GROUND-WATER WITHDRAWALS FROM THE COASTAL PLAIN OF NEW JERSEY, 1956-80

By Eric F. Vowinkel

U.S. GEOLOGICAL SURVEY

Open-File Report 84-226

Prepared in cooperation with the
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION,
DIVISION OF WATER RESOURCES

Trenton, New Jersey

1984

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information, write to:

District Chief
U.S. Geological Survey
Room 418, Federal Building
402 East State Street
Trenton, New Jersey 08608

Copies of this report can be purchased from:

Open-File Services Section
Western Distribution Section
U.S. Geological Survey
Box 25425, Federal Center
Denver, Colorado 80225
(Telephone: (303) 234-5888)

CONTENTS

	Page
Abstract	1
Introduction	2
Purpose and scope	2
Previous studies	2
Acknowledgments	4
Ground-Water Withdrawal Data Management System	4
Ground-Water Site Inventory	5
Ground-Water Withdrawal Inventory	5
Ground-water withdrawals from the Coastal Plain	6
Withdrawals by type of use	6
Public supply	6
Industrial	12
Agricultural	13
Withdrawals by aquifer	14
Potomac-Raritan-Magothy aquifer system	22
Englishtown aquifer	23
Wenonah-Mount Laurel aquifer	23
Atlantic City 800-foot sand	24
Kirkwood-Cohansey aquifer system	25
Other aquifers	26
Summary and conclusions	27
Selected references	28
Glossary	32

ILLUSTRATIONS

Figure 1.	Map of the Coastal Plain of New Jersey	3
2.	Maps of ground-water withdrawal sites in the Coastal Plain of New Jersey by type of use, 1956-80	8
3.	Graph of ground-water withdrawals from the Coastal Plain of New Jersey by type of use, 1956-80	10
4.	Graph of monthly ground-water withdrawals from the Coastal Plain of New Jersey by type of use, 1980	11
5.	Maps of withdrawal sites in the Potomac-Raritan-Magothy aquifer system, Englishtown aquifer, and Wenonah-Mount Laurel aquifer in New Jersey, 1956-80	16
6.	Maps of withdrawal sites in the Atlantic City 800-foot sand and the Kirkwood-Cohansey aquifer system in New Jersey, 1956-80	18

ILLUSTRATIONS--Continued

Page

7. Graph of withdrawals from the Coastal Plain of New Jersey by aquifer, 1956-80..... 20

8. Graph of monthly withdrawals from the Coastal Plain of New Jersey by aquifer, 1980... 21

TABLES

Page

Table 1. Ground-water withdrawals from the Coastal Plain of New Jersey by type of use and county, 1980... 7

2. Lithology and water-bearing characteristics of geologic formations of the Coastal Plain of New Jersey..... 15

3. Withdrawals from the Coastal Plain of New Jersey by aquifer and county, 1980..... 19

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

For those readers who may prefer to use International System units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain SI unit
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
foot (ft)	0.3048	meter (m)
foot per second (ft/s)	0.3048	meter per second (m/s)
inch (in.)	25.40	millimeter (mm)
mile (mi)	1.609	kilometer (km)
million gallons per day (Mgal/d)	0.0438	cubic meter per second (m^3/s)
square foot (ft^2)	0.0929	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)

GROUND-WATER WITHDRAWALS FROM THE COASTAL PLAIN OF NEW JERSEY, 1956-80

By Eric F. Vowinkel

ABSTRACT

Withdrawal and site data for wells with pump capacities of 100,000 gallons per day or greater in the Coastal Plain of New Jersey are stored in computer files for the years 1956-80. The data are aggregated by computer into tables, graphs, and maps to show the distribution of ground-water withdrawals. Withdrawals are reported by type of use and aquifer for each county in the Coastal Plain.

Public-supply wells withdraw the largest quantity of ground water in the Coastal Plain, followed by industrial and agricultural wells. In 1980, public-supply withdrawals were about 280 million gallons per day. Maximum monthly withdrawals were about 355 million gallons per day in July, and the lowest rate was about 215 million gallons per day in February. Average industrial withdrawals were about 65 million gallons per day. Ground-water withdrawals for agriculture differ significantly during the year due to crop irrigation. In 1980, about 75 percent of the agricultural withdrawals occurred from June through September.

Several aquifers are used as sources of water supply in the Coastal Plain. Five regional aquifers are the major sources of water for public-supply, industrial, or agricultural use. In decreasing order of withdrawals in 1980, in million gallons per day they are: The Potomac-Raritan-Magothy aquifer system, 243; Kirkwood-Cohansey aquifer system, 70; Atlantic City 800-foot sand, 21; Englishtown aquifer, 12; and the Wenonah-Mount Laurel aquifer, 5. The Potomac-Raritan-Magothy aquifer system is the primary source of ground water in Camden, Burlington, Gloucester, Salem, Middlesex, Monmouth, and Mercer Counties. The Kirkwood-Cohansey aquifer system is the primary source of water supply in Atlantic, Cape May, Ocean, and Cumberland Counties.

INTRODUCTION

Ground water is the primary source of freshwater supply in the Coastal Plain of New Jersey (fig. 1). The Coastal Plain covers all of Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Monmouth, Ocean, and Salem Counties and parts of Mercer and Middlesex Counties. Many water-supply problems associated with the increasing demand for ground water in the Coastal Plain have been documented by the U.S. Geological Survey. These problems include decreasing ground-water levels and induced recharge of fresh, brackish, or saline water from surface water or from adjacent aquifers. In order to correlate these problems with ground-water withdrawals, a Ground-Water Withdrawal Data Management System was developed by the U.S. Geological Survey to aid planners and ground-water modelers in the management of ground-water supply. Simulation models of aquifers within the Coastal Plain require accurate ground-water withdrawal information as part of the analysis.

Purpose and Scope

The purpose of this report is to present aggregated ground-water withdrawal data that have been computerized for the Coastal Plain of New Jersey and to describe the Ground-Water Site Inventory (GWSI) and Ground-Water-Withdrawal Inventory files of the Ground-Water-Withdrawal Data Management System.

Data were collected for the 25-year period, 1956-80, on large-capacity wells (pump capacities of 100,000 gallons per day or greater), in cooperation with the New Jersey Department of Environmental Protection, Division of Water Resources. The data are aggregated by type of use, aquifer, and county and are presented in tables, graphs, and maps to show the distribution of withdrawals.

Previous Studies

Computerized ground-water withdrawal data for the Coastal Plain of New Jersey were reported by Vowinkel and Foster (1981). In that report, ground-water withdrawal data were reported by type of use, aquifer, and county for 1978.

Earlier studies of the Coastal Plain report withdrawal data for individual counties, aquifers, or local areas, and usually for a limited period. Water-resources investigations that report ground-water withdrawal data for the Coastal Plain include: Clark and others, 1968 (Atlantic County); Rush, 1968 (Burlington County); Farlekas and others, 1976 (Camden County); Gill, 1962a (Cape May County), Rooney, 1971 (Cumberland County); Hardt and Hilton, 1969 (Gloucester County); Vecchioli and Palmer, 1962 (Mercer County); Barksdale and others, 1943 (Middlesex County); Jablonski, 1968 (Monmouth County), Anderson and Appel, 1969 (Ocean

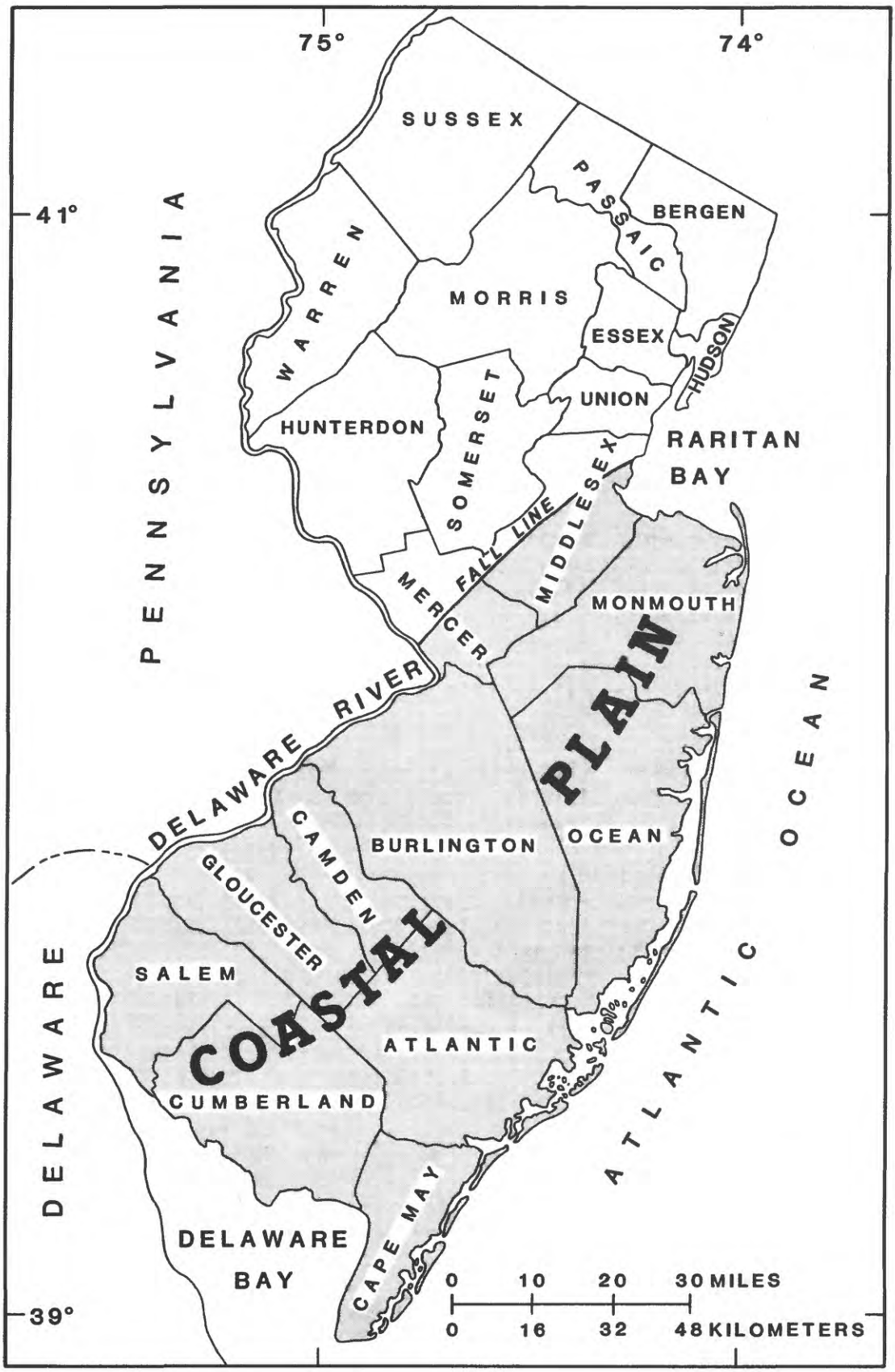


Figure 1.-- The Coastal Plain of New Jersey.

County); and Rosenau and others, 1969 (Salem County). Parker and others (1964) investigated the water resources of the Delaware River basin. Rhodehamel (1973, 1970) investigated the geology and hydrology of the Mullica River basin and the Pine Barrens region of the Coastal Plain.

Aquifer-simulation studies that have reported ground-water withdrawal data for modeled areas of aquifers in the Coastal Plain include those of the Potomac-Raritan-Magothy aquifer system (Luzier, 1980), Farrington aquifer (Farlekas, 1979), Englishtown aquifer (Nichols, 1977b), and the Wenonah-Mount Laurel aquifer (Nemickas, 1976).

Acknowledgments

Special thanks are extended to the New Jersey Department of Environmental Protection, Division of Water Resources (NJDEP/DWR) and the New Jersey Bureau of Geology for assisting in the collection of data.

Acknowledgment is given to private and public organizations (drillers, water companies, industries, and farmers) for providing well-construction and withdrawal information to the NJDEP/DWR or directly to the U.S. Geological Survey when requested.

GROUND-WATER WITHDRAWAL DATA MANAGEMENT SYSTEM

A Ground-Water Withdrawal Data Management System for the Coastal Plain of New Jersey has been developed and maintained through a cooperative agreement between the U.S. Geological Survey and NJDEP/DWR. Records of completed wells are obtained by NJDEP/DWR from well drillers and withdrawal data from well owners through an extensive permit system. The U.S. Geological Survey maintains the computer data files and develops computer programs for analyzing and retrieving data.

The Ground-Water Withdrawal Data Management System is a subset of the New Jersey Water-Use Data System (NJWUDS) being developed to store individual site water-use information for New Jersey. This information will be aggregated by functional use category for each county and hydrologic unit within the state and then transmitted to the National Water-Use Data System (NWUDS) computer files at U.S. Geological Survey National Headquarters, Reston, Virginia. Both NJWUDS and NWUDS are capable of storing withdrawal, usage and return information. However, this report deals exclusively with ground-water withdrawal information.

The data-management system consists of two data files. The Ground-Water Site Inventory contains data on selected wells in New Jersey. The Ground-Water Withdrawal Inventory stores monthly withdrawals for wells or well fields with pump capacities of 100,000 gallons per day or greater. Computer software has been

developed to interface the two data files and compile them into tables, graphs, and maps. Each data file is described briefly in the following sections.

Ground-Water Site Inventory

The Ground-Water Site Inventory (GWSI) is part of the WATSTORE computer storage and retrieval system used by the U.S. Geological Survey (U.S. Geological Survey, 1975). The GWSI file contains physical, hydrologic, and geologic data for selected well sites throughout the United States. The New Jersey District of the U.S. Geological Survey maintains a subset of the information entered into the National file on the District's minicomputer.

Most of the data stored in the computer file is obtained from records of completed wells submitted by licensed well drillers to NJDEP/DWR. The well records provide information on the dimensions of wells and well-acceptance tests at the time of construction. Additional information, such as latitude, longitude, and altitude of the land surface of the site, is determined in the field or from topographic maps. The aquifer is determined from sediment logs and available geophysical logs.

Ground-Water Withdrawal Inventory

The State of New Jersey has taken an active role in the management of water supply. Various laws pertaining to the diversion or withdrawal of water have been passed in order to regulate water supply. The history of the State's role in water-supply management is chronicled in Tasks VIII and X of the New Jersey Statewide Water-Supply Plan (Havens and Emerson, Inc., and others, 1980). Several laws require water users to report the amount of water diverted or withdrawn by their facility or well to NJDEP/DWR on a quarterly or annual basis.

State approval of ground-water withdrawals for public supply has been required since 1910. Withdrawal rates have been reported to the regulatory agency since 1917. In 1947 a statute was enacted requiring private users of ground water in protected areas to obtain permits and report withdrawals from wells with pump capacities of 100,000 gallons per day or greater.

Owners of wells with pump capacities of 100,000 gallons per day drilled prior to the enactment of the 1947 statute were given "grandfather rights." These owners were allowed to continue pumping ground water without obtaining a permit and were not required to report withdrawals to NJDEP until 1980. Legislation enacted in 1980 required all owners with grandfather rights to obtain permits and report withdrawal data.

The Ground-Water Withdrawal Inventory includes monthly withdrawal-rate data on individual wells or well fields in the Coastal Plain with pump capacities of 100,000 gallons per day or greater for the period 1956-80. Approximately 80 percent of the

withdrawal data in the file is based on metered pumpage and is reported by well owners to NJDEP/DWR on a quarterly basis. Withdrawals reported by farmers usually are estimates based on the rated capacity of the pump and the number of hours of operation. About 10 percent of the data consists of estimates of hours of operation by the owner. The remaining 10 percent of the data consists of estimates of unreported or missing data.

GROUND-WATER WITHDRAWALS FROM THE COASTAL PLAIN

Ground-water-withdrawal and site data can be aggregated by the computer into tables, graphs, and maps to show the distribution of demand for ground water in the Coastal Plain. In this report, data are aggregated by: (1) Type of use, (2) aquifer, and (3) county. Trends and variations in withdrawal data reported in the tables, graphs, and maps are analyzed for their hydrologic significance.

Withdrawals by Type of Use

Ground-water-withdrawal data are aggregated into three use categories: (1) Public supply, (2) industrial, and (3) agricultural. Ground-water-withdrawal sites for the three use categories are located in figure 2 and withdrawals for the three use categories for the 11 Coastal Plain counties for 1980 are given in table 1. The withdrawals do not include domestic or unavailable grandfather-rights withdrawals.

Figure 3 shows trends of ground-water withdrawals from 1956-80 for the three use categories and their combined total withdrawals. Figure 4 shows monthly withdrawals for each category and their combined total withdrawals for 1980.

Public Supply

Public-supply systems consist of public and private water companies, semipublic wells for mobile home communities or recreational facilities, and self-supplied institutions, such as hospitals, schools, or correctional facilities. Public-supply wells provide potable water primarily to the public for domestic use which includes such activities as drinking, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. However, public-supply systems may sell part of their water to industry and to other private organizations for uses other than domestic.

Public-supply withdrawals are metered and reported quarterly to NJDEP/DWR. Because the withdrawals are metered and few grandfather rights exist in this category, data reliability is estimated to be greater than 90 percent.

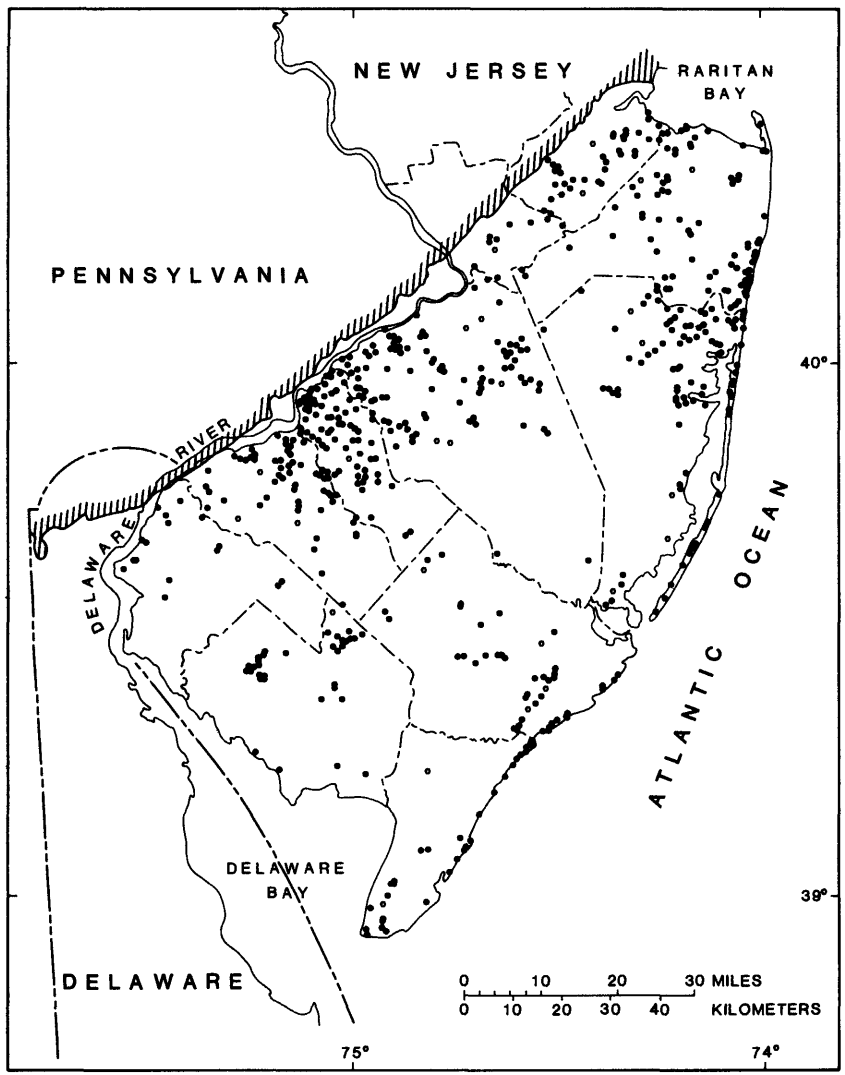
Table 1.--Ground-water withdrawals from the Coastal Plain of New Jersey by type of use and county, 1980*

[Mgal/d]

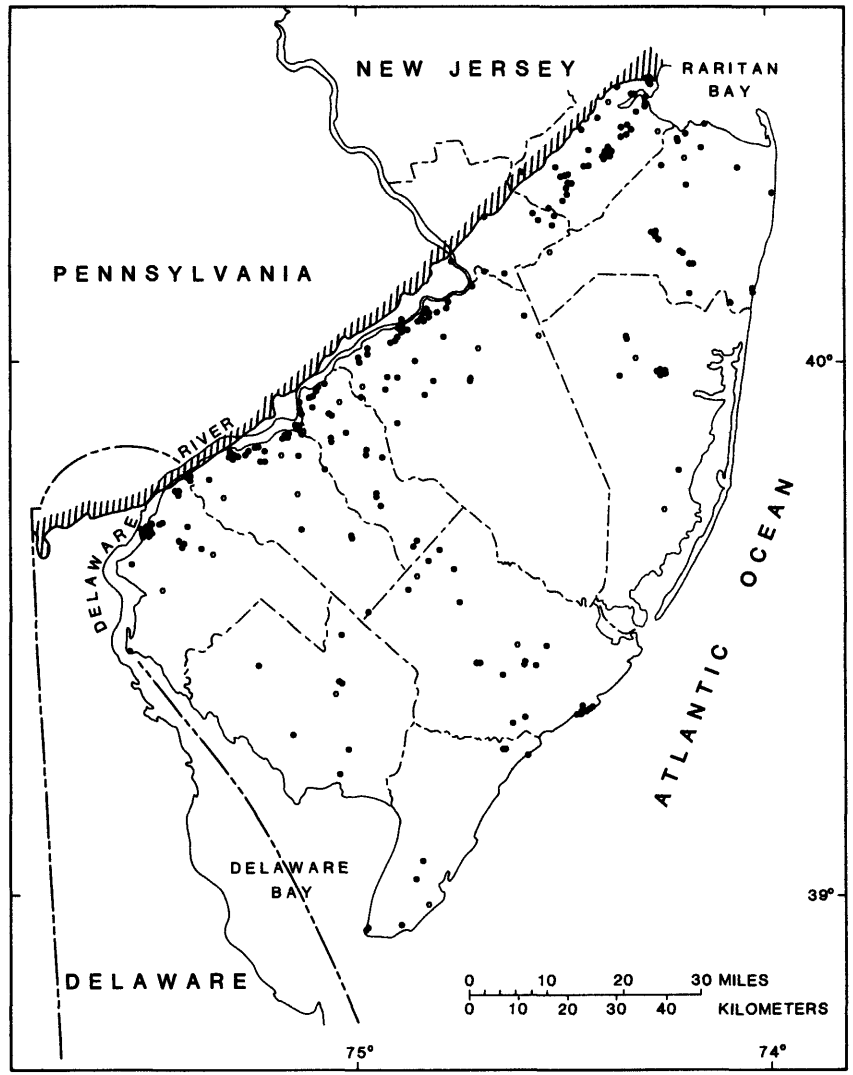
County	Public Supply	Industrial	Agricultural	Total**
Atlantic	24.2	1.2	3.3	28.7
Burlington	33.9	6.2	1.6	41.7
Camden	73.9	3.8	0.1	77.8
Cape May	12.0	1.4	.3	13.7
Cumberland	15.2	4.5	1.7	21.4
Gloucester	19.6	9.8	.5	29.9
Mercer	7.7	.8	.1	8.6
Middlesex	26.2	21.0	.3	47.5
Monmouth	28.5	3.8	.6	32.9
Ocean	33.6	9.4	<.1	43.0
Salem	2.9	4.7	1.7	9.3
Total	277.7	66.6	10.2	354.5

* Withdrawals do not include domestic or unavailable grandfather-rights withdrawals.

** Total withdrawals may not exactly match with table 3 due to rounding of decimals.



PUBLIC SUPPLY



INDUSTRIAL

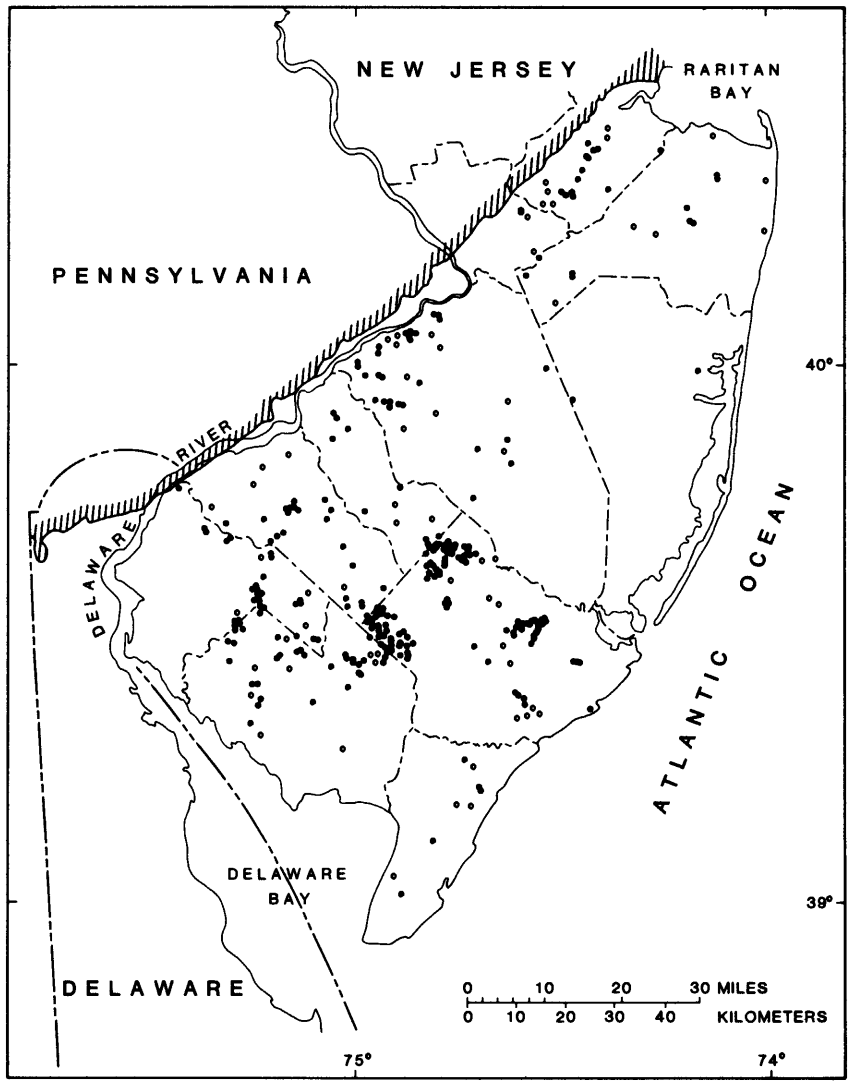


Figure 2.-- Ground-water withdrawal sites in the Coastal Plain of New Jersey by the type of use, 1956-80.

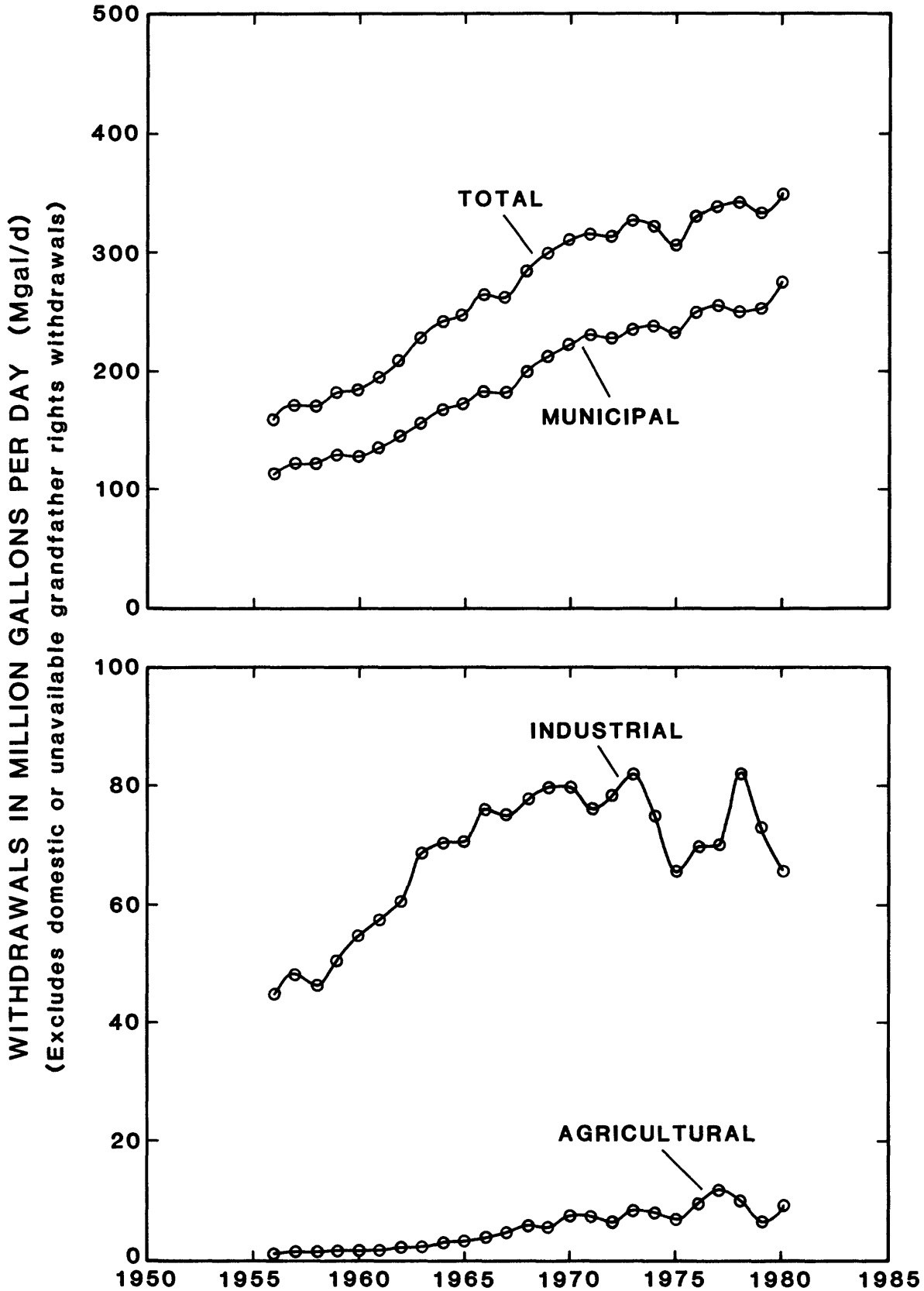


Figure 3.-- Ground-water withdrawal rates from the Coastal Plain of New Jersey by type of use, 1956-80.

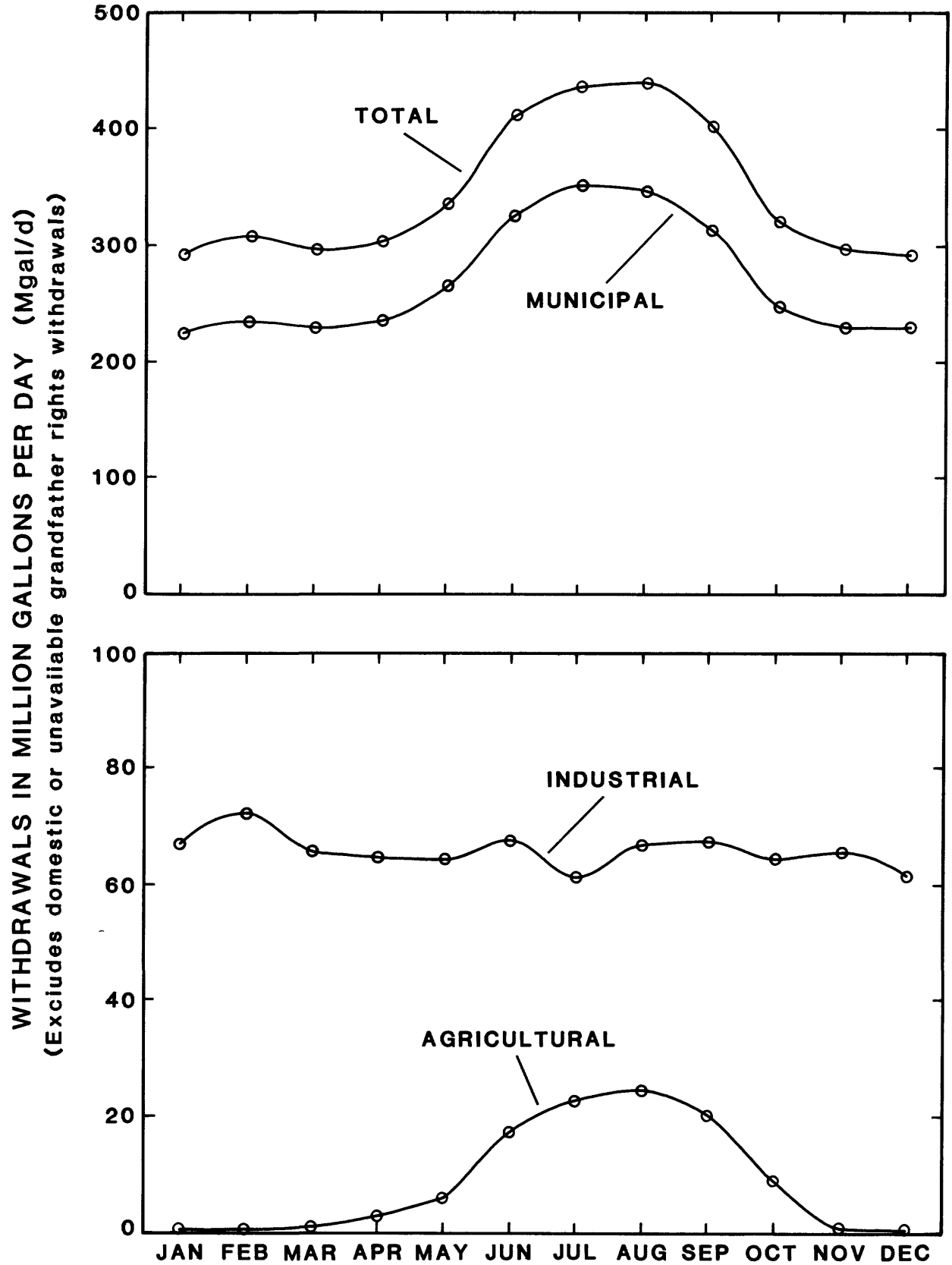


Figure 4.-- Monthly ground-water withdrawal rates from the Coastal Plain of New Jersey by type of use, 1980

Figure 2 shows the location and concentration of ground-water withdrawal sites by type of use. Public-supply well sites are most numerous along the Delaware River; fewer are found near the Atlantic Coast and Raritan Bay. Withdrawal sites are least numerous in the interior and southward where population density is lower and private domestic wells are more common.

Public-supply withdrawals have increased steadily from 1956-80, but there are variations in demand and seasonal fluctuations within each county. The withdrawals from each county in 1980 are given in table 1. The greatest withdrawals from public-supply wells are in Camden (74 Mgal/d), Burlington (34 Mgal/d), Monmouth (28 Mgal/d), and Middlesex (26 Mgal/d) Counties.

Figure 3 shows that public-supply wells withdraw the most ground water in the Coastal Plain. Withdrawals more than doubled from about 120 Mgal/d in 1956 to almost 280 Mgal/d in 1980. Withdrawals have increased in each county in the Coastal Plain from 1956-80. Withdrawals have increased most rapidly in Ocean County from about 6 Mgal/d in 1956 to about 33 Mgal/d in 1980. Salem, Middlesex, and Camden are the only counties in the Coastal Plain in which public-supply withdrawals did not at least double from 1956-80; however, withdrawals in Camden County have increased over 30 Mgal/d, from about 41 Mgal/d in 1956 to about 74 Mgal/d in 1980.

Figure 4 shows variations in monthly public-supply withdrawals in 1980. The withdrawals are fairly constant from October through April and increase rapidly from May through August as the demand for water for lawns, filling of swimming pools, washing of cars, and other uses during the summer increases. The maximum monthly withdrawal rate in 1980 was 355 Mgal/d in July, and the lowest rate was about 215 Mgal/d in February. Each county in the Coastal Plain shows similar variations in withdrawals, except for differences in the amount of increase during the summer. The increase from winter to summer is most apparent in counties bordering the Atlantic Ocean. Withdrawals in Cape May County in 1980 showed the greatest seasonal variation, rising from about 7 Mgal/d in November to about 28 Mgal/d in August. This rise is due almost exclusively to the large summer influx of tourists.

Industrial

Industrial withdrawals include pumpage from self-supplied industrial and commercial wells having pump capacities of 100,000 gallons per day or greater. The water is used primarily for industrial processes, cooling, air conditioning, or sanitation. Generally, dewatering projects are not included in the data file because these withdrawals are mostly of short duration. However, at a construction project by Jersey Central Power and Light (JCPL) in Ocean County from 1977 through 1980, withdrawals for the JCPL project were significant and are included in the withdrawal inventory.

Industrial well owners report monthly withdrawals to NJDEP/DWR quarterly or annually. Some industrial well owners retained grandfather rights until 1980. Estimates of industrial withdrawals were made if data could not be obtained from the owners. Some industrial wells are not metered, and withdrawals from them were estimated by the owners, based on the hours of operation and the rated pump capacity.

Figure 2 shows the location and distribution of industrial ground-water withdrawal sites. Most of the withdrawal sites are located along a corridor adjacent to the Delaware River and Raritan Bay. Few industrial wells are located along the Atlantic Coast or in the interior of the Coastal Plain.

Industrial withdrawals in 1980 are reported for each county in table 1. The counties with the greatest industrial ground-water withdrawals, in Mgal/d, are Middlesex, 21; Gloucester, 9.8; Ocean, 9.4; Burlington, 6.2; Salem, 4.7; and Cumberland, 4.5.

Figure 3 shows that industrial withdrawals increased steadily from 1956-73. During 1974 and 1975, withdrawals decreased sharply. At this time, several of the larger industries in the Coastal Plain reduced their use of ground water. Withdrawals reported by E.I. duPont in Salem County, Mobil and Texaco Oil Companies in Gloucester County, and the Duhernal Water System in Middlesex County declined considerably. Withdrawals increased substantially from 1976-78 because of a dewatering project at the JCPL nuclear power plant in Ocean County. During construction in 1978 an average of 12.5 Mgal/d was withdrawn from the JCPL dewatering wells. The dewatering decreased significantly by 1980, and total withdrawals from industrial wells declined to about the same level as in 1975.

Seasonal variations in industrial withdrawals are small. Figure 4 shows that monthly withdrawals are fairly constant, with a slight decline in July. The decline seems to correspond with many industries shutting down for a short time around the 4th of July.

Agricultural

Agricultural withdrawals are primarily from wells used to irrigate crops, and, to a much lesser extent, for stock and poultry water supply. Streams and ponds also are sources of water supply for agriculture in the Coastal Plain. However, withdrawal data in the Ground-Water Withdrawal Inventory include only ground-water withdrawals from wells with pump capacities of 100,000 gallons per day or greater.

Withdrawals from agricultural wells usually are estimated by each owner and reported annually to the NJDEP/DWR. The estimates are based on the rated capacity of the pump and the hours of operation; therefore, the data are not very accurate. In addition, many farmers had grandfather rights and were not required to

submit monthly withdrawal data to NJDEP/DWR prior to 1980. Estimates of withdrawals from these wells are even less accurate.

Figure 2 shows the location and concentration of agricultural ground-water withdrawal sites. Most of the sites are located in rural areas in the interior of the Coastal Plain and toward the south.

Table 1 gives ground-water withdrawals from agricultural wells in each county. Approximately 250 agricultural well owners reported withdrawals totaling about 10 Mgal/d in 1980 to NJDEP/DWR. Ground-water withdrawals from agricultural wells are greatest in Atlantic, Cumberland, and Salem Counties.

Figure 3 shows trends in agricultural ground-water withdrawals. The withdrawals seem to be low in comparison to municipal and industrial pumpage. (The Mgal/d average is an annual average.) Figure 4 shows that withdrawals for agriculture are significantly higher from May through October; about 75 percent of the withdrawals occurred from June through September in 1980. A maximum withdrawal of about 25 Mgal/d was reported in August.

Withdrawals by Aquifer

The geologic formations underlying the Coastal Plain differ in lithology, thickness, and water-bearing characteristics (table 2). The formations also differ in lateral extent and in freshwater and saltwater content. These characteristics determine the usefulness of a formation, group of formations, or part of a formation as an aquifer. In addition, demand for water varies with changes in population, industry, and agriculture. For these reasons, different aquifers are used in different areas or counties as primary sources of water.

Five regionally extensive aquifers in the Coastal Plain are capable of yielding large quantities of water. They are the Potomac-Raritan-Magothy aquifer system, the Englishtown aquifer, the Wenonah-Mount Laurel aquifer, the Atlantic City 800-foot sand of the Kirkwood Formation, and the Kirkwood-Cohansey aquifer. Each of these aquifers is discussed in order of oldest to youngest. Figures 5 and 6 show the location and concentration of withdrawal sites for each aquifer from 1956-80.

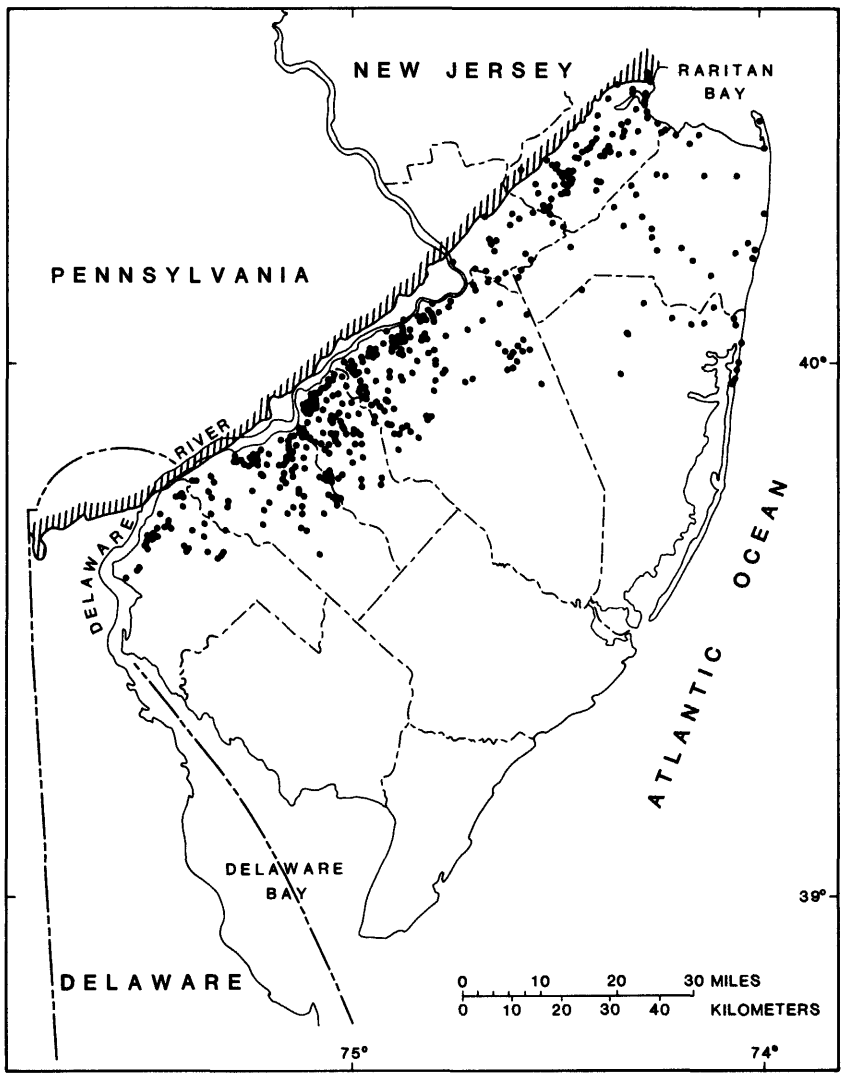
Table 3 reports ground-water withdrawals by aquifer and county in 1980. The withdrawal data do not include domestic or unavailable grandfather-rights withdrawals. Because a majority of grandfather rights belong to owners in the southern part of the Coastal Plain, the data reported for the older and deeper aquifers are more accurate. Data reported for the Kirkwood-Cohansey aquifer have the lowest reliability, whereas those for the Potomac-Raritan-Magothy aquifer system have the highest.

Figure 7 shows the relative importance of the five aquifers for water supply and trends in withdrawals from each aquifer from

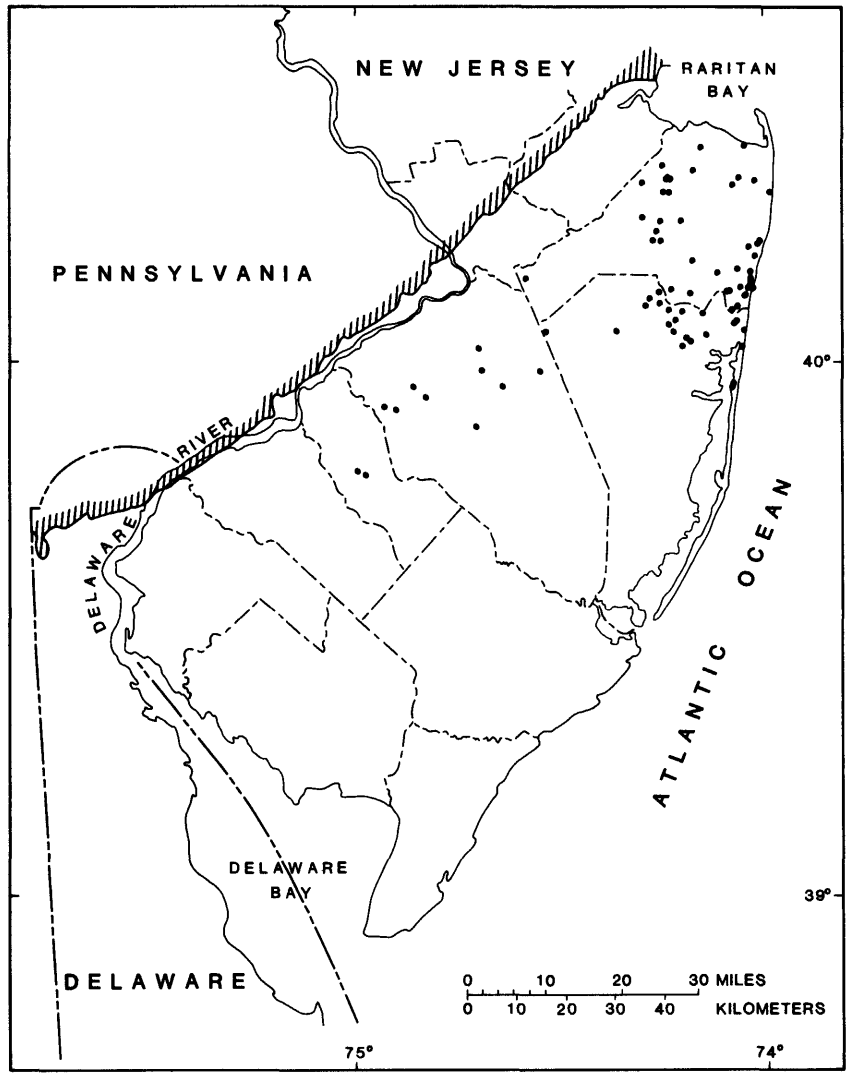
Table 2.--Lithology and water-bearing characteristics of geologic formations of the Coastal Plain of New Jersey.

(Modified from Walker, 1983, p.7)

SYSTEM	GEOLOGIC UNIT	LITHOLOGY	HYDROLOGIC CHARACTERISTICS
Quaternary	Alluvial deposits	Sand, silt, and black mud.	Locally may yield small quantities of water to shallow wells.
	Beach sand and gravel	Sand, quartz, light-colored, medium grained, pebbly.	
	Cape May Formation	Sand, quartz, light-colored, heterogeneous, clayey, pebbly, glauconitic.	Thicker sands are capable of yielding large quantities of water.
Tertiary	Pensauken Formation		
	Bridgeton Formation		
	Beacon Hill Gravel	Gravel, quartz, light-colored, sandy.	No known wells tap this formation.
	Cohansey Sand	Sand, quartz, light-colored, medium to coarse-grained, pebbly; local clay beds.	A major aquifer. Ground-water occurs generally under water-table conditions. In Cape May County, the aquifer is under artesian conditions. Inland from the coast and in the northern part of Ocean County, the Cohansey Sand is in hydraulic connection with the Kirkwood Formation, forming the unconfined Kirkwood-Cohansey aquifer system.
	Kirkwood Formation	Sand, quartz, gray to tan, very fine- to medium-grained, micaceous, and dark-colored diatomaceous clay.	Includes a major and minor artesian aquifer near the coast. The major aquifer is the Atlantic City 800-foot sand. The minor aquifer is the Rio Grande water-bearing zone or upper aquifer. The Kirkwood Formation includes up to three confining layers near the coast. Inland from the coast and in the northern part of Ocean County, the Kirkwood Formation is hydraulically connected to the unconfined Cohansey Sand, forming the unconfined Kirkwood-Cohansey aquifer system.
	Piney Point Formation	Sand, quartz and glauconitic, fine- to coarse-grained.	Minor aquifer in New Jersey. Greatest thickness in Cumberland County.
	Shark River Marl	Sand, quartz and glauconite, gray, brown, and green, fine- to coarse-grained, clayey, and green silty and sandy clay.	Locally may yield small quantities of water to wells.
	Manasquan Formation		Locally may yield small to moderate quantities of water to wells.
	Vincentown Formation	Sand, quartz, gray and green, fine- to coarse-grained, glauconitic, and brown clayey, very fossiliferous, glauconite and quartz calcarenite.	Locally may yield small to moderate quantities of water to wells.
	Hornerstown Sand	Sand, glauconite, green, medium- to coarse-grained, clayey.	Locally may yield small quantities of water to wells.
Cretaceous	Tinton Sand	Sand, quartz, and glauconite, brown and gray, fine- to coarse-grained, clayey, micaceous.	No known wells tap this sand.
	Red Bank Sand		Yields small quantities of water to wells in Monmouth County.
	Navesink Formation	Sand, glauconite, and quartz, green, black, and brown, medium- to coarse-grained, clayey.	Locally may yield small quantities of water to wells.
	Mount Laurel Sand	Sand, quartz, brown and gray, fine- to coarse-grained, glauconitic.	A major aquifer in the northern part of the Coastal Plain. A sand unit within the two formations forms the Wenonah-Mount Laurel aquifer.
	Wenonah Formation	Sand, quartz, gray and brown, very fine- to fine-grained, glauconitic, micaceous.	
	Marshalltown Formation	Sand, quartz and glauconite, gray and black, very fine to medium-grained, very clayey.	Leaky confining bed.
	Englishtown Formation	Sand, quartz, tan and gray, fine- to medium-grained; local clay beds.	A major aquifer in the northern part of the Coastal Plain, the Englishtown aquifer consists of two sand units in Ocean and Monmouth Counties.
	Woodbury Clay	Clay, gray and black, micaceous.	The two formations form the Merchantville-Woodbury confining unit, a major confining layer throughout the New Jersey Coastal Plain. Locally the Merchantville may contain a thin water-bearing sand.
	Merchantville Formation	Clay, gray and black, micaceous, glauconitic, silty; locally very fine-grained quartz and glauconitic sand.	
	Magothy Formation	Sand, quartz, light-gray, fine-grained, and dark-gray lignitic clay.	Potomac-Raritan-Magothy aquifer system: Upper aquifer referred to as Old Bridge aquifer in the northern Coastal Plain.
	Raritan Formation	Sand, quartz, light-gray, fine- to coarse-grained, pebbly, arkosic, red, white, and variegated clay.	Major confining layer
	Potomac Group	Alternating clay, silt, sand, and gravel.	Middle aquifer referred to as the Farrington aquifer in the northern Coastal Plain is combined with sands of the Potomac Group forming a large lower aquifer, as used in this report.
Pre-Cretaceous	Pre-Cretaceous basement	Precambrian and lower Paleozoic crystalline rocks, metamorphic schist and gneiss; locally Triassic basalt, sandstone, and shale	Except along Fall Line, no wells obtain water from these consolidated rocks.



POTOMAC-RARITAN-MAGOTHY



ENGLISHTOWN

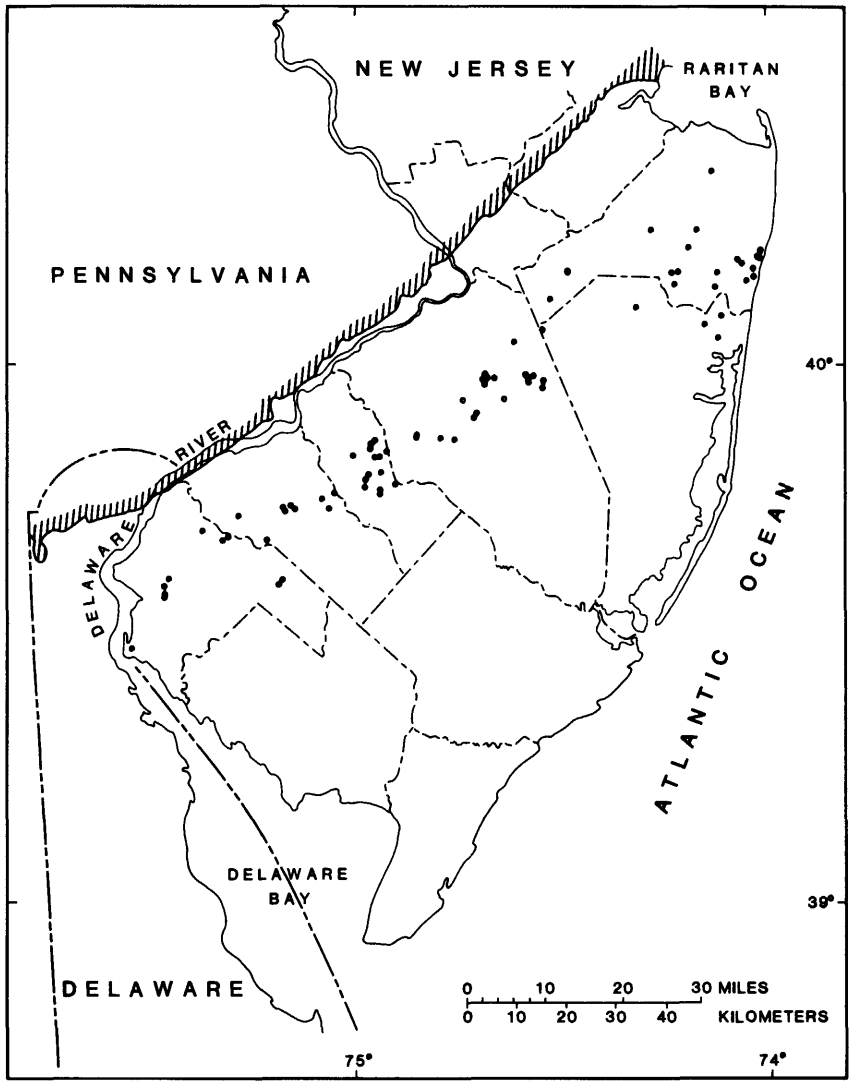


Figure 5.-- Withdrawal sites in the Potomac-Raritan-Magothy aquifer system, Englishtown aquifer, and Wenonah-Mount Laurel aquifer in New Jersey, 1956-80.

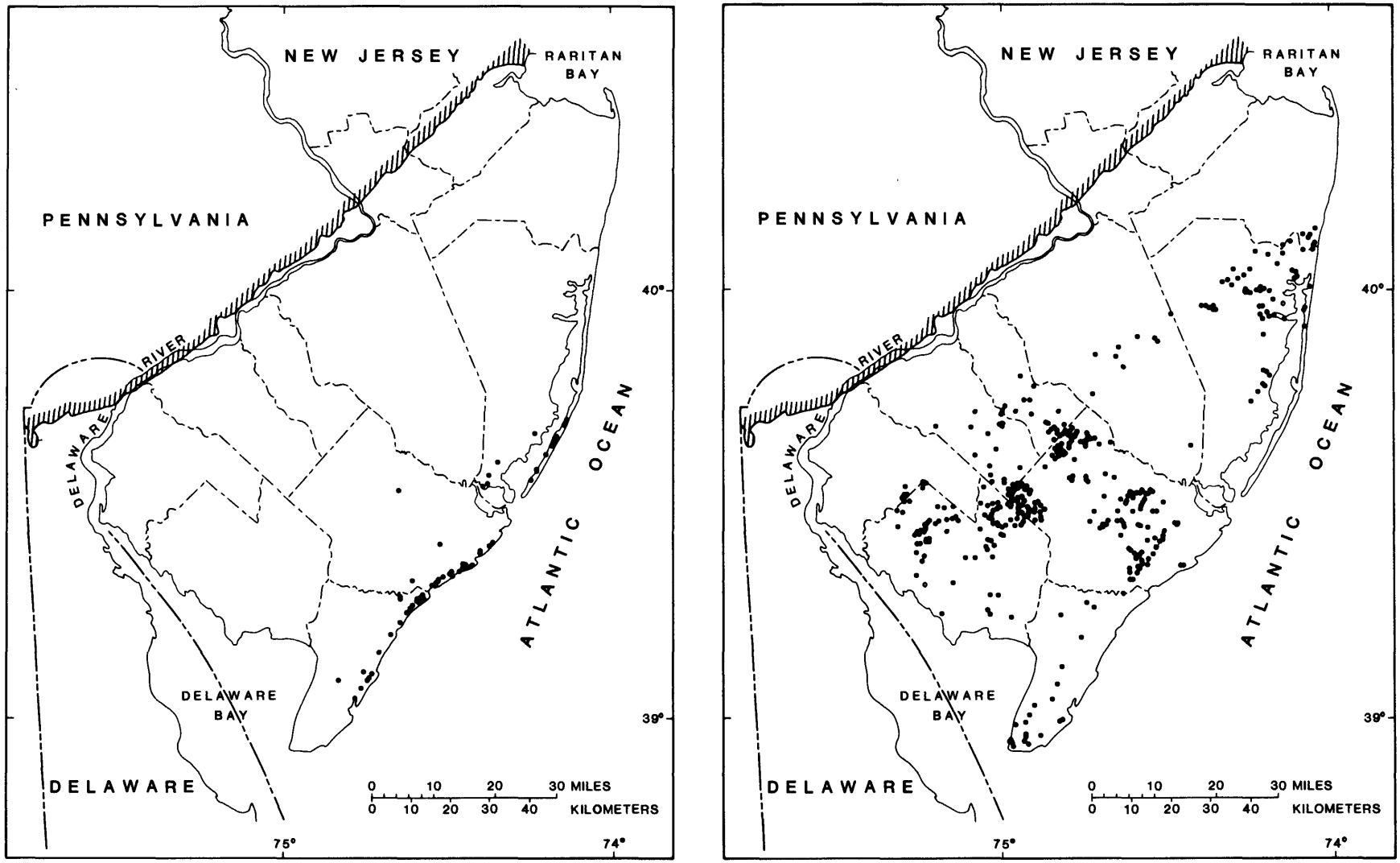


Figure 6.--Withdrawal sites in the Atlantic City 800-foot sand and the Kirkwood-Cohansey aquifer system in New Jersey, 1956-80.

Table 3.--Withdrawals from the Coastal Plain of New Jersey by aquifer and county, 1980*

[Mgal/d]

County	Aquifer						
	Potomac-Raritan-Magothy	English-town	Wenonah-Mount Laurel	Atlantic City 800-foot sand	Kirkwood-Cohansey	Other	Total**
Atlantic	-	-	-	9.5	19.0	0.1	28.6
Burlington	39.2	0.6	1.2	-	.7	-	41.7
Camden	74.8	.9	1.0	-	1.1	<.1	77.8
Cape May	-	-	-	6.5	6.6	.6	13.7
Cumberland	-	-	-	-	21.3	<.1	21.3
Gloucester	27.7	-	.1	-	2.3	-	30.1
Mercer	8.6	-	-	-	-	-	8.6
Middlesex	47.5	-	-	-	-	-	47.5
Monmouth	23.7	6.2	1.3	-	1.1	.7	33.0
Ocean	15.8	4.5	<.1	4.6	15.8	2.4	43.0
Salem	5.9	-	1.3	-	2.1	-	9.3
Total	243.2	12.2	4.9	20.5	70.0	3.8	354.6

* Withdrawals do not include domestic users or unavailable grandfather-rights withdrawals.

** Total withdrawals may not match exactly with table 1 due to independent rounding of decimals.

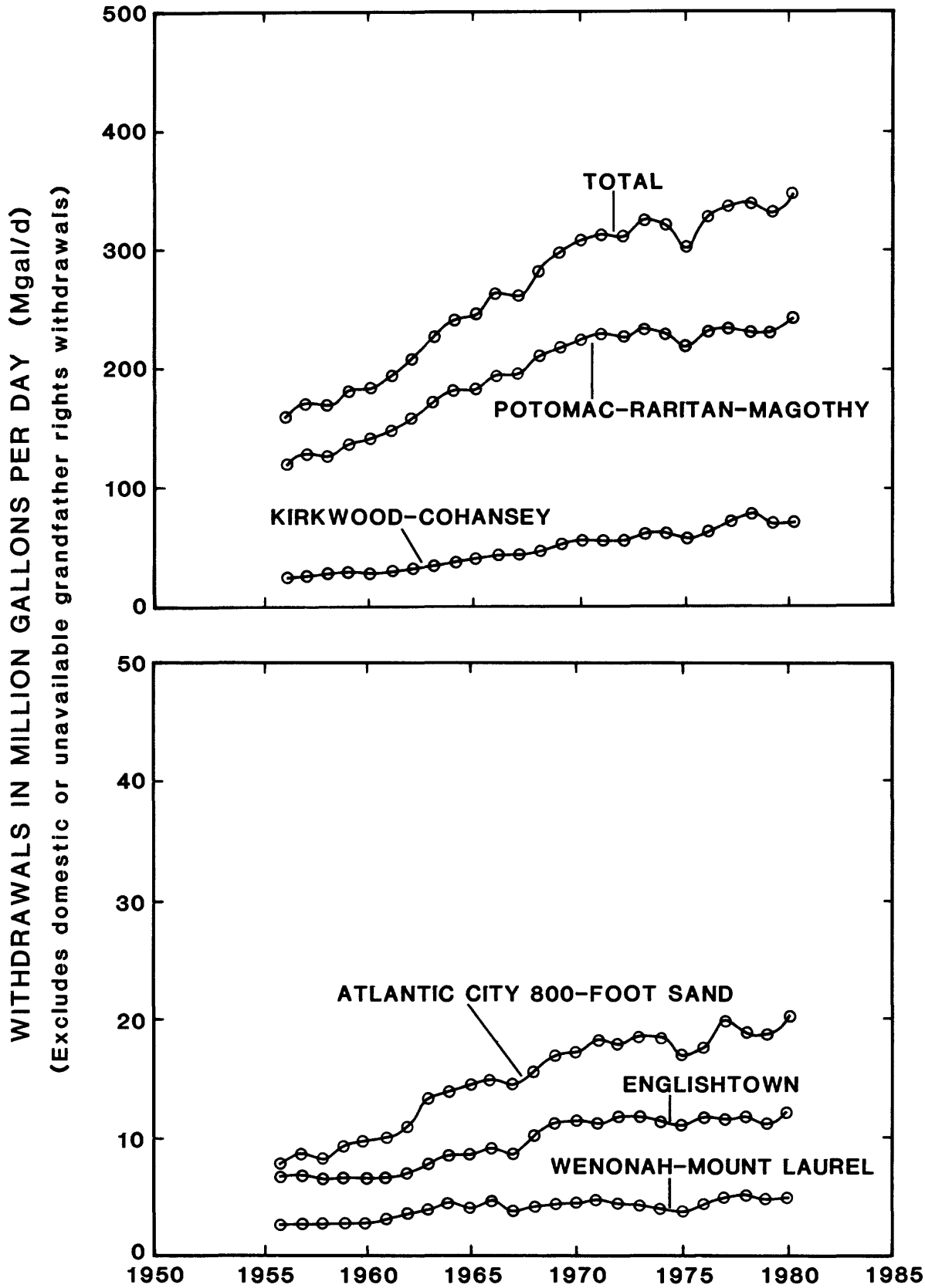


Figure 7.-- Withdrawal rates from the Coastal Plain of New Jersey by aquifer, 1956-80

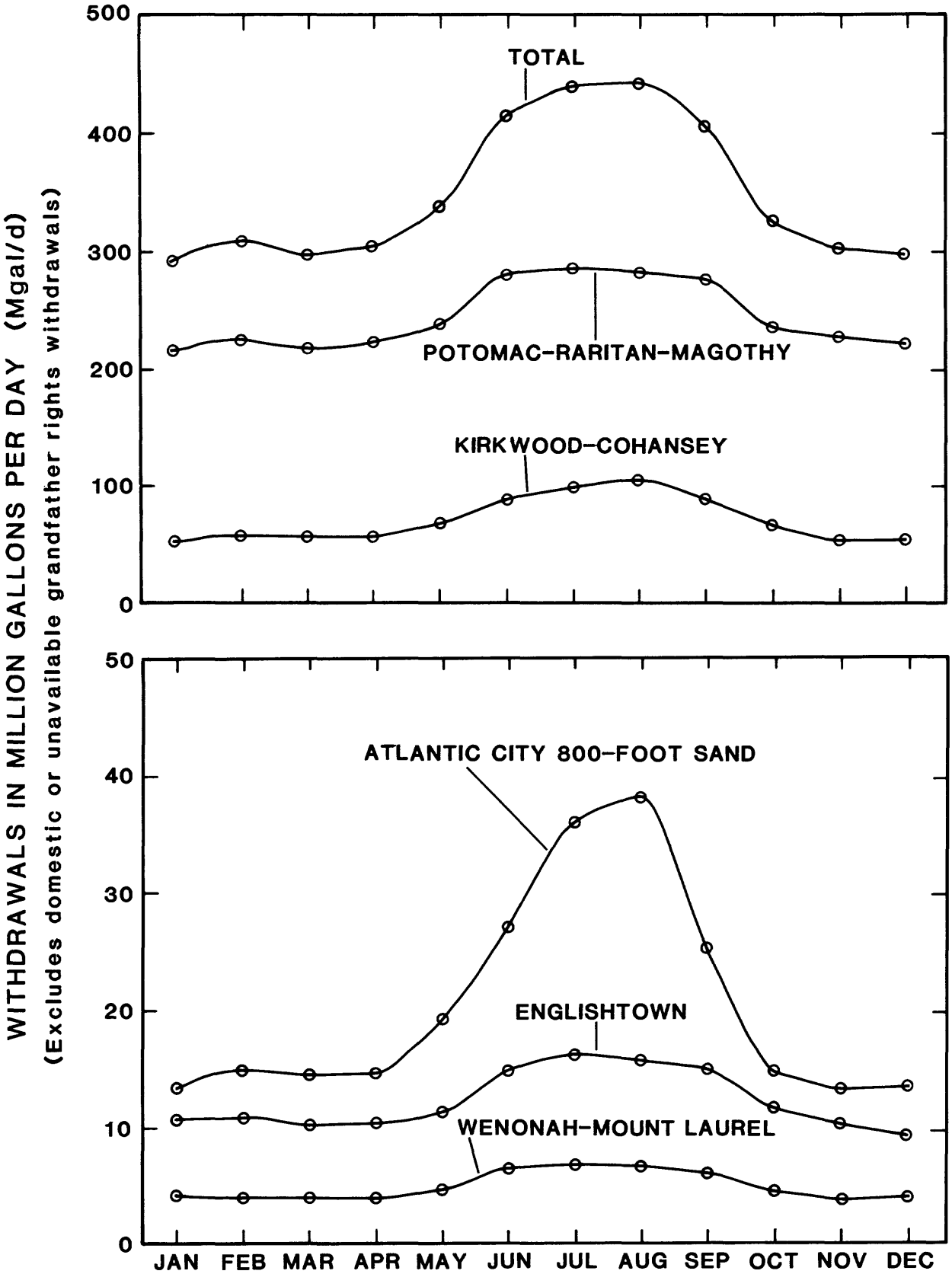


Figure 8.-- Monthly withdrawal rates from the Coastal Plain of New Jersey by aquifer, 1980

1956-80. The Potomac-Raritan-Magothy aquifer system is the most extensively pumped aquifer, followed in decreasing order by the Kirkwood-Cohansey, Atlantic City 800-foot sand of the Kirkwood Formation, Englishtown, and Wenonah-Mount Laurel aquifers. Figure 8 shows monthly withdrawals for each aquifer for 1980. Seasonal variations in withdrawals occur for each aquifer.

Potomac-Raritan-Magothy Aquifer System

The Potomac Group and the Raritan and Magothy Formations form the regionally extensive Potomac-Raritan-Magothy aquifer system. The aquifer system underlies the entire Coastal Plain of New Jersey and parts of adjacent states. The wedged-shaped mass of interbedded sand, silt, and clay is exposed in a narrow outcrop along the Fall Line and thickens in the seaward direction. The Potomac-Raritan-Magothy aquifer system in the northern part of the Coastal Plain consists of two major aquifers: the Farrington aquifer and the Old Bridge aquifer. Reports by Luzier (1980), Farlekas (1979), Gill and Farlekas (1976), and Walker (1983) contain detailed information on the hydrology and geology of the Potomac-Raritan-Magothy aquifer system.

Figure 5 shows the location of wells and well field sites that tap the Potomac-Raritan-Magothy aquifer system. The heaviest concentration of withdrawal sites is along the Delaware River in Camden County.

The Potomac-Raritan-Magothy aquifer system is the most heavily pumped aquifer in the Coastal Plain. Table 3 shows that the aquifer system is the only source of ground water in the Coastal Plain in Middlesex and Mercer Counties. The Potomac-Raritan-Magothy aquifer system is the primary source of ground-water supply in Camden (75 Mgal/d), Burlington (39 Mgal/d), Gloucester (28 Mgal/d), Monmouth (24 Mgal/d), and Salem (6 Mgal/d) Counties.

Figure 7 shows that withdrawals from the Potomac-Raritan-Magothy aquifer system doubled from about 120 Mgal/d in 1956 to about 245 Mgal/d in 1980. Most of the increase occurred from 1956 to 1971. After 1971, withdrawals remained fairly constant. Withdrawals from this aquifer increased significantly in Ocean and Monmouth Counties from 1970-80, but decreased in Gloucester County during the same period.

Seasonal variations in withdrawals from the Potomac-Raritan-Magothy aquifer system are shown in figure 8. In 1980, withdrawals were above the yearly average of 245 Mgal/d from June through September reaching a peak of about 285 Mgal/d in July. The lowest rate was about 215 Mgal/d in January.

Englishtown Aquifer

The Englishtown aquifer overlies the Merchantville and Woodbury confining unit in the central and northern parts of the Coastal Plain. In northern and eastern Ocean County, the aquifer consists of two water-bearing sands. Upper and lower units of quartz sand with thin interbeds of dark sandy silt are separated by a thick sequence of sandy and clayey lignitic silt. Additional information on the geology and hydrology of the Englishtown aquifer can be found in reports by Nichols (1977a, 1977b) and Walker (1983).

The Englishtown aquifer is a significant source of water in the northeastern part of the Coastal Plain. Figure 5 shows the location and concentration of withdrawal sites in the Englishtown aquifer. The majority of the sites are in Monmouth and Ocean Counties. Table 3 shows that in 1980, withdrawals were about 6.2 and 4.5 Mgal/d from the Englishtown aquifer in Monmouth and Ocean Counties, respectively.

Figure 7 shows that the Englishtown aquifer is the fourth most heavily pumped aquifer in the Coastal Plain. Withdrawals from large-capacity wells almost doubled from 1956-80. Most of the increase occurred from 1956-69. Withdrawals have been nearly constant since 1970. Withdrawals from the Englishtown aquifer from 1956-80 increased more rapidly in Ocean County than in Monmouth County.

Variations in monthly withdrawals from the Englishtown aquifer are shown in figure 8. A general increase in withdrawals from May through September is apparent. In 1980, the highest monthly withdrawal, 16 Mgal/d in July, was about 1.8 times greater than the lowest monthly withdrawal of 9 Mgal/d in December.

Wenonah-Mount Laurel Aquifer

The Wenonah Formation and Mount Laurel Sand are distinct lithologic units; however, they are hydraulically connected and form the Wenonah-Mount Laurel aquifer. The Mount Laurel Sand is a coarser sand unit than the Wenonah Formation and is the major component of the aquifer. More information on the lithology, hydrology, location, and extent of the Wenonah-Mount Laurel aquifer can be found in reports by Nemickas (1976) and Walker (1983).

The Wenonah-Mount Laurel aquifer is an important source of water supply in the central and western parts of the Coastal Plain. The location and concentration of withdrawal sites tapping the Wenonah-Mount Laurel aquifer are shown in figure 5. The withdrawal sites lie in a northwest to southeast trend from Monmouth to Salem Counties.

In 1980, withdrawals from the Wenonah-Mount Laurel aquifer were about 5 Mgal/d. Table 3 shows that withdrawals in 1980 were

similar for Salem (1.3 Mgal/d), Monmouth (1.3 Mgal/d), Burlington (1.2 Mgal/d), and Camden (1.0 Mgal/d) Counties. Small amounts of water are pumped from the Wenonah-Mount Laurel aquifer in Gloucester and Ocean Counties.

Figure 7 shows that the Wenonah-Mount Laurel aquifer is the fifth most heavily pumped aquifer in the Coastal Plain. Withdrawal rates almost doubled from the period 1956-80. Most of the increase occurred from 1956-71. Withdrawals have not increased significantly since 1971.

Seasonal variations in withdrawals from the Wenonah-Mount Laurel aquifer are shown in figure 8. In 1980, withdrawals were above the annual average from June through September. The maximum monthly withdrawal was in July (6.8 Mgal/d), and the lowest rate was in November (3.8 Mgal/d).

Atlantic City 800-foot Sand

The Kirkwood Formation consists of several water-bearing zones. The most important confined aquifer in the series of sands and clays in the Kirkwood Formation is the Atlantic City 800-foot sand. This aquifer is separated from other sands in the Kirkwood Formation by a confining unit. The aquifer extends from Ocean County south through Cape May County. More information on the geology and hydrology of the Atlantic City 800-foot sand can be found in reports by Parker and others (1964), Gill (1962b), and Walker (1983).

Wells that tap the Atlantic City 800-foot sand are shown in figure 6. The Atlantic City 800-foot sand is an important source of water supply for the barrier islands and shoreline communities in Atlantic, Cape May, and Ocean Counties.

The Atlantic City 800-foot sand is the third most heavily pumped aquifer in the Coastal Plain. In 1980, an average of about 21 Mgal/d were pumped from this aquifer. Withdrawals from wells in Atlantic County (9.5 Mgal/d) accounted for almost half of the total withdrawals from the Atlantic City 800-foot sand. Withdrawals from the aquifer were about 6.5 Mgal/d in Cape May County and 4.5 Mgal/d in Ocean County.

Withdrawals from the Atlantic City 800-foot sand more than doubled from 1956-80 (fig. 7). The withdrawals increased in both Ocean and Cape May Counties from 1956-80, whereas they declined slightly in Atlantic County since 1970.

Seasonal variations in withdrawals from the Atlantic City 800-foot sand are significant. Because of the large summer tourist trade along the Atlantic shore, withdrawals were almost three times greater in August (38 Mgal/d) than in November (13 Mgal/d). Figure 8 shows that more than half of the withdrawals occur from June through September.

Kirkwood-Cohansey Aquifer System

The Kirkwood-Cohansey aquifer system is composed of the generally unconfined sediments of the Kirkwood Formation and Cohansey Sand. The Kirkwood Formation and Cohansey Sand crop out in about two-thirds of the Coastal Plain. Ground water in the Kirkwood-Cohansey aquifer is generally under water-table conditions, except in Cape May County where the aquifer is confined. Inland from the coast and in the northern part of Ocean County, the Kirkwood Formation is in hydraulic connection with the Cohansey Sand and they act as a single aquifer system. More information on the characteristics of the Kirkwood-Cohansey aquifer can be found in reports by Rhodehamel (1973, 1970).

The Kirkwood-Cohansey aquifer system is used as a source of water supply in each Coastal Plain county except Middlesex and Mercer. The reported withdrawals from this aquifer system (table 3) would be greater if unknown grandfather-rights and domestic withdrawals were included in the data files. Information on these users of ground water is either unavailable or of poor quality, which causes difficulty in estimating withdrawals. Most grandfather rights were owned by farmers who use shallow irrigation wells. Also, many households in the southern part of the Coastal Plain, not connected to public-supply systems, usually obtain water from individual shallow wells screened in the Cohansey Sand.

Despite the lack of information on withdrawal data from the aquifer system, some general trends and variations in pumpage are apparent. Figure 7 shows that the Kirkwood-Cohansey aquifer system is the second most important source of water supply in the Coastal Plain. Known withdrawals were about 70 Mgal/d in 1980.

Withdrawals from the aquifer system increased steadily from 1956-80. A significant increase occurred in 1978 due to a dewatering project by JCPL mentioned previously. The Kirkwood-Cohansey aquifer system is the primary source of water supply in Cumberland, Atlantic, and Cape May Counties. Table 3 shows that withdrawals in Ocean County from the Potomac-Raritan-Magothy aquifer system (15.8 Mgal/d) are about the same as from the Kirkwood-Cohansey aquifer system (15.8 Mgal/d). If withdrawals by grandfather-rights and domestic users were included in the data files, then the Kirkwood-Cohansey system would be indicated as the primary source of water supply in Ocean County.

Withdrawals from the Kirkwood-Cohansey aquifer system increase significantly from June through September 1980 (fig. 8). Withdrawals in August (104 Mgal/d) are about double the withdrawals in January (51 Mgal/d). The large increase during the summer is due primarily to irrigation withdrawals in the southern part of the Coastal Plain and for public supply along the Atlantic Coast.

Other Aquifers

Several other geologic formations in the Coastal Plain may act as aquifers, but only on a local basis. The water-bearing characteristics of each formation are described briefly in table 2. No known withdrawal wells tap the Woodbury Clay, Tinton Sand, or Beacon Hill Formation. Except near the Fall Line, no wells obtain water from the Pre-Cretaceous rocks underlying the Coastal Plain. The Merchantville Formation, Navesink Formation, Red Bank Sand, Hornerstown Sand, Shark River Marl, and some alluvial deposits yield small quantities of water to wells.

There are minor aquifers within the Vincentown, Manasquan, Piney Point, and Cape May Formations in the Coastal Plain. The Vincentown and Manasquan aquifers are capable of yielding small to moderate quantities of water to wells, primarily in Ocean and Monmouth Counties. The Piney Point aquifer is used as a minor source of water in Cumberland County. Thick Quaternary deposits, such as the Cape May formation, are capable of yielding large quatities of water to wells in Cape May County.

SUMMARY AND CONCLUSIONS

Ground water is the primary source of freshwater supply in the Coastal Plain of New Jersey. Areal and seasonal variations in demand for ground water are due to changes in population, industry, and agriculture. The Ground-Water Withdrawal Data Management System is a valuable device that is used to show where the variations in demand are the greatest.

Withdrawal of water from public-supply wells increased significantly from about 120 Mgal/d in 1956 to about 280 Mgal/d in 1980. The maximum monthly withdrawal was about 355 Mgal/d in July, and the lowest was about 215 Mgal/d in February. The most rapid increase in public-supply well withdrawals occurred in Ocean County, whereas Camden County experienced the largest increase in total public-supply withdrawals. Variations in monthly withdrawals for public supply are greatest in the counties that border the Atlantic Coast because of the tourist trade during the summer.

Withdrawals from industrial wells increased steadily from 1956-73, but decreased sharply from 1974-75. Average industrial withdrawals were about 65 Mgal/d in 1980. Seasonal variations in withdrawals from industrial wells are small. Withdrawals from wells used for agriculture change significantly during the year. Approximately 75 percent of the agricultural withdrawals in 1980 occurred from June through September.

Five regional aquifers in the Coastal Plain are capable of yielding large quantities of water. Data for 1980 show that the Potomac-Raritan-Magothy aquifer system (243 Mgal/d) is the largest source of ground water in the Coastal Plain, followed by the Kirkwood-Cohansey aquifer system (70 Mgal/d), Atlantic City 800-foot sand of the Kirkwood Formation (21 Mgal/d), Englishtown aquifer (12 Mgal/d), and the Wenonah-Mount Laurel aquifer (5 Mgal/d). Seasonal variations in withdrawals from each aquifer are significant and should be considered in a hydrologic analysis. The largest seasonal fluctuation occurs in the Atlantic City 800-foot sand. In 1980 withdrawals in August were almost three times greater than in November.

The Ground-Water Data Management System is used in this report to show areal and seasonal variations in ground-water demand in the Coastal Plain. The withdrawal data can be correlated with other measured data such as water levels to show cause-and-effect relationships. Computer models can use the data for analysis of stresses on the aquifers and on the interconnections between them.

SELECTED REFERENCES

Anderson, H. R., and Appel, C. A., 1969, Geology and ground-water resources of Ocean County, New Jersey: New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply Special Report 29, 93 p.

Appel, C. A., 1962, Salt-water encroachment into aquifers of the Raritan Formation in the Sayreville area, Middlesex County, New Jersey: New Jersey Department of Conservation and Economic Development Special Report 17, 47 p.

Barksdale, H. C., Greenman, D. W., Lang, S. M., Hilton, G. S., and Outlaw, D. E., 1958, Ground-water resources in the tri-state region adjacent to the lower Delaware River: New Jersey Department of Conservation and Economic Development Special Report 13, 190 p.

Barksdale, H. C., Johnson, M. E., Schaefer, E. J., Baker, R. C., and DeBuchananne, G. D., 1943, The ground-water supplies of Middlesex County, N.J.: New Jersey State Water Policy Commission Special Report 8, 160 p.

Barksdale, H. C., and others, 1936, Supplementary report on the ground-water supplies of the Atlantic City region: New Jersey Water Policy Commission Special Report 6, 139 p.

Clark, G. A., Meisler, Harold, Rhodehamel, E. C., and Gill, H. E., 1968, Summary of ground-water resources of Atlantic County, New Jersey with special reference to public water supplies: New Jersey Department of Conservation and Economic Development Water Resources Circular 18, 53 p.

Donsky, Ellis, 1963, Record of wells and ground-water quality in Camden County, New Jersey: New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply Water Resources Circular 10, 70 p.

Farlekas, G. M., 1979, Geohydrology and digital-simulation model of the Farrington aquifer in the northern Coastal Plain of New Jersey: U.S. Geological Survey Water-Resources Investigations 79-106, 55 p.

Farlekas, G. M., Nemickas, Bronius, and Gill, H. E., 1976, Geology and ground-water resources of Camden County, New Jersey: U.S. Geological Survey Water-Resources Investigations 76-76, 146 p.

Forman, R. T., 1979, Pine Barrens: Ecosystem and Landscape, Academic Press, New York, 601 p.

Gill, H. E., 1959, Geology and ground-water resources of the Cape May Peninsula, Lower Cape May County, New Jersey: New Jersey Department of Conservation and Economic Development Water Resources Circular 1, 19 p.

Gill, H. E., 1962a, Ground-water resources of Cape May County, New Jersey, salt-water invasion of principal aquifers: New Jersey Department of Conservation and Economic Development Special Report 18, 171 p.

_____, 1962b, Records of wells, well logs, and summary of stratigraphy of Cape May County, New Jersey: New Jersey Department of Conservation and Economic Development Water Resources Circular 8, 54 p.

Gill, H. E., and Farlekas, G. M., 1976, Geohydrologic maps of the Potomac-Raritan-Magothy aquifer system in the New Jersey Coastal Plain: U.S. Geological Survey Hydrologic Investigations Atlas HA-557.

Hardt, W. F., 1963, Public water supplies in Gloucester County, New Jersey: New Jersey Department of Conservation and Economic Development Water Resources Circular 9, 55 p.

Hardt, W. F., and Hilton, G. S., 1969, Water resources and geology of Gloucester County, New Jersey: New Jersey Department of Conservation and Economic Development Special Report 30, 130 p.

Havens and Emerson, Inc., Parsons, Brinckerhoff, Quade, and Douglas, Inc., Westwater and Gaston, Inc., Water Resources Engineers, Geraghty and Miller, Inc., in Association for the New Jersey Statewide Water-Supply Plan, Tasks VIII and V, June 1980.

Jablonski, L. A., 1968, Ground-water resources of Monmouth County, New Jersey: New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply Special Report 23, 117 p.

Langbein, W. B., and Iseri, K. T., 1960, General introduction and hydrologic definitions: U.S. Geological Survey Water-Supply Paper 1541-A, 29 p.

Lohman, S. W., and others, 1972, Definitions of selected ground-water terms--revisions and conceptual refinements: U.S. Geological Survey Water-Supply Paper 1988, 21 p.

Luzier, J. E., 1980, Digital-simulation and projection of head changes in the Potomac-Raritan-Magothy aquifer system, Coastal Plain, New Jersey: U.S. Geological Survey Water-Resources Investigations 80-11, 72 p.

Nemickas, Bronius, 1976, Digital-simulation model of the Wenonah-Mount Laurel aquifer in the Coastal Plain of New Jersey: U.S. Geological Survey Open-File Report 75-672, 42 p.

Nichols, W. D., 1977a, Geohydrology of the Englishtown Formation in the northern Coastal Plain of New Jersey: U.S. Geological Survey Water-Resources Investigations 76-123, 62 p.

_____, 1977b, Digital computer simulation model of the Englishtown aquifer in the northern Coastal Plain of New Jersey: U.S. Geological Survey Open-File Report 77-73, 101 p.

Parker, G. G., Hely, A. G., Keighton, W. B., and Olmsted, F. H., 1964, Water resources of the Delaware River basin: U.S. Geological Survey Professional Paper 381, 200 p.

Rhodehamel, E. C., 1970, A hydrologic analysis of the New Jersey Pine Barrens region: New Jersey Department of Environmental Protection, Division of Water Resources, Water Resources Circular 22, 35 p.

_____, 1973, Geology and water resources of the Wharton Tract and Mullica River basin in southern New Jersey: New Jersey Department of Environmental Protection, Division of Water Resources Special Report 36, 58 p.

Rooney, J. G., 1971, Ground-water resources Cumberland County, New Jersey: New Jersey Department of Environmental Protection, Division of Water Resources Special Report 34, 83 p.

Rosenau, J. C., Lang, S. M., Hilton, G. S., and Rooney, J. G., 1969, Geology and ground-water resources of Salem County, New Jersey: New Jersey Department of Conservation and Economic Development Special Report 33, 142 p.

Rush, F. E., 1962, Records of wells and ground-water quality in Burlington County, New Jersey: New Jersey Department of Conservation and Economic Development Water Resources Circular 7, 104 p.

Rush, F. E., 1968, Geology and ground-water resources of Burlington County, New Jersey: New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply Special Report 26, 65 p.

Schaefer, F. L., and Walker, R. L., 1981, Saltwater intrusion into the Old Bridge aquifer in the Keyport-Union Beach area of Monmouth County, New Jersey: U.S. Geological Survey Water-Supply Paper 2184, 28 p.

Seaber, P. R., 1965, Variations in chemical character of water in the Englishtown Formation, New Jersey: U.S. Geological Survey Professional Paper 498-B, 35 p.

SELECTED REFERENCES--Continued

Vecchioli, John, and Palmer, M. M., 1962, Ground-water resources of Mercer County, New Jersey: New Jersey Department of Conservation and Economic Development Special Report 19, 71 p.

Vowinkel, E. F., and Foster, W. K., 1981, Hydrogeologic conditions in the Coastal Plain of New Jersey: U.S. Geological Survey Open-File Report 81-405, 39 p.

Walker, R. L., 1983, Evaluation of water levels in major aquifers of the New Jersey Coastal Plain, 1978: U.S. Geological Survey Water-Resources Investigations Report 82-4077, 56 p.

Widmer, Kemble, 1965, Geology of the ground-water resources of Mercer County, New Jersey: New Jersey Department of Conservation and Economic Development Geologic Report Series 7, 115 p.

U.S. Geological Survey, 1975, WATSTORE User's Guide Volume 2 Ground-water File: U.S. Geological Survey Open-File Report 75-589.

GLOSSARY

Aquifer. A geologic 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.

Ground water. Water saturating a geologic strata (layer) beneath the land surface.

Ground water, unconfined. Water in an aquifer that has a water table.

Ground water, confined. Water under pressure significantly greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs. Artesian is synonymous with confined.

Ground-water withdrawal site. The location of a well or well field that is a source of water supply.

Outcrop area. Area where strata are exposed at land surface or found just below the surface soil.

Saltwater intrusion. The movement of salt or brackish water into a freshwater aquifer due to the lowering of the freshwater head below sea level by pumping.

Water table. That surface in an unconfined water body at which the pressure is atmospheric.

Well field. Two or more wells of a common owner located in a limited area that usually pump water from the same aquifer.

Withdrawal use of water. The water removed from the ground or diverted from a stream, pond, or lake for use.