POCOMKE	15.5	15	--	215	--	6.40
Rj 31-08	02-05-86	1430	MANOKIN	16.0	33	--	250	--	6.00
	04-04-86	1430	MANOKIN	16.5	34	--	295	260	6.13
	07-09-86	1325	MANOKIN	18.0	35	--	300	--	6.46
	08-21-86	1310	MANOKIN	17.0	34	--	270	235	6.30
	11-24-86	1435	MANOKIN	17.0	34	125	250	--	6.40

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	PH LAB (STAND-ARD UNITS)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	ALKA-LINITY TOTAL FIELD MG/L AS CACO3	ALKA-LINITY, CARBON-ATE IT-FLD (MG/L - CACO3)	BICAR-BONATE TOTAL FIELD MG/L AS HCO3	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, TOTAL (MG/L AS P)
Rj 22-08	--	2.2	6	--	7	0.04	--	--	0.58
	--	--	--	--	--	--	--	--	--
Rj 31-07	6.50	50	--	--	--	--	0.11	--	--
	--	--	--	--	--	--	--	--	--
	6.80	126	--	--	--	--	<0.10	0.21	--
	--	--	--	--	--	--	--	--	--
	6.80	56	--	105	--	--	<0.10	0.09	--
	--	--	102	--	--	--	--	--	--
Rj 31-08	--	--	--	--	--	--	--	--	--
	6.50	105	--	--	--	--	<0.10	0.03	--
	--	--	--	--	--	--	--	--	--
	6.40	85	--	88	--	--	<0.10	--	--
	--	--	90	--	--	--	--	--	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB TOT FLD MG/L AS CACO3	HARD-NESS NONCAR-BONATE (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM
Rj 22-08	--	4000	4000	4020	440	710	5500	38	74
	--	--	--	--	--	--	--	--	--
Rj 31-07	<0.01	70	--	70	20	4.9	9.8	0.5	22
	--	--	--	--	--	--	--	--	--
	0.07	72	--	72	20	5.3	10	0.5	22
	--	--	--	--	--	--	--	--	--
	0.03	72	--	72	20	5.3	11	0.6	24
	--	--	--	--	--	--	--	--	--
Rj 31-08	--	--	--	--	--	--	--	--	--
	0.01	49	--	49	15	2.8	30	2	56
	--	--	--	--	--	--	--	--	--
	<0.01	49	--	49	15	2.9	25	2	51
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	SULFATE DIS- SOLVED (MG/L AS SO4)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	SILICA, DIS- SOLVED (MG/L AS SIO2)	IRON, TOTAL RECOV- ERABLE (UG/L AS FE)	IRON, DIS- SOLVED (UG/L AS FE)	MANGA- NESE, TOTAL RECOV- ERABLE (UG/L AS MN)	MANGA- NESE, DIS- SOLVED (UG/L AS MN)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)
Rj 22-08	80	1300	<0.1	29	120000	130000	1100	1300	17200
	--	--	--	--	--	--	--	--	--
Rj 31-07	3.4	1.7	<0.1	36	--	7700	--	94	138
	--	--	--	--	--	--	--	--	--
	2.8	19	<0.1	38	--	10000	--	110	147
	--	--	--	--	--	--	--	--	--
	3.3	2.0	<0.1	38	--	8000	--	100	150
	--	--	--	--	--	--	--	--	--
Rj 31-08	--	--	--	--	--	--	--	--	--
	2.4	12	<0.1	33	--	14000	--	130	166
	--	--	--	--	--	--	--	--	--
	2.8	2.2	<0.1	33	--	14000	--	120	153
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(DELAWARE WELLS)

WELL No.	SOLIDS, SUM OF CONSTIT-UENTS, DIS-SOLVED (MG/L)	ELEV. OF LAND SURFACE DATUM FT ABOVE SEA LEVEL	PUMP OR FLOW PERIOD PRIOR TO SAM-PLING (MIN)	DEPTH OF WELL, TOTAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH BELOW LAND SURFACE (WATER-LEVEL) (FT)	ALKA-LINITY LAB (MG/L AS CACO3)
Rj 22-08	18000	5.0	45	115.00	110	115	--	--
	--	5.0	10	115.00	110	115	4.11	--
Rj 31-07	150	5.0	--	200.00	150	200	--	82
	--	5.0	--	200.00	150	200	--	--
	170	5.0	--	200.00	150	200	--	82
	--	5.0	--	200.00	150	200	--	--
	150	5.0	--	200.00	150	200	--	83
	--	5.0	15	200.00	150	200	--	--
Rj 31-08	--	5.0	--	365.00	345	365	--	--
	190	5.0	15	365.00	345	365	--	73
	--	5.0	--	365.00	345	365	--	--
	160	5.0	--	365.00	345	365	--	58
	--	5.0	20	365.00	345	365	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	DATE	TIME	AQUIFER UNIT	TEMPER-ATURE (DEG C)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLOW RATE, INSTAN-TANEOUS (GPM)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM)	PH (STAND-ARD UNITS)	PH LAB (STAND-ARD UNITS)
WO Ae 23	09-17-75	1645	MANOKIN	13.5	7.5	--	--	--	--	--
	09-11-85	1320	MANOKIN	14.0	7.1	50	151	134	6.60	6.60
	02-10-86	1350	MANOKIN	14.0	5.0	60	138	--	6.35	--
	04-11-86	1125	MANOKIN	14.0	6.9	50	135	140	6.30	6.70
	07-09-86	1505	MANOKIN	14.5	7.0	43	146	--	6.35	--
	08-22-86	1250	MANOKIN	15.0	6.5	36	140	125	6.80	6.80
	12-04-86	1613	MANOKIN	14.5	7.0	40	130	--	6.53	--
WO Ae 24	09-17-75	1200	OCN CTY	13.5	10	--	--	--	--	--
	09-11-85	1410	OCN CTY	14.0	11	15	485	439	6.90	6.80
	02-10-86	1415	OCN CTY	14.0	6.0	60	480	--	6.85	--
	04-11-86	1210	OCN CTY	14.0	8.2	60	475	434	6.75	7.00
	07-09-86	1540	OCN CTY	14.5	9.5	43	490	--	6.82	--
	08-22-86	1325	OCN CTY	14.5	9.4	36	470	433	7.10	7.10
	12-04-86	1638	OCN CTY	14.0	9.5	40	395	--	6.91	--
WO Ae 25	09-19-75	1200	POCOMKE	13.5	12	--	--	--	--	--
	09-11-85	1300	POCOMKE	14.0	11	18	530	465	6.70	6.80
	02-10-86	1440	POCOMKE	14.0	8.5	60	485	--	6.95	--
	04-11-86	1300	POCOMKE	14.0	10	--	492	456	6.70	7.00
	07-09-86	1600	POCOMKE	14.5	10	60	515	--	6.88	--
	08-22-86	1410	POCOMKE	14.5	12	48	490	419	7.10	7.10
	12-04-86	1700	POCOMKE	14.0	9.0	48	490	--	6.93	--
WO Ah 34	04-26-72	0945	MANOKIN	--	55	--	--	--	--	--
	04-27-72	0310	MANOKIN	16.0	53	815	341	--	7.50	--
	05-17-76	1200	MANOKIN	--	56	--	--	--	--	--
	09-02-76	1200	MANOKIN	--	97	--	--	--	--	--
	09-22-76	1645	MANOKIN	--	83	--	--	--	--	--
	10-26-76	1200	MANOKIN	16.5	84	--	480	--	--	--
	12-07-76	1550	MANOKIN	--	87	--	--	--	--	--
	04-21-77	--	MANOKIN	17.0	88	--	--	--	--	--
	05-26-77	--	MANOKIN	17.5	80	--	--	--	--	--
	09-03-85	1145	MANOKIN	16.0	87	--	505	457	5.90	6.40
	10-21-85	1040	MANOKIN	16.0	85	--	460	--	--	--
	04-08-86	1145	MANOKIN	16.5	81	--	475	437	6.10	6.60
	07-14-86	1020	MANOKIN	17.0	82	--	490	--	6.48	--
	08-27-86	0955	MANOKIN	18.0	84	--	485	454	6.52	6.60
	12-01-86	1210	MANOKIN	16.0	86	--	480	--	4.40	--
WO Bg 15	09-10-85	1445	MANOKIN	14.5	26	75	310	261	6.60	6.50
	10-23-85	1045	MANOKIN	15.0	24	--	275	--	--	--
	02-10-86	1110	MANOKIN	15.0	25	60	275	--	6.50	--
	04-10-86	1125	MANOKIN	15.0	20	60	269	268	6.40	6.80

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	ALKA-LINITY TOTAL FIELD MG/L AS CACO3	ALKA-LINITY, CARBON-ATE IT-FLD (MG/L - CACO3)	BICAR-BONATE TOTAL FIELD MG/L AS HCO3	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, TOTAL (MG/L AS P)
WO Ae 23	--	56	--	68	--	0.04	--	--	0.13
	27	--	--	--	--	--	0.10	--	--
	--	--	--	--	--	--	--	--	--
	54	--	--	--	--	--	<0.10	0.21	--
	--	--	--	--	--	--	--	--	--
	21	--	67	--	--	--	<0.10	0.03	--
	37	66	--	--	--	--	--	--	--
WO Ae 24	--	221	--	270	--	0.01	--	--	0.50
	53	--	--	--	--	--	<0.10	0.03	--
	--	--	--	--	--	--	--	--	--
	76	--	--	--	--	--	<0.10	0.37	--
	--	--	--	--	--	--	--	--	--
	39	--	255	--	--	--	<0.10	0.21	--
	58	242	--	--	--	--	--	--	--
WO Ae 25	--	238	--	290	--	0.02	--	--	0.45
	89	--	--	--	--	--	0.11	--	--
	--	--	--	--	--	--	--	--	--
	90	--	--	--	--	--	<0.10	0.06	--
	--	--	--	--	--	--	--	--	--
	41	--	265	--	--	--	<0.10	0.09	--
	--	--	--	--	--	--	--	--	--
WO Ah 34	--	--	--	--	--	--	--	--	--
	5.5	89	--	110	0.07	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	82	--	100	--	0.84	--	--	0.21
	--	90	--	110	--	0.95	--	--	0.16
	207	--	--	--	--	--	0.14	--	--
	--	--	--	--	--	--	--	--	--
	128	--	--	--	--	--	<0.10	0.12	--
	--	--	--	--	--	--	--	--	--
	72	--	122	--	--	--	<0.10	0.06	--
	8640	112	--	--	--	--	--	--	--
WO Bg 15	44	--	--	--	--	--	<0.10	0.61	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	69	--	--	--	--	--	<0.10	0.83	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB TOT FLD MG/L AS CACO3	HARD-NESS NONCAR-BONATE (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM
WO Ae 23	--	41	0	41	12	2.6	9.4	0.7	32
	<0.01	38	0	38	9.1	3.6	9.4	0.7	33
	--	--	--	--	--	--	--	--	--
	0.07	38	0	38	9.2	3.7	9.4	0.7	33
	--	--	--	--	--	--	--	--	--
	0.01	38	0	38	9.1	3.6	9.6	0.7	34
	--	--	--	--	--	--	--	--	--
WO Ae 24	--	200	0	200	76	2.6	7.4	0.2	7
	0.01	210	0	210	77	3.2	7.7	0.2	7
	--	--	--	--	--	--	--	--	--
	0.12	220	0	220	83	3.1	7.9	0.2	7
	--	--	--	--	--	--	--	--	--
	0.07	190	0	190	70	2.6	7.5	0.3	8
	--	--	--	--	--	--	--	--	--
WO Ae 25	--	220	0	220	86	1.8	8.3	0.3	7
	<0.01	220	0	220	85	2.3	8.3	0.3	8
	--	--	--	--	--	--	--	--	--
	0.02	230	0	230	90	2.2	8.6	0.3	7
	--	--	--	--	--	--	--	--	--
	0.03	230	0	230	90	2.2	8.7	0.3	7
	--	--	--	--	--	--	--	--	--
WO Ah 34	--	--	--	--	--	--	--	--	--
	--	80	0	80	23	5.6	38	2	49
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	<0.01	73	0	73	21	4.9	57	3	61
	--	--	--	--	--	--	--	--	--
	0.04	72	0	72	21	4.7	54	3	61
	--	--	--	--	--	--	--	--	--
	0.02	73	0	73	21	5.1	57	3	61
	--	--	--	--	--	--	--	--	--
WO Bg 15	0.20	63	0	63	17	5.0	24	1	44
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.27	60	0	60	16	4.9	24	1	45

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	POTASSIUM, DISSOLVED (MG/L AS K)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	IRON, TOTAL RECOVERABLE (UG/L AS FE)	IRON, DISSOLVED (UG/L AS FE)	MANGANESE, TOTAL RECOVERABLE (UG/L AS MN)	MANGANESE, DISSOLVED (UG/L AS MN)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)
WO Ae 23	2.9	1.7	0.1	28	5200	--	110	--	--
	3.4	1.8	<0.1	27	--	4800	--	97	98
	--	--	--	--	--	--	--	--	--
	3.1	12	<0.1	28	--	5400	--	97	93
	--	--	--	--	--	--	--	--	--
	2.9	12	<0.1	28	--	6600	--	82	98
	--	--	--	--	--	--	--	--	--
WO Ae 24	1.3	2.3	0.2	28	12000	--	90	--	--
	1.4	1.2	<0.1	29	--	14000	--	82	286
	--	--	--	--	--	--	--	--	--
	1.2	7.2	<0.1	30	--	14000	--	91	289
	--	--	--	--	--	--	--	--	--
	1.5	3.8	0.1	29	--	12000	--	84	290
	--	--	--	--	--	--	--	--	--
WO Ae 25	0.7	3.0	0.1	31	13000	--	120	--	--
	0.7	11	0.1	34	--	13000	--	120	307
	--	--	--	--	--	--	--	--	--
	0.6	8.6	<0.1	34	--	14000	--	130	309
	--	--	--	--	--	--	--	--	--
	0.8	8.7	0.1	36	--	14000	--	130	324
	--	--	--	--	--	--	--	--	--
WO Ah 34	--	--	--	--	--	--	--	--	--
	4.7	0	0.1	33	12000	--	180	--	216
	--	0.5	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	14000	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	2.1	0.1	33	1900	--	140	--	276
	--	0.5	0.3	34	1900	--	130	--	267
	5.1	16	<0.1	34	--	12000	--	130	278
	--	--	--	--	--	--	--	--	--
	3.8	19	<0.1	34	--	13000	--	140	258
	--	--	--	--	--	--	--	--	--
	4.4	14	<0.1	36	--	12000	--	130	264
	--	--	--	--	--	--	--	--	--
WO Bg 15	3.5	12	0.1	36	--	8700	--	130	168
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	3.2	18	<0.1	36	--	8900	--	110	173

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	SOLIDS, SUM OF CONSTIT-UENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS NO3)	ELEV. OF LAND SURFACE DATUM FT ABOVE SEA LEVEL	PUMP OR FLOW PERIOD PRIOR TO SAM-PLING (MIN)	DEPTH OF WELL, TOTAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH BELOW LAND SURFACE (WATER-LEVEL) (FT)	ALKA-LINITY LAB (MG/L AS CACO3)
WO Ae 23	98	--	40.0	--	280.00	270	280	--	--
	99	--	40.0	70	280.00	270	280	--	55
	--	--	40.0	30	280.00	270	280	13.40	--
	110	--	40.0	40	280.00	270	280	--	56
	--	--	40.0	25	280.00	270	280	16.11	--
	120	--	40.0	40	280.00	270	280	16.79	55
	--	--	40.0	26	280.00	270	280	16.70	--
WO Ae 24	260	--	40.0	--	200.00	190	200	--	--
	280	--	40.0	60	200.00	190	200	--	219
	--	--	40.0	25	200.00	190	200	10.57	--
	290	--	40.0	--	200.00	190	200	--	222
	--	--	40.0	25	200.00	190	200	13.60	--
	290	--	40.0	30	200.00	190	200	14.13	219
	--	--	40.0	18	200.00	190	200	13.96	--
WO Ae 25	290	--	40.0	--	118.00	108	118	--	--
	300	--	40.0	80	118.00	108	118	--	231
	--	--	40.0	25	118.00	108	118	8.25	--
	310	--	40.0	--	118.00	108	118	--	234
	--	--	40.0	15	118.00	108	118	11.76	--
	330	--	40.0	40	118.00	108	118	11.93	231
	--	--	40.0	20	118.00	108	118	11.60	--
WO Ah 34	--	--	5.0	--	450.00	350	450	--	--
	210	0.31	5.0	1200	450.00	350	450	--	--
	--	--	5.0	--	450.00	350	450	--	--
	--	--	5.0	--	450.00	350	450	--	--
	--	--	5.0	--	450.00	350	450	--	--
	--	--	5.0	--	450.00	350	450	--	--
	--	--	5.0	--	450.00	350	450	--	--
	--	--	5.0	--	450.00	350	450	--	--
	--	--	5.0	--	450.00	350	450	--	--
	290	--	5.0	--	450.00	350	450	--	85
	--	--	5.0	--	450.00	350	450	--	--
	280	--	5.0	--	450.00	350	450	--	83
	--	--	5.0	--	450.00	350	450	--	--
	310	--	5.0	760	450.00	350	450	--	85
	--	--	5.0	10	450.00	350	450	--	--
WO Bg 15	190	--	7.0	40	325.00	288	318	--	90
	--	--	7.0	30	325.00	288	318	--	--
	--	--	7.0	40	325.00	288	318	-2.28	--
	190	--	7.0	60	325.00	288	318	--	90

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	DATE	TIME	AQUIFER UNIT	TEMPER-ATURE (DEG C)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLOW RATE, INSTAN-TANEOUS (GPM)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM)	PH (STAND-ARD UNITS)
WO Bg 15	07-10-86	1435	MANOKIN	15.0	25	60	270	--	6.40
	08-26-86	1150	MANOKIN	15.5	26	40	266	254	6.75
	12-03-86	1300	MANOKIN	15.0	26	60	260	--	6.24
WO Bg 45	02-10-86	1205	UNCONFD	13.5	13	70	73	--	6.15
	04-10-86	1230	UNCONFD	13.5	14	70	75	--	5.70
	07-10-86	1525	UNCONFD	14.0	15	70	80	--	5.80
	08-26-86	1305	UNCONFD	14.0	15	40	77	--	5.83
	12-03-86	1405	UNCONFD	13.5	15	50	78	--	5.25
WO Bg 46	02-10-86	1145	POCOMKE	14.0	6.0	70	270	--	6.65
	04-10-86	1200	POCOMKE	14.0	10	60	258	--	6.40
	07-10-86	1505	POCOMKE	14.0	10	60	275	--	6.50
	08-26-86	1230	POCOMKE	14.5	10	50	238	--	6.60
	12-03-86	1335	POCOMKE	14.0	10	60	260	--	6.28
WO Bg 47	10-28-76	1200	OCN CTY	16.5	68	--	--	--	--
	06-19-85	0955	OCN CTY	16.0	53	18	410	--	6.85
	08-29-85	1530	OCN CTY	15.0	52	30	412	366	6.70
	10-22-85	1430	OCN CTY	16.0	49	--	395	--	--
	02-12-86	1225	OCN CTY	15.5	49	50	385	--	6.60
	04-09-86	1440	OCN CTY	16.0	47	--	370	373	6.50
	07-10-86	1310	OCN CTY	16.5	50	33	400	--	6.70
	08-26-86	1550	OCN CTY	16.5	51	26	380	356	6.75
	12-03-86	1555	OCN CTY	16.0	49	35	350	--	7.00
WO Bg 48	10-28-76	1200	MANOKIN	17.0	87	--	485	--	--
	06-19-85	1130	MANOKIN	18.0	65	30	430	--	6.75
	08-29-85	1700	MANOKIN	16.0	68	50	454	415	6.60
	10-22-85	1400	MANOKIN	17.0	63	--	440	--	--
	02-12-86	1140	MANOKIN	16.5	65	60	430	--	6.65
	04-09-86	1400	MANOKIN	16.5	62	--	432	429	6.50
	07-10-86	1235	MANOKIN	16.5	65	43	440	--	6.62
	08-26-86	1510	MANOKIN	17.0	65	30	430	--	6.69
	12-03-86	1520	MANOKIN	17.0	67	40	400	--	6.85
WO Bg 49	10-16-75	1345	OCN CTY	14.5	17	--	--	--	--
	06-19-85	1435	OCN CTY	15.0	15	16	418	--	7.57
	09-10-85	1245	OCN CTY	15.0	15	15	448	415	7.40
	10-23-85	1230	OCN CTY	15.5	15	15	420	--	--
	02-06-86	1555	OCN CTY	15.0	12	23	418	--	7.15
	04-10-86	1420	OCN CTY	15.0	12	25	400	413	7.30
	07-11-86	1345	OCN CTY	15.5	15	15	430	--	7.33
	12-04-86	1150	OCN CTY	15.0	16	20	390	--	7.68
WO Bh 28	09-03-85	1515	MANOKIN	16.0	160	--	820	748	6.70

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	PH LAB (STAND-ARD UNITS)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	ALKA-LINITY TOTAL FIELD MG/L AS CACO3	ALKA-LINITY, CARBON-ATE IT-FLD (MG/L - CACO3)	BICAR-BONATE TOTAL FIELD MG/L AS HCO3	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, TOTAL (MG/L AS P)
WO Bg 15	--	--	--	--	--	--	--	--	--
	6.80	35	--	102	--	--	<0.10	0.92	--
	--	108	97	--	--	--	--	--	--
WO Bg 45	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	56	--	20	--	--	--	--	--
	--	152	14	--	--	--	--	--	--
WO Bg 46	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	59	--	122	--	--	--	--	--
	--	119	117	--	--	--	--	--	--
WO Bg 47	--	--	95	--	120	<0.10	--	--	0.27
	--	--	--	--	--	--	--	--	--
	6.60	39	--	--	--	--	<0.10	0.09	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.80	62	--	--	--	--	<0.10	1.0	--
	--	--	--	--	--	--	--	--	--
	6.90	41	--	120	--	--	<0.10	1.1	--
	--	20	105	--	--	--	--	--	--
WO Bg 48	--	--	107	--	130	<0.10	--	--	0.29
	--	--	--	--	--	--	--	--	--
	6.60	51	--	--	--	--	<0.10	0.58	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.80	65	--	--	--	--	<0.10	0.95	--
	--	--	--	--	--	--	--	--	--
	--	47	--	118	--	--	--	--	--
	--	30	108	--	--	--	--	--	--
WO Bg 49	--	--	201	--	250	0.28	--	--	0.13
	--	--	--	--	--	--	--	--	--
	7.40	15	--	--	--	--	<0.10	0.21	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	7.60	20	--	205	--	--	<0.10	0.18	--
	--	--	--	--	--	--	--	--	--
	--	7.4	183	--	--	--	--	--	--
WO Bh 28	6.70	44	--	--	--	--	<0.10	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB TOT FLD MG/L AS CACO3	HARD-NESS NONCAR-BONATE (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM
WO Bg 15	--	--	--	--	--	--	--	--	--
	0.30	71	0	71	20	5.2	24	1	41
	--	--	--	--	--	--	--	--	--
WO Bg 45	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Bg 46	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Bg 47	--	68	0	68	15	7.3	56	3	62
	--	--	--	--	--	--	--	--	--
	0.03	59	0	59	13	6.4	49	3	62
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.33	62	0	62	14	6.5	50	3	61
	--	--	--	--	--	--	--	--	--
	0.37	140	17	140	45	5.9	23	0.9	26
	--	--	--	--	--	--	--	--	--
WO Bg 48	--	70	0	70	15	8.0	65	3	64
	--	--	--	--	--	--	--	--	--
	0.19	70	0	70	15	7.9	51	3	58
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.31	74	0	74	16	8.3	53	3	58
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Bg 49	--	120	0	120	33	10	37	1	37
	--	--	--	--	--	--	--	--	--
	0.07	100	0	100	27	8.0	48	2	48
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.06	120	0	120	31	9.5	42	2	41
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Bh 28	<0.01	110	0	110	19	16	94	4	61

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	POTASSIUM, DISSOLVED (MG/L AS K)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	IRON, TOTAL RECOVERABLE (UG/L AS FE)	IRON, DISSOLVED (UG/L AS FE)	MANGANESE, TOTAL RECOVERABLE (UG/L AS MN)	MANGANESE, DISSOLVED (UG/L AS MN)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)
WO Bg 15	--	--	--	--	--	--	--	--	--
	3.4	20	0.1	37	--	9600	--	98	179
	--	--	--	--	--	--	--	--	--
WO Bg 45	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Bg 46	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Bg 47	5.8	0.7	0.1	36	7400	100	120	120	224
	--	--	--	--	--	--	--	--	--
	4.9	12	0.1	35	--	8300	--	97	226
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	5.3	27	<0.1	37	--	8200	--	94	202
	--	--	--	--	--	--	--	--	--
	5.1	13	0.1	35	--	7000	--	85	220
	--	--	--	--	--	--	--	--	--
WO Bg 48	7.1	1.2	0.2	37	4300	400	100	100	267
	--	--	--	--	--	--	--	--	--
	9.1	1.2	0.1	37	--	4700	--	94	250
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	7.6	9.2	0.2	37	--	4800	--	91	253
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Bg 49	10	2.9	0.2	23	2200	--	50	--	--
	--	--	--	--	--	--	--	--	--
	11	<0.2	<0.1	23	--	990	--	24	243
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	9.9	18	<0.1	23	--	1500	--	29	252
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Bh 28	13	2.0	0.1	34	--	7400	--	140	411

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	ELEV. OF LAND SURFACE DATUM FT ABOVE SEA LEVEL	PUMP OR FLOW PERIOD PRIOR TO SAMPLING (MIN)	DEPTH OF WELL, TOTAL (FT)	DEPTH TO TOP OF SAMPLE INTERVAL (FT)	DEPTH TO BOTTOM OF SAMPLE INTERVAL (FT)	DEPTH BELOW LAND SURFACE (WATER-LEVEL) (FT)	ALKALINITY LAB (MG/L AS CACO3)
WO Bg 15	--	7.0	45	325.00	288	318	1.62	--
	210	7.0	40	325.00	288	318	2.76	88
	--	7.0	30	318.00	288	318	--	--
WO Bg 45	--	10.0	15	77.00	56	77	6.89	--
	--	10.0	20	77.00	56	77	8.20	--
	--	10.0	15	77.00	56	77	9.59	--
	--	10.0	30	77.00	56	77	9.28	--
	--	10.0	25	77.00	56	77	9.10	--
WO Bg 46	--	10.0	25	200.00	164	194	1.29	--
	--	10.0	35	200.00	164	194	2.22	--
	--	10.0	30	200.00	164	194	5.04	--
	--	10.0	35	200.00	164	194	5.61	--
	--	10.0	25	194.00	164	194	4.08	--
WO Bg 47	250	5.0	--	268.00	258	268	--	--
	--	5.0	50	268.00	258	268	--	--
	240	5.0	60	268.00	258	268	--	100
	--	5.0	30	268.00	258	268	--	--
	--	5.0	25	268.00	258	268	5.44	--
	260	5.0	40	268.00	258	268	--	102
	--	5.0	30	268.00	258	268	11.04	--
	260	5.0	35	268.00	258	268	12.16	101
	--	5.0	30	268.00	258	268	6.86	--
WO Bg 48	280	5.0	--	420.00	410	420	--	--
	--	5.0	30	420.00	410	420	--	--
	260	5.0	50	420.00	410	420	--	105
	--	5.0	30	420.00	410	420	--	--
	--	5.0	40	420.00	410	420	5.54	--
	260	5.0	35	420.00	410	420	--	106
	--	5.0	40	420.00	410	420	12.40	--
	--	5.0	45	420.00	410	420	13.85	--
	--	5.0	40	420.00	410	420	7.34	--
WO Bg 49	250	10.0	--	243.00	233	243	10.00	--
	--	10.0	65	243.00	233	243	--	--
	--	10.0	55	243.00	233	243	--	198
	--	10.0	--	243.00	232	243	--	--
	--	10.0	30	243.00	232	243	10.42	--
	270	10.0	--	243.00	232	243	--	201
	--	10.0	35	243.00	232	243	19.12	--
	--	10.0	30	243.00	233	243	8.97	--
WO Bh 28	410	5.0	--	294.00	248	294	--	115

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	DATE	TIME	AQUIFER UNIT	TEMPER-ATURE (DEG C)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLOW RATE, INSTAN-TANEOUS (GPM)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM)	PH (STAND-ARD UNITS)
WO Bh 28	10-21-85	1115	OCN CTY	17.0	80	--	480	--	--
	02-06-86	1215	OCN CTY	16.0	200	--	900	--	6.65
	04-08-86	1300	OCN CTY	17.0	160	--	837	802	6.35
	07-14-86	1145	OCN CTY	17.0	150	--	760	--	6.47
	08-27-86	1340	OCN CTY	17.0	160	--	740	741	6.72
	12-01-86	1345	OCN CTY	16.0	120	--	670	--	6.70
WO Bh 31	04-24-86	1120	MANOKIN	16.5	260	--	1080	1070	6.65
WO Bh 34	09-06-85	1145	MANOKIN	15.0	18	37	241	196	6.60
	10-22-85	1050	MANOKIN	16.5	15	43	220	--	--
	02-06-86	1155	MANOKIN	15.5	15	60	218	--	--
	04-09-86	1210	MANOKIN	16.5	14	60	219	214	6.30
	07-14-86	1510	MANOKIN	16.5	16	41	230	--	6.52
	08-27-86	1640	MANOKIN	17.0	15	30	207	193	6.69
	12-04-86	1000	MANOKIN	16.0	16	40	203	--	6.71
WO Bh 84	04-18-73	1518	UNCONFD	--	39	150	338	--	7.90
	10-27-76	1200	UNCONFD	16.0	39	--	--	--	--
	10-22-85	1240	UNCONFD	16.0	37	60	350	--	--
	02-06-86	1400	UNCONFD	14.5	38	60	347	--	--
	04-08-86	1440	UNCONFD	15.5	36	33	350	255	6.60
	07-14-86	1225	UNCONFD	16.0	39	55	365	--	6.76
	08-27-86	1505	UNCONFD	16.0	40	50	365	346	6.91
	12-03-86	1125	UNCONFD	15.5	46	50	370	--	6.69
WO Bh 85	04-20-73	1453	POCOMKE	--	46	25	412	--	8.00
	10-27-76	1200	POCOMKE	17.5	46	--	--	--	--
	10-22-85	1200	POCOMKE	16.5	45	8.0	440	--	--
	02-06-86	1340	POCOMKE	15.0	45	8.0	418	--	--
	04-08-86	1350	POCOMKE	16.0	43	20	430	414	6.50
	07-14-86	1205	POCOMKE	16.5	46	20	430	--	6.67
	08-27-86	1425	POCOMKE	16.5	46	16	410	405	6.79
	12-03-86	1050	POCOMKE	16.0	46	16	410	--	6.60
WO Bh 89	09-15-86	1300	MANOKIN	17.5	440	--	1500	1680	6.70
WO Cg 32	09-03-85	1430	OCN CTY	16.0	40	--	468	436	7.40
	10-21-85	1130	OCN CTY	17.0	37	--	430	--	--
	02-06-86	1255	OCN CTY	16.0	32	--	450	--	7.00
	04-08-86	1530	OCN CTY	16.5	37	--	450	441	6.60
	07-14-86	1300	OCN CTY	17.0	38	--	460	--	6.98
	08-27-86	1120	OCN CTY	17.0	35	--	440	--	7.14
WO Cg 69	06-19-85	1810	OCN CTY	17.0	18	18	445	--	7.60
	09-09-85	1230	OCN CTY	15.0	19	16	445	419	7.10
	10-23-85	1350	OCN CTY	15.5	17	25	430	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	PH LAB (STAND-ARD UNITS)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	ALKA-LINITY TOTAL FIELD MG/L AS CACO3	ALKA-LINITY, CARBON-ATE IT-FLD (MG/L - CACO3)	BICAR-BONATE TOTAL FIELD MG/L AS HCO3	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)
WO Bh 28	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.80	101	--	--	--	--	<0.10	0.06	0.02
	--	--	--	--	--	--	--	--	--
	6.80	50	--	135	--	--	<0.10	0.21	0.07
	--	--	--	--	--	--	--	--	--
WO Bh 31	6.80	55	--	--	--	--	<0.10	0.09	0.03
WO Bh 34	6.30	36	--	--	--	--	0.11	--	<0.01
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.70	71	--	--	--	--	<0.10	0.06	0.02
	--	--	--	--	--	--	--	--	--
	6.60	40	--	102	--	--	<0.10	0.34	0.11
	--	34	90	--	--	--	--	--	--
WO Bh 84	--	2.6	108	--	130	0.264	0.27	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	7.10	40	--	--	--	--	<0.10	0.8	0.26
	--	--	--	--	--	--	--	--	--
	7.00	31	--	132	--	--	<0.10	0.64	0.21
	--	51	128	--	--	--	--	--	--
WO Bh 85	--	2.6	136	--	170	0.063	0.07	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.90	84	--	--	--	--	<0.10	0.49	0.16
	--	--	--	--	--	--	--	--	--
	6.90	45	--	143	--	--	<0.10	0.49	0.16
	--	60	124	--	--	--	--	--	--
WO Bh 89	7.00	0.7	172	1.7	--	--	<0.10	0.03	0.01
WO Cg 32	7.40	13	--	--	--	--	<0.10	0.21	0.07
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	7.60	84	--	--	--	--	<0.10	0.28	0.09
	--	--	--	--	--	--	--	--	--
	--	25	--	177	--	--	--	--	--
WO Cg 69	--	--	--	--	--	--	--	--	--
	7.30	30	--	--	--	--	<0.10	0.15	0.05
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB TOT FLD MG/L AS CACO3	HARD-NESS NONCAR-BONATE (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM	POTAS-SIUM, DIS-SOLVED (MG/L AS K)
WO Bh 28	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	110	0	110	19	16	110	5	66	10
	--	--	--	--	--	--	--	--	--
	110	0	110	18	16	96	4	65	1.3
	--	--	--	--	--	--	--	--	--
WO Bh 31	130	0	130	23	17	160	6	71	12
WO Bh 34	58	0	58	14	5.7	11	0.6	27	5.4
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	61	0	61	15	5.7	12	0.7	28	5.0
	--	--	--	--	--	--	--	--	--
	58	0	58	14	5.6	11	0.6	27	4.7
	--	--	--	--	--	--	--	--	--
WO Bh 84	88	0	88	17	11	30	1	40	8.1
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	90	7	90	18	11	29	1	38	9.1
	--	--	--	--	--	--	--	--	--
	88	0	88	17	11	29	1	39	8.7
	--	--	--	--	--	--	--	--	--
WO Bh 85	93	0	93	16	13	41	2	44	14
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	100	0	100	17	14	38	2	42	11
	--	--	--	--	--	--	--	--	--
	100	0	100	17	14	39	2	42	14
	--	--	--	--	--	--	--	--	--
WO Bh 89	210	210	210	25	37	230	7	68	16
WO Cg 32	130	0	130	33	11	36	1	36	11
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	130	0	130	33	11	36	1	36	9.5
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Cg 69	--	--	--	--	--	--	--	--	--
	130	0	130	32	12	34	1	33	15
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	SULFATE DIS-SOLVED (MG/L AS SO4)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTIT-UENTS, DIS-SOLVED (MG/L)
WO Bh 28	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	38	0.2	33	--	7200	--	130	431	460
	--	--	--	--	--	--	--	--	--
	1.4	0.2	33	--	7100	--	130	430	410
	--	--	--	--	--	--	--	--	--
WO Bh 31	0.9	0.2	33	--	9200	--	180	588	590
WO Bh 34	27	<0.1	35	--	12000	--	100	138	170
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	26	0.1	35	--	12000	--	91	161	170
	--	--	--	--	--	--	--	--	--
	2.5	0.1	36	--	5300	--	100	152	160
	--	--	--	--	--	--	--	--	--
WO Bh 84	6.0	0.3	33	11000	--	120	--	--	210
	--	--	--	6300	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	12	<0.1	36	--	6400	--	75	228	210
	--	--	--	--	--	--	--	--	--
	13	0.1	35	--	6300	--	78	212	240
	--	--	--	--	--	--	--	--	--
WO Bh 85	5.0	0.5	6.6	19000	--	270	--	--	220
	--	--	--	4400	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	5.4	<0.1	33	--	4200	--	74	235	250
	--	--	--	--	--	--	--	--	--
	3.4	0.1	33	--	4500	--	87	222	260
	--	--	--	--	--	--	--	--	--
WO Bh 89	3.6	0.2	35	--	7800	--	120	1140	800
WO Cg 32	0.5	0.2	26	--	550	--	82	260	260
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.2	0.2	25	--	1400	--	82	253	260
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
WO Cg 69	--	--	--	--	--	--	--	--	--
	0.4	<0.1	21	--	1000	--	47	257	250
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	NITROGEN, NITRATE DISSOLVED (MG/L AS NO3)	ELEV. OF LAND SURFACE DATUM FT ABOVE SEA LEVEL	PUMP OR FLOW PERIOD PRIOR TO SAMPLING (MIN)	DEPTH OF WELL, TOTAL (FT)	DEPTH TO TOP OF SAMPLE INTERVAL (FT)	DEPTH TO BOTTOM OF SAMPLE INTERVAL (FT)	DEPTH BELOW LAND SURFACE (WATER-LEVEL) (FT)	ALKALINITY LAB (MG/L AS CACO3)
WO Bh 28	--	5.0	--	294.00	248	294	--	--
	--	5.0	20	294.00	248	294	--	--
	--	5.0	--	294.00	248	294	--	117
	--	5.0	--	294.00	248	294	--	--
	--	5.0	760	294.00	248	294	--	118
	--	5.0	15	294.00	248	294	--	--
WO Bh 31	--	5.0	--	278.00	263	278	--	127
WO Bh 34	--	4.0	60	353.00	337	353	--	73
	--	4.0	20	353.00	337	353	7.75	--
	--	4.0	20	353.00	337	353	4.19	--
	--	4.0	45	353.00	337	353	--	73
	--	4.0	20	353.00	337	353	12.52	--
	--	4.0	40	353.00	337	353	14.69	72
	--	4.0	25	353.00	337	353	5.74	--
WO Bh 84	1.2	5.0	30	86.00	81	86	--	--
	--	5.0	--	86.00	81	86	--	--
	--	5.0	--	86.00	81	86	--	--
	--	5.0	15	86.00	81	86	4.46	--
	--	5.0	--	86.00	81	86	--	83
	--	5.0	15	86.00	81	86	5.07	--
	--	5.0	50	86.00	81	86	5.16	110
	--	5.0	33	86.00	81	86	2.65	--
WO Bh 85	0.27	5.0	5	195.00	190	195	--	--
	--	5.0	--	195.00	190	195	--	--
	--	5.0	45	195.00	190	195	--	--
	--	5.0	60	195.00	190	195	4.46	--
	--	5.0	55	195.00	190	195	--	137
	--	5.0	30	195.00	190	195	6.27	--
	--	5.0	50	195.00	190	195	6.98	137
	--	5.0	30	195.00	190	195	2.95	--
WO Bh 89	--	5.0	--	500.00	388	500	90.00	159
WO Cg 32	--	4.0	--	280.00	245	280	--	168
	--	4.0	--	280.00	245	280	--	--
	--	4.0	--	280.00	245	280	--	--
	--	4.0	--	280.00	245	280	--	172
	--	4.0	--	280.00	245	280	--	--
	--	4.0	760	280.00	245	280	--	--
WO Cg 69	--	10.0	85	235.00	215	235	--	--
	--	10.0	65	235.00	215	235	--	195
	--	10.0	45	235.00	215	235	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	DATE	TIME	AQUIFER UNIT	TEMPER-ATURE (DEG C)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLOW RATE, INSTAN-TANEOUS (GPM)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM)	PH (STAND-ARD UNITS)
WO Cg 69	02-06-86	1445	OCN CTY	15.0	12	35	420	--	7.35
	04-10-86	1600	OCN CTY	15.0	17	50	400	423	7.40
	08-26-86	1015	OCN CTY	15.5	18	14	420	418	7.56
	12-04-86	1310	OCN CTY	15.0	19	25	390	--	--
WO Cg 75	09-03-85	1400	MANOKIN	17.0	78	--	500	456	6.90
	10-21-85	1135	MANOKIN	17.0	31	--	435	--	--
	02-06-86	1235	MANOKIN	16.5	59	--	525	--	6.00
	04-08-86	1615	MANOKIN	17.0	69	--	460	456	6.40
	07-14-86	1255	MANOKIN	18.0	77	--	500	--	6.46
	08-27-86	1145	MANOKIN	18.0	78	--	470	462	6.81
	12-01-86	1310	MANOKIN	17.0	64	--	430	--	6.73
WO De 36	09-11-75	1200	MANOKIN	15.5	9.3	--	340	--	--
	09-12-85	1600	MANOKIN	15.0	8.2	5.0	390	357	7.60
	04-24-86	1400	MANOKIN	17.0	8.0	4.5	300	--	--
WO Dg 21	10-09-75	1445	MANOKIN	16.0	26	--	365	--	--
	09-06-85	1445	MANOKIN	16.0	25	11	499	469	8.00
	10-24-85	1655	MANOKIN	16.5	24	21	485	--	--
	02-12-86	1415	MANOKIN	16.0	23	25	485	--	7.60
	04-11-86	1540	MANOKIN	16.5	24	27	475	482	7.40
	07-11-86	1110	MANOKIN	17.0	25	25	500	--	7.71
	08-25-86	1210	MANOKIN	17.0	24	16	480	487	7.92
	12-04-86	1415	MANOKIN	16.0	25	20	490	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	PH LAB (STAND-ARD UNITS)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	ALKA-LINITY TOTAL FIELD MG/L AS CACO3	ALKA-LINITY, CARBON-ATE IT-FLD (MG/L - CACO3)	BICAR-BONATE TOTAL FIELD MG/L AS HCO3	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, TOTAL (MG/L AS P)
WO Cg 69	--	--	--	--	--	--	--	--	--
	7.60	15	--	--	--	--	<0.10	0.18	--
	8.20	11	--	205	--	--	<0.10	--	--
	--	--	199	--	--	--	--	--	--
WO Cg 75	6.70	26	--	--	--	--	<0.10	0.92	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	6.90	84	--	--	--	--	<0.10	0.95	--
	--	--	--	--	--	--	--	--	--
	7.00	36	--	120	--	--	<0.10	1.2	--
	--	--	--	--	--	--	--	--	--
WO De 36	--	--	172	--	210	0.06	--	--	0.25
	7.40	8.8	--	--	--	--	0.13	0.37	--
	--	--	--	--	--	--	--	--	--
WO Dg 21	--	--	223	--	270	0.27	--	--	0.21
	7.70	4.1	--	--	--	--	<0.10	0.43	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	7.90	17	--	--	--	--	<0.10	0.52	--
	--	--	--	--	--	--	--	--	--
	7.90	5.2	--	222	--	--	<0.10	0.43	--
	--	--	205	--	--	--	--	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB TOT FLD MG/L AS CACO3	HARD-NESS NONCAR-BONATE (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM
WO Cg 69	--	--	--	--	--	--	--	--	--
	0.06	130	0	130	32	12	36	1	35
	--	140	0	140	33	13	34	1	33
	--	--	--	--	--	--	--	--	--
WO Cg 75	0.30	59	0	59	9.5	8.5	65	4	67
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.31	60	0	60	10	8.6	64	4	66
	--	--	--	--	--	--	--	--	--
	0.39	59	0	59	9.5	8.6	64	4	67
	--	--	--	--	--	--	--	--	--
WO De 36	--	110	0	110	36	5.1	29	1	35
	0.12	120	0	120	39	5.8	29	1	33
	--	--	--	--	--	--	--	--	--
WO Dg 21	--	150	0	150	39	13	44	2	37
	0.14	140	0	140	33	13	44	2	39
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	0.17	150	0	150	37	13	45	2	38
	--	--	--	--	--	--	--	--	--
	0.14	150	0	150	37	13	42	2	37
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	POTASSIUM, DISSOLVED (MG/L AS K)	SULFATE DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	IRON, TOTAL RECOVERABLE (UG/L AS FE)	IRON, DISSOLVED (UG/L AS FE)	MANGANESE, TOTAL RECOVERABLE (UG/L AS MN)	MANGANESE, DISSOLVED (UG/L AS MN)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)
WO Cg 69	--	--	--	--	--	--	--	--	--
	11	3.8	<0.1	20	--	1400	--	49	264
	12	1.1	0.1	24	--	1100	--	46	246
	--	--	--	--	--	--	--	--	--
WO Cg 75	9.0	2.5	0.2	29	--	6300	--	180	270
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	7.8	5.9	0.2	29	--	5500	--	150	260
	--	--	--	--	--	--	--	--	--
	7.2	8.4	0.2	29	--	7000	--	170	260
	--	--	--	--	--	--	--	--	--
WO De 36	3.7	1.8	0.3	30	2600	--	110	--	--
	4.3	0.4	0.1	27	--	730	--	91	227
	--	--	--	--	--	--	--	--	--
WO Dg 21	8.9	.2.0	0.1	21	1000	--	50	--	--
	12	0.5	<0.1	19	--	33	--	41	285
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	9.6	2.7	0.1	19	--	300	--	42	276
	--	--	--	--	--	--	--	--	--
	9.0	0.7	0.1	20	--	30	--	42	278
	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA
(MARYLAND WELLS)

WELL No.	SOLIDS, SUM OF CONSTIT-UENTS, DIS-SOLVED (MG/L)	ELEV. OF LAND SURFACE DATUM FT ABOVE SEA LEVEL	PUMP OR FLOW PERIOD PRIOR TO SAM-PLING (MIN)	DEPTH OF WELL, TOTAL (FT)	DEPTH TO TOP OF SAMPLE INTER-VAL (FT)	DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT)	DEPTH BELOW LAND SURFACE (WATER-LEVEL) (FT)	ALKA-LINITY LAB (MG/L AS CACO3)
WO Cg 69	--	10.0	45	235.00	215	235	9.89	--
	250	10.0	45	235.00	215	235	--	200
	260	10.0	60	235.00	215	235	20.11	195
	--	10.0	40	235.00	215	235	9.12	--
WO Cg 75	270	5.0	--	427.00	367	427	--	106
	--	5.0	--	427.00	367	427	--	--
	--	5.0	--	427.00	367	427	--	--
	270	5.0	--	427.00	367	427	--	109
	--	5.0	--	427.00	367	427	--	--
	290	5.0	30	427.00	367	427	--	106
	--	5.0	10	427.00	367	427	--	--
WO De 36	220	30.0	--	330.00	320	330	9.00	--
	220	30.0	100	330.00	320	330	--	181
	--	30.0	50	330.00	320	330	12.97	--
WO Dg 21	290	6.0	--	310.00	300	310	3.50	--
	280	6.0	75	310.00	300	310	--	214
	--	6.0	45	310.00	300	310	--	--
	--	6.0	40	310.00	300	310	1.03	--
	290	6.0	40	310.00	300	310	--	225
	--	6.0	40	310.00	300	310	2.42	--
	280	6.0	55	310.00	300	310	4.63	225
	--	6.0	30	310.00	300	310	2.51	-