REPORT OF

THE RIVER MASTER

OF THE DELAWARE RIVER

For the period
December 1, 1988 - November 30, 1989

by Stanley P. Sauer, William E. Harkness, and Bruce E. Krejmas
with a section on water quality by Kirk E. White

U.S. Geological Survey

Open-File Report 90-551

Reston, Virginia

1990

U.S. DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

Delaware River Master
U.S. Geological Survey
433 National Center
Reston, VA 22092
or
Deputy Delaware River Master
U.S. Geological Survey
405 Broad Street
Milford, PA 18337

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

Multiply Inch-Pound unit	By	To Obtain Metric unit
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
million gallons (Mgal)	3,785	cubic meter (m^3)
billion gallons (Bgal)	3.785	cubic hectometer (m^3)
cubic foot per second-day ($(ft^3/s)\cdot d$)	0.002447	cubic hectometer (hm^3)
	Flow	
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

ADDITIONAL CONVERSION FACTORS AND DEFINITIONS

Multiply	By	To Obtain
Million gallons per day (Mgal/d)	1.547	cubic foot per second (ft^3/s)
Billion gallons per day (Bgal/d)	1547	cubic foot per second (ft^3/s)
Million gallons (Mgal)	1.547	cubic foot per second-day ($(ft^3/s)\cdot d$)

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

Section I

RIVER MASTER LETTER OF TRANSMITTAL

and

SPECIAL REPORT

 (PAGE 3 FOLLOWS)

OFFICE OF THE DELAWARE RIVER MASTER
United States Geological Survey
433 National Center, Reston, Virginia 22092

September 21, 1990

The Honorable
William H. Rehnquist
Chief Justice of the Supreme Court
of the United States

The Honorable
Michael N. Castle
Governor of Delaware

The Honorable
James J. Florio
Governor of New Jersey

The Honorable
Mario M. Cuomo
Governor of New York

The Honorable
Robert P. Casey
Governor of Pennsylvania

The Honorable
David N. Dinkins
Mayor of the City of New York

New Jersey v. New York et al
No. 5 Original, October Term 1950

Dear Sirs:

For the record and in compliance with the provisions of the Amended Decree of the Supreme Court of the United States entered June 7, 1954, I am transmitting herewith the thirty-sixth Annual Report of the River Master of the Delaware River for the year December 1, 1988 to November 30, 1989.

Precipitation in the upper Delaware River basin during the 1989 River Master report year ranged from 39 persent of the long-term average during December to 207 percent during May (See table 1). Total precipitation during the year was about 1.45 inches above average. Precipitation during the December to May period, when reservoirs typically refill, was 2.09 inches below normal. However, the wet conditions at the end of April and during May filled the reservoirs and ended the drought warning that was in effect for much of the period.

On December 1, 1988, when this report year began, combined storage in the New York City reservoirs in the upper Delaware River basin was 137 billion gallons (Bgal), 51 percent of the combined capacity. Normal storage on December 1, based on 21 years of data is 161 Bgal.

During the December through May period, storage in the New York City reservoirs usually increases in response to lower demand for water and higher base flows in the streams in the basin. However, during the 1989 report year, storage began to decline in early December, in response to the very low precipitation and declined steadily until late February. On January 11, 1989, storage dropped into the drought-warning zone of the operation curves for the reservoirs. On January 16, 1989, the allowable diversions by New York City and New Jersey and the flow objective for the Delaware River at Montague, New Jersey were reduced to the levels mandated by the "Interstate Water Management Recommendation of the Parties to the U.S. Supreme Court Decree of 1954."

In addition, the augmented conservation releases from the reservoirs were reduced to the basic conservation levels. (See table 2). In spite of these actions the storage continued to decline and reached the midpoint of the drought-warning zone of the operation curves for the reservoirs on February 5, 1989. Consequently, the allowable diversions to New York City and New Jersey were immediately reduced a second time and the Montague flow objective was reduced effective February 8, 1989, due to the three-day delay in the design period.

During the February 6-8, 1989, period, there were numerous discussions with representatives of the Parties to the Decree and the Delaware River Basin Commission concerning the need for taking additional actions immediately in an attempt to delay or prevent entering the drought zone of the operations curves Those discussions resulted in the unanimous request of the Parties to the Decree to the Executive Director of the Delaware River Basin Commission and this office to implement the following emergency actions:

1. Diversions to New York City shall be limited to a running average of 560 Mgal/d, minus an amount equivalent to the amount that would normally be released to meet the Good Faith Montague flow objective, above and beyond the basic conservation releases.

2. There will be no releases from the three New York City Delaware River Basin Reservoirs to meet the Montague flow objective, and basic conservation releases shall continue to be made.

3. Deficits in the Good Faith flow objective at Trenton will be made up by releases from the down-basin reservoirs.

4. Out-of-basin diversions to New Jersey shall be limited to the present 70 Mgal/d.

We considered the request and determined that hydrologic conditions in the upper basin were severe enough to warrant taking additional actions to improve water supply storage. In addition we determined that the requested actions probably would not save a very large quantity of water in storage, but also would not have a severe detrimental impact downstream from the reservoirs. Therefore, in order to achieve maximum benefit from the requested actions, we approved the proposal and put it into effect on February 9, 1989.

It was agreed that these actions would continue until the droughtwarning conditions terminated, the basin entered a drought condition as defined by the Interstate Water Management Recommendations or April 30, 1989, whichever came first. (DRBC Resolution No. 89-5).

Storage declined briefly into the drought zone of the operation curves on March 24, 1989 but precipitation averaging about one inch occurred that same day in the upper basin and served to increase storage above the drought zone by the next day. Storage continued to increase throughout the spring and conditions were such that a return to operations as prescribed in the Decree was ordered on May 12, 1989.

The reservoirs reached a maximum combined storage for the report year of 270.157 Bgal, on June 25, 1989. On June 1, 1989, the start of the water operations year, storage was 256.922 Bgal and Cannonsville reservoir was spilling.

Throughout the year, diversions for water supply for New York City and releases designed to maintain the flow of the Delaware River at Montague were made as directed by this office. Diversions by New York City from the Delaware River basin reservoirs did not exceed the limit specified by the Decree.

The Delaware River Master Advisory Committee met at Monticello, New York on May 31, 1989 to discuss hydrologic conditions in the basin and operational procedures during the 1989 release season. As River Master, I informed the committee that on the basis of information provided by New York City, the excess quantity that would be released beginning June 15 was 7.381 Bgal. This water would be released at rates designed to maintain the Montague target flow at 100 ft^3/s above the normal 1,750 ft^3/s specified by the Decree.

Following the Advisory Committee meeting the River Master Office and the New York City Bureau of Water Supply hosted a two-day inspection tour of hydrologic facilities in the upper Delaware River basin. Approximately 40 people representing various agencies with interests in the management of water resources in the Delaware River basin participated in the tour. In addition to an inspection of the facilities in the upper basin owned and operated by New York City, the group toured the West Delaware Hydroelectric plant, Lake Wallenpaupack Dam, the Upper Delaware Scenic and Recreational River and the Mongaup hydroelectric facilities. At each of the stops on the tour, the management of the various facilities made informative presentations to the group.

During the report year, the River Master and staff participated in meetings of the Delaware River Basin Commission to assess water-supply conditions. Upon invitation of the representatives of the Parties to the Decree, the Deputy River Master met periodically with those representatives as a member of the Flow Management Technical Advisory Committee. Discussions primarily centered on proposals for the management of releases from reservoirs in the basin and other measures designed to cope with streamflow deficiences whenever they occur.

The U.S. Geological Survey continued the operation of its field office of the Delaware River Master at Milford, Pennsylvania. William E. Harkness, Deputy Delaware River Master, continued in charge of the office, assisted by Bruce E. Krejmas and Beverly A. Roberts.

During the report year, the Milford office continued the weekly distribution of summary river data. These weekly reports contained preliminary data on releases from the New York City reservoirs to the Delaware River, diversions to the New York City water-supply system, reservoir contents, daily segregation of flow of the Delaware River at Montague gaging station, and diversions by New Jersey. The reports were made available to the State and City representatives on the Delaware River Master Advisory Committee and to other parties interested in the Delaware River operations. A special monthly summary of past hydrologic conditions, supplemented by an "outlook" of the river flow for the forthcoming month, was made available to the representatives on the Advisory Committee.

Section II of the report describes in detail Delaware River operations during the report year. As shown on page 23 the City of New York diverted a total of 216.984 Bgal from the basin during the report year ending November 30, 1989 and released 66.159 Bgal from Pepacton, Cannonsville, and Neversink Reservoirs to the Delaware River during the same period. The River Master directed releases to the Delaware River from these reservoirs totaling 36.822 Bgal.

Section III of the report describes water quality at various sites in the Delaware River Estuary. It was prepared by Kirk E. White, U.S. Geological Survey, Malvern, Pennsylvania and contains data showing the extent of salinity encroachment and other water-quality characteristics in the estuary.

During the report year, the following individuals functioned as members of the River Master Advisory Committee:

Delaware	Dr. Robert R. Jordan
New Jersey	Dirk C. Hofman, P.E.
New York	Russell C. Mt. Pleasant
New York City	Harvey W. Schultz
Pennsylvania	John E. McSparran

The appreciation of the River Master and staff is expressed for the continued excellent cooperation of all the representatives of the Parties to the Decree. Also, appreciation is extended to the Pennsylvania Power & Light Company and the Orange and Rockland Utilities, Inc. for their cooperation in keeping us informed of their plans for power generation and resulting releases as requested by this office. As usual, it is gratifying to report that New York City complied willingly with the terms of the Decree and with the directives of the River Master. New Jersey also cooperated fully with the directives of the River Master concerning their diversions from the basin.

A draft of this report was furnished to the Advisory Committee members for comment.

Sincerely yours,

Stanley P. Sauer

Stanley P. Sauer, P.E.
Delaware River Master

(PAGE 9 FOLLOWS)

Section II

REPORT OF DELAWARE RIVER OPERATIONS

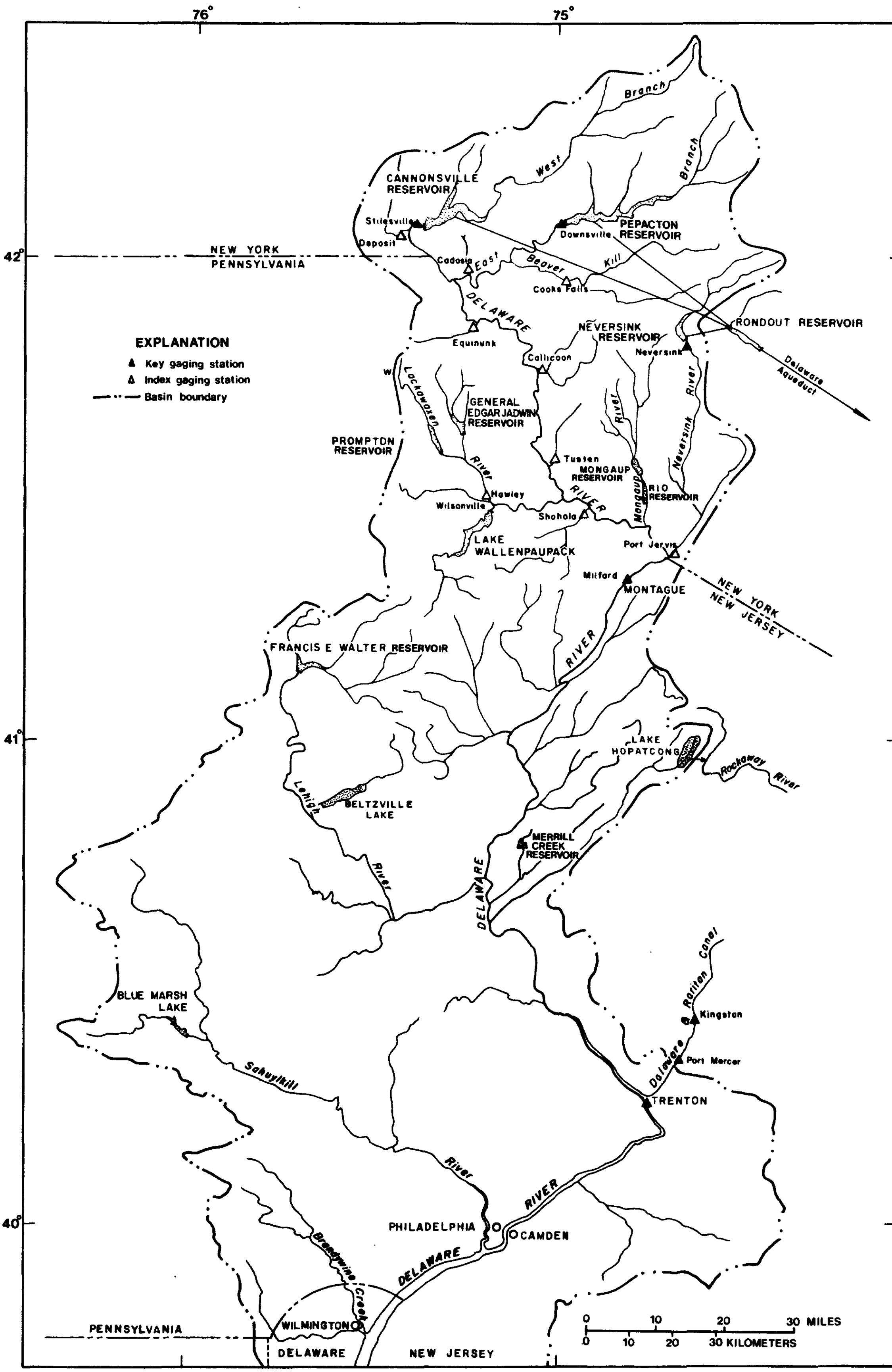

Figure 1. - Delaware River Basin upstream from Wilmington, Delaware.

Section II

REPORT OF DELAWARE RIVER OPERATIONS

by William E. Harkness and Bruce E. Krejmas

ABSTRACT

A Decree of the Supreme Court of the United States in 1954 established the position of Delaware River Master. The Decree authorizes diversions of water from the Delaware River basin (Figure 1) and requires compensating releases from certain New York City owned reservoirs to be made under the supervision and direction of the River Master. Reports to the Court, not less frequently than annually, were stipulated.

During the 1989 report year, December 1, 1988, to November 30, 1989, precipitation and runoff ranged from below average to above average in the Delaware River basin. For the year as a whole, precipitation was 1.45 inches above average. Reservoir storage in the basin declined into the drought-warning zone of the operation curves for the reservoirs on January 11, 1989 and operations were conducted as prescribed in the Interstate Water Management Recommendations of the Parties to the Decree from January 16 to February 8. From February 9 to April 30 at the request of the Parties to the Decree, releases to meet the Montague flow objective were suspended as part of operations designed to avoid or delay entry into a drought emergency in the basin. In response to increased precipitation in April and May, storage increased and operations were returned to those prescribed in the Decree on May 12. Storage improved from a low of 45.2 percent of capacity on February 15 to 99.7 percent of capacity on June 25, and remained above the median for the remainder of the report year.

Diversions from the Delaware River basin by New York City and New Jersey did not exceed those authorized by the terms of the Amended Decree. Releases were made as directed by the River Master at rates designed to meet the Montague flow objective on 88 days during the year. Releases were made at the augmented or basic conservation rates or at rates designed to relieve thermal stress in the streams downstream from the reservoirs at other times. The excess release quantity as defined by the Decree was expended on October 18, 1989 and the Montague design rate was reduced from 1,850 ft^3/s to 1,750 ft^3/s.

New York City and New Jersey complied fully with the terms of the Decree and with the directives of the River Master during the year.

INTRODUCTION

The Amended Decree of the United States Supreme Court entered June 7, 1954 authorized diversions of water from the Delaware River basin and provided for releases of water from certain New York City reservoirs to the Delaware River to be made under the supervision and direction of the River Master. The Decree also stipulated that reports be made to the Court not less frequently than annually. This report describes the River Master operations from December 1, 1988 to November 30, 1989.

Part of the hydrologic data presented are records of flow and water quality at U.S. Geological Survey gaging stations. These records were collected, computed, and furnished by the Offices of the U.S. Geological Survey at Albany, New York, Malvern, Pennsylvania, and West Trenton, New Jersey, in cooperation with the States of New York and New Jersey, the Commonwealth of Pennsylvania, and the City of New York.

Definitions of Terms and Procedures

The following definitions apply to various terms and procedures used in the operations described in this report. A table for converting inch-pound units to International System of Units (SI) is given on page v. The map of the Delaware River basin (fig. 1), indicates the location of pertinent streams and reservoirs.

Time of day. - Time of day is expressed in 24-hour eastern standard time, which included a 23-hour day April 2 and a 25-hour day October 29.

Rate of flow. - Mean discharge for any stated 24-hour period, in cubic feet per second (ft^3/s) or million gallons per day (Mgal/d).

Rate of flow at Montague. - Daily mean discharge of the Delaware River at Montague, N.J., on a calendar-day basis.

Reservoir-controlled releases. - Controlled releases from reservoirs passed through outlet valves in the dams or through turbines in powerplants. This does not include spillway overflow at the reservoirs.

Uncontrolled runoff at Montague. - Runoff from the drainage area upstream from Montague exclusive of the drainage area upstream from the Downsville, Cannonsville, Neversink, Wallenpaupack, and Rio dams but including spillway overflow at these dams.

Point of maximum reservoir depletion. - Elevation at the top of the highest outlet, sometimes referred to as minimum full-operation level.

Storage or contents. - Usable volume of water in a reservoir. Unless otherwise indicated, volume is computed on the basis of level pool and above the point of maximum depletion.

Capacity. - Total usable volume between the point of maximum depletion and the elevation of the lowest crest of the spillway.

Diversions. - The transfer of water by New York City from Pepacton, Cannonsville, and Neversink Reservoirs in the upper Delaware River basin through the East Delaware, West Delaware, and Neversink Tunnels, respectively, to its water-supply system.

Also, the transfer of water by New Jersey from the Delaware River through the Delaware and Raritan Canal.

Excess quantity and seasonal period for its release. - As defined in the Decree, the excess quantity of water equals 83 percent of the amount by which the estimated consumption in New York City during the year is less than the City's estimate of continuous safe yield (1,665 Mgal/d stipulated by 1954 Decree) from all its sources of supply obtainable without pumping, except that the excess quantity should not exceed 70 billion gallons. Each year the "seasonal period" for release of the excess quantity begins on June 15. The design rate for that period becomes effective at Montague on that date and continues in effect until the following March 15, or until the cumulative total of excess-release credits becomes equal to the seasonal quantity, whichever occurs first.

Daily excess-release credits. - Daily credits and deficits during the seasonal period are equal to the algebraic difference between the daily mean discharge at Montague and 1,750 ft^3/s; however, the daily credit cannot exceed the 24-hour period releases from Pepacton, Cannonsville, and Neversink Reservoirs routed to Montague and made in accordance with direction, with the following exception. During the seasonal period, credits are also made for part or all of other releases from these reservoirs contributing to daily mean discharge at Montague between the excess-release rate and 1,750 ft^3/s.

Precipitation

Precipitation observed on the basin above Montague totaled 44.61 inches for the 1989 report year and was 1.45 inches above the long-term average. Precipitation ranged from 39 percent of the long-term average in December, 1988 to 207 percent of the average in May, 1989. Table 1 compares the monthly precipitation during the report year with the long-term average.

Table 1.- Precipitation in inches,
Delaware River basin upstream from Montague, N.J.

Month	December 1940 to November 1988 Average	December 1988 to November 1989			
		Amount	Percentage of average	Excess (+) or deficit (-)	
				Month	Cumulative
December	3.42	1.32	39	-2.10	-2.10
January	2.89	1.44	50	-1.45	-3.55
February	2.76	1.96	71	-.80	-4.35
March	3.25	2.81	86	-.44	-4.79
April	3.78	2.00	53	-1.78	-6.57
May	4.18	8.66	207	+4.48	-2.09
June	3.91	6.16	158	+2.25	+.16
July	4.17	2.88	69	-1.29	-1.13
August	3.92	3.36	86	-.56	-1.69
September	3.73	5.55	149	+1.82	+.13
October	3.32	5.29	159	+1.97	+2.10
November	3.83	3.18	83	-.65	+1.45
12 months	43.16	44.61	103	+1.45	

These data were computed from records collected by the National Weather Service, New York City Department of Environmental Protection, Bureau of Water Supply and the River Master, at ten stations distributed over the basin area above Montague.

December to May is generally considered the normal time of year when surface- and ground-water reservoirs fill. During this period in 1988-89, precipitation totalling 18.19 inches was observed, which was 90 percent of the 48-year average. However, 8.66 inches or 48 percent of the total occurred in May. During June to November, 26.42 inches of precipitation was observed, which was 115 percent of the long-term average. The maximum monthly precipitation received during the year for any of the ten stations was 10.70 inches in May at Rock Hill, New York; the minimum monthly precipitation observed was 0.76 inches in December at Milford, Pennsylvania.

Acknowledgments

The River Master daily operation records were prepared by the Milford Office of the Delaware River Master from hydrologic data collected principally on a day-to-day basis. Data for these records were collected and computed by the Milford Office or were furnished by agencies as follows: Data from Pepacton, Cannonsville, and Neversink Reservoirs by the New York City Department of Environmental Protection, Bureau of Water Supply; from Delaware and Raritan Canal by the New Jersey Water Supply Authority; from Lake Wallenpaupack by the Pennsylvania Power & Light Company; and from Rio Reservoir by Orange and Rockland Utilities, Inc. Precipitation data and quantitative precipitation forecasts were provided by the National Oceanic and Atmospheric Administration, National Weather Service.

OPERATIONS

December to May

During the first half of the report year, precipitation was 2.09 inches below average and ranged from 39 percent of the long-term average in December to 207 percent in May (See table 1.) Runoff in the upper basin was below normal during December through April and was above normal during May.

On December 1, 1988, Pepacton Reservoir contained 79.988 Bgal of water in storage above the point of maximum depletion, or 57.1 percent of the reservoir's storage capacity of 140.190 Bgal. Cannonsville Reservoir contained 48.247 Bgal, or 50.4 percent of the reservoir's storage capacity of 95.706 Bgal and Neversink Reservoir contained 9.063 Bgal, or 25.9 percent of the reservoir's storage capacity of 34.941 Bgal. The combined storage in the three reservoirs as of December 1 was 137.298 Bgal, or 50.7 percent of their combined capacity. Daily storages in Pepacton, Cannonsville, and Neversink Reservoirs are shown in tables 10, 11, and 12, respectively, and the combined storage is shown graphically in figure 2.

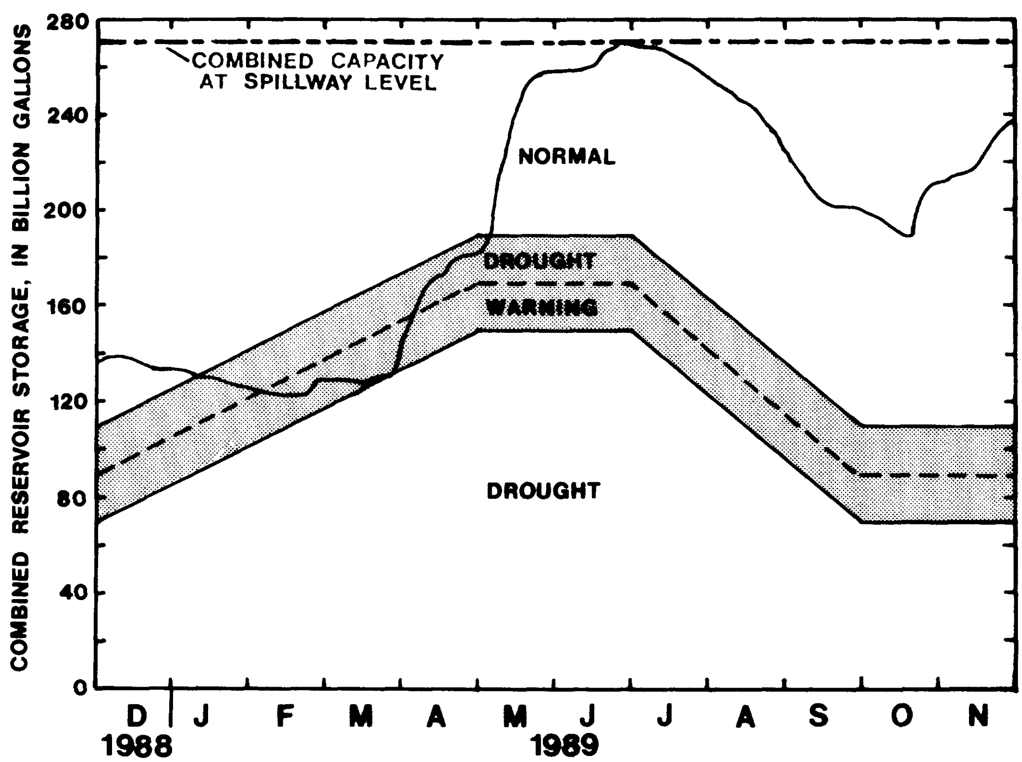

Figure 2. - Operating curves for New York City reservoirs in the Delaware River basin compared with the actual contents of the reservoirs, December 1, 1988 to November 30, 1989. (Sources: Operating curves from Interstate Water Management Recommendations of the Parties to the U.S. Supreme Court Decree of 1954, reservoir contents from New York City Bureau of Water Supply data.

Operations on December 1, 1988 were being conducted as prescribed by the Decree. The Montague flow objective was 1,750 ft^3/s and the allowable diversions to New York City and New Jersey were 800 Mgal/d and 100 Mgal/d respectively. The average diversion to New York City since June 1, 1988 was 743 Mgal/d. Conservation releases from New York City reservoirs were being made at the augmented levels shown in table 2.

Table 2.- Conservation release rates for New York City Delaware River basin reservoirs

Reservoir	Operative dates	Conservation releases rates	
		Basic (ft^3/s)	Augmented (ft^3/s)
Neversink	April 1-7	5	45
	April 8 to October 31	15	45
	November 1 to March 31	5	25
Pepacton	April 1-7	6	70
	April 8 to October 31	19	70
	November 1 to March 31	6	50
Cannonsville	April 1-15	8	45
	April 16 to June 14	23	45
	June 15 to August 15	23	325
	August 16 to October 31	23	45
	November 1-30	23	33
	December 1 to March 31	8	33

As discussed in Section I, storage in New York City reservoirs declined into the drought-warning zone of the operation curves for the reservoirs on January 11, 1989. On January 16, 1989, allowable diversions by New York City and New Jersey were reduced to 680 Mgal/d and 85 Mgal/d, respectively and the Montague flow objective was reduced to 1,655 ft^3/s. The augmented conservation releases were reduced to the basic rates listed in table 2.

On February 5, 1989 operations were again reduced to the levels required for the lower half of the drought-warning zone. Allowable diversions by New York City and New Jersey were reduced to 560 Mgal/d and 70 Mgal/d, respectively and the Montague flow objective was reduced to 1,550 ft^3/s.

On February 9, 1989, additional actions were taken at the unanimous request of the Parties to the Decree to limit the use of water stored in the New York City reservoirs in an attempt to avoid entering the drought zone of the operation curves. It was agreed that releases designed to meet the Montague flow objective would not be made and that, if the discharge at the Montague gaging station fell below the design rate of 1,550 ft^3/s, New York City would subsequently reduce their diverions out of the basin by an amount equivalent to the shortfall. Table 3 summarizes the savings that resulted from those actions. During the administration of these actions, February 9 to May 11, 1989, the discharge at the Montague gaging station fell below the design rate on nine days resulting in a total shortfall of 839 Mgal (see table 3). During the February 5 to May 11, 1989 period, New York City diverted 49,750 Mgal or 4,010 Mgal less than the amount that would have been allowed at the 560 Mgal/d rate. The agreement required them to reduce their diversions a total of 839 Mgal less than the 560 Mgal/d rate but they diverted considerably less (3,171 Mgal) than the amount allowed.

Table 3. - Diversions to New York City, shortfall at Delaware River at Montague, New Jersey, and the computed savings resulting from the actions taken February 8, 1989 to conserve water. Daily values in million gallons.

Date	Days	Diversions to New York City				Montague shortfall		Cumulative savings
		Daily	Cumulative	Allowable	Cutback	Daily	Cumulative	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Feb. 5	1	471	471	560				
6	2	582	1,053	1,120				
7	3	471	1,524	1,680				
8	4	614	2,138	2,240				
9	5	618	2,756	2,800	44			44
10	6	618	3,374	3,360	-14			-14
11	7	470	3,844	3,920	76			76
12	8	470	4,314	4,480	166	226	226	392
13	9	469	4,783	5,040	257	162	388	645
14	10	564	5,347	5,600	253	0	388	641
15	11	560	5,907	6,160	253	0	388	641
16	12	550	6,457	6,720	263	0	388	651
17	13	553	7,010	7,280	270	0	388	658
18	14	469	7,479	7,840	361	0	388	749
19	15	469	7,948	8,400	452	32	420	872
20	16	469	8,417	8,960	543	162	582	1,125
21	17	569	8,986	9,520	534	0	582	1,116
22	18	559	9,545	10,080	535	0	582	1,117
23	19	552	10,097	10,640	543	0	582	1,125
24	20	552	10,649	11,200	551	0	582	1,133
25	21	470	11,119	11,760	641	0	582	1,223
26	22	470	11,589	12,320	731	0	582	1,313
27	23	536	12,125	12,880	755	0	582	1,337
28	24	543	12,668	13,440	772	0	582	1,354

Col. 2 - Number of days since Feb. 5, 1989.
Col. 3 - Total for 24 hours beginning at 0800.
Col. 4 - Summation of Col. 3.
Col. 5 - Col. 2 x 560 Mgal/d.
Col. 6 - Col. 5 - Col. 4.
Col. 7 - (1,550 - Col. 11 of table 16)/1.547.
Col. 8 - Summation of Col. 7.
Col. 9 - Col. 6 + Col. 8

Table 3. - Diversions to New York City, shortfall at Delaware River at Montague, New Jersey, and the computed savings resulting from the actions taken February 8, 1989 to conserve water. - continued

Daily values in million gallons.

Date	Days	Diversions to New York City				Montague shortfall		Cumulative
		Daily	Cumulative	Allowable	Cutback	Daily	Cumulative	savings
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mar. 1	25	542	13,210	14,000	790	0	582	1,372
2	26	545	13,755	14,560	805	0	582	1,387
3	27	458	14,213	15,120	907	0	582	1,489
4	28	469	14,682	15,680	998	0	582	1,580
5	29	469	15,151	16,240	1,089	0	582	1,671
6	30	569	15,720	16,800	1,080	0	582	1,662
7	31	646	16,366	17,360	994	0	582	1,576
8	32	569	16,935	17,920	985	0	582	1,567
9	33	570	17,505	18,480	975	0	582	1,557
10	34	575	18,080	19,040	960	0	582	1,542
11	35	468	18,548	19,600	1,052	0	582	1,634
12	36	459	19,007	20,160	1,153	103	685	1,838
13	37	746	19,753	20,720	967	19	704	1,671
14	38	745	20,498	21,280	782	19	723	1,505
15	39	745	21,243	21,840	597	58	781	1,378
16	40	745	21,988	22,400	412	58	839	1,251
17	41	594	22,582	22,960	378	0	839	1,217
18	42	298	22,880	23,520	640	0	839	1,479
19	43	299	23,179	24,080	901	0	839	1,740
20	44	494	23,673	24,640	967	0	839	1,806
21	45	595	24,268	25,200	932	0	839	1,771
22	46	596	24,864	25,760	896	0	839	1,735
23	47	598	25,462	26,320	858	0	839	1,697
24	48	587	26,049	26,880	831	0	839	1,670
25	49	458	26,507	27,440	933	0	839	1,772
26	50	497	27,004	28,000	996	0	839	1,835
27	51	597	27,601	28,560	959	0	839	1,798
28	52	595	28,196	29,120	924	0	839	1,763
29	53	595	28,791	29,680	889	0	839	1,728
30	54	593	29,384	30,240	856	0	839	1,695
31	55	596	29,980	30,800	820	0	839	1,659

Col. 2 - Number of days since Feb. 5, 1989.
Col. 3 - Total for 24 hours beginning at 0800.
Col. 4 - Summation of Col. 3.
Col. 5 - Col. 2 x 560 Mgal/d.
Col. 6 - Col. 5 - Col. 4.
Col. 7 - (1,550 - Col. 11 of table 16)/1.547.
Col. 8 - Summation of Col. 7.
Col. 9 - Col. 6 + Col. 8

Table 3. - Diversions to New York City, shortfall at Delaware River at Montague, New Jersey, and the computed savings resulting from the actions taken February 8, 1989 to conserve water. - continued

Daily values in million gallons.

Date	Days	Diversions to New York City				Montague shortfall		Cumulative
		Daily	Cumulative	Allowable	Cutback	Daily	Cumulative	savings
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Apr. 1	56	557	30,537	31,360	823		839	1,662
2	57	488	31,025	31,920	895		839	1,734
3	58	598	31,623	32,480	857		839	1,696
4	59	596	32,219	33,040	821		839	1,660
5	60	597	32,816	33,600	784		839	1,623
6	61	597	33,413	34,160	747		839	1,586
7	62	596	34,009	34,720	711		839	1,550
8	63	605	34,614	35,280	666		839	1,505
9	64	299	34,913	35,840	927		839	1,766
10	65	489	35,402	36,400	998		839	1,837
11	66	503	35,905	36,960	1,055		839	1,894
12	67	501	36,406	37,520	1,114		839	1,953
13	68	677	37,083	38,080	997		839	1,836
14	69	689	37,772	38,640	868		839	1,707
15	70	641	38,413	39,200	787		839	1,626
16	71	477	38,890	39,760	870		839	1,709
17	72	297	39,187	40,320	1,133		839	1,972
18	73	299	39,486	40,880	1,394		839	2,233
19	74	299	39,785	41,440	1,655		839	2,494
20	75	298	40,083	42,000	1,917		839	2,756
21	76	298	40,381	42,560	2,179		839	3,018
22	77	298	40,679	43,120	2,441		839	3,280
23	78	298	40,977	43,680	2,703		839	3,542
24	79	696	41,673	44,240	2,567		839	3,406
25	80	697	42,370	44,800	2,430		839	3,269
26	81	705	43,075	45,360	2,285		839	3,124
27	82	675	43,750	45,920	2,170		839	3,009
28	83	731	44,481	46,480	1,999		839	2,838
29	84	610	45,091	47,040	1,949		839	2,788
30	85	483	45,574	47,600	2,026		839	2,865

Col. 2 - Number of days since Feb. 5, 1989.
Col. 3 - Total for 24 hours beginning at 0800.
Col. 4 - Summation of Col. 3.
Col. 5 - Col. 2 x 560 Mgal/d.
Col. 6 - Col. 5 - Col. 4.
Col. 7 - (1,550 - Col. 11 of table 16)/1.547.
Col. 8 - Summation of Col. 7.
Col. 9 - Col. 6 + Col. 8

Table 3. - Diversions to New York City, shortfall at Delaware River at Montague, New Jersey, and the computed savings resulting from the actions taken February 8, 1989 to conserve water. - continued

Daily values in million gallons.

Date (1)	Days (2)	Diversions to New York City: Daily (3)	Diversions to New York City: Cumulative (4)	Diversions to New York City: Allowable (5)	Diversions to New York City: Cutback (6)	Montague shortfall: Daily (7)	Montague shortfall: Cumulative (8)	Cumulative savings (9)
May 1	86	706	46,280	48,160	1,880		839	2,719
2	87	707	46,987	48,720	1,733		839	2,572
3	88	709	47,696	49,280	1,584		839	2,423
4	89	711	48,407	49,840	1,433		839	2,272
5	90	365	48,772	50,400	1,628		839	2,467
6	91	126	48,898	50,960	2,062		839	2,901
7	92	0	48,898	51,520	2,622		839	3,461
8	93	0	48,898	52,080	3,182		839	4,021
9	94	267	49,165	52,640	3,475		839	4,314
10	95	292	49,457	53,200	3,743		839	4,582
11	96	293	49,750	53,760	4,010		839	4,849

Col. 2 - Number of days since Feb. 5, 1989.
Col. 3 - Total for 24 hours beginning at 0800.
Col. 4 - Summation of Col. 3.
Col. 5 - Col. 2 x 560 Mgal/d.
Col. 6 - Col. 5 - Col. 4.
Col. 7 - (1,550 - Col. 11 of table 16)/1.547.
Col. 8 - Summation of Col. 7.
Col. 9 - Col. 6 + Col. 8

Even with the reduced diversions and the suspension of releases to meet the Montague flow objective, the combined storage declined into the drought zone of the operation curves for the reservoirs on March 24, 1989. However, rainfall averaging slightly more than one inch occurred in the upper Delaware River basin on that day and the storage increased in response to the subsequent runoff above the drought zone by the next day averting the need to further reduce operation levels in the basin. Storage continued to increase steadily and by May 5, 1989 it reached the normal zone of the operation curves. On May 12, 1989, storage had been more than 5 Bgal above the drought-warning zone for five consecutive days allowing a return to normal operations as prescribed in the Decree.

Pepacton Reservoir filled to capacity on June 26 and spilled a total of 114 Mgal during June 26-29, 1989.

Cannonsville Reservoir filled to capacity and began spilling on May 17, 1989. It spilled May 17 to June 2, 10-11, and June 13 to July 1, 1989 and was at least 99.0 percent full from May 16 to July 9, 1989. Approximately 8,922 Mgal spilled during the year.

Neversink Reservoir filled to capacity on May 18 and spilled a total of 1,475 Mgal during May 18-22, 1989.

The maximum volume of water in storage in the reservoirs, as shown in figure 2, was 270.157 Bgal on June 25 when Cannonsville reservoir was spilling. During the December to May period, combined storage increased by 120.164 Bgal, or 44.4 percent of capacity.

Diversions to Rondout Reservoir by the City of New York totaled 95.469 Bgal during the December 1 to May 31 period (525 Mgal/d). During this same period, the anticipated discharge at Montague, exclusive of water released from the City reservoirs, fell below the applicable design rate on 31 days. Releases were directed to meet the Montague flow objective on 22 of the 31 days. New York City made releases for conservation purposes at the augmented conservation rates shown in table 2 December 1, 1988 to January 15, 1989 and May 24-31 and at the basin rates January 16 to May 23, 1989.

There were 16 days during the December to May period when the observed discharge at Montague was less than the prevailing design rate. (See table 15.) Of these deficiencies seven were the result of difficulty in predicting the effect of the accumulation of ice during cold weather on runoff and on transit time from the reservoirs. The other nine days were during the drought warning period when the Parties to the Decree agreed not to direct releases to meet the Montague flow objective as a means to save stored water. (DRBC Resolution No. 89-5)

Inflow to the City's reservoirs during the December through May period generally exceeds draft rates and therefore increases storage. The average inflow to Pepacton, Cannonsville, and Neversink Reservoirs for these six months during the 48-year period, December 1940 to May 1988, was 301.3 Bgal. During the corresponding six months of the current report year, inflow to the three reservoirs totaled 232.6 Bgal. Evaporation loss was not included in the computation. Storage in the three reservoirs increased from 136.758 Bgal on November 30, 1988 to 256.998 Bgal on May 31, 1989.

June to November

Precipitation during the June to November period was above average in June, September, and October and was below average in July, August, and November. Precipitation during the period was 26.42 inches, 3.54 inches above the 48-year average. (See table 1.)

Diversions to Rondout Reservoir June 1 to November 30 totaled 121.515 Bgal. The equivalent diversion rate did not exceed the limit specified by the Decree and was 664 Mgal/d on November 30. Releases were directed to satisfy the Montague Formula on 66 days when the anticipated discharge at Montague exclusive of water released from the City reservoirs fell below the design rate. Releases at augmented conservation rates or at rates designed to relieve thermal stress were made at other times from each reservoir by New York City. A total of 2,682 $(ft^3/s)\cdot d$ (1.734 Bgal) was released for the relief of thermal stress between June 2 and August 16.

During June 1-14, the flow required to be maintained in the Delaware River at Montague was the minimum basic rate of 1,750 ft^3/s. The forecasted discharge, exclusive of releases from Pepacton, Cannonsville, and Neversink Reservoirs, and the observed discharge at Montague were greater than the design rate throughout the period.

On June 15, the seasonal period began for release of the excess quantity of water from the reservoirs, and the design rate at Montague was increased to 1,850 ft^3/s. This rate was composed of the basic rate of 1,750 ft^3/s plus 100 ft^3/s of the required excess releases.

The New York City Department of Environmental Protection, Bureau of Water Supply, furnished the River Master with the following advance data for the 1989 calendar year:

1. The estimated continuous safe yield from all the City's sources, obtainable without pumping, is 1,665 Mgal/d, or a total during the calendar year 1989 of 1.665 Bgal/d x 365 days = 607.725 Bgal. gallons.

2. The estimated consumption that the City must provide from all its sources of supply during the calendar year 1989 is 591.582 + 7.250 = 598.832 Bgal.

On the basis of the provisions of the Decree and the above data, the aggregate quantity of excess-release water was 83 percent of (607.725-598.832) or 7.381 Bgal. The Montague design rate during the excess release period beginning June 15, 1989, was computed as:

$$1{,}750\ ft^3/s + \frac{7.381\ Bgal \times 1{,}547\ (ft^3/s)/(Bgal/d)}{120\ days} = 1{,}850\ ft^3/s$$

Data on consumption of water by the City of New York for each calendar year, beginning in 1950, are shown in table 17.

The design rate of 1,850 ft^3/s at Montague was required June 15 to October 21 when the excess quantity was expended. Releases from the City reservoirs were designed and directed to maintain the rate of 1,850 ft^3/s at Montague on most days beginning July 16, except July 22-29 when runoff from precipitation was high.

During June to November there were 66 days when the advance estimate of flow at Montague exclusive of releases from New York City reservoirs was less than the design rate and releases were directed to meet the Montague Formula. Also during this period there were 27 days when the observed flow at Montague was less than the design rate. Of those 27 days that were below the design rate, nine were low because of the balancing adjustment and six additional days were within two percent of the designed flow.

The hydrographs of plate 1, show the total discharge at Montague; the portion derived from uncontrolled runoff downstream from the reservoirs; the portion contributed by the power reservoirs; and the portion contributed by Pepacton, Cannonsville, and Neversink Reservoirs. In analyzing the water budget at Montague, the uncontrolled runoff downstream from the reservoirs was computed as the residual of observed flow less releases from all reservoirs and therefore was subject to all the errors in observations, transit times, and routing of the several components of flow. All of these uncertainties are contained in the computed hydrograph of uncontrolled runoff.

Summary

From December 1, 1988, to November 30, 1989, diversions to Rondout Reservoir totaled 216.984 Bgal, and all releases from the New York City reservoirs to the Delaware River totaled 66.159 Bgal.

During the year, maximum storage in Pepacton Reservoir was 140.320 Bgal, on June 26, 28-29, 1989. Maximum storage in Cannonsville Reservoir was 97.540 Bgal, on June 18-19. Maximum storage in Neversink Reservoir was 35.180 Bgal, on May 18. The maximum combined storage in the three reservoirs during the year was 270.157 Bgal, on June 25 when Cannonsville Reservoir was spilling.

Minimum combined storage in the reservoirs during the year was 122.519 Bgal on February 15, 1989. Minimum storage in Pepacton Reservoir was 64.934 Bgal (46.3 percent of capacity) on February 5, 1989. Minimum storage in Cannonsville Reservoir was 43.788 Bgal (45.8 percent of capacity) on March 15, 1989 and minimum storage in Neversink Reservoir was 8.173 Bgal (23.4 percent of capacity) on December 24, 1988.

A resume of the combined storage of the three reservoirs on the first day of the month June 1967 to November 1989 is shown in figure 4. Storage was below the median December through June, and was above the median July through November. On March 1 and April 1, the combined storage was the lowest during the period of record. Storage was below the twenty-fifth percentile for six consecutive months from January through June, because of the drought warning conditions in the basin.

On November 30, 1989, combined storage in the three reservoirs was 237.772 Bgal, or 87.8 percent of their combined capacity. During the year, combined storage increased 101.014 Bgal, or 37.3 percent of capacity.

SUPPLEMENTARY RELEASE FROM WALLENPAUPACK POWERPLANT

An agreement between Pennsylvania Power & Light Company and New York City provides for supplementary releases from Wallenpaupack hydroelectric powerplant if the Delaware River Basin Commission requests compensation for water consumed at the company's Martins Creek steam-electric generating station. Releases may be requested if the flow of the Delaware River at Trenton, N.J. is expected to be less than 3,000 ft^3/s for more than three consecutive days. No supplementary releases were requested during the year.

COMPONENTS OF FLOW, DELAWARE RIVER AT MONTAGUE, N.J.

The data and computations of the various components of flow formed the basic operational records required to carry out the River Master's specific responsibilities with respect to the Montague Formula during the report year. The operational record has two parts: the advance estimates of the daily average flow at Montague, exclusive of controlled releases from New York City's reservoirs (table 15) and the segregation of the daily average flow at Montague among its various source components (table 16). The time intervals required for water to travel from the various sources to Montague were taken into account.

Discharge of the Delaware River at Montague was composed of the following source components:

1. Controlled releases from Lake Wallenpaupack on Wallenpaupack Creek in the production of hydroelectric power.

2. Controlled releases from Rio Reservoir on Mongaup River in the production of hydroelectric power.

3. Runoff from the uncontrolled area upstream from Montague.

4. Controlled releases from Pepacton, Cannonsville, and Neversink Reservoirs of New York City.

The release from the City's reservoirs necessary to maintain the applicable rate of flow at Montague was computed from the advance estimates of flow at Montague, exclusive of controlled releases from the City's reservoirs.

TIME OF TRANSIT

The average times for the effective transit of water from the various sources of controlled supply to Montague used for discharge routing during the 1989 report year are as follows:

Source	Hours
Pepacton Reservoir	60
Cannonsville Reservoir	48
Neversink Reservoir	33
Lake Wallenpaupack	16
Rio Reservoir	8

This schedule was developed from reservoir and powerplant operations and gaging-station records of prior years and was found generally suitable. At times, noticeable exceptions occur, for example, when a large release from Cannonsville Reservoir follows a small one, a large part of the release is expended in filling the channel en route, and the remainder may appear at Montague as much as 18 hours late. During the winter, the cold weather causes ice to form in the stream, which, together with the low streamflow, gradually increases the resistance to streamflow and lengthens the time of transit.

On several occasions, when large releases were directed following small ones, these releases were directed to begin from 9 to 12 hours earlier than normal to compensate for the expected increase in travel time. These adjustments were helpful in getting the directed releases to Montague within the appropriate time frame, but were not fully successful. Therefore, the observed Montague flow tended to be low on the first day that these releases were expected to arrive and to be high on the second or third day. The average of the observed flow for approximately three days when this procedure was used was usually close to the design rate.

SEGREGATION OF FLOW AT MONTAGUE

The River Master daily operation record of reservoir releases and daily segregation of flow among the various source components contributing to the flow of the Delaware River at Montague is shown in table 16. The arrangement of data conforms with the downstream movement of water from the various sources to Montague. A horizontal summation of data in the table is equivalent to routing the various contributions to Montague, using the schedule for travel time of water discussed previously. The uncontrolled runoff was computed by subtracting the contributions of the several other sources from the observed discharge at Montague.

COMPUTATION OF DIRECTED RELEASES

In the daily operations, it was necessary that the River Master utilize: (1) discharges computed from recorded or reported stream gage heights for various 24-hour periods without current information about changes in stage-discharge relations that might have occurred; (2) daily discharge from New York City's three reservoirs obtained from venturi meters; (3) rainfall reports for the previous 24 hours; (4) actual powerplant operations converted to daily discharge; (5) advance estimates of power demand converted to daily discharge; (6) advance estimates of uncontrolled runoff at Montague; and (7) average times for routing of water from the several sources. Variable errors of estimate occur in projecting data, but these data must be used in the daily design and direction of releases from the reservoirs.

The time of transit of water from Pepacton Reservoir to Montague was greater than that from any other reservoir above Montague, therefore, the time of daily directed releases to maintain prescribed rates of flow at Montague was based on time of transit from Pepacton Reservoir. Releases from Cannonsville and Neversink Reservoirs were timed to arrive at Montague concurrently with releases from Pepacton Reservoir. To allow for the actual differences in transit times, daily directed releases began at Pepacton at 1200 hours, at Cannonsville at 2400 hours, and at 1500 hours the following day at Neversink.

The determination of the amount of release required from the City's reservoirs to maintain specified rates of flow at Montague was based on estimates of releases from Lake Wallenpaupack and Rio Reservoir and an estimate of the uncontrolled runoff at Montague. Taking into account the time of transit from these sources to Montague, this determination required that advance estimates of the following components be made on the morning of each day: (1) the expected release of water from Lake Wallenpaupack for power production for a 24-hour period, beginning at 0800, two days later; (2) expected release of water from Rio Reservoir for power production for a 24-hour period, beginning at 1600 hours, two days later; and (3) expected uncontrolled runoff at Montague three days later. The River Master daily operation record for computing daily directed release from the City's reservoirs during the periods of low flow is shown in table 15.

The electric power companies cooperated fully in furnishing advance estimates of powerplant releases. As the hydroelectric plants were used chiefly for meeting peak-power demands of the system, advance estimates were subject to many modifying factors such as the influence of the vagaries of weather upon peak-power demand and unpredictable transmission and mechanical difficulties in electric-system operation. In addition, the power companies are members of wide area power pools which may present unforeseen demands for power generation. As a result, the actual use of water for power generation was at times at considerable variance with the advance estimates that were used by the River Master's office in design computation.

For computation purposes during periods of low flow, the estimate of uncontrolled runoff at Montague three days in advance was treated as two items: (1) present runoff and (2) estimated increase in runoff from precipitation. The present runoff was computed for 2,143 square miles (mi^2) of uncontrolled drainage area above Montague based on conditions over the drainage area as of 0800 on the morning the estimate was made. The estimated increase in runoff was computed from precipitation which was forecast to occur on the day the estimate was made and the following two days. Estimated quantities for these items are shown in table 15.

During the winter period, the advance estimate of the uncontrolled runoff (present conditions) was based on flows at nearby gaging stations and on the recession curve of the computed uncontrolled flow at Montague projected to the design date, three days hence.

During open-river conditions, the present runoff portion of the advance estimate of uncontrolled runoff was based on discharges as of 0800 at gaging stations listed below:

Station	Drainage area (mi^2)
Beaver Kill at Cooks Falls, N.Y.	241
Cadosia Creek at Cadosia, N.Y.	17.9
Oquaga Creek at Deposit, N.Y.	67.6
Equinunk Creek at Equinunk, Pa.	56.3
Callicoon Creek at Callicoon, N.Y.	110
Tenmile River at Tusten, N.Y.	45.6
Lackawaxen River at Hawley, Pa.	290
Shohola Creek near Shohola, Pa.	83.6
Neversink River at Port Jervis, N.Y.	336

The procedure for computing the advance estimate combined a routing and recession (as applicable) of the 0800 discharges of the Beaver Kill, Oquaga, Equinunk, Callicoon, and Shohola Creeks and Tenmile, Lackawaxen, and Neversink Rivers gaging stations to Montague, with a computed yield from the remaining ungaged, uncontrolled drainage area. Releases from Neversink Reservoir were deducted from discharge of the Neversink River site. The yield from the ungaged, uncontrolled drainage area was estimated on the basis of the yield of Cadosia, Oquaga, Equinunk, and Callicoon Creeks, and Tenmile and Lackawaxen Rivers with routing and recession by individual gaging stations. The yield from the ungaged-uncontrolled area was adjusted periodically to account for differences between the forecasted uncontrolled runoff and the observed runoff at the Montague gaging station.

The advance estimate of increase in runoff from precipitation is shown in table 15 under the heading of "Weather Adjustment." The National Weather Service Office, Philadelphia, Pa., cooperated throughout the low-flow periods by furnishing quantitative forecasts of average precipitation over the drainage area above Montague and air temperatures for each day of the threeday design period. During the winter, the probable increase in runoff was estimated from the current state of snow and ice and from forecasted temperature and precipitation for the several days under consideration. During open-river conditions, runoff from the forecasted precipitation was estimated from previously established relationships.

The total anticipated flow at Montague, exclusive of releases from the City's reservoirs (table 15), was the sum of the forecasted releases from the power reservoirs, the estimated uncontrolled runoff under then current conditions, and the weather adjustment. The amount by which this computed flow was less than the prescribed Montague rate indicated the expected deficiency at Montague, which would have to be made up by corresponding releases from New York City reservoirs.

There were times when revised forecasts of weather or powerplant releases became available before the completion of the required release from New York City reservoirs. At such times, the release required from New York City reservoirs was recomputed on the basis of the revised information, and the release required was changed to the revised indicated deficiency. Usually this procedure resulted in a reduced release requirement from New York City reservoirs and the conservation of water. Only the final figures are shown in table 15.

ANALYSIS OF FORECASTS

Forecasts of the flow at Montague based on the anticipated flow of the several components (exclusive of the release from the City's reservoirs) vary somewhat with those actually experienced on most days even under the most favorable conditions. The daily variations in the several components are often partially compensating with the resulting forecast being fairly accurate.

The advance estimate of flow of the Delaware River at Montague exclusive of the releases from the New York City reservoirs was less than the design rate on 29 days scattered throughout the period from December 1, 1988 to July 29, 1989. Beginning July 30, the advance estimate was less than the design rate on most days, except August 10, 15, 16, September 23 - 30, October 3-4, 6-8, and October 19 to November 30, and releases were directed. The table below compares the advance estimates of the various contributions to the flow at Montague to the observed operations during the July 30 to September 22 and October 9-18, 1989 periods when releases were directed on most days.

	Advance estimates $[(ft^3/s)\cdot d]$	Observed operations $[(ft^3/s)\cdot d]$
New York City releases		
Directed	[a] 48,709	[b] 48,637
Other		[c] 4,161
Power releases		
Lake Wallenpaupack	12,178	14,802
Rio Reservoir	4,276	9,388
Runoff from uncontrolled area	49,854	64,702

[a] Directed release as designed.
[b] Actual release in response to direction.
[c] Includes conservation releases and releases for the relief of thermal stress.

The table shows that during the period of comparison, New York City released slightly less water, 0.1 percent, than was directed. The power companies released 22 percent more water from Lake Wallenpaupack and 120 percent more water from Rio Reservoir than was forecast. The total power releases were 47 percent more than the forecast. The forecasted runoff from the uncontrolled area during the period was 30 percent less than the observed runoff from the uncontrolled area. However, if the September 20-22 period which was greatly affected by runoff from unforecasted precipitation are removed from the comparison periods, the forecasted runoff from the uncontrolled area would only be 8.2 percent less than the observed runoff. The precipitation during those three days was 2.46 inches and less than one inch was forecast for the period.

The principle reason for the relatively large difference between the forecasted releases for power generation and the observed operations is because of the demands on the power companies by the power pools. The shortage of electrical power in the Northeast United States during the 1989 release season resulted in these demands being higher than usual. In addition, the demands are not made with sufficient lead time to be included in the forecasts.

On the basis of the observed discharges at Montague, exact forecasting of releases required from the City's reservoirs during the comparison period, July 30 to September 22 and October 9-18, would have totaled 44,213 $(ft^3/s) \cdot d$. The directed releases totaled 48,709 $(ft^3/s) \cdot d$, or 10.2 percent more than for exact forecasting. For the entire 1989 report year, the total of 56,964 $(ft^3/s) \cdot d$ were directed to meet the Montague flow objective. Exact forecasting would have required 51,554 $(ft^3/s) \cdot d$ or 9.5 percent less than the directed amount.

A comparison of the hydrographs on figure 3, of forecasted uncontrolled runoff and the actual uncontrolled runoff indicate that the forecasting procedures were generally adequate. The forecast included anticipated uncontrolled runoff under then-existing conditions plus the weather adjustment based on forecast precipitation. Analysis of the hydrographs indicate that the forecast procedures tended to underestimate the runoff during high precipitation events and to overestimate the runoff during extended dry periods. Adjustments to the forecast procedures were made to compensate for these tendencies, but due to the delay between the release of water and the observation of the affect that release had on the Montague flow, it takes several days for adjustments to become effective.

Analysis of the precipitation forecasts indicate that frequently when a precipitation event moves through the basin, the total precipitation forecasted for the three-day design period is fairly accurate but the storm may occur either earlier or later in the period. The accuracy of the runoff forecasts are significantly affected by the timing of the precipitation events.

DIVERSIONS TO NEW YORK CITY WATER SUPPLY

The 1954 Amended Decree allows New York City to divert water from the Delaware River basin at a rate not to exceed 800 Mgal/d. The Decree also specifies that the rate of diversion will be computed as the aggregate total diversion beginning on June 1 of each year divided by the number of days elapsed since the previous May 31.

Table 14 shows diversions from Pepacton, Cannonsville, and Neversink Reservoirs to the New York City water-supply system during the report year. The tabulation includes a running account of the average rates of the combined diversions from the reservoirs, computed as prescribed by the Decree or the "Interstate Water Management Recommendation of the Parties to the Decree". The tabulation below shows the allowable maximum diversion rates and the actual diversions during those periods.

Effective dates	Allowable diversions Mgal/d	Actual diversions Mgal/d
June 1, 1988 to Jan. 15, 1989	800	715
Jan. 16 to Feb. 4, 1989	680	673
Feb. 5 to May 11, 1989	560*	518
May 12-31, 1989	800	238
June 1 to Nov. 30, 1989	800	664

*The allowable diversion during this period was affected by the actions unanimously requested by the Parties to the Decree on February 8, 1989. See tables and the discussion on pages 16-20.

During the year a total of 216.984 Bgal of water was diverted to the New York City water supply system. The allowable diversion during the year was 275.971 Bgal.

STORAGE IN NEW YORK CITY RESERVOIRS

The New York City Board of Water Supply determined the "point of maximum depletion" and other pertinent reservoir levels and contents of Pepacton, Cannonsville, and Neversink Reservoirs as follows:

[Elev. is distance above sea level]

Reservoir level	Pepacton Res.		Cannonsville Res.		Neversink Res.	
	Elev. (ft)	Contents (Bgal)	Elev. (ft)	Contents (Bgal)	Elev. (ft)	Contents (Bgal)
Full pool or spillway crest	1,280.00	*140.190	1,150.00	*95.706	1,440.00	*34.941
Point of maximum depletion	1,152.00	*3.511	1,040.00	*1.020	1,319.00	*0.525
Sill of diversion tunnel	1,143.00	*4.200	+1,035.00	*1.564	1,314.00	
Sill of river outlet tunnel	1,126.50		1,020.5		1,314.00	
Dead storage		1.800		0.328		1.680

*Contents shown are quantities stored between listed elevations.
+Elevation of mouth of inlet channel of diversion works.

Tables 10, 11, and 12 show storage in Pepacton, Cannonsville, and Neversink Reservoirs, respectively, above the "point of maximum depletion" or minimum full-operating level.

On December 1, 1988 combined storage in the three reservoirs was 137.298 Bgal, which was 27.298 Bgal above the drought warning level as defined by the Interstate Water Management Recommendations of the Parties to the Decree. Storage generally declined throughout the winter months, except for a brief rise in late February, until late March. As discussed earlier, storage reached the drought-warning zone of the operating curves on January 16, 1989 and the drought zone on March 24. Storage increased rapidly during late March and April and the drought warning was terminated on May 12, 1989. Storage remained fairly constant during late May and early June. Heavy rains during June and subsequent runoff increased storage to the maximum combined levels on June 25, 1989.

Storage decreased seasonally from late June through mid-October in response to normal diversions to the New York City water-supply system and the releases required to maintain the Montague flow objective. Precipitation averaging more than four inches over the upper basin occurred during the October 17-21 period. The resulting runoff helped to increase storage from a seasonal low of 189.239 Bgal on October 19 to 237.772 Bgal on November 30, 1989.(See figure 2).

COMPARISONS OF RIVER MASTER OPERATION DATA AND OTHER STREAMFLOW RECORDS

It has been explained that the River Master operations are, in effect, day-to-day operations, for which it is necessary to use preliminary records of streamflow. The following summaries show comparison of records used in the River Master operations and U.S. Geological Survey records. In the comparison of releases, data were used in units of Mgal/d and converted to ft^3/s in the summaries.

Releases from New York City Reservoirs

The River Master operations data on the controlled releases from Pepacton, Cannonsville, and Neversink Reservoirs, to the Delaware River were obtained from calibrated instruments connected to venturi meters installed in the outlet conduits.

The Geological Survey gaging station on the East Branch Delaware River at Downsville, N.Y., is 0.5 mile downstream from Pepacton Reservoir dam. The discharge shown in table 4 includes releases and spillage from Pepacton Reservoir. It also includes a small amount of seepage, which enters the channel between the dam and gage site, and a small amount of runoff, which originates between the dam and gage site. The drainage area at the dam is 371 mi^2 and at the gaging station is 372 mi^2.

Releases were made at the augmented and basic conservation rates and at rates designed by New York State to relieve thermal stress during the year. For flows of approximately 6, 19, 50, 70, and 100 ft^3/s reported by New York City, the venturi meter instruments indicated -11.4, -10.1, +0.4, +5.5, and +12.5 percent difference, respectively, in rates of release from the reservoir than those shown by the gaging-station record. These differences are similar to the differences observed in previous years. During November 1989, the venturi instruments recorded releases averaging 48.7 ft^3/s which was 16 percent less than the 58.0 ft^3/s average flow recorded by the USGS. It is uncertain what caused this difference and more tests are planned during the 1990 report year to determine if this was an isolated incident or if the meter needs to be recalibrated at this flow rate. This difference was not observed at other flow rates.

The Geological Survey gaging station on the West Branch Delaware River at Stilesville, N.Y. is 1.4 miles downstream from Cannonsville Dam. The discharge shown in table 5 includes releases and spillage from Cannonsville Reservoir and the runoff from 2 mi^2 of drainage area between the dam and the gage site. The drainage area at the dam is 454 mi^2, and that at the gaging station is 456 mi^2.

Releases were made in a range from basic conservation rates to high rates necessary to meet the Montague flow objective during the year. For flows of approximately 10, 30, and 45 ft^3/s at the gaging station, the venturi meter instruments indicated 18.6, 17.1, and 7.3 percent less water, respectively, being released from the reservoir than the amount shown by the gaging-station records. At flows of approximately 380 and 1,170 ft^3/s, the agreement was better with the venturi indicating 4.5 and 3.3 percent less discharge respectively, than that shown by the gagingstation records. The gaging-station records are considered good for flows above 700 ft^3/s and fair below. In addition, the gaging-station records reflect some runoff from precipitation on the area between the dam and the gaging station which affects the comparison shown at the low flows.

The Geological Survey gaging station on the Neversink River at Neversink, N.Y., is 1,650 feet downstream from Neversink Dam. The discharge shown in table 7 includes releases from Neversink Reservoir and, during storms, a small amount of runoff, which originates between the dam and gage site. The drainage area at the dam is 92.5 mi^2 and that at the gaging station is 92.6 mi^2.

Releases were made at augmented and basic conservation rates designed to relieve thermal stress during the year. For flows of approximately 4.5, 14, 23, 43, and 68 ft^3/s at the Geological Survey gaging station, the venturi meter instrument indicated +3.8, +10.6, +7.3, +4.7, and -0.9 percent difference, respectively, in rates of release from the reservoir than those shown by the gaging-station records.

The above comparisons indicate good agreement between the data from the venturi meters and U.S. Geological Survey gaging stations at Pepacton and Neversink Reservoirs and for flows above 80 ft^3/s at Cannonsville Reservoir. The gaging-station records are considered only fair at the Stilesville gage for flows below 700 ft^3/s. Therefore, the venturi instruments are considered to provide more accurate records at the low-flow rates.

Releases from Lake Wallenpaupack

In the River Master operations, December 1 to November 30, records of daily discharge through the Wallenpaupack powerplant were furnished by the Pennsylvania Power & Light Company (see table 16). Daily discharges were computed on an 0800 to 0800-time basis to allow for the 16-hour average transit time to Montague.

The records of daily mean discharges for Wallenpaupack Creek at Wilsonville, Pa., published by the U.S. Geological Survey, were also furnished by the Company. These discharges, shown in table 6, represent the flow through the turbines of the powerplant and are computed on a midnight-to-midnight basis.

During December 1988 through November 1989, the River Master's record based on computations by Pennsylvania Power & Light Company, agrees with the U.S. Geological Survey record except for a slight variation due to the difference in the time frame and rounding of the computations.

Delaware River at Montague, N.J.

The River Master's operation record indicated 0.2 percent more discharge for the year than the U.S. Geological Survey record, and daily records were in good agreement.

Diversion Tunnels

Records of diversions through the East Delaware, West Delaware, and Neversink Tunnels were furnished to the River Master's Office by the City of New York. These records were obtained from New York City's calibrated instruments connected to venturi meters installed in the tunnel conduits. These instruments include a differential pressure transmitter which is connected to a numerical totalizer that records the volume of water discharged and a rate-of-flow indicator that records on a Bristol-type chart. It's also connected to a single tube mercury manometer which is used to check the rate-of-flow indicator. The totalizer readings are transmitted electronically to the New York City Bureau of Water Supply and are reported to the River Master office daily. Current-meter measurements were made by the River Master's office to verify the accuracy of the reported diversions. The current-meter measurements were made in the outlet channels downstream from the tunnels.

Water is diverted from Pepacton Reservoir through the East Delaware tunnel into Rondout Reservoir. The conditions in the outlet channel, which is used for measuring discharge from the tunnel by current meter, were unfavorable for much of the year due to the high water levels in Rondout reservoir. The results of two current-meter measurements made during the year showed on the average that the venturi-meter instruments gave higher figures by 5.5 percent for the totalizer, 7.0 percent for the manometer and 7.4 percent for the indicator needle. The remotely transmitted readings of the totalizer showed an average of 7.0 percent higher than the measured discharge.

Comparison of the data provided by New York City with discharges obtained from recorded gage-heights and the rating curve for the weir on the outlet channel indicate that the data provided by New York City were within acceptable limits.

The powerplant that used the water diverted through the tunnel operated most days of the year. On days when the powerplant was not in operation, there was a small amount of leakage through the wicket gates, which was not recorded on the totalizer. Results of a current-meter measurement March 28, 1989 indicated a rate of 12.3 ft^3/s from cooling water and leakage. This measurement agrees with measurements made in previous years and indicates that the leakage has not changed substantially with time.

When the powerplant is not operating, the leakage by-passes the venturi instruments and is not measured. When the powerplant is operating, the leakage is included in the measured flow. Since the powerplant was not operated on 80 days and operated a portion of the time on 92 additional days during the year, the unmeasured flow is approximately 1.0 Bgal.

Based upon measurements obtained this year and in previous years, the record of quantity of water diverted through the East Delaware Tunnel should be substantially correct.

The West Delaware Tunnel is used to divert water from Cannonsville Reservoir into Rondout Reservoir. Three current-meter measurements made during the year indicated that the venturi instruments gave higher results by 1.0 percent for the totalizer, and 12.1 percent for the manometer. The remotely transmitted data from the totalizer showed a +2.4 percent difference. Inspections of the channel downstream from the outlet, when valves were closed showed negligible leakage.

A powerplant which uses the water diverted through the West Delaware Tunnel began operations in December 1988 and operates only when diversions are less than 300 Mgal/d. When the powerplant is not operating, the valves on the pipelines to the powerplant are closed, therefore, there is no leakage through the system.

The results of the measurements and inspections made this year and during past years indicate that the reported record of the quantity of water diverted through the West Delaware Tunnel was substantially correct.

The Neversink Tunnel is used to divert water from Neversink Reservoir into Rondout Reservoir. Results of the comparative data from venturi measurements and two current-meter measurements showed that on average, the venturi instruments were higher by 0.8 percent for the totalizer, 5.4 percent for the manometer, and 3.8 percent for the indicator needle. The remotely transmitted data from the totalizer were 2.0 percent higher than the measurements.

When the powerplant that used the water diverted through the Neversink Tunnel was not in operation, a small amount of leakage occurred that was not recorded on the venturi instruments. Based on two measurements made during the previous report year and one measurement made during the current year, the average rate of leakage is 14.0 ft^3/s (9.0 Mgal/d). When the powerplant was operating, the leakage was included in the recorded flow. Based on the above rate and on records of power plant operations, approximately 2.1 Bgal of water was diverted but unrecorded.

DIVERSIONS BY NEW JERSEY

According to the terms of the Decree, New Jersey may divert for use outside the Delaware River basin from the Delaware River or its tributaries in New Jersey, without compensating releases, a quantity of water not to exceed 100 Mgal/d (154.7 ft^3/s) as a monthly average, with the diversion on any day not to exceed 120 Mgal/d (185.6 ft^3/s).

Prior to 1986, the diversions through the Delaware & Raritan Canal were measured at Kingston Lock. Since 1986, water has been diverted on a regular basis from the canal into Carnegie Lake and into the Millstone River upstream from the gaging station at the Kingston Lock. The New Jersey Water Supply Authority (NJWSA) made computations of the amount being diverted on a daily basis and provided the data to the River Master office weekly. Table 13 is a listing of the data provided by the NJWSA.

At the River Master Advisory Committee meeting in May 1986 the apparent inadequacy of the current monitoring system was discussed. Following that meeting, the River Master requested New Jersey to improve the monitoring system to provide accurate records of their diversions. In response to the River Master's request, the State of New Jersey in cooperation with the U.S. Geological Survey began the installation of an acoustic velocity meter and remote sensing equipment at Port Mercer near the Delaware-Raritan divide. The installation was completed during 1987. Since installation, numerous attempts have been made to adjust the equipment to obtain reliable data. For a variety of reasons, much of the equipment has been replaced but it was still not providing reliable data by the end of the 1989 report year.

The 30-day average diversion was computed weekly based on data provided by NJWSA throughout the year to monitor compliance with the terms of the Decree and with the reduced diversions allowed during the period of drought warning. The maximum 30-day average diversion was 94.1 Mgal/d during the 30-day period ending December 11, 1988. The maximum daily diversion reported was 131 million gallons on May 6, 1989. These computations indicate that on a monthly basisthe diversions by New Jersey did not exceed the limits allowed by the Decree or by the Interstate Water Management Recommendations. The reported diversion on May 6, 1989 exceeded the 120 Mgal/d limitation but that value was affected by inflow into the canal from precipitation in the Raritan basin. It is uncertain what the actual diversion from the basin was on that day, but it is thought to be less than the limitation.

The data provided by the New Jersey Water Supply Authority for the flow at the Kingston Lock were compared to the U.S. Geological Survey record for the flow in the canal at the Kingston Lock and were found to be within 3.8 percent for the year except for May, June, July, and October. During these periods the difference varied from 10 to 20 percent. These differences were caused by inaccuracies in the computations during construction periods and the use of different rating curves by the USGS and the NJWSA.

CONFORMANCE OF OPERATIONS AS PROVIDED UNDER AMENDED DECREE OF THE U.S. SUPREME COURT, DATED JUNE 7, 1954

Operations were conducted as prescribed by the Decree December 1, 1988 to January 15, 1989 and May 12 to November 30, 1989; as prescribed in the Interstate Water Management Recommendations of the parties to the Decree January 16 to February 8 and May 1-11, 1989; and by the actions taken by the Parties to the Decree February 9 to April 30, 1989. Diversions from the Delaware River basin to the New York City water-supply system were less than the 800 Mgal/d authorized by the Decree.

Under Compensating Releases of the Montague Formula, New York City released water from its reservoirs at rates designed by the River Master to maintain the applicable Montague flow objectives and complied fully with the directives of the River Master during the year.

Diversions from the Delaware River basin by New Jersey were within the limits prescribed by the Decree and the Interstate Water Management Recommendations of the Parties to the Decree. New Jersey also complied fully with the requests of the River Master.

Table 4.- Daily mean discharge, in cubic feet per second, of East Branch Delaware River at Downsville, N.Y. (01417000) for the year ending November 30, 1989. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	50	51	6.8	7.0	7.7	21	65	67	65	65	66	62
2	50	51	6.8	7.0	7.6	22	65	67	65	65	66	58
3	50	55	6.7	7.0	7.7	21	65	79	73	65	66	58
4	49	51	6.6	7.0	7.6	21	65	92	96	65	66	58
5	49	50	6.5	7.0	7.6	20	65	80	120	65	66	58
6	49	49	6.7	7.0	7.7	23	65	65	133	65	67	57
7	49	50	6.8	7.0	12	22	66	64	111	65	67	58
8	49	51	6.7	7.0	21	22	67	63	77	77	67	58
9	49	51	6.7	6.8	21	21	66	63	65	89	67	58
10	49	52	6.7	6.8	21	22	66	63	64	88	67	58
11	49	52	6.6	6.8	21	22	66	64	65	77	67	58
12	49	52	6.7	6.8	21	22	67	65	66	66	67	58
13	49	52	6.7	6.8	21	22	68	65	67	67	67	58
14	51	52	6.8	6.8	21	22	68	65	67	67	67	57
15	51	52	7.0	6.9	21	22	66	65	76	67	67	57
16	51	28	6.9	6.8	21	21	67	65	88	67	67	58
17	51	6.9	6.8	6.8	21	20	65	65	89	68	67	57
18	51	6.8	6.8	7.1	21	20	65	65	89	67	67	57
19	51	29	6.8	6.9	21	20	67	65	89	68	67	58
20	49	53	6.8	6.9	20	19	67	65	88	69	68	58
21	49	31	7.8	6.9	20	19	68	63	88	69	67	58
22	50	6.4	7.3	6.8	20	19	67	63	89	67	67	58
23	50	6.3	7.1	6.8	20	36	67	63	87	66	68	58
24	49	6.3	7.0	7.3	20	63	67	73	87	66	69	58
25	51	6.3	7.0	7.3	20	63	95	98	76	66	69	58
26	52	27	7.0	7.3	20	63	190	106	64	66	69	58
27	50	50	7.0	7.2	20	63	205	106	65	65	69	58
28	51	30	7.0	7.2	20	64	172	98	65	65	69	58
29	51	6.4		7.4	20	64	122	76	65	66	69	58
30	51	26		7.8	20	65	75	63	65	66	69	58
31	50	38		7.7		65		65	65		69	
Total	1,549	1,128.4	192.1	217.9	529.9	1,009	2,449	2,226	2,469	2,054	2,090	1,739
Mean	50.0	36.4	6.86	7.03	17.7	32.5	81.6	71.8	79.6	68.5	67.4	58.0

Year total 17,653.3 $(ft^3/s)\cdot d$ Mean 48.4 ft^3/s

Table 5.- Daily mean discharge, in cubic feet per second, of West Branch Delaware River at Stilesville, N.Y. (01425000) for the year ending November 30, 1989. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	42	123	11	9.4	17	31	173	429	397	1,150	43	42
2	42	49	10	9.5	14	35	236	386	385	1,150	44	39
3	42	43	10	9.4	15	33	369	383	377	1,190	44	39
4	43	43	9.5	9.6	16	31	112	384	669	1,220	43	39
5	43	69	9.7	9.9	18	32	68	387	529	1,260	43	39
6	45	120	9.3	8.9	17	72	66	383	690	1,070	42	40
7	46	48	9.6	9.9	16	74	64	384	448	1,070	196	40
8	47	43	9.3	9.2	14	72	65	383	377	1,450	129	40
9	48	43	9.3	9.2	14	72	65	383	421	1,410	95	42
10	50	42	9.3	9.3	13	58	76	382	446	1,090	217	41
11	53	41	9.5	9.3	13	55	93	382	825	1,020	125	41
12	55	36	9.5	9.3	12	55	94	383	583	749	284	41
13	54	35	9.4	9.2	12	51	86	383	379	713	746	42
14	53	35	9.9	9.3	12	51	133	382	377	719	488	42
15	213	35	12	10	12	50	580	382	377	1,410	222	43
16	615	24	8.4	9.6	27	50	818	382	377	687	144	63
17	245	10	11	9.4	29	251	1,180	382	418	95	100	65
18	62	10	9.4	11	29	718	1,510	381	883	431	48	49
19	43	10	9.3	10	29	940	1,480	381	779	229	49	46
20	41	36	9.4	9.7	29	1,010	1,310	385	760	217	56	45
21	77	186	17	9.8	29	1,020	1,120	382	882	83	54	45
22	543	26	13	9.6	29	983	908	383	894	61	49	44
23	609	10	10	9.6	29	897	878	380	921	48	48	44
24	522	9.9	9.6	15	29	726	1,160	378	1,010	45	48	44
25	327	9.8	9.9	16	29	551	1,290	436	1,020	43	48	44
26	182	10	9.7	14	29	445	1,160	689	1,130	43	48	45
27	81	272	9.7	13	29	449	1,040	711	1,160	42	48	44
28	47	190	9.6	13	29	498	633	580	1,200	42	48	45
29	44	25		16	29	510	574	754	1,220	42	48	44
30	111	10		19	29	465	525	390	1,260	42	48	44
31	182	28		19		288		452	1,110		49	
Total	4,607	1,671.7	283.3	345.1	648	10,573	17,866	13,242	22,304	18,821	3,694	1,321
Mean	149	53.9	10.1	11.1	21.6	341	596	427	719	627	119	44.0

Year total 95,376.1 $(ft^3/s)\cdot d$ Mean 261 ft^3/s

Table 6.- Daily mean discharge, in cubic feet per second, of Wallenpaupack Creek at Wilsonville, Pa. (01432000) for the year ending November 30, 1989. Record furnished by Pennsylvania Power & Light Company.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	472	0	475	466	0	0	1,110	0	479	0	0	894
2	468	0	476	236	0	0	734	0	480	0	321	1,430
3	0	502	461	238	54	0	0	488	441	0	354	1,460
4	0	994	0	0	0	0	0	0	632	0	284	1,460
5	473	971	0	0	0	0	222	932	0	44	354	1,460
6	461	611	711	594	0	613	0	1,160	0	0	343	1,160
7	475	273	707	1,080	0	1,650	0	800	232	294	0	977
8	437	0	479	1,050	0	1,830	0	0	213	280	0	1,440
9	460	329	552	419	0	1,840	411	0	219	0	402	1,430
10	0	280	470	301	0	1,840	0	892	226	263	358	1,320
11	30	241	0	0	48	1,830	0	819	239	768	337	820
12	906	219	0	0	99	1,840	243	712	0	684	348	356
13	688	238	708	254	0	1,850	219	696	0	681	349	837
14	464	0	702	234	0	1,840	339	692	226	699	0	845
15	0	0	245	0	0	1,840	359	0	232	627	0	0
16	724	226	225	75	0	1,840	816	0	608	0	316	0
17	232	311	356	0	0	1,840	470	708	209	0	362	120
18	249	256	0	0	97	1,860	464	718	236	341	345	0
19	471	246	0	0	0	1,860	812	691	0	352	346	0
20	438	236	0	176	0	1,860	706	642	0	307	812	0
21	407	0	227	0	0	1,850	822	693	0	769	0	0
22	414	0	235	0	0	1,690	1,120	60	155	585	0	0
23	0	472	277	53	0	1,000	1,190	0	492	463	0	0
24	0	463	834	0	0	1,450	701	831	0	470	0	0
25	0	467	0	0	0	1,450	1,060	995	0	699	0	0
26	0	708	0	0	0	1,440	1,730	935	0	752	223	0
27	229	717	474	0	0	1,250	1,200	930	0	517	496	0
28	84	0	480	0	0	0	1,200	614	114	486	223	0
29	231	0		211	0	0	1,190	0	0	460	0	306
30	234	709		190	0	867	463	0	328	0	492	149
31	0	693		437		942		460	0	0	676	
Total	9,047	10,162	9,094	6,014	298	38,172	17,581	15,468	5,761	10,541	7,741	16,464
Mean	292	328	325	194	9.93	1,231	586	499	186	351	250	549

Year total 146,343 $(ft^3/s)\cdot d$ Mean 401 ft^3/s

Table 7.- Daily mean discharge, in cubic feet per second, of Neversink River at Neversink, N.Y. (01436000) for the year ending November 30, 1989. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	23	23	4.1	4.4	4.8	14	44	46	45	44	42	28
2	23	23	4.1	4.4	4.9	15	43	46	45	43	43	22
3	23	23	4.0	4.4	5.0	14	44	57	53	43	40	22
4	22	23	4.0	4.4	5.0	14	43	74	75	43	41	22
5	23	23	4.0	4.4	5.0	15	44	63	88	43	40	22
6	23	23	4.0	4.4	5.1	16	44	42	89	42	40	22
7	23	23	4.1	4.4	7.7	15	44	41	79	42	39	22
8	23	23	4.1	4.4	14	15	44	41	60	52	40	23
9	23	23	4.1	4.4	14	15	44	41	46	68	40	24
10	23	23	4.1	4.4	13	15	44	41	46	68	40	24
11	23	23	4.1	4.4	13	14	43	41	46	58	40	24
12	23	23	4.1	4.4	13	14	44	42	46	42	41	23
13	23	23	4.1	4.4	14	14	44	42	47	42	41	24
14	23	23	4.3	4.4	13	14	44	42	46	42	40	24
15	23	23	4.5	4.4	14	14	44	42	54	41	40	24
16	23	12	4.2	4.4	14	15	44	42	68	41	40	25
17	23	4.5	4.1	4.5	14	200	44	42	68	41	40	24
18	23	4.6	4.2	4.6	14	817	44	42	68	41	40	24
19	23	4.6	4.1	4.6	14	598	44	42	68	41	40	24
20	23	10	4.1	4.6	14	432	44	43	68	42	42	24
21	22	22	5.5	4.6	14	419	44	42	68	41	41	22
22	23	16	4.4	4.6	13	254	45	42	68	41	41	24
23	23	4.3	4.3	4.6	13	33	45	42	67	41	42	24
24	24	4.2	4.4	5.0	14	45	45	52	67	41	42	24
25	23	4.3	4.4	5.1	14	45	45	69	59	41	42	24
26	23	4.3	4.4	4.7	14	45	45	69	44	41	42	24
27	24	10	4.4	4.7	14	45	45	69	44	37	40	24
28	23	22	4.4	4.9	14	45	45	66	44	45	39	24
29	23	16		5.0	14	45	45	58	44	40	39	23
30	23	4.7		5.1	14	44	46	59	43	40	39	24
31	23	5.6		5.0		44		52	43		39	
Total	713	494.1	118.6	142.0	353.5	3,344	1,327	1,532	1,796	1,327	1,255	708
Mean	23.0	15.9	4.24	4.58	11.8	108	44.2	49.4	57.9	44.2	40.5	23.6

Year total 13,110.2 $(ft^3/s)\cdot d$ Mean 35.9 ft^3/s

Table 8.- Daily mean discharge, in cubic feet per second, of the Delaware River at Montague, N.J. (01438500) for the year ending November 30, 1989. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	3,720	1,900	2,500	3,100	14,100	2,260	4,810	4,150	2,240	1,820	1,940	5,290
2	3,730	2,100	2,560	2,730	11,400	6,340	5,500	3,330	2,070	1,650	1,990	5,910
3	3,320	2,100	2,770	2,450	9,240	15,100	4,690	3,130	2,210	1,660	2,850	5,550
4	2,560	2,100	2,380	2,230	8,670	10,600	3,660	3,160	2,520	1,590	2,930	5,330
5	2,700	2,600	1,730	1,890	8,670	7,810	3,340	3,100	2,310	1,620	2,570	5,380
6	2,940	2,400	1,950	2,250	9,240	27,000	3,450	7,550	1,840	1,600	2,350	5,060
7	2,630	2,000	2,440	2,560	10,200	41,900	4,190	5,840	2,000	1,590	2,050	4,880
8	2,520	1,800	2,000	2,650	9,380	26,700	4,330	4,710	2,600	1,710	1,540	4,360
9	2,560	1,900	2,100	2,490	8,060	18,300	4,250	3,980	2,200	1,740	1,490	4,960
10	2,370	2,300	2,000	2,020	7,430	16,200	6,260	3,490	2,250	1,750	1,960	6,830
11	1,630	2,200	1,750	1,840	6,420	29,500	6,770	4,020	2,040	2,270	1,770	6,570
12	1,650	1,950	1,200	1,380	5,690	27,200	5,330	3,480	2,090	2,350	2,050	5,230
13	2,300	1,900	1,300	1,520	5,030	19,700	4,910	3,020	2,040	2,030	1,920	4,820
14	2,000	2,100	2,000	1,510	4,950	15,100	5,450	2,850	2,280	1,870	1,850	4,960
15	2,100	1,800	2,000	1,440	4,470	13,100	8,870	2,710	2,390	1,800	1,810	4,700
16	1,700	1,800	2,600	1,450	5,310	12,100	14,600	1,820	2,260	1,980	1,820	4,230
17	2,100	2,200	2,500	2,320	5,940	22,900	13,700	1,750	2,570	2,170	2,360	10,600
18	2,000	2,200	2,200	2,020	5,560	22,700	13,500	2,470	1,840	1,530	2,830	9,450
19	2,100	1,800	1,500	2,130	5,070	16,200	10,900	2,510	1,700	1,380	4,080	7,280
20	2,100	1,800	1,300	2,950	4,580	13,400	9,810	2,420	1,890	5,040	16,400	6,210
21	1,900	1,600	1,990	2,770	4,280	11,600	8,510	2,790	2,090	6,770	41,700	5,910
22	2,000	1,400	9,450	2,380	3,920	10,400	9,120	3,060	2,470	6,400	22,900	5,650
23	1,800	1,500	7,670	2,010	3,590	8,460	8,640	2,460	2,440	5,280	13,600	4,800
24	1,600	2,000	5,260	2,330	3,500	9,180	9,910	2,440	2,400	4,510	10,200	4,490
25	2,300	1,800	4,270	6,490	3,300	9,110	12,300	3,110	1,800	4,150	8,240	4,150
26	2,900	1,700	2,730	9,780	2,900	7,700	11,200	3,080	1,740	4,790	6,700	3,990
27	2,800	2,200	2,920	9,010	2,580	6,780	8,880	3,100	1,710	4,910	6,240	4,010
28	2,400	2,400	3,030	8,010	2,450	5,910	7,930	3,150	1,710	3,570	5,610	3,900
29	2,000	1,750		8,200	2,410	4,970	6,960	2,650	1,860	3,150	4,890	3,980
30	2,400	2,210		11,200	2,100	4,810	5,970	1,810	1,860	2,710	4,460	4,230
31	2,200	2,650		13,500		4,840		1,830	2,310		4,710	
Total	73,030	62,160	78,100	118,610	180,440	447,870	227,740	98,970	65,730	85,390	187,810	162,710
Mean	2,356	2,005	2,789	3,826	6,015	14,450	7,591	3,193	2,120	2,846	6,058	5,424

Year total 1,788,560 $(ft^3/s) \cdot d$ Mean 4,900 ft^3/s

Table 9.- Daily mean discharge, in cubic feet per second, of Delaware River at Trenton, N.J. (01463500) for the year ending November 30, 1989. Preliminary U.S. Geological Survey record.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	10,900	5,370	5,570	7,400	25,400	5,710	11,900	13,300	4,760	3,930	8,820	11,500
2	9,860	4,830	5,620	7,060	23,500	9,390	11,200	10,800	5,050	4,180	8,390	11,600
3	9,350	4,790	5,470	6,630	19,800	15,700	11,300	9,240	5,120	3,680	10,200	12,300
4	8,630	4,790	5,680	6,070	17,200	23,500	10,700	8,260	4,920	3,460	9,790	12,300
5	7,470	4,700	5,610	5,820	16,400	18,100	9,300	9,900	5,020	3,360	8,840	11,400
6	7,030	3,630	4,590	5,930	17,200	35,800	8,740	11,100	5,170	3,310	8,010	10,900
7	7,590	4,730	4,210	6,190	18,600	74,900	10,800	13,200	5,070	3,330	7,250	10,600
8	6,990	4,160	4,810	6,150	18,700	65,700	14,400	13,000	4,700	3,350	6,830	10,300
9	6,690	4,890	4,540	5,840	17,100	49,500	14,500	11,500	4,880	3,260	6,170	10,800
10	6,320	4,950	3,770	6,010	15,500	45,100	20,900	9,470	5,030	3,340	5,450	13,200
11	6,240	4,870	3,590	5,600	14,100	49,200	17,800	8,280	4,540	3,340	5,540	13,700
12	5,260	5,270	3,700	5,930	12,700	58,100	15,700	8,530	5,010	3,310	5,590	13,200
13	4,010	6,020	3,640	5,620	11,500	47,300	14,600	8,300	6,910	3,870	5,520	11,800
14	4,680	5,930	3,510	5,130	10,700	36,900	13,600	7,930	10,600	3,920	5,480	10,600
15	5,060	6,740	4,040	5,340	10,500	31,000	13,500	7,060	10,100	3,820	5,140	10,700
16	5,460	7,750	5,300	5,290	12,300	29,500	19,600	6,810	8,470	3,560	4,910	10,700
17	4,490	6,770	5,240	5,350	11,700	41,800	30,200	7,220	6,560	4,000	5,100	13,800
18	4,480	6,040	5,320	5,670	11,900	53,700	27,100	6,870	5,850	5,560	9,260	19,800
19	4,450	6,140	4,910	7,180	11,400	43,900	24,400	6,420	5,280	6,040	11,900	17,800
20	4,430	5,710	4,350	6,510	10,400	34,000	20,600	6,740	4,810	31,900	32,700	15,000
21	4,720	5,210	5,680	7,060	9,540	28,300	18,600	9,060	4,670	36,600	62,400	13,400
22	4,970	4,470	12,000	8,370	8,790	24,400	20,600	7,360	4,870	25,400	64,100	12,200
23	4,620	4,060	18,000	7,690	8,330	21,900	22,200	7,620	5,170	20,200	40,300	11,900
24	4,770	4,240	15,800	7,320	7,730	23,000	26,200	7,140	5,230	17,600	29,900	10,800
25	5,290	4,360	11,700	13,000	7,320	23,100	23,800	6,670	5,140	14,100	24,300	9,940
26	5,720	4,690	9,850	16,300	7,100	20,700	23,800	7,360	4,590	13,400	19,500	9,780
27	6,130	4,700	7,970	19,600	6,760	18,000	22,100	7,070	4,090	15,400	16,600	9,550
28	5,980	4,900	7,610	17,900	6,270	15,900	19,000	6,640	3,940	14,100	14,800	9,880
29	6,370	5,220		15,900	5,920	14,200	17,300	6,320	3,880	11,700	13,400	9,770
30	5,580	5,070		15,700	5,800	12,400	15,200	5,840	3,920	10,000	12,200	9,520
31	5,450	5,180		22,500		11,700		5,260	3,980		11,300	
Total	188,990	160,180	182,080	272,060	380,160	982,400	529,640	260,270	167,330	283,020	479,690	358,740
Mean	6,096	5,167	6,503	8,776	12,670	31,690	17,650	8,396	5,398	9,434	15,470	11,960

Year total 4,244,560 $(ft^3/s)\cdot d$ Mean 11,630 ft^3/s

Table 10. - Storage in Pepacton Reservoir, N.Y., for year ending November 30, 1989
(Storage in millions of gallons above elevation 1,152.00 ft. Add 7,711 million gallons for total contents above sill of outlet tunnel, elevation 1,126.50 ft.) Storage at spillway level is 140,190 million gallons.
(River Master daily operations record; gage reading at 0800)

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	79,988	71,892	65,445	70,295	77,695	92,309	126,989	139,914	134,336	121,625	111,531	113,849
2	79,865	71,583	65,323	70,486	78,641	93,141	127,320	139,620	133,743	121,300	111,498	113,750
3	79,728	71,390	65,225	70,537	79,551	94,950	127,653	139,510	133,563	120,855	111,334	113,684
4	79,551	71,046	65,128	70,664	80,261	96,113	127,881	139,252	133,114	120,446	110,844	113,634
5	79,428	70,753	64,934	70,842	80,947	97,070	128,128	139,013	132,738	120,021	110,501	113,486
6	79,155	70,409	65,055	71,110	81,705	98,998	128,356	139,326	132,434	119,546	110,242	113,453
7	78,925	70,104	65,189	71,161	82,649	102,414	128,779	139,362	132,184	119,036	110,030	113,354
8	78,790	69,826	65,274	71,097	83,471	104,510	129,025	139,399	131,791	118,580	109,543	113,305
9	78,492	69,638	65,238	71,288	84,215	106,148	129,394	139,271	131,327	118,226	109,088	113,453
10	78,248	69,285	65,164	71,199	85,032	107,428	129,979	139,050	130,972	117,721	108,637	113,338
11	77,964	68,958	65,177	71,250	85,500	109,511	130,351	138,903	130,475	117,282	108,411	113,519
12	77,641	68,582	65,250	71,390	85,740	111,874	130,741	138,700	130,103	116,830	108,250	113,470
13	77,132	68,358	65,433	71,558	86,137	113,684	131,202	138,443	129,749	116,311	107,928	113,486
14	76,890	67,946	65,531	71,313	86,494	115,010	131,774	138,242	129,483	115,859	107,444	113,387
15	76,595	67,572	65,519	71,148	86,823	116,144	132,648	137,785	129,042	115,559	107,268	113,453
16	76,250	67,411	65,898	71,033	87,238	116,981	133,455	137,767	128,673	115,127	107,028	113,453
17	75,892	67,127	65,934	70,855	87,768	118,429	134,426	137,712	128,198	114,761	106,548	114,628
18	75,493	67,115	66,093	70,804	88,461	119,936	135,439	137,366	127,741	114,412	106,436	115,226
19	75,189	66,905	66,069	70,982	89,053	121,043	136,254	137,055	127,320	113,915	106,132	115,725
20	74,847	66,560	65,959	71,161	89,534	122,121	136,836	136,727	126,901	113,799	106,404	116,445
21	74,545	66,227	66,473	71,390	89,971	122,860	137,384	136,581	126,639	113,931	109,836	116,914
22	74,243	66,142	68,208	71,288	90,482	123,653	137,895	136,454	126,202	113,783	111,678	117,132
23	73,862	66,264	68,694	71,148	90,820	124,326	138,369	136,309	125,714	113,585	112,777	117,586
24	73,576	66,179	69,197	71,224	90,114	124,847	139,215	136,381	125,298	113,503	113,321	118,075
25	73,485	66,044	69,512	71,583	91,320	125,263	140,116	136,019	124,812	113,288	113,733	118,142
26	73,211	65,922	69,726	72,124	91,615	125,350	140,320	135,747	124,326	113,058	113,898	118,462
27	72,912	65,861	70,028	72,665	91,791	125,749	140,246	135,366	123,860	112,942	114,047	118,867
28	72,600	65,739	70,231	73,237	91,865	125,993	140,320	135,095	123,463	112,629	114,130	119,155
29	72,523	65,665		74,059	91,894	126,237	140,320	135,276	123,084	112,382	113,981	119,291
30	72,317	65,775		75,005	92,012	126,464	140,006	134,895	122,585	111,776	113,898	119,291
31	72,124	65,678		76,356		126,744		134,678	122,190		113,898	
Change	-7,836	-6,446	+4,553	+6,125	+15,656	+34,732	+13,262	-5,328	-12,488	-10,414	+2,122	+5,393
Equiv. Mgal/d	-252.8	-207.9	+162.6	+197.6	+521.9	+1,120	+442.1	-171.9	-402.8	-347.1	+68.5	+179.8
Equiv. ft^3/s	-391	-322	+252	+306	+807	+1,733	+684	-266	-623	-537	+106	+278

Change for year +39,331 Mgal   Equiv. for year +108 Mgal/d   Equiv. for year +167 ft^3/s

Table 11. - Storage in Cannonsville Reservoir, N.Y., for year ending November 30, 1989
(Storage in millions of gallons above elevation 1,040.00 ft. Add 2,584 million gallons for total contents above sill of outlet tunnel, elevation 1,020.50 ft.) Storage at spillway level is 95,706 million gallons.
(River Master daily operations record; gage reading at 0800)

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	48,247	53,856	49,492	46,857	52,420	66,121	96,076	95,851	88,419	79,230	68,987	75,086
2	48,748	53,856	49,410	46,602	53,856	66,134	95,963	95,584	88,252	78,761	68,881	75,500
3	49,119	53,856	49,469	46,402	54,956	66,949	95,676	95,341	88,176	78,194	68,656	75,846
4	49,585	53,856	49,469	46,224	56,080	67,370	95,311	95,098	88,028	77,476	68,417	76,274
5	49,971	53,762	49,235	45,957	57,362	67,794	95,067	94,976	87,825	76,799	68,179	76,578
6	50,344	53,482	48,948	45,868	58,571	70,006	95,219	95,098	87,710	76,108	67,967	76,910
7	50,636	53,342	48,748	45,679	59,950	75,155	95,478	95,037	87,825	75,514	67,688	77,186
8	50,963	53,284	48,492	45,390	61,103	78,512	95,447	94,976	87,797	74,851	67,268	77,517
9	51,208	53,226	48,192	45,045	62,186	80,888	95,341	94,854	87,753	74,050	67,000	77,821
10	51,488	53,284	47,814	44,778	63,116	82,305	95,706	94,611	87,638	73,384	66,643	78,526
11	51,662	53,284	47,525	44,422	63,740	84,892	95,722	94,352	87,479	72,748	66,338	79,106
12	51,767	53,284	47,213	44,144	64,262	87,883	95,722	94,185	87,117	72,218	65,981	79,673
13	51,861	53,307	46,946	44,022	64,772	90,503	95,691	93,987	87,117	71,954	65,523	80,211
14	51,966	53,004	46,680	43,877	64,759	92,360	95,851	93,622	87,031	71,570	64,822	80,667
15	52,152	53,097	46,402	43,788	64,886	93,881	96,237	93,318	87,016	71,119	64,364	81,163
16	52,059	53,097	46,579	43,922	65,090	95,098	96,494	92,907	86,944	70,377	64,160	81,683
17	51,966	53,097	46,491	43,977	65,561	96,237	97,009	92,497	86,886	70,271	63,854	83,923
18	51,966	53,027	46,224	43,966	66,019	97,025	97,540	92,131	86,641	70,338	63,854	85,181
19	52,152	53,004	45,957	44,144	66,338	97,313	97,540	91,903	86,164	70,165	63,854	86,164
20	52,246	52,910	45,679	44,233	66,643	97,412	97,412	91,888	85,947	69,966	64,262	87,002
21	52,467	52,724	45,501	44,300	66,873	97,428	97,122	92,010	85,571	69,953	67,384	87,724
22	52,525	52,525	46,924	44,311	67,089	97,412	96,768	91,766	85,138	69,847	70,165	88,419
23	52,350	52,397	47,491	44,233	67,268	97,412	96,446	91,386	84,747	69,741	71,556	88,891
24	52,129	51,872	47,569	44,233	67,370	97,025	96,462	90,990	84,183	69,662	72,337	89,286
25	52,152	51,488	47,469	45,000	67,064	96,752	96,864	90,655	83,721	69,636	72,973	89,606
26	52,339	51,161	47,291	45,757	66,949	96,543	96,623	90,275	83,128	69,636	73,490	89,910
27	52,525	50,858	47,213	46,390	66,834	96,494	96,494	89,880	82,478	69,516	73,821	90,336
28	52,747	50,449	47,035	46,946	66,656	96,768	96,285	89,530	81,828	69,410	74,050	90,640
29	53,191	50,122		47,691	66,439	96,768	96,237	89,286	81,149	69,305	74,160	90,959
30	53,576	49,877		48,737	66,261	96,768	96,076	88,800	80,543	68,987	74,271	91,142
31	53,576	49,691		50,531		96,334		88,419	79,880		74,713	
Change	+5,818	-3,885	-2,656	+3,496	+15,730	+30,073	-258	-7,657	-8,539	-10,893	+5,726	+16,429
Equiv. Mgal/d	+187.7	-125.3	-94.9	+112.8	+524.3	+970.1	-8.60	-247.0	-275.5	-363.1	+184.7	+547.6
Equiv. ft^3/s	+290	-194	-147	+174	+811	+1,501	-13.3	-382	-426	-562	+286	+847

Change for year +43,384 Mgal   Equiv. for year +119 Mgal/d   Equiv. for year +184 ft^3/s

Table 12. - Storage in Neversink Reservoir, N.Y. for year ending November 30, 1989
(Storage in millions of gallons above elevation 1,319.00. Add 525 million gallons for total contents above sill of outlet tunnel, elevation 1,314.00 ft.) Storage at spillway level is 34,941 million gallons.
(River Master daily operation record; gage reading at 0800)

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	9,063	8,578	9,985	12,218	17,750	23,501	33,857	33,403	31,527	22,116	17,928	23,987
2	9,098	8,627	10,067	12,278	18,032	23,846	33,732	33,437	31,290	21,803	17,840	24,128
3	9,095	8,693	10,132	12,304	18,257	24,785	33,625	33,499	31,012	21,496	18,078	24,193
4	9,083	8,737	10,192	12,378	18,540	25,134	33,504	33,509	30,740	21,101	18,201	24,274
5	9,058	8,747	10,240	12,450	18,875	25,391	33,422	33,543	30,424	20,836	18,278	24,303
6	9,025	8,762	10,267	12,542	19,235	26,847	33,293	33,683	30,127	20,443	18,342	24,323
7	9,010	8,811	10,307	12,597	19,701	28,517	33,216	33,751	29,801	20,098	18,434	24,384
8	8,998	8,868	10,352	12,539	20,020	29,217	33,077	33,814	29,464	19,737	18,486	24,425
9	8,955	8,925	10,381	12,591	20,250	29,670	32,971	33,857	29,182	19,348	18,536	24,425
10	8,918	8,983	10,397	12,641	20,465	30,041	32,924	33,877	28,875	19,051	18,586	24,527
11	8,878	9,018	10,429	12,699	20,641	30,970	32,862	33,925	28,570	18,719	18,629	24,871
12	8,819	9,058	10,464	12,757	20,802	31,761	32,757	33,935	28,276	18,409	18,686	24,961
13	8,752	9,130	10,504	12,781	20,961	32,198	32,681	33,940	28,014	18,071	18,753	25,014
14	8,695	9,185	10,544	12,830	21,104	32,552	32,571	33,959	27,836	17,774	18,796	25,072
15	8,666	9,236	10,598	12,898	21,253	32,871	32,757	33,959	27,580	17,501	18,853	25,126
16	8,605	9,292	10,721	13,099	21,446	33,144	32,871	33,979	27,313	17,189	18,929	25,176
17	8,556	9,367	10,770	13,191	21,688	34,601	32,976	33,979	27,005	16,874	18,968	25,629
18	8,497	9,428	10,810	13,319	21,899	35,180	33,000	33,940	26,663	16,551	19,134	25,804
19	8,436	9,490	10,851	13,589	22,085	35,155	32,966	33,853	26,367	16,424	19,253	25,921
20	8,381	9,531	10,883	13,707	22,232	35,150	33,009	33,761	26,051	16,544	19,562	26,022
21	8,337	9,554	10,954	13,822	22,412	35,140	33,009	33,746	25,674	17,271	21,596	26,202
22	8,282	9,559	11,565	13,895	22,537	35,100	33,048	33,669	25,358	17,394	22,283	26,363
23	8,229	9,602	11,798	13,966	22,666	34,911	33,062	33,606	25,039	17,584	22,646	26,473
24	8,173	9,638	11,902	14,040	22,768	34,793	33,134	33,528	24,715	17,805	22,925	26,617
25	8,214	9,700	11,967	14,290	22,882	34,719	33,177	33,293	24,352	17,854	23,123	26,684
26	8,205	9,744	12,034	14,728	22,984	34,591	33,129	33,067	24,023	17,882	23,306	26,834
27	8,257	9,811	12,093	15,117	23,083	34,497	33,225	32,838	23,729	17,963	23,461	26,953
28	8,301	9,845	12,127	15,541	23,190	34,326	33,297	32,538	23,393	17,963	23,585	27,060
29	8,402	9,879		16,146	23,294	34,179	33,355	32,330	23,040	17,952	23,713	27,258
30	8,475	9,920		16,735	23,401	34,023	33,384	32,052	22,756	17,910	23,825	27,339
31	8,529	9,975		17,305		33,920		31,817	22,474		23,825	
Change	-511	+1,446	+2,152	+5,178	+6,096	+10,519	-536	-1,567	-9,343	-4,564	+5,915	+3,514
Equiv. mgal/d	-16.5	+46.6	+76.9	+167.0	+203.2	+339.3	-17.9	-50.5	-301.4	-152.1	+190.8	+117.1
Equiv. ft^3/s	-25.5	+72.2	+119	+258	+314	+525	-27.6	-78.2	-466	-235	+295	+181

Change for year +18,299 Mgal Equiv. for year +50.1 Mgal/d Equiv. for year +77.6 ft^3/s

Table 13. - Diversions by New Jersey through the Delaware & Raritan Canal in million gallons
Record furnished by New Jersey Water Supply Authority

Day	December 1988			January 1989			February			March		
	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total
1		85	85		88	88		77	77		66	66
2		85	85		88	88		76	76		65	65
3		97	97		88	88		70	70		65	65
4		97	97		88	88		71	71		63	63
5		95	95		88	88		70	70		63	63
6		95	95		88	88		69	69		65	65
7		94	94		80	80		69	69		65	65
8		92	92		80	80		69	69		65	65
9		87	87		88	88		66	66		65	65
10		88	88		88	88		65	65		65	65
11		89	89		88	88		65	65		65	65
12		89	89		88	88		65	65		65	65
13		89	89		90	90		64	64		66	66
14		88	88		83	83		65	65		66	66
15		88	88		86	86		69	69		66	66
16		88	88		85	85		66	66		66	66
17		88	88		84	84		67	67		67	67
18		88	88		79	79		66	66		62	62
19		88	88		79	79		65	65		63	63
20		88	88		77	77		67	67		59	59
21		88	88		76	76		67	67		55	55
22		88	88		76	76		69	69		55	55
23		84	84		76	76		66	66		60	60
24		89	89		69	69		67	67		60	60
25		90	90		69	69		67	67		63	63
26		90	90		74	74		66	66		63	63
27		89	89		76	76		66	66		61	61
28		88	88		75	75		66	66		61	61
29		88	88		75	75					61	61
30		88	88		75	75					60	60
31		88	88		77	77					62	62
Total			2,768			2,521			1,895			1,953
Mean			89.3			81.3			67.7			63.0
Maximum			97			90			77			67

Table 13. - Diversions by New Jersey through the Delaware & Raritan Canal in million gallons - continued
Record furnished by New Jersey Water Supply Authority

Day	April			May			June			July		
	Waste gate	Kingston Lock	Daily total	Lake Carnegie	Kingston Lock	Daily total	Lake Carnegie	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total
1		62	62		69	69	56		56		63	63
2		61	61		68	68	73.5		73.5		63	63
3		61	61		68	68	62		62		63	63
4		32	32		69	69	63		63		62	62
5		38	38		69	69	60.5		60.5		63	63
6		48	48	62	69	131	66		66		67	67
7		53	53	65	26	91	71		71		59	59
8		53	53	53	6	59	67		67		59	59
9		53	53	54		54	65		65		57	57
10		60	60	55		55	77		77		65	65
11		64	64	63		63	66		66		57	57
12		63	63	54		54	49		49		52	52
13		62	62	46		46	47		47		54	54
14		63	63	49		49	31		31		56	56
15		62	62	46		46	33		33		51	51
16		64	64	51		51		62	62		51	51
17		63	63	63		63		68	68		12	12
18		63	63	51		51		65	65		0	0
19		63	63	56		56		64	64		26	26
20		63	63	61		61		59	59		68	68
21		63	63	49		49		57	57		69	69
22		67	67	54		54		61	61		66	66
23		67	67	56		56		61	61		66	66
24		67	67	77		77		61	61			
25		74	74	67		67		61	61		66	66
26		69	69	51		51		62	62		67	67
27		69	69	70		70		62	62		67	67
28		69	69	51		51		62	62		68	68
29		69	69	65		65		65	65		68	68
30		69	69	76		76		66	66		68	68
31				79		79					68	68
Total			1,834			1,968			1,823			1,787
Mean			61.1			63.5			60.8			57.6
Max			74			131			77			69

Table 13. - Diversions by New Jersey through the Delaware & Raritan Canal in million gallons - continued

Record furnished by New Jersey Water Supply Authority

Day	August			September			October			November		
	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total	Waste gate	Kingston Lock	Daily total
1		68	68		76	76		81	81		80	80
2		68	68		74	74		81	81	5	0	5
3		66	66		73	73		83	83	14	53	67
4		68	68		73	73		84	84	11	25	36
5		65	65		73	73		81	81	25	33	58
6		65	65		73	73		81	81	21		21
7		68	68		72	72		84	84	25		25
8		69	69		71	71		83	83	25		25
9		69	69		71	71		83	83	25		25
10		69	69		71	71		83	83	25		25
11		69	69		70	70		79	79	25		25
12		73	73		70	70		79	79	25		25
13		67	67		65	65		79	79	25		25
14		70	70		69	69		77	77	25		25
15		69	69		76	76		76	76	26		26
16		69	69		78	78		76	76	26	2	28
17		76	76		83	83		74	74	26	2	28
18		77	77		83	83		77	77	12	43	55
19		74	74		83	83		70	70		43	43
20		71	71		95	95		71	71		43	43
21		71	71		87	87		69	69		26	26
22		70	70		81	81		83	83		26	26
23		71	71		80	80		85	85		27	27
24		73	73		89	89		84	84		27	27
25		75	75		89	89		79	79		31	31
26		75	75		88	88		83	83		35	35
27		74	74		82	82		83	83		48	48
28		73	73		81	81		81	81		48	48
29		73	73		81	81		81	81		48	48
30		73	73		81	81		80	80		47	47
31		79	79					79	79			
Total			2,197			2,338			2,469			1,053
Mean			70.9			77.9			79.6			35.1
Maximum			79			95			85			80

Table 14. - Diversions to New York City water supply
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1988	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1988 to date	Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average to date June 1, 1988 to Jan. 15 or Jan. 16 - 31, 1989
Dec. 1	441	0	93	743	Jan. 1	441	285	0	713
2	444	0	105	742	2	440	300	0	713
3	444	0	103	741	3	441	291	0	713
4	445	0	114	740	4	441	299	0	713
5	443	0	107	739	5	443	299	0	713
6	444	0	102	738	6	444	299	0	714
7	442	0	102	737	7	443	299	0	714
8	444	0	107	736	8	442	299	0	714
9	444	0	97	735	9	441	299	0	714
10	443	0	89	734	10	442	236	0	714
11	441	0	99	733	11	443	158	0	713
12	441	0	88	732	12	443	273	0	713
13	441	0	98	731	13	445	452	0	714
14	444	0	97	730	14	445	357	0	714
15	443	0	108	729	15	444	300	0	715
16	444	0	90	728	16	391	275	0	666
17	443	0	101	727	17	393	275	0	667
18	442	0	99	726	18	391	276	0	667
19	442	0	98	725	19	390	275	0	666
20	444	0	97	724	20	389	275	0	666
21	443	0	94	723	21	258	276	0	644
22	442	0	99	722	22	0	276	0	591
23	443	0	93	721	23	227	462	0	604
24	443	0	101	721	24	232	473	0	615
25	443	0	107	720	25	219	473	0	623
26	443	0	0	718	26	227	472	0	630
27	445	0	0	717	27	226	470	0	635
28	443	10	0	716	28	225	472	0	640
29	445	17	0	715	29	0	472	0	628
30	442	150	0	714	30	276	472	0	636
31	443	16	0	713	31	430	471	34	655
Total	13,734	193	2,488			10,912	10,611	34	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average to date Jan. 16 to Feb. 4 or Feb. 5-28	Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average Feb. 5 to date
Feb. 1	444	471		670	Mar. 1	73	469	0	528
2	445	339		676	2	75	470	0	529
3	278	298		671	3	66	392	0	526
4	278	443		673	4	0	469	0	524
5	0	471		471	5	0	469	0	522
6	111	471		526	6	100	469	0	524
7	0	471		508	7	100	469	77	528
8	143	471		534	8	100	469	0	529
9	148	470		551	9	102	468	0	530
10	148	470		562	10	107	468	0	532
11	0	470		549	11	0	468	0	530
12	0	470		539	12	0	459	0	528
13	0	469		531	13	448	298	0	534
14	95	469		535	14	447	298	0	539
15	91	469		537	15	446	299	0	545
16	81	469		538	16	447	298	0	550
17	84	469		539	17	296	298	0	551
18	0	469		534	18	0	298	0	545
19	0	469		530	19	0	299	0	539
20	0	469		526	20	195	299	0	538
21	100	469		529	21	296	299	0	539
22	89	470		530	22	297	299	0	541
23	82	470		531	23	300	298	0	542
24	82	470		532	24	289	298	0	543
25	0	470		529	25	159	299	0	541
26	0	470		527	26	198	299	0	540
27	66	470		527	27	298	299	0	541
28	74	469		528	28	297	298	0	542
					29	296	299	0	543
					30	295	298	0	544
					31	297	299	0	545
Total	2,839	12,825	0			6,024	11,211	77	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average Feb. 5 to date	Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average to date Feb. 5 to May 11 or May 12-31
Apr. 1	271	286		545	May 1	223	483	0	538
2	189	299		544	2	224	483	0	540
3	300	298		545	3	225	484	0	542
4	298	298		546	4	227	484	0	544
5	299	298		547	5	223	142	0	542
6	298	299		548	6	126	0	0	537
7	298	298		549	7	0	0	0	532
8	307	298		549	8	0	0	0	526
9	0	299		546	9	0	267	0	523
10	190	299		545	10	0	292	0	521
11	206	297		544	11	0	293	0	518
12	205	296		543	12	0	0	0	0
13	206	471		545	13	0	0	0	0
14	207	482		547	14	0	0	0	0
15	158	483		549	15	0	0	0	0
16	0	477		548	16	0	0	0	0
17	0	297		544	17	0	0	0	0
18	0	299		541	18	0	0	0	0
19	0	299		538	19	0	0	0	0
20	0	298		534	20	0	0	0	0
21	0	298		531	21	0	0	0	0
22	0	298		528	22	0	0	302	27
23	0	298		525	23	0	215	316	69
24	224	472		528	24	0	281	334	111
25	213	484		530	25	0	281	291	144
26	221	484		532	26	0	283	284	172
27	191	484		534	27	0	2	312	181
28	251	480		536	28	0	0	272	187
29	127	483		537	29	0	0	270	191
30	0	483		536	30	0	426	200	214
					31	0	500	182	238
Total	4,659	10,935	0			1,248	4,916	2,763	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date	Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date
June 1	0	327	226	553	July 1	440	298	0	608
2	0	435	181	585	2	441	297	0	612
3	0	500	189	619	3	440	297	0	616
4	0	500	186	636	4	438	297	0	620
5	0	117	184	569	5	439	297	0	623
6	0	246	189	547	6	442	297	0	626
7	0	429	184	556	7	444	297	0	629
8	0	500	194	573	8	445	297	0	632
9	0	141	179	545	9	445	297	0	635
10	0	493	189	559	10	444	297	0	638
11	0	500	186	570	11	458	209	0	638
12	0	500	168	579	12	443	225	0	639
13	0	499	201	588	13	443	287	0	641
14	0	501	0	582	14	442	287	0	643
15	0	499	205	590	15	135	287	0	638
16	0	352	174	586	16	171	287	0	634
17	0	318	188	581	17	438	287	94	638
18	0	318	194	577	18	440	150	95	639
19	0	311	99	569	19	441	78	100	639
20	0	317	100	561	20	442	0	94	637
21	0	445	37	557	21	195	114	97	632
22	0	501	95	559	22	300	317	98	634
23	9	501	95	561	23	0	316	96	630
24	0	501	97	563	24	400	173	238	633
25	292	501	144	577	25	453	137	239	637
26	430	300	0	583	26	454	137	238	640
27	437	298	0	589	27	451	124	238	643
28	439	298	1	594	28	209	110	236	642
29	442	298	0	599	29	150	297	240	642
30	441	298	0	604	30	244	293	250	645
					31	450	0	318	647
Total	2,490	11,744	3,885			11,577	7,086	2,671	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date	Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date
Aug. 1	451	0	250	648	Sept. 1	456	0	307	680
2	451	0	286	649	2	456	0	284	681
3	451	0	293	651	3	454	0	394	682
4	451	0	289	652	4	454	0	256	683
5	302	0	296	651	5	451	0	402	684
6	238	0	297	649	6	452	0	333	685
7	452	0	297	651	7	453	0	345	687
8	451	0	277	652	8	454	0	364	688
9	449	0	284	653	9	455	0	280	688
10	450	0	293	654	10	454	0	313	689
11	449	0	296	656	11	456	0	284	690
12	448	0	295	657	12	455	0	315	690
13	447	0	291	658	13	455	0	298	691
14	447	0	294	659	14	455	0	289	692
15	450	66	297	661	15	454	0	328	692
16	451	0	299	662	16	454	0	341	693
17	447	0	302	663	17	454	0	324	694
18	446	0	300	664	18	454	0	102	693
19	446	0	312	666	19	455	212	106	694
20	445	0	378	667	20	450	266	111	695
21	447	0	309	669	21	453	225	103	696
22	448	0	307	670	22	452	219	107	696
23	452	0	288	670	23	452	230	97	697
24	451	0	326	672	24	452	235	103	698
25	451	0	290	673	25	453	189	103	698
26	450	0	307	673	26	452	198	101	699
27	449	0	318	675	27	451	198	98	699
28	450	0	353	676	28	451	203	103	699
29	452	0	303	677	29	454	203	89	700
30	454	0	330	678	30	442	198	97	700
31	455	0	319	679					
Total	13,581	66	9,376			13,593	2,576	6,777	

Table 14. - Diversions to New York City water supply - continued
Million gallons per day for 24-hour period beginning 0800 local time
(River Master daily operation record)

Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date	Date 1989	East Delaware Tunnel	West Delaware Tunnel	Never-sink Tunnel	Average June 1, 1989 to date
Oct. 1	452	202	116	701	Nov. 1	453	0	105	706
2	452	286	0	701	2	450	0	89	705
3	451	294	0	701	3	418	0	96	704
4	447	284	0	702	4	400	0	98	703
5	452	296	0	702	5	399	0	101	702
6	453	296	0	702	6	399	0	74	700
7	454	296	0	703	7	399	0	69	699
8	453	295	0	703	8	450	0	70	698
9	453	295	0	703	9	417	0	68	696
10	460	294	0	704	10	400	0	77	695
11	452	294	0	704	11	399	0	67	693
12	451	293	0	704	12	400	0	79	692
13	448	294	0	705	13	399	0	58	691
14	453	295	0	705	14	398	0	68	689
15	452	294	0	705	15	399	0	70	688
16	453	295	0	706	16	400	0	74	687
17	455	295	0	706	17	400	0	70	686
18	452	295	0	706	18	268	0	74	684
19	451	278	0	706	19	0	0	71	680
20	453	296	0	707	20	333	196	0	679
21	454	297	0	707	21	332	185	0	678
22	455	296	0	707	22	194	203	0	677
23	454	289	0	708	23	0	203	0	674
24	452	296	0	708	24	334	203	0	673
25	456	296	0	708	25	196	203	0	672
26	452	296	0	708	26	0	204	0	669
27	451	296	0	709	27	240	200	0	668
28	471	309	0	709	28	243	200	0	666
29	455	296	0	709	29	244	202	0	665
30	454	1	100	708	30	243	200	0	664
31	455	0	98	707					
Total	14,056	8,439	314			9,607	2,199	1,478	

Table 15.- New York City Reservoir release design data

(River Master daily operation record)

MONTAGUE DESIGN RATE = 1,750 ft³/s DECEMBER 1, 1988 TO JANUARY 18, 1989; 1,655 ft³/s JANUARY 19 TO FEBRUARY 7; 1,550 ft³/s FEBRUARY 8 TO MAY 14 AND 1,750 ft³/s MAY 15 TO JUNE 14

The estimated Montague discharge was greater than the Montague design rate December 1-17, 20-23, 30-31; January 9-21, 24-28, 31 to February 1, 4-8; and May 1 to June 14

As discussed elsewhere in this report no releases were directed to meet the Montague flow objective from February 9 to April 30, 1989

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft^3/s	Powerplant release forecasts: Rio Reservoir ft^3/s	Uncontrolled runoff: Present conditions ft^3/s	Uncontrolled runoff: Weather adjustment ft^3/s	Date	Discharge ft^3/s	Indicated deficiency ft^3/s	Balancing adjustment ft^3/s	Directed Release ft^3/s	Computations of the Balancing Adjustment: Adjusted Directed release: Daily ft^3/s	Adjusted Directed release: Cumulative $(ft^3/s)\cdot d$	Actual deficiency: Daily ft^3/s	Actual deficiency: Cumulative $(ft^3/s)\cdot d$	Cumulative difference $(ft^3/s)\cdot d$	Balancing adjustment ft^3/s
1988/89	1	2	3	4		5	6	7	8	9	10	11	12	13	14
Dec. 15	0	0	750	0	Dec. 18	750	1,000		1,000						
16	237	400	800	0	19	1,437	313		313						
21	0	106	800	44	24	950	800		800						
22	0	0	800	200	25	1,000	750		750						
23	0	0	800	300	26	1,100	650		650						
24	0	0	900	400	27	1,300	450		450						
25	237	0	1,200	93	28	1,530	220		220						
26	237	0	1,100	263	29	1,600	150		150						
29	0	0	1,500	0	Jan. 1	1,500	250		250						
30	0	0	1,520	0	2	1,520	230		230						
31	0	0	1,550	0	3	1,550	200		200						
Jan. 1	237	0	1,450	3	4	1,690	60		60						
2	237	0	1,400	3	5	1,640	110		110						
3	237	0	1,413	0	6	1,650	100		100						
4	237	0	1,363	0	7	1,600	150		150						
5	0	0	1,300	250	8	1,550	200		200						
19	0	0	1,500	0	22	1,500	155		155						
20	0	0	1,400	0	23	1,400	255		255						
26	0	0	950	255	29	1,205	450		450						
27	178	0	1,100	140	30	1,418	237		237						
30	476	0	1,097	0	Feb. 2	1,573	82		82						
31	476	0	1,064	87	3	1,627	28		28						

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 13 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 15.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 15), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Note.--Cols. 9-14 are used only for the computation of the balancing adjustment June 15 to Oct. 18.

Table 15.- New York City Reservoir release design data - continued

(River Master daily operation record)

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft³/s	Rio Reservoir ft³/s	Uncontrolled runoff: Present conditions ft³/s	Weather adjustment ft³/s	Date	Discharge ft³/s	Indicated deficiency ft³/s	Balancing adjustment ft³/s	Directed Release ft³/s	Computations of the Balancing Adjustment: Adjusted Directed release: Daily ft³/s	Cumulative (ft³/s)·d	Actual deficiency: Daily ft³/s	Cumulative (ft³/s)·d	Cumulative difference (ft³/s)·d	Balancing adjustment ft³/s
1989	1	2	3	4		5	6	7	8	9	10	11	12	13	14
MONTAGUE DESIGN RATE = 1,850 ft³/s JUNE 15 TO OCTOBER 21, 1989															
The estimated Montague discharge was greater than the Montague design rate June 15 to July 15, 1989															
July 13	0	0	1,441	0	July 16	1,441	409		409	409	409	508	508	-99	+10
14	0	100	1,291	0	17	1,391	459		459	459	868	565	1,073	-205	+20
15	706	200	1,052	0	18	1,933	0		0	0	868	0	1,073	-205	+20
16	706	0	921	0	19	1,627	223		223	223	1,091	0	1,073	+18	-2
17	706	0	948	0	20	1,654	196	+10	206	206	1,297	0	1,073	+224	-22
18	706	0	900	223	21	1,829	21	+20	41	41	1,338	0	1,073	+265	-26
The estimated Montague discharge was greater than the Montague design rate July 22-29, 1989															
27	0	0	840	412	30	1,252	598	-26	572	572	1,910	770	1,919	-9	+1
28	0	0	924	0	31	924	926	-26	900	901	2,811	911	2,830	-19	+2

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 13 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 15.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 15), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Note.--Cols. 9-14 are used only for the computation of the balancing adjustment June 15 to Oct. 18.

Table 15.- New York City Reservoir release design data - continued

(River Master daily operation record)

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft³/s	Powerplant release forecasts: Rio Reservoir ft³/s	Uncontrolled runoff: Present conditions ft³/s	Uncontrolled runoff: Weather adjustment ft³/s	Date	Discharge ft³/s	Indicated deficiency ft³/s	Balancing adjustment ft³/s	Directed Release ft³/s	Computations of the Balancing Adjustment: Adjusted Directed release: Daily ft³/s	Adjusted Directed release: Cumulative (ft³/s)·d	Actual deficiency: Daily ft³/s	Actual deficiency: Cumulative (ft³/s)·d	Cumulative difference (ft³/s)·d	Balancing adjustment ft³/s
1989	1	2	3	4		5	6	7	8	9	10	11	12	13	14
July 29	473	0	910	0	Aug. 1	1,383	467	-26	441	441	3,252	98	2,928	+324	-32
30	473	0	773	32	2	1,278	572	-19	553	554	3,806	314	3,242	+564	-56
31	473	177	700	0	3	1,350	500	+1	501	504	4,310	134	3,376	+934	-93
Aug. 1	473	355	753	0	4	1,581	269	+2	271	271	4,581	0	3,376	+1,205	-100
2	473	180	662	15	5	1,330	520	-32	488	488	5,069	40	3,416	+1,653	-100
3	0	0	866	100	6	966	884	-56	828	832	5,901	832	4,248	+1,653	-100
4	0	250	766	102	7	1,118	732	-93	639	639	6,540	565	4,813	+1,727	-100
5	237	350	781	168	8	1,536	314	-100	214	214	6,754	138	4,951	+1,803	-100
6	237	350	819	252	9	1,658	192	-100	92	92	6,846	273	5,224	+1,622	-100
7	237	0	1,616	0	10	1,853	0	-100	0	0	6,846	88	5,312	+1,534	-100
8	237	0	993	0	11	1,230	620	-100	520	521	7,367	331	5,643	+1,724	-100
9	237	0	798	174	12	1,209	641	-100	541	541	7,908	291	5,934	+1,974	-100
10	0	0	697	88	13	785	1,065	-100	965	965	8,873	755	6,689	+2,184	-100
11	0	250	665	190	14	1,105	745	-100	645	645	9,518	195	6,884	+2,634	-100
12	237	350	701	688	15	1,976	0	-100	0	0	9,518	0	6,884	+2,634	-100
13	237	350	899	378	16	1,864	0	-100	0	0	9,518	76	6,960	+2,558	-100
14	237	350	940	249	17	1,776	74	-100	0	0	9,518	0	6,960	+2,558	-100
15	237	350	827	28	18	1,442	408	-100	308	308	9,826	532	7,492	+2,334	-100
16	237	177	744	11	19	1,169	681	-100	581	588	10,414	728	8,220	+2,194	-100
17	0	0	677	16	20	693	1,157	-100	1,057	1,049	11,463	979	9,199	+2,264	-100
18	0	0	600	243	21	843	1,007	-100	907	907	12,370	667	9,866	+2,504	-100
19	0	0	569	249	22	818	1,032	-100	932	926	13,296	346	10,212	+3,084	-100
20	0	0	702	21	23	723	1,127	-100	1,027	1,031	14,327	491	10,703	+3,624	-100
21	0	0	708	17	24	725	1,125	-100	1,025	1,027	15,354	517	11,220	+4,134	-100
22	0	0	667	12	25	679	1,171	-100	1,071	1,069	16,423	1,139	12,359	+4,064	-100
23	0	0	609	0	26	609	1,241	-100	1,141	1,139	17,562	1,279	13,638	+3,924	-100
24	0	0	599	0	27	599	1,251	-100	1,151	1,154	18,716	1,304	14,942	+3,774	-100
25	0	0	538	0	28	538	1,312	-100	1,212	1,209	19,925	1,359	16,301	+3,624	-100
26	0	0	491	5	29	496	1,354	-100	1,254	1,249	21,174	1,229	17,530	+3,644	-100
27	0	0	459	20	30	479	1,371	-100	1,271	1,275	22,449	1,275	18,805	+3,644	-100
28	0	0	421	32	31	453	1,397	-100	1,297	1,302	23,751	862	19,667	+4,084	-100

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 13 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 15.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 15), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Note.--Cols. 9-14 are used only for the computation of the balancing adjustment June 15 to Oct. 18.

Table 15.- New York City Reservoir release design data - continued

(River Master daily operation record)

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft³/s	Rio Reservoir ft³/s	Uncontrolled runoff: Present conditions ft³/s	Weather adjustment ft³/s	Date	Discharge ft³/s	Indicated deficiency ft³/s	Balancing adjustment ft³/s	Directed Release ft³/s	Computations of the Balancing Adjustment: Adjusted Directed release: Daily ft³/s	Cumulative (ft³/s)·d	Actual deficiency: Daily ft³/s	Cumulative (ft³/s)·d	Cumulative difference (ft³/s)·d	Balancing adjustment ft³/s
1989	1	2	3	4		5	6	7	8	9	10	11	12	13	14
Aug. 29	0	0	412	8	Sept. 1	420	1,430	-100	1,330	1,327	25,078	1,347	21,014	+4,064	-100
30	0	0	530	35	2	565	1,285	-100	1,185	1,180	26,258	1,350	22,364	+3,894	-100
31	0	0	456	67	3	523	1,327	-100	1,227	1,225	27,483	1,395	23,759	+3,724	-100
Sept. 1	0	0	463	69	4	532	1,318	-100	1,218	1,219	28,702	1,449	25,208	+3,494	-100
2	0	0	477	0	5	477	1,373	-100	1,273	1,273	29,975	1,483	26,691	+3,284	-100
3	0	0	455	0	6	455	1,395	-100	1,295	1,287	31,262	1,537	28,228	+3,034	-100
4	0	0	403	0	7	403	1,447	-100	1,347	1,344	32,606	1,594	29,822	+2,784	-100
5	331	0	284	0	8	615	1,235	-100	1,135	1,135	33,741	1,265	31,087	+2,654	-100
6	331	0	275	0	9	606	1,244	-100	1,144	1,144	34,885	1,234	32,321	+2,564	-100
7	0	0	219	0	10	219	1,631	-100	1,531	1,531	36,416	1,600	33,921	+2,495	-100
8	0	0	203	8	11	211	1,639	-100	1,539	1,537	37,953	1,147	35,068	+2,885	-100
9	356	0	198	0	12	554	1,296	-100	1,196	1,191	39,144	721	35,789	+3,355	-100
10	356	0	227	60	13	643	1,207	-100	1,107	1,110	40,254	930	36,719	+3,535	-100
11	713	0	230	0	14	943	907	-100	807	803	41,057	803	37,522	+3,535	-100
12	713	0	227	0	15	940	910	-100	810	812	41,869	862	38,384	+3,485	-100
13	713	0	170	60	16	943	907	-100	807	803	42,672	703	39,087	+3,585	-100
14	0	0	210	64	17	274	1,576	-100	1,476	1,476	44,148	1,226	40,313	+3,835	-100
15	0	0	372	693	18	1,065	785	-100	685	685	44,833	1,025	41,338	+3,495	-100
16	356	0	399	1,168	19	1,923	0	-100	0	0	44,833	627	41,965	+2,868	-100
17	356	0	696	118	20	1,170	680	-100	580	585	45,418	0	41,965	+3,453	-100
18	356	0	787	300	21	1,443	407	-100	307	301	45,719	0	41,965	+3,754	-100
19	356	0	667	461	22	1,484	366	-100	266	261	45,980	0	41,965	+4,015	-100

The estimated Montague discharge was greater than the Montague design rate Sept. 23-30, 1989

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 13 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 15.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 15), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Note.--Cols. 9-14 are used only for the computation of the balancing adjustment June 15 to Oct. 18.

Table 15.- New York City Reservoir release design data - continued

(River Master daily operation record)

Date of advance estimate	Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases: Powerplant release forecasts: Lake Wallenpaupack ft³/s	Powerplant release forecasts: Rio Reservoir ft³/s	Uncontrolled runoff: Present conditions ft³/s	Uncontrolled runoff: Weather adjustment ft³/s	Date	Discharge ft³/s	Indicated deficiency ft³/s	Balancing adjustment ft³/s	Directed Release ft³/s	Computations of the Balancing Adjustment: Adjusted Directed release: Daily ft³/s	Adjusted Directed release: Cumulative (ft³/s)·d	Actual deficiency: Daily ft³/s	Actual deficiency: Cumulative (ft³/s)·d	Cumulative difference (ft³/s)·d	Balancing adjustment ft³/s
1989	1	2	3	4		5	6	7	8	9	10	11	12	13	14
Sept. 28	0	0	1,834	0	Oct. 1	1,834	16	-100	0	0	45,980	97	42,062	+3,918	-100
29	0	212	1,449	102	2	1,763	87	-100	0	0	45,980	8	42,070	+3,910	-100
30	358	340	1,241	99	3	2,038	0	-100	0	0	45,980	0	42,070	+3,910	-100
Oct. 1	358	340	1,098	112	4	1,908	0	-100	0	0	45,980	0	42,070	+3,910	-100
2	358	200	1,070	45	5	1,673	177	-100	77	77	46,057	0	42,070	+3,987	-100
3	358	0	1,610	0	6	1,968	0	-100	0	0	46,057	0	42,070	+3,987	-100
4	358	0	1,411	0	7	1,769	81	-100	0	0	46,057	0	42,070	+3,987	-100
5	0	0	1,681	71	8	1,752	98	-100	0	0	46,057	413	42,483	+3,574	-100
6	0	0	1,367	0	9	1,367	483	-100	383	383	46,440	727	43,210	+3,230	-100
7	358	0	1,198	0	10	1,556	294	-100	194	192	46,632	62	43,272	+3,360	-100
8	358	0	1,128	0	11	1,486	364	-100	264	264	46,896	315	43,587	+3,309	-100
9	358	0	1,065	21	12	1,444	406	-100	306	303	47,199	73	43,660	+3,539	-100
10	358	106	934	66	13	1,464	386	-100	286	283	47,482	203	43,863	+3,619	-100
11	358	0	966	0	14	1,324	526	-100	426	422	47,904	422	44,285	+3,619	-100
12	0	0	813	0	15	813	1,037	-100	937	919	48,823	949	45,234	+3,589	-100
13	0	227	892	0	16	1,119	731	-100	631	626	49,449	646	45,880	+3,569	-100
14	358	227	845	13	17	1,443	407	-100	307	295	49,744	0	45,880	+3,864	-100
15	358	227	810	49	18	1,444	406	-100	306	303	50,047	0	45,880	+4,167	-100

The estimated Montague discharge was greater than the Montague design rate Oct. 19 to Nov. 30, 1989

Col. 1 - Furnished by power company.
Col. 2 - Furnished by power company.
Col. 3 - Computed from index stations.
Col. 4 - Computed increase in runoff based on weather forecasts.
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.
Col. 6 = Design rate - Col. 5, when positive; otherwise Col. 6 = 0.
Col. 7 = Col. 13 (4 days earlier).
Col. 8 = Design rate - Col. 5 + Col. 7, when positive; otherwise Col. 8 = 0.
Col. 9 = Col. 7, from Table 15.
Col. 10 = Summation of Col. 9.
Col. 11 = Design rate - (Col. 9 + Col. 10 from Table 15), when positive; otherwise Col. 11 = 0.
Col. 12 = Summation of Col. 11.
Col. 13 = Col. 10 - Col. 12.
Col. 14 = Col. 13 divided by minus 10, limited to ±100.

Note.--Cols. 9-14 are used only for the computation of the balancing adjustment June 15 to Oct. 18.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J.
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1988	1	2	3	4		5	6		7	8	9	10	11	12	13
Nov. 28	0	48	39	23	Nov. 30	0	386	Dec. 1	0	110	386	3,234	3,730		
29	0	48	39	25	Dec. 1	472	273	2	0	112	745	2,883	3,740		
30	0	48	40	25	2	468	209	3	0	113	677	2,530	3,320		
Dec. 1	0	48	40	25	3	0	0	4	0	113	0	2,457	2,570		
2	0	48	40	25	4	0	266	5	0	113	266	2,331	2,710		
3	0	48	40	25	5	473	230	6	0	113	703	2,124	2,940		
4	0	48	40	25	6	461	0	7	0	113	461	2,066	2,640		
5	0	48	40	25	7	475	0	8	0	113	475	1,932	2,520		
6	0	48	40	25	8	437	152	9	0	113	589	1,868	2,570		
7	0	48	40	25	9	460	0	10	0	113	460	1,797	2,370		
8	0	48	40	25	10	0	0	11	0	113	0	1,517	1,630		
9	0	48	40	25	11	114	454	12	0	113	568	969	1,650		
10	0	48	40	25	12	822	446	13	0	113	1,268	919	2,300		
11	0	48	40	25	13	742	248	14	0	113	990	897	2,000		
12	0	48	40	25	14	409	184	15	0	113	593	1,394	2,100		
13	0	51	40	25	15	58	354	16	0	116	412	1,172	1,700		
14	0	53	40	25	16	666	238	17	0	118	904	1,078	2,100		
15	1,000	51	926	25	17	232	156	18	1,002	0	388	610	2,000		
16	313	53	238	25	18	301	305	19	316	0	606	1,178	2,100		
17	0	53	40	25	19	442	408	20	0	118	850	1,132	2,100		
18	0	53	40	25	20	415	124	21	0	118	539	1,243	1,900		
19	0	50	40	25	21	407	291	22	0	115	698	1,187	2,000		
20	0	50	40	25	22	414	149	23	0	115	563	1,122	1,800		
21	800	50	727	22	23	0	0	24	799	0	0	801	1,600		
22	750	53	678	25	24	0	0	25	756	0	0	1,544	2,300		
23	650	50	583	25	25	0	0	26	658	0	0	2,242	2,900		
24	450	50	379	25	26	0	82	27	454	0	82	2,264	2,800		
25	220	53	145	25	27	229	0	28	223	0	229	1,948	2,400		
26	150	54	73	25	28	84	43	29	152	0	127	1,721	2,000		
27	0	51	40	25	29	231	0	30	0	116	231	2,053	2,400		
28	0	53	40	25	30	234	0	31	0	118	234	1,848	2,200		
Total	4,333	1,548	4,667	770		9,046	4,998		4,360	2,625	14,044	52,061	73,090		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin
and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1988/89	1	2	3	4		5	6		7	8	9	10	11	12	13
Dec. 29	250	51	176	25	Dec. 31	0	0	Jan. 1	252	0	0	1,648	1,900		
30	230	51	155	25	Jan. 1	0	0	2	231	0	0	1,869	2,100		
31	200	51	127	25	2	0	252	3	203	0	252	1,645	2,100		
Jan. 1	60	51	40	25	3	586	294	4	60	56	880	1,104	2,100		
2	110	56	40	25	4	1,043	238	5	110	11	1,281	1,198	2,600		
3	100	54	40	25	5	838	124	6	100	19	962	1,319	2,400		
4	150	53	79	25	6	611	0	7	157	0	611	1,232	2,000		
5	200	48	127	25	7	273	0	8	200	0	273	1,327	1,800		
6	0	50	40	25	8	0	106	9	0	115	106	1,679	1,900		
7	0	51	40	25	9	329	35	10	0	116	364	1,820	2,300		
8	0	51	40	25	10	280	0	11	0	116	280	1,804	2,200		
9	0	53	40	25	11	241	0	12	0	118	241	1,591	1,950		
10	0	53	37	25	12	219	60	13	0	115	279	1,506	1,900		
11	0	53	32	25	13	238	0	14	0	110	238	1,752	2,100		
12	0	53	34	25	14	0	0	15	0	112	0	1,688	1,800		
13	0	53	32	25	15	0	0	16	0	110	0	1,690	1,800		
14	0	53	32	20	16	271	142	17	0	105	413	1,682	2,200		
15	0	50	15	5	17	294	216	18	0	70	510	1,620	2,200		
16	0	6	8	5	18	228	0	19	0	19	228	1,553	1,800		
17	0	6	8	5	19	246	160	20	0	19	406	1,375	1,800		
18	0	6	8	5	20	236	142	21	0	19	378	1,203	1,600		
19	155	51	80	25	21	0	78	22	156	0	78	1,166	1,400		
20	255	48	178	25	22	0	124	23	251	0	124	1,125	1,500		
21	0	6	8	5	23	472	0	24	0	19	472	1,509	2,000		
22	0	6	8	5	24	463	149	25	0	19	612	1,169	1,800		
23	0	6	8	5	25	467	57	26	0	19	524	1,157	1,700		
24	0	6	8	5	26	708	241	27	0	19	949	1,232	2,200		
25	0	6	9	5	27	717	0	28	0	20	717	1,663	2,400		
26	450	51	373	25	28	0	24	29	449	0	24	1,277	1,750		
27	237	51	159	25	29	177	46	30	235	0	223	1,762	2,220		
28	0	6	8	5	30	704	0	31	0	19	704	1,947	2,670		
Total	2,397	1,190	1,989	570		9,641	2,488		2,404	1,345	12,129	46,312	62,190		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Date 1989	Directed Amount 1	Pepacton 2	Cannonsville 3	Neversink 4	Date	Lake Wallen-paupack 5	Rio Reservoir 6	Date	N.Y.C. reservoirs Directed 7	N.Y.C. reservoirs Other 8	Power-plants 9	Computed uncon-trolled 10	Total 11	Excess Release Credits Daily 12	Excess Release Credits Cumul. 13
Jan. 29	0	6	8	5	Jan. 31	522	0	Feb. 1	0	19	522	1,969	2,510		
30	82	51	25	6	Feb. 1	475	0	2	82	0	475	2,013	2,570		
31	28	15	8	5	2	476	227	3	28	0	703	2,059	2,790		
Feb. 1	0	6	8	5	3	461	160	4	0	19	621	1,750	2,390		
2	0	6	8	5	4	0	0	5	0	19	0	1,721	1,740		
3	0	6	8	5	5	177	126	6	0	19	303	1,648	1,970		
4	0	6	8	5	6	711	159	7	0	19	870	1,561	2,450		
5	0	6	8	5	7	530	0	8	0	19	530	1,451	2,000		
6	0	6	8	5	8	598	184	9	0	19	782	1,299	2,100		
7	0	6	8	5	9	546	53	10	0	19	599	1,382	2,000		
8	0	6	8	5	10	356	0	11	0	19	356	1,375	1,750		
9	0	6	8	5	11	0	0	12	0	19	0	1,181	1,200		
10	0	6	8	5	12	177	0	13	0	19	177	1,104	1,300		
11	0	6	8	5	13	704	0	14	0	19	704	1,277	2,000		
12	0	6	8	5	14	528	124	15	0	19	652	1,329	2,000		
13	0	6	8	5	15	245	485	16	0	19	730	1,851	2,600		
14	0	6	8	5	16	287	131	17	0	19	418	2,063	2,500		
15	0	6	8	5	17	294	0	18	0	19	294	1,987	2,200		
16	0	6	8	5	18	0	0	19	0	19	0	1,481	1,500		
17	0	6	8	5	19	0	11	20	0	19	11	1,270	1,300		
18	0	6	8	5	20	0	252	21	0	19	252	1,749	2,020		
19	0	6	8	5	21	227	606	22	0	19	833	8,598	9,450		
20	0	6	8	5	22	235	472	23	0	19	707	6,984	7,710		
21	0	6	8	5	23	302	486	24	0	19	788	4,463	5,270		
22	0	6	8	5	24	809	358	25	0	19	1,167	3,094	4,280		
23	0	6	8	5	25	0	394	26	0	19	394	2,327	2,740		
24	0	6	8	5	26	0	244	27	0	19	244	2,667	2,930		
25	0	6	8	5	27	474	223	28	0	19	697	2,324	3,040		
Total	110	222	241	141		9,134	4,695		110	494	13,829	63,877	78,310		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases: N.Y.C. reservoirs Directed	Controlled releases: N.Y.C. reservoirs Other	Controlled releases: Power-plants	Computed uncon-trolled	Total	Excess Release Credits Daily	Excess Release Credits Cumul.
Date 1989	Amount 1	2	3	4		5	6		7	8	9	10	11	12	13
Feb. 26		6	8	5	Feb. 28	480	390	Mar. 1		19	870	2,231	3,120		
27		6	8	5	Mar. 1	466	468	2		19	934	1,787	2,740		
28		6	8	5	2	236	673	3		19	909	1,532	2,460		
Mar. 1		6	8	5	3	238	294	4		19	532	1,689	2,240		
2		6	8	5	4	0	206	5		19	206	1,675	1,900		
3		6	8	5	5	0	496	6		19	496	1,745	2,260		
4		6	8	5	6	673	390	7		19	1,063	1,488	2,570		
5		6	8	5	7	1,120	283	8		19	1,403	1,248	2,670		
6		6	8	5	8	1,014	167	9		19	1,181	1,300	2,500		
7		6	8	5	9	408	209	10		19	617	1,414	2,050		
8		6	8	5	10	239	319	11		19	558	1,273	1,850		
9		6	8	5	11	0	0	12		19	0	1,371	1,390		
10		6	8	5	12	23	191	13		19	214	1,287	1,520		
11		6	8	5	13	231	92	14		19	323	1,178	1,520		
12		6	8	5	14	234	0	15		19	234	1,207	1,460		
13		6	8	5	15	0	0	16		19	0	1,441	1,460		
14		6	8	5	16	75	0	17		19	75	2,246	2,340		
15		6	8	5	17	0	167	18		19	167	1,844	2,030		
16		6	8	5	18	0	0	19		19	0	2,121	2,140		
17		6	8	5	19	0	92	20		19	92	2,859	2,970		
18		6	8	5	20	176	379	21		19	555	2,216	2,790		
19		6	8	5	21	0	397	22		19	397	1,974	2,390		
20		6	8	5	22	8	49	23		19	57	1,944	2,020		
21		6	8	5	23	45	344	24		19	389	1,932	2,340		
22		6	8	5	24	0	0	25		19	0	6,511	6,530		
23		6	8	5	25	0	0	26		19	0	9,781	9,800		
24		6	8	5	26	0	273	27		19	273	8,738	9,030		
25		6	8	5	27	0	415	28		19	415	7,586	8,020		
26		6	8	5	28	0	351	29		19	351	7,850	8,220		
27		6	8	5	29	211	592	30		19	803	10,378	11,200		
28		6	8	5	30	190	624	31		19	814	12,667	13,500		
Total	0	186	248	155		6,067	7,861		0	589	13,928	104,513	119,030		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued

(River Master daily operation record)

Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date 1989	Amount								Directed	Other				Daily	Cumul.
	1	2	3	4		5	6		7	8	9	10	11	12	13
Mar. 29		6	8	5	Mar. 31	437	667	Apr. 1		19	1,104	12,977	14,100		
30		6	8	5	Apr. 1	0	592	2		19	592	10,789	11,400		
31		6	8	5	2	0	571	3		19	571	8,660	9,250		
Apr. 1		6	8	5	3	54	560	4		19	614	8,047	8,680		
2		6	8	5	4	0	748	5		19	748	7,923	8,690		
3		6	8	5	5	0	741	6		19	741	8,500	9,260		
4		6	8	5	6	0	706	7		19	706	9,575	10,300		
5		6	8	5	7	0	709	8		19	709	8,672	9,400		
6		6	8	15	8	0	688	9		29	688	7,363	8,080		
7		17	8	15	9	0	688	10		40	688	6,722	7,450		
8		19	8	15	10	0	507	11		42	507	5,891	6,440		
9		19	8	15	11	81	475	12		42	556	5,102	5,700		
10		19	8	15	12	66	454	13		42	520	4,478	5,040		
11		19	8	15	13	0	691	14		42	691	4,237	4,970		
12		19	8	15	14	0	468	15		42	468	3,980	4,490		
13		19	8	15	15	0	592	16		42	592	4,696	5,330		
14		19	8	15	16	0	486	17		42	486	5,432	5,960		
15		19	25	15	17	0	532	18		59	532	4,979	5,570		
16		19	25	15	18	97	571	19		59	668	4,353	5,080		
17		19	25	15	19	0	503	20		59	503	4,028	4,590		
18		19	25	15	20	0	504	21		59	504	3,737	4,300		
19		19	25	15	21	0	521	22		59	521	3,350	3,930		
20		19	25	15	22	0	426	23		59	426	3,115	3,600		
21		19	25	15	23	0	532	24		59	532	2,919	3,510		
22		19	25	15	24	0	567	25		59	567	2,694	3,320		
23		19	25	15	25	0	315	26		59	315	2,546	2,920		
24		19	25	15	26	0	160	27		59	160	2,371	2,590		
25		19	25	15	27	0	160	28		59	160	2,241	2,460		
26		19	25	15	28	0	277	29		59	277	2,094	2,430		
27		19	25	15	29	0	0	30		59	0	2,051	2,110		
Total	0	451	461	370		735	15,411		0	1,282	16,146	163,522	180,950		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1989	1	2	3	4		5	6		7	8	9	10	11	12	13
Apr. 28		19	25	15	Apr. 30	0	160	May 1		59	160	2,061	2,280		
29		19	25	15	May 1	0	287	2		59	287	6,024	6,370		
30		19	25	15	2	0	507	3		59	507	14,534	15,100		
May 1		19	25	15	3	0	567	4		59	567	9,974	10,600		
2		19	25	15	4	0	305	5		59	305	7,556	7,920		
3		19	25	15	5	0	652	6		59	652	26,389	27,100		
4		19	25	15	6	1,074	840	7		59	1,914	40,127	42,100		
5		19	25	17	7	1,794	840	8		61	2,634	24,005	26,700		
6		19	25	17	8	1,829	840	9		61	2,669	15,770	18,500		
7		19	25	17	9	1,840	840	10		61	2,680	13,459	16,200		
8		19	25	17	10	1,834	826	11		61	2,660	26,779	29,500		
9		19	26	15	11	1,829	854	12		60	2,683	24,557	27,300		
10		20	26	15	12	1,845	727	13		61	2,572	17,167	19,800		
11		20	26	15	13	1,845	752	14		61	2,597	12,442	15,100		
12		20	26	15	14	1,848	794	15		61	2,642	10,397	13,100		
13		20	26	15	15	1,840	596	16		61	2,436	9,603	12,100		
14		20	26	15	16	1,840	777	17		61	2,617	20,322	23,000		
15		19	26	15	17	1,845	883	18		60	2,728	19,912	22,700		
16		19	26	15	18	1,856	826	19		60	2,682	13,558	16,300		
17		19	26	15	19	1,858	780	20		60	2,638	10,702	13,400		
18		19	26	15	20	1,853	725	21		60	2,578	9,062	11,700		
19		19	26	15	21	1,850	656	22		60	2,506	7,834	10,400		
20		19	26	15	22	1,124	684	23		60	1,808	6,642	8,510		
21		19	26	17	23	1,438	741	24		62	2,179	6,979	9,220		
22		19	26	46	24	1,448	851	25		91	2,299	6,730	9,120		
23		63	48	45	25	1,448	433	26		156	1,881	5,703	7,740		
24		70	45	45	26	1,437	81	27		160	1,518	5,142	6,820		
25		70	45	46	27	774	0	28		161	774	5,015	5,950		
26		70	45	45	28	0	301	29		160	301	4,549	5,010		
27		70	45	45	29	51	535	30		160	586	4,084	4,830		
28		70	45	45	30	819	269	31		160	1,088	3,572	4,820		
Total	0	893	912	687		37,219	18,929		0	2,492	56,148	390,650	449,290		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.

Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs: Directed, Date 1989	Directed: Amount 1	Pepacton 2	Cannonsville 3	Neversink 4	Controlled releases from power reservoirs: Date	Lake Wallen-paupack 5	Rio Reservoir 6	Delaware River at Montague, Segregation of flow: Date	Controlled releases, N.Y.C. reservoirs: Directed 7	N.Y.C. reservoirs: Other 8	Power-plants 9	Computed uncon-trolled 10	Total 11	Excess Release Credits: Daily 12	Excess Release Credits: Cumul. 13
May 29		70	45	45	May 31	939	291	June 1		160	1,230	3,390	4,780		
30		70	45	45	June 1	1,113	184	2		160	1,297	4,033	5,490		
31		70	45	45	2	734	266	3		160	1,000	3,520	4,680		
June 1		70	176	45	3	0	301	4		291	301	3,058	3,650		
2		71	370	45	4	0	160	5		486	160	2,684	3,330		
3		71	45	45	5	222	475	6		161	697	2,592	3,450		
4		71	45	45	6	0	645	7		161	645	3,374	4,180		
5		71	45	45	7	0	524	8		161	524	3,635	4,320		
6		71	45	45	8	0	599	9		161	599	3,480	4,240		
7		74	45	45	9	411	436	10		164	847	5,239	6,250		
8		71	45	45	10	0	549	11		161	549	6,040	6,750		
9		71	45	45	11	0	479	12		161	479	4,690	5,330		
10		71	45	45	12	243	486	13		161	729	4,040	4,930		
11		71	45	45	13	219	713	14		161	932	4,367	5,460		
12		76	45	45	14	339	528	15		166	867	7,847	8,880		
13		71	45	45	15	359	663	16		161	1,022	13,417	14,600		
14		70	371	45	16	816	684	17		486	1,500	11,814	13,800		
15		70	371	45	17	470	712	18		486	1,182	11,832	13,500		
16		70	374	45	18	464	535	19		489	999	9,412	10,900		
17		68	376	45	19	812	549	20		489	1,361	7,980	9,830		
18		68	374	45	20	706	563	21		487	1,269	6,764	8,520		
19		71	371	45	21	935	567	22		487	1,502	7,141	9,130		
20		71	370	45	22	1,147	595	23		486	1,742	6,432	8,660		
21		70	371	45	23	1,053	723	24		486	1,776	7,668	9,930		
22		70	560	45	24	701	738	25		675	1,439	10,286	12,400		
23		70	704	45	25	1,678	706	26		819	2,384	8,097	11,300		
24		70	705	45	26	1,218	702	27		820	1,920	6,160	8,900		
25		70	704	45	27	1,241	695	28		819	1,936	5,185	7,940		
26		74	707	45	28	1,193	645	29		826	1,838	4,296	6,960		
27		70	370	45	29	1,050	0	30		485	1,050	4,445	5,980		
Total	0	2,122	7,904	1,350		18,063	15,713		0	11,376	33,776	182,918	228,070		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.
Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.

Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 - 24 hours of calendar day shown.
Col 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning June 15, 1989 = 11,418 $(ft^3/s)\cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs: Directed Date 1989	Directed Amount 1	Pepacton 2	Cannonsville 3	Neversink 4	Controlled releases from power reservoirs: Date	Lake Wallenpaupack 5	Rio Reservoir 6	Delaware River at Montague, Segregation of flow: Date	Controlled releases N.Y.C. reservoirs Directed 7	N.Y.C. reservoirs Other 8	Power-plants 9	Computed uncontrolled 10	Total 11	Excess Release Credits Daily 12	Excess Release Credits Cumul. 13
June 28	0	70	370	45	June 30	463	206	July 1	0	485	669	3,016	4,170	0	0
29	0	70	402	45	July 1	0	128	2	0	517	128	2,695	3,340	0	0
30	0	70	370	45	2	0	177	3	0	485	177	2,488	3,150	0	0
July 1	0	70	368	45	3	488	262	4	0	483	750	1,947	3,180	0	0
2	0	70	367	74	4	0	230	5	0	511	230	2,369	3,110	0	0
3	0	101	365	73	5	1,398	335	6	0	539	1,733	5,298	7,570	0	0
4	0	101	367	43	6	693	460	7	0	511	1,153	4,186	5,850	0	0
5	0	70	367	43	7	800	244	8	0	480	1,044	3,206	4,730	0	0
6	0	70	368	43	8	0	32	9	0	481	32	3,487	4,000	0	0
7	0	68	362	43	9	0	202	10	0	473	202	2,825	3,500	0	0
8	0	68	367	43	10	892	404	11	0	478	1,296	2,256	4,030	0	0
9	0	68	367	43	11	819	270	12	0	478	1,089	1,923	3,490	0	0
10	0	68	364	43	12	712	35	13	0	475	747	1,818	3,040	0	0
11	0	68	360	43	13	696	60	14	0	471	756	1,633	2,860	0	0
12	0	68	364	43	14	692	145	15	0	475	837	1,408	2,720	0	0
13	409	68	367	43	15	0	0	16	409	69	0	1,342	1,820	70	70
14	459	68	364	43	16	0	0	17	459	16	0	1,285	1,760	10	80
15	0	68	367	43	17	708	0	18	0	478	708	1,294	2,480	0	80
16	223	68	365	43	18	718	0	19	223	253	718	1,326	2,520	223	303
17	206	68	367	43	19	691	113	20	206	272	804	1,148	2,430	206	509
18	41	68	365	43	20	642	145	21	41	435	787	1,537	2,800	41	550
19	0	68	367	43	21	693	0	22	0	478	693	1,899	3,070	0	550
20	0	68	367	43	22	60	131	23	0	478	191	1,801	2,470	0	550
21	0	68	367	43	23	0	298	24	0	478	298	1,674	2,450	0	550
22	0	68	367	43	24	831	496	25	0	478	1,327	1,315	3,120	0	550
23	0	68	365	68	25	995	394	26	0	501	1,389	1,200	3,090	0	550
24	0	97	435	70	26	935	517	27	0	602	1,452	1,056	3,110	0	550
25	0	119	698	68	27	930	390	28	0	885	1,320	965	3,170	0	550
26	0	119	699	68	28	613	124	29	0	886	737	1,037	2,660	76	626
27	572	119	562	59	29	0	0	30	572	168	0	1,080	1,820	70	696
28	900	101	741	59	30	0	0	31	901	0	0	939	1,840	90	786
Total	2,810	2,403	12,691	1,536		15,469	5,798		2,811	13,819	21,267	61,453	99,350		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.
Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.

Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 - 24 hours of calendar day shown.
Col 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning June 15, 1989 = 11,418 $(ft^3/s)\cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallenpaupack	Rio Reservoir	Date	Controlled releases			Computed uncontrolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Powerplants				
Date	Amount								Directed	Other				Daily	Cumul.
1989	1	2	3	4		5	6		7	8	9	10	11	12	13
July 29	441	67	374	57	July 31	460	0	Aug. 1	441	57	460	1,292	2,250	441	1,227
30	553	67	441	46	Aug. 1	479	0	2	554	0	479	1,057	2,090	339	1,566
31	501	70	388	46	2	480	255	3	504	0	735	981	2,220	467	2,033
Aug. 1	271	70	371	46	3	441	525	4	271	216	966	1,077	2,530	271	2,304
2	488	70	373	67	4	632	184	5	488	22	816	994	2,320	488	2,792
3	828	94	650	88	5	0	11	6	832	0	11	1,007	1,850	100	2,892
4	639	118	529	88	6	3	277	7	639	96	280	1,005	2,020	174	3,066
5	214	150	661	87	7	229	128	8	214	684	357	1,355	2,610	176	3,242
6	92	150	425	68	8	213	142	9	92	551	355	1,222	2,220	100	3,342
7	0	101	351	46	9	219	535	10	0	498	754	1,008	2,260	88	3,430
8	520	70	405	46	10	226	375	11	521	0	601	918	2,040	289	3,719
9	541	70	425	46	11	239	287	12	541	0	526	1,033	2,100	350	4,069
10	965	68	851	46	12	0	0	13	965	0	0	1,095	2,060	310	4,379
11	645	68	531	46	13	0	223	14	645	0	223	1,432	2,300	550	4,929
12	0	71	365	46	14	226	362	15	0	482	588	1,330	2,400	0	4,929
13	0	76	364	46	15	232	414	16	0	486	646	1,128	2,260	76	5,005
14	0	68	365	68	16	608	348	17	0	501	956	1,113	2,570	0	5,005
15	308	99	365	68	17	209	244	18	308	224	453	865	1,850	100	5,105
16	581	99	421	68	18	236	0	19	588	0	236	886	1,710	-40	5,065
17	1,057	99	882	68	19	0	0	20	1,049	0	0	871	1,920	170	5,235
18	907	101	738	68	20	0	149	21	907	0	149	1,034	2,090	340	5,575
19	932	101	758	67	21	0	521	22	926	0	521	983	2,430	680	6.255
20	1,027	99	865	67	22	155	379	23	1,031	0	534	825	2,390	636	6,891
21	1,025	101	859	67	23	492	46	24	1,027	0	538	795	2,360	608	7,499
22	1,071	99	903	67	24	0	0	25	1,069	0	0	711	1,780	30	7,529
23	1,141	97	975	67	25	0	0	26	1,139	0	0	571	1,710	-40	7,489
24	1,151	97	1,012	45	26	0	0	27	1,154	0	0	546	1,700	-50	7,439
25	1,212	67	1,097	45	27	0	0	28	1,209	0	0	491	1,700	-50	7,389
26	1,254	70	1,134	45	28	114	0	29	1,249	0	114	507	1,870	120	7,509
27	1,271	70	1,160	45	29	0	0	30	1,275	0	0	575	1,850	100	7,609
28	1,297	70	1,187	45	30	328	0	31	1,302	0	328	660	2,290	535	8,144
Total	20,932	2,717	20,225	1,815		6,221	5,405		20,940	3,817	11,626	29,367	65,750		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.
Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.

Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
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Col 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning June 15, 1989 = 11,418 $(ft^3/s)\cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Rio Reservoir	Date	Controlled releases			Computed uncon-trolled	Total	Excess Release Credits	
									N.Y.C. reservoirs		Power-plants				
Date	Amount								Directed	Other				Daily	Cumul.
1989	1	2	3	4		5	6		7	8	9	10	11	12	13
Aug. 29	1,330	68	1,214	45	Aug. 31	0	0	Sept. 1	1,327	0	0	503	1,830	80	8,224
30	1,185	68	1,067	45	Sept. 1	0	0	2	1,180	0	0	500	1,680	-70	8,154
31	1,227	68	1,112	45	2	0	0	3	1,225	0	0	455	1,680	-70	8,084
Sept. 1	1,218	68	1,106	45	3	0	0	4	1,219	0	0	401	1,620	-130	7,954
2	1,273	68	1,160	45	4	0	0	5	1,273	0	0	367	1,640	-110	7,844
3	1,295	68	1,174	45	5	44	0	6	1,287	0	44	269	1,600	-150	7,694
4	1,347	68	1,231	45	6	0	0	7	1,344	0	0	256	1,600	-150	7,544
5	1,135	67	1,023	45	7	294	0	8	1,135	0	294	291	1,720	-30	7,514
6	1,144	67	1,032	45	8	280	0	9	1,144	0	280	336	1,760	10	7,524
7	1,531	68	1,414	68	9	0	28	10	1,531	19	28	222	1,800	50	7,574
8	1,539	97	1,372	68	10	263	347	11	1,537	0	610	93	2,240	490	8,064
9	1,196	97	1,027	67	11	768	174	12	1,191	0	942	187	2,320	570	8,634
10	1,107	97	968	45	12	684	39	13	1,110	0	723	197	2,030	277	8,911
11	807	70	690	43	13	681	57	14	803	0	738	309	1,850	100	9,011
12	810	70	699	43	14	699	0	15	812	0	699	289	1,800	50	9,061
13	807	70	690	43	15	627	0	16	803	0	627	520	1,950	200	9,261
14	1,476	70	1,363	43	16	0	0	17	1,476	0	0	624	2,100	350	9,611
15	685	70	572	43	17	0	0	18	685	0	0	825	1,510	-240	9,371
16	0	71	43	43	18	341	0	19	0	157	341	882	1,380	-370	9,001
17	580	73	469	43	19	352	145	20	585	0	497	3,988	5,070	580	9,581
18	307	71	187	43	20	307	713	21	301	0	1,020	5,439	6,760	301	9,882
19	266	74	144	43	21	769	677	22	261	0	1,446	4,623	6,330	261	10,143
20	0	76	42	43	22	585	596	23	0	161	1,181	3,818	5,160	0	10,143
21	0	76	42	43	23	463	627	24	0	161	1,090	3,069	4,320	0	10,143
22	0	70	42	43	24	470	120	25	0	155	590	3,275	4,020	0	10,143
23	0	70	42	43	25	699	535	26	0	155	1,234	3,321	4,710	0	10,143
24	0	70	42	43	26	801	376	27	0	155	1,177	3,558	4,890	0	10,143
25	0	70	42	37	27	484	0	28	0	149	484	2,887	3,520	0	10,143
26	0	70	42	53	28	469	106	29	0	165	575	2,360	3,100	0	10,143
27	0	70	42	43	29	460	0	30	0	155	460	2,095	2,710	0	10,143
Total	22,265	2,180	20,093	1,388		10,540	4,540		22,229	1,432	15,080	45,959	84,700		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.
Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
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Col. 13 - Season limit of cumulative credit beginning June 15, 1989 = 11,418 $(ft^3/s) \cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallenpaupack	Rio Reservoir	Date	Controlled releases: N.Y.C. reservoirs Directed	Controlled releases: N.Y.C. reservoirs Other	Controlled releases: Power-plants	Computed uncon-trolled	Total	Excess Release Credits Daily	Excess Release Credits Cumul.
Date 1989	Amount 1	2	3	4		5	6		7	8	9	10	11	12	13
Sept.28	0	70	42	45	Sept.30	0	0	Oct. 1	0	157	0	1,753	1,910	97	10,240
29	0	70	42	46	Oct. 1	0	113	2	0	158	113	1,729	2,000	8	10,248
30	0	70	42	48	2	321	258	3	0	160	579	2,131	2,870	0	10,248
Oct. 1	0	70	42	45	3	354	124	4	0	157	478	2,325	2,960	0	10,248
2	77	70	42	46	4	284	156	5	77	81	440	1,992	2,590	77	10,325
3	0	70	42	45	5	354	177	6	0	157	531	1,692	2,380	0	10,325
4	0	70	42	43	6	343	0	7	0	155	343	1,582	2,080	0	10,325
5	0	68	42	43	7	0	0	8	0	153	0	1,437	1,590	-160	10,165
6	383	70	274	43	8	0	0	9	387	0	0	1,123	1,510	-240	9,925
7	194	70	79	43	9	402	18	10	192	0	420	1,368	1,980	192	10,117
8	264	70	152	43	10	358	39	11	265	0	397	1,138	1,800	50	10,167
9	306	70	190	43	11	337	273	12	303	0	610	1,167	2,080	303	10,470
10	286	70	170	43	12	348	216	13	283	0	564	1,083	1,930	180	10,650
11	426	68	308	46	13	349	0	14	422	0	349	1,079	1,850	100	10,750
12	937	68	808	43	14	0	0	15	919	0	0	901	1,820	70	10,820
13	631	68	515	43	15	0	273	16	626	0	273	931	1,830	80	10,900
14	307	68	184	43	16	316	492	17	295	0	808	1,267	2,370	295	11,195
15	306	68	192	43	17	362	492	18	303	0	854	1,683	2,840	223	11,418
16	0	68	40	45	18	345	578	19	0	153	923	3,054	4,130		
17	0	68	40	45	19	346	613	20	0	153	959	15,288	16,400		
18	0	68	40	45	20	812	804	21	0	153	1,616	39,831	41,600		
19	0	68	40	45	21	0	840	22	0	153	840	22,007	23,000		
20	0	68	42	46	22	0	801	23	0	156	801	12,643	13,600		
21	0	70	42	46	23	0	882	24	0	158	882	9,160	10,200		
22	0	70	42	46	24	0	790	25	0	158	790	7,282	8,230		
23	0	73	42	48	25	0	450	26	0	163	450	6,077	6,690		
24	0	71	42	48	26	280	450	27	0	161	730	5,419	6,310		
25	0	71	42	46	27	439	468	28	0	159	907	4,564	5,630		
26	0	71	42	43	28	223	535	29	0	156	758	3,966	4,880		
27	0	71	42	45	29	57	649	30	0	158	706	3,616	4,480		
28	0	74	45	43	30	662	592	31	0	162	1,254	3,294	4,710		
Total	4,117	2,159	3,749	1,385		7,292	11,083		4,072	3,221	18,375	162,582	188,250		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.
Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.

Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 - 24 hours of calendar day shown.
Col 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning June 15, 1989 = 11,418 $(ft^3/s)\cdot d$.

Table 16. - Controlled releases for reservoirs in the upper Delaware River basin and segregation of flow of Delaware River at Montague, N.J. - continued
(River Master daily operation record)
Mean discharge in cubic feet per second for 24 hours

Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague Segregation of flow							
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallenpaupack	Rio Reservoir	Date	Controlled releases: N.Y.C. reservoirs		Controlled releases: Power-plants	Computed uncontrolled	Total	Excess Release Credits	
Date	Amount								Directed	Other				Daily	Cumul.
1989	1	2	3	4		5	6		7	8	9	10	11	12	13
Oct. 29		71	42	43	Oct. 31	673	482	Nov. 1		156	1,155	3,969	5,280		
30		71	42	37	Nov. 1	1,158	418	2		150	1,576	4,184	5,910		
31		68	32	25	2	1,432	148	3		125	1,580	3,855	5,560		
Nov. 1		50	34	25	3	1,459	241	4		109	1,700	3,531	5,340		
2		48	34	25	4	1,460	489	5		107	1,949	3,334	5,390		
3		48	34	25	5	1,438	603	6		107	2,041	2,922	5,070		
4		48	34	25	6	1,101	663	7		107	1,764	3,019	4,890		
5		48	34	25	7	1,051	394	8		107	1,445	2,808	4,360		
6		48	34	25	8	1,438	390	9		107	1,828	3,035	4,970		
7		48	34	25	9	1,430	528	10		107	1,958	4,775	6,840		
8		48	34	25	10	845	546	11		107	1,391	5,102	6,600		
9		48	34	25	11	820	124	12		107	944	4,179	5,230		
10		48	34	25	12	356	351	13		107	707	4,016	4,830		
11		48	34	25	13	837	453	14		107	1,290	3,563	4,960		
12		48	34	25	14	845	571	15		107	1,416	3,187	4,710		
13		48	34	25	15	0	596	16		107	596	3,537	4,240		
14		48	34	25	16	0	493	17		107	493	10,000	10,600		
15		48	34	25	17	120	426	18		107	546	8,807	9,460		
16		48	34	25	18	0	500	19		107	500	6,693	7,300		
17		48	36	25	19	0	621	20		109	621	5,490	6,220		
18		50	36	25	20	0	592	21		111	592	5,217	5,920		
19		50	32	25	21	0	624	22		107	624	4,929	5,660		
20		50	36	25	22	0	426	23		111	426	4,273	4,810		
21		50	36	26	23	0	475	24		112	475	3,913	4,500		
22		50	36	26	24	0	426	25		112	426	3,622	4,160		
23		50	36	26	25	0	329	26		112	329	3,549	3,990		
24		50	36	26	26	0	528	27		112	528	3,390	4,030		
25		50	36	26	27	0	326	28		112	326	3,472	3,910		
26		50	36	26	28	0	493	29		112	493	3,385	3,990		
27		50	36	26	29	407	319	30		112	726	3,402	4,240		
Total	0	1,528	1,052	787		16,870	13,575		0	3,367	30,445	129,158	162,970		

Col. 2 - 24 hours beginning 1200 of date shown.
Col. 3 - 24 hours ending 2400 one day later.
Col. 4 - 24 hours beginning 1500 one day later.
Col. 5 - 24 hours beginning 0800 of date shown.
Col. 6 - 24 hours beginning 1600 of date shown.
Col. 7 = Col. 2 + Col. 3 + Col. 4 in response to Col. 1.
Col. 8 = Col. 2 + Col. 3 + Col. 4 - Col. 7.
Col. 9 = Col. 5 + Col. 6.

Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 - 24 hours of calendar day shown.
Col 12 = Col. 11 - Col. 8 - 1,750 ft^3/s computed algebraically, but not greater than Col. 7; except that part of Col. 8 contributing to the excess-release increment of Col. 11.
Col. 13 - Season limit of cumulative credit beginning June 15, 1989 = 11,418 $(ft^3/s) \cdot d$.

Table 17. - Consumption of Water by New York City - 1950 to 1989. Data furnished by New York City, Department of Environmental Protection, Bureau of Water Supply

Year	Average daily consumption			Annual consumption (bg)
	City proper (Mgal/d)	Outside communities (Mgal/d)	Total (Mgal/d)	
1950	953.3	29.1	982.4	358.576
51	1,041.9	28.1	1,070.0	390.550
52	1,087.0	32.7	1,119.7	409.810
53	1,093.9	44.6	1,138.5	415.552
54	1,063.4	46.3	1,109.7	405.040
1955	1,109.9	45.3	1,155.2	421.648
56	1,111.3	48.9	1,160.2	424.633
57	1,169.0	57.2	1,226.2	447.563
58	1,152.9	49.6	1,202.5	438.912
59	1,204.3	60.3	1,264.6	461.579
1960	1,199.4	58.9	1,258.3	460.529
61	1,221.0	64.0	1,285.0	469.022
62	1,207.6	68.8	1,276.4	465.896
63	1,218.0	76.7	1,294.7	472.582
64	1,189.2	79.4	1,268.6	464.295
1965	1,052.1	71.2	1,123.3	409.995
66	1,044.9	73.2	1,118.1	408.128
67	1,135.3	71.0	1,206.3	440.302
68	1,242.0	78.2	1,320.2	483.175
69	1,328.7	80.1	1,408.8	514.229
1970	1,400.3	90.4	1,490.7	544.116
71	1,423.6	87.9	1,511.5	551.695
72	1,412.4	83.0	1,495.4	547.340
73	1,448.9	95.4	1,544.3	563.681
74	1,441.8	96.3	1,538.1	561.409
1975	1,415.0	92.1	1,507.1	550.093
76	1,435.0	95.8	1,530.8	560.264
77	1,483.0	104.7	1,587.7	579.510
78	1,479.4	103.0	1.582.4	577.566
79	1,513.0	104.6	1,617.6	590.426
1980	1,506.3	110.1	1,616.3	591.582
81	1,309.5	100.0	1,409.5	514.475
82	1,383.0	104.8	1,487.8	543.060
83	1,424.2	112.6	1,536.8	561.010
84	1,465.2	113.9	1,579.1	577.963
1985	1,325.4	106.5	1,431.9	522.656
86	1,351.1	115.2	1,466.3	535.200
87	1,447.1	119.8	1,566.9	571.885
88	1,484.3	125.6	1,609.9	589.090
89	1,402.0	113.4	1,515.4	553.158

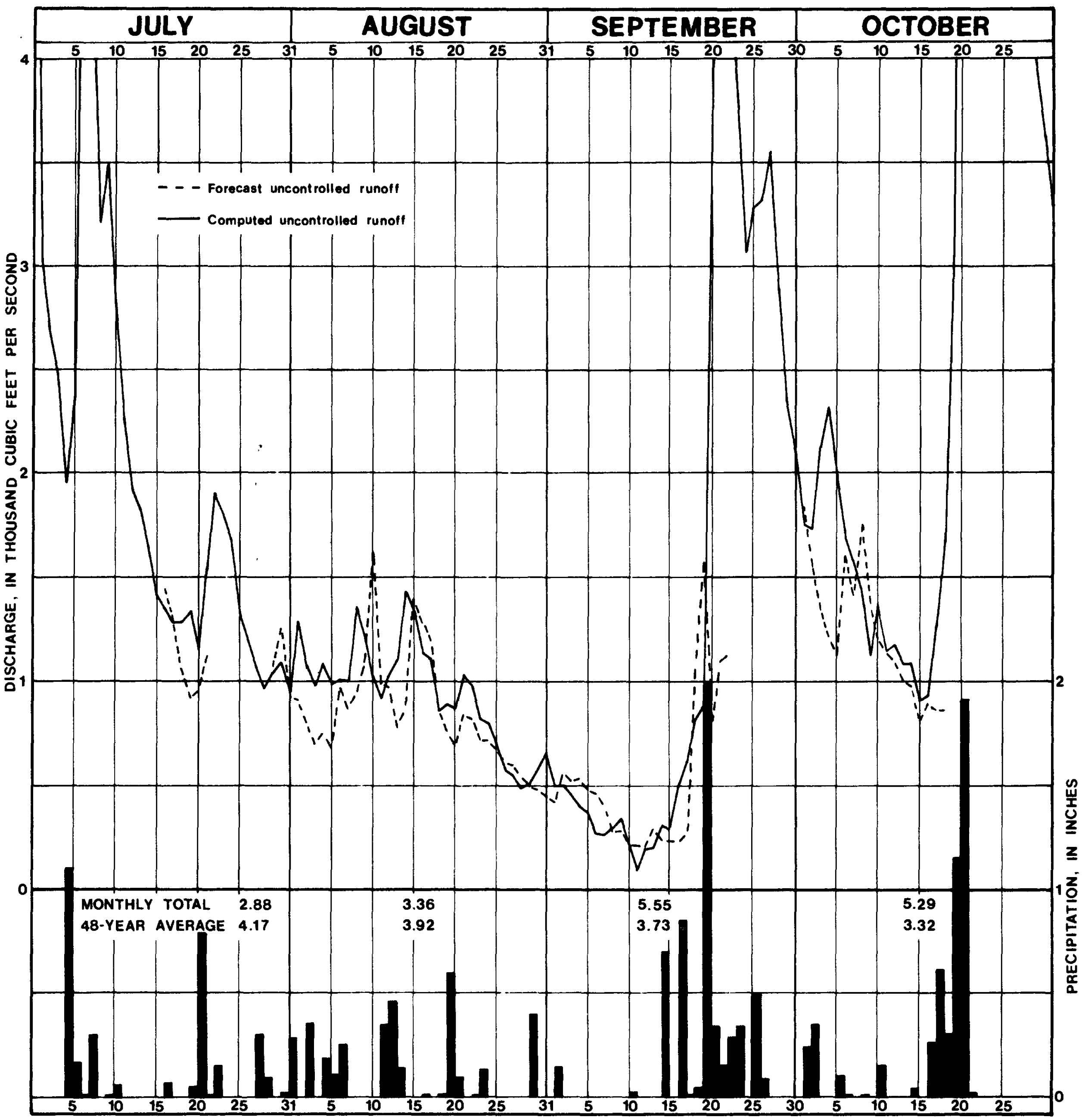

Figure 3. - Uncontrolled runoff component, Delaware River at Montague, N.J., July 1 to October 31, 1989.

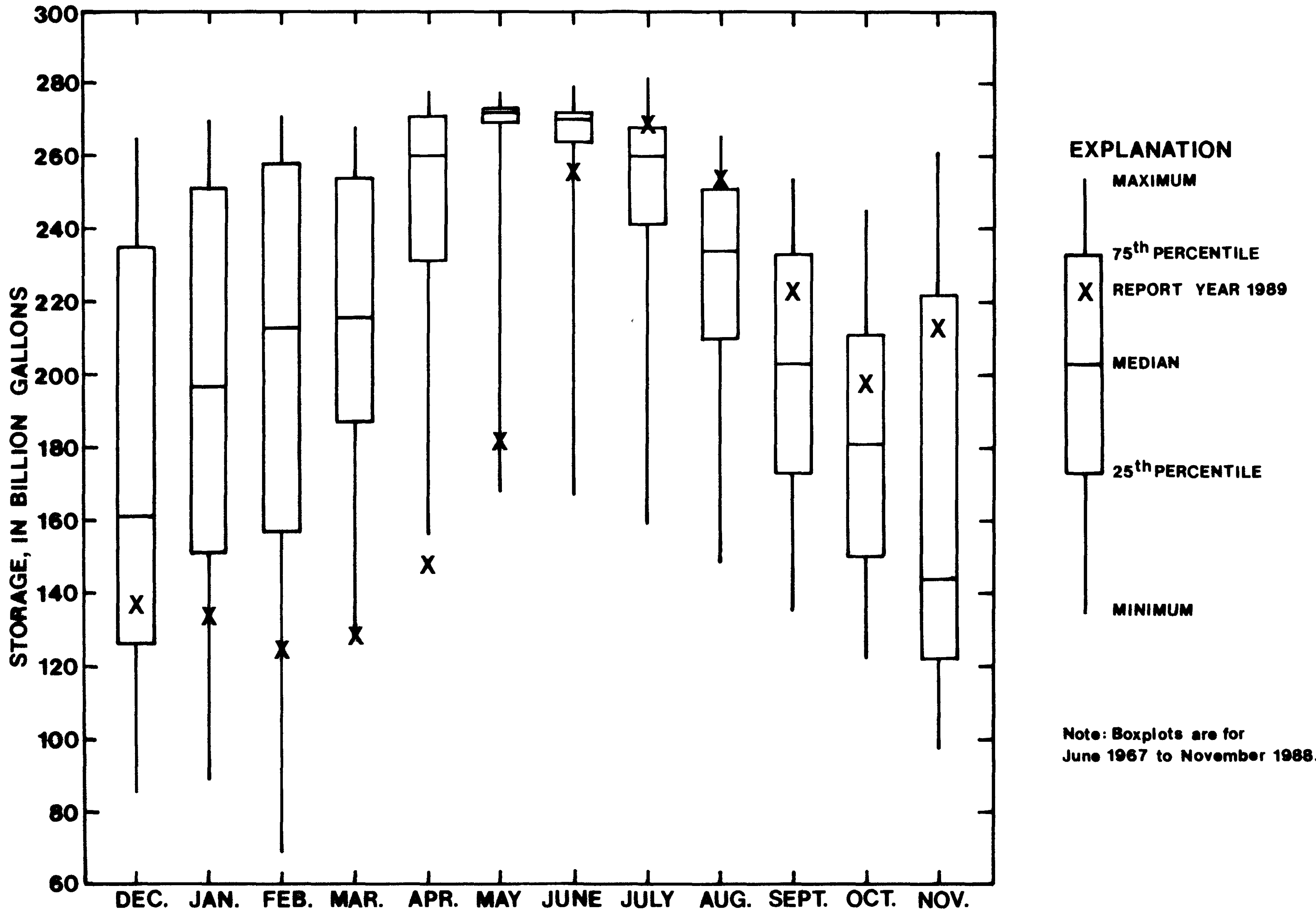

Figure 4. - Combined storage in Pepacton, Cannonsville, and Neversink Reservoirs on the first day of the month, December 1988 to November 1989.

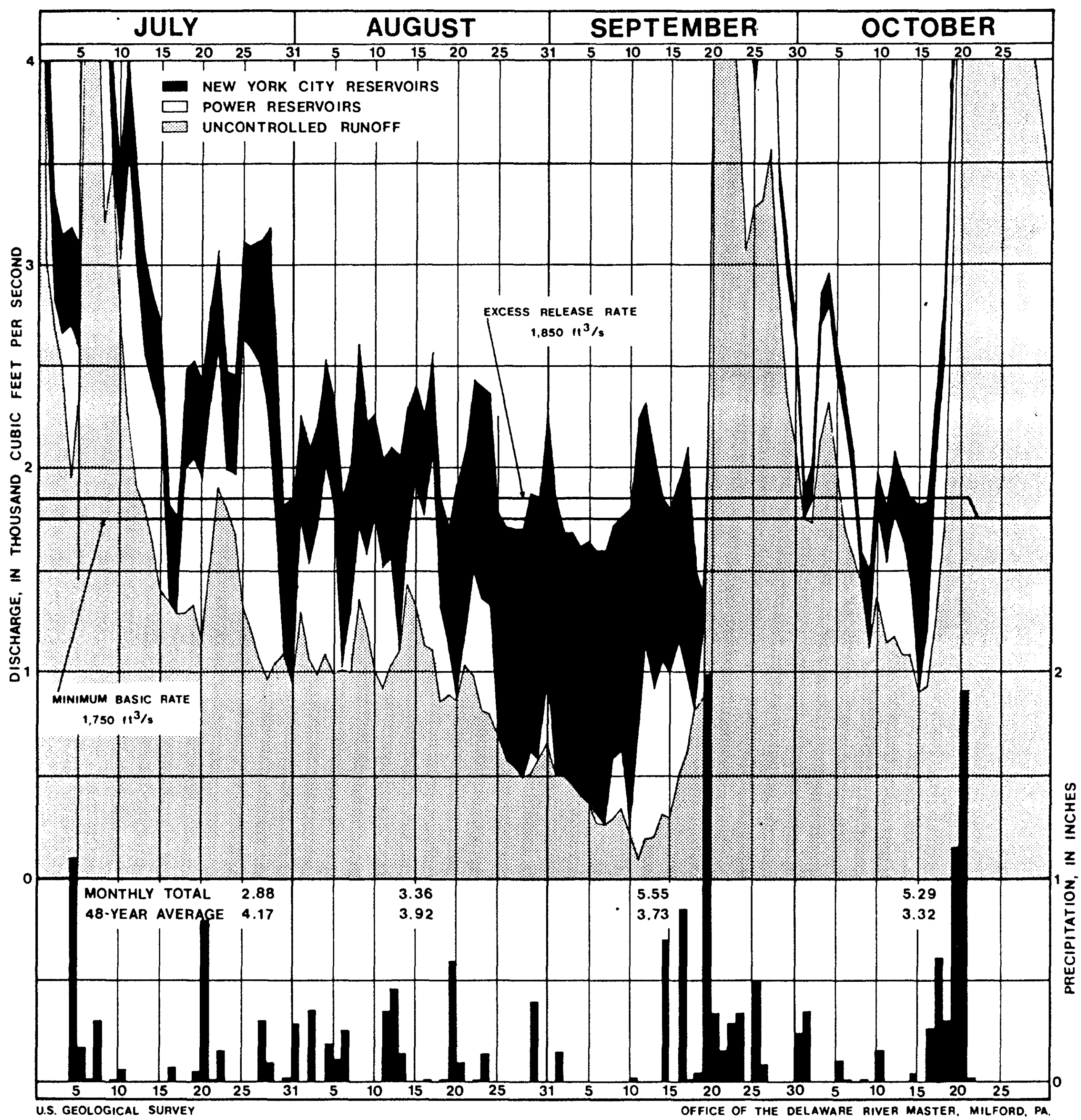

Plate 1. - Components of flow, Delaware River at Montague, N.J., July 1 to October 31, 1989.

(PAGE 77 FOLLOWS)

Section III

WATER QUALITY OF THE DELAWARE RIVER ESTUARY

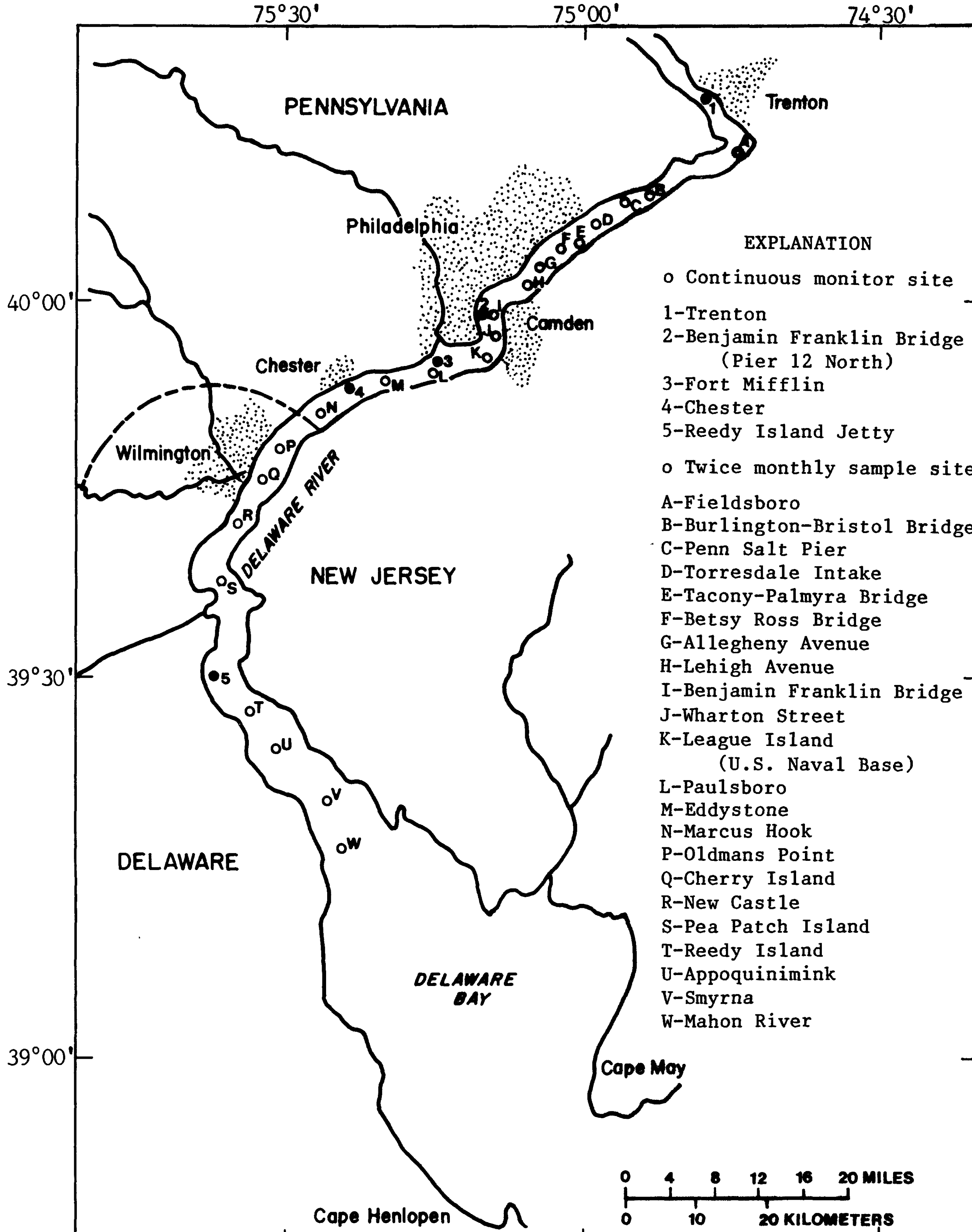

Figure 5.- Delaware River Estuary

Section III

WATER QUALITY OF THE DELAWARE RIVER ESTUARY

By Kirk E. White

INTRODUCTION

This section describes the water-quality monitoring program conducted by the U.S. Geological Survey in the Delaware Estuary during the 1989 report year. Also presented here are some of the data that were obtained by this program and a brief discussion of the significance of the data.

WATER-QUALITY MONITORING PROGRAM

Water quality of the Delaware River and Estuary was monitored between Trenton, N.J., and Reedy Island Jetty, Del.. Data were acquired continuously by electronic instruments at five monitor sites, one at Trenton, just upstream of the head of tidewater and at four sites in the estuary (fig. 5). The monitors at Chester, Pa., Fort Mifflin, Pa. and Benjamin Franklin Bridge were not operated from early December 1988 through the end of February 1989. At Fort Mifflin the water was monitored for two parameters: temperature and specific conductance. At the remaining sites, the water was monitored for four parameters: temperature, specific conductance, dissolved oxygen, and pH.

Additional data were obtained twice a month from March to November at 23 sites between Fieldsboro, N.J., and the mouth of the Mahon River (see fig. 5). At each of these sites, samples of water were collected at the center of the river channel. These samples were analyzed for temperature, chloride, alkalinity, biochemical oxygen demand, specific conductance, dissolved oxygen, and pH.

Data obtained from the continuous monitoring sites were processed by computer and stored for future reference by the U.S. Geological Survey. They were also distributed regularly to cooperators and published annually by the U.S. Geological Survey in "Water Resources Data for Pennsylvania, Volume 1, Delaware River Basin." Data from the twice a month sites were collected by the state of Delaware for the Delaware River Basin Commission (DRBC) at 18 sites and for the City of Philadelphia Water Department at 5 additional sites. These data are available from the DRBC or from STORET.

The above-described programs were carried out in cooperation with the City of Philadelphia Water Department, Delaware River Basin Commission, Delaware River Master, and other agencies of federal, state, and county governments.

ESTUARINE WATER-QUALITY DATA DURING 1989

The following is a summary and discussion of the data that were collected during the 1989 report year.

Streamflow

Streamflow is a vital factor which influences the water quality of the estuary. Increased streamflow usually results in better water quality by limiting salt-water intrusion and diluting the concentration of dissolved minerals, both of which contribute to a lower specific conductance and chloride level. Increased flow also aids in maintaining lower water temperature during warm weather and supporting higher dissolved-oxygen levels.

On the basis of the streamflow records for the Delaware River at Trenton, mean monthly streamflow was lowest for the year during January (5,167 ft^3/s) and highest for the year during May (31,690 ft^3/s). (See table 9). The monthly mean streamflow was above the respective median for the period of record April, May, June, September, October, and November, and below the median for the remainder of the year.

Temperature

The significance of water temperature in regard to water quality in the estuary lies in its profound influence on various physical, chemical, and biological properties of the water. In general, increases in water temperature have deleterious effects on water quality by lowering the saturation level of dissolved oxygen and increasing biological activities.

The primary factors involved in controlling water temperature in the estuary are climatic; however, various uses of the water by man can also have significant effects.

Based on records from Benjamin Franklin Bridge (Pier 12 North) Philadelphia, Pa., mean monthly temperatures for the period June to November 1989 were below normal from June through October and exceeded the norm during November. The norm is based on historical temperature records from 1962 to 1988 (see fig. 6). Temperature data for the period March through June 9 are not available, due to suspension of the monitoring station.

Specific Conductance and Chloride

Specific conductance is the ability of a solution to conduct electricity. Basically, it can be used to measure the amount of ionized material in solution and relates approximately to dissolved-solids content.

Specific conductance values in bodies of water usually reflect the geochemistry of the drainage basin; however, pollution and the intrusion of oceanic salts can also have considerable effects. Increasing streamflows reduce the concentration of dissolved solids, thus lowering specific conductance and chloride levels. Conversely, decreasing flows have the opposite effects.

In the Delaware Estuary, the intrusion of oceanic salts is important to those who must use the estuary as a water supply. For this reason, chloride concentration is of great interest. Water with chloride concentrations in excess of 250 mg/L (milligrams per liter) is usually considered undesirable for domestic use and water with concentrations in excess of 50 mg/L is unsatisfactory for some industrial uses.

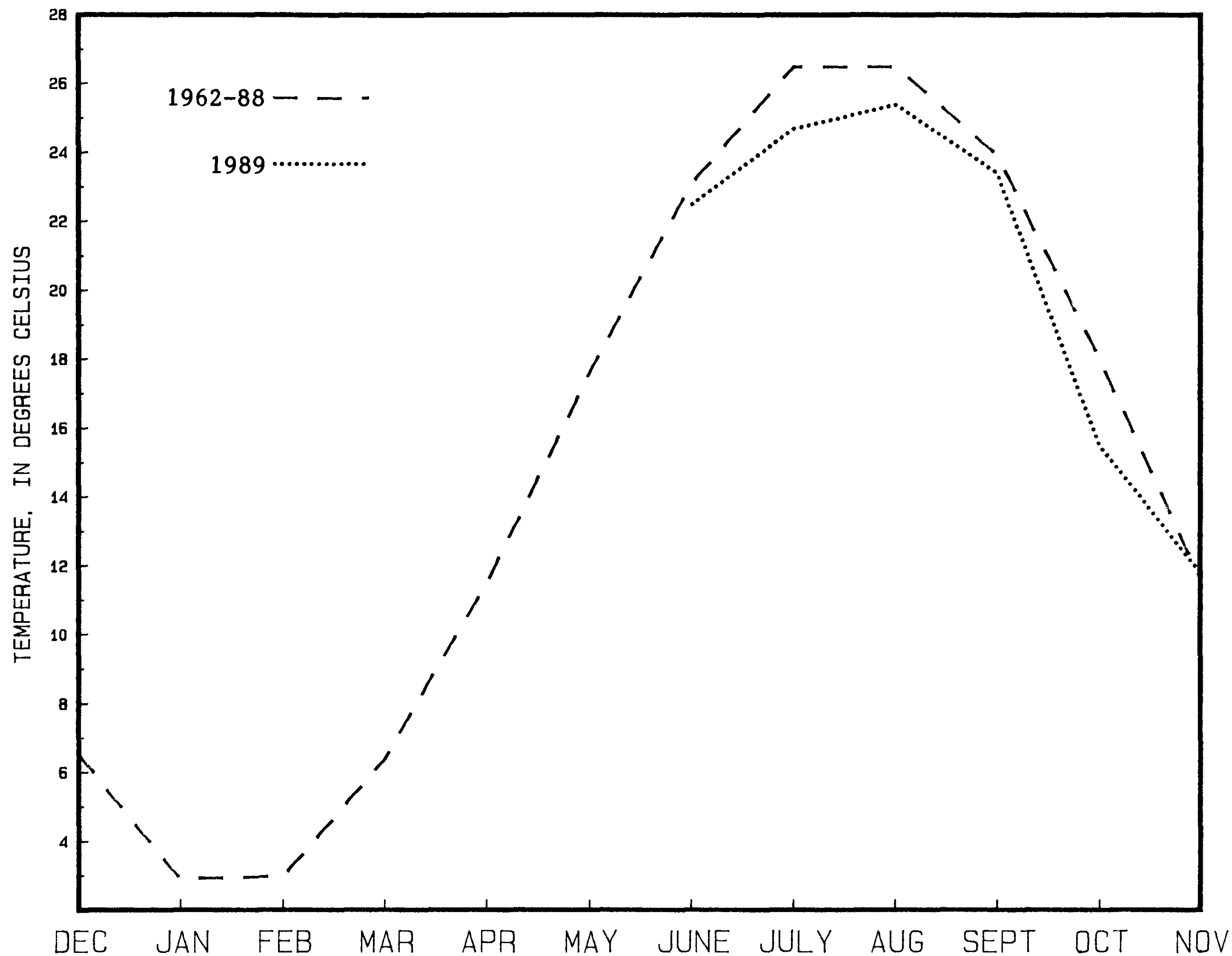

Figure 6. - Mean monthly temperatures of the Delaware River at Benjamin Franklin Bridge, Philadelphia, Pennsylvania.

As sea water has a chloride concentration of approximately 19,000 mg/L, the location of a body of water in relation to the sea can influence chloride levels in that body of water. For this reason, chloride concentrations in the Delaware Estuary generally increase with distance downstream toward the Delaware Bay and Atlantic Ocean.

Chloride concentration was not measured directly at Fort Mifflin, Pa., and Reedy Island Jetty, Del., but a correlation between specific conductance and chloride concentration has been developed based on analyses of water samples taken in the estuary. Chloride concentrations at those sites presented in tables 18 and 20 were estimated from that relationship. The relationship is less reliable when chloride concentrations are lower than 30 mg/L because other ionized materials may be present in amounts large enough to affect the conductance-chloride relationship. Therefore, chloride concentrations derived from specific conductance are not given when the relationship indicates chloride concentrations of less than 30 mg/L. Chloride concentrations at Chester, Pa. were furnished by Scott Paper Company (see table 19).

At Fort Mifflin, the maximum daily chloride concentration equaled or exceeded 50 mg/L, 6 percent of the time (see table 18). The maximum was 100 mg/L on April 27. At Chester, the minimum daily chloride concentration equaled or exceeded 50 mg/L, 9 percent of the time and the maximum daily concentration was greater than 50 mg/L, 24 percent of the time (See table 19). The maximum daily chloride concentration was 126 mg/L on September 16 and 18. Minimum chloride con-centrations at Reedy Island Jetty were below 250 mg/L on April 12, May 7 through June 2, June 11 and 12, June 22 through July 2, July 5 through 11, and November 21 (see table 20). During the year, maximum chloride concentrations typically ranged from 2,000 to 6,000 mg/L. One notable exception is May 8 through 27, when spring storms resulted in a drop of the maximum daily chloride concentrations to a range of 30 to 780 mg/L (see table 20). The maximum at this site was 9,000 mg/L on December 6.

Dissolved Oxygen

Dissolved oxygen is necessary in water for the respiration of aquatic organisms. It also plays a significant role in chemical reactions in aquatic environments. The major sources of dissolved oxygen in water are diffusion from the air and photosynthesis in aquatic plants. Dissolved-oxygen levels are limited by temperature, salinity, and the partial pressure of atmospheric oxygen.

Dissolved-oxygen levels in the estuary tend to be highest near Trenton and to decrease with distance downstream to a point near or somewhat downstream from the Benjamin Franklin Bridge where minimum values are usually reached. The monitor at this site was suspended at Pier 11 North on July 29, 1988 and was installed at Pier 12 North on June 9, 1989.

Table 18.- Daily maximum and minimum chloride concentrations, Delaware River at Fort Mifflin, Pa., in milligrams per liter December 1, 1988 to November 30, 1989

[A dash (-) indicates missing data; * indicates less than 30 mg/L (milligrams per liter); max is maximum value; min is minimum value]

Day	December		January		February		March		April		May		June		July		August		September		October		November	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1							38	30	33	*	38	*	*	*	*	*	30	*	-	-	*	*	*	*
2							38	30	31	*	43	*	30	*	*	*	*	*	-	-	*	*	*	*
3							37	*	*	*	40	*	*	*	*	*	*	*	-	-	33	*	*	*
4							42	*	*	*	40	*	*	*	*	*	*	*	-	-	32	*	31	*
5							39	30	33	*	36	*	*	*	30	*	*	*	-	-	31	*	*	*
6							40	30	33	*	40	*	*	*	*	*	*	*	-	-	*	*	-	-
7							43	30	34	*	*	*	36	*	*	*	35	*	-	-	31	*	-	-
8							44	32	31	*	*	*	35	*	*	*	40	*	-	-	*	*	*	*
9							46	32	31	*	*	*	*	*	*	*	38	*	-	-	30	*	35	*
10							48	33	32	*	*	*	*	*	*	*	36	*	-	-	*	*	31	*
11							47	31	32	*	*	*	*	*	*	*	41	*	-	-	33	*	31	*
12							68	33	31	*	*	*	*	*	*	*	48	*	42	32	*	*	39	*
13							56	34	33	*	*	*	*	*	30	*	35	*	40	33	31	*	*	*
14							54	32	35	*	*	*	*	*	30	*	31	*	42	33	*	*	-	-
15							64	36	35	*	*	*	*	*	*	*	*	*	61	34	30	*	*	*
16							66	35	40	*	*	*	*	*	*	*	*	*	44	34	*	*	33	*
17							53	35	38	*	*	*	*	*	*	*	*	*	58	34	*	*	45	*
18							51	35	35	*	*	*	*	*	*	*	*	*	55	34	38	*	43	*
19							-	-	35	*	*	*	*	*	*	*	*	*	56	34	63	*	30	*
20							47	35	35	*	*	*	*	*	*	*	*	*	56	*	62	*	*	*
21							46	35	31	*	*	*	*	*	*	*	-	-	*	*	*	*	*	*
22							50	36	*	*	*	*	*	*	*	*	-	-	*	*	*	*	*	*
23							44	36	*	*	*	*	*	*	*	*	-	-	*	*	*	*	*	*
24							42	35	*	*	*	*	*	*	*	*	-	-	*	*	*	*	*	*
25							41	32	*	*	*	*	*	*	*	*	-	-	*	*	*	*	*	*
26							37	*	30	*	*	*	*	*	30	*	-	-	33	*	*	*	*	*
27							32	*	100	*	*	*	*	*	32	*	-	-	*	*	*	*	*	*
28							31	*	36	*	*	*	*	*	30	*	-	-	*	*	-	-	31	*
29							33	*	35	*	*	*	*	*	*	*	-	-	*	*	-	-	33	*
30							31	*	38	*	*	*	*	*	*	*	-	-	*	*	*	*	*	*
31							32	*			*	*			33	*	-	-			*	*		

Table 19.- Daily maximum and minimum chloride concentrations, Delaware River at Chester, Pa., in milligrams per liter December 1, 1988, to November 30, 1989. Collection and analysis by Scott Paper Company.
[A dash (-) indicates missing data; * indicates less than 30 mg/L (milligrams per liter); max is maximum value; min is minimum value]

Day	December		January		February		March		April		May		June		July		August		September		October		November	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	-	-	43	40	59	47	48	42	48	40	42	33	36	32	34	*	40	30	48	45	45	*	43	*
2	34	*	48	37	55	48	47	43	46	35	42	33	36	*	33	*	44	31	50	45	32	*	38	*
3	40	*	50	37	55	45	45	42	42	35	38	32	34	*	36	*	44	33	48	45	34	*	*	-
4	38	*	46	42	50	46	50	43	38	32	40	35	38	*	34	*	44	33	48	46	38	32	30	*
5	36	*	45	40	56	49	48	43	40	34	45	36	32	*	30	*	38	34	56	47	35	*	*	*
6	35	*	55	40	53	48	48	41	38	30	40	36	34	*	30	*	40	32	57	50	34	*	36	*
7	52	30	55	40	56	48	48	45	42	33	36	34	31	*	*	*	45	32	61	56	37	*	42	*
8	44	30	58	49	54	52	54	46	38	35	35	*	31	*	*	*	43	31	63	50	30	*	32	*
9	34	*	58	47	52	46	54	50	40	31	*	*	34	*	30	*	39	35	58	45	31	*	40	*
10	35	*	55	48	52	47	66	50	38	30	*	*	40	*	30	*	50	34	60	46	35	30	*	*
11	33	*	60	47	53	47	58	53	36	*	*	*	31	*	34	*	39	36	70	56	35	30	30	*
12	36	*	60	47	53	48	54	52	38	30	34	*	37	*	32	*	42	36	70	58	36	30	34	*
13	35	*	55	48	61	51	60	52	38	*	*	*	36	30	33	*	42	38	78	55	36	32	34	30
14	41	*	57	46	55	50	60	54	35	30	*	*	32	*	35	*	42	38	90	55	35	*	33	30
15	36	30	54	49	54	48	57	54	37	31	32	*	33	*	35	*	48	41	115	54	42	32	32	*
16	34	31	55	46	53	49	58	50	38	30	*	*	*	*	34	*	50	38	126	57	38	32	30	*
17	37	30	55	47	54	50	60	53	38	32	*	*	36	*	35	*	45	40	95	55	38	30	32	*
18	40	34	51	47	57	50	52	48	37	34	*	*	30	*	35	*	44	38	126	59	38	34	32	*
19	40	*	49	45	54	50	56	51	36	30	*	*	32	*	36	*	42	39	77	58	38	33	-	32
20	40	34	54	48	61	50	58	53	36	30	*	*	30	*	36	*	41	38	62	40	50	36	41	30
21	40	34	51	44	57	52	56	50	37	*	34	*	30	*	31	*	42	40	42	38	42	38	38	*
22	39	32	49	44	58	47	56	51	32	30	*	*	33	*	36	*	42	38	50	36	54	*	34	*
23	42	40	53	46	52	47	54	50	36	30	*	*	33	*	36	*	46	38	46	35	36	*	34	*
24	42	36	54	48	55	45	51	47	36	*	32	*	30	*	35	*	45	37	46	30	42	*	37	*
25	43	38	52	46	48	43	50	48	38	30	*	*	34	*	34	*	44	37	44	38	32	*	42	33
26	44	36	59	48	50	43	54	47	40	32	32	*	34	*	33	*	43	35	42	*	*	*	39	33
27	48	37	52	45	48	41	55	47	40	32	34	*	*	*	43	30	46	38	46	*	*	*	46	32
28	45	40	58	46	48	42	48	46	40	35	34	*	30	*	40	34	46	39	40	*	34	*	45	34
29	46	38	49	46			56	45	44	30	35	32	30	*	36	30	52	40	31	*	*	*	43	32
30	44	38	54	48			48	44	40	31	31	31	32	*	36	31	52	45	30	*	34	*	38	30
31	40	38	50	46			52	40			32	*			33	32	52	43			36	*		

Table 20.- Daily maximum and minimum chloride concentrations, Delaware River at Reedy Island Jetty, Del., in milligrams per liter
December 1, 1988 to November 30, 1989

[A dash(-) indicates missing data; * indicates less than 30 mg/L (milligrams per liter; max is maximum value; min is minimum value]

Day	December		January		February		March		April		May		June		July		August		September		October		November	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	3000	730	4300	2000	5100	1900	5700	2400	3000	1000	-	-	2200	160	2500	130	3300	910	-	-	-	-	-	-
2	3400	750	5900	2400	4700	1900	5000	2100	3400	750	-	-	1900	210	2300	210	3700	1000	-	-	-	-	-	-
3	4100	770	5600	2300	-	-	5700	2400	3200	850	-	-	2100	250	2500	270	3300	1100	-	-	-	-	-	-
4	3600	920	6300	2700	-	-	6900	3100	2700	760	2300	600	2100	300	2400	320	3500	1100	-	-	-	-	-	-
5	4700	1400	7100	2800	-	-	6800	3200	1700	640	2600	560	2100	350	2300	240	3600	1200	4900	-	-	-	-	-
6	9000	1700	7100	3500	-	-	-	3500	1800	460	2500	500	2200	420	750	140	3300	1200	4600	2500	-	-	-	-
7	4900	780	7400	3800	-	-	6700	3700	2300	430	1300	170	1800	420	560	130	3200	1300	-	-	-	-	2900	710
8	5000	1800	7600	3900	-	-	6700	3600	1800	410	330	95	1800	350	660	120	4100	1300	-	-	-	-	3000	680
9	5400	1900	5800	3400	-	-	7300	3700	1600	370	740	74	1100	350	1200	120	4200	1400	-	-	-	-	2900	780
10	5200	2200	5900	3400	-	-	7300	3800	1000	300	120	62	830	260	1600	150	3800	1500	-	-	-	-	2900	770
11	4100	2100	5000	3200	-	-	7500	3500	1300	250	95	40	1300	160	2000	170	5000	2000	-	-	-	-	2200	580
12	4800	2000	5400	3100	-	-	6600	3800	1300	230	43	*	2100	190	3000	310	5600	2400	-	-	5100	2000	1200	410
13	5700	2300	5400	2800	-	-	6500	3400	1300	280	35	*	2800	400	3300	650	6000	2300	6200	-	4300	2000	1900	400
14	6200	2300	4800	2800	4100	2400	6600	3400	1200	250	30	*	3800	480	3800	770	5900	1900	5800	2900	-	-	2200	370
15	5400	2700	5500	2800	5300	2500	6100	3300	1300	300	30	*	3400	590	4200	910	5600	2000	6100	3000	-	-	1900	430
16	5200	2200	4900	2600	5000	2500	5100	3100	2000	310	340	*	2500	710	4200	1100	5300	2200	5900	3200	-	-	2200	560
17	5400	2200	5200	2500	5000	2100	5400	3200	2200	-	780	*	1800	520	4400	1100	5300	2000	6300	3200	-	-	1300	420
18	5800	2700	4600	2300	5200	2300	-	-	2300	360	490	*	1600	320	4900	1100	5100	2100	5800	3100	-	-	710	330
19	6300	2700	5300	2100	5300	2600	-	-	2400	440	65	*	1900	280	4300	1300	5100	2200	6000	3200	-	-	1300	280
20	5300	780	5400	2300	5200	2500	-	-	2700	410	170	*	1700	260	3800	1100	5000	2200	5700	2600	-	-	920	280
21	4800	2100	2900	550	5300	2400	-	-	2500	490	140	*	1600	260	3100	900	4700	2200	3600	1500	-	-	660	120
22	4900	2100	4800	1800	3900	2100	-	-	2700	530	230	*	1200	240	-	-	4800	2200	3700	1400	-	-	3500	370
23	5900	2300	4700	1800	3600	2000	-	-	2900	550	490	31	900	220	-	-	4900	2200	2500	1400	-	-	4800	1600
24	5400	2600	5100	1900	4500	900	-	-	2500	520	620	31	730	150	-	-	5000	2200	2800	920	-	-	5600	2000
25	4700	2500	4800	2300	6200	2100	-	-	2900	530	640	30	410	130	-	-	5200	2200	3000	950	-	-	5700	2000
26	4100	2000	5000	2300	6200	2300	-	-	2900	640	650	30	660	140	-	-	4800	2300	2600	1100	1500	300	4700	1500
27	4800	740	4100	2200	4800	1900	-	-	3000	630	520	33	700	110	-	-	5200	2200	-	-	1800	360	5400	1900
28	4400	2100	4600	2100	4600	2000	2600	2600	3000	750	1000	35	900	95	-	-	-	-	-	-	2200	370	5500	2300
29	3000	1600	4400	1900			3300	1200	-	-	1800	40	1500	84	-	-	-	-	-	-	2300	410	4000	1500
30	4100	1600	4600	1700			3200	1200	-	-	1400	77	2200	100	-	-	-	-	-	-	1500	480	4400	1500
31	4300	1900	5200	2300			4300	1200			1900	84			2800	940	-	-			-	-		

During the period June 9 through November 25, 1989 daily mean dissolved-oxygen concentration at the Benjamin Franklin Bridge was below 5 mg/L from June 10 through 18, June 22 through August 25, September 5 through 21, and October 15 through 19 (see table 21). The minimum daily mean was 2.1 mg/L on August 3 and 4 and September 18. At Chester, the daily mean dissolved-oxygen concentration was below 5 mg/L from June 13 through 16, June 20, June 25 through July 4, July 6 through 31, August 3, and September 14, 15, 21, and 22 (see table 22). The lowest daily mean was 3.8 mg/L on July 24 through 26. The minimum hourly value was 3.6 mg/L on July 24 through 26. At Reedy Island Jetty, the minimum hourly value was 4.1 mg/L on August 27.

Figure 7 shows the frequency of hourly dissolved-oxygen concentration at Benjamin Franklin Bridge and Chester during the critical summer period, July through September, 1989. Dissolved-oxygen concentration was equal to or below 4 mg/L, 8 percent of the time at Chester in 1989, as compared with 40 percent of the time in 1988. At Benjamin Franklin Bridge the dissolved-oxygen concentration was equal to or below 4 mg/L, 70 percent of the time.

Hydrogen-Ion Concentration (pH)

Hydrogen-ion concentration (pH) is fundamentally a measure of acidity or alkalinity. Values of pH below 7 indicate acidity, whereas values above 7 indicate alkalinity. In natural waters, pH generally ranges from 6.0 to 8.5. The main factors controlling the pH of a body of water are usually the geochemistry of the drainage basin and external influences such as pollution. Photosynthetic activity can also have a considerable influence on pH values. Increased photosynthetic activity (algal bloom) produces higher pH values. All pH values at Benjamin Franklin Bridge, Chester, and Reedy Island Jetty were in a range of 6.4 to 8.5. The pH range for each station is: Reedy Island Jetty, 6.4 to 8.5; Chester, 6.4 to 7.5; Benjamin Franklin Bridge, 6.5 to 7.4. The pH in the estuary tends to be lowest near Trenton, N.J., and to increase downstream.

Table 21 .- Dissolved oxygen, Delaware River at Benjamin Franklin Bridge at Philadelphia, Pa.
Daily mean dissolved oxygen in milligrams per liter
December 1, 1988 to November 30, 1989
[The monitor was installed June 9, 1989; a dash (-) indicates missing data]

Day	December	January	February	March	April	May	June	July	August	September	October	November
1								4.3	2.3	6.0	5.3	7.3
2								4.1	2.2	5.9	5.1	7.3
3								3.9	2.1	5.5	5.1	7.2
4								3.7	2.1	5.2	5.4	7.2
5								3.8	2.3	4.9	5.6	7.0
6								3.6	2.5	4.5	5.5	6.9
7								3.7	2.6	4.0	5.4	6.7
8								3.6	2.7	3.6	5.5	6.6
9								3.5	3.0	3.2	5.4	6.5
10							3.7	3.4	3.1	2.9	5.4	6.7
11							4.5	3.4	3.2	2.7	5.4	7.2
12							4.4	3.2	3.2	2.7	5.2	7.5
13							4.3	3.1	2.9	2.6	5.3	7.6
14							4.3	3.0	2.9	2.5	5.2	-
15							4.2	2.8	2.9	2.3	4.9	-
16							4.2	2.8	2.7	2.5	4.7	7.2
17							4.6	2.8	2.6	2.3	4.6	7.4
18							4.9	2.5	2.9	2.1	4.5	7.6
19							5.1	2.4	3.1	2.3	4.9	8.0
20							5.2	2.3	3.1	2.7	5.4	8.0
21							5.1	2.3	3.3	3.2	6.8	-
22							4.9	-	3.6	-	7.7	8.6
23							4.8	-	3.7	5.0	7.9	8.5
24							4.7	-	4.1	5.4	7.9	8.6
25							4.6	-	4.7	5.2	7.9	8.7
26							4.5	-	5.1	5.0	7.8	-
27							4.3	-	5.7	5.1	7.7	-
28							4.1	-	6.0	5.1	7.7	-
29							-	-	6.1	5.3	7.6	-
30							-	-	6.0	5.5	7.5	-
31								-	5.7		7.4	

Table 22.- Dissolved oxygen, Delaware River at Chester, Pa.
Daily mean dissolved oxygen in milligrams per liter
December 1, 1988, to November 30, 1989
[Monitor was not in operation December 2, 1988 to February 28, 1989; a dash (-) indicates missing data.]

Day	December	January	February	March	April	May	June	July	August	September	October	November
1	9.1			9.1	8.8	8.2	6.7	4.7	5.3	6.9	5.8	8.3
2				9.1	8.8	8.1	6.5	4.8	5.1	6.8	6.1	8.3
3				9.1	8.6	8.1	6.6	4.8	4.9	6.4	5.8	8.2
4				9.2	8.4	7.9	6.7	4.7	-	6.4	6.0	8.4
5				9.1	8.3	7.5	6.9	5.3	-	6.6	6.5	8.4
6				9.0	8.0	7.8	7.0	4.9	-	6.3	6.8	8.4
7				9.1	7.9	7.8	6.6	4.4	-	6.1	6.8	8.3
8				9.8	7.9	8.3	6.0	4.2	-	6.0	6.7	8.0
9				10.2	7.9	8.5	5.4	4.2	-	5.8	6.7	7.9
10				10.2	7.9	8.9	5.3	4.5	-	5.8	7.0	8.0
11				10.1	7.8	9.6	5.4	4.7	-	5.5	7.1	8.3
12				9.9	7.6	9.9	5.0	4.5	7.7	5.2	7.0	8.5
13				9.9	7.4	9.9	4.8	4.5	10.2	5.1	6.9	8.3
14				9.7	7.6	9.8	4.7	4.3	6.3	4.9	6.6	8.0
15				9.6	7.9	9.7	4.8	4.0	5.7	4.8	6.4	7.8
16				9.5	8.2	9.5	4.9	4.2	5.5	5.2	6.3	8.0
17			9.0	9.4	8.3	9.5	5.3	4.8	5.3	5.3	6.3	8.6
18			8.9	9.4	8.3	9.4	5.2	4.4	5.4	5.1	6.3	8.9
19			8.9	9.3	8.3	9.4	5.0	4.2	6.0	5.7	7.3	9.1
20			8.8	9.1	8.3	9.0	4.9	4.6	6.3	5.5	7.8	9.4
21			8.8	9.1	8.4	8.5	5.0	4.6	6.7	4.5	7.6	9.9
22			8.6	8.9	8.7	8.2	5.0	4.5	7.2	4.6	8.4	9.9
23			8.6	8.8	8.9	7.9	5.1	4.0	-	6.0	8.9	9.9
24			8.8	9.3	9.0	7.7	5.0	3.8	-	6.0	9.0	10.1
25			9.0	9.3	8.9	7.4	4.9	3.8	-	5.9	9.0	10.3
26			9.0	9.1	8.8	7.2	4.8	3.8	8.6	5.8	8.8	10.3
27			9.1	8.9	8.7	7.0	4.7	4.1	8.9	5.8	8.7	10.2
28			9.1	8.7	8.8	6.9	4.7	4.2	8.7	5.7	8.6	10.2
29				8.5	8.7	6.8	4.8	4.4	8.2	5.9	8.4	10.3
30				8.4	8.5	6.9	4.8	4.6	7.8	5.9	8.3	10.4
31				8.5		6.9		4.8	7.4		8.1	

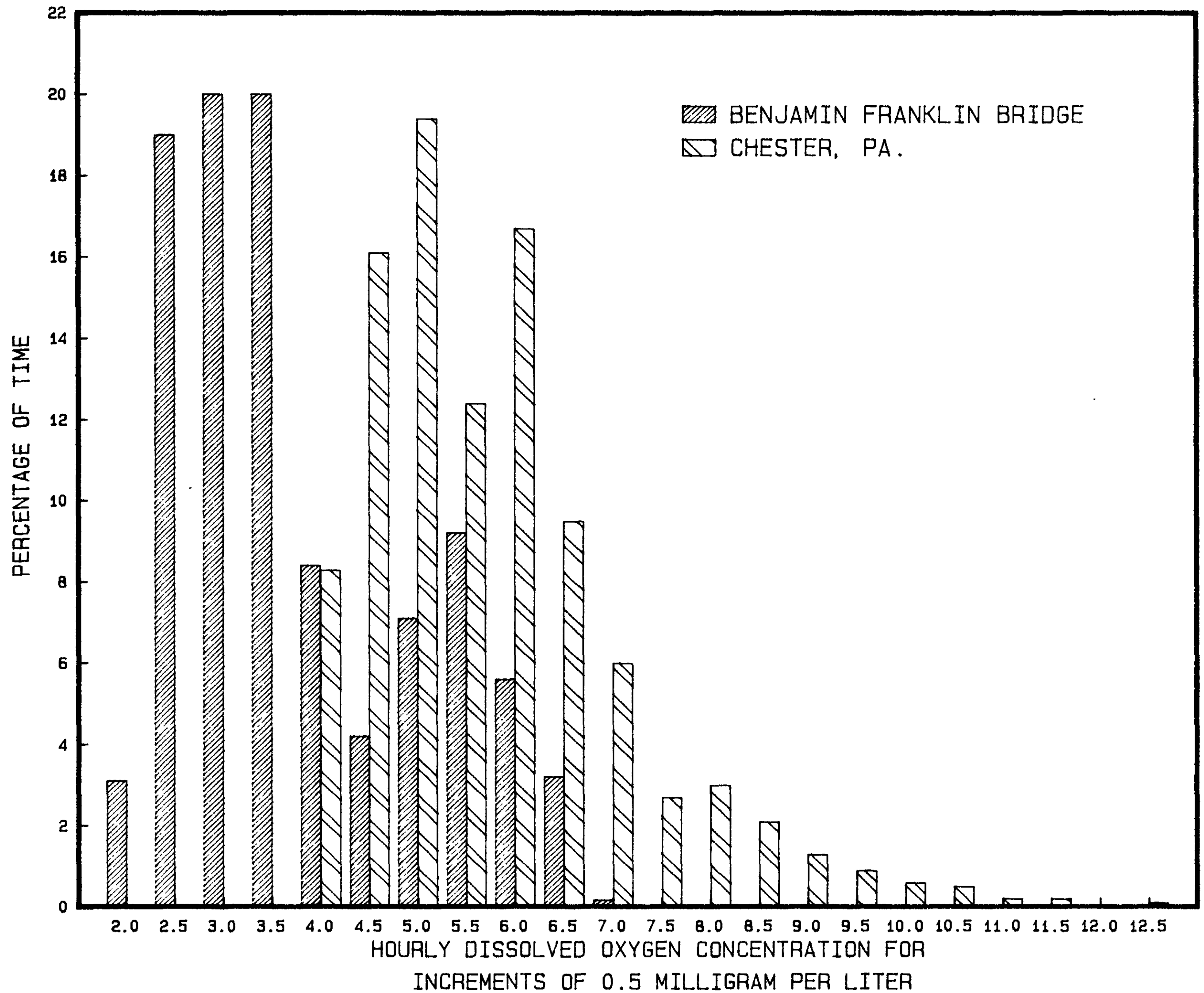

Figure 7. - Frequency of occurrence of dissolved-oxygen concentrations at two stations in the Delaware River, during July, August and September 1989.