USGS
science for a changing world

WITHDRAWALS OF GROUND WATER AND SURFACE WATER IN NEW JERSEY, 1994

INTRODUCTION

New Jersey, with 886 persons per square mile, is the most densely populated and the most highly urbanized State in the Nation. About 33 percent of the land area in New Jersey is defined as urban by the U.S. Bureau of the Census (1992). The five northeastern counties--Bergen, Essex, Hudson, Passaic, and Union--contain about 40 percent of the population of New Jersey and 9 percent of the land area in the State (U.S. Bureau of the Census, 1991) (fig. 1).

Temperature and the amount and frequency of precipitation can affect the use of water, especially withdrawals by irrigation, public-supply, and thermoelectric-power users (Clawges and Titus, 1993; Nawyn and Clawges, 1995). In 1994, the average temperature was 53° F, and average precipitation was about 47.5 in. (inches). The average annual precipitation in New Jersey during 1961-90 was 45 in., and the average temperature was 53° F (National Climatic Data Center, 1995). Statewide precipitation was greater than average during the first 3 months of 1994 and during August and September; it was less than average during the other months. In the Coastal Plain, average precipitation during the growing season was more than 2 in. greater than the average precipitation for this season during 1961-90.

Data on withdrawals of ground water and surface water in New Jersey during 1994 were compiled from monthly reports submitted to the New Jersey Department of Environmental Protection by water users with pumping equipment capable of producing 100,000 gallons per day or greater. Estimated data are noted in the text. In 1994, withdrawals totaled 2,224 Mgal/d (million gallons per day)--592 Mgal/d of ground water and 1,632 Mgal/d of surface water (table 1). The largest withdrawals of ground water were 67 Mgal/d in Camden County; the largest withdrawals of surface water were 536 Mgal/d in Mercer County (fig. 1; table 1).

GROUND-WATER WITHDRAWALS

About 64 percent of ground-water withdrawals in New Jersey are from aquifers in the Coastal Plain. Withdrawals from aquifers in the Piedmont, Highlands, and Valley and Ridge Physiographic Provinces totaled about 36 percent of all ground-water withdrawals (fig. 1; table 2).

Figure 1. Counties and physiographic provinces in New Jersey.

Coastal Plain

Withdrawals from aquifers in the Coastal Plain (fig. 1) totaled 378 Mgal/d, including 274 Mgal/d for public supply and 104 Mgal/d for self supply (table 2). Withdrawals from the Potomac-Raritan-Magothy aquifer system, the primary source of ground water for public supply in New Jersey totaled 180 Mgal/d. Withdrawals from the Upper, Middle, Lower, and undifferentiated aquifers of the Potomac-Raritan-Magothy aquifer system were 60, 55, 55, and 10 Mgal/d, respectively (table 2). Withdrawals totaled 84 Mgal/d from the Kirkwood-Cohansey aquifer system and 20 Mgal/d from the Atlantic City 800-foot sand (table 2). Withdrawals from unclassified aquifers in the Coastal Plain totaled 66 Mgal/d, including 19 Mgal/d by public suppliers and 47 Mgal/d by self-supply users (table 2).

Table 1. Withdrawals of water in New Jersey, by county and type of water, 1994

[Withdrawals in million gallons per day, Mgal/d; --, not reported; **, values less than 1 Mgal/d]

County	Type of water: Ground water	Type of water: Surface water
Atlantic	43	3
Bergen	30	109
Burlington	58	185
Camden	67	3
Cape May	14	7
Cumberland	30	49
Essex	26	7
Gloucester	34	32
Hudson	**	--
Hunterdon	13	117
Mercer	14	536
Middlesex	54	4
Monmouth	25	35
Morris	53	51
Ocean	51	10
Passaic	8	266
Salem	9	27
Somerset	12	117
Sussex	11	6
Union	18	12
Warren	20	56
State	[1]592	1,632

[1] Total includes 1 Mgal/d each for mining and thermoelectric-power use throughout the State.

Non-Coastal Plain

The Piedmont, Highlands, and Valley and Ridge Physiographic Provinces (fig. 1) are the non-Coastal Plain provinces; withdrawals there totaled 214 Mgal/d, including 142 Mgal/d for public supply and 72 Mgal/d for self supply (table 2). Withdrawals from glacial-deposit aquifers totaled 79 Mgal/d, including 65 Mgal/d for public supply and 14 Mgal/d for self supply (table 2). Withdrawals from aquifers of the Brunswick Group totaled 64 Mgal/d, including 50 Mgal/d for public supply and 14 Mgal/d for self supply (table 2). Withdrawals of aqui-

fers of the Kittatinny Supergroup, Franklin Limestone, and Precambrian crystalline-rock aquifers totaled 15 Mgal/d, including 11 Mgal/d for public supply and 4 Mgal/d for all other uses (table 2). Withdrawals from unclassified aquifers in the non-Coastal Plain provinces of New Jersey totaled 55 Mgal/d and included public-supply withdrawals of 16 Mgal/d and self-supply withdrawals of 39 Mgal/d (table 2).

Table 2. Withdrawals of ground water from the Coastal Plain and non-Coastal Plain physiographic provinces in New Jersey, by aquifer and type of supply, 1994

[Figures may not add to totals because of independent rounding. Withdrawals in million gallons per day, Mgal/d; --, not reported; **, value less than 1 Mgal/d]

Aquifer	Type of supply: Public supply	Type of supply: Self supply
Coastal Plain Aquifers		
Kirkwood-Cohansey aquifer system	65	19
Rio-Grande water-bearing zone	1	--
Atlantic City 800-foot sand	19	1
Piney Point aquifer	2	1
Vincentown aquifer	1	**
Wenonah-Mount Laurel aquifer	5	12
Englishtown aquifer system	5	**
Potomac-Raritan-Magothy aquifer system		
Upper aquifer	55	5
Middle Aquifer	43	12
Lower aquifer	50	5
Undifferentiated	9	1
Unclassified aquifers	19	47
Coastal Plain total	274	104
Non-Coastal Plain Aquifers		
Glacial-deposit aquifers	65	14
Aquifers of the Brunswick Group	50	14
Aquifers of the Kittatinny Supergroup, Franklin Limestone, and Precambrian crystalline-rock aquifers	11	4
Unclassified aquifers	16	39
Non-Coastal Plain total	142	72
State total	416	176

SURFACE-WATER WITHDRAWALS

Withdrawals of surface water totaled 1,632 Mgal/d (table 1). The largest surface-water withdrawals were in Mercer (536 Mgal/d), Passaic (266 Mgal/d), Burlington (185 Mgal/d), Hunterdon (117 Mgal/d), Somerset (117 Mgal/d), and Bergen (109 Mgal/d) Counties (table 1). Public suppliers (699 Mgal/d) and thermoelectric-power (612 Mgal/d) facilities were the largest users of surface water. Additional surface-water withdrawals were reported by industrial (152 Mgal/d), mining (78 Mgal/d), irrigation (90 Mgal/d), and commercial (1 Mgal/d) users throughout the State. The Delaware River was the chief source of surface water for thermoelectric-power generation and industrial use. About 85 Mgal/d of surface water was transferred from the Delaware River at Hunterdon County to Somerset County through the Delaware and Raritan Canal (fig. 2).

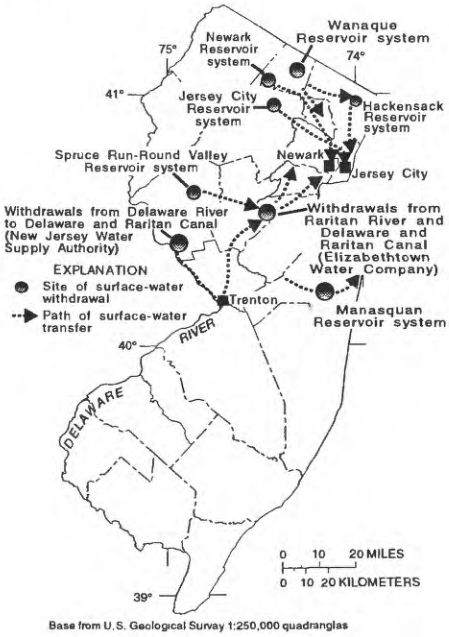

Figure 2. Transfers of surface water among public-supply systems in New Jersey.

Surface water withdrawn in one county for public supply can be widely distributed among several counties through interconnected water systems. Water from the Wanaque Reservoir (Passaic County), one of the largest reservoirs in the State, is distributed to communities throughout northeastern New Jersey (fig. 2). Water from reservoirs in Morris County is distributed to municipalities in Essex (City of Newark) and Hudson (Jersey City) Counties. Water users in Middlesex County receive water from reservoirs in Monmouth County.

WITHDRAWALS BY CATEGORY OF USE

The categories of water use are public supply, domestic, commercial, irrigation, industrial, mining, and thermoelectric power. Water users can be self-supplied or publicly supplied. Public suppliers deliver water to domestic, commercial, industrial, thermoelectric-power and public water users. Irrigation and mining users are entirely self-supplied.

Public Supply

Public-supply withdrawals totaled 1,115 Mgal/d (table 3), including 416 Mgal/d of ground water and 699 Mgal/d of surface water. About 80 percent (892 Mgal/d) of the public-supply withdrawals are metered deliveries; the remaining 20 percent (223 Mgal/d) are attributed to distribution-system maintenance, public water use, or unaccounted-for water. Metered deliveries include domestic (570 Mgal/d), commercial (195 Mgal/d), industrial (103 Mgal/d), and thermoelectric-power (24 Mgal/d) (fig. 3). Distribution-system maintenance (11 Mgal/d) includes the backwashing of filters and well screens (fig. 3). Unaccounted-for water use was estimated to be about 155 Mgal/d, including distribution losses, such as water leaks, improperly registering meters, and unauthorized connections (fig. 3). Public water use for municipal facilities, such as offices, parks, and schools, was estimated to be about 57 Mgal/d (fig. 3).

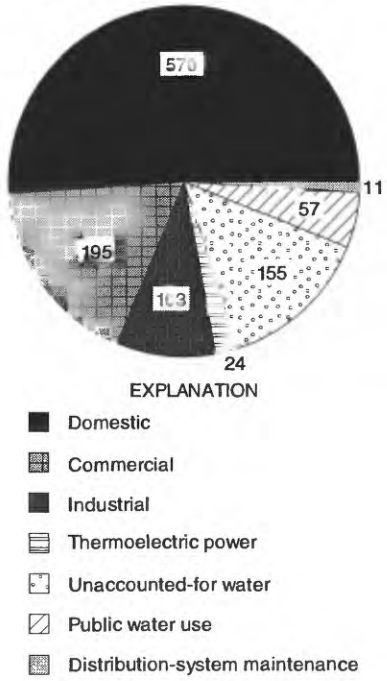

Figure 3. Estimated water deliveries of public suppliers in New Jersey, by category of use; estimated distribution-system-maintenance usage; and estimated distribution losses, 1994. (Values are in million gallons per day.)

Most of the water delivered by public suppliers is for domestic use; however, three general patterns of deliveries for commercial and industrial use are seen in the State. In urban areas in northern and central New Jersey, many large commercial and industrial users are publicly supplied; in urban areas of the Coastal Plain, many large-volume users are self-supplied. In most suburban areas and many coastal areas of the State, industrial users are absent, and commercial users are publicly supplied.

Withdrawals by County

Withdrawals for public supply totaled 271 Mgal/d in Passaic County (table 3), including about 58 Mgal/d of surface water

Table 3. Withdrawals of ground water and surface water in New Jersey for public supply and self supply, by county and category of use, 1994

[Figures may not add to totals because of independent rounding. Withdrawal data are metered values, except as noted. All values in million gallons per day; **, withdrawals less than 1 million gallons per day; --, not reported.]

		Self supply							
County	Public supply	Domestic[1]	Commercial	Irrigation[2]	Industrial	Mining	Thermo-electric power	Unclass-ified use	County total[2,3]
Atlantic	30	6	1	8	**	--	--	1	46
Bergen	116	2	2	**	18	--	--	1	139
Burlington	37	7	1	85	3	4	104	2	243
Camden	63	3	**	1	1	2	--	--	70
Cape May	9	4	**	1	**	7	**	--	21
Cumberland	16	4	**	6	4	48	--	1	79
Essex	31	**	1	**	1	--	--	--	33
Gloucester	21	4	**	2	36	1	--	2	66
Hudson	--	--	**	--	**	--	--	--	**
Hunterdon	[4]90	6	--	**	11	--	23	--	130
Mercer	43	2	**	**	20	--	485	--	550
Middlesex	45	2	**	1	5	3	--	2	58
Monmouth	53	4	**	1	1	--	--	1	60
Morris	88	7	**	**	4	5	--	--	104
Ocean	45	9	1	1	--	4	--	1	61
Passaic	271	3	--	**	**	--	--	--	274
Salem	5	2	--	9	19	--	**	1	36
Somerset	123	5	**	**	**	**	--	1	129
Sussex	5	7	**	--	--	5	--	--	17
Union	19	**	**	**	10	**	--	1	30
Warren	5	3	5	**	59	--	--	4	76
State	1,115	80	11	115	192	[3]80	[3]613	18	2,224

[1] Estimated water-use value.
[2] Includes withdrawal values estimated by water user.
[3] Value may not equal total due to rounding.
[4] Includes water transfer from Delaware River in Hunterdon County to Raritan River in Somerset County.

pumped to the Wanaque Reservoir. Withdrawals for public supply totaled 123 Mgal/d in Somerset County, 116 Mgal/d in Bergen County, 90 Mgal/d in Hunterdon County, and 88 Mgal/d in Morris County (table 3). In general, public suppliers in the Coastal Plain withdraw primarily ground water. Withdrawals in Camden County were 63 Mgal/d and accounted for 15 percent of all public-supply withdrawals of ground water (416 Mgal/d) in New Jersey (table 2). Withdrawals of ground water for public supply were 44 Mgal/d in Middlesex County, 41 Mgal/d in Ocean County, and 34 Mgal/d in Burlington County. The largest ground-water withdrawals for public supply in the non-Coastal Plain were 43 Mgal/d in Morris County.

Per Capita Use

About 6.9 million persons or 88 percent of the residents of New Jersey are served by public-supply systems (table 4). In 1994, domestic deliveries in the State were estimated to be 570 Mgal/d (fig. 3), and the per capita use of publicly supplied domestic users was estimated to be 83 gal/d (gallons per day). The smallest daily domestic deliveries were 538 Mgal/d in February (per capita use, 78 gal/d); the largest daily domestic deliveries were 660 Mgal/d in July (per capita use, 96 gal/d). Per capita use in July was 18 gal/d greater than per capita use in February because of high outdoor water use.

Domestic

Withdrawals for domestic use were estimated to be 650 Mgal/d, including an estimated 80 Mgal/d (table 3) withdrawn from private wells. Domestic deliveries (570 Mgal/d) of publicly supplied water were estimated to be 51 percent of total public-supply withdrawals. Self-supplied domestic withdrawals were estimated by multiplying the number of users, 969,000 (U.S. Bureau of the Census, 1992, 1994), by the per capita coefficient of 83 gal/d. This per capita value was estimated on the basis of the per capita use of publicly supplied residents (table 4).

Table 4. Population of New Jersey, by county and type of water supply, 1994

[Population data from U.S. Bureau of the Census, 1992, 1996; --, not reported]

	Population	
County	Publicly supplied	Self-supplied
Atlantic	158,000	71,000
Bergen	812,000	23,000
Burlington	317,000	80,000
Camden	477,000	31,000
Cape May	49,000	48,000
Cumberland	88,000	50,000
Essex	769,000	4,000
Gloucester	183,000	54,000
Hudson	555,000	--
Hunterdon	40,000	72,000
Mercer	299,000	29,000
Middlesex	662,000	22,000
Monmouth	516,000	50,000
Morris	343,000	85,000
Ocean	331,000	107,000
Passaic	423,000	33,000
Salem	39,000	26,000
Somerset	194,000	56,000
Sussex	50,000	85,000
Union	492,000	1,000
Warren	52,000	42,000
State	6,849,000	969,000

Commercial

Withdrawals for commercial use totaled 206 Mgal/d, including self-supplied withdrawals of 11 Mgal/d (table 3), chiefly ground water, and publicly supplied deliveries of 195 Mgal/d (fig. 3). Commercial deliveries of publicly supplied water were estimated to be 17 percent of total public-supply withdrawals. The largest self-supplied ground-water withdrawals for commercial use were 5 Mgal/d in Warren County where the Pequest (State-operated) fish hatcheries are located. Self-supplied withdrawals of surface water for commercial use were about 1 Mgal/d.

Irrigation

Withdrawals for self-supplied irrigation use totaled 115 Mgal/d (table 3)--25 Mgal/d of ground water and 90 Mgal/d of surface water. Withdrawals in Burlington County, chiefly surface water for cranberry production, were 85 Mgal/d (table 3), which accounted for about 74 percent of withdrawals for irrigation use in the State. The largest ground-water withdrawals were 11 Mgal/d in Burlington County and 4 Mgal/d in Cumberland County.

New Jersey, the Garden State, supports a viable agricultural trade because of the State's productive soils, proximity to major markets, and abundant water resources. In 1994, about 9,000 farms occupied 17 percent (848,000 acres or 1,330 mi^2) of the land area of the State (U.S. Bureau of the Census, 1994). The chief irrigated crops were vegetables, tree fruits (peaches), small fruit (blueberries) or nut crops, and sod (turf). In 1994, the largest number of irrigated acres (excluding cranberry acreage) were estimated to be in Cumberland (21,500), Salem (18,000), Gloucester (17,000), and Atlantic Counties (16,100) (Craig A. Storlie, Rutgers Research and Development Center, oral commun., 1996; New Jersey Agricultural Statistics Service, 1995).

Industrial

Withdrawals for industrial use totaled 295 Mgal/d. Self-supplied withdrawals totaled 192 Mgal/d (table 3)--40 Mgal/d of ground water and 152 Mgal/d of surface water. Publicly supplied deliveries to industrial users were estimated to be 103 Mgal/d or 9 percent of total public-supply withdrawals (fig. 3). Withdrawals for self-supplied industrial use, chiefly of surface water, were 59 Mgal/d in Warren County and 36 Mgal/d in Gloucester County (table 3). The largest withdrawals of self-supplied ground water for industrial use were 6 Mgal/d in Gloucester County and 5 Mgal/d each in Bergen and Middlesex Counties. Paper-products manufacturing and chemical production along the Delaware River in Warren (59 Mgal/d) and Hunterdon (11 Mgal/d) Counties accounted for nearly all of the withdrawals for industrial use in these counties (table 3). Chemical and oil refinery facilities accounted for much of the industrial withdrawals reported in Bergen, Gloucester, and Middlesex Counties.

In 1994, the number of self-supplied industrial facilities in New Jersey totaled about 300, including chemical, petroleum, and paper-manufacturing facilities that require large volumes of water for cooling or production processes. Self-supplied industrial users accounted for about 2 percent of all industrial facilities in New Jersey (U.S. Bureau of the Census, 1994); however, the most recent (1983) data on water use in manufacturing from the U.S. Bureau of the Census (1986) indicated that 85 percent of total withdrawals for industrial purposes were made by self-supplied water users. In 1994, self-supplied industrial withdrawals were estimated to be 65 percent of total industrial water use in New Jersey. Many self-supplied industrial facilities are purchasing supplemental water from local public suppliers, and the water requirements of self-supplied water users have decreased as a result of water conservation practices (Ploeser and others, 1992).

Mining

Withdrawals for self-supplied mining use in New Jersey totaled 80 Mgal/d (table 3). Surface-water withdrawals totaled 78 Mgal/d; the balance was ground water. The largest withdrawals for mining use were 48 Mgal/d in Cumberland County, 7 Mgal/d in Cape May County, and 5 Mgal/d each in Morris and Sussex Counties (table 3). The geologic resources of New Jersey support a diversity of mining activities for the 158 mining facilities in the State (Horner, 1992, p. 249). Crushed stone, consisting of basalt and granite, is extracted throughout the Piedmont, Highlands, and Valley and Ridge Physiographic Provinces. Shale is quarried in the Piedmont Province. Among the states, New Jersey ranks third in the production of industrial sand and gravel (U.S. Bureau of Mines, 1995). New Jersey is the only state to produce greensand, a water softening, filtration medium used to remove soluble iron and manganese from ground water and as an organic conditioner for soils. (Harrison, 1988; U.S. Bureau of Mines, 1995).

Thermoelectric Power

Withdrawals for thermoelectric-power use in New Jersey totaled 637 Mgal/d, including self-supplied withdrawals of 613 Mgal/d (table 3) and public-supply deliveries of about 24 Mgal/d (fig. 3). Ground-water withdrawals were about 1 Mgal/d. Withdrawals from the Delaware River (612 Mgal/d) in Mercer, Burlington, and Hunterdon Counties were 485 Mgal/d, 104 Mgal/d, and 23 Mgal/d, respectively (table 3). The surface-water withdrawals are chiefly non-consumptive (about 1 percent); water is used for once-through cooling of condensers and returned to Delaware River (Paul A. Mensing, Public Service Electric and Gas Company, Newark, N.J., written commun., 1996). Withdrawals of saline water and deliveries of reclaimed wastewater for thermoelectric-power use in New Jersey were not included.

REFERENCES CITED

Clawges, R.M., and Titus, E.O., 1993, Method for predicting water demand for crop uses in New Jersey in 1990, 2000, 2010, and 2220, and for estimating water use for livestock and selected sectors of the food-processing industry in New Jersey in 1987: U.S. Geological Survey Water-Resources Investigations Report 92-4145, 211 p.

Harrison, D.K., 1988, New Jersey minerals yearbook 1988: Washington, D.C., U.S. Government Printing Office, 8 p.

Horner, E.R., ed., 1992, Almanac of the 50 states: Basic data profiles with comparative tables: Palo Alto, California, Information Publications, p. 243-50.

National Climatic Data Center, 1995, Climatological data annual summary, New Jersey, 1994: Asheville, N.C., National Oceanic and Atmospheric Administration, v. 99, no. 13, 12 p.

Nawyn, J.P., and Clawges, R.M., 1995, Withdrawals of ground water and surface water in New Jersey, 1989-90, U.S. Geological Survey Open-File Report 94-324, 52 p.

New Jersey Agricultural Statistics Service, 1995, New Jersey agriculture 1995--Annual report and agricultural statistics: New Jersey Agricultural Statistics Service Circular 540, Trenton, N.J., 88 p.

Ploeser, J.H., Pike, C.W., and Kobrick, J.D., 1992, Nonresidential water conservation: A good investment: Journal of American Water Works Association, v. 84. no. 10, p. 65-73.

U.S. Bureau of the Census, 1986, Water use in manufacturing, in 1982 census of manufacturers, Washington, D.C.: U.S. Government Printing Office, subject series MC82-S-6, 72 p.

_____ 1991, Statistical abstract of the United States: 1991 (111th ed.): Washington, D.C., U.S. Government Printing Office, 968 p.

_____ 1992, Census of population and housing, 1990: Washington,D.C, Summary Tape File 3 on CD-ROM (New Jersey).

_____ 1994, City and county data book, 1994: Washington, D.C., U.S. Government Printing Office, p. 368-381.

_____ 1996, Time series of resident population for minor civil divisions, April 1, 1990 to July 1, 1994: Population Distribution and Population Estimates Branches.

URL: http://www.census.gov/ftp/pub/population/estimates/metro-city/mcd94tsNJ.txt

U.S. Bureau of Mines, 1995, Mineral industrial surveys: New Jersey: Mines Fax Back, Document-on-Demand System, available at (202) 219-3644, 5 p.

—John P. Nawyn

Information on New Jersey water-use data can be obtained from:

U.S. Geological Survey
Mountain View Office Park
810 Bear Tavern Road, Suite 210
West Trenton, New Jersey 08628
(609) 771-3964 or jnawyn@usgs.gov

Fact Sheet FS-120-97
July 1997