REPORT OF

THE RIVER MASTER

OF THE DELAWARE RIVER

For the period

December 1, 1985 - November 30, 1986

by Stanley P. Sauer, William E. Harkness, and Bruce E. Krejmas
with a section on water quality by Karen L. Vogel

U.S. GEOLOGICAL SURVEY

Open-File Report 87-250

Reston, Virginia

1987

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

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

Copies of report can
be purchased from:

Open-file Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225

C O N T E N T S

	Page
Section I - River Master letter of transmittal and special report-----	1
Section II - Report of Delaware River operations -----	9
Abstract -----	11
Introduction -----	12
Definitions of terms and procedures -----	12
Precipitation -----	13
Acknowledgments -----	14
Operations -----	14
December to May -----	14
June to November -----	17
Summary -----	18
Supplementary release from Wallenpaupack powerplant -----	19
Water budget, Delaware River at Montague, N.J. -----	19
Time of transit -----	20
Segregation of flow at Montague -----	21
Computation of directed releases -----	21
Analysis of forecasts -----	23
Diversions to New York City water supply -----	24
Storage in New York City reservoirs -----	24
Comparisons of River Master operation data and other streamflow records -----	25
Releases from New York City reservoirs -----	25
Releases from Lake Wallenpaupack -----	27
Delaware River at Montague, N.J. -----	27
Diversion tunnels -----	27
Diversions by New Jersey -----	29
Conformance of operations under Amended Decree -----	29
Section III - Water quality of the Delaware River estuary -----	71
Introduction -----	73
Water-quality monitoring program -----	73
Estuarine water-quality data during 1986 -----	73
Streamflow -----	74
Temperature -----	74
Specific conductance and chloride -----	74
Dissolved oxygen -----	76
Hydrogen-ion concentration (ph) -----	86

I L L U S T R A T I O N S

	Page
Figure 1. Map of Delaware River basin above Wilmington, Del. -----	10
2. Operating curves for New York City reservoirs -----	15
3. Hydrograph of uncontrolled component, Delaware River at Montague, N.J., June 1 to November 30, 1986 -----	67
4. Combined storage in Pepacton, Cannonsville and Neversink Reservoirs, June 1967 to December 1986 -----	68
5. Map of Delaware River estuary -----	72
6. Mean monthly temperatures of Delaware River at Benjamin Franklin Bridge, Philadelphia, Pa. -----	75
7. Frequency of dissolved-oxygen concentration in the Delaware River -----	81
8. Changes in mean monthly dissolved-oxygen concentrations of the Delaware River at Benjamin Franklin Bridge, Philadelphia, Pa. -----	82
9. Changes in mean monthly dissolved-oxygen concentrations of the Delaware River at Chester, Pa. -----	83
Plate 1. Hydrograph of components of flow, Delaware River at Montague, N.J., June 1 to November 30, 1986 -----	69

T A B L E S

Table 1. Precipitation in Delaware River basin above Montague, N.J.----	13
2. Conservation release rates for New York City Delaware River basin reservoirs -----	16
3. Daily discharge East Branch Delaware River at Downsville, N.Y.	31
4. Daily discharge West Branch Delaware River at Stilesville, N.Y.	32
5. Daily discharge Wallenpaupack Creek at Wilsonville, Pa. -----	33
6. Daily discharge Neversink River at Neversink, N.Y. -----	34
7. Daily discharge Delaware River at Montague, N.J. -----	35
8. Daily discharge Delaware River at Trenton, N.J. -----	36
9. Storage in Pepacton Reservoir, N.Y. -----	37
10. Storage in Cannonsville Reservoir, N.Y. -----	38
11. Storage in Neversink Reservoir, N.Y. -----	39
12. Diversions to New Jersey -----	40
13. Diversions to New York City water supply -----	44
14. New York City reservoir release design data -----	50
15. Reservoir releases and segregation of flow at Montague, N.J.--	54
16. New York City consumption of water 1940 to 1986 -----	66
17. Chloride concentrations, Delaware River at Fort Mifflin, Pa.--	77
18. Chloride concentrations, Delaware River at Chester, Pa. -----	78
19. Chloride concentrations, Delaware River at Reedy Island Jetty, Del. -----	79
20. Dissolved oxygen, Delaware River at Benjamin Franklin Bridge, Philadelphia, Pa. -----	84
21. Dissolved oxygen, Delaware River at Chester, Pa. -----	85

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

<u>Multiply Inch-Pound unit</u>	<u>By</u>	<u>To Obtain Metric unit</u>
Length		
inch (in.)	25.40	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 gallon	3.785	cubic hectometer (m ³)
cfs-day	0.002447	cubic hectometer (hm ³)
Flow		
million gallons per day (mgd)	0.04381	cubic meter per second (m ³ /s)
cubic foot per second (cfs)	0.02832	cubic meter per second (m ³ /s)

Section I
RIVER MASTER LETTER OF TRANSMITTAL
and
SPECIAL REPORT

1
page 3 follows

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

July 10, 1987

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
Thomas H. Kean
Governor of New Jersey

The Honorable
Mario M. Cuomo
Governor of New York

The Honorable
Robert P. Casey
Governor of Pennsylvania

The Honorable
Edward I. Koch
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-third Annual Report of the River Master of the Delaware River for the year December 1, 1985 to November 30, 1986.

It should be noted that Mr. Francis T. Schaefer, who served as Delaware River Master since May 5, 1975, retired from Federal Service in March 1986. However, he continued to serve as River Master until December 31, 1986. Mr. Schaefer guided the operations of the office of the Delaware River Master during the development of the augmented conservation releases program for the enhancement of river quality, fishery, esthetics, and recreation. His leadership was also instrumental during the negotiations that led to the "Interstate Water Management Recommendations of the Parties to the Supreme Court Decree of 1954".

My designation by the Chief Hydrologist, with the concurrence of the Director, U.S. Geological Survey, as successor to Mr. Schaefer, was made effective January 1, 1987.

The recovery from the drought of 1984-85, which was underway at the end of the 1985 report year continued into the current year. On December 1, 1985, the beginning of the report year, the contents of Cannonsville, Pepacton, and Neversink reservoirs totaled 181 billion gallons. By December 18, 1985 the contents totaled 199 billion gallons and had been more than 40 billion gallons above the drought-warning zone of the operating rule curve, figure 2, since November 16. Therefore, in accordance with procedures outlined in the "Interstate Water Management Recommendations of the Parties to the 1954 Decree", the Delaware River Basin Commission declared an end to the state of emergency in the water supplies of the basin which had been in effect since May 13, 1985.

On October 31, 1985, the Delaware River Basin Commission with the unanimous approval of the parties to the decree had modified the schedule of diversions and streamflow objectives from those that had been instituted to combat the drought. Allowable New York City diversions were increased to 740 million gallons per day, the Montague flow objective was increased to 1,700 cfs, and the New Jersey diversions and Trenton flow objective were returned to normal levels. These levels of operation were discontinued on December 18 and the normal levels specified by the Decree were put into effect the following day.

Throughout the remainder of 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 and as provided in the Decree. Diversions by New York City from the Delaware River basin reservoirs did not exceed the limit specified by the Decree or the limits imposed during the period of water-supply deficiency.

The dredging project on the Delaware & Raritan Canal by the State of New Jersey, which had kept the canal closed during the 1985 report year, was sufficiently completed by mid-December to allow diversion of water from the Delaware River. The Canal was officially opened on December 18, 1985. Diversions by the State of New Jersey during the year were within the limits allowed by the Decree.

The Delaware River Master Advisory Committee met in Sparrow Bush, New York, on May 23, 1986 to discuss hydrologic conditions in the basin and operational procedures during the 1986 release season. Mr. Schaefer informed the committee that the excess release quantity that would be released beginning June 15 was 7.381 billion gallons. This quantity would be released at rates designed to maintain the Montague target flow at 100 cfs above the normal 1,750 cfs specified by the Decree.

A proposal by Pennsylvania to change the method currently being used to correct for differences between directed releases and the amount required to precisely maintain the Montague formula was discussed. The Milford office was requested to study the proposal, compare it with the current method and submit a recommendation to the Advisory Committee. A study was completed and submitted to the Advisory Committee on August 5, 1986. However, the release period for 1986 was in progress by that time and no action on the proposal was taken. Additional studies will be completed and the proposal will be considered again prior to the 1987 release period.

Also discussed at the meeting was the inadequacy of the monitoring system for the New Jersey diversions through the Delaware & Raritan Canal. As a result of this discussion, this office requested New Jersey to take whatever steps were necessary to improve the monitoring system to provide accurate data on their diversion of water from the Delaware River. Plans are currently underway to install an acoustic velocity meter and remote transmission equipment designed to meet the need for information. That project should be completed within the next year. It should be noted that the discussion was not prompted by a concern that New Jersey was violating the provisions of the Decree but only that at times the present gages do not provide accurate data. It should also be noted that New Jersey is cooperating fully with the concern expressed by the Advisory Committee and this office.

On October 6-7, at the invitation of New York City, this office sponsored an inspection of a portion of the New York City water supply system. The inspection trip was attended by approximately 40 persons from various Federal, State and local agencies interested in the water resources of the Delaware River basin. New York City, Bureau of Water Supply personnel hosted the trip and provided very interesting commentary on their facilities and their use of water from the Delaware River basin.

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 parties to the Decree, the River Master or his assistants 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 deficiencies 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 Beverly A. Roberts. In April, Bruce E. Krejmas transferred to the Milford office to replace Robert W. Baebenroth, who transferred from the office November 1, 1985.

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 the 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 18, the City of New York diverted a total of 243.603 billion gallons from the basin during the report year ending November 30, 1986 and released 66.522 billion gallons 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 26.752 billion gallons.

Section III of the report describes water quality at various sites in the Delaware River Estuary. It was prepared by Karen L. Vogel, U.S. Geological Survey, Malvern, Pennsylvania. It 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	Edward A. Karath, P.E. William E. Lee
New York City	Joseph T. McGough, Jr. Harvey W. Schultz
Pennsylvania	R. Timothy Weston

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, with the emergency reductions of diversions and releases, and with the directives of the River Master.

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

Sincerely yours,

A handwritten signature in cursive script, appearing to read "Stanley P. Sauer".

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

Section II
REPORT OF DELAWARE RIVER OPERATIONS

Figure 1. - Delaware River Basin Above 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 reservoirs of the City of New York 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 1986 report year, December 1, 1985, to November 30, 1986, precipitation and runoff varied from below average to above average in the Delaware River basin. For the year as a whole, precipitation was 4.3 inches above average. Runoff was near average. Operations were under a status of drought at the beginning of the report year. The drought emergency was terminated on December 18, 1985, by the Delaware River Basin Commission, and operations were returned to normal as prescribed by the Decree for the remainder of the report year. Storage in the reservoirs increased to capacity during the winter months and all New York City Delaware River Basin reservoirs spilled throughout the 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 69 days during the June to November period. Releases were made at 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 not expended by the end of the report year.

New York City 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 reservoirs of the City of New York 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, 1985 to November 30, 1986.

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 27 and a 25-hour day October 26.

Rate of flow. - Mean discharge for any stated 24-hour period, in cubic feet per second (cfs) or million gallons per day (mgd).

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 above Montague exclusive of the drainage area above the Downsview, Cannonsville, Neversink, Wallenpaupack, and Mongaup 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 City of New York diverts water 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.

The State of New Jersey diverts water from the Delaware River through the Delaware & 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 mgd 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 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 cfs; however, the daily credit cannot exceed the 24-hour period releases from Pepacton, Cannonsville and Never-sink 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 cfs.

Precipitation

Precipitation observed on the basin above Montague totaled 47.56 inches for the 1986 report year and was 4.4 inches above the long term average. Precipitation varied from 55 percent of the long term average in September to about 1.5 times the average in June, July and November. Table 1 compares the monthly precipitation during the report year with the long term average.

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

Month	December 1940 to November 1985 Average	December 1985 to November 1986			
		Amount	Percentage of average	Excess (+) or deficit (-)	
				Month	Cumulative
December	3.49	2.62	75	-0.87	-0.87
January	2.87	3.46	121	+59	-.28
February	2.78	3.80	137	+1.02	+.74
March	3.30	3.66	111	+.36	+1.10
April	3.76	3.77	100	+.01	+1.11
May	4.22	3.63	86	-.59	+.52
June	3.95	6.23	158	+2.28	+2.80
July	4.07	6.03	148	+1.96	+4.76
August	3.92	3.29	84	-.63	+4.13
September	3.72	2.04	55	-1.68	+2.45
October	3.31	3.26	98	-.05	+2.40
November	3.79	5.77	152	+1.98	+4.38
12 months	43.18	47.56	110	+4.38	

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 1985-86, precipitation totalling 20.94 inches was observed, which was 103 percent of the 45-year average. During June to November, 26.62 inches of precipitation was observed, which was 117 percent of the 45-year average. The maximum monthly precipitation listed during the year for any of the ten stations was 9.70 inches in June at Narrowsburg, N.Y.; the minimum monthly precipitation observed was 1.39 inches in September at Milford, Pennsylvania.

Acknowledgments

Part of the hydrologic data presented are records of 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 Trenton, New Jersey, in cooperation with the States of New York and New Jersey, the Commonwealth of Pennsylvania, and the City of New York.

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 Lake Wallenpaupack by the Pennsylvania Power & Light Company; and from Mongaup 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 0.5 inches above average and ranged from 75 percent of the long term average in December to 137 percent in February (See table 1.) Precipitation during the last three months of the previous report year was 5.4 inches above average, which resulted in runoff in the upper basin being slightly above normal during December through March. Runoff was below normal during April and May, because precipitation during that period was slightly below normal and temperatures were above normal during late March and April.

On December 1, 1985, Pepacton Reservoir contained 83.164 billion gallons of water in storage above the point of maximum depletion, or 59.3 percent of the reservoir's storage capacity of 140.190 billion gallons. Cannonsville Reservoir contained 71.066 billion gallons, or 74.3 percent of the reservoir's storage capacity of 95.706 billion gallons and Neversink Reservoir contained 26.659 billion gallons, or 76.3 percent of the reservoir's storage capacity of 34.941 billion gallons. The combined storage in the three reservoirs as of December 1 was 180.889 billion gallons, or 66.8 percent of their combined capacity. Daily storages in Pepacton, Cannonsville and Neversink Reservoirs are shown in tables 9, 10 and 11, 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, 1985 to November 30, 1986.

On October 30, 1985, during the previous report year, the Delaware River Basin Commission, in response to improved reservoir storage and general hydrologic conditions in the basin had modified the restrictions that had been placed on diversions and flow objectives in the basin. The parties to the Decree approved the action and the Montague flow objective was set at 1,700 cfs, allowable diversions to New York City were increased to 740 mgd, and the New Jersey diversions and the Trenton flow objective were returned to normal levels. The conservation releases from New York City reservoirs were set at the basic summer levels rather than being reduced to winter levels which would have occurred on November 1. (See table 2.)

By December 18, the storage in the reservoirs had been more than 40 billion gallons above the drought warning zone of the operating curves for 30 consecutive days. Therefore, per the "Interstate Water Management Recommendations of the Parties to the Decree", the Delaware River Basin Commission with the unanimous approval of the parties to the Decree declared an end to the state of emergency in the water supplies of the basin. As a result the flow objectives and allowable diversions were returned to the normal levels as defined by the decree. Conservation releases were returned to 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 (cfs)	Augmented (cfs)
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

Water-supply conditions continued to improve throughout the winter months. Cannonsville reservoir filled to capacity and began spilling on February 25. Cannonsville reservoir spilled continuously from February 25 to June 25, except May 4-20 when it was within 0.5 ft of spillway level. A total of 86.785 billion gallons spilled during the year. The reservoir reached an all time high elevation of 1,156.73 ft on March 16. Storage on that date was 106.705 billion gallons, 111.5 percent of capacity.

Pepacton reservoir filled to capacity on March 22. The reservoir spilled March 22 to April 18, May 22 to June 1, and June 6-21. A total of 16.475 billion gallons spilled during the year.

Neversink reservoir filled to capacity and spilled briefly on two occasions. During the period, May 21-25, a total of 1.584 billion gallons spilled and June 13-17, 0.181 billion gallons spilled, for a total spillage from Neversink reservoir during the year of 1.765 billion gallons.

The combined storage in the reservoirs, as shown in figure 2, reached a peak for the year of 275.672 billion gallons, 102 percent of capacity, on May 24.

Diversions to Rondout reservoir by the City of New York totaled 107.649 billion gallons during the December 1 to May 31 period. During this same period, the anticipated discharge at Montague, exclusive of water released from the City reservoirs, fell below the applicable design rate on four days and releases totaling 670 cfs-days (433 million gallons) were directed to meet the Montague flow objective. In addition to the Rivermaster directed releases, New York City made releases for conservation purposes at rates set forth in the Delaware River Basin Commission, Resolution No. 85-41, and the Interstate Water Management Recommendations of the Parties to the Decree. Releases were made at the rates prescribed by DRBC Dec. 1-18, and at the augmented conservation rates shown in table 2, December 19 to May 31.

There was only one day during the December to May period when the observed discharge at Montague was less than the prevailing design rate. (See table 15.) This deficiency was the result of difficulty in predicting the effect of the accumulation of ice during cold weather.

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 45-year period, December 1940 to May 1985, was 303.8 billion gallons. During the corresponding six months of the current report year, inflow to the three reservoirs totaled 305.9 billion gallons. Evaporation loss was not included in the computation. Storage in the three reservoirs increased from 179.361 billion gallons on November 30, 1985 to 270.824 billion gallons May 31, 1986.

June to November

Precipitation during the June to November period was above average in June, July and November, was below average in August and September, and was near average in October. Precipitation for the period was 26.62 inches, which was 3.86 inches above average. (See table 1.)

Diversions to Rondout Reservoir June 1 to November 30 totaled 135.954 billion gallons. The equivalent diversion rate did not exceed the limit specified by the Decree and was 743 mgd on November 30. Releases were directed to satisfy the Montague Formula on 69 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 the City of New York. A total of 3,189 cfs-days (2.062 billion gallons) was released for the relief of thermal stress between July 6 and August 25.

During June 1-14, the flow required to be maintained in the Delaware River at Montague was the minimum basic rate of 1,750 cfs. The forecasted discharge, exclusive of releases from Pepacton, Cannonsville and Neversink Reservoirs, was greater than 1,750 cfs each day. During that period the observed discharge at Montague was always greater than 1,750 cfs.

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 cfs. This rate was composed of the basic rate of 1,750 cfs plus 100 cfs of 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 1986 calendar year:

1. The estimated continuous safe yield, from all the City's sources, obtainable without pumping, is 1,665 mgd, or a total during the calendar year 1986 of $1,665 \times 365 \text{ days} = 607.725$ billion gallons.
2. The estimated consumption that the City must provide from all its sources of supply during the calendar year 1986 is $591.582 + 7.250 = 598.832$ billion gallons.

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 billion gallons. The Montague design rate during the excess release period beginning June 15, 1986, was computed as:

$$1,750 \text{ cfs} + \frac{7.381 \text{ billion gallons} \times 1,547 \text{ cfs/bgd}}{120 \text{ days}} = 1,850 \text{ cfs}$$

Data on consumption of water by the City of New York for each calendar year, beginning in 1940, are shown in table 16.

The design rate of 1,850 cfs at Montague was required continuously after June 15 because the excess-release quantity was not expended by the end of the report year. Directed releases from the City reservoirs were designed to maintain the rate of 1,850 cfs at Montague but because the runoff from precipitation was high for much of the period, only 9,092 cfs-days (5.877 billion gallons) of the available 11,418 cfs-days (7.381 billion gallons) was released by November 30.

During June to November there were 69 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 33 days when the observed flow at Montague was less than the design rate.

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, 1985, to November 30, 1986, diversions to Rondout Reservoir totaled 243.603 billion gallons, and all releases from the New York City reservoirs to the Delaware River totaled 102,909 cfs-days (66.522 billion gallons).

During the year, maximum storage in Pepacton Reservoir was 141.857 billion gallons, on May 24. Maximum storage in Cannonsville Reservoir was 106.705 billion gallons, on March 16. Maximum storage in Neversink Reservoir was 35.294 billion gallons, on May 23. The maximum combined storage in the three reservoirs during the year was 275.672 billion gallons, or 102 percent of capacity, on May 24.

Minimum storage during the year in Pepacton Reservoir was 83.164 billion gallons, or 59 percent of capacity on December 1, 1985. The minimum storage in Cannonsville Reservoir was 67.993 billion gallons, or 71 percent of capacity on November 6, 1986. Minimum storage in Neversink Reservoir was 16.917 billion gallons, or 48 percent of capacity on November 8 and 20, 1986. Minimum combined storage in the three reservoirs was 180.889 billion gallons, or 67 percent of capacity December 1, 1985.

A resume' of the combined storage of the three reservoirs on the first day of the month June 1967 to December 1986 is shown in figure 4. Storage was above the median all months except February and May.

On November 30, 1986, combined storage in the three reservoirs was 223.121 billion gallons, or 82 percent of their combined capacity. During the year, combined storage increased 42.232 billion gallons, or 16 percent of capacity.

SUPPLEMENTARY RELEASE FROM WALLENPAUPACK POWERPLANT

An agreement between Pennsylvania Power & Light Company and the City of New York 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 cfs for more than three consecutive days. No supplementary releases were requested during the year.

WATER BUDGET, DELAWARE RIVER AT MONTAGUE, N.J.

The data and computations of the water budget formed the basic operational records required to carry out the River Master's specific responsibilities with respect to the Montague Formula and Interstate Water Management Recommendations and the DRBC Conservation Orders 1-7 during the report year. The water budget has two parts: (1) advance estimates of the daily average flow at Montague, exclusive of controlled releases from New York City's reservoirs (table 14) and (2) segregation of the daily average flow at Montague among its various source components (table 15). 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 Mongaup 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 the City of New York.

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 1986 report year are as follows:

<u>Source</u>	<u>Hours</u>
Pepacton Reservoir	60
Cannonsville Reservoir	48
Neversink Reservoir	33
Lake Wallenpaupack	16
Mongaup Reservoir	12

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, e.g., 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 during September and October 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 15 on page 54. 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 power-plant 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 Mongaup 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 Mongaup Reservoir for power production for a 24-hour period, beginning at 1200, 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 14.

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. 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 2,156 square miles 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 14.

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 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 (square miles)
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
Termile 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 Termile, 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 Termile and Lackawaxen Rivers with routing and recession by individual gaging stations.

The advance estimate of increase in runoff from precipitation is shown in table 14 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 three-day 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 14), 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 release in substantial amount 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 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 14.

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 two days each month during January, May and June, eight days during July, four days during August and on an almost continuous basis from September 1 to November 9 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 August 31 to November 9, 1986 period when releases were directed on most days.

	Advance estimates (cfs-days)	Observed operations (cfs-days)
New York City releases		
Directed	^a 36,049	^b 36,253
Other		2,602
Power releases		
Lake Wallenpaupack	14,394	15,283
Mongaup Reservoir	^c 11,438	^c 9,997
Runoff from uncontrolled area	57,596	63,885

^a Directed release as designed.

^b Actual release in response to direction.

^c Aug. 31 to Oct. 5, Oct. 12 to Nov. 8.

The table shows that during the period of comparison, New York City released slightly more water, 0.6 percent, than was directed. The power companies released 6.2 percent more water from Lake Wallenpaupack and 13 percent less water from Mongaup reservoir than was forecast. The total power releases were 2.1 percent less than the forecast. The forecast runoff from the uncontrolled area during the period was 11 percent less than the observed runoff from the uncontrolled area.

On the basis of the observed discharges at Montague, exact forecasting of releases required from the City's reservoirs during the period, August 31 to November 9, would have totaled 37,501 cfs-days. The releases, as designed, totaled 36,253 cfs-days, or 3.3 percent less than for exact forecasting.

A comparison of the hydrographs on figure 3, of forecast 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.

DIVERSIONS TO NEW YORK CITY WATER SUPPLY

Table 13 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 Delaware River Basin Commission Resolution No. 85-41, approved by the parties to the Decree December, 1-18 and by the Decree thereafter. The tabulation shows that the allowable maximum equivalent diversion rates were not exceeded at any time.

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:

Reservoir Level	Pepacton Res.		Cannonsville Res.		Neversink Res.	
	Elev. (feet)	Contents (billion gallons)	Elev. (feet)	Contents (billion gallons)	Elev. (feet)	Contents (billion gallons)
Full pool or spillway crest	1,280.00	*140.190	1,150.00	*95.706	1,440.00	*34.941
Point of maxi- mum 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 9, 10 and 11 show storage in Pepacton, Cannonsville and Neversink Reservoirs, respectively, above "point of maximum depletion" or minimum full-operating level.

On December 1, 1985 combined storage in the three reservoirs was 180.889 billion gallons, which was 71 billion gallons above the drought warning level as defined by the Interstate Water Management Recommendations. Storage increased gradually throughout the winter months with only a slight drop in mid-January because of reduced inflow during the cold weather. Combined storage reached 100 percent of capacity on March 20 and remained near full operating levels through June.

Storage decreased seasonally throughout the summer and fall in response to normal diversions to the New York City water-supply system and releases required to maintain the Montague flow objective. Heavy precipitation occurred during November and storage increased from a seasonal low of 186.439 billion gallons on November 8 to 223.121 billion gallons on November 30.

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 Geological Survey records. In the comparison of releases approximating conservation rates only, data were used in units of million gallons per day and converted to cubic feet per second 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 3 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 372 square miles.

Releases were made at conservation or other rates by New York City during the year. For flows of approximately 19, 50 and 70 cfs at the gaging station, the venturi meter instruments indicated 0, -0.4 and +1.7 percent difference, respectively, in rates of release from the reservoir than those shown by the gaging-station records.

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 4 includes releases and spillage from Cannonsville Reservoir and the runoff from 2 square miles of drainage area between the dam and the gage site. The drainage area at the dam is 454 square miles, and that at the gaging station is 456 square miles.

Releases were made in a range from conservation to high rates during the year. For flows of approximately 37 and 52 cfs at the gaging station, the venturi meter instruments indicated 7.4 and 12 percent less water, respectively, being released from the reservoir than those shown by the gaging-station records. At flows of approximately 375, 750 and 1,180 cfs, the venturi indicated 8.8, 2.4 and 1.8 percent more discharge respectively, than that shown by the gaging-station records. The gaging station records are considered good for flows above 750 cfs and fair below.

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 6 includes releases and spillage 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 square miles and that at the gaging station is 92.6 square miles.

Releases were made at conservation or other low flows by New York City during the year. For flows of approximately 15, 22 and 44 cfs at the Geological Survey gaging station, the venturi meter instrument indicated +2.7, +13 and +2.9 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 all stations for all ranges of flow except for flows below 700 cfs at Cannonsville Reservoir and for flows at the winter augmented rate at Neversink reservoir. The gaging station records are considered only fair at these sites for these ranges of flow. Therefore, the venturi instruments are considered to provide more accurate records.

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 15). 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 Geological Survey, were also furnished by the Company. These discharges, shown in table 5, represent the flow through the turbines of the powerplant and are computed on a midnight to midnight basis.

During December 1985 through November 1986, the River Master's record based on computations by Pennsylvania Power & Light Company, indicated 0.3 percent less discharge than the Geological Survey record. This difference was primarily due to the difference in the time frame of the computations.

Delaware River at Montague, N.J.

The River Master's operation record indicated 0.3 percent less discharge for the year than the Geological Survey record, and daily records were generally 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. 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 diverted from Pepacton Reservoir discharges 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 most of the year due to the high water levels in Rondout reservoir. The results of one current-meter measurement made in 1985 and one measurement just after the end of the report year showed on the average that the venturi-meter instruments gave higher figures by 7.5 percent for the totalizer, 7.4 percent for the manometer and 7.4 percent for the indicator needle.

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 accurate.

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 4, 1982, indicated a rate of 10.9 cfs from cooling water and leakage. No measurements of the leakage were made during the year. Discharges obtained from the rating curve indicate that the leakage was approximately the same as when it was last measured.

When the power plant is not operating, the leakage by-passes the venturi instruments and is not measured. When the power plant is operating, the leakage is included in the measured flow. Since the power plant operated on all but 19 days during the year the unmeasured flow is small.

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. One current-meter measurement made during the year, indicated that the venturi instruments gave higher results by 7.1 percent for the totalizer, 9.9 percent for the manometer and 13 percent for the indicator needle. Inspections of the channel downstream from the outlet, when valves were closed showed negligible leakage.

The results of these 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 showed that the venturi measurements and two current-meter measurements, one in 1985 and one made during the year, agreed fairly well. The average difference between the two methods showed the venturi higher by 4.9 percent for the totalizer, 8.4 percent for the manometer, and 11.4 percent for the indicator needle.

When the power plant 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 in January 1987 and numerous measurements made in previous years, the average rate of leakage is 13 cfs (8.4 mgd). When the power plant was operating, the leakage was included in the recorded flow. Based on the above rate and on records of power plant operations, approximately 2.0 billion gallons of water was diverted but was unrecorded. The recorded diversion from Neversink Reservoir was 55.1 billion gallons during the year (see table 13). Therefore this computation indicates the unrecorded diversion was approximately 3.5 percent, which is within the accuracy of the measurements.

DIVERSIONS BY NEW JERSEY

According to the terms of the Decree, the State of 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 mgd (154.7 cfs) as a monthly average, with the diversion on any day not to exceed 120 mgd (185.6 cfs).

In order to increase the carrying capacity of the Delaware & Raritan Canal, the New Jersey Water Supply Authority began dredging the canal in March 1984. The canal was closed on March 16, 1984 near Washington Crossing, New Jersey and remained closed until December 18, 1985.

In previous years, the diversions through the Delaware & Raritan Canal were measured at the Kingston Lock. In 1986 water was 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 made computations of the amount being diverted on a daily basis and provided the data to the River Master office weekly. Table 12 is a listing of the data provided by the Water Supply Authority.

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 began preparations for the installation of an acoustic velocity meter and remote sensing equipment at Port Mercer near the Delaware-Raritan divide. Plans call for the installation to be completed during 1987.

The allowable diversion rate was as specified by the decree for the entire report year. The 30-day average diversion was computed weekly throughout the year to monitor compliance with the terms of the decree. The maximum 30-day average was 92.8 mgd March 31 to April 29. On February 20 and April 17-18, the records indicate that the maximum daily diversion allowed by the decree was exceeded. However, while the records indicate a flow in the canal of 124 million gallons February 20, 233 million gallons on April 17 and 161 million gallons April 18, these values include significant but unmeasured amounts of inflow into the canal from Duck Pond Run in the Raritan River Basin. It is not possible to determine exactly what the diversions on these days were, but they are estimated to have been about 80 mgd.

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

At the beginning of the report year, operations were being conducted as prescribed by Delaware River Basin Commission Conservation Order No. 8. However, on December 18, conservation measures including reductions in allowable diversions from the basin and rates of flow of the Delaware River at Montague were terminated and operations as prescribed by the Decree were instituted for the remainder of the report year.

Diversions from the Delaware River basin to the water-supply system of the City of New York were less than the 800 mgd authorized by the Decree. Diversions during the period of drought also were less than the permissible rates in effect for that period. Allowable and actual diversions are shown in the following table:

Effective dates	Allowable diversions Equivalent rate not to exceed (mgd)	Actual diversions (mgd)
Nov. 1 to Dec. 18, 1985	740	708
Dec. 19, 1985 to May 31, 1986	800	574
June 1 to Nov. 30, 1986	800	743

Under Compensating Releases of the Montague Formula, the City released water from its reservoirs at rates designed by the River Master to maintain 1,700 cfs at Montague December 1 - 21, 1,750 cfs December 22 to June 14, and 1,850 cfs June 15 to November 30. New York City complied fully with the directives of the River Master during the year.

Diversions from the Delaware River basin by the State of New Jersey were within the limits prescribed by the Decree.

Table 3. - Daily discharge, in cubic feet per second, of East Branch Delaware River at Downsview, N.Y.
(01417000) for the year ending November 30, 1986. Preliminary
U.S. Geological Survey record.

Mean values												
Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	20	48	52	48	654	70	97	75	69	68	68	126
2	21	48	52	48	564	70	77	76	70	68	68	126
3	20	49	49	49	488	70	74	76	70	68	69	125
4	19	48	49	49	414	70	73	75	70	81	68	125
5	19	49	53	48	374	70	74	75	70	99	68	90
6	19	49	51	49	367	70	205	74	71	87	68	53
7	19	50	50	50	367	70	1,130	94	70	70	68	56
8	19	50	51	51	319	70	1,460	112	70	67	68	55
9	19	50	51	55	264	71	1,470	110	70	68	66	53
10	19	50	51	50	216	71	1,100	100	70	68	66	55
11	19	50	51	53	188	72	937	81	70	81	66	58
12	19	50	51	53	154	72	1,060	73	70	100	66	55
13	19	50	51	53	127	72	1,240	72	70	87	66	53
14	19	50	51	55	98	72	1,070	72	70	69	67	54
15	18	50	51	69	84	72	782	72	70	70	66	54
16	18	50	53	55	185	79	557	72	70	69	66	54
17	18	50	50	53	114	78	598	84	70	71	66	57
18	18	50	52	51	101	74	443	95	70	72	66	56
19	33	50	50	50	70	74	279	95	70	72	66	55
20	50	51	50	50	69	74	250	95	70	71	66	54
21	50	51	50	50	70	79	185	95	70	70	66	56
22	50	49	50	61	68	79	100	81	70	72	66	55
23	51	50	50	547	69	894	75	72	70	72	66	55
24	52	51	51	926	69	2,680	74	83	70	71	66	56
25	53	51	53	938	70	2,550	76	95	70	69	66	56
26	50	52	53	833	70	1,850	75	95	70	70	66	57
27	49	53	55	772	71	1,330	75	95	70	69	66	56
28	52	52	49	791	70	728	74	95	70	68	66	57
29	49	51		754	70	398	74	95	84	68	66	58
30	48	50		706	70	219	75	82	97	68	66	58
31	48	51		701		119		68	82		88	
Total	977	1,553	1,430	8,118	5,914	12,367	13,859	2,634	2,223	2,203	2,086	1,978
Mean	31.5	50.1	51.1	262	197	399	462	85.0	71.7	73.4	67.3	65.9
Year total 55,342 cfs-days												Mean 152 cfs

Table 4. - Daily discharge, in cubic feet per second, of West Branch Delaware River at Stilesville, N.Y.
(01425000) for the year ending November 30, 1986. Preliminary
U.S. Geological Survey record.

Mean values												
Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	34	36	37	824	1,160	197	689	340	340	113	441	343
2	35	36	37	835	1,060	136	646	342	340	57	575	469
3	34	36	37	845	960	98	501	340	347	51	495	521
4	33	36	37	785	890	63	346	340	345	286	84	564
5	32	36	38	723	827	53	252	340	345	1,080	59	379
6	32	36	37	687	813	53	434	340	368	613	64	67
7	31	36	38	649	806	53	1,240	393	360	78	62	89
8	31	36	37	556	761	52	1,810	455	352	57	52	46
9	31	35	37	499	707	52	2,040	455	352	57	48	48
10	31	36	37	500	679	52	1,850	463	351	130	335	43
11	31	36	37	855	668	52	1,690	580	349	430	353	42
12	32	36	37	1,690	653	52	1,460	429	345	1,130	129	41
13	31	36	37	1,710	625	52	1,560	350	345	946	140	41
14	31	35	37	2,500	583	51	1,540	350	345	347	105	41
15	31	35	37	11,000	548	52	1,650	345	345	328	57	40
16	30	35	37	14,800	595	52	1,380	345	345	396	48	41
17	30	151	38	8,720	689	57	1,310	345	345	708	323	41
18	30	201	39	5,750	706	54	1,160	386	234	773	289	41
19	29	51	40	4,830	683	56	914	535	66	1,400	68	42
20	35	44	42	5,720	665	59	788	530	53	1,210	51	42
21	37	41	44	4,840	656	117	694	433	53	1,090	252	62
22	37	39	44	3,760	660	802	573	345	52	1,020	64	50
23	37	38	42	2,980	697	1,790	474	345	53	877	115	45
24	37	37	41	2,430	706	2,230	415	340	182	802	679	46
25	37	37	52	2,000	799	2,130	373	645	193	856	314	45
26	37	39	316	1,730	744	1,840	344	582	64	639	161	54
27	37	38	564	1,540	677	1,530	341	503	52	678	198	61
28	37	37	747	1,490	604	1,290	340	466	51	767	180	53
29	36	37		1,420	419	1,080	341	453	553	688	199	49
30	36	37		1,330	289	913	340	408	694	694	130	47
31	36	37		1,240		785		345	654		309	
Total	1,038	1,436	2,603	89,238	21,329	15,853	27,495	12,868	8,873	18,301	6,379	3,493
Mean	33.5	46.3	93.0	2,879	711	511	917	415	286	610	206	116
Year total 208,906 cfs-days												
Mean 572 cfs												

Table 5. - Daily discharge, in cubic feet per second, of Wallenpaupack Creek at Wilsonville, Pa.
(01432000) for the year ending November 30, 1986. Record furnished by
Pennsylvania Power & Light Company.

Mean values												
Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	1,530	0	0	0	953	955	0	678	405	0	220	0
2	1,460	468	0	0	953	943	0	710	0	701	238	0
3	1,460	470	1,010	866	980	964	0	744	0	729	287	0
4	1,470	0	1,020	942	963	978	0	0	400	719	0	0
5	1,470	0	1,020	956	0	797	582	0	368	691	0	0
6	1,460	652	1,020	1,000	0	944	978	0	275	0	230	0
7	743	710	1,030	940	233	932	1,710	905	415	0	228	0
8	984	645	0	0	0	930	1,710	701	397	702	0	0
9	952	0	0	0	0	967	1,690	704	635	703	240	0
10	950	613	1,020	953	0	0	1,390	702	0	727	246	0
11	935	0	941	469	0	0	1,030	713	1,150	723	0	0
12	950	0	966	469	0	466	956	0	1,140	709	0	0
13	965	649	972	935	0	0	1,440	0	402	0	356	0
14	0	938	962	965	0	0	1,430	486	0	0	351	0
15	0	1,050	0	531	3.0	0	1,460	439	1,140	726	344	0
16	478	1,020	0	896	0	0	1,370	730	0	703	349	0
17	472	102	950	1,650	700	0	1,420	704	389	705	317	0
18	605	0	1,160	1,770	895	0	1,400	1,070	1,670	357	0	0
19	994	0	1,610	1,780	0	0	1,450	2.0	695	356	0	0
20	667	702	1,620	1,770	0	0	1,450	0	658	0	471	0
21	0	0	1,660	1,780	465	0	912	426	711	0	475	0
22	0	514	1,450	1,780	485	918	925	416	714	0	0	0
23	826	992	965	1,790	405	946	930	440	0	0	483	0
24	0	969	952	1,790	939	0	810	424	0	0	440	0
25	0	0	1,030	1,780	945	0	579	439	701	0	0	549
26	762	0	1,030	1,170	0	0	599	0	813	0	0	572
27	465	967	1,020	1,160	0	913	688	0	706	0	0	555
28	0	1,010	970	964	920	975	0	427	719	0	0	579
29	0	1,090	0	936	967	985	0	458	713	189	0	590
30	469	1,010	0	943	953	1,040	437	434	0	568	0	627
31	488	818	0	949	0	0	471	0	0	0	0	0
Total	21,555	15,389	24,378	31,934	11,759.0	14,653	27,346	13,223.0	15,216	10,008	5,275	3,472
Mean	695	496	871	1,030	392	473	897	427	491	334	170	116
Year total 194,208.0 cfs-days												
Mean 532 cfs												

Table 6. - Daily discharge, in cubic feet per second, of Neversink River at Neversink, N.Y.
(01436000) for the year ending November 30, 1986. Preliminary
U.S. Geological Survey record.

Day	Mean values											
	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	15	23	22	21	47	43	42	43	47	62	43	55
2	15	23	22	21	45	43	42	43	46	51	44	57
3	14	23	21	21	44	43	42	42	47	51	44	59
4	15	24	21	21	44	42	42	43	45	45	42	58
5	15	24	21	21	43	43	43	43	46	45	43	44
6	15	24	21	21	43	43	43	43	47	48	41	20
7	15	23	21	21	44	43	43	63	47	46	43	20
8	15	23	21	22	43	43	42	87	46	46	45	21
9	15	23	21	22	42	43	42	88	44	46	46	21
10	15	23	21	22	42	43	42	79	45	46	43	21
11	15	22	21	22	42	44	42	60	46	45	43	21
12	15	22	21	22	43	43	43	46	46	52	42	21
13	14	22	21	23	45	45	46	46	46	68	41	20
14	13	22	22	24	43	45	98	45	45	60	42	20
15	14	23	21	24	43	45	91	45	46	46	45	19
16	14	23	21	23	44	45	62	45	46	45	38	17
17	14	22	21	22	45	45	99	55	47	46	38	23
18	14	22	21	22	45	45	50	68	46	46	38	18
19	18	23	21	23	46	45	43	68	47	47	39	22
20	24	23	21	22	46	45	43	68	47	45	39	19
21	24	23	21	22	44	266	43	67	47	46	37	22
22	24	23	21	22	43	1,030	43	54	46	45	37	20
23	24	23	21	22	43	806	43	45	46	43	37	18
24	24	23	21	22	43	235	43	57	45	43	38	19
25	23	23	21	22	44	59	42	69	47	43	37	19
26	24	24	21	22	43	45	43	71	47	43	37	21
27	24	22	21	22	43	45	43	70	46	43	37	21
28	23	22	21	22	44	46	43	69	43	44	37	21
29	23	22		22	44	44	43	68	45	44	37	21
30	23	16		22	43	42	43	58	54	43	36	21
31	23	22		34	42	42	47	47	70	42	42	
Total	563	700	591	694	1,313	3,536	1,469	1,795	1,458	1,423	1,251	779
Mean	18.2	22.6	21.1	22.4	43.8	114	49.0	57.9	47.0	47.4	40.4	26.0
Year total 15,572 cfs-days												
Mean 42.7 cfs												

Table 7. - Daily discharge, in cubic feet per second, of the Delaware River at Montague, N.J.
(01438500) for the year ending November 30, 1986. Preliminary
U.S. Geological Survey record.

Day	Mean values											
	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	13,400	3,100	5,320	6,050	8,990	7,000	3,920	2,600	6,070	1,700	2,260	1,470
2	16,800	2,500	4,150	5,040	8,270	6,100	3,600	3,100	5,390	1,660	1,830	1,480
3	17,700	3,000	4,500	4,990	7,610	5,860	3,400	4,410	5,750	2,100	1,920	1,520
4	13,300	2,830	5,350	5,800	6,980	4,970	3,080	3,730	4,730	2,020	3,540	1,740
5	11,100	2,190	5,200	5,580	6,400	4,300	2,640	2,410	4,410	1,990	5,250	1,810
6	10,000	2,100	5,250	5,500	5,810	4,500	9,800	2,210	3,780	1,980	3,540	2,050
7	8,470	3,100	5,100	5,260	6,860	4,640	18,200	1,930	3,520	1,990	2,910	2,250
8	7,770	3,200	4,380	4,420	6,560	4,360	14,900	2,830	5,850	1,600	2,400	2,420
9	7,180	2,800	3,270	3,000	5,510	4,040	13,600	2,840	4,650	1,930	1,870	5,100
10	6,770	2,100	3,580	3,350	4,960	3,770	11,000	2,820	3,840	1,790	1,930	10,700
11	6,480	2,900	4,430	5,180	4,880	2,500	9,050	2,640	3,210	1,810	1,780	8,080
12	8,290	1,800	3,770	7,380	4,660	2,370	11,500	2,730	4,270	1,790	1,470	6,600
13	9,070	1,800	3,800	9,070	4,420	2,760	19,700	2,800	3,710	1,840	1,490	5,770
14	7,980	2,700	3,800	12,700	4,170	2,210	15,600	4,320	2,700	1,960	1,800	4,800
15	6,440	3,000	3,400	77,200	3,970	1,950	12,100	4,600	2,280	1,610	2,410	3,910
16	5,990	2,700	2,350	75,900	4,750	2,050	10,800	3,870	3,250	2,020	2,770	3,410
17	5,870	2,600	2,500	44,700	10,300	2,110	10,100	3,570	2,160	1,880	2,440	3,290
18	5,400	1,700	4,470	31,600	12,500	2,940	9,400	3,230	3,160	1,950	2,090	4,040
19	4,860	1,800	6,520	29,400	9,150	2,990	8,060	3,400	3,900	1,850	1,680	4,570
20	4,400	4,000	8,270	42,800	7,130	2,680	7,110	2,610	3,240	2,010	1,620	4,600
21	3,800	13,500	9,610	30,900	6,650	3,120	5,960	2,640	2,740	2,110	2,000	11,000
22	3,500	10,600	11,700	22,600	7,090	12,000	5,310	2,830	2,660	1,820	2,070	17,500
23	3,700	9,160	11,000	17,700	8,120	18,700	4,840	2,590	2,580	1,860	1,700	11,800
24	4,400	7,500	9,510	14,700	8,470	14,500	4,470	2,100	1,800	1,910	2,040	9,770
25	3,900	6,500	8,580	13,300	12,300	12,100	3,980	1,870	1,910	1,780	1,830	10,900
26	3,600	6,630	7,320	11,700	12,400	10,300	3,500	1,830	2,730	1,710	1,710	10,300
27	4,200	10,000	6,710	11,700	10,300	8,940	3,380	2,080	2,680	2,000	1,760	23,400
28	3,500	9,200	6,530	12,000	9,260	8,100	3,270	2,590	2,320	1,800	2,210	21,700
29	3,000	7,560		11,200	8,720	6,960	2,320	2,900	2,170	1,670	2,010	14,600
30	3,100	6,200		10,300	7,850	6,060	2,150	2,920	2,100	1,980	1,710	11,000
31	3,400	6,150		9,690		5,150		5,890	1,430		1,690	
Total	217,370	144,920	160,370	550,710	225,040	180,030	236,740	92,890	104,990	56,120	67,730	221,580
Mean	7,012	4,675	5,728	17,760	7,501	5,807	7,891	2,996	3,387	1,871	2,185	7,386

Year total 2,258,490 cfs-days

Mean 6,188 cfs

Table 8. - Daily discharge, in cubic feet per second, of Delaware River at Trenton, N.J.
(01463500) for the year ending November 30, 1986. Preliminary
U.S. Geological Survey record.

Mean values												
Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	33,600	7,240	13,700	14,000	15,800	17,000	9,190	4,740	11,000	3,830	3,770	3,310
2	33,600	7,310	12,500	13,300	14,900	15,200	7,490	5,190	10,700	3,230	3,840	3,530
3	36,500	6,640	13,600	11,800	13,900	13,700	6,940	6,380	17,700	3,400	3,980	3,310
4	33,100	7,170	13,300	11,400	13,000	12,800	6,480	6,910	16,700	3,420	3,840	3,030
5	26,900	7,400	14,500	12,100	12,300	11,800	6,050	6,960	12,600	3,710	4,660	3,100
6	23,300	6,600	15,900	12,000	12,000	11,000	5,770	5,560	10,700	4,890	7,660	3,940
7	21,000	5,810	14,800	11,600	11,600	10,200	14,100	4,870	8,930	4,700	7,020	4,690
8	18,300	5,640	13,200	10,800	12,300	10,400	26,100	4,530	7,440	4,060	5,540	5,030
9	16,700	4,990	12,200	9,790	12,400	10,100	22,400	4,480	8,620	3,800	4,730	5,920
10	15,800	5,250	10,500	8,470	10,900	9,320	20,400	5,140	8,040	3,440	4,120	7,200
11	15,000	5,550	9,820	9,080	9,990	8,880	16,600	5,190	8,080	3,570	3,650	14,500
12	15,300	5,430	10,500	15,000	9,640	7,600	14,700	4,860	6,460	3,410	3,520	14,500
13	17,500	5,340	9,320	18,300	9,260	6,960	19,900	5,250	6,690	3,290	3,400	12,000
14	18,500	4,900	8,530	25,200	8,830	6,910	28,600	5,500	6,600	3,180	3,210	10,400
15	17,100	4,100	8,650	53,600	8,500	6,360	23,400	5,990	5,340	3,250	3,430	9,080
16	14,600	3,900	8,860	128,000	13,200	6,030	19,000	7,350	4,890	3,320	3,810	7,760
17	13,500	3,950	7,460	92,900	30,000	5,930	16,500	6,590	4,910	3,050	4,460	6,880
18	13,000	4,970	9,650	64,800	36,800	6,010	15,100	5,930	6,260	3,350	4,490	6,510
19	11,900	5,340	22,200	51,100	33,000	6,030	14,200	6,310	5,970	3,290	4,130	9,410
20	10,500	7,720	25,500	49,200	25,600	6,880	12,600	7,340	6,920	3,320	3,890	10,500
21	9,950	14,600	26,900	54,200	21,200	6,790	11,400	7,210	6,500	3,340	3,300	20,300
22	10,100	24,600	31,700	41,500	19,500	9,400	10,400	6,070	6,640	3,690	3,270	28,500
23	9,710	18,800	28,300	33,200	21,300	21,100	9,370	5,220	6,830	3,580	3,450	29,700
24	11,000	15,700	24,600	27,900	22,000	26,700	8,390	5,010	6,330	3,620	3,330	22,000
25	11,900	13,500	21,400	24,300	21,800	20,900	7,590	4,580	5,900	3,730	3,100	18,800
26	10,100	28,700	18,900	22,100	25,600	17,800	7,240	4,020	5,010	3,650	3,670	22,300
27	8,830	30,600	16,600	20,100	25,400	15,300	6,570	6,110	4,970	3,620	3,570	29,600
28	8,340	26,700	14,900	19,500	22,200	13,500	6,150	5,140	5,050	4,010	3,600	39,200
29	8,260	21,400		19,300	20,200	12,500	6,000	4,900	4,710	4,410	3,750	33,000
30	6,950	16,500		18,000	18,900	11,000	5,300	5,540	4,330	4,010	4,090	24,700
31	6,820	14,900		16,700		9,910		6,620	4,120		3,730	
Total	507,660	341,250	437,990	919,240	532,020	354,010	383,930	175,490	234,640	109,170	126,010	412,700
Mean	16,380	11,010	15,640	29,650	17,730	11,420	12,800	5,661	7,569	3,639	4,065	13,760
Year total 4,534,110 cfs-days												Mean 12,420 cfs

Table 9. - Storage in Pepacton Reservoir, N.Y., for year ending November 30, 1986
(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	83,164	93,527	97,983	105,129	140,391	139,987	140,227	137,931	133,312	127,811	115,060	103,957
2	84,272	93,438	98,138	105,288	140,894	139,969	140,135	137,676	134,049	127,390	114,662	103,531
3	85,726	93,319	98,276	105,447	140,839	139,969	139,969	137,439	134,480	126,954	114,246	103,074
4	86,894	93,259	98,368	105,542	140,727	139,712	139,712	137,092	134,660	126,534	114,246	102,680
5	87,652	93,200	98,506	105,638	140,727	139,583	139,528	136,745	134,678	126,098	114,014	102,227
6	88,302	93,096	98,737	105,717	140,672	139,399	140,061	136,363	134,624	125,697	113,700	101,961
7	88,779	92,962	98,814	105,765	140,672	139,215	141,024	135,982	134,823	125,263	113,305	101,695
8	89,403	92,799	98,921	105,733	140,616	139,031	141,246	135,566	134,805	124,847	112,959	101,383
9	89,957	92,651	98,983	105,717	140,560	138,774	141,357	135,149	134,732	124,413	112,530	101,461
10	90,219	92,487	99,014	105,685	140,505	138,572	141,116	134,714	134,588	123,963	112,152	101,961
11	90,496	92,383	99,044	106,164	140,468	138,278	140,950	134,247	134,480	123,515	111,760	102,164
12	90,967	92,235	99,014	107,380	140,412	137,986	141,042	134,067	134,229	123,067	111,318	102,274
13	91,364	92,101	98,998	107,992	140,394	137,676	141,265	133,995	134,013	122,619	110,925	102,383
14	91,747	91,953	98,952	109,283	140,301	137,366	141,116	133,977	133,725	122,173	110,631	102,289
15	92,220	91,732	98,921	118,260	140,246	137,001	140,894	133,743	133,419	121,728	110,371	102,211
16	92,665	91,570	98,860	126,639	140,301	136,709	140,690	133,437	133,204	121,300	110,014	102,070
17	92,888	91,394	98,845	129,589	140,227	136,690	140,783	133,078	132,970	120,855	109,657	101,961
18	93,052	91,261	98,875	131,488	140,264	136,581	140,598	132,720	132,702	120,446	109,267	101,805
19	93,126	90,952	99,060	132,916	140,135	136,345	140,486	132,345	132,381	119,970	108,879	101,742
20	93,185	91,718	99,056	136,345	139,969	136,164	140,449	131,952	132,059	119,563	108,476	101,539
21	93,245	92,903	100,001	138,443	139,767	136,290	140,357	131,595	131,702	119,087	108,105	102,508
22	93,542	93,647	101,445	139,859	139,712	137,712	140,209	131,220	131,345	118,648	107,718	103,594
23	93,812	94,246	102,414	140,764	139,675	140,635	140,061	130,794	130,972	118,243	107,332	104,209
24	93,872	94,606	103,184	141,079	139,583	141,857	139,877	130,387	130,617	117,906	106,948	104,812
25	93,901	94,935	103,815	141,116	139,638	141,765	139,657	129,979	130,263	117,468	106,564	105,574
26	93,797	95,690	104,240	141,079	139,675	141,506	139,418	129,518	129,873	117,148	106,164	106,116
27	93,722	96,521	104,574	141,024	139,749	141,301	139,142	129,306	129,483	116,680	105,860	108,701
28	93,677	96,963	104,891	141,042	139,914	140,876	138,848	129,095	129,095	116,278	105,479	110,680
29	93,617	97,268		141,024	139,951	140,616	138,627	129,625	128,902	115,876	105,145	111,842
30	93,677	97,527		140,987	139,987	140,430	138,296	130,156	128,655	115,459	104,732	112,563
31	93,587	97,710		140,968		140,264		132,273	128,251		104,383	
Change	+11,258	+4,123	+7,181	+36,077	-981	+277	-1,968	-6,023	-4,022	-12,792	-11,076	+8,180
Equiv. mgd	+363.2	+133.0	+256.5	+1,164	-32.7	+8.94	-65.6	-194.3	-129.7	-426.4	-357.3	+272.7
Equiv. cfs	+562	+206	+397	+1,180	-50.6	+13.8	-101	-301	-201	-660	-553	+422
Change for year +30,234 million gallons							Equiv. for year +82.8 mgd			Equiv. for year +128.1 cfs		

Table 10. - Storage in Cannonsville Reservoir, N.Y., for year ending November 30, 1986
(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	71,066	75,030	81,625	97,251	97,846	96,237	97,090	94,657	87,580	89,104	74,326	69,675
2	71,821	74,851	82,146	97,299	97,701	96,012	97,058	94,444	88,013	88,967	74,008	69,384
3	73,079	74,727	82,579	97,267	97,589	95,803	96,832	94,276	88,328	88,830	73,490	68,947
4	73,901	74,658	83,027	97,202	97,283	95,630	96,591	94,033	88,724	88,587	73,622	68,550
5	74,561	74,575	83,504	97,122	97,218	95,387	96,253	93,729	88,754	88,086	73,834	68,060
6	75,058	74,478	83,995	97,074	97,235	95,158	96,494	93,455	88,648	87,406	73,954	67,993
7	75,472	74,326	84,487	97,009	97,170	95,128	97,492	93,090	88,997	87,132	73,981	68,046
8	75,707	74,133	84,863	96,929	97,106	95,143	98,265	92,847	89,089	87,031	73,967	68,139
9	75,901	73,967	85,224	96,832	97,090	95,158	98,539	92,436	89,286	86,872	73,940	68,536
10	75,970	73,808	85,571	96,832	97,074	95,174	98,426	92,055	89,454	86,655	73,808	69,371
11	76,053	73,649	85,889	96,945	97,041	95,174	98,184	91,583	89,621	86,424	73,477	69,980
12	76,315	73,530	85,990	98,249	97,041	95,158	97,959	91,249	89,758	85,846	73,265	70,470
13	76,702	73,371	86,048	98,265	96,993	95,113	98,088	91,157	89,819	85,065	73,146	70,920
14	76,951	73,238	86,077	98,684	96,929	95,067	98,120	91,325	89,819	84,501	73,026	71,272
15	77,075	73,013	86,279	102,916	96,832	95,006	97,911	91,294	89,804	84,140	72,973	71,517
16	77,103	72,814	86,539	106,705	96,897	94,946	97,573	91,127	89,804	83,735	72,934	71,728
17	77,200	72,629	86,785	103,753	97,009	95,143	97,428	90,868	89,819	83,302	72,801	71,967
18	77,227	72,285	87,031	101,677	97,025	95,234	97,315	90,625	89,834	82,680	72,470	72,126
19	77,089	72,139	87,464	100,743	97,074	95,250	96,929	90,366	89,956	81,987	72,324	72,430
20	76,923	72,725	88,161	101,532	97,074	95,402	96,687	89,940	90,077	80,961	72,232	72,629
21	76,758	74,588	89,469	101,017	97,041	95,754	96,591	89,621	90,184	80,170	72,073	73,490
22	76,619	75,763	91,386	100,325	97,041	96,993	96,366	89,302	90,321	79,410	71,887	75,707
23	76,440	76,675	93,014	99,681	97,058	98,200	96,157	88,997	90,397	78,581	71,742	76,937
24	76,288	77,324	94,322	99,215	97,058	98,700	95,947	88,632	90,503	78,111	71,464	78,083
25	76,288	77,711	95,341	98,828	97,186	98,651	95,835	88,267	90,518	77,531	71,026	79,576
26	76,177	78,180	96,414	98,506	97,138	98,442	95,660	87,782	90,564	76,896	70,748	80,694
27	75,970	79,037	96,864	98,345	97,025	98,104	95,417	87,479	90,610	76,550	70,656	83,865
28	75,763	79,742	97,122	98,297	96,993	97,830	95,280	87,161	90,686	75,901	70,536	86,843
29	75,624	80,225		98,184	96,736	97,589	95,128	86,886	90,625	75,389	70,311	88,572
30	75,431	80,694		98,056	96,478	97,363	94,915	86,828	90,077	74,809	70,205	89,925
31	75,251	81,177		97,975		97,186		87,161	89,545		69,993	
Change	+4,755	+5,926	+15,945	+853	-1,497	+708	-2,271	-7,754	+2,384	-14,736	-4,816	+19,932
Equiv. mgd	+153.4	+191.2	+569.5	+27.5	-49.9	+22.8	-75.7	-250	+76.9	-491	-155	+664.4
Equiv. cfs	+237	+296	+881	+42.6	-77.2	+35.3	-117	-387	+119	-760	-240	+1,030
Change for year +19,429 million gallons	Equiv. for year +53.2 mgd											Equiv. for year 82.3 cfs

Table 11. - Storage in Neversink Reservoir, N.Y. for year ending November 30, 1986
(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	26,659	28,018	27,438	27,056	34,218	33,139	33,120	33,192	29,569	25,967	21,401	17,781
2	27,005	27,953	27,430	27,022	34,086	33,273	32,895	33,115	29,262	25,816	21,291	17,643
3	27,507	28,005	27,399	26,992	33,901	33,379	32,966	33,134	29,137	25,649	21,146	17,473
4	27,732	27,831	27,369	26,966	33,693	33,485	33,043	33,048	29,013	25,495	21,211	17,312
5	27,883	27,779	27,365	26,928	33,480	33,577	33,105	32,947	28,857	25,345	21,215	17,155
6	28,014	27,719	27,374	26,889	33,230	33,669	33,317	32,838	28,702	25,263	21,131	17,059
7	28,097	27,632	27,344	26,847	33,072	33,761	33,528	32,714	28,755	25,143	21,006	16,988
8	28,167	27,537	27,318	26,791	32,843	33,838	33,751	32,557	28,764	25,006	20,885	16,917
9	28,241	27,434	27,275	26,714	32,690	33,911	33,920	32,410	28,685	24,867	20,738	16,995
10	28,285	27,356	27,219	26,655	32,648	33,974	34,023	32,264	28,588	24,711	20,626	17,196
11	28,315	27,288	27,172	26,625	32,576	34,027	34,115	32,104	28,508	24,559	20,473	17,257
12	28,420	27,202	27,120	26,625	32,510	34,076	34,282	31,986	28,438	24,397	20,342	17,281
13	28,522	27,129	27,051	26,595	32,410	34,130	34,783	31,916	28,315	24,230	20,153	17,278
14	28,610	27,043	26,979	26,659	32,359	34,174	35,040	31,827	28,197	24,052	20,039	17,233
15	28,623	26,936	26,911	28,623	32,245	34,213	35,040	31,728	28,071	23,874	19,968	17,165
16	28,628	26,842	26,851	30,254	32,174	34,257	35,016	31,606	27,944	23,685	19,869	17,107
17	28,636	26,736	26,778	30,767	32,264	34,340	34,996	31,471	27,818	23,545	19,767	17,053
18	28,636	26,650	26,748	31,081	32,307	34,428	34,892	31,336	27,840	23,389	19,646	17,053
19	28,601	26,566	26,753	31,392	32,278	34,478	34,714	31,187	27,766	23,218	19,525	16,992
20	28,553	26,693	26,787	33,211	32,259	34,522	34,547	31,025	27,654	23,067	19,380	16,917
21	28,526	27,034	26,795	33,727	32,226	34,976	34,287	30,892	27,528	22,902	19,250	17,244
22	28,500	27,163	26,987	34,159	32,278	35,234	34,086	30,721	27,417	22,752	19,123	17,615
23	28,478	27,227	27,077	34,394	32,302	35,294	33,862	30,615	27,288	22,599	18,990	17,757
24	28,442	27,236	27,107	34,571	32,316	35,115	33,794	30,428	27,172	22,474	18,839	17,830
25	28,407	27,223	27,129	34,438	32,387	34,966	33,722	30,268	27,026	22,326	18,693	17,994
26	28,381	27,292	27,116	34,296	32,505	34,783	33,630	30,104	26,889	22,182	18,551	18,109
27	28,311	27,442	27,081	34,282	32,614	34,561	33,538	30,050	26,740	22,031	18,448	19,584
28	28,267	27,516	27,073	34,321	32,662	34,257	33,451	29,928	26,595	21,872	18,331	20,183
29	28,202	27,498		34,282	32,843	34,003	33,379	29,796	26,452	21,715	18,208	20,465
30	28,145	27,494		34,292	33,005	33,702	33,293	29,643	26,308	21,554	18,071	20,633
31	28,080	27,464		34,282		33,374		29,518	26,144		17,935	
Change	+1,544	-616	-391	+7,209	-1,277	+369	-81	-3,775	-3,374	-4,590	-3,619	+2,698
Equiv. mgd	+49.8	-19.9	-14.0	+232.5	-42.6	+11.9	-2.70	-121.8	-108.8	-153	-116.7	+89.9
Equiv. cfs	+77.1	-30.7	-21.6	+360	-65.9	+18.4	-4.18	-188	-168	-237	-181	+139
Change for year -5,903 million gallons												Equiv. for year 25.0 cfs
Equiv. for year -16.2 mgd												

Table 12. - Diversions by New Jersey through the
Delaware & Raritan Canal in million gallons
Record furnished by New Jersey Water Supply Authority

Day	December 1985			January 1986			February		
	Carnegie Lake	Waste gate	Kingston Lock	Daily Total	Carnegie Lake	Waste gate	Kingston Lock	Daily Total	Daily Total
1					16		65	81	28
2					16		66	82	51
3					16		65	81	23
4					21		67	88	38
5					14		68	82	50
6					23		68	91	13
7					21		63	84	0
8					22		59	93	0
9					13		54	75	0
10					21		65	86	26
11					22		68	90	54
12					23		66	89	25
13					23		67	90	0
14					23		65	100	0
15					14		63	77	0
16					19		64	83	37
17					19		65	84	68
18	38		0	38	20		67	87	75
19	42		0	42	21		67	88	109
20	42		0	42	19		67	86	124
21	20		36	56	23		0	23	104
22	-9		45	36	31		13	44	65
23	-16		47	31	0		73	73	106
24	14		45	59	0		73	73	105
25	16		53	69	0		70	70	116
26	7		58	65	0		67	67	109
27	9		53	62	0		76	76	90
28	12		62	74	0		63	63	74
29	16		67	83	0		71	71	
30	16		65	81	0		71	71	
31	15		64	79	0		80	80	

Canal opened December 18, 1985

Table 12. - Diversions by New Jersey through the Delaware & Raritan Canal in million gallons-continued
Record furnished by New Jersey Water Supply Authority

Day	March			April			May		
	Carnegie Lake	Waste gate	Kingston Lock	Daily Total	Carnegie Lake	Waste gate	Kingston Lock	Daily Total	Daily Total
1		0	74	74		0	84	84	
2		0	65	65		0	82	82	
3		0	65	65		0	82	82	
4		0	66	66		0	80	80	
5		0	63	63		0	79	79	
6		0	58	58		0	98	98	
7		0	50	50		0	95	95	
8		0	53	53		0	98	98	
9		0	56	56		0	81	81	
10		0	58	58		0	81	81	
11		0	61	61		0	81	81	
12		0	62	62		0	81	81	
13		18	63	81		0	81	81	
14		29	63	92		0	81	81	
15		29	66	95		0	79	79	
16		29	65	94		25	85	110	
17		29	65	94		130	103	233	
18		29	63	92		76	85	161	
19		29	62	91		34	86	120	
20		29	62	91		14	89	103	
21		29	62	91		0	91	91	
22		26	62	88		0	64	64	
23		16	63	79		0	69	69	
24		12	63	75		0	84	84	
25		5	63	68		0	83	83	
26		0	75	75		0	79	79	
27		0	75	75		0	88	88	
28		0	75	75		0	86	86	
29		0	75	75		0	76	76	
30		0	74	74		0	48	48	
31		0	73	73					

Note: Canal closed April 29, flow April 30 is from storage.

Table 12. - Diversions by New Jersey through the Delaware & Raritan Canal in million gallons-continued
Record furnished by New Jersey Water Supply Authority

Day	June				July				August			
	Carnegie Lake	Waste gate	Kingston Lock	Daily Total	Carnegie Lake	Waste gate	Kingston Lock	Daily Total	Carnegie Lake	Waste gate	Kingston Lock	Daily Total
1										24	48	72
2										12	49	61
3										24	48	72
4										11	48	59
5										29	20	49
6										49	0	49
7										49	0	49
8										49	0	49
9										24	23	47
10										24	33	57
11										12	44	56
12										25	43	68
13										31	41	72
14										12	41	53
15	26	0	0	26						3	55	58
16	32	44	0	76						0	52	52
17	13	44	21	78						0	53	53
18	0	33	26	59						0	54	54
19	0	23	30	53						0	55	55
20	0	19	35	54						0	55	55
21	0	12	63	75						0	55	55
22	0	12	59	71						10	56	66
23	0	0	58	58						18	55	73
24	0	0	61	61						9	56	65
25	0	0	61	61						12	56	68
26	0	0	55	55						12	56	68
27	0	0	51	51						12	55	67
28	0	28	55	83						4	55	59
29	0	5	49	54						0	55	55
30	0	0	46	46						0	55	55
31	0	24	45	69						0	55	55

Canal reopened July 15

Table 12. - Diversions by New Jersey through the Delaware & Raritan Canal in million gallons-continued
Record furnished by New Jersey Water Supply Authority

Day	September				October				November			
	Carnegie Lake	Waste gate	Kingston Lock	Daily Total	Carnegie Lake	Waste gate	Kingston Lock	Daily Total	Carnegie Lake	Waste gate	Kingston Lock	Daily Total
1			55	55	0		56	56	34	0	50	84
2			55	55	0		56	56	35	0	50	86
3			55	55	0		54	54	33	0	50	83
4			55	55	0		53	53	35	0	50	85
5			55	55	0		56	56	34	0	50	84
6			55	55	0		55	55	42	0	52	94
7			55	55	0		55	55	39	0	52	91
8			55	55	13		55	68	40	0	53	93
9			55	55	22		53	75	40	0	54	94
10			55	55	27		52	79	41	0	59	100
11			55	55	30		52	82	35	0	55	90
12			55	55	29		52	81	45	0	58	103
13			55	55	29		52	81	38	0	57	95
14			55	55	31		52	83	29	0	56	85
15			55	55	30		52	82	28	0	55	83
16			56	56	29		53	82	25	0	53	78
17			56	56	35		51	86	21	0	53	74
18			56	56	32		51	83	25	0	55	80
19			56	56	36		51	87	41	0	47	88
20			56	56	37		52	89	46	16	46	101
21			57	57	40		53	93	40	24	40	112
22			57	57	43		52	95	39	10	39	88
23			56	56	43		52	95	39	0	58	97
24			56	56	42		52	94	34	0	58	92
25			56	56	40		52	92	32	0	56	88
26			56	56	41		52	93	30	4	56	90
27			57	57	41		52	93	39	12	48	99
28			57	57	41		52	93	43	5	55	103
29			56	56	37		52	89	43	0	55	98
30			56	56	35		50	85	34	0	53	87
31					36		50	86				

Table 13. - Diversions to New York City water supply
 Million gallons per day for 24-hour period beginning 0900 local time
 (River Master daily operation record)

Date 1985	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date Nov. 1, 1985 to Dec. 18 or Dec. 19-31, 1985	Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date Dec. 19, 1985 to date
Dec. 1	0	494	152	683	Jan. 1	240	402	115	751
2	0	495	113	681	2	244	316	0	738
3	9	496	116	679	3	239	290	241	740
4	260	496	110	685	4	238	290	117	735
5	243	496	119	690	5	238	289	115	729
6	245	496	115	694	6	244	289	116	725
7	0	497	119	692	7	244	289	120	722
8	0	497	106	690	8	245	289	125	719
9	245	497	116	694	9	243	289	124	716
10	187	497	113	697	10	241	289	116	713
11	195	497	113	699	11	241	289	118	710
12	189	478	113	701	12	244	288	110	707
13	193	497	116	704	13	244	288	118	705
14	0	497	117	702	14	244	289	120	703
15	0	497	125	700	15	245	288	116	701
16	208	497	124	703	16	243	288	125	700
17	208	498	123	705	17	245	288	118	698
18	209	496	119	708	18	433	288	123	703
19	209	497	119	825	19	56	288	120	695
20	205	497	122	824	20	244	289	118	694
21	0	497	113	753	21	245	289	116	693
22	0	497	114	718	22	244	290	118	692
23	189	496	124	736	23	243	290	116	690
24	275	407	115	746	24	244	290	123	689
25	312	402	115	758	25	246	290	121	689
26	260	402	115	760	26	246	290	120	688
27	240	403	112	760	27	241	59	119	681
28	240	402	123	760	28	239	0	123	673
29	111	402	130	750	29	244	0	113	666
30	236	402	114	750	30	244	0	127	659
31	234	402	123	750	31	239	0	132	652
Total	4,902	14,624	3,668			7,530	7,713	3,703	

Table 13. - Diversions to New York City water supply - continued
 Million gallons per day for 24-hour period beginning 0900 local time
 (River Master daily operation record)

Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date Dec. 19, 1985 to date	Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date Dec. 19, 1985 to date
Feb. 1	239	0	128	646	Mar. 1	244	0	116	546
2	238	0	123	640	2	244	0	120	543
3	244	0	109	634	3	245	0	113	541
4	245	0	118	628	4	245	0	116	539
5	243	0	117	623	5	247	0	114	536
6	245	0	126	618	6	245	0	125	534
7	245	0	119	613	7	260	0	119	532
8	245	0	119	608	8	261	0	120	530
9	244	0	121	603	9	265	0	119	529
10	247	0	121	599	10	186	138	117	527
11	239	187	117	598	11	245	189	128	528
12	239	187	124	597	12	254	181	128	528
13	242	186	115	596	13	244	181	118	528
14	247	39	123	593	14	239	37	120	527
15	246	0	124	589	15	238	0	120	525
16	246	0	124	585	16	238	0	120	523
17	246	0	115	582	17	240	0	114	521
18	244	0	126	578	18	244	0	114	519
19	244	0	116	575	19	244	0	114	518
20	244	0	122	572	20	244	0	253	517
21	244	0	124	568	21	252	0	0	515
22	244	0	122	565	22	245	0	110	513
23	243	0	124	562	23	242	0	104	511
24	243	0	119	559	24	245	0	391	512
25	245	0	116	557	25	243	0	403	514
26	244	0	127	554	26	245	0	381	515
27	245	0	113	551	27	245	0	384	516
28	244	0	115	548	28	247	0	403	517
					29	248	0	358	518
					30	248	0	392	519
					31	243	0	370	520
Total	6,824	599	3,367			7,575	726		5,804

Table 13. - Diversions to New York City water supply - continued
 Million gallons per day for 24-hour period beginning 0900 local time
 (River Master daily operation record)

Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date Dec. 19, 1985 to date	Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date Dec. 19, 1985 to date
Apr. 1	244	0	380	521	May 1	449	498	0	546
2	243	0	408	523	2	450	498	0	549
3	243	0	380	524	3	450	497	0	552
4	241	0	388	525	4	451	497	0	555
5	241	0	434	526	5	452	497	0	558
6	240	0	365	527	6	449	301	0	559
7	245	0	414	528	7	450	210	0	560
8	258	0	328	528	8	449	181	0	561
9	301	0	187	528	9	449	181	0	561
10	299	0	203	528	10	449	181	0	562
11	303	0	199	528	11	447	180	0	562
12	303	0	202	527	12	458	181	0	563
13	304	0	157	527	13	462	180	0	563
14	300	0	208	527	14	452	181	0	564
15	294	0	195	526	15	445	180	0	564
16	299	0	146	526	16	451	181	0	565
17	297	0	148	525	17	451	180	0	565
18	452	0	159	526	18	451	180	0	565
19	452	0	137	526	19	463	180	0	566
20	452	0	161	527	20	445	180	0	566
21	450	0	146	527	21	451	8	377	568
22	450	0	157	528	22	449	0	414	570
23	450	0	156	529	23	56	0	365	569
24	450	0	142	529	24	0	0	391	568
25	451	163	148	531	25	0	0	415	567
26	433	178	157	533	26	0	0	403	566
27	451	185	153	535	27	413	0	455	568
28	452	406	0	537	28	450	0	385	569
29	450	497	0	540	29	450	0	411	571
30	449	498	0	543	30	449	0	420	573
					31	410	0	393	574
Total	10,497	1,927	6,258			12,151	5,352	4,429	

Table 13. - Diversions to New York City water supply - continued
 Million gallons per day for 24-hour period beginning 0900 local time
 (River Master daily operation record)

Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date June 1, 1986 to date	Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date June 1, 1986 to date
June 1	448	0	338	786	July 1	450	178	149	710
2	450	340	0	788	2	450	178	144	712
3	450	297	0	774	3	450	179	147	713
4	407	381	0	778	4	449	178	145	715
5	400	235	0	749	5	450	178	145	717
6	400	0	0	691	6	450	178	156	719
7	399	0	0	649	7	452	169	177	721
8	400	0	0	618	8	450	178	117	722
9	400	0	0	594	9	450	178	147	723
10	399	0	0	574	10	448	178	147	724
11	443	391	5	598	11	450	178	148	725
12	452	70	0	592	12	450	178	88	725
13	450	0	0	581	13	450	177	210	728
14	450	0	143	582	14	450	177	146	729
15	450	0	145	583	15	450	178	149	730
16	450	0	270	591	16	450	178	152	731
17	450	0	312	601	17	449	177	147	732
18	450	183	314	621	18	450	178	153	733
19	450	183	312	638	19	450	177	146	734
20	450	180	394	657	20	450	177	137	734
21	450	180	292	670	21	450	177	164	735
22	451	180	321	682	22	450	177	112	735
23	449	179	143	686	23	451	177	187	737
24	450	179	149	690	24	450	177	150	738
25	449	179	144	693	25	450	177	147	738
26	450	179	150	697	26	450	177	152	739
27	449	179	153	700	27	450	177	151	740
28	451	179	158	703	28	450	177	149	740
29	451	178	133	705	29	452	177	153	741
30	451	179	144	707	30	449	177	149	742
					31	450	177	154	742
Total	13,149	4,051	4,020			13,950	5,494		4,618

Table 13. - Diversions to New York City water supply - continued
 Million gallons per day for 24-hour period beginning 0900 local time
 (River Master daily operation record)

Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date June 1, 1986 to date	Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date June 1, 1986 to date
Aug. 1	451	56	158	741	Sept. 1	450	184	156	706
2	451	0	154	739	2	450	182	163	707
3	450	0	149	737	3	450	182	153	708
4	450	178	161	738	4	450	182	151	709
5	450	178	157	738	5	451	180	156	709
6	449	178	153	739	6	450	180	152	710
7	459	178	165	740	7	450	180	152	711
8	450	34	156	738	8	450	180	153	712
9	450	0	145	736	9	451	179	156	712
10	450	0	152	734	10	449	184	153	713
11	450	0	155	733	11	449	178	159	714
12	449	0	151	731	12	450	178	156	714
13	449	0	152	729	13	450	178	161	715
14	450	0	149	727	14	450	178	169	716
15	451	0	152	726	15	450	178	165	717
16	451	0	154	724	16	450	178	152	717
17	451	0	147	722	17	449	177	155	718
18	450	0	155	721	18	449	177	156	718
19	450	0	142	719	19	450	177	158	719
20	450	0	155	718	20	451	178	161	720
21	450	0	152	717	21	451	178	157	720
22	449	0	150	715	22	450	177	154	721
23	449	0	151	714	23	450	176	153	721
24	448	0	159	713	24	450	176	153	722
25	450	0	142	711	25	375	176	153	722
26	450	0	159	710	26	447	176	158	722
27	452	0	153	709	27	449	175	162	723
28	173	0	158	705	28	449	175	154	723
29	258	180	152	703	29	450	175	159	724
30	449	185	158	704	30	451	175	159	724
31	450	185	159	705					
Total	13,489	1,352	4,755			13,421	5,349	4,699	

Table 13. - Diversions to New York City water supply - continued
 Million gallons per day for 24-hour period beginning 0900 local time
 (River Master daily operation record)

Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date June 1, 1986 to date	Date 1986	East Delaware Tunnel	West Delaware Tunnel	Never- sink Tunnel	Average to date June 1, 1986 to date
Oct. 1	454	175	160	725	Nov. 1	449	175	157	736
2	448	175	167	725	2	449	174	166	736
3	275	174	154	724	3	450	174	162	737
4	452	173	171	725	4	450	174	166	737
5	451	173	160	725	5	452	174	155	737
6	450	173	163	726	6	451	176	165	738
7	449	175	149	726	7	451	174	157	738
8	449	175	166	727	8	450	174	174	738
9	451	174	144	727	9	450	174	158	739
10	451	175	168	727	10	450	167	160	739
11	450	175	151	728	11	449	174	160	739
12	450	174	204	729	12	458	174	163	739
13	450	174	160	729	13	455	175	156	740
14	448	175	162	729	14	451	175	168	740
15	448	174	139	730	15	450	175	169	740
16	452	175	158	730	16	450	174	157	741
17	452	175	156	730	17	451	175	157	741
18	452	175	158	731	18	449	175	172	741
19	451	174	163	731	19	451	175	170	741
20	450	175	161	732	20	451	175	161	742
21	450	175	155	732	21	451	176	155	742
22	450	174	160	732	22	450	176	155	742
23	448	174	168	733	23	450	176	152	742
24	450	174	173	733	24	449	176	157	743
25	469	182	163	734	25	449	177	136	743
26	450	174	168	734	26	450	177	148	743
27	450	175	165	734	27	451	177	146	743
28	450	175	163	735	28	452	177	149	743
29	450	175	169	735	29	452	176	149	743
30	420	175	160	735	30	452	53	149	743
31	449	175	168	736					
Total	13,769	5,416	5,026			13,523	5,124	4,749	

Table 14.- New York City Reservoir release design data

(River Master daily operation record)												
Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases												
Date of advance estimate	Powerplant release		Uncontrolled runoff		Date	Discharge		Indicated deficiency adjustment cfs	Balancing adjustment cfs		Directed release	
	Lake Wallenpaupack cfs	Mongaupack Reservoir cfs	Present conditions cfs	Weather adjustment cfs		cfs	cfs				Daily cfs	Cumulative cfs
1985/86	1	2	3	4		5	6	7	8	9	10	11
Jan. 16	0	0	1,460	0	Jan. 19	1,460	290	0	290			
17	0	54	1,450	0	20	1,504	246	0	246			
June 26	0	194	1,523	7	June 29	1,724	126	0	126	126	42	42
27	0	65	1,398	77	30	1,540	310	0	310	436	201	243
July 10	0	194	902	51	July 13	1,147	703	+39	742	1,178	0	823
11	0	259	818	251	14	1,328	522	+39	561	1,739	0	823
22	473	0	1,208	0	25	1,681	169	-92	77	1,816	491	1,598
23	473	0	1,052	0	26	1,525	325	-92	233	2,049	554	2,152
24	0	0	896	12	27	908	942	-92	850	2,899	692	2,844
25	0	0	755	250	28	1,005	845	-63	782	3,681	56	2,900
26	473	0	733	332	29	1,538	312	-22	290	3,971	0	2,900
27	473	0	1,271	32	30	1,776	74	+10	84	4,055	0	2,900
Aug. 15	0	65	1,380	13	Aug. 18	1,458	392	-100	292	4,347	0	3,169
21	0	0	1,484	106	24	1,590	260	-100	160	4,507	208	3,377
22	0	65	1,462	63	25	1,590	260	-100	160	4,667	128	3,505
28	0	0	988	2	31	990	860	-100	760	5,427	1,193	4,698
												729
												-73

MONTAGUE DESIGN RATE = 1,700 CFS DECEMBER 1-21, 1985, 1,750 CFS DECEMBER 22, 1985 TO JUNE 14, 1986, AND 1,850 CFS JUNE 15 TO NOVEMBER 30, 1986

The estimated Montague discharge was greater than the Montague design rate

December 1, 1985 to January 18, 1986, January 21 to June 28, July 1-12, 15-24, 31 to August 17, 19-23, and 26-30,

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. 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 = Summation of Col. 8.

Col. 10 = Design rate - (Col. 9 + Col. 10 from Table 15), when positive; otherwise Col. 10 = 0.

Col. 11 = Summation of Col. 10.

Col. 12 = Col. 9 - Col. 11.

Col. 13 = Col. 12 divided by minus 10, limited to +100.

Table 14.- New York City Reservoir release design data - continued

Advance estimate of discharge of Delaware River at Montague (River Master daily operation record)														
exclusive of New York City reservoir releases														
Date of advance estimate	Powerplant release forecasts		Uncontrolled runoff		Date	Discharge cfs	Indicated deficiency adjustment cfs	Balancing adjustment cfs	Directed release		Actual deficiency		Cumulative difference cfs-days	Balancing adjustment cfs
	Lake Wallenpaupack cfs	Mongaup Reservoir cfs	Present conditions cfs	Weather adjustment cfs					Daily cfs	Cumulative cfs	Daily cfs	Cumulative cfs		
1986	1	2	3	4		5	6	7	8	9	10	11	12	13
Aug. 29	0	0	854	0	Sept. 1	854	996	-100	896	6,323	1,037	5,735	588	-59
30	0	65	848	0	2	913	937	-100	837	7,160	992	6,727	433	-43
31	711	270	769	0	3	1,750	100	-100	0	7,160	0	6,727	433	-43
Sept. 1	711	270	705	7	4	1,693	157	-73	84	7,244	0	6,727	517	-52
2	711	270	703	0	5	1,684	166	-59	107	7,351	48	6,775	576	-58
3	711	205	671	0	6	1,587	263	-43	220	7,571	163	6,938	633	-63
4	0	0	644	20	7	664	1,186	-43	1,143	8,714	1,127	8,065	649	-65
5	0	86	640	9	8	735	1,115	-52	1,063	9,777	1,325	9,390	387	-39
6	713	324	750	11	9	1,798	52	-58	0	9,777	110	9,500	277	-28
7	713	346	735	6	10	1,800	50	-63	0	9,777	207	9,707	70	-7
8	713	216	698	0	11	1,627	223	-65	158	9,935	201	9,908	27	-3
9	713	216	641	0	12	1,570	280	-39	241	10,176	310	10,218	-42	+4
10	713	151	574	72	13	1,510	340	-28	312	10,488	344	10,562	-74	+7
11	0	0	555	65	14	620	1,230	-7	1,223	11,711	1,132	11,694	17	-2
12	0	65	245	0	15	310	1,540	-3	1,537	13,248	1,781	13,475	-227	+23
13	714	216	461	0	16	1,391	459	+4	463	13,711	277	13,752	-41	+4
14	714	216	456	0	17	1,386	464	+7	471	14,182	482	14,234	-52	+5
15	714	216	394	0	18	1,324	526	-2	524	14,706	435	14,669	37	-4
16	357	216	438	0	19	1,011	839	+23	862	15,568	850	15,519	49	-5
17	357	151	442	0	20	950	900	+4	904	16,472	743	16,262	210	-21
18	0	0	258	53	21	311	1,539	+5	1,544	18,016	1,270	17,532	484	-48
19	0	43	453	19	22	515	1,335	-4	1,331	19,347	1,320	18,852	495	-50
20	0	162	451	0	23	613	1,237	-5	1,232	20,579	1,206	20,058	521	-52
21	0	162	483	25	24	670	1,180	-21	1,159	21,738	1,059	21,117	621	-62
22	0	162	504	138	25	804	1,046	-48	998	22,736	1,050	22,167	569	-57
23	0	162	488	210	26	860	990	-50	940	23,676	1,091	23,258	418	-42
24	0	119	635	47	27	801	1,049	-52	997	24,673	865	24,123	550	-55
25	0	0	596	474	28	1,070	780	-62	718	25,391	788	24,911	480	-48
26	0	43	642	253	29	938	912	-57	855	26,246	1,038	25,949	297	-30
27	0	162	719	37	30	918	932	-42	890	27,136	814	26,763	373	-37
Col. 1 - Furnished by power company.													Col. 10 = Design rate - (Col. 9 + Col. 10 from Table 15), when positive; otherwise Col. 10 = 0.	
Col. 2 - Furnished by power company.													Col. 11 = Summation of Col. 10.	
Col. 3 - Computed from index stations.													Col. 12 = Col. 9 - Col. 11.	
Col. 4 - Computed increase in runoff based on weather forecasts.													Col. 13 = Col. 12 divided by minus 10, limited to +100.	
Col. 5 = Col. 1 + Col. 2 + Col. 3 + Col. 4.														

Table 14.- New York City Reservoir release design data - continued

(River Master daily operation record)													
Advance estimate of discharge of Delaware River at Montague exclusive of New York City reservoir releases													
Date of advance estimate	Powerplant release forecasts			Uncontrolled runoff		Date	Discharge		Indicated deficiency		Balancing adjustment		Cumulative difference cfs-days
	Lake Wallenpaupack cfs	Mongaup Reservoir cfs	Present conditions cfs	Weather adjustment cfs			Daily cfs		Cumulative cfs		Daily cfs		
1986	1	2	3	4			5	6	7	8	9	10	11
Sept. 28	0	162	803	4	Oct. 1	969	381	-55	826	27,962	400	27,163	799
29	0	162	726	91	2	979	871	-48	823	28,785	867	28,030	755
30	238	162	669	195	3	1,264	586	-30	556	29,341	515	28,545	796
Oct. 1	238	119	645	94	4	1,096	754	-37	717	30,058	0	28,545	1,513
2	0	0	753	456	5	1,209	641	-80	561	30,619	0	28,545	2,074
3	0	65	822	901	6	1,788	62	-76	0	30,619	0	28,545	2,074
4	October 7-11, 1986 the estimated Montague				7		0	-80	0	30,619	0	28,545	2,074
5					8		0	-100	0	30,619	0	28,545	2,074
6	discharge was above the Montague design rate				9		0	-100	0	30,619	158	28,703	1,916
7					10		0	-100	0	30,619	110	28,813	1,806
8					11		0	-100	0	30,619	237	29,050	1,569
9	0	0	1,210	0	12	1,210	640	-100	540	31,159	935	29,985	1,174
10	0	0	1,180	5	13	1,250	600	-100	500	31,659	846	30,831	828
11	238	173	1,075	70	14	1,556	294	-100	194	31,853	242	31,073	780
12	238	173	993	42	15	1,446	404	-100	304	32,157	0	31,073	1,084
13	358	389	979	563	16	2,289	0	-100	0	32,157	0	31,073	1,084
14	358	259	1,122	156	17	1,895	0	-83	0	32,157	0	31,073	1,084
15	358	162	1,456	0	18	1,976	0	-78	0	32,157	0	31,073	1,084
16	0	0	1,225	0	19	1,225	625	-100	525	32,682	707	31,780	902
17	0	65	1,338	0	20	1,403	447	-100	347	33,029	634	32,414	615
18	477	356	1,228	0	21	2,061	0	-100	0	33,029	27	32,441	588
19	477	389	1,078	0	22	1,944	0	-100	0	33,029	0	32,441	588
20	0	389	934	0	23	1,323	527	-90	437	33,466	582	33,023	443
21	477	389	1,051	0	24	1,917	0	-62	0	33,466	0	33,023	443
22	477	194	1,034	0	25	1,705	145	-59	86	33,552	197	33,220	332
23	0	0	801	0	26	801	1,049	-59	990	35,542	1,112	34,332	210
24	0	194	973	187	27	1,354	496	-44	452	34,994	542	34,874	120
25	0	389	933	247	28	1,569	281	-44	237	35,231	0	34,874	357
26	0	389	956	127	29	1,472	378	-33	345	35,576	216	35,090	486
27	0	162	1,308	0	30	1,470	380	-21	359	35,935	511	35,601	334
28	0	162	1,409	0	31	1,571	279	-12	267	36,202	451	36,052	150

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 = Summation of Col. 8.

Col. 10 = Design rate - (Col. 9 + Col. 10 from Table 15), when positive; otherwise Col. 10 = 0.

Col. 11 = Summation of Col. 10.

Col. 12 = Col. 9 - Col. 11.

Col. 13 = Col. 12 divided by minus 10, limited to ± 100 .

Table 15. - 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 cubic feet per second for 24 hours										
Controlled releases from New York City reservoirs					Delaware River at Montague					
Controlled releases from power reservoirs					Segregation of flow					
Controlled releases					Controlled releases					
from power reservoirs					N.Y.C. reservoirs					
from power reservoirs					Power-plants					
from power reservoirs					Other					
from power reservoirs					Directed					
from power reservoirs					Date					
from power reservoirs					Mongaup Reservoir					
from power reservoirs					Lake Wallen-paupack					
from power reservoirs					Date					
from power reservoirs					Neversink					
from power reservoirs					Cannonsville					
from power reservoirs					Pepacton					
from power reservoirs					Directed					
from power reservoirs					Amount					
from power reservoirs					Date					
from power reservoirs					1985/86					
from power reservoirs					1					
from power reservoirs					2					
from power reservoirs					3					
from power reservoirs					4					
from power reservoirs					5					
from power reservoirs					6					
from power reservoirs					7					
from power reservoirs					8					
from power reservoirs					9					
from power reservoirs					10					
from power reservoirs					11					
from power reservoirs					12					
from power reservoirs					13					
from power reservoirs					14					
from power reservoirs					15					
from power reservoirs					16					
from power reservoirs					17					
from power reservoirs					18					
from power reservoirs					19					
from power reservoirs					20					
from power reservoirs					21					
from power reservoirs					22					
from power reservoirs					23					
from power reservoirs					24					
from power reservoirs					25					
from power reservoirs					26					
from power reservoirs					27					
from power reservoirs					28					
from power reservoirs					29					
from power reservoirs					30					
from power reservoirs					31					
from power reservoirs					Total					
from power reservoirs					536					
from power reservoirs					1,562					
from power reservoirs					1,381					
from power reservoirs					772					
from power reservoirs					15,015					
from power reservoirs					7,733					
from power reservoirs					546					
from power reservoirs					3,169					
from power reservoirs					22,748					
from power reservoirs					118,457					
from power reservoirs					144,920					

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 1200 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 15. - 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 cubic feet per second for 24 hours												
Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague				
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Mongaup Reservoir	Segregation of flow			Computed uncontrolled	Total
Date	Amount							N.Y.C. reservoirs	Power-plants	Other		
1986	1	2	3	4	Jan. 31	5	6	7	8	9	10	11
Jan. 29	0	51	34	25	Jan. 31	792	373	0	110	1,165	4,045	5,320
30	0	50	34	26	Feb. 1	0	292	0	110	292	3,748	4,150
31	0	53	34	26	Feb. 2	56	464	3	113	520	3,867	4,500
Feb. 1	0	53	34	25	3	1,010	427	0	112	1,437	3,801	5,350
2	0	51	34	25	4	1,023	470	0	110	1,493	3,597	5,200
3	0	51	34	25	5	1,013	475	0	110	1,488	3,652	5,250
4	0	51	34	25	6	1,016	464	7	110	1,480	3,510	5,100
5	0	50	34	25	7	976	232	0	109	1,208	3,063	4,380
6	0	50	34	25	8	0	211	9	109	211	2,950	3,270
7	0	50	34	25	9	63	221	0	109	284	3,187	3,580
8	0	50	34	25	10	960	437	0	109	1,397	2,924	4,430
9	0	50	34	25	11	941	54	0	109	995	2,666	3,770
10	0	50	34	25	12	1,024	157	0	109	1,181	2,510	3,800
11	0	51	34	25	13	975	351	0	110	1,326	2,364	3,800
12	0	50	34	25	14	900	221	0	109	1,121	2,170	3,400
13	0	51	34	25	15	0	0	0	110	0	2,240	2,350
14	0	51	34	25	16	61	0	0	110	61	2,329	2,500
15	0	51	34	25	17	950	76	0	110	1,026	3,194	4,330
16	0	50	34	25	18	1,591	238	0	109	1,829	4,542	6,480
17	0	50	34	25	19	1,624	189	0	109	1,813	6,308	8,230
18	0	50	34	25	20	1,627	292	0	109	1,919	7,602	9,630
19	0	50	34	25	21	1,631	362	0	109	1,993	9,598	11,700
20	0	50	34	25	22	968	43	0	109	1,011	9,980	11,100
21	0	48	34	25	23	965	221	0	107	1,186	8,247	9,540
22	0	50	34	25	24	1,010	346	0	109	1,356	7,015	8,480
23	0	50	34	25	25	1,027	367	0	109	1,394	5,777	7,280
24	0	51	34	25	26	1,023	356	0	110	1,379	5,191	6,680
25	0	51	34	25	27	1,013	324	0	110	1,337	5,033	6,480
Total	0	1,414	952	702		24,239	7,663	0	3,068	31,902	125,110	160,080

Table 15. - 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 cubic feet per second for 24 hours													
Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague					
Directed		Neversink		Lake Wallenpaupack		Mongaup Reservoir		N.Y.C. reservoirs		Controlled releases		Computed	
Date	Amount	Pepacton	Cammonsville	Date	5	6	Date	Directed	Other	Power-plants	Uncontrolled	Total	
1986	1	2	3	4				7	8	9	10	11	
Feb. 26	0	57	34	25	909	243	Mar. 1	0	116	1,152	4,702	5,970	
27	0	50	34	25	0	200	2	0	109	200	4,731	5,040	
28	0	50	34	25	2	221	3	0	109	223	4,658	4,990	
Mar. 1	0	50	34	25	865	324	4	0	109	1,189	4,442	5,740	
2	0	50	34	25	942	297	5	0	109	1,239	4,232	5,580	
3	0	50	34	25	956	324	6	0	109	1,280	4,051	5,440	
4	0	50	34	25	1,001	308	7	0	109	1,309	3,782	5,200	
5	0	51	34	25	940	211	8	0	110	1,151	3,139	4,400	
6	0	51	34	25	0	146	9	0	110	146	2,954	3,210	
7	0	50	34	25	0	54	10	0	109	54	3,157	3,320	
8	0	56	34	25	953	146	11	0	115	1,099	3,936	5,150	
9	0	51	34	25	469	0	12	0	110	469	6,801	7,380	
10	0	50	34	25	469	0	13	0	109	469	8,512	9,090	
11	0	50	34	25	935	0	14	0	109	935	11,656	12,700	
12	0	50	34	25	1,019	265	15	0	109	1,284	76,607	78,000	
13	0	50	34	25	477	545	16	0	109	1,022	74,069	75,200	
14	0	51	34	26	1,377	502	17	0	111	1,879	42,110	44,100	
15	0	53	34	25	1,756	437	18	0	112	2,193	29,295	31,600	
16	0	50	34	25	1,775	475	19	0	107	2,250	27,043	29,400	
17	0	48	34	25	1,770	518	20	0	107	2,288	40,005	42,400	
18	0	50	34	25	1,770	459	21	0	109	2,229	28,462	30,800	
19	0	50	34	25	1,778	459	22	0	109	2,237	20,054	22,400	
20	0	50	34	25	1,784	454	23	0	109	2,238	15,153	17,500	
21	0	50	34	25	1,794	508	24	0	109	2,302	12,189	14,600	
22	0	51	34	25	1,785	502	25	0	110	2,287	10,803	13,200	
23	0	51	34	25	1,187	459	26	0	110	1,646	9,944	11,700	
24	0	50	34	25	1,171	443	27	0	109	1,614	9,877	11,600	
25	0	50	59	25	1,172	427	28	0	134	1,599	10,267	12,000	
26	0	51	34	25	964	448	29	0	110	1,412	9,678	11,200	
27	0	51	34	25	938	416	30	0	110	1,354	8,736	10,200	
28	0	51	34	25	941	421	31	0	110	1,362	8,218	9,690	
Total	0	1,571	1,079	776	31,899	10,212		0	3,426	42,111	503,263	548,800	

Table 15. - 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)

[illegible]

Col	2 - 24 hours beginning 1200 of date shown, except 23 hours Apr. 26.
Col.	3 - 24 hours ending 2400 one day later, except 23 hours Apr. 26.
Col.	4 - 24 hours beginning 1500 one day later, except 23 hours Apr. 25.
Col.	5 - 24 hours beginning 0800 of date shown, except 23 hours Apr. 26.
Col.	6 - 24 hours beginning 1200 of date shown, except 23 hours Apr. 26.

Col. 8 = Col. 2 + Col. 3 + Col. 4.
Col. 9 = Col. 5 + Col. 6.
Col. 10 = Col. 11 - Col. 7 - Col. 8 - Col. 9.
Col. 11 = 24 hours of calendar day shown,
except 23 hours Apr. 27.

Table 15. - 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)

(River basin daily operation records)													
Mean cubic feet per second for 24 hours													
Controlled releases from New York City reservoirs					Controlled releases from power reservoirs				Delaware River at Montague				
Directed		Pepacton	Cannonsville	Neversink	Lake Wallenpaupack		Mongaup Reservoir	Date	Segregation of flow				
Date	Amount				5	6			7	8	9	10	11
1986	1	2	3	4	5	6	7	8	9	10	11	Total	
Apr. 28	0	70	45	45	Apr. 30	952	502	May 1	0	160	1,454	5,336	6,950
29	0	70	46	45	May 1	955	43	2	0	161	998	4,891	6,050
30	0	70	46	45	2	1,192	173	3	0	161	1,365	4,334	5,860
May 1	0	70	46	46	3	954	0	4	0	162	954	3,844	4,960
2	0	70	46	45	4	738	38	5	0	161	776	3,363	4,300
3	0	70	46	45	5	799	194	6	0	161	993	3,346	4,500
4	0	70	46	45	6	946	275	7	0	161	1,221	3,198	4,580
5	0	70	46	45	7	928	194	8	0	161	1,122	2,977	4,260
6	0	70	46	45	8	930	221	9	0	161	1,151	2,708	4,020
7	0	70	46	45	9	967	194	10	0	161	1,161	2,418	3,740
8	0	70	46	45	10	0	0	11	0	161	0	2,329	2,490
9	0	70	46	45	11	0	49	12	0	161	49	2,150	2,360
10	0	70	46	45	12	466	205	13	0	161	671	1,888	2,720
11	0	70	46	46	13	0	162	14	0	162	162	1,866	2,190
12	0	70	46	46	14	0	70	15	0	162	70	1,698	1,930
13	0	70	46	46	15	0	200	16	0	162	200	1,668	2,030
14	0	70	46	46	16	0	130	17	0	162	130	1,808	2,100
15	73	66	46	46	17	0	0	18	73	85	0	2,682	2,840
16	61	73	46	46	18	0	76	19	61	104	76	2,729	2,970
17	0	70	46	46	19	0	275	20	0	162	275	2,213	2,650
18	0	70	46	46	20	0	292	21	0	162	292	2,706	3,160
19	0	70	46	46	21	0	157	22	0	162	157	11,781	12,100
20	0	70	46	46	22	918	319	23	0	162	1,237	17,201	18,600
21	0	71	46	46	23	946	356	24	0	163	1,302	12,935	14,400
22	0	71	46	46	24	0	448	25	0	163	448	11,489	12,100
23	0	71	46	46	25	0	319	26	0	163	319	9,818	10,300
24	0	71	46	46	26	0	405	27	0	163	405	8,342	8,910
25	0	70	46	46	27	913	346	28	0	162	1,259	6,639	8,060
26	0	70	46	46	28	976	308	29	0	162	1,284	5,484	6,930
27	0	70	46	46	29	984	448	30	0	162	1,432	4,446	6,040
28	0	70	46	45	30	1,041	356	31	0	161	1,397	3,542	5,100
Total	134	2,173	1,425	1,413		15,605	6,755		134	4,877	22,360	151,829	179,200

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 1200 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 15. - 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 cubic feet per second for 24 hours													
Controlled releases from New York City reservoirs						Controlled releases from power reservoirs				Delaware River at Montague			
Directed		Pepacton	Cannonsville	Neversink	Controlled releases from power reservoirs		Segregation of flow				Computed uncontrolled	Total	
Date	Amount				Lake Wallenpaupack	Mongaup Reservoir	Date	N.Y.C. reservoirs	Other	Power-plants			
1986	1	2	3	4	5	6	7	8	9	10	11		
May 29	0	71	46	45	May 30	216	0	162	216	3,532	3,910		
30	0	68	46	45	June 1	43	0	159	43	3,600	3,398		
31	0	70	46	45	2	265	0	161	265	2,974	3,400		
June 1	0	70	46	45	3	265	0	161	265	2,674	3,100		
2	0	70	46	45	4	189	0	161	189	2,280	2,630		
3	0	70	46	45	5								
4	0	70	53	45	6	259	0	161	841	8,948	9,950		
5	0	70	46	45	7	464	0	168	2,013	16,019	18,200		
6	0	70	46	45	8	437	0	161	2,145	14,900	14,900		
7	0	70	46	45	9	432	0	161	2,141	11,198	13,500		
8	0	70	46	45	10	459	0	161	2,047	8,792	11,000		
9	0	68	46	45	11	518	0	159	1,446	7,405	9,010		
10	0	70	46	45	12	518	0	161	1,546	9,893	11,600		
11	0	70	46	45	13	486	0	161	1,919	17,520	19,600		
12	0	70	46	45	14	410	0	161	1,861	13,478	15,500		
13	0	70	46	45	15	421	0	161	1,846	9,993	12,000		
14	0	70	46	45	16	459	0	161	1,919	8,620	10,700		
15	0	70	381	45	17	508	0	496	1,868	7,636	10,000		
16	0	70	379	45	18	459	0	494	1,872	6,954	9,320		
17	0	70	364	45	19	454	0	479	1,862	5,689	8,030		
18	0	70	354	45	20	448	0	469	1,913	4,688	7,070		
19	0	70	367	46	21	454	0	483	1,417	3,980	5,880		
20	0	70	376	45	22	454	0	491	1,365	3,374	5,230		
21	0	70	377	45	23	427	0	492	1,352	2,976	4,820		
22	0	70	376	43	24	470	0	489	1,400	2,561	4,450		
23	0	70	376	45	25	324	0	491	1,134	2,335	3,960		
24	0	70	376	45	26	405	0	491	984	2,005	3,480		
25	0	70	376	45	27	410	0	491	1,009	1,840	3,340		
26	126	71	376	45	28	437	0	492	1,125	1,643	3,260		
27	310	70	376	45	29	49	126	366	49	1,759	2,300		
Total	436	2,099	5,973	1,349	30	54	310	181	54	1,595	2,140		
						11,194	436	8,985	38,106	188,353	235,880		

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 1200 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 15. - Controlled releases from 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 cubic feet per second for 24 hours (River master daily operation record)													
Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague					
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen- paupack	Mongaup Reservoir	Date	Segregation of flow			Computed	
Date	Amount								N.Y.C. reservoirs	Power- plants	uncon- trolled		
1986	1	2	3	4	5	6	7	8	9	10	11	Total	
June 28	0	70	376	45	June 30	437	205	July 1	0	491	642	1,447	2,580
29	0	70	376	45	July 1	680	259	2	0	491	939	1,680	3,110
30	0	71	376	45	2	709	286	3	0	492	995	2,803	4,290
July 1	0	71	374	45	3	744	238	4	0	490	982	2,208	3,680
2	0	71	374	45	4	0	167	5	0	490	167	1,723	2,380
3	0	71	374	45	5	0	238	6	0	490	238	1,462	2,190
4	0	71	374	45	6	0	151	7	0	490	151	1,269	1,910
5	0	70	374	50	7	907	259	8	0	494	1,166	1,150	2,810
6	0	70	435	90	8	701	481	9	0	595	1,182	1,053	2,830
7	0	122	493	90	9	702	281	10	0	705	983	1,112	2,800
8	0	121	493	88	10	702	243	11	0	702	945	983	2,630
9	0	113	492	71	11	713	232	12	0	676	945	1,099	2,720
10	742	90	611	46	12	0	243	13	747	0	243	1,810	2,800
11	561	68	447	46	13	0	81	14	561	0	81	3,678	4,320
12	0	70	374	46	14	486	292	15	0	490	778	3,312	4,580
13	0	70	374	45	15	442	464	16	0	489	906	2,455	3,850
14	0	70	376	45	16	727	481	17	0	491	1,208	1,851	3,550
15	0	70	374	46	17	707	394	18	0	490	1,101	1,639	3,230
16	0	70	374	70	18	1,067	378	19	0	514	1,445	1,441	3,400
17	0	101	424	70	19	0	378	20	0	595	378	1,617	2,590
18	0	101	563	70	20	0	362	21	0	734	362	1,534	2,630
19	0	101	563	70	21	426	416	22	0	734	842	1,244	2,820
20	0	101	453	63	22	416	437	23	0	617	853	1,140	2,610
21	0	96	373	45	23	440	0	24	0	514	440	1,126	2,080
22	77	70	373	48	24	424	0	25	77	414	424	935	1,850
23	233	70	373	71	25	439	0	26	233	281	439	857	1,810
24	850	99	692	71	26	0	0	27	862	0	0	1,158	2,020
25	782	99	616	71	27	0	0	28	786	0	0	1,794	2,580
26	290	99	537	71	28	427	0	29	290	417	427	1,756	2,890
27	84	99	487	70	29	458	0	30	84	572	458	1,806	2,920
28	0	99	487	67	30	434	205	31	0	653	639	4,518	5,810
Total	3,619	2,634	13,782	1,835	13,188	7,171	3,640	14,611	20,359	53,660	92,270		

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 1200 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 15. - Controlled releases from 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 cubic feet per second for 24 hours														
Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague						
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallen-paupack	Mongaup Reservoir	Date	Segregation of flow				Computed uncontrolled	Total
Date	Amount								N.Y.C. reservoirs Directed	Other	Power-plants			
1986	1	2	3	4		5	6		7	8	9	10	11	
July 29	0	99	430	48	July 31	471	243	Aug. 1	0	577	714	4,709	6,000	
30	0	71	371	48	Aug. 1	405	135	2	0	490	540	4,390	5,420	
31	0	70	371	46	2	0	0	3	0	487	0	5,313	5,800	
Aug. 1	0	70	371	46	3	0	76	4	0	487	76	4,217	4,780	
2	0	70	371	46	4	400	270	5	0	487	670	3,253	4,410	
3	0	70	373	46	5	368	286	6	0	489	654	2,647	3,790	
4	0	71	373	46	6	275	248	7	0	490	523	2,557	3,570	
5	0	71	371	48	7	415	205	8	0	490	620	4,720	5,830	
6	0	71	371	46	8	413	383	9	0	488	796	3,356	4,640	
7	0	71	374	45	9	620	59	10	0	490	679	2,651	3,820	
8	0	71	373	45	10	0	157	11	0	489	157	2,544	3,190	
9	0	71	373	45	11	1,149	146	12	0	489	1,295	2,476	4,260	
10	0	70	373	45	12	1,137	0	13	0	488	1,137	2,075	3,700	
11	0	70	373	46	13	402	16	14	0	489	418	1,803	2,710	
12	0	71	373	45	14	0	238	15	0	489	238	1,543	2,270	
13	0	71	373	45	15	1,143	205	16	0	489	1,348	1,393	3,230	
14	0	71	373	46	16	0	178	17	0	490	178	1,472	2,140	
15	292	71	373	45	17	874	97	18	294	195	971	1,680	3,140	
16	0	70	373	45	18	1,185	243	19	0	488	1,428	1,984	3,900	
17	0	70	209	46	19	695	135	20	0	325	830	2,085	3,240	
18	0	70	43	46	20	658	65	21	0	159	723	1,838	2,720	
19	0	70	43	45	21	711	200	22	0	158	911	1,591	2,660	
20	0	70	43	46	22	714	178	23	0	159	892	1,509	2,560	
21	160	70	43	45	23	0	0	24	158	0	0	1,642	1,800	
22	160	70	43	45	24	0	92	25	158	0	92	1,630	1,880	
23	0	70	210	46	25	701	178	26	0	326	879	1,455	2,660	
24	0	70	207	46	26	813	216	27	0	323	1,029	1,288	2,640	
25	0	71	43	46	27	706	157	28	0	160	863	1,267	2,290	
26	0	71	43	42	28	719	189	29	0	156	908	1,066	2,130	
27	0	70	43	45	29	713	167	30	0	158	880	1,022	2,060	
28	760	71	657	45	30	0	0	31	773	0	0	657	1,430	
Total	1,372	2,213	8,760	1,415		15,687	4,762		1,383	11,005	20,449	71,833	104,670	

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 1200 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 15. - Controlled releases from 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 cubic feet per second for 24 hours												
Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague				
Directed		Pepacton	Cannonsville	Neversink	Date	Lake Wallenpaupack	Mongaup Reservoir	Date	Segregation of flow			
Date	Amount								N.Y.C. reservoirs	Power-plants	Computed uncontrolled	Total
1986	1	2	3	4		5	6		7	8	9	10
Aug. 29	896	104	733	70	Aug. 31	0	0	Sept. 1	907	0	0	813
30	837	101	671	70	Sept. 1	2	59	2	842	0	61	797
31	0	70	43	46	2	699	119	3	0	159	818	1,133
Sept. 1	84	70	43	53	3	729	265	4	84	82	994	1,200
2	107	70	43	45	4	719	243	5	107	51	962	840
3	220	70	108	45	5	691	184	6	223	0	875	1,910
4	1,143	99	1,010	48	6	0	0	7	1,157	0	0	723
5	1,063	101	928	46	7	0	43	8	1,075	0	43	1,600
6	0	71	43	46	8	702	130	9	0	160	832	1,900
7	0	68	43	46	9	703	173	10	0	157	876	1,800
8	158	70	43	48	10	727	243	11	161	0	970	1,810
9	241	68	127	45	11	723	173	12	240	0	896	1,780
10	312	70	199	45	12	709	162	13	314	0	871	1,820
11	1,223	102	1,062	68	13	0	173	14	1,232	0	173	1,950
12	1,537	108	1,373	70	14	0	16	15	1,551	0	16	1,620
13	463	71	340	46	15	726	227	16	457	0	953	2,030
14	471	71	365	46	16	703	140	17	482	0	843	1,850
15	524	71	418	46	17	705	232	18	535	0	937	1,950
16	862	71	753	46	18	357	238	19	870	0	595	1,870
17	904	71	794	48	19	356	92	20	913	0	448	2,020
18	1,544	70	1,425	45	20	0	0	21	1,540	0	0	580
19	1,331	70	1,214	46	21	0	54	22	1,330	0	54	476
20	1,232	70	1,120	46	22	0	151	23	1,236	0	151	493
21	1,159	70	1,044	45	23	0	92	24	1,159	0	92	699
22	998	70	885	45	24	0	97	25	1,000	0	97	703
23	940	70	826	45	25	0	173	26	941	0	173	586
24	997	70	880	45	26	0	157	27	995	0	157	828
25	718	70	603	45	27	0	0	28	718	0	0	1,980
26	855	70	743	45	28	0	32	29	858	0	32	1,062
27	890	70	778	46	29	189	216	30	894	0	405	1,670
Total	21,709	2,297	18,657	1,476		9,440	3,884		21,821	609	13,324	20,556
												56,310

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 1200 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 15. - Controlled releases from 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 cubic feet per second for 24 hours													
Controlled releases from New York City reservoirs					Controlled releases from power reservoirs			Delaware River at Montague					
Directed		Pepacton	Cannonsville	Neversink	Controlled releases from power reservoirs		Lake Wallenpaupack 5	Mongaup Reservoir 6	Segregation of flow			Total	
Date	Amount				Date	Date			N.Y.C. reservoirs	Power-plants	Computed uncontrolled		
1986	1	2	3	4					7	8	9	10	11
Oct. 29	306	70	192	45	Oct. 31	0	140	307	0	140	1,083	1,530	
30	489	70	354	63	Nov. 1	0	0	487	0	0	963	1,450	
31	592	135	396	67	2	0	16	598	0	16	886	1,500	
Nov. 1	733	141	531	68	3	0	146	740	0	146	844	1,730	
2	767	141	565	68	4	0	184	774	0	184	842	1,800	
3	838	141	631	67	5	0	178	839	0	178	1,013	2,030	
4	509	141	342	26	6	0	146	509	0	146	1,555	2,210	
5	167	50	94	26	7	0	103	170	0	103	2,117	2,390	
6	113	48	42	26	8	0	0	116	0	0	5,174	5,290	
7	0	53	34	26	9	0	81	0	113	81	10,506	10,700	
8	0	48	34	26	10	0	238	0	108	238	7,694	8,040	
9	0	50	34	28	11	0	367	0	112	367	6,091	6,570	
10	0	51	34	28	12	0	340	0	113	340	5,297	5,750	
11	0	51	34	28	13	0	194	0	113	194	4,473	4,780	
12	0	48	34	26	14	0	108	0	108	108	3,664	3,880	
13	0	50	34	23	15	0	0	0	107	0	3,293	3,400	
14	0	50	34	25	16	0	32	0	109	32	3,129	3,270	
15	0	50	34	26	17	0	367	0	110	367	3,553	4,030	
16	0	50	34	25	18	0	286	0	109	286	4,165	4,560	
17	0	51	34	28	19	0	416	0	113	416	4,051	4,580	
18	0	50	34	25	20	0	394	0	109	394	10,697	11,200	
19	0	50	34	26	21	0	383	0	110	383	16,907	17,400	
20	0	50	40	28	22	0	383	0	118	383	11,199	11,700	
21	0	50	34	22	23	0	421	0	106	421	9,223	9,750	
22	0	50	34	23	24	0	416	0	107	416	10,377	10,900	
23	0	50	36	25	25	549	410	0	111	959	9,230	10,300	
24	0	50	36	25	26	572	405	0	111	977	22,512	23,600	
25	0	50	34	26	27	555	405	0	110	960	20,530	21,600	
26	0	50	36	26	28	579	389	0	112	968	13,520	14,600	
27	0	50	36	26	29	590	394	0	112	984	9,804	10,900	
Total	4,514	1,989	3,875	997		2,845	7,342	4,540	2,321	10,187	204,392	221,440	

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 1200 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. - Consumption of Water by New York City - 1940 to 1986.
 Data furnished by New York City, Department of
 Environmental Protection, Bureau of Water Supply

Year	Consumption in City proper		Furnished to outside communities (mgd)	Total (mgd)	Annual (bg)
	(mgd)	(gpcd) ^{1/}			
1940	922.7	124	21.6	944.3	345.614
41	964.2	130	24.8	989.0	360.985
42	906.7	124	21.5	928.2	338.793
43	942.7	133	21.5	964.2	351.933
44	1,004.9	144	26.5	1,031.4	377.492
1945	1,056.2	146	22.0	1,078.2	393.543
46	1,117.1	146	24.1	1,141.2	416.538
47	1,159.0	149	30.4	1,189.4	434.131
48	1,172.3	150	31.5	1,203.8	440.591
49	1,166.9	149	36.2	1,203.1	439.132
1950	953.3	121	29.1	982.4	358.576
51	1,041.9	131	28.1	1,070.0	390.550
52	1,087.0	136	32.7	1,119.7	409.810
53	1,093.9	135	44.6	1,138.5	415.552
54	1,063.4	131	46.3	1,109.7	405.040
1955	1,109.9	136	45.3	1,155.2	421.648
56	1,111.3	136.2	48.9	1,160.2	424.633
57	1,169.0	143	57.2	1,226.2	447.563
58	1,152.9	140.8	49.6	1,202.5	438.912
59	1,204.3	146.8	60.3	1,264.6	461.579
1960	1,199.4	153.9	58.9	1,258.3	460.529
61	1,221.0	156.0	64.0	1,285.0	469.022
62	1,207.6	153.5	68.8	1,276.4	465.896
63	1,218.0	154.1	76.7	1,294.7	472.582
64	1,189.2	149.8	79.4	1,268.6	464.295
1965	1,052.1	131.9	71.2	1,123.3	409.995
66	1,044.9	130.4	73.2	1,118.1	408.128
67	1,135.3	141.0	71.0	1,206.3	440.302
68	1,242.0	153.6	78.2	1,320.2	483.175
69	1,328.7	163.5	80.1	1,408.8	514.229
1970	1,400.3	177.3	90.4	1,490.7	544.116
71	1,423.6	182.1	87.9	1,511.5	551.695
72	1,412.4	182.6	83.0	1,495.4	547.340
73	1,448.9	189.4	95.4	1,544.3	563.681
74	1,441.8	190.5	96.3	1,538.1	561.409
1975	1,415.0	189.0	92.1	1,507.1	550.093
76	1,435.0	193.9	95.8	1,530.8	560.264
77	1,483.0	202.6	104.7	1,587.7	579.510
78	1,479.4	204.4	103.0	1,582.4	577.566
79	1,513.0	211.5	104.6	1,617.6	590.426
1980	1,506.3	213.0	110.1	1,616.3	591.582
81	1,309.5	184.6*	100.0	1,409.5	514.475
82	1,383.0	194.2*	104.8	1,487.8	543.060
83	1,424.2	199.4*	112.6	1,536.8	561.010
84	1,465.2	204.4*	113.9	1,579.1	577.963
1985	1,325.4	184.4*	106.5	1,431.9	522.656
86	1,351.1	187.3*	115.2	1,466.3	535.200

^{1/} Gallons per Capita per day, (1970-85 revised).

*Provisional

FIGURE 3—UNCONTROLLED COMPONENT, DELAWARE RIVER AT MONTAGUE, N.J. 1986

Figure 4. - Combined storage in Pepacton, Cannonsville, and Neversink Reservoirs on first day of month, June 1967 to December 1986

PLATE I. COMPONENTS OF FLOW, DELAWARE RIVER AT MONTAGUE, N.J. 1986

Section III
WATER QUALITY OF THE DELAWARE RIVER ESTUARY

Figure 5.- Delaware River Estuary

Section III

WATER QUALITY OF THE DELAWARE RIVER ESTUARY

By Karen L. Vogel

INTRODUCTION

This section describes the water-quality monitoring program carried out by the U.S. Geological Survey in the Delaware Estuary during the 1986 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 Ship John Shoal Lighthouse, N.J. Data were acquired continuously by electronic instruments at six monitor sites, one at Trenton, just upstream of the head of tidewater and at five sites in the estuary (fig. 5). The monitors at Chester, Pa., Fort Mifflin, Pa. and Benjamin Franklin Bridge were not operated from early December 1985 through the end of March 1986. Due to instrument malfunctions at Fort Mifflin, there is no record for specific conductance from March to early April. The monitor at Ship John Shoal Lighthouse was not operated in December 1985 and was permanently shut-down on July 14, 1986. At Ship John Shoal Lighthouse and 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 at fourteen sites between Fieldsboro, N.J., and Marcus Hook, Pa. (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 under the auspices of the Delaware River Basin Commission for the City of Philadelphia Water Department. These data can be obtained from the City of Philadelphia Water Department.

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 1986

The following is a summary and discussion of the data that were collected during the 1986 report year. Additional information can be found in the tables at the end of this section.

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.

Based on streamflow records for the Delaware River at Trenton, mean monthly streamflow was lowest for the year during September (3,639 cfs) and highest for the year during March (29,650 cfs) (see table 8). The mean monthly streamflow was above the respective median for the period of record December, February through April, June, and November and below the median for the rest 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 11 North) Philadelphia, Pa., mean monthly temperatures for the period March to November 1986 were below normal in July, August, September, and November and equaled or exceeded the norm for the remainder of the reporting period. The norm is based on historical temperature records from 1962 to 1985 (see fig. 6).

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 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 17 and 19 were derived 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., (table 18) were furnished by Scott Paper Company.

At Fort Mifflin, the maximum daily chloride concentration equaled or exceeded 50 mg/L 21 percent of the time (see table 17). The maximum was 77 mg/L on July 27 and October 5. At Chester, the minimum chloride concentration equaled or exceeded 50 mg/L on July 19, 20, 23, and 25 through 31, August 1 through 3, September 4 through November 14, and November 21. A minimum chloride concentration exceeding 250 mg/L occurred on September 26 with a value of 280 mg/L (see table 18). The maximum daily chloride concentration in the estuary at Chester was greater than 50 mg/L 36 percent of the time and greater than 250 mg/L 15 percent of the time. The maximum at Chester was 528 mg/L on November 5. Minimum chloride concentrations in excess of 30 mg/L and 250 mg/L were recorded 99 and 94 percent of the time, respectively, at Reedy Island Jetty. During the period December through May, maximum chloride concentrations commonly ranged from 1,000 to 4,000 mg/L, whereas the common maximum chloride range for June through November was 3,000 to 8,000 mg/L (see table 19). The maximum at this site was 8,425 mg/L on November 4.

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.

Table 17. - Chloride concentrations, Delaware River at Fort Mifflin, Pa.
Daily maximum and minimum chloride concentrations in milligrams per liter
December 1, 1985 to November 30, 1986

A dash (-) indicates missing data; * indicates less than 30 mg/L.

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																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								
20																								
21																								
22																								
23																								
24																								
25																								
26																								
27																								
28																								
29																								
30																								
31																								

Table 18. - Chloride concentrations, Delaware River at Chester, Pa.1/
Daily maximum and minimum chloride concentrations in milligrams per liter
December 1, 1985 to November 30, 1986. Collection and analysis by Scott Paper Company.
A dash (-) indicates missing data; * indicates less than 30 mg/L.

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	30	*	35	30	35	30	35	32	*	*	*	*	36	34	32	32	85	55	85	44	338	137	452	141
2	30	*	35	30	35	30	35	32	30	*	30	*	36	34	35	31	78	52	95	45	341	138	350	185
3	*	*	32	30	35	32	35	32	30	*	30	*	36	34	35	32	62	50	90	49	380	152	188	140
4	*	*	35	30	35	30	35	32	30	*	*	*	36	35	34	34	53	45	130	50	380	173	190	165
5	*	*	35	30	37	35	35	34	30	*	30	*	35	33	34	34	52	46	210	63	273	138	528	184
6	*	*	35	30	38	35	36	34	30	*	32	*	36	33	34	34	50	45	200	60	240	130	360	194
7	*	*	35	30	38	35	36	33	30	*	30	*	36	35	35	34	50	40	205	64	238	117	355	167
8	*	*	35	30	40	36	34	32	32	*	30	*	37	35	37	36	47	40	195	70	335	133	355	155
9	*	*	38	30	46	40	35	32	*	*	30	*	36	30	37	36	48	41	190	80	325	118	300	136
10	*	*	35	35	45	42	35	32	30	*	*	*	36	32	39	37	45	38	320	95	390	104	202	92
11	*	*	35	32	48	44	36	32	34	30	*	*	36	35	46	40	50	37	310	92	389	129	182	74
12	30	*	38	33	48	45	35	34	32	30	30	*	36	33	57	42	50	40	290	95	460	146	160	66
13	*	*	35	33	48	45	35	34	30	30	30	*	30	*	56	44	50	40	345	88	375	138	110	50
14	*	*	35	30	47	42	36	33	30	*	30	*	30	*	54	40	46	40	300	120	292	121	110	53
15	*	*	38	33	47	45	36	34	30	*	30	30	*	*	55	41	55	40	450	120	300	106	66	48
16	*	*	35	33	48	44	35	31	30	*	31	30	*	*	55	40	56	38	400	100	350	106	64	44
17	*	*	35	34	52	46	35	*	30	*	31	30	*	*	48	40	60	40	420	130	380	135	70	45
18	*	*	35	35	53	48	*	*	30	30	32	30	*	*	66	45	120	45	450	170	425	137	70	40
19	*	*	35	35	53	48	*	*	30	*	32	30	*	*	80	50	80	46	390	200	319	121	65	47
20	32	*	37	35	50	49	*	*	30	*	30	30	*	*	87	50	108	45	510	180	330	142	60	46
21	32	*	37	35	50	42	*	*	30	*	34	30	*	*	105	45	78	45	440	200	310	145	35	50
22	*	*	38	35	45	44	*	*	30	*	34	33	30	*	105	45	70	45	480	200	400	144	35	42
23	32	*	41	38	45	38	*	*	32	*	38	33	30	*	96	50	68	45	434	210	368	154	37	*
24	-	-	40	37	40	36	*	*	30	*	38	34	30	30	85	48	60	43	320	150	329	136	40	*
25	32	*	40	35	39	36	*	*	*	*	36	35	30	30	105	60	52	38	370	210	345	140	38	*
26	30	*	36	30	38	35	*	*	30	*	36	34	30	30	110	60	56	38	350	280	406	138	35	*
27	30	*	35	30	40	35	*	*	*	*	36	35	33	32	85	78	56	39	-	-	440	141	*	*
28	35	*	30	30	36	35	*	*	30	*	36	35	33	33	97	55	52	41	-	-	290	150	32	*
29	35	30	32	*			*	*	30	*	36	35	34	32	100	59	52	40	299	205	350	133	32	*
30	35	30	33	30			*	*	30	*	36	34	33	31	100	52	60	40	331	140	290	125	35	*
31	35	30	34	30			*	*	36	36	36	34	34	95	54	60	45			364	136			

Table 19. - Chloride concentrations, Delaware River at Reedy Island Jetty, Del.
Daily maximum and minimum chloride concentrations in milligrams per liter
December 1, 1985 to November 30, 1986

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	2984	389	2518	760	-	-	2182	366	963	125	1860	344	-	-	5155	2056	7499	3975	8400	3875	6300	3291	8044	4325
2	2704	603	3190	783	321	2098	2196	366	1030	125	1692	274	-	-	5400	2168	7565	3687	8308	3875	6817	3510	7916	4560
3	569	171	3364	850	2336	274	3022	411	1030	137	2140	228	-	-	5900	2140	7133	3437	7700	3925	6885	3875	8220	4700
4	1934	310	3092	895	2700	332	3162	479	1188	148	3619	344	-	-	5963	2210	6775	2966	8176	4200	6817	3850	8425	5124
5	2438	366	3670	895	2994	400	3291	535	1230	159	3602	603	4350	1566	5972	2322	7266	2826	8400	4375	5981	3700	7945	5155
6	3204	456	3218	749	2560	377	3800	580	2112	217	3700	659	4520	1440	5600	2042	6987	3190	7887	4174	6350	3585	8308	5155
7	4200	816	-	-	2938	422	-	-	1860	262	3900	816	4300	1496	6250	2098	6500	3022	7266	4650	6375	3510	8044	5124
8	5031	1008	-	-	3036	467	-	-	1874	274	3975	1008	4520	1566	-	-	6275	2882	7858	4440	6885	3636	7858	4520
9	4400	895	-	-	2280	422	-	-	2070	389	4116	1426	4200	1300	-	-	6275	2798	7750	4325	5981	3510	6851	4520
10	4375	974	2532	119	1972	389	3218	816	2028	355	5124	1314	3925	1244	-	-	5990	2700	7750	4520	6936	3218	6851	4325
11	4200	997	4000	636	2000	445	3619	693	2588	366	4560	1412	4200	1160	-	-	5825	2756	6600	2980	7466	3950	6902	4174
12	4375	1118	4174	1008	2322	467	2854	614	2910	512	4325	1300	3636	1019	-	-	5963	2560	-	-	7466	3975	6902	3850
13	4174	1160	3900	1230	1874	400	2448	636	3106	524	5217	1734	4440	1118	-	-	-	-	-	-	6400	4058	5990	3619
14	3106	850	3875	1042	3148	366	3190	591	2966	591	-	-	3975	1132	-	-	-	-	-	-	6600	3875	6000	3364
15	3036	907	3925	1314	2616	563	2826	400	2896	670	-	-	3687	974	-	-	-	-	-	-	6250	3700	5550	3036
16	2406	816	3875	1132	2994	603	704	52	3687	805	-	-	3700	985	-	-	-	-	-	-	6600	3875	5945	3050
17	2098	648	3825	1118	3619	805	125	31	2994	636	-	-	3510	726	-	-	-	-	-	-	6936	3975	6400	3204
18	1440	512	3825	1132	4174	1160	45	*	3008	715	-	-	4145	726	-	-	-	-	5963	3975	6936	3975	6817	3585
19	2672	445	4200	1510	4375	1342	377	*	3975	377	3950	1524	4520	895	-	-	-	-	6775	3900	6953	4116	6325	3291
20	3022	434	5093	1776	4700	1370	546	*	3700	805	3700	1440	4200	1019	-	-	5963	3700	6834	3975	7133	4200	7600	3585
21	3700	828	3510	1230	4116	1118	1972	*	2952	693	-	-	4700	1174	-	-	6936	3585	6450	4029	7466	4116	6919	2518
22	4200	1174	4375	1314	3687	738	2700	332	2532	400	-	-	5310	1328	-	-	-	-	6851	4087	6953	4087	4174	1874
23	4145	715	4000	974	4145	749	3134	524	2252	296	-	-	5217	1608	-	-	-	-	6375	4058	6970	4174	5031	2168
24	5062	1146	4200	1356	3670	580	2392	321	2840	310	-	-	5062	1552	-	-	-	-	6350	3670	6834	3975	5600	1972
25	4650	1524	5093	1482	2434	445	2042	285	3291	355	-	-	3975	1426	-	-	5936	3148	6775	3687	6834	4350	5093	1398
26	3900	1272	4145	940	2728	411	1594	274	3653	411	-	-	4200	1524	-	-	6250	2742	6851	3850	6970	4400	4750	1468
27	4174	1008	3364	726	2784	400	1566	239	2868	422	-	-	4560	1622	-	-	5945	2994	7000	3825	7650	4116	4029	1146
28	2854	704	1202	816	2420	389	1160	182	2574	434	-	-	4116	1566	5972	2966	6817	2700	6750	3925	7945	4700	4116	853
29	3850	794	-	-	-	-	1790	171	2434	389	-	-	4480	1636	6250	3092	7400	3700	6902	4029	7916	4375	3900	726
30	3653	963	-	-	-	-	929	159	1440	332	-	-	5000	2014	6834	3218	7600	3670	6775	3585	7650	4400	3364	636
31	3670	952	-	-	-	-	895	137	-	-	-	-	-	-	6902	3585	7945	3875	-	-	7800	4440	-	-

A dash (-) indicates missing data; * indicates less than 30 mg/L.

During the past year, mean dissolved-oxygen concentration at the Benjamin Franklin Bridge was below 5 mg/L (Delaware River Basin Commission, Ad Hoc Task Force, March 1979) on May 23, June 10 through 13, July 2 through August 6, and August 12 through November 11 (see table 20). The minimum daily mean was 1.7 on July 23 and 24. At Chester, the mean dissolved-oxygen concentration was below 5 mg/L from May 18 to September 12 (see table 21). The lowest daily mean was 1.2 mg/L on July 29. The minimum hourly value was 0.7 mg/L also on July 29. At Reedy Island Jetty, the minimum hourly value was 3.9 mg/L on August 5.

Figure 7 shows the frequency of hourly dissolved-oxygen concentration at Benjamin Franklin Bridge (Pier 11 North) and Chester during the critical summer period, July through September 1986. Dissolved-oxygen concentration was at or below 4 mg/L 77 percent of the time at the Benjamin Franklin Bridge in 1986. Data for 1985 indicate that it was at or below 4 mg/L 92 percent of the time. Dissolved-oxygen data for Chester show a bimodal distribution. Concentrations at or below 4 mg/L occurred 87 percent of the time in 1986 as compared to 55 percent of the time in 1985. Since dissolved-oxygen concentrations are higher upstream at Benjamin Franklin Bridge and dissolved-oxygen concentrations at Chester depict a bimodal distribution, the Chester data suggests that a local source of contamination was present during most, but not all, of the summer. This type of situation, bimodal dissolved-oxygen data distribution in conjunction with a lower range of dissolved-oxygen values, also occurred at Chester in the summer of 1982. At that time, it also was suggested that the data indicated a local contamination event.

To determine how dissolved-oxygen concentrations have varied historically, data from two stations on Delaware River, Benjamin Franklin Bridge and Chester, Pennsylvania were analyzed for the period 1962 to 1986. Dissolved-oxygen concentrations were monitored on a daily basis beginning in November 1960 for Benjamin Franklin Bridge and in December 1961 for Chester. These data have been published annually in the U.S.G.S. Water Resources Data for Pennsylvania.

Figures 8 and 9 show that mean monthly dissolved-oxygen concentrations for both stations on Delaware River are lower during the warmer summer months and higher during the colder winter months. Also, mean monthly dissolved-oxygen concentrations have increased with time at both stations except for the months of October and November 1982-86 at Benjamin Franklin Bridge. Since these values are for a shorter (5 years) period, they may show an increase when averaged over a ten year period.

At Benjamin Franklin Bridge, the period of time mean monthly dissolved-oxygen concentrations were below 4 mg/L decreased from seven months during 1962-71 to five months during 1982-86. The minimum monthly mean increased from 0.3 mg/L for September 1962-71 to 2.2 mg/L for August and September 1982-86 (fig. 8). At Chester, the period of time mean monthly dissolved-oxygen concentrations were below 4 mg/L decreased from seven months during 1962-71 to three months during 1982-86. The minimum monthly mean increased from 0.8 mg/L for July 1962-71 to 2.9 mg/L for August 1982-86 (fig. 9). The improvement in dissolved-oxygen concentrations is more marked at Chester than it is at Benjamin Franklin Bridge. This can be attributed to full compliance for all effluent water quality parameters at the Philadelphia Southwest water pollution control plant on January 1, 1984. The Philadelphia Northeast and Southeast water pollution control plants were in full compliance for all effluent water quality parameters in the fall of 1986 (Mr. Wm. Wankoff, City of Philadelphia Water Department, personal communication, March 27, 1986). This should contribute to continuing improvements in dissolved-oxygen concentrations.

Figure 7. - Frequency of dissolved-oxygen concentrations at two stations in the Delaware River during July, August, and September 1986.

Figure 8. - Changes in mean monthly dissolved-oxygen concentrations of Delaware River at Benjamin Franklin Bridge, Philadelphia, Pennsylvania for the periods 1962-71, 1972-81, and 1982-86.

Figure 9. - Changes in mean monthly dissolved-oxygen concentrations of Delaware River at Chester, Pennsylvania for the periods 1962-71, 1972-81, and 1982-86.

Table 20. - Dissolved oxygen, Delaware River at Benjamin Franklin Bridge at Philadelphia, Pa.

Daily mean dissolved oxygen in milligrams per liter

December 1, 1985 to November 30, 1986

A dash (-) indicates missing data.

Day	December		January		February		March		April		May		June		July		August		September		October		November	
	Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean	
1	7.3		-		-		-		11.4		9.6		6.2		5.8		2.8		3.5		3.0		4.5	
2	7.4		-		-		-		11.2		9.5		6.3		4.9		3.3		3.5		2.9		4.5	
3	7.1		-		-		-		11.1		9.3		6.4		4.1		3.9		3.5		2.9		4.5	
4	6.9		-		-		-		11.1		9.0		6.5		3.6		4.4		3.4		2.8		4.3	
5	6.8		-		-		-		11.0		8.9		6.6		3.7		4.7		3.2		2.8		4.4	
6	-		-		-		-		10.6		8.8		6.2		3.8		4.8		3.0		-		4.3	
7	-		-		-		-		10.2		8.7		5.8		3.5		5.1		2.9		-		4.3	
8	-		-		-		-		11.8		8.6		5.5		3.5		5.1		2.9		-		4.3	
9	-		-		-		-		11.5		8.5		5.2		3.0		5.1		2.9		-		4.3	
10	-		-		-		-		11.4		8.3		4.7		2.8		5.0		3.1		-		4.6	
11	-		-		-		-		11.4		8.3		4.7		2.9		5.1		3.4		4.2		4.8	
12	-		-		-		-		9.2		8.2		4.6		2.7		4.8		3.8		4.3		5.0	
13	-		-		-		-		9.1		7.9		4.3		2.6		4.5		3.9		4.2		5.2	
14	-		-		-		-		9.0		7.8		5.1		2.5		4.4		3.8		4.0		5.4	
15	-		-		-		-		8.9		7.5		5.4		2.7		-		3.7		4.0		5.5	
16	-		-		-		-		8.5		7.2		5.6		2.8		-		4.0		3.9		5.5	
17	-		-		-		-		9.4		7.2		5.9		2.7		-		4.1		3.8		5.6	
18	-		-		-		-		10.2		7.3		5.8		2.4		-		4.1		3.9		5.5	
19	-		-		-		-		9.8		7.5		5.8		2.3		-		-		4.0		5.5	
20	-		-		-		-		9.7		7.3		5.6		1.8		-		-		4.2		5.5	
21	-		-		-		-		9.8		6.8		5.5		1.8		3.5		-		4.2		5.7	
22	-		-		-		-		9.6		5.4		5.4		1.9		2.8		-		4.3		6.2	
23	-		-		-		-		9.3		4.8		5.4		1.7		2.7		3.6		4.3		6.4	
24	-		-		-		-		9.1		5.5		5.1		1.7		3.0		3.3		4.5		6.6	
25	-		-		-		-		9.3		6.0		5.3		1.9		3.3		3.0		4.4		6.8	
26	-		-		-		-		9.3		6.3		5.4		-		3.3		3.1		4.2		7.0	
27	-		-		-		-		9.6		6.2		5.9		-		3.4		3.0		4.1		7.1	
28	-		-		-		-		11.6		6.4		6.0		-		3.3		2.8		4.0		6.3	
29	-		-		-		-		11.6		6.4		5.9		-		3.2		2.8		4.1		6.3	
30	-		-		-		-		11.6		6.3		6.0		-		3.3		2.9		4.2		6.2	
31	-		-		-		-		11.5		6.2		-		-		3.4		-		4.5		-	

Table 21. - Dissolved oxygen, Delaware River at Chester, Pa.
Daily mean dissolved oxygen in milligrams per liter
December 1, 1985 to November 30, 1986
A dash (-) indicates missing data.

Day	December		January		February		March		April		May		June		July		August		September		October		November	
	Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean	
1	10.3						-		8.7		6.8		3.9		3.5		1.8		2.1		6.3		8.8	
2	10.6						-		8.5		7.0		4.3		3.5		1.9		2.0		6.2		8.5	
3	11.1						-		8.2		7.2		4.4		3.3		1.7		2.0		6.4		8.6	
4	11.1						-		7.9		7.3		4.5		3.2		1.5		2.0		6.1		8.8	
5	11.1						-		7.5		7.3		4.5		3.3		1.5		2.0		6.1		9.1	
6	-						-		7.4		7.2		4.2		3.1		1.9		2.0		6.6		9.6	
7	-						-		7.0		7.1		3.9		3.1		2.1		1.9		7.0		9.2	
8	-						11.0		6.8		6.8		3.6		3.0		2.0		1.9		7.5		9.0	
9	-						11.0		7.0		6.9		3.3		2.9		2.1		1.9		7.5		8.8	
10	-						10.9		7.1		6.9		3.0		2.8		2.1		2.0		7.7		8.7	
11	-						10.9		7.3		6.7		3.3		2.8		2.1		2.0		8.5		8.8	
12	-						10.7		7.5		6.6		3.1		2.7		2.0		2.1		8.8		8.7	
13	-						10.5		7.5		6.6		3.0		2.6		2.0		-		8.7		8.6	
14	-						9.9		7.4		6.2		2.4		2.5		2.0		-		8.3		9.0	
15	-						9.5		7.3		5.7		2.0		2.5		-		-		8.1		9.3	
16	-						9.8		7.7		5.4		2.2		2.4		-		-		8.2		9.3	
17	-						10.0		7.5		5.1		2.8		2.2		-		-		8.1		9.3	
18	-						10.1		7.3		4.9		2.9		2.1		-		-		8.2		9.4	
19	-						10.2		7.6		4.9		3.0		2.1		-		-		8.4		10.2	
20	-						10.2		7.8		4.9		3.2		1.9		-		8.2		8.4		10.5	
21	-						10.1		7.6		4.8		3.3		1.8		1.9		8.2		8.5		11.4	
22	-						10.1		7.4		4.2		3.4		1.5		2.0		8.2		8.5		12.3	
23	-						9.9		7.4		3.5		3.6		1.5		2.0		8.4		8.3		12.2	
24	-						9.7		7.5		3.0		3.5		1.4		2.0		8.0		-		12.4	
25	-						9.7		7.6		2.6		3.5		1.5		2.0		7.5		-		12.8	
26	-						9.7		7.3		2.6		3.6		1.6		2.1		7.1		-		13.0	
27	-						9.6		7.2		2.9		3.7		1.6		2.1		6.9		-		13.3	
28	-						9.5		7.0		3.0		3.7		1.3		1.9		7.0		-		13.5	
29	-						9.3		6.8		3.2		3.6		1.2		2.0		6.7		-		13.7	
30	-						9.1		6.8		3.4		3.6		1.3		2.1		6.6		-		13.9	
31	-						8.9				3.6				1.5		2.1				-			

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 6.1 to 8.0. The pH range for each station is: Reedy Island Jetty, 7.1 to 8.0; Chester, 6.3 to 7.6; Benjamin Franklin Bridge, 6.1 to 7.2. The pH in the estuary tends to be lowest near Trenton, N.J., and to increase downstream.