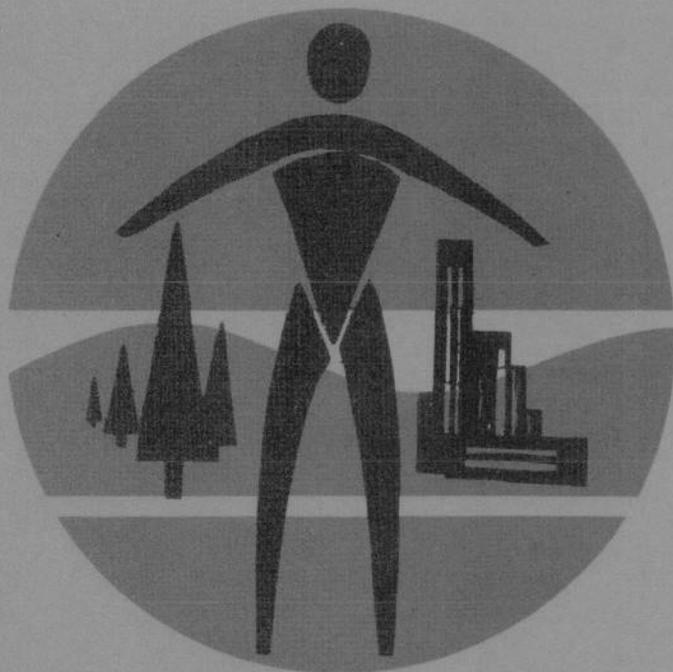


**Supplemental Report on Releases
from
New York City Reservoirs
in the
Upper Delaware River Basin**



prepared for
Upper Delaware River
Regional Water Resources
Planning Board

April, 1976

New York State Department of Environmental Conservation

WMP-P7 (200-12/76)

SUPPLEMENTAL REPORT
ON
RELEASES
FROM
NEW YORK CITY RESERVOIRS
IN THE
UPPER DELAWARE RIVER BASIN

New York State Department of Environmental Conservation

Office of Program Development, Planning
and Research
Division of Fish and Wildlife

and

New York State Department of Law
Bureau of Environmental Protection

April 1976

Abstract

This supplemental report on proposed releases from New York City reservoirs in the Upper Delaware River Basin has been prepared by the New York State Department of Environmental Conservation (DEC) and Department of Law. The purpose is to present the results of additional studies subsequent to the March 1974 report prepared by DEC for the Upper Delaware River Regional Water Resources Planning Board.

The studies include reanalysis of the flexible system operation scheme proposed in 1974 using improved data and methodology. An additional analysis was made of modified schemes to alleviate thermal stress conditions. The results of additional work on temperature-flow relationships, stream fisheries and canoeing are also presented.

The studies validate the conclusions and recommendations in the March 1974 report with some minor modifications.

A draft agreement to implement the flexible system operation scheme for the Delaware reservoirs has been prepared and was presented to New York City officials on December 12, 1975. A joint State-City task force has been established to review the draft agreement and determine further action on meeting the conservation release objectives.

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Chapter I. Summary

Introduction

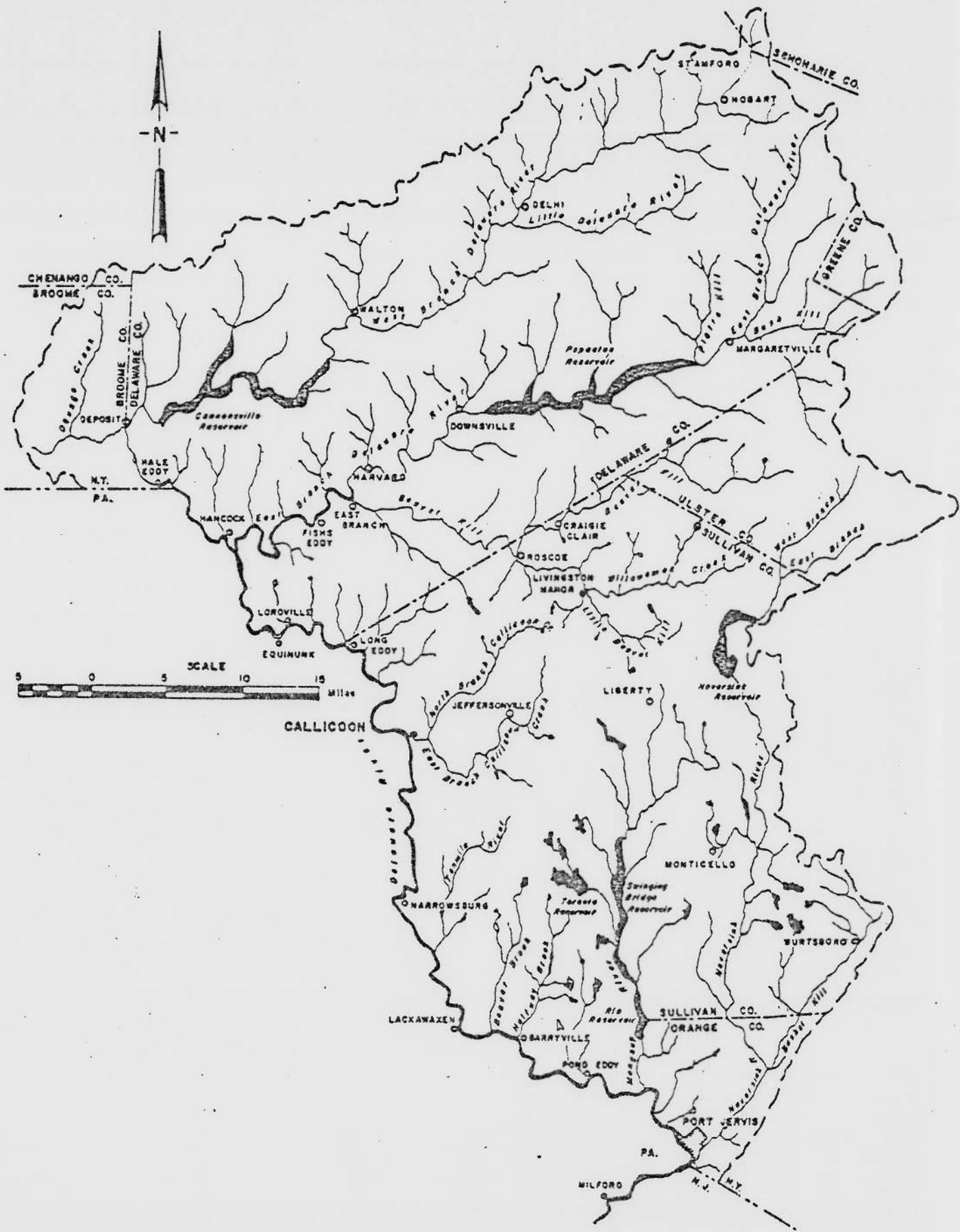
Because of local concerns about New York City's reservoir operations and other water management problems in the Upper Delaware River Basin (Figure 1), Delaware and Sullivan Counties petitioned the State in 1968 for a study of the water resources of the Basin. Subsequently, after public hearings, the Upper Delaware River Regional Water Resources Planning Board was established in April 1969 with the responsibility for preparing a comprehensive plan for the protection, conservation, development and beneficial use of the water and related resources in the Basin. The Board's studies have been essentially completed, and a draft comprehensive water resources management plan has been prepared and is now receiving public input and review.

In 1971, as part of the Board study, Department staff began an investigation of problems caused by releases from the City's Delaware reservoirs. The Neversink River was studied first because changes in the City's operation of Neversink Reservoir after Cannonsville became fully operational in March 1967 had accentuated low flow problems. Cannonsville was being used to meet the 1954 Supreme Court water release requirements, and only the minimum conservation releases were being made from Neversink Reservoir. The prolonged periods of low flows were causing serious deterioration of the stream environment, especially during the summer.

The Neversink watershed hydrologic capability and reservoir operations were analyzed, and streamflow needs were identified for fishery resources, canoeing and other recreation uses, aesthetics, water quality management and scouring to maintain a desirable stream habitat. Various methods were investigated for meeting streamflow needs, in addition to changes in reservoir releases. Finally, a seasonal reservoir release schedule was proposed, and alternative actions for obtaining the desired releases were discussed briefly.

Next, in the fall of 1972, as part of the continuing Board study, an investigation was begun of the total New York City Delaware system, since it was apparent that any changes in operation of Neversink Reservoir had to be related to the other reservoirs, and that the total system should be analyzed. Also, at this time, there was rapidly developing local concern about the impact of Cannonsville releases on the West Branch and Delaware River. The results of the system analysis are presented in a March 1974 report, entitled, "Proposed Alternative Releases for New York City Reservoirs in the Upper Delaware River Basin." They are summarized later in this Chapter.

Subsequently, early in 1975, the methodology and results of the system analysis were reviewed in detail with staff of the New York City Environmental Protection Administration, Department of Water Resources. As a result, further analyses were made using additional City data and changing the methodology to incorporate improvements suggested by City staff. The results of the reanalysis are presented in detail in Chapter II.



Upper Delaware River Basin

Figure 1

Also, in the spring of 1975 a program of additional studies was developed by DEC staff to acquire data that were lacking and make further analyses. The program included collection of temperature-flow data, a literature survey and laboratory study of temperature-fish relationships, a fishery resources survey, analysis of flow habitat relationships and evaluation of recreational resources. Even though New York City did not make varying releases from the reservoirs as we requested, a substantial part of the program was carried out in the summer of 1975. The results of the data collection and analysis are presented in Chapters III, IV and V.

March 1974 Report

The City's present method of operating their three reservoirs in the Upper Delaware River Basin and the problems that have resulted are discussed in detail in the March 1974 report entitled, "Proposed Alternative Releases for New York City Reservoirs in the Upper Delaware River Basin", prepared by the Department of Environmental Conservation for the Upper Delaware River Regional Water Resources Planning Board.

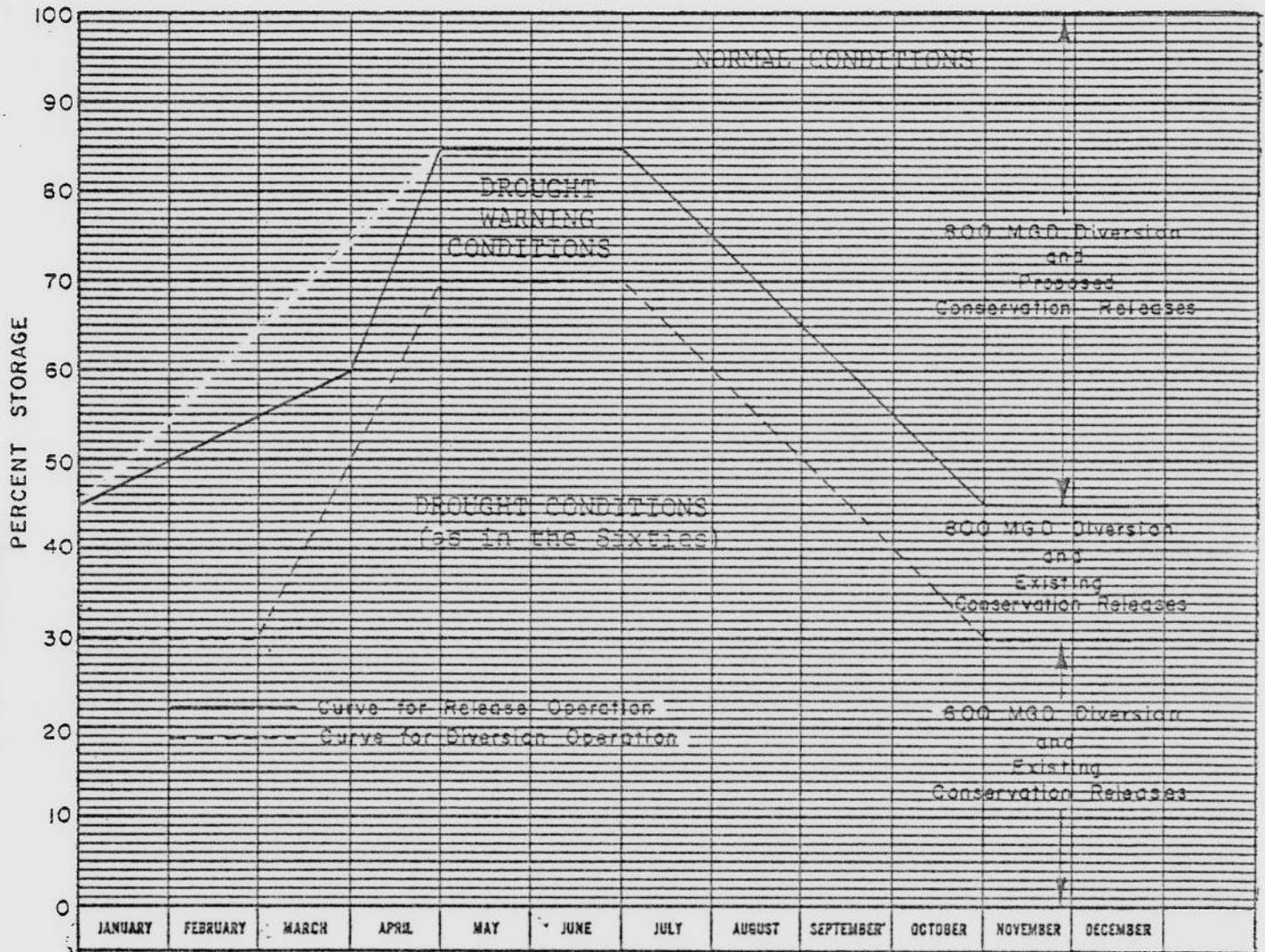
The report discusses present operation of the reservoirs, environmental problems and needs in the rivers downstream from the dams, and results of the system analysis.

The capability of the City reservoir system to provide proposed higher conservation releases was analyzed by computer runs using a mathematical model of the system operation and data for a 45-year period, 1922-1967.

A flexible operation scheme was developed for making diversions and releases based on the amount of water in the reservoirs at different times during the year. Based on the computer analysis, three zones were established with different operating criteria for normal, drought-warning and drought conditions (Figure 2).

During normal periods, when the reservoirs have large amounts of water stored in them, 800 mgd could be diverted for City water supply and the proposed higher conservation releases would be made. During drought-warning periods, when the storage becomes critical, 800 mgd could still be diverted for water supply, but the higher conservation releases would be reduced to the existing minimum levels. During drought conditions water supply diversions to the City would have to be reduced. The analysis showed that 600 mgd could be diverted during a drought such as that of the mid-60's.

The study showed that the flexible system operation of Neversink, Pepacton and Cannonsville reservoirs would continue to assure about the same level of diversion for New York City water supply, meet the Montague flow requirements and provide higher conservation releases. The increased conservation releases would significantly improve stream fisheries by reducing water temperatures during the summer and by limiting wide variations in temperatures. Water quality in the rivers would be improved and environmental values enhanced.



FLEXIBLE OPERATION
 NEW YORK CITY DELAWARE SYSTEM

MARCH 1974

Figure 2



The following recommendations were made in the report:

1. The proposed flexible operation scheme should be adopted for New York City's Delaware water supply system. This includes proposed conservation releases of 81 mgd from Cannonsville Reservoir, 45 mgd from Pepacton Reservoir and 32 mgd from Neversink Reservoir.

2. A minimum flow of 1,000 cfs should be maintained on the Delaware River at Callicoon during non-drought periods.

3. Supplemental releases for stream flushing should be made on a trial basis.

4. Preference should be given to Cannonsville Reservoir to meet the Montague requirements. However, these releases should be made in a more graduated manner that at present to avoid sudden changes in environmental conditions downstream.

5. During the first few years of operation, intensive ecological studies of stream biology, water quality and temperature, and dissolved oxygen should be made together with an evaluation of the environmental effect and the effect on recreational quality to determine if further modifications in operation would be desirable. This would allow for minor refinements to achieve optimum release rates.

Post-March 1974 Studies

Reservoir System Capability

Reanalysis of Flexible System Operation Proposed in March 1974 Report

During the spring and summer of 1975, as a result of staff level discussions between the City and DEC, a reanalysis was made of the flexible system operation based on additional data and changes in the methodology suggested by City staff. Three major adjustments were made. The first was to use reservoir inflow data developed by the City based on actual stream flow measurements. These data were considered more reliable than previous data based on statistical correlations between stream gaging stations. The second change was to revise the method for determining releases from the City reservoirs to meet the Montague flow requirement. The revised procedure is based on actual operation of the power generating reservoirs in New York and Pennsylvania and is more representative of existing conditions. The third change was to raise and reshape the release and diversion curves to make them fit more nearly to the City's present operating rule curves. As a result the period of normal conditions is reduced and the drought-warning and drought conditions occur earlier.

The system capability was reanalyzed with these changes. The results showed that the proposed conservation releases could be made less of the time and that the average diversion to the City would be reduced somewhat over the original computer runs. However, the diversions under drought warning and drought conditions would remain essentially the same. The changes do not affect the conclusions and recommendations in the March 1974 report.

Analysis of Modified Flexible System Operation Schemes

The need for short-term releases to alleviate stress conditions and to protect downstream fisheries during summer periods when high temperatures occur was emphasized by a fish kill on the East Branch Delaware River in August 1975. Local sportsmen also expressed a strong preference for higher releases during critical summer periods. They recommended that 600 mgd be released from the three reservoirs for up to 30 days. They also suggested that the releases proposed in the March 1974 report be made for an additional 60 or 90 days during the summer, and the present low conservation releases be continued during the remainder of the year.

These proposals were incorporated into 30-day, 90-day and 120-day schemes. The 30-day scheme includes the 600 mgd release for 30 summer days and the releases proposed by DEC in the March 1974 report for the remainder of the year. The 90-day scheme includes the 30-day high releases, 60-days with the DEC proposed releases, and present releases for the remainder of the year. The 120-day scheme includes 30 additional days of the DEC proposed releases. Another scheme was proposed by DEC for seasonal releases from Cannonsville based on existing limitations of the outlet works. These four schemes and the original scheme in the March 1974 report were analyzed in December 1975.

From a system capability standpoint, the results confirmed that the 90-day scheme has the least impact on the storage followed by the 120-day scheme, DEC Cannonsville seasonal scheme, March 1974 report scheme and the 30-day scheme in that order. However, when biological objectives are considered, the 90-day and 120-day schemes only protect the existing fishery resources and the DEC Cannonsville seasonal and March 1974 report schemes only enhance the fishery resources, but do not provide any releases that would alleviate the thermal stress conditions. The 30-day scheme will both alleviate thermal stress conditions and provide additional opportunities for increased fish production.

The analysis of the 30-day scheme, based on 33 years of record, indicates that it will be possible to meet flow objectives for the three summer months about 9 times out of ten, with objectives for the remaining months met about 6 times out of ten. The rest of the operations will be in the drought warning and drought zones during which only the present conservation releases would occur. Even with these limitations the 30-day scheme is preferred as best protecting the existing fishery and enhancing propagation.

An additional analysis linked to temperature-flow relationships is being made, however, to insure that downstream water temperature requirements will be met.

Temperature-Flow Analysis

A preliminary analysis of temperature-flow relationships in the streams below Cannonsville and Pepacton Reservoirs was made for the March 1974 report. A set of mathematical equations was developed that gave valuable insight into the impacts that increased releases from the two reservoirs could have on downstream temperatures. However, the need for additional analysis was apparent and early in 1975 a program was developed to collect daily water and air temperature data at many locations for a range of reservoir releases. However, only limited data were obtained, particularly on the Neversink River, because New York City did not cooperate in the request to vary release flows.

A further study has been initiated to develop the thermal flow relationships for four selected stations (Hale Eddy, Harvard, Callicoon and Woodbourne) in the Upper Delaware River Basin. To the extent that data are available, the study is scheduled to be completed in May 1976. Investigations will be made of the Delaware Reservoir System's capability to provide release flows that will insure average water temperatures of 68°, 73°, and 77°F (the range of upper lethal temperatures for salmonids) at the four stations. The relationships will be very reliable for Hale Eddy (West Branch) and Callicoon (Delaware River). Those for Harvard (East Branch) and Woodbourne (Neversink River) will require additional data before they can be finalized. Cooperation from the City will be required to obtain desired releases for the analysis.

Fisheries Analysis

In the summer of 1975 fisheries information was obtained on (1) fish kills, including documentation of a fish kill in the East Branch Delaware River; (2) thermal tolerance and thermal shock characteristics of trout, small mouth bass and American shad; (3) impact on fish production; and (4) potential improvements in fishery resources from increased conservation releases and larger releases during critical periods.

The size of the Delaware River and its major tributaries generally precludes the reporting and subsequent documentation of fish kills, although they are known to have occurred. However, on August 6, 1975, a fish kill in the East Branch Delaware River was reported to DEC and was documented. The investigation confirmed that thermal stress was the primary cause of mortality.

The short term study of thermal tolerance and shock characteristics was made based on available literature and laboratory experiments. Results indicate that the continued existence of a fishable trout population in the East Branch below Harvard and in the Delaware River is exceedingly precarious under the present release schedule. Smallmouth bass become acclimated to higher temperatures, and their upper thermal tolerance limits would rarely be exceeded in the Delaware River system. However, lower thermal tolerance limits for juvenile smallmouth bass are commonly exceeded in the West Branch below Cannonsville Reservoir. The American shad appears to have relatively high thermal tolerances but lower limits that are similar to those for smallmouth bass. Based on 1975 data the West Branch Delaware River would be unsuitable for shad.

Significant improvements in fishery resources are expected from increased conservation releases. These include extension of suitable trout habitat and improvement of juvenile shad habitat in the East Branch and West Branch, possible extension of trout habitat in the Neversink River and protection and enhancement of trout, smallmouth bass and American shad fisheries in the Delaware River.

Analysis of Canoeing and Other Water Sports

The main stem of the Delaware River is one of the finest canoeing routes in New York State. The section between Hancock and Port Jervis is the longest uninterrupted run on any river in the State and is recognized both regionally and nationally for its scenic and recreational canoeing features. The river provides a white-water challenge to the expert canoeist during periods of high water and is an enjoyable float for the novice during periods of more normal flow. Privately-owned canoe liveries provide canoe rentals, portage and access, and public access is also available.

In the summer of 1975 the New York State Department of Law received assistance from a local resident to assess canoeing and other water sports in detail. Evaluations were made of related businesses, access to the resources, present and future demands and minimum water level needs.

It was found that canoeing adds the highest per day dollar value to the region's economy. However, serious problems are associated with the growing number of canoeists. Increased releases would allaviate some of the problems. One of the major benefits would be to increase the carrying capacity of the river by making it canoeable more of the time from Hancock to Narrowsburg.

Agreement Status

The March 1974 report was sent to the New York City Environmental Protection Administration and discussed with City officials several times. In July 1974, we believe the City informally agreed to double the Neversink Reservoir release from 10 mgd to 20 mgd from June 15 to September 15 and to make releases in a more graduated manner from Cannonsville Reservoir whenever possible. However, the additional releases were made only from the Neversink Reservoir by the City for 40-days during the July 16-September 15, 1974 period when the Delaware River Master directed releases to meet the Montague requirement.

A field study was made to evaluate benefits but the releases were inadequate for any substantial conclusions. Abrupt changes in releases were made from Cannonsville Reservoir on only seven days during the same period compared with 15 days in 1973. However, the improvement was due mainly to more favorable hydrologic conditions.

On November 4, 1974 the Department referred the Delaware releases problem to the Attorney General's office (AGO) for appropriate action because of lack of progress on implementing the March 1974 report recommendations. Discussions were begun with the City Environmental Protection Administration (EPA) at the staff level, and numerous meetings have been held since February 1975 between staffs of DEC, AGO and NYC EPA to review the March 1974 report and exchange technical information.

DEC and City representatives at the executive level met in July 1975 and the City announced that they would undertake the following five-point program:

1. Make additional summer releases of 10 mgd from Neversink Reservoir when the Delaware River Master directs releases to meet requirements of the 1954 Supreme Court Decree
2. Attain a more graduated rate of release from Cannonsville Reservoir
3. Make cold water releases through the Cannonsville outlet works whenever there was spillway overflow and the cold water release was requested by DEC
4. Monitor operation of the Shandaken tunnel to minimize impact on Esopus Creek and notify and consult with DEC on closing the tunnel
5. Open additional City lands around Cannonsville Reservoir for deer hunting in 1975

As a result, the 20 mgd release from Neversink was made during the August 1 - September 15, 1975 period on 24 days when the Delaware River Master requested releases to meet the Montague flow requirement. Periods when abrupt changes in releases were made from Cannonsville Reservoir during

1972, 1973, 1974 and 1975 were identified by DEC and referred to the City. Staff of NYC EPA have been reviewing how operations could have been changed during these periods to make more graduated releases. No cold water releases from Cannonsville were necessary in the summer of 1975. The last two points of the program were undertaken.

Concurrently, during the summer of 1975, Environmental Conservation Commissioner Reid corresponded on the releases problem with Mayor Beame and met with Robert Low, Administrator of the New York City Environmental Protection Administration. On December 12, 1975, Commissioner Reid presented a draft agreement to Mr. Low for the three Delaware reservoirs.

The goals and objectives of the agreement are to: (1) assure New York City the present allowable level of diversion from the Delaware River Basin for water supply, (2) meet the Montague flow requirements specified in the 1954 Supreme Court Decree, and (3) provide increased conservation releases to protect and enhance stream fisheries, improve boating and other recreational uses of the streams, assist in meeting water quality standards and increase the aesthetic and economic values of the most significant stream resources in the Upper Delaware River Basin. The improved program for conservation releases would permit DEC to conduct physical, chemical, biological, recreation and economic studies for evaluation of the release flow-environmental and recreational quality relationships for up to three years. During or at the end of the three-year period, the agreement could be modified on the basis of the additional information obtained.

As a basis for negotiations, a joint State-City task force was established in February to review the draft agreement. The task force met twice in early March, and then the City asked that no further meetings be held pending discussion between Administrator Low and Commissioner Reid. The State objectives for the task force are to:

- resolve specific points and issues in the draft Delaware agreement
- agree on the methodology of analysis, results obtained, and data used for the Delaware reports and draft agreement
- agree on the biological and environmental objectives of the draft agreement
- establish the operating parameters and methods of the Delaware reservoir system to achieve the objectives
- establish the items, responsibility, and time schedule for additional analyses to be done during the three-year period on the agreement

Based on results of these efforts, the other options of legislation and/or litigation would be considered. Following is a summary of the major provisions of the Delaware agreement.

-- During normal hydrologic conditions, increased conservation releases as follows:

Cannonsville Reservoir	- 81 mgd (125 cfs)
Pepacton Reservoir	- 45 mgd (70 cfs)
Neversink Reservoir	- 32 mgd (50 cfs)

-- Under normal hydrologic conditions, graduated releases from Cannonsville Reservoir equivalent to year-round conservation releases of 81 mgd (125 cfs) as follows:

September 15 - May 30 - 32 mgd (50 cfs) depending on capacity of branch pipes
June 1 - September 14 - 217 mgd (325 cfs) depending on capacity of minimum-size orifice

These releases to be made until the Cannonsville outlet works are modified to provide the desired 81 mgd (125 cfs).

-- During drought and drought-warning conditions minimum releases of:

	<u>Summer</u>	<u>Winter</u>
Cannonsville Reservoir	- 15 mgd	5 mgd
Pepacton Reservoir	- 12 mgd	4 mgd
Neversink Reservoir	- 10 mgd	3 mgd

-- Establishment and maintenance of a continuous reservoir surveillance program by the City and DEC. DEC will have to install and monitor automated telephone gaging stations at Callicoon, Hale Eddy, Fishs Eddy and a site on the Neversink River.

-- During years when spring runoff does not cause spillway overflow, the release, on request from DEC, not to exceed a one-day period, water for stream flushing as follows:

Neversink	Maximum outlet capacity
Pepacton	Maximum outlet capacity
Cannonsville	- 1,000 cfs

-- To improve the fishery in the stream below the reservoirs and at the request of DEC and when one or more reservoirs are spilling, the release of water from the conservation releases outlet works.

-- To maintain a minimum flow of 1,000 cfs on the Delaware River at Callicoon during normal hydrologic periods with reasonably balanced flows from Cannonsville and Pepacton Reservoirs.

-- In addition to the proposed releases on a year-round basis and at the request of DEC, and for a period not to exceed 30 days, the release of 100 mgd (155 cfs) from the Neversink, 200 mgd (310 cfs) from Pepacton, 300 mgd (465 cfs) from Cannonsville to alleviate stress conditions and to protect downstream fisheries. DEC will have to install and monitor automated telephonic gaging stations at Callicoon, Hale Eddy, Fishs Eddy and a site on Neversink River.

-- Representatives of DEC and City to meet at least four times a year on problems related to the river.

-- The parties to review at the end of three years of operation, during which DEC will conduct certain ecological studies in cooperation with the City and make further modifications as necessary.

Local Interests

Upper Delaware River Regional Water Resources Planning Board

Since its inception in April 1969 the Upper Delaware River Regional Water Resources Planning Board has been studying the water and related resource problems in the New York portion of the Upper Delaware River Basin. The Delaware reservoir releases problem has been given major consideration by the Board. Other significant problems in the basin are the need for flood damage reduction and pollution abatement and the lack of water-oriented recreation facilities.

Since they sponsored the March 1974 report, the Board has been preparing their plan for comprehensive management of the water resources of the basin. They have developed a tentative plan in which improved management and operation of the City's Delaware system reservoirs is a major element of the early action program. The Board's central recommendation for implementation of the flexible operation scheme is related to many of the other major early action recommendations, particularly the following:

- Interstate and Interbasin Water Supply Management
- Improvement of Water Quality in Cannonsville Reservoir
- Basinwide Water Quality Management
- Wild, Scenic and Recreational Rivers Proposals
- Management of Canoeing on the Delaware River
- Water Related Recreation
- Fish and Wildlife Management

Several of the long range alternatives also relate to implementation of the flexible operation scheme. After the Board holds public information meetings scheduled for April 1976, they will submit their final plan to DEC for approval.

Catskill Waters

In December 1974, Mr. Frank Mele of Woodstock called a meeting of citizens concerned about lack of progress on the conservation release problem and the advocative group called Catskill Waters was founded. It is a coalition of many sportsmen's and recreation groups. Since that time they have prepared a series of descriptive materials regarding fishing in the Delaware Basin. They also initiated a questionnaire survey to identify caterers to fishermen along the Delaware River. The responses showed that businesses in the area would profit from increased tourism generated by improved river conditions. Another questionnaire survey of 66 fishermen on the Delaware River, by Catskill Waters, indicated that fish kills were observed in 1973 and 1974, and water conditions were too low and variable.

After a year of intensive activity, including many discussions with public officials, Catskill Waters has led its coalition of various groups to seek State legislation in the area of reservoir management and water conservation in New York City. Their continued support is seen as a key to the success of implementation of the flexible operation scheme.