ESTIMATED PUBLIC-WATER SUPPLY AND INDUSTRIAL-COMMERCIAL GROUND-WATER WITHDRAWALS AND RETURNS IN NASSAU COUNTY, LONG ISLAND, NEW YORK, 1973-79

By Deborah S. Snavely and James Williams

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CONVERSION FACTORS AND ABBREVIATIONS

The following factors may be used to convert inch-pound units of measurement in this report to International Systems (SI) units.

Multiply inch-pound unit	by	To obtain SI unit
	Length	
inch (in.)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
acre	4047.	square meter (m^2)
	Volume	
gallon (gal)	3.785	liter (L)
	Flow	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
gallon per day (gal/d)	3.785	liter per day (L/d)
million gallons per day (Mgal/d)	0.04381	cubic meters per second (m^3/s)

ESTIMATED PUBLIC-WATER SUPPLY AND INDUSTRIAL-COMMERCIAL GROUND-WATER WITHDRAWALS AND RETURN IN NASSAU COUNTY, LONG ISLAND, NEW YORK, 1973-79

By Deborah S. Snavely and James Williams[1]

ABSTRACT

Nassau County is totally dependent upon ground water for potable fresh water. The two largest water-use categories in Nassau County are public-water supply and combined industrial-commercial use. The combined ground-water withdrawals for these uses in 1975 was nearly 202 million gallons per day (Mgal/d). The main source of supply is the Magothy Formation; during 1973-79, public-water suppliers withdrew about 85 percent of their water from this aquifer. This report summarizes in tables and histograms the data filed with the New York State Department of Environmental Conservation by public-supply and industrial-commercial well operators and by sanitary-sewer district operators and includes estimates made by various planning agencies, water-management agencies, and consultants.

The county's population decreased by about 72,000, or 5 percent, during 1973-79. The predominant land use in 1975 was residential (65 percent). The county was largely suburban with some industrial land use (1.9 percent) and somewhat larger commercial land use (5.6 percent).

Of the 202 Mgal/d withdrawn in 1975 for public-water supply and industrial-commercial use, 133 Mgal/d was returned to the ground after use, and about 69 Mgal/d was discharged to tidewater by sewage-treatment plants. An additional 34 Mgal/d of ground water seeped into sewerlines and was discharged to tidewater.

INTRODUCTION

Nassau County, one of the four counties on Long Island (fig. 1), is entirely dependent upon ground water for its freshwater supply. The U.S. Environmental Protection Agency has designated the ground-water reservoir as the sole source of water supply for the area. The large demand on the finite ground-water supply, and the extension of sewerlines that discharge to treatment plants and subsequently to tidewater, results in a loss of water from the ground-water system. Data on water withdrawals and returns are, therefore, essential to water-supply managers on Long Island.

Purpose and Scope

The purpose of this report is to document (1) ground-water withdrawals for public supply and self-supplied industrial-commercial use during 1973-79 in Nassau County, and (2) water returns to the ground and tidewater through sanitary sewers, septic tanks, diffusion wells, and recharge basins. The data

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[1] New York State Department of Environmental Conservation

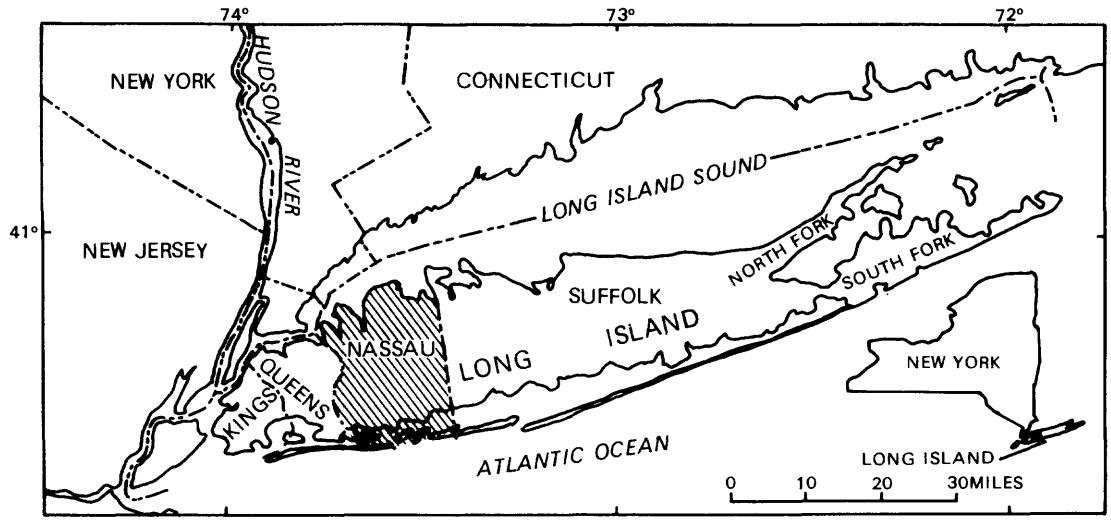


Figure 1.--Location of Nassau County, Long Island, N.Y.

presented herein are derived from pumpage figures and outflow data compiled by the New York State Department of Environmental Conservation and from estimates provided by water-management agencies on Long Island.

Source of Data

Withdrawal Data

Since 1933, the New York State Department of Environmental Conservation (referred to herein as NYSDEC and formerly known as the New York State Water Power and Control Commission) has been responsible for issuing permits for well construction. Until July 1, 1954, this procedure applied to any well or well field withdrawing more than 100,000 gal/d (69 gal/min); thereafter, the requirement was extended to include all wells pumping at least 45 gal/min (Kilburn, 1982).

Issuance of a permit requires information on the proposed well location, pumping rate, and total volume of water to be withdrawn daily; NYSDEC approves the application on the basis of need and the effects of withdrawal on the area. If approval is given, the owner submits additional data concerning well construction, aquifer, and water characteristics. NYSDEC also requires that the volume of water pumped be reported on a monthly or annual basis, depending upon the proposed amount and the density of wells in the area. The self-supplied well owners report directly to NYSDEC; the public-water suppliers tabulate pumpage monthly and annually and submit the information at the end of the year to the Nassau County Department of Public Works, which reviews the pumpage data and forwards copies to NYSDEC.

The accuracy of pumpage data depends upon the source of the records. All public-water-supply wells in Nassau County are metered and are inspected at least once by a NYSDEC engineer. Nearly all wells used for purposes other than for public supply that are required to report pumpage are metered; however, some operators do not report every month or report only at irregular intervals, if at all. In 1979, 73 percent of the industrial-commercial

systems that were required to report pumpage submitted data from meter readings, 17 percent submitted estimates by the well owner, and 10 percent were estimates made by NYSDEC. All estimates are based on either pump capacity multiplied by hours of operation or are extrapolated from previous data. Pumpage by the industries and commercial establishments who are not required to report is estimated by NYSDEC from the pump capacity and previous records.

The number of public-water suppliers, industries, and commercial establishments, the number of wells they have, and the sources of data for each group in 1979 are summarized in table 1; this distribution is considered representative of the 1973-79 period. The withdrawal data presented herein are pumpage figures tabulated by NYSDEC.

Table 1.--Sources of pumpage data for public supply and industrial-commercial water withdrawals in Nassau County, 1979.

	Public water supply facilities	Industrial-commercial facilities	
		Required to report to NYSDEC	Not required to report to NYSDEC
Total number of facilities	4[illegible]	109	[1]746
Total number of wells	350	152	unknown
SOURCE OF DATA:			
From meters			
Facilities	46	80	0
Wells	350	122	-
Estimated by well owner			
Facilities	0	18	0
Wells	0	18	-
Estimated by NYSDEC			
Facilities	0	11	[1]746
Wells	0	12	-

[1] Number is approximate.

Return Data

In 1973, New York passed the State Pollutant Discharge Elimination System Act (SPDES), which provides for State permits for point-source discharges to surface waters, in conformance with the 1972 Federal Water Pollution Control Act. In addition, the State law controls discharge of pollutants to ground water. A SPDES permit must be obtained before an owner or operator of any wastewater system can legally discharge sanitary, industrial, or commercial wastewaters into the surface or ground waters of the State.

The permit application asks for a variety of information on the proposed wastewater discharge, including how many gallons per day and where the discharge will be made. After analyzing the application thoroughly, NYSDEC issues or denies the permit. After a permit is issued, the permit holders are required to submit Discharger Monitoring Reports on a prescribed schedule. Municipal dischargers submit monthly operating reports.

The return data presented in this report that represent information furnished to the NYSDEC on Discharge Monitoring Reports include the municipal sanitary sewage outflow to tidewater, the discharge of treated sewage to recharge basins and diffusion wells, and the return of water by industrial and commercial enterprises through private recharge basins and diffusion wells. The filing of these data and their accuracy are mandated and enforceable by law; therefore the data are considered to be reliable. At least annually the department conducts a detailed, comprehensive inspection of each significant permitted facility to determine whether the discharger is meeting permit conditions. Some of these data have also been published by water-management and planning agencies; the pertinent references are included at the end of this report.

The Nassau County Department of Health estimated the amount of water discharged by septic systems (Smith, 1975). Greeley and Hansen Engineers (1971) approximated the amount of water that leaks out of conveyance pipes, the amount of water used for lawn sprinking, and the amount of water that infiltrates into sewerlines. These estimates do not have the accuracy of meter ' flow data, however.

Acknowledgments

This compilation was done in cooperation with the New York State Department of Environmental Conservation as part of the U.S. Geological Survey's National Water-Use Information Program. The authors thank Daniel Rourke, Anthony Candela, and Robert O'Reilly of the New York State Department of Environmental Conservation for their assistance in report preparation and providing pumpage data and facility identifications. Thanks are also extended to Chabot Kilburn of the U.S. Geological Survey for extensive review of the public-water-supply data.

DESCRIPTION OF AREA

Hydrogeologic Environment

Nassau County is in the western part of Long Island between Queens and Suffolk Counties (fig. 1). It encompasses about 291 mi^2 and consists of two geologically distinct zones--the northern part, which is characterized by a heavily eroded shore and terminal moraines, and the southern part, which is an outwash plain that slopes gently toward the south shore. The major features of the present topography are a result of glacial deposition and subsequent erosion. The terminal moraine forms a line of hills composed of poorly sorted rock debris that was deposited during melting of the ice sheet. The moderately flat outwash plain of sand and gravel was deposited by streams of glacial meltwater. The eroded headlands along the shores are composed of glacial

deposits reworked by streams and waves. Ocean currents along the south shore formed offshore bars and barrier beaches (Cohen and others, 1968).

The ground-water reservoir of Nassau County consists of southward-dipping unconsolidated deposits overlying crystalline bedrock (fig. 2). The deposits are composed of gravel, sand, silt, clay, and mixtures thereof. The upper glacial aquifer contains the water table and is the youngest unit (Ragone and others, 1980). Below it are fluvial and deltaic deposits of Cretaceous age. Of these, the Jameco Gravel, Magothy Formation, and Lloyd Sand Member of the Raritan Formation are major aquifers; the Gardiners Clay, clay member of the Raritan Formation, and the bedrock do not transmit appreciable quantities of water and are not aquifers. A more detailed description of the hydrogeology of Nassau County is given in Franke and McClymonds (1972).

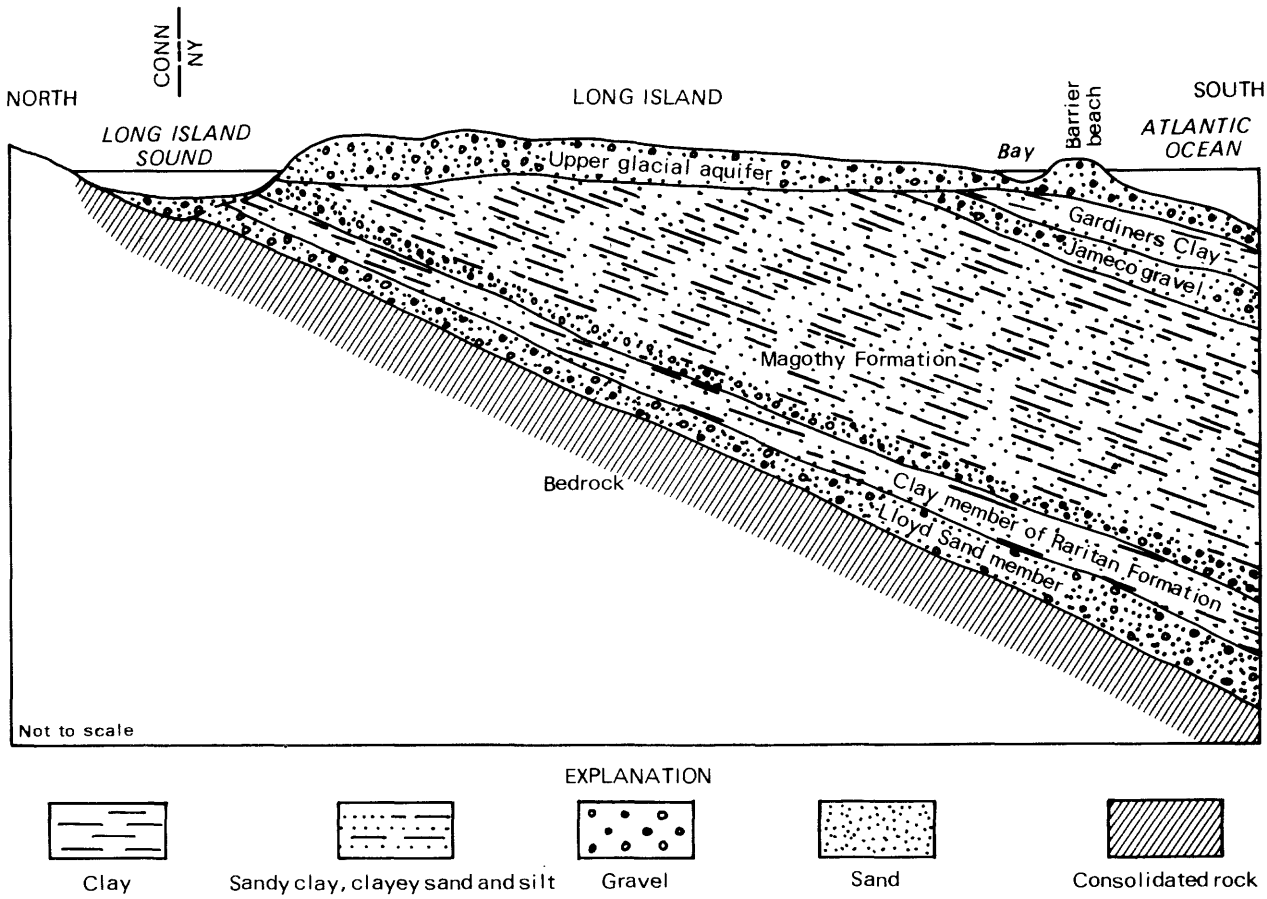


Figure 2.--Generalized geologic section showing relative position of major aquifers. (From Franke and McClymonds, 1972.)

Population and Land Use

During 1900-40, the population of Nassau County remained below 500,000, but rapid suburban expansion during the 1950's led to a large increase. By 1965 the population had exceeded 1.4 million (Cohen and others, 1968) but has decreased slightly since then. The annual population figures for 1973-79, plotted in figure 3, indicate a 5-percent decrease during this time.

Year	Population*
1973	1,405,300
1974	1,394,300
1975	1,382,600
1976	1,370,000
1977	1,356,400
1978	1,345,700
1979	1,333,300

* 1973-79 data estimated by Long Island Regional Planning Board, rounded to nearest 100.

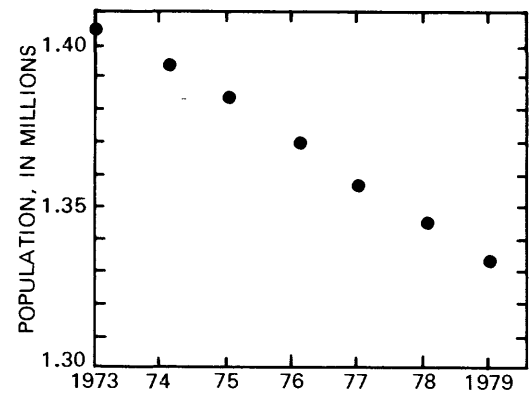


Figure 3.--Population of Nassau County, 1973-79. (Data from Long Island Regional Planning Board, written commun., 1982.)

Land-use data as of 1975 are summarized in figure 4; these data are representative of 1973-79. The high percentage of residential use (65 percent) reflects the suburban character of the county (Nassau-Suffolk Regional Planning Board, 1978). Industry, a relatively small land-use component (1.9 percent) in Nassau County, consists mainly of diversified light manufacturing (Seaburn and Aronson, 1974); land use for commercial purposes is somewhat larger (5.6 percent). Virtually no commercial agriculture or livestock operations remain in the county.

Land use	Percentage of total area	
Residential		65.0
Nonresidential		33.2
Industry	1.9	
Commerce	5.6	
Utility and landfill	0.4	
Institutional and open space	25.3	
Vacant		1.8

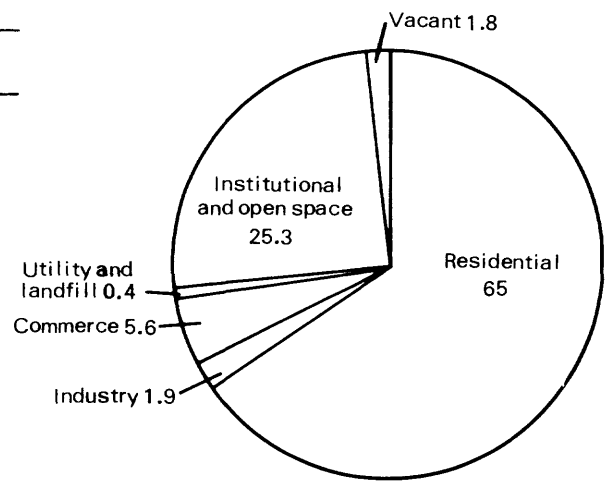
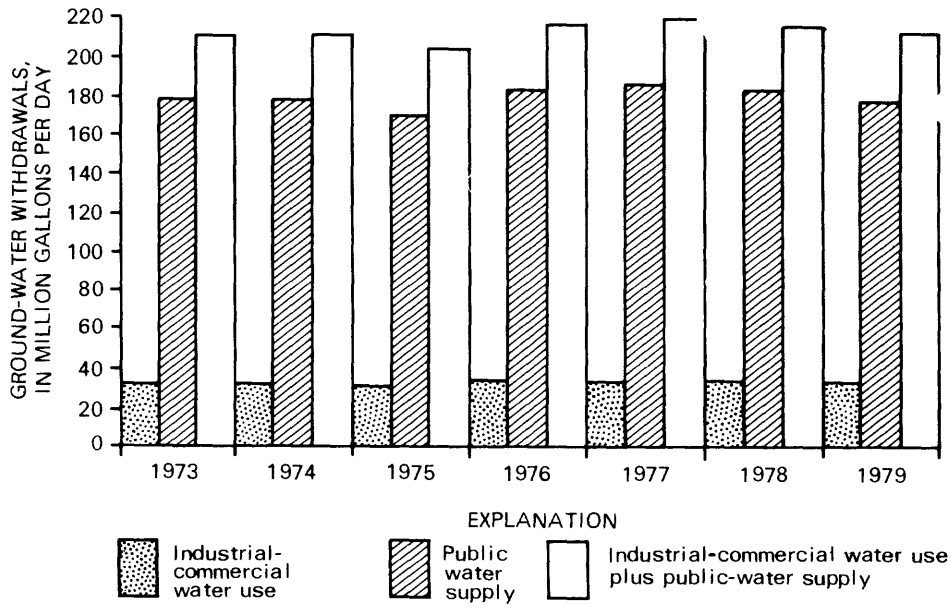


Figure 4.--Land use in Nassau County, 1975. (Data from Nassau-Suffolk Regional Planning Board.)

GROUND-WATER WITHDRAWALS

Withdrawals for public-water supply and industrial-commercial water use are summarized in figure 5 and discussed in the following paragraphs.



Ground-Water Withdrawals		
Year	Million gallons	Million gallons per day
1973	76,894	211
1974	76,913	211
1975	73,651	202
1976	78,559	215
1977	79,347	217
1978	77,977	214
1979	76,316	209

Figure 5.--Ground-water withdrawals for public-supply and industrial-commercial use 1973-79. (Data from New York State Department of Environmental Conservation.)

Public Water Supply

Nassau County contains 46 public-water-supply systems, seven of which are privately owned. Except for a few large estates and a few rural homes, all domestic water is from public supply. The total annual ground-water withdrawal for public-water supply from each aquifer during 1973-79 is summarized in figure 6; these data indicate that approximately 86 percent of the water withdrawn for public supply is from the Magothy Formation. The general service area of each public-water supplier is depicted in figure 7.

	Yearly withdrawals by aquifer								Total ground-water withdrawals	
	Upper glacial		Jameco		Magothy		Lloyd			
Year	Million gallons	Million gallons per day	Million gallons	Million gallons per day	Million gallons	Million gallons per day	Million gallons	Million gallons per day	Million gallons	Million gallons per day
1973	2,775	7.6	1,809	5.0	55,869	153.1	4,687	12.8	65,141	178.5
1974	2,695	7.4	1,704	4.7	56,093	153.7	4,742	13.0	65,233	178.7
1975	2,229	6.1	1,665	4.6	53,164	145.6	4,986	13.7	62,044	170.0
1976	2,514	6.9	2,015	5.5	56,992	156.1	4,923	13.5	66,445	182.0
1977	3,002	8.2	2,145	5.9	57,335	157.1	4,893	13.4	67,375	184.6
1978	1,639	4.5	1,806	4.9	57,834	158.4	4,763	13.1	66,042	180.9
1979	1,066	2.9	1,897	5.2	56,059	153.6	5,056	13.8	64,088	175.6
Total	15,921	43.6	13,041	35.7	393,345	1,077.6	34,050	93.3	456,368	-
7-year average	2,275	6.2	1,863	5.1	56,192	153.9	4,864	13.3	65,195	178.6

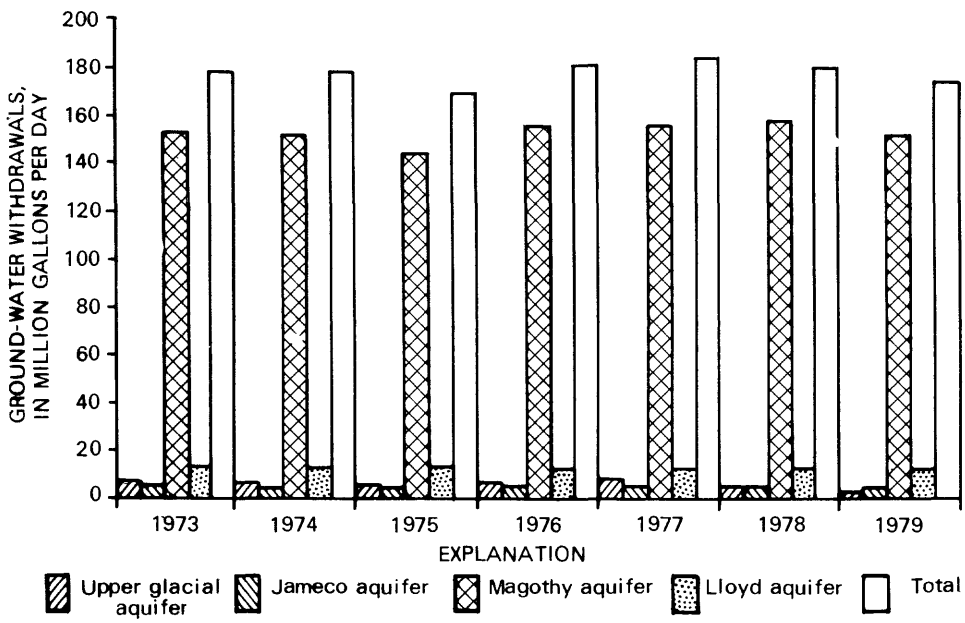
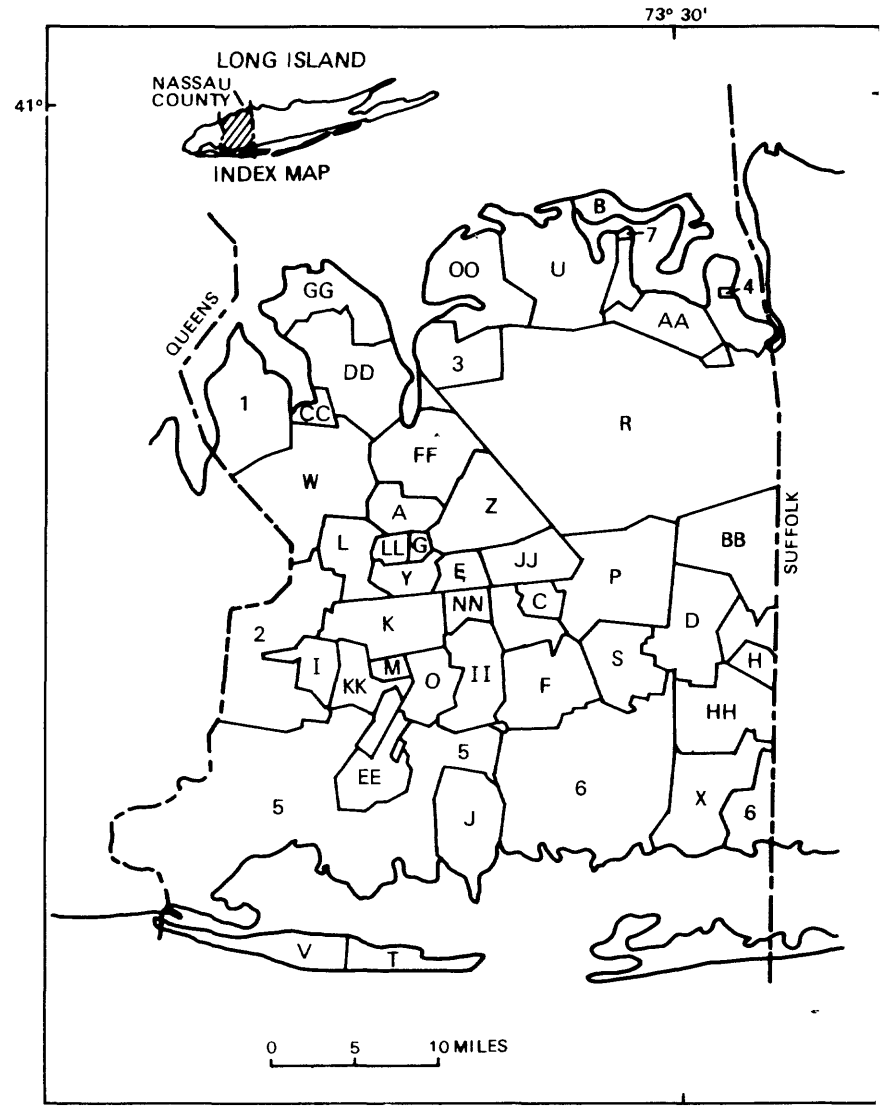


Figure 6.--Ground-water withdrawals for public-water supply, 1973-79, by aquifer. (Data from New York State Department of Environmental Conservation.)

PUBLIC-WATER SUPPLIERS
IN NASSAU COUNTY

A. Publicly Owned Companies

A - Albertson Water Dist.
B - Village of Bayville
C - Bowling Green Estates Water Dist.
D - Bethpage Water Dist.
E - Carle Place Water Dist.
F - East Meadow Water Dist.
G - East Williston Water Dist.
H - Village of Farmingdale
I - Franklin Square Water Dist.
J - Village of Freeport
K - Village of Garden City
L - Garden City Park Water Dist.
M - Garden City South Water Dist.
N - Glenwood Water Dist.
O - Village of Hempstead
P - Hicksville Water Dist
R - Jericho Water Dist.
S - Levittown Water Dist.
T - Lido-Point Lookout Water Dist.
U - Locust Valley Water Dist.
V - City of Long Beach
W - Manhasset-Lakeville Water Dist.
X - Massapequa Water Dist.
Y - Village of Mineola
Z - Village of Old Westbury
AA - Oyster Bay Water Dist.
BB - Plainview Water Dist.
CC - Village of Plandome
DD - Port Washington Water Dist.
EE - Village of Rockville Centre
FF - Roslyn Water Dist.
GG - Village of Sands Point
HH - South Farmingdale Water Dist.
II - Uniondale Water Dist.
JJ - Westbury Water Dist.
KK - West Hempstead-Hempstead Gardens Water Dist.
LL - Village of Williston Park
NN - Rossevelt Field Water Dist.
OO - City of Glen Cove



Base from Nassau County Department of Public Works

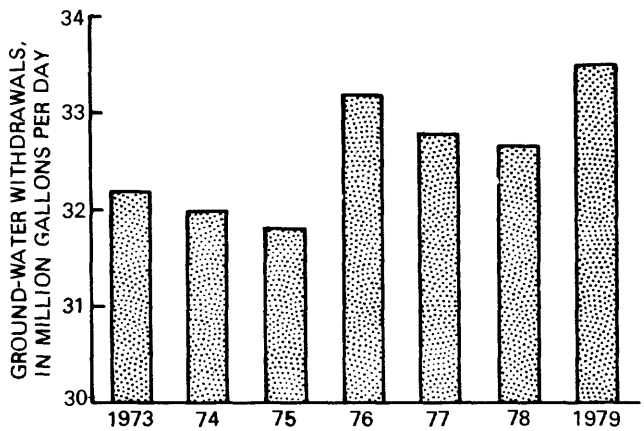
B. Privately Owned Companies

1 - Citizens Water Supply Co.
2 - Jamaica Water Supply Co. (Nassau)
3 - Sea Cliff Water Co.
4 - Assoc. of Property Owners of Sel-Vra-Acres
5 - Long Island Water Corp.
6 - Utilities & Industries Corp. Massapequa-Merrick Plant
7 - Assoc. of Owners of Mill Neck Estates

Figure 7.--General service area of public-water suppliers in Nassau County. (Data from Nassau County Department of Public Works.)

Industrial-Commercial Water Use

The water withdrawals for industrial and commercial processes are summarized in figure 8. This category includes water used for cooling and for watering lawns, golf courses, nurseries, and athletic fields; process water; and other industrial or commercial uses. Withdrawals in this category changed less than 10 percent during 1973-79.



Year	Ground-water withdrawals	
	Million gallons	Million gallons per day
1973	11,753	32.2
1974	11,680	32.0
1975	11,607	31.8
1976	12,115	33.2
1977	11,972	32.8
1978	11,935	32.7
1979	12,227	33.5

Figure 8.--Ground-water withdrawals for industrial-commercial use, 1973-79. (Data from New York State Department of Environmental Conservation.)

CONSUMPTIVE USE

After water is withdrawn, the processes of distribution and use may effectively prevent it from being returned immediately to ground water or a surface-water body. This phenomenon is known as consumptive use and has been defined by Solley and others (1983) as:

> Water that is no longer available because it has been evaporated, transpired, incorporated into products or crops, consumed by man or livestock, or otherwise removed from the water environment.

The amounts of water consumed by manufacturing processes and evapotranspiration can be quite significant, depending on the climate and types of the water-use activities involved. In Nassau County, for example, it has been estimated that 29 Mgal/d of water from public-water-supply systems is used for lawn sprinkling (Greeley and Hansen, 1971). Most of this water will evaporate before or after it hits the ground or will be transpired by plants.

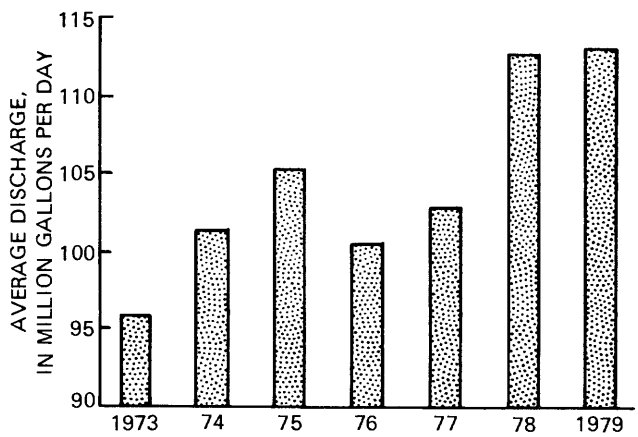
An analysis of the amount of water incorporated into products, and of the evapotranspiration losses associated with various water uses, is beyond the scope of this report, so it is assumed that these losses occur somewhere between and during the phases of water withdrawal, delivery, use, and return. Volumes of water withdrawn or returned can be documented or estimated, but these items cannot be joined into a unified water budget without estimates of consumptive use, including evapotranspiration.

WASTEWATER DISCHARGE

Once water is withdrawn and used, it is disposed of as wastewater. Wastewater may be disposed of by several methods, including sewage-treatment plants, septic tanks, diffusion (injection) wells, and recharge basins. Except for sewage-treatment plants, which discharge to tidewater and thereby remove water from the ground-water system, all of these methods return water to the ground.

Sanitary Sewers

In 1975, approximately 55 percent of the population of Nassau County was served by a public sanitary-sewer system. The amount of water discharged by sewage-treatment plants during 1973-79 is summarized in figure 9. The amount of water discharged to sewers during this interval was generally increasing because the sewer districts were expanding and serving larger areas. All but approximately 1.2 Mgal/d of this water was discharged to tidewater and constitutes a net loss from the ground-water system. One study has predicted that ground-water levels in an area of Nassau County may drop by as much as 16 ft after 20 years of complete sewering (Ku and Sulam, 1979).



Year	Annual discharge: Million gallons	Annual discharge: Million gallons per day
1973	35,025	96.0
1974	37,000	101.4
1975	38,467	105.4
1976	36,719	100.6
1977	37,628	103.1
1978	41,139	112.7
1979	41,329	113.2

Figure 9.--Average discharge from sewage-treatment plants in Nassau County, 1973-79. (Data from New York State Department of Environmental Conservation.)

Domestic Waste-Disposal System

Residences not served by public-sewer systems have individual waste-disposal systems including cesspools, septic tanks, and leaching fields. In these systems, bacterial action digests the solid materials, and the liquid effluent is discharged to the ground. In theory, filtration by earth materials provides additional treatment so that the liquid is relatively clean when it arrives at the water table (Geraghty and Miller, 1977).

In 1975, approximately 45 percent of the population of Nassau County had individual residential disposal systems, which returned about 60 Mgal/d to the ground (Smith, 1975).

Diffusion Wells

Diffusion wells, which inject wastewater back into the ground, have been in use on Long Island since the 1930's. In 1933, the New York State Water Power and Control Commission (now NYSDEC) established a general policy (Johnson, 1948) prohibiting

> ...the drilling of new industrial wells with capacities in excess of 100,000 gal/d, unless the water pumped is returned in an uncontaminated condition into the ground through diffusion wells or other approved structures...

During 1975, industries in Nassau County returned 12.33 Mgal/d of water to the ground through diffusion wells (Geraghty and Miller, 1977). A small amount of treated effluent from sewage-treatment plants is also discharged to the ground through diffusion wells; 1.2 Mgal/d of treated sewage is returned through diffusion wells and recharge basins combined (Geraghty and Miller, 1977).

Recharge Basins

Recharge basins are unlined, open pits that dispose of water by infiltration into the sandy, highly permeable soil on Long Island (Seaburn, 1970). Some industries use recharge basins to dispose of wastewater. In 1975, about 0.8 Mgal/d of wastewater was returned to recharge basins by industries (Geraghty and Miller, 1977). Recharge basins are also used to a small degree to return treated sewage to the ground.

Other Returns

Another method of return to the ground is through conveyance loss or distribution-pipe leakage. Whether this water reaches the water table and recharges the ground water or is lost through evapotranspiration, it represents water that is withdrawn but never delivered for use. Geraghty and Miller (1977) have estimated that approximately 30 Mgal/d of the water withdrawn for public-water supply is returned to the ground through distribution-pipe leakage.

Finally, Greeley and Hansen (1971) have estimated that approximately 32 percent of the water discharged by sewage-treatment plants in Nassau County comes from the infiltration of ground water into the sewerlines below the water table; in 1975 this percentage would amount to about 34 Mgal/d. Even though the exact amount is unknown, it represents a signficant discharge to tidewater.

SUMMARY AND CONCLUSIONS

Documentation of water use in Nassau County is important to water-management agencies because ground water is the county's sole source of freshwater supply. Applications to install wells withdrawing more than 45 gal/min must be approved by the New York State Department of Environmental Conservation (NYSDEC). A permit must also be secured from the NYSDEC before an owner or operator of any wastewater system can legally discharge sanitary, industrial, or commercial wastewaters into the surface or ground waters of the State. Most of the data presented in this report are from withdrawal records filed with NYSDEC by public-water supply and self-supplied industrial and commercial users and discharge data filed by the sanitary-sewer districts and individual industries. Some of the data were estimated by NYSDEC and some by other water-management agencies and consultants.

The withdrawals from aquifers and returns to the ground and tidewater by public-water suppliers and industrial-commercial users during 1975 are summarized on page 14. The year 1975 is used as an index to represent, in general, the study interval 1973-79.

Public-water suppliers are almost totally dependent upon the Magothy Formation for ground water. During 1973-79, more than five times as much water was withdrawn by public-water suppliers than by self-supplied industrial and commercial users; this reflects the predominantly residential character of the county.

Some of the water withdrawn by public suppliers and by self-supplied industrial-commercial users is returned to sewage-treatment plants that discharge to tidewater; some is returned to the ground through septic systems, cesspools, recharge basins and diffusion wells, and some is lost through consumptive use, including evapotranspiration.

Table 2.--Withdrawals from ground water and returns to the ground and tidewater, Nassau County, 1975.

[Mgal/d = million gallons per day]

	Public-water supply		Industrial-commercial self-supplied		Total	
	million gallons	Mgal/d	million gallons	Mgal/d	million gallons	Mgal/d
Withdrawals	62,050	170.0	11,607	31.8	73,657	201.8
RETURNS:						
To the ground:						
Pipe leakage	10,950	30.0	--	--	10,950	30.0
Septic systems	21,900	60.0	--	--	21,900	60.0
Lawn sprinking	10,585	29.0	--	--	10,585	29.0
Sewage-treatment plants to recharge basins or diffusion wells					438	1.2
Private recharge basins	--	--	292	0.8	292	0.8
Diffusion wells	--	--	4,500	12.3	4,500	12.3
Total					48,665	133.3
To tidewater:						
Sewage-treatment plants (includes approx. 34 Mgal/d of ground water that infiltrates into sewer pipes)						
Total					38,033	104.2

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