PROPOSED ALTERNATIVE RELEASES FROM NEW YORK CITY RESERVOIRS IN THE UPPER DELAWARE RIVER BASIN

prepared for

Upper Delaware River
Regional Water Resources
Planning Board

March, 1974

New York State Department of Environmental Conservation

PROPOSED ALTERNATIVE RELEASES

from

NEW YORK CITY RESERVOIRS

in the

UPPER DELAWARE RIVER BASIN

prepared for the
Upper Delaware River
Regional Water Resources Planning Board

Plan Development Bureau
Office of Program Development, Planning and Research
New York State Department of Environmental Conservation

March, 1974

TABLE OF CONTENTS

(Chapter III - cont'd)

LIST OF TABLES

LIST OF FIGURES

(List of Figures cont'd)

PREFACE

The Upper Delaware River Regional Water Resources Planning Board was established in April 1969 by the New York State Water Resources Commission (now Department of Environmental Conservation) following applications by Sullivan and Delaware Counties. The Board is responsible for the preparation of a comprehensive plan for the protection, conservation, development and utilization of the water resources of the Upper Delaware Basin. Staff assistance is provided to the Board by the Department of Environmental Conservation. By agreement of the two counties, four of the seven members represent Sullivan County and three represent Delaware County. Members of the Board are unsalaried.

Since its formation the Board has held some 30 meetings to review the progress of planning, hear technical and environmental reports from a diversity of water resource interests, and provide direction to the ongoing study. During the early stages of the study, the Board expressed concern over environmental quality problems in the Neversink River caused largely by inadequate releases from the Neversink Reservoir, and requested that the Department investigate the problem in conjunction with the Board's comprehensive water resources study of the Basin. This resulted in the Board's Neversink Report dated January 1972. The Board then requested that the Department investigate environmental problems arising from inadequate releases from the other two New York City reservoirs in the Upper Delaware Basin - Pepacton and Cannonsville - and that the three reservoirs be investigated as a single system. This report, prepared by the Department for the Board, presents the results of that investigation.

It has been found that the City's reservoirs, operated as a system, are capable of maintaining higher downstream releases during non-drought periods than those which are currently made. The level of releases necessary to maintain an acceptable standard of environmental quality in the rivers below the reservoirs has been identified. An operating procedure is recommended which would allow the higher releases to be made without reducing the safe water supply yield available to the City.

MEMBERS

Upper Delaware River
Regional Water Resources Planning Board

Members	County
Joseph M. Purcell, Chairman	Sullivan
Lowell C. Peckham, Vice Chairman	Delaware
Manny Bogner	Sullivan
Howard S. Dickson	Delaware
John Lennon	Sullivan
Robert Mastro	Sullivan
Darrell F. Singer	Delaware

ACKNOWLEDGEMENTS

This study was undertaken by the Department of Environmental Conservation at the request of the Upper Delaware River Regional Water Resources Planning Board. Fish and wildlife requirements were determined primarily by Regions 3 and 4 of this Department. The American Canoe Association, canoe livery owners along the Delaware River and concerned citizens contributed significantly by identifying flow requirements for canoeing. Basic hydrologic data used by the Department of Environmental Conservation in performing the operation studies were provided by the U.S. Army Corps of Engineers Hydrologic Engineering Center in Davis, California, and by the Albany District Office of the U.S. Geological Survey. The assistance of these agencies, organizations and individuals as well as others who contributed in important ways is gratefully acknowledged.

CHAPTER I

SUMMARY

This technical report on proposed alternative releases from New York City reservoirs in the Upper Delaware River Basin has been prepared by the New York State Department of Environmental Conservation for the Upper Delaware River Regional Water Resources Planning Board. The investigations for this report were undertaken by the Department at the request of the Regional Board, and as part of the staff services for development of its comprehensive basin plan.

The investigations leading to this report resulted from State and local concern about water releases from the three New York City reservoirs. This concern has developed primarily since 1967, when Cannonsville Reservoir became fully operational. Conservation releases have been made from all three reservoirs. The present method of operation of the system results in long periods of low flows and short periods of high flows. Large temperature changes also occur in the streams below the dams as large slugs of cold water are released. These flow patterns seriously handicap fish and wildlife resource management, water quality management and recreational use of the streams. This report describes the present operation of the reservoir system with the environmental management problems that result. It proposes an alternative operating program which will greatly restore downstream environmental quality while continuing to meet existing water supply and flow requirements.

Present Operation of the System

The system in the Upper Delaware River Basin which is operated by New York City for water supply, consists of Neversink, Pepacton and Cannonsville Reservoirs. Water is diverted from the reservoirs through underground tunnels to Rondout Reservoir in the Hudson River Basin, and conveyed from there to New York City through the Delaware Aqueduct. The three reservoirs receive runoff from 917 square miles, about 40 percent of the drainage area of the basin in New York State.

Neversink Reservoir was built first and began to supply water to the City in 1953. Pepacton Reservoir was completed next in 1955, followed by Cannonsville Reservoir in 1967. The three reservoirs have a useable capacity of about 271 billion gallons and supply about 40 percent of New York City's water needs. They are operated in conjunction with two other major City water supply systems in the Catskills and Croton River Basin.

Diversion from the Delaware Basin to meet New York City water supply needs became a controversial issue that had to be settled by the United States Supreme Court. The Court issued a Decree in 1931 and an Amended Decree in 1954, prescribing certain operation requirements. The 1954 Decree authorizes the City to make diversions for water

supply but requires that a minimum flow must be maintained at Montague, New Jersey. The Delaware River Master, appointed by the Supreme Court, specifies releases which are to be made and monitors the City's reservoir operations. Another legal requirement in New York State is for low flows --called conservation releases-- to be passed through the dams at all times to meet fish and wildlife and other environmental water needs.

In practice, downstream flow requirements established by the 1954 Decree have been met primarily from Cannonsville Reservoir since it became operational in 1967. New York City water supply needs have been met primarily from Neversink and Pepacton Reservoirs.

New York City Upper Delaware - Operating Constraints

A. Diversion for City Water Supply

The City may divert an average of 800 mgd (million gallons per day) for water supply, according to the 1954 Decree. Diversions are made by the City as necessary to meet its needs, and have averaged about 600 mgd since Cannonsville was completed. On particular days, diversions have been over 1,100 mgd and, since June 1, 1973, have averaged about 700 mgd. To ensure that maximum water supplies are available, the City operates the system to have the reservoirs full at least after spring runoff has occurred and to avoid losing water over the dams. About 80 percent of the City's supply from the Delaware system has been diverted from Neversink and Pepacton Reservoirs, which have better quality water than Cannonsville. Also, hydroelectric power is generated with diversions from Neversink and Pepacton.

B. Releases to Meet Flow Requirements at Montague, New Jersey

The City must maintain a minimum flow of 1,750 cfs (cubic feet per second) at Montague, New Jersey according to the 1954 Decree. During much of the year this flow is met without any releases from the City reservoirs. However, during the summer and autumn low-flow periods, releases from the City system are necessary. In addition to the basic flow of 1,750 cfs, the 1954 Decree requires that a higher flow be maintained at Montague from June 15 to March 15 each year by releasing so-called excess water. The flow objective and the amount of water to be released during this period, if necessary, are determined by the difference between the City's water consumption and its assured supply from the entire City water supply system. Since 1971, the flow requirement has been reduced by the River Master from the maximum of 2,650 cfs to 2,270 cfs, and is expected to decrease further as City water use increases.

The City may meet Montague requirements from any of the three reservoirs, but uses Cannonsville primarily for this purpose, reserving the higher quality water in the other two reservoirs for water supply needs.

C. Conservation Releases

The City is required to make minimum releases from each reservoir for conservation purposes, primarily to meet fish and wildlife needs. No minimum releases were prescribed for Neversink and Pepacton Reservoirs when they were built. Subsequently they were established by a "gentlemen's agreement" between New York City and the former Conservation Department. The releases agreed upon are now legally required on the basis of the New York State Supreme Court proceedings on downstream riparian rights that were acquired by the City. Conservation releases for Cannonsville Reservoir were required by the former New York State Water Power and Control Commission when it approved construction of the reservoir. Conservation releases are low, ranging from 3 to 5 mgd in the winter to 10 to 15 mgd in the summer. The United State Supreme Court was not a party to establishment of these releases, and the Delaware River Master has no jurisdiction over them.

In summary, present operations of the New York City reservoirs must meet the following requirements:

City Water Supply

Legal maximum average	800 mgd

Montague Flow Requirements

Minimum	1,750 cfs (1,131 mgd)
June 14-March 15	Variable higher flows up to 2,650 cfs (1,713 mgd)

Conservation Releases

	Summer	Winter
Cannonsville	15 mgd	5 mgd
Pepacton	12 mgd	4 mgd
Neversink	10 mgd	3 mgd

Problems in Present Operation

Environmental problems associated with the present operation of the three reservoirs are caused by the low conservation releases and the manner in which Montague requirements are met.

Conservation releases are based on low flows which had occurred in the streams before the reservoirs were built. Under natural conditions such low flows occurred for short periods and had not caused any known damage to fish and wildlife resources. It was assumed that these flows would occur for only a few days at a time. Therefore, no restrictions were placed on the length of time that they could be made. However, under the City's present operating procedures, minimum flows occur for long periods, particularly below Neversink and Pepacton Reservoirs.

The releases required to meet the Montague requirement are determined by the Delaware River Master, based on an analysis of runoff from the drainage area between the dams and Montague, and releases expected from other reservoirs in Pennsylvania and New York which are primarily used for power generation. The River Master tells the City how much water is needed but the City decides from which reservoir or reservoirs it will be released. Most of the releases to meet Montague requirements are made from Cannonsville Reservoir. A large amount of water may be released in a short time, causing rapid changes in river stages, flow velocities and water temperatures.

These operating practices have upset stream ecology, caused severe damage or destruction of downstream fisheries, interfered with recreational use of the streams, prevented stream water quality standards from being met and generally reduced the value of the most significant stream resources in the basin.

On the East Branch Delaware River and Neversink River, trout production is severely limited by high water temperatures which occur in the summer as a result of low conservation releases. Also during the winter, prolonged low flows allow anchor ice to form around large stones in riffle areas reducing aquatic food production. With the recommended conservation releases, both streams could sustain much larger trout populations and provide greater fishing opportunities.

On the West Branch Delaware River, both cold and warmwater fisheries have been almost eliminated by wide fluctuations in streamflows and temperatures, resulting from low conservation releases and releases to meet Montague requirements. Higher water temperatures from low conservation releases prevent development of good trout fishing, while large releases of much colder water for the Montague requirements can cause fish kills and prevent establishment of a warmwater fishery. Also, the large releases cause high stages and strong currents and make fishing almost impossible. With proper flow regulation, the West Branch could be made into a more productive coldwater fishery.

On the Delaware River major fish population shifts have occurred as a result of current operation practices. This is most evident in the upper reach from Callicoon to Hancock which formerly supported a warmwater fishery. This fishery has been nearly eliminated. Large volumes of cold water released sporadically from Cannonsville have induced a fish population reversal to cold water tolerant forms. Survival of these cold water forms is precarious during non-drought years as a result of sudden increases in water temperature induced by abrupt cutoffs of high volume cold water flows. If the several recommendations of this report are followed, production of a high quality stable coldwater fishery would most likely result. The fisheries of the entire Delaware down to Port Jervis would also benefit from higher more uniform flow.

Before the reservoirs were constructed canoeing also was a favorite sport on the three streams during the spring and at other times when the natural streamflow as high. Now canoeing is possible on the tributaries only occasionally when water spills over the dams. During the summer additional flows are required on the Delaware River for canoeing which has become an increasingly popular recreation activity in recent years. More than 600 canoes have been observed on the river between Hancock and Port Jervis on a Saturday afternoon in the early summer.

Proposed Conservation Releases

Additional conservation releases required to meet fish and wildlife needs are:

	Present	Proposed
Cannonsville	5-15 mgd(7.7-23.1 cfs)	81 mgd (125 cfs)
Pepacton	4-12 mgd(6.2-18.5 cfs)	45 mgd (70 cfs)
Neversink	3-10 mgd(4.6-15.4 cfs)	32 mgd (50 cfs)

The proposed conservation releases are about 3 to 5 times higher than the present summer releases and about 10 to 16 times higher than the winter releases. No seasonal variation is proposed.

In addition to these minimum conservation releases required on the tributary streams below the dams, releases are needed to maintain a year-round flow of 1,000 cfs on the Delaware River at Callicoon. This flow would greatly improve the coldwater fishery in the river from Hancock to Callicoon, the warmwater fishery from Narrowsburg to Port Jervis and the mixed fishery from Callicoon to Narrowsburg. It would also provide for canoeing needs.

Higher flows are also needed in the streams below the dams one day each spring to flush out accumulated sediment and other materials. In some years reservoir overflow is enough to accomplish the desired flushing. If not, releases should be made.

Capability of the Reservoir System

The capability of the City reservoir system to provide the proposed conservation releases was analyzed by means of two mathematical models that were developed to represent operation of each reservoir alone and as an integral part of a system. Potential operating schemes were prepared and tested by computer runs with the models.

Data for a 45-year period from October 1922 to September 1967 were used. This period of record includes two major droughts which adequately provide for exceptionally low water yield conditions. Statistically the 30's drought would occur about once in 12 years, and the much more severe 60's drought would occur about once in 400 years.

Integrated System Analysis

In system analysis, operation of all three reservoirs was integrated to meet diversion needs, flow requirements at Montague, and the proposed higher conservation releases.

A number of alternative operating schemes were tested and results indicate that a flexible operation scheme best meets all the needs. In this scheme, diversions and releases are made according to the amount of water in the reservoirs.

During non-drought periods when the reservoirs have large amounts of water stored in them, 800 mgd would be available for City water supply and the proposed higher conservation releases would be made. In drought warning periods when the water stored in the reservoirs is reduced to predetermined levels, 800 mgd would still be available for water supply, but the higher conservation releases would be reduced to the existing minimum levels.

The analysis shows that the Delaware system is capable of providing water supply diversions of 600 mgd under severe drought conditions with the flexible operation scheme while still meeting the Montague requirements and maintaining present conservation releases. This is equivalent to the present safe yield of the Delaware system.

The water available for diversion to the City would fall below an average of 800 mgd about 17 percent of the time. However, this study showed that in a drought such as that of the mid-60's, 600 mgd could still be maintained for City water supply. The average diversion available to the City for water supply over the 45-year study period was 770 mgd. However, the diversions made by the City have averaged about 600 mgd since Cannonsville was completed in 1967. Prior to this time, the average diversions made by the City were considerably less.

If the Montague flow requirement were reduced during severe drought periods (as was done during the 60's drought), diversions to the City would not have to be reduced as low as 600 mgd. For example, reduction of the flow requirement at Montague to 1,500 cfs would allow 720 mgd to be diverted for City water supply resulting in an increase in the safe yield.

What Flexible System Operation Can Do

The flexible system operation of Neversink, Pepacton and Cannonsville Reservoirs will continue to assure the same level of diversion for New York City water supply, meet the Montague flow requirements and provide greatly improved conservation releases which will permit revitalization of this prime recreation and aesthetic resource.

A. New York City Water Supply

The amount of water diverted to the City would not be reduced and the City could continue to give preference to diversions from Neversink and Pepacton Reservoirs and minimize withdrawals from Cannonsville Reservoir when its water quality is poor. The average amount of water diverted from each reservoir would not change significantly, as shown below:

	Present	Proposed
Neversink	23 percent	24 percent
Pepacton	59 percent	55 percent
Cannonsville	18 percent	21 percent

Present diversions from Cannonsville Reservoir vary widely from month to month and under the proposal increases could be made during periods of better quality. Also, the quality of water in Cannonsville should improve in the future as new treatment plants go into operation upstream of the reservoir.

B. Montague Flow Requirements

1. The Montague flow requirements of the 1954 Supreme Court Decree would continue to be met. The minimum flow of 1,750 cfs would be maintained and excess releases would be made as required.

2. The present City policy of maximizing the use of Cannonsville Reservoir to meet the Montague flow requirements could be continued. However, the releases for this purpose should be made in a more gradual manner.

C. Conservation Releases

1. The proposed higher conservation releases would be maintained under normal conditions. During drought-warning and drought periods, the higher conservation releases would be reduced to the present minimum levels.

2. A minimum flow of 1,000 cfs for fish and wildlife would be maintained on the Delaware River at Callicoon during non-drought periods. This would also satisfy flow requirements for canoeing from April through October.

3. Increased conservation releases would significantly improve stream fisheries by reducing water temperatures during the summer and by limiting wide variations in temperatures. Water quality would be improved and environmental values enhanced.

D. Special Requirements

During years when natural spring runoff does not cause spillway overflow of sufficient magnitude to accomplish flushing - 500 cfs at Neversink and 1,000 cfs at Pepacton and Cannonsville Reservoirs - these releases could be made without adverse effects on meeting other requirements. Flushing releases should occur before May 15 of each year and should be for one day.

E. Other Considerations

1. There would be no significant loss in revenue for power generated by water diverted from Neversink and Pepacton Reservoirs, since only a slight reduction would be made in the amount of water diverted from the two reservoirs.

2. Reservoir drawdowns would be more nearly the same for the three reservoirs. Present operations result in large drawdowns for Neversink and Cannonsville Reservoirs during the summer and autumn. Flexible system operation would reduce them as shown in the following comparison of fluctuations between the mean stages at the end of May and October.

	Present	Proposed
Cannonsville	55 feet	26 feet
Pepacton	26 feet	34 feet
Neversink	41 feet	32 feet

Recommendations

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 as indicated on a trial basis.

4. Preference should be given to the use of Cannonsville Reservoir to meet the Montague requirements. However, these releases should be made in a more graduated manner than 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.

CHAPTER II

PRESENT OPERATION OF THE RESERVOIRS

Introduction

This chapter presents general information on the New York City Reservoir system in the Upper Delaware River Basin commonly known as the Delaware System. The operating criteria, River Master formulas, conservation release requirements, the present operation of the individual reservoirs and associated problems are presented in this chapter.

General

The Upper Delaware River Basin is that portion of the Delaware River Basin upstream of Port Jervis. The New York State portion has an area of about 2,404 square miles, and is roughly triangular in shape, approximately 75 miles long in the north-south direction and about 55 miles wide in the east-west direction. About 35 percent of the basin is in the Catskill State Park. The basin map, Fig. II-1, details the principal streams and reservoirs. The basin includes areas which receive the greatest amount of precipitation in the State. Average annual precipitation varies from about 40 inches along the Delaware River to about 60 inches in the Catskills.

The basin contains three major reservoirs - Cannonsville, Pepacton and Neversink which were developed by the City as sources of water supply. Water is diverted from these reservoirs via underground tunnels to the Rondout Reservoir east of the basin and conveyed from there by the Delaware Aqueduct. Of the 2,404 square miles that are drained by the Delaware River, 917 square miles are controlled by Cannonsville, Pepacton and Neversink Reservoirs. Pertinent features of these reservoirs are presented in Table II-1. Stage-area and stage-capacity curves for these reservoirs are presented in Figs. II-2 to II-4.

Cannonsville Reservoir has the largest drainage area but the smallest useable capacity to drainage area ratio. It has a greater assurance of filling under normal hydrologic conditions than the other two reservoirs. The City considers Neversink's water as the best in quality and Cannonsville's water as the poorest in quality. Cannonsville is subject to large algae blooms.

Other large reservoirs in the basin are Rio, Swinging Bridge and Toronto Reservoirs, which are used by Orange and Rockland Utilities, Inc. for power generation.

Groundwater of acceptable quality for domestic and limited industrial use is available within the Basin and is used to satisy most of

the in-basin water supply needs. The major use of the water of the basin is for diversion to New York City for water supply and for release to regulate downstream flow.

Operation of the New York City Reservoir System

The original U.S. Supreme Court Decree was issued in 1931 and amended in 1954. The Amended Decree authorizes the City to divert for water supply purposes up to an average of 800 million gallons per day (mgd), provided compensatory downstream releases are made to maintain a minimum basic flow at Montague, New Jersey of 1,750 cubic feet per second (cfs).

In addition, the Amended Decree requires the City to release an excess quantity of water equal to 83 percent of the amount by which the estimated consumption in New York City is less than the City's estimate of continuous safe yield from all its sources of supply except that the excess quantity shall not exceed 70 billion gallons. The seasonal period for release of the excess quantity begins on June 15, when the higher rate becomes effective at Montague and continues in effect until the following March 15 or earlier if the excess quantity has been fully released. The excess release available through March 15, 1974 is 62,633 cfs-days to maintain a flow of 2,270 cfs at Montague. The Amended Decree should be referred to for other details related to the excess releases. New York City is given the operational authority to determine from which reservoir the releases will be made to meet the Montague flow requirement. The City's operating procedure is to maximize releases from Cannonsville Reservoir and to reserve Neversink and Pepacton Reservoirs for water supply diversions.

The City's objective is to keep their system in balance by maintaining reservoir storages in relative proportion to the runoff potential from the respective watershed areas so that each reservoir has an equal chance of filling. Local conservationists often attribute the City's operating policy to the following factors:

1. Water in Cannonsville is inferior in quality to that in Neversink and Pepacton.

2. Water diverted to New York City from Neversink passes through a power plant owned by the Central Hudson Gas & Electric Corporation and diversions from Pepacton pass through a plant owned by Orange and Rockland Utilities, Inc. The City has a contract with these firms and receives annual revenue from them. No power is generated with water from Cannonsville.

River Master Formulas

The U.S. Supreme Court decree provided for locating a gaging station at Montague, New Jersey and the appointment of a River Master to administer the provisions of the decree.

Flows of the Delaware River at Montague are made up of the following components:

1. Controlled releases from Lake Wallenpaupack on Wallenpaupack Creek, Pennsylvania for the production of hydroelectric power

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

3. Uncontrolled runoff from the area above Montague

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

Therefore, determination of the amount of releases required from the City's reservoirs is complex because the City must make up the difference between the combined flows from the other sources and the required flow at Montague. Taking into account the time of transit from these sources to Montague, advance estimates of the three components are made on the morning of each day as follows:

1. The expected release of water from Lake Wallenpaupack power production for a 24 hour period beginning at 0800 hours two days later

2. The expected release of water from Rio Reservoir power production for a 24 hour period beginning at 1600 hours two days later

3. The expected uncontrolled runoff at Montague three days later.

Adjustments also are made in the expected flow at Montague based on forecasts from the Weather Bureau.

From this information the River Master directs that a certain quantity of water be released from the New York City reservoirs to meet the minimum flow requirement at Montague on a daily basis for three days later based on the time of travel from Pepacton Reservoir to Montague which is greater than from the other two reservoirs. Releases from Cannonsville and Neversink Reservoirs are timed to arrive at Montague concurrently with releases from Pepacton Reservoir. The amount to be released from each reservoir to make up the total flow requirement is determined by New York City.

The release requirements proved unreasonable during the 1961-66 drought, and some requirements were waived by the River Master and the Delaware River Basin Commission. Modification of the decree is urged by the City of New York(1).

Present Conservation Releases

There were no minimum conservation flows prescribed for Neversink and Pepacton Reservoirs at the time they were built. Subsequently, releases were established by a "gentlemen's agreement" between the City and the New York State Conservation Department (now Department of Environmental Conservation). The agreement for releases acquired legal status when it was made a part of the New York State Supreme Court proceedings on acquisition of riparian rights downstream from the dams. Minimum flows for Cannonsville were established by the New York State Water Power and Control Commission (now Department of Environmental Conservation) in its approval of the construction of the reservoir. The minimum conservation releases are as follows:

Cannonsville Reservoir

April 16 - November 30	15 mgd (23.1 cfs)
December 1 - April 15	5 mgd (7.7 cfs)

Pepacton Reservoir

April 8 - October 31	12 mgd (18.5 cfs)
November 1 - April 7	4 mgd (6.2 cfs)

Neversink Reservoir

April 8 - October 31	10 mgd (15.4 cfs)
November 1 - April 7	3 mgd (4.6 cfs)

At no time did the U.S. Supreme Court become a party to these decisions and the River Master has no control over the minimum conservation releases. When no releases are ordered by the River Master to meet the Montague requirements, minimum conservation releases are maintained by the City; at other times they are included in the larger releases to meet the Montague flow requirement.

The minimum conservation releases established were based on the minimum flows of record which occurred naturally before impoundment. Apparently consideration was given to the fishery resource and spawning periods in relation to prior drought flows. However, no agreements were reached on the duration of minimum flows nor for periodic high flows for flushing and limited scouring of fine sediments. Since Cannonsville Reservoir became operational in March 1967, the City has been maximizing releases from Cannonsville Reservoir water to meet the

(1) Numbers in parentheses refer to the Bibliography

flow requirement at Montague and making only minimum conservation releases from Pepacton and Neversink Reservoirs to conserve the better quality water for diversion to the City. As a result, drastic fluctuations between high and low flows have occurred in the West Branch Delaware River, and prolonged low flows have occurred on the East Branch Delaware and Neversink Rivers.

Associated Problems

The prolonged minimum conservation releases have altered river conditions and created water of substantially inferior quality for fishing and recreation, upset the ecology of the streams and caused several related problems. The effects of the present operation on the fish habitat are summarized below:

A. West Branch Delaware River

1. A viable warmwater fishery has ceased to exist on the West Branch as a result of the flow fluctuation, which varies from minimum conservation releases to high flows, and the wide variation in water temperatures

2. Trout production in the West Branch is limited by periods of high water temperatures (associated with conservation releases) which usually occur early in June, before the excess water is released, and occasionally during the summer when heavy rainfall precludes the need for any release to meet the Montague requirement

3. The river is virtually unfishable during some periods in the summer when large quantities of water are being released from the reservoir causing strong currents and high stages.

B. East Branch Delaware River

Trout production in the East Branch is limited by:

1. high summer water temperatures associated with minimum conservation releases from Pepacton Reservoir

2. lack of space resulting from low summer and winter flows

3. decreased invertebrate production associated with fluctuating water levels and anchor ice formation (because of extremely low winter flows) in riffle areas

4. lack of spawning success resulting from anchor ice formation.

C. Neversink Reservoir

The problems on the Neversink River are similar to those on the East Branch Delaware River.

Local Concerns

Conservationists are concerned about the existing pattern of low conservation releases for extended periods and the imbalance of larger releases made to meet the flow requirement at Montague. This concern has been expressed in a variety of ways. In 1971, the Sullivan County Board of Supervisors established the Neversink Delaware Study Commission which studied the problem of low flow in the Neversink River and issued a report in May, 1973. Assemblyman Gilman, Chairman of the Assembly Standing Committee on Conservation held a hearing on low flow problems in the Neversink River in October 1972. Numerous newpaper articles have appeared which present the concerns of fishermen, recreationists and local citizens over problems caused by low flow releases from the City reservoirs. Considerable correspondence regarding the problem has been received by the Governor, the Commissioner of Environmental Conservation and the Delaware River Basin Commission. Adverse effects are cited on the ecology of the streams, particularly on fish habitat and water quality, which inhibit their use. Local people feel that the present impact on the environment mandates a review of the diversion and release requirements. There is an increasing demand for management of the City reservoirs that is environmentally acceptable. Present problems and concerns have arisen because it was not envisioned at the time the minimum flows were established that under New York City operating procedures they would become the total flow for extensive periods of time rather than minimums which would be experienced only for a few days in some years. Many people believe that changes in the past 20 years, since the conservation releases were first agreed upon, have made the upward revision of releases an immediate necessity to meet fishing and recreation needs, and maintain stream quality standards.

TABLE II-1

Pertinent Features of the New York City Reservoirs

Details	Cannonsville Reservoir	Pepacton Reservoir	Neversink Reservoir
Latitude	42° 03' 46"	42° 04' 38"	41° 49' 40"
Longitude	75° 22' 29"	74° 57' 04"	74° 38' 21"
Dam Located at	Stilesville	Downsville	Neversink
County	Delaware	Delaware	Sullivan
Type of Dam	Earth fill, rock-faced	Earth fill, rock-faced	Earth fill, rock-faced
Storage Began	Sept. 1963	Sept. 1954	June 1953
Construction Completed	1967	1955	1955
Length of Diversion Tunnel to Rondout Reservoir (miles)	85	26	5.5
Drainage Area (square miles)	454	371	91.8
Diversion Began	Jan. 1964	Jan. 1955	Dec. 1953
Spillway Crest Level (feet above msl)	1,150	1,280	1,440
Capacity at Crest Level			
(acre-feet)	302,460	459,130	113,930
(million gallons)	98,618	149,700	37,146
Water Surface Area at Crest Level (acres)	4,750	5,700	1,500
Minimum Operating Level (feet above msl)	1,040	1,152	1,319
Capacity at Minimum Operating Level			
(acre-feet)	8,930	29,470	6,760
(million gallons)	2,912	9,609	2,205

TABLE II-1 (cont'd)

Details	Cannonsville Reservoir	Pepacton Reservoir	Neversink Reservoir
Diversion Sill Level (feet above msl)	1,035	1,143	1,314
Capacity at Diversion Sill Level			
(acre-feet)	5,800	18,700	5,150
(million gallons)	1,892	6,098	1,680
Outlet Sill Level (feet above msl)	1,020.5	1,126.5	1,314.0
Capacity at Outlet Sill Level			
(acre-feet)	1,010	5,820	5,150
(million gallons)	328	1,898	1,680
Useable Capacity			
(acre-feet)	293,530	429,660	107,170
(million gallons)	95,706	140,090	34,941
Ratio of Useable Capacity to Drainage Area			
(acre-feet per square mile)	646.5	1,158.1	1,167.4
(billion gallons per square mile)	0.211	0.378	0.381

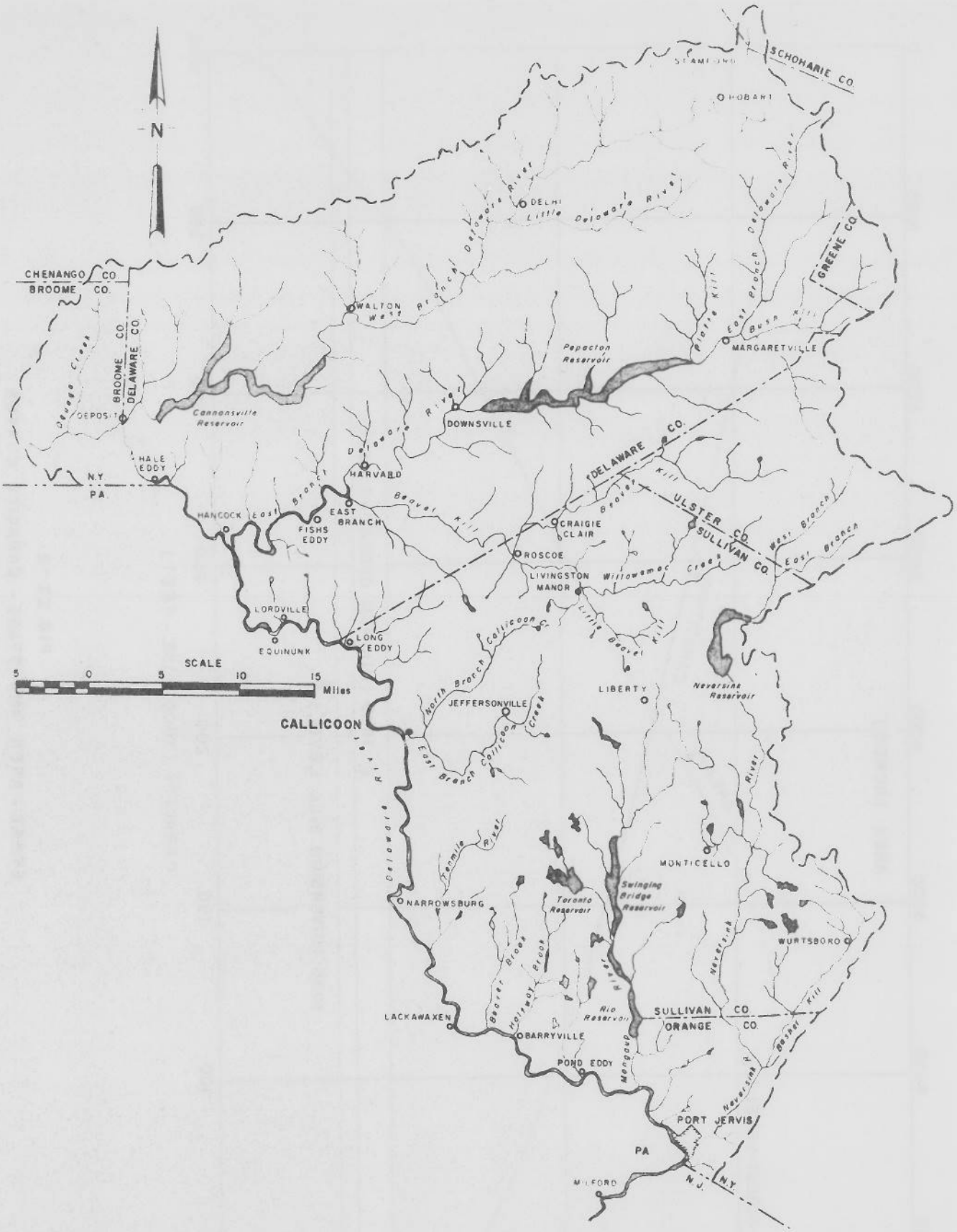

FIG. II-1
UPPER DELAWARE RIVER BASIN

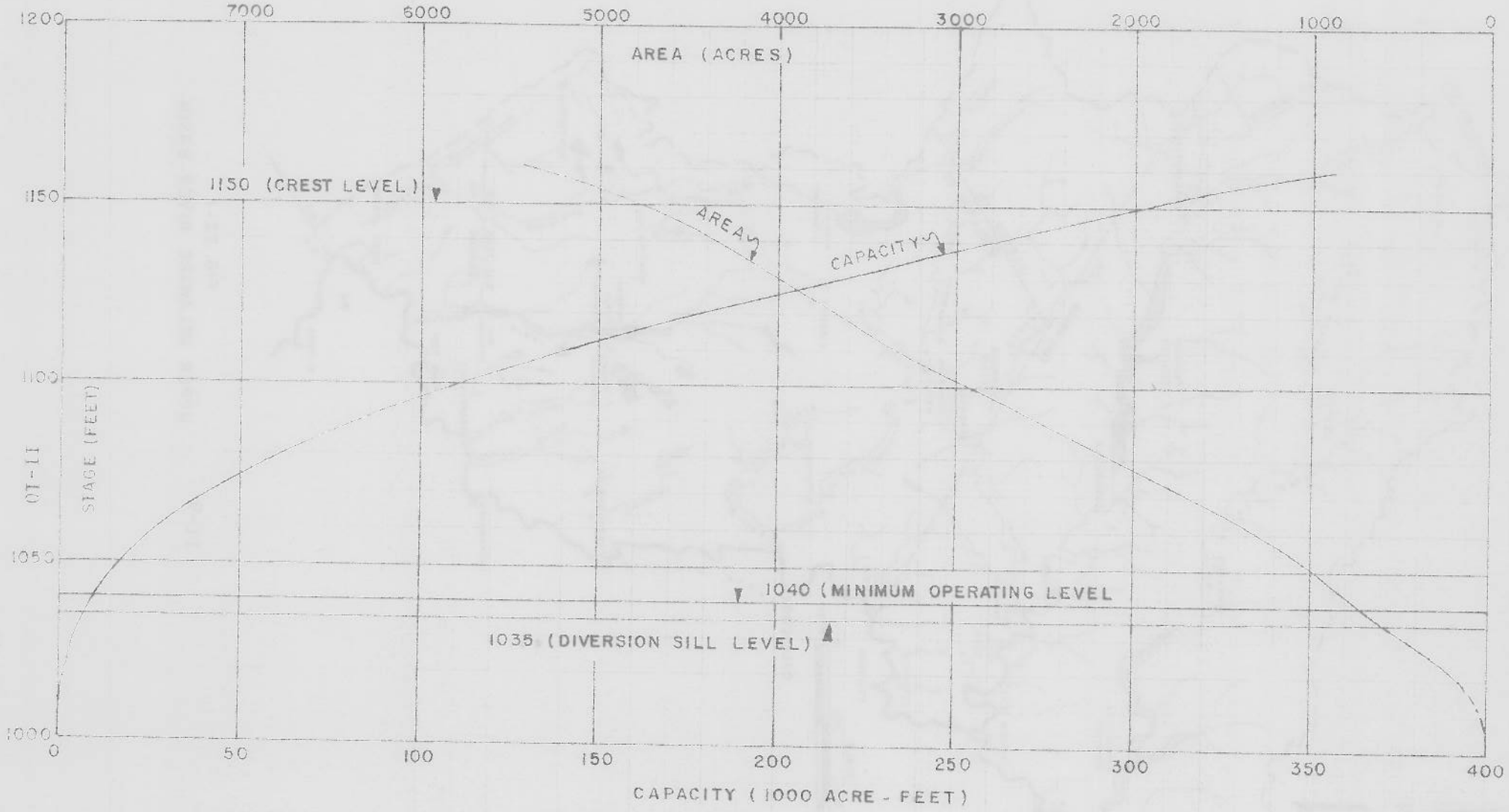

FIG. II-2

STAGE - AREA AND STAGE - CAPACITY CURVES

CANNONSVILLE RESERVOIR

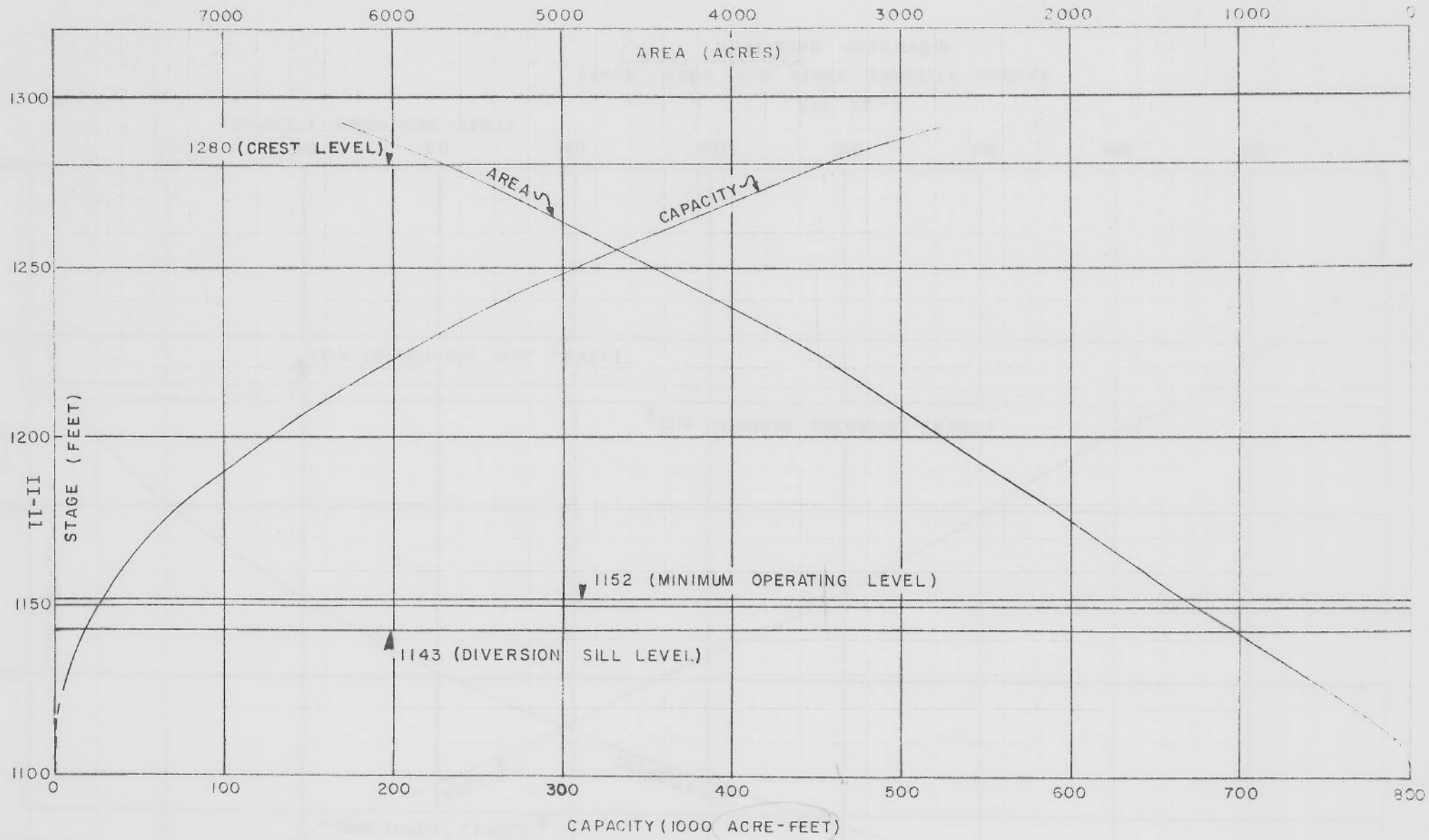

FIG. II-3

STAGE - AREA AND STAGE - CAPACITY CURVES

PEPACTON RESERVOIR

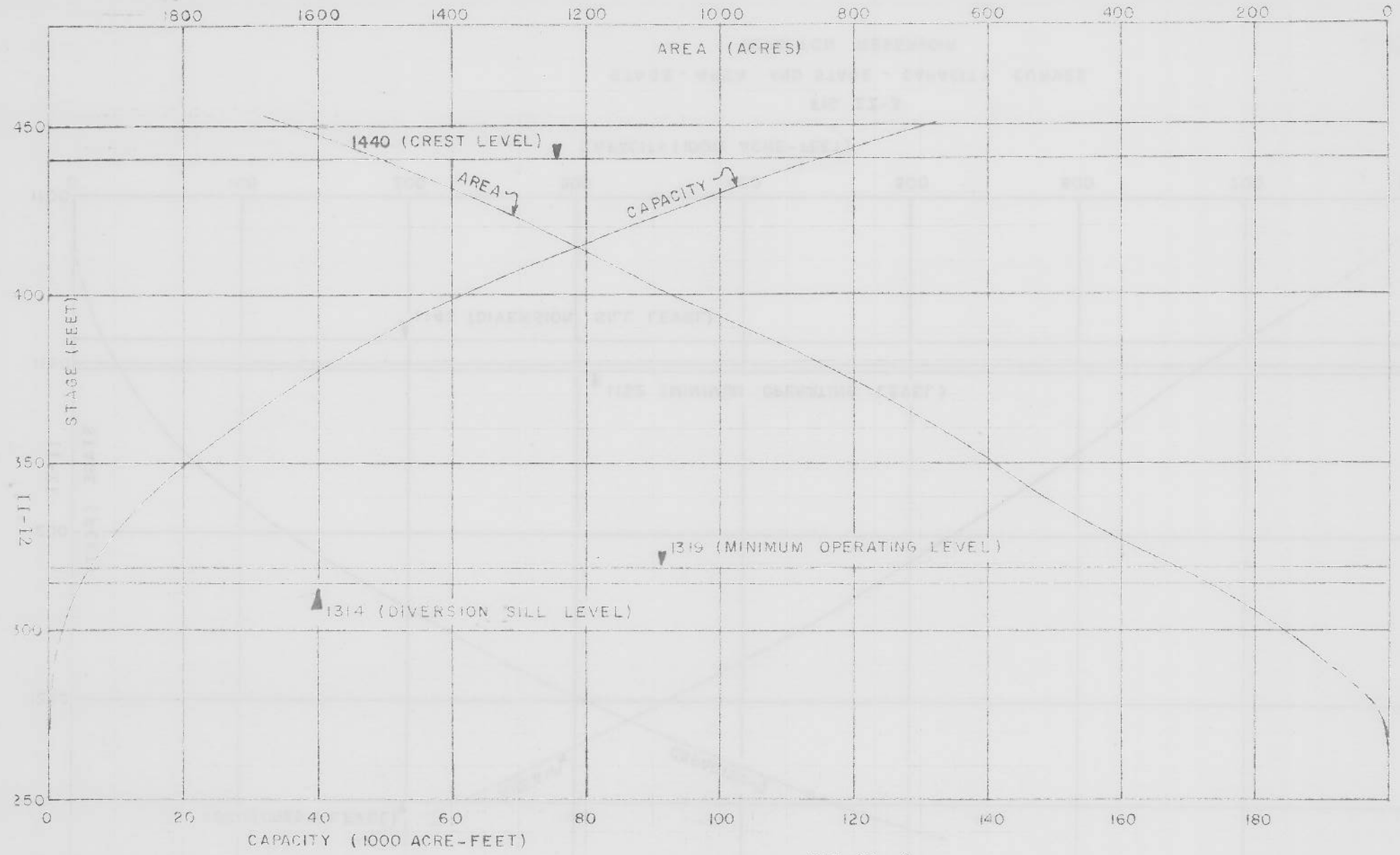

FIG. II - 4

STAGE - AREA AND STAGE - CAPACITY CURVES

NEVERSINK RESERVOIR

CHAPTER III

ENVIRONMENTAL QUALITY OF THE RIVERS

Introduction

The streamflow required in the major rivers of the Upper Delaware River Basin to meet the needs for fish, wildlife, water quality, and recreation and other ecological and environmental aspects are evaluated in this Chapter. The major rivers of the basin are the West Branch Delaware River and East Branch Delaware River which meet at Hancock and flow southeast as the Delaware River, and the Neversink River which enters the Delaware River at Port Jervis. Determination of the streamflow requirements to preserve environmental quality provides a base for this detailed investigation of the multi-purpose capabilities of New York City Delaware Reservoirs individually and on a system basis. The information also serves as input for comprehensive plan formulation in the Upper Delaware River Basin.

I. Environmental Quality of the West Branch Delaware River

Stream Classifications

Reaches of the West Branch are classified as follows:

From Hancock to the initial monument at the New York-Pennsylvania border....A(t) - (water supply and trout),

From the initial monument to Cannonsville Dam....B(t) - (bathing and trout),

From Cannonsville Dam to Cable Hollow Creek, about four miles downstream of Walton....A(t) - (water supply and trout),

From Cable Hollow Creek to Chambers Hollow Creek, about four miles upstream of Walton....B - (bathing),

From Chambers Hollow Creek to the Village of Stamford....C(t) - (trout),

From Stamford to a small pond one-half mile upstream of Utsayantha Lake....B - (bathing),

From there to the source....A - (water supply).

From Hancock to Cable Hollow Creek, from Chambers Hollow Creek to Stamford, and from a small pond one-half mile upstream of Utsayantha Lake to the source the dissolved oxygen requirement is 5.0 milligrams per litre (mg/l), which is the standard for trout waters.

The reaches from Cable Hollow Creek to the Chambers Hollow Creek, and from Stamford to the small pond one-half mile upstream of Utsayantha Lake have a dissolved oxygen requirement of 4.0 mg/l. The stream classifications are shown in Fig. III-1.

Waste Sources

Along the West Branch upstream of Cannonsville Reservoir, the major sources of waste are the population centers of Stamford, Hobart, Bloomville, Bovina Center, Delhi, Delancey, Hamden, Walton and various industries(2). Fig. III-2 shows the location of these waste sources. A high degree of secondary treatment and tertiary treatment are required by New York State at several of these communities in order to meet stream standards.

The Village of Stamford presently has a collection system and a primary treatment plant. This level of treatment is considered inadequate by the State. The Village is constructing a treatment plant which will provide 90 percent Ultimate Oxygen Demand (UOD) removal.

Prospect Dairy in Stamford currently routes its wastes through the Village plant. They have decided to discontinue this practice and provide their own treatment.

The Village of Hobart presently has a collection system and a primary treatment plant. The Village is under orders to construct a system which will restrict effluent UOD to 12 lbs. per day, equivalent to 96 percent removal efficiency.

The hamlet of Bloomville relies on individual septic systems and these appear to be adequate since there have been no reports of pollution of the adjacent stream. The Parnett Packing Company is located in the hamlet and has constructed a treatment plant which provides 85 percent Biochemical Oxygen Demand (BOD) and 50 percent Nitrogenous Oxygen Demand (NOD) removal in May 1973.

The Village of Delhi constructed a trickling filter in August 1973 which provides 85 percent BOD and 50 percent NOD removal. The plant serves the State University at Delhi and Dairyman's Cooperative.

Middletown Milk and Creamery provides spray irrigation treatment of its wastes presently. They have proposed adding a lagoon system to increase the quality of treatment and this is presently under review by the State.

The Village of Walton has no municipal waste treatment system. Individual septic systems are presently used and some wastes are finding their way into the West Branch Delaware River. The Village is under orders to construct a waste treatment system which will

furnish 96 percent BOD and 87 percent NOD removal. Dairy product wastes from Breakstone Foods will also be handled in this system.

The hamlets of Bovina Center, Hamden and Delancey have individual septic systems which are adequate.

Downstream from Cannonsville Reservoir the major concentrated sources of waste are the Villages of Deposit and Hancock. The Village of Deposit presently has no collection system or treatment facilities. Wastes are handled by individual septic systems or are discharged untreated into tributaries of the West Branch. The Village is under State orders to construct treatment facilities.

Hancock discharges wastes into both the East and West Branches of the Delaware River. The Village is on a voluntary schedule to prepare plans for a complete sewerage system.

Table III-1 lists the estimated present and future waste loadings in the West Branch Delaware River. A minimum flow of 10 cfs is sufficient to maintain dissolved oxygen standards at Deposit and at Hancock.

Water quality in Cannonsville Reservoir is poor in late summer and early fall due to algae growth but should be improved with the pollution abatement programs underway in the communities upstream from the reservoir. Also, further decomposition of the bottom material will reduce algae growth.

Fishery Resources

Smallmouth bass, brown trout and chain pickerel are the major game fish species inhabiting the Cannonsville Reservoir. The reservoir exhibits symptoms characteristic of cultural eutrophication. Summer algae blooms are heavy and the deeper waters lack sufficient quantities of dissolved oxygen to support fish life. Although brown trout are common at the present time, the development of a substantial brown trout fishery will hinge on the outcome of efforts to reduce nutrient input to the reservoir. Permits are issued by the New York City Department of Water Resources for shore and boat fishing.

The 18-mile section of the West Branch Delaware River between Cannonsville Reservoir and its junction with the East Branch Delaware at Hancock are controlled by releases from Cannonsville Reservoir. The Route 17 Quickway and Erie Lackawanna Railroad limit access from the easterly side of the river, but secondary roads provide access on the westerly side.

The West Branch is shallower than the East Branch and tributary streams suitable for trout spawning and nursery areas are less numerous than in the East Branch basin. Flow and water temperature fluctuations resulting from the Cannonsville Reservoir operations have fish populations in limbo between a cold and warmwater environment. When sufficient quantities of coldwater are released, conditions are suitable for trout.

However, when releases are at the minimum, temperatures are better suited for warmwater species such as smallmouth bass and sunfish. Unfortunately, as a result of flow fluctuations, conditions are not well suited to either warm or coldwater species on a long term basis. and, therefore, is not providing the fishing opportunity of which it is capable. Fish populations are sparse and include brown trout and smallmouth bass. The section between the New York-Pennsylvania boundary and Cannonsville Reservoir is stocked with 3,800 brown trout yearlings annually in an effort to provide more fishing opportunity. Shad do not migrate into the West Branch Delaware in significant numbers.

A year-round flow of 125 cfs, which is the 90 consecutive day low-flow with a return frequency of one in five years, is considered desirable to maintain a suitable environment for fish and wildlife below Cannonsville Reservoir. The flow of 125 cfs was determined from a 90 consecutive day low-flow frequency curve for West Branch Delaware River at Hale Eddy, based on flow records for the period 1915 to 1961, as shown in Fig. III-3. Flow data are also available on the West Branch at Stilesville for the period 1954 to 1962 but the Hale Eddy data are preferred because of the much longer period of record.

There is also need for an annual one-day high flow of 1,000 cfs for the purposes of beneficial scouring. Suspended solids are carried into streams from surrounding land. If sediment is left to accumulate in the streambed, it smothers food organisms produced on the stream bottom which are necessary for fish, tends to fill in pools and may smother fish eggs which are deposited in streambed gravel. In unimpounded streams, these sediments are naturally flushed from the stream during high flow periods. With dams controlling the watershed, the peak of these high flows are reduced resulting in a greater accumulation of sediment. The requirement of flow for beneficial scouring could be met in some years by reservoir spill during the early spring runoff period.

Recreation and Aesthetics

The West Branch Delaware River is an attraction for many vacationers and recreationists each summer. Fishing and canoeing are popular activities on the river. Cannonsville Reservoir also is used for fishing and boating although both are subject to strict regulation by the City.

In order to help determine the streamflow requirement for canoeing, American Canoe Association volunteers surveyed the river from Deposit to Hancock on April 29, 1973[3]. The volunteers observed that the river was close to the minimum canoeing level. A check of the Hale Eddy gage showed the flow to be 814 cfs. Analysis of flow data for the period 1966 to 1968 shows that such a flow at the Hale Eddy gage corresponds to a release of about 460 cfs from Cannonsville Reservoir during the months of April and May when canoeing is desired.

Summary of Streamflow Needs for Environmental Quality

The environmental use or objective of the West Branch below Cannonsville Reservoir and the corresponding best estimates of mimimum releases are summarized as follows:

Environmental Use or Objective	Minimum Flow Requirement below Cannonsville Dam
Maintain Stream Standards	10 cfs
Fishery	
Habitat Requirements	125 cfs
Beneficial Scouring	1,000 cfs
Recreation and Aesthetics	125 cfs
Canoeing	814 cfs (460 cfs release)

II. Environmental Quality of the East Branch Delaware River

Stream Classifications

The East Branch from Hancock upstream to the Downsville Dam is classified as C(t) - (trout). From Downsville Dam to Margaretville, the classification is A(t) - (water supply and trout). The remainder of the stream to its source is classified C(t) - (trout).

The major tributary to the East Branch, the Beaver Kill - Willowemoc Creek system, is classified as C(t) - (trout) for all reaches outside the Catskill Park. Fig. III-4 shows these stream classifications.

The entire East Branch, the Beaver Kill and Willowemoc Creeks have a dissolved oxygen requirement of 5.0 mg/l, which is the standard for trout waters.

Waste Sources

Along the East Branch and tributaries upstream of Pepacton Reservoir the major sources of waste are Fleischmanns, Roxbury, Halcottsville, Margaretville and Andes[2]. Fig. III-5 shows the location of these waste sources.

The village of Fleischmanns is a resort community. The summer population numbers about five times as many people as the permanent population. There is no collection system and individual disposal systems are used. Some septic tank effluent makes its way into Bush Kill, a tributary of the East Branch. However, this problem is considered minor and the Department of Environmental Conservation rates it of Priority 4 - marginal importance.

The hamlets of Roxbury, Halcottsville and Andes have individual disposal systems which are considered adequate. Margaretville has a sewage treatment plant which was built by the City of New York in order to protect Pepacton Reservoir. This plant provides a high degree of treatment and meets State Health Department standards.

Below Pepacton Reservoir, the major waste sources are Hancock on the East Branch, and Livingston Manor and Roscoe on the Beaver Kill and Willowemoc Creeks.

Effluent discharges from private sewers flow directly into both the East and West Branches of the Delaware at Hancock. The village is presently on a voluntary schedule to complete plans for a sewerage system.

Livingston Manor has a treatment plant(4) which needs improvement to meet 85 percent BOD and 50 percent NOD standards. Roscoe has an outdated primary treatment plant. Plans are presently under review by the Deparment of Environmental Conservation for a new plant which will provide adequate treatment.

Table III-2 shows the estimated present and future waste loadings in the East Branch Delaware River. A secondary treatment level, 85 percent BOD and 50 percent NOD removal, was used for all public systems and the net effect of efficient and inefficient private waste systems was estimated to be equivalent to a secondary treatment level. The major source of wastes on the East Branch below Pepacton Reservoir, as indicated before is the Village of Hancock. However, the amount of waste which reaches the stream is considered small. A flow of 10 cfs is sufficient to maintain dissolved oxygen standards.

Fishery Resources

The Pepacton Reservoir has become well known for the fishing it provides for trophy-size brown trout. Most of the reservoir's trout population is the result of natural reproduction in the many high quality tributaries. Young trout produced in tributary streams usually migrate to the reservoir as two-year-olds, feed on the reservoir's abundant alewife population and quickly grow to a large size. Smallmouth bass also provide significant fishing opportunities. It is estimated that 40-50,000 angler trips occur to the reservoir each year. Access is readily available from Route 30. Shore and boat fishing are allowed by permit issued by the New York City Department of Water Resources.

The 32-mile section of the East Branch Delaware River between Pepacton Reservoir and its junction with the West Branch is annually stocked with approximately 12,000 brown trout yearlings which supplement a trout population naturally produced in a number of small tributary streams. Shad are seasonally abundant during their spawning migration.

Over 15,000 anglers fish the river each year. During the late 1950's when large volumes of water were being released from Pepacton Reservoir, the East Branch became well known as a quality (i.e., it produced numbers of large trout) trout fishery. Although some good catches are still made, trout fishing has become spotty because of the low flow conditions and high water temperatures which now prevail in the river.

The fishery resource can be described as two distinct reaches. Reach #1 extends from Hancock upstream to the junction with the Beaver Kill at the hamlet of East Branch. Here the river descends through a steep sided valley through a series of deep pools separated by boulder-rubble riffles. The river is bounded on the north by the Route 17 Quickway. The Peas Eddy Road between Hancock and Peas Eddy, and Old Ontario and Western Railroad bed between Fishs Eddy and East Branch provide access to the river. Brown and rainbow trout are found near areas of spring seepage while smallmouth bass, sunfish and some walleye predominate in the more extensive warmer section. During May and June, shad are abundant and attract a large number of anglers. American eels are taken commercially near Hancock.

Reach #2, from East Branch to Pepacton Reservoir is a slower moving stretch which passes through a narrow, flat, valley floor. Long, placid pools separated by short, gravel riffles characterize this reach which is accessible from Route 30. Smallmouth bass, pickerel and sunfish are common and shad migrate into the area, but are less abundant than in Reach #1. Trout are also taken, particularly in the upper section which receives some cold water from Downs Brook and Pepacton Reservoir. In addition to the unfavorable effects of inadequate releases on water temperatures, trout production is severely limited by lack of space. Anchor ice formation and stream bottom exposure caused by low flow conditions limit aquatic food production essential for trout growth and survival. Flushing of the stream bottom would be beneficial, but only occurs during years when substantial quantities of water spill from the reservoir. Approximately five miles of public fishing rights have been acquired along this reach.

The 16-mile section of the Beaver Kill between East Branch and its junction with the Willowemoc at Roscoe, which averages 130 feet in width, descends at a moderate rate between tree-lined banks through a series of deep pools separated by boulder-rubble riffles. Access is readily available from Old Route 17, which along with the Route 17 Quickway, parallels the entire section. Approximately 13 miles of public fishing rights and two fishermen parking areas have been acquired along the Beaver Kill between East Branch and Roscoe. This reach, one of the most popular stream fishery resources in the State, is annually stocked with approximately 30,000 brown trout yearlings and fished by 15,000 anglers each year. The popularity of the stream is the result of its substantial trout population (both stocked and wild), its wadeability, scenic setting and nationwide fame.

The entire section of the Beaver Kill from Roscoe to the source is classified as a trout resource. In the lower river, from Roscoe upstream to Lew Beach (10 miles) the environment is the most suitable for brown trout production. From Lew Beach upstream to Turnwood (four miles) both brook and brown trout are produced. From Turnwood upstream to source (6.8 miles), the stream is most productive for brook trout. The major controlling factor for distribution of trout species in the upper watershed is water temperature. Brook trout prefer the cooler headwaters while brown trout are more adaptable to the relatively warmer waters of the middle and lower reaches of the river. Absence of competitive species in the upper watershed also favors production of brook trout.

The lower river (Roscoe to Lew Beach) environment is capable of producing wild brown trout up to two pounds although occasionally fish more than twice this size are taken. Most of the fishing is provided by brown trout from eight to fourteen inches in length (approximately four ounces to one pound).

The upper river (Turnwood to source) brook trout fishery is capable of producing wild brook trout up to about ten inches in length. Most of the fishing is provided by brook trout from five to nine inches long (approximately one to four ounces). Although their size is small these are excellent quality fish from all standpoints: aesthetics, sport and food value. Although no creel census information for the upper Beaver Kill is available, it can be assumed by comparative estimate with previous creel census data taken from the Willowemoc and Lower Beaver Kill that angling pressure is similar An annual estimate of angler use on public water would be 1,500 anglers per mile per year. The annual catch is composed of both wild brook and brown trout and hatchery stocked brown trout. The annual stocking rate is:

1) Roscoe upstream to Rockland Bridge, 2.1 miles; 4,000 brown trout yearlings (eight inches)

2) Beaver Kill Campsite, 1.0 mile; 2,000 brown trout yearlings.

Note: The Lew Beach bridge area is not stocked. This short section (0.5 miles) supports a good fishery for naturally spawned brook and brown trout.

There are no impassable barriers to fish migration in the entire system. A ten-foot stepped waterfall is located near Turnwood but large trout are able to negotiate it at normal flows. A nonmigratory resident population of rainbow trout is reported to be established in this area.

The 90 consecutive day low-flow frequency curve for East Branch Delaware River at Downsville, based on flow records for the period

1942 to 1952, is shown in Fig. IV-6. A year-round flow of 70 cfs, which is the 90 consecutive day low-flow with a return frequency of one in five years, is considered desirable to maintain a suitable environment for fish and wildlife below Pepacton Reservoir. There is a need for an annual one-day high flow of 1,000 cfs for the purpose of beneficial scouring. This requirement could be met in some years by reservoir spill during the early spring runoff period.

Recreation and Aesthetics

Present recreational use of Pepacton Reservoir is restricted to fishing and boating, both subject to strict regulation by the City. The East Branch Delaware River is an attraction for many vacationers and recreationists each summer. Fishing and canoeing are popular sports. The few miles of the East Branch, before reaching Pepacton Reservoir, are a great fast run looping through the lower Catskills. From Downsville to Hancock the river is a thrilling and majestic run at high water, on sweeping current with some mild rapids[5].

American Canoe Association volunteers surveyed the river from Downsville to East Branch on June 9, 1973[3] to help determine the flow needed for canoeing. Based on a flow of 2,000 cfs observed at the Harvard gage for that day the volunteers judged that the river would be canoeable with a river flow of 1,570 cfs at the Harvard gage. This quantity of flow very seldom occurs at the Harvard gage without very large releases from Pepacton Reservoir. Analysis of flow data for the period 1966 to 1968 shows that the flow of 1,570 cfs in the reach below East Branch will be available most of the time during the months of April and May when canoeing is desired. Therefore, no additional releases are required for canoeing below East Branch, however, it would be unrealistic to provide releases necessary for canoeing between Downsville and East Branch.

Summary of Streamflow Needs for Environmental Quality

The environmental use or objective of the East Branch below Pepacton Reservoir and the corresponding best estimates of minimum releases are summarized as follows:

Environmental Use or Objective	Minimum Flow Requirement Below Pepacton Dam
Maintain Stream Standards	10 cfs
Fishery	
Habitat requirements	70 cfs
Beneficial scouring	1,000 cfs
Recreation and Aesthetics	70 cfs
Canoeing	1,570 cfs (no additional release)

III. Environmental Quality of the Neversink River

The streamflow problems and desired level of minimum flows for maintaining environmental quality in the Neversink River were presented in an earlier report by the Department published in January 1972[6]. The information pertinent to this study is included herein.

Stream Classifications

From Port Jervis upstream to the Basher Kill, the Neversink River is classified as B-(bathing) with standards for dissolved oxygen of 4.0 mg/l, and requirements for disinfection of sewerage effluents and removal of all solids.

From Basher Kill to Neversink Reservoir the river is classified as B(t) - (bathing and trout). The dissolved oxygen standard for this reach is 5 mg/l. The reservoir is classified as A(t) - (water supply and trout), but the upstream river is again classified as B(t). The East and West Branches of the Neversink are classified C(t) - (trout). Fig. III-7 shows these stream classifications.

Waste Sources

On the Upper Neversink River above Sheldrake Creek the Woodbourne Rehabilitation Institute, hamlets of Woodbourne, Fallsburg, and South Fallsburg are the major sources of waste. Fig. III-8 shows the location of these waste sources.

The Woodbourne Rehabilitation Institute serves a population of about 1000 and has a secondary waste treatment plant. Sewage wastes in the hamlets of Woodbourne and Fallsburg are disposed of through septic tank and tile field systems, and multiple private sewer outlets.

South Fallsburg, which serves a population of 14,140 and two small slaughter houses, has recently constructed trickling filters, primary and secondary settling tanks, and digesters to provide a secondary level of waste treatment. The plant started operation in November 1971, and has significantly reduced the waste loadings to the river.

Sheldrake Creek, which enters the Neversink one mile above Bridgeville, receives residual waste from three major communities: Loch Sheldrake Park, Monticello, and Kiamesha Lake. These communities have secondary treatment facilities and are considering tertiary treatment to improve the water quality on the small receiving streams of Tannery, Kiamesha and Sheldrake Creeks.

Sullivan County is a popular resort area with the summer population reaching 175,000 or three-and-one-half times the year round population. Inadequate treatment facilities or lack of maintenance of facilities

at hotels and rural cottages serving these summer visitors contribute further to the BOD loading of the river. Odors, visible solids, coloration, sludge deposits and inadequate chlorine residuals are evident in many areas. Several other sources, e.g. leaching from landfills and drainage from golf courses are suspected of contributing to BOD loadings, but surveys have not been completed to confirm these sources. Additional smaller waste loadings in the lower Neversink watershed, and the above mentioned larger sources are shown in Table III-3.

The minimum conservation releases from Neversink Reservoir are inadequate to provide a satisfactory water quality. Insufficient flow in combination with inadequately treated waste discharges, have created health hazards for swimming and damage to trout. Public complaints, letters, and news articles have deplored the reduced streamflows on the Neversink River particularly since 1967 when releases from the Neversink Reservoir to maintain flows at Montague were curtailed. A minimum flow of 30 cfs is required to maintain stream standards.

Fishery Resources

The Neversink River is classified from the confluence of the Basher Kill to its source as a trout resource but "rough fish" and warmwater species are common or predominant in many areas. As will be discussed later, although low flows from Neversink Reservoir have caused impairment of the stream as a trout resource, pollution and natural conditions are also limiting factors for trout production.(7) Fishing which is currently possible is largerly due to the State stocking program. Approximately four miles out of a total of about 60 miles of the river have been reserved for public fishing access. Large tracts of private land and long reaches of good trout fishing waters are posted.

The fishery resource is divided into five reaches starting from Port Jervis to the headwaters. Reach # 1 from Port Jervis to just south of the Sullivan County line is an aesthetically attractive area characterized by rolling hills and countryside. The stream has an average gradient of 20 feet per mile, is shallow and as much as 110 feet wide in some locations. It is inhabited mainly by warmwater species, walleye, yellow perch, smallmouth bass, chain pickerel and American eels. Trout are also taken, especially in the upper section of the reach which receives cool water from the Bush Kill. The reach is accessible at bridge crossings, and is not posted to any extent. About four-and-one half miles are stocked annually with 3600 yearling trout.

Reach #2 from the Sullivan County line to one mile downstream of Bridgeville is heavily wooded, inaccessible and privately owned. It has a gradient of 40 feet per mile, and is the gorge section of the Neversink. It is very attractive and relatively undeveloped. It is believed to be spring fed and inhabited primarily by trout. Since this reach is posted, the State does not stock this section of the stream, but it is stocked by landowners.

In reach #3 from Bridgeville to Fallsburg the character of the Neversink changes from fast-flowing trout waters to a slow-moving stream inhabited mainly by sunfish, chain pickerel and minnows. Smallmouth bass were once abundant in this section. They are now rare. This is the problem section. Partially treated wastes from Monticello (via Sheldrake Creek), South Fallsburg, and several smaller sources are discharged into this reach. Flow regulation at Neversink Reservoir has resulted in a wide, exposed streambed in which radiation of summer heat from exposed shoals and boulders raises the water temperature to 27°C. Reduced velocities result in deposition of fine sediments that limit production of aquatic organisms. Flushing and scouring of the stream bottom would be beneficial, but does not regularly occur due to the relatively uniform flow regulation by Neversink Reservoir. Although accessibility is good, stocking has been eliminated in the Bridgeville area; the upper area is stocked annually with 1300 brown trout yearlings.

Reach #4 from Fallsburg to Neversink Reservoir is inhabited by trout, although suckers and fallfish are also present and undoubtedly limit trout production. There are no large waste sources in this reach, but inadequate releases from Neversink Reservoir deplete fish food organisms and trout are adversely affected by anchor-ice formation in the winter. Public accessibility is good, and 8.3 miles are stocked annually with 8400 brown trout fingerlings and 2000 brook trout yearlings. Fishing pressure is estimated at 300 to 500 anglers per mile per year.

Reach #5 includes the Neversink Reservoir and the East and West Branches of the Neversink. The Reservoir contains yellow perch and other warmwater species as well as trout, but because of the coldwater, depth and general lack of nutrients, both have a slow growth rate. The Department of Environmental Conservation has introduced landlocked salmon in the reservoir. Rainbow smelt, a forage fish, was previously introduced and has become successfully established. Headwater areas are inhabited by both brook and brown trout, and are exceptionally good trout spawning waters. The East and West Branches are almost entirely posted. The different reaches are shown in Fig. III-7.

The earlier report on Neversink River recommended the following release schedule:

June 1 - October 31 ...30 cfs
November 1 - March 31...15 cfs
April 1 - May 31 ...50 cfs

After further study, the Division of Fish and Wildlife concluded that a constant release of 50 cfs is required to maintain suitable environment for fish and wildlife below Neversink Reservoir. This flow is believed to be adequate to prevent lethal temperatures from occurring and to maintain a trout stream of environmental quality.

The 90 consecutive day low-flow with a return frequency of one in five years is 50 cfs for the Neversink River at Woodbourne based on flow periods for the period 1938 to 1951 as shown in Fig. III-9. There is a need for an annual one-day high flow of 500 cfs for the purpose of beneficial scouring. This requirement could be met in some years by reservoir spill during the early spring runoff period, although the City attempts to minimize spill from the Neversink Reservoir because of the good quality water.

Recreation and Aesthetics

Present recreational use of Neversink Reservoir is restricted to fishing and boating, both subject to strict regulation. The Neversink River is an attraction for many vacationers and recreationists each summer. Hotels, bungalow colonies and summer homes have been constructed in the river valley. Fishing, as previously described, is a popular activity and is common in many areas. Highways, such as Route 17, 55, 52, and 42 and smaller town and semiprivate roads provide access and vistas of the river.

Prior to the construction of Neversink Reservoir, the Neversink River was navigable by canoe throughout April, most of May and sometimes in the fall when flows reached levels of 400-600 cfs. Among canoeing circles the Neversink was known as one of the best rivers in southeastern New York[5]. Below the reservoir the river was a fast, dashing stream with hidden turns, riffles and sometimes deep wooded ravines; all of which comprised a delightful course to the recreational canoeist. Between Bridgeville and Oakland Valley the river flows through a gorge 600-700 feet deep and is increasingly rougher, wilder and more challenging.

American Canoe Association volunteers surveyed the river several times[3] in the spring and summer of 1973 judging the canoeability at various uncontrolled levels of flow. They recommend a flow of 500 cfs at the Oakland Valley gage as the minimum desirable and noted that such a flow would provide suitable canoeing conditions for the entire river below the dam. An analysis of flow data for the period 1966 to 1968 shows that the flow of 500 cfs at Oakland Valley gage corresponds to a downstream release of 200 cfs from the Neversink Reservoir in the months of April and May when canoeing is desired.

Summary of Streamflow Needs for Environmental Quality

The environmental use or objective of the Neversink and corresponding best estimates of minimum releases are summarized as follows:

Environmental Use or Objective	Minimum Flow Requirement below Neversink Reservoir
Maintain Stream Standards	30 cfs
Fishery	
Habitat Requirements	50 cfs
Beneficial Scouring	500 cfs
Recreation and Aesthetics	30 cfs
Canoeing	500 cfs (200 cfs release)

IV. Environmental Quality of the Delaware River

Stream Classifications

The Delaware River from the confluence of the East Branch Delaware River and West Branch Delaware River at Hancock to Narrowsburg is classified as A(t) - (water supply and trout). From Narrowsburg to the intersection of the New York, New Jersey and Pennsylvania State boundary lines referenced by the Tristate Rock Monument, the river is classified as A-(water supply).

The dissolved oxygen requirement for the entire reach of the river from Hancock to Tristate Rock Monument is 5.0 mg/l, which is the standard for trout waters.

Waste Sources

There are a few small scattered villages along the river. They have no municipal waste collection and treatment systems and depend on individual septic systems. While some sewage is discharged from several small communities and industries, the river water is generally of good quality.

Table III-4 presents the estimated present and future waste loadings in the Delaware River. A minimum flow of 10 cfs is sufficient to maintain dissolved oxygen standards at Callicoon and at Narrowsburg.

Fishery Resources

The Delaware River offers some of the finest sport fishing potential to be found in any river fishery in New York State, both from the variety of species available and from a quality (large fish for a given species) standpoint. Principal species of interest are smallmouth bass, walleye, American shad, rainbow trout, brown trout, and American eel. Of these species, smallmouth bass, walleye, American shad and American eel are distributed over the entire river.

From a fisheries standpoint, the river can be divided into two reaches: one providing primarily warmwater fishing and the other primarily coldwater.

The warmwater reach extends from Port Jervis upstream to Callicoon (50.0 stream miles). Smallmouth bass are abundant with the bulk of the catch being eight to twelve inches in length. However, occasional fish up to 18 inches (three pounds) are taken. Walleye are common to all of the deep eddies and range between 16 and 24 inches. Much larger walleye are also caught, some exceeding 30 inches and weighing more than 10 pounds. The American eel is taken both by angling and spearing. The latter method is often extremely productive. The river is waded at night using a light to spot the eels which forage over the shallows during the nocturnal period. In past years, a sizeable commercial eel fishery existed, but operation of eel weirs is not a common practice today. Four permits to operate commercial weirs were issued in 1973. The American shad represents a significant resource and the sport fishery is extremely popular.

The coldwater reach extends from Callicoon upstream to Hancock (27.1 stream miles). At present, rainbow trout appear to predominate in the section. Average size of both rainbows and brown is 14 inches (one pound) although fish 19-22 inches long are common (about three pounds). The rainbow trout are entirely of wild origin and no stocking is done. Brown trout are predominatly of wild origin with a few migrant hatchery fish entering the catch. No brown trout are stocked in this section of the Delaware River. Average size of the brown trout is similar to that of the rainbow with an occasional fish over 24 inches taken.

To many anglers and biologists, this is the finest trout river in the entire northeast. But the existence of the fishery has been repeatedly threatened since 1967 by the Connonsville release pattern featuring instantaneous and extreme fluctuations in volume of flow and correspondingly dramatic temperature changes. Trout survival has on many occasions been compromised. Severe damge to the trout fishery can occur during the warmer summer period whenever abrupt cutoff of high volume flows occur. For example, for defineable periods during the summer of 1972 and 1973 this situation prevailed. Water temperatures abruptly increased to over 80 degrees Fahrenheit and trout were found congregated in dense schools at cool feeder stream inlets. Field investigations indicated that trout mortality did occur. The future value of the trout fishery will be directly related to the extent to which the recommendations of this report are implemented.

Three fishing access sites are provided for the purpose of small boat and canoe launching. These are located at Narrowsburg, Cochecton and Callicoon, situated 36.3, 44.8 and 50.0 miles upstream from Port Jervis, respectively. Future planning includes development of two additional fishing access sites at Barryville and Skinners Falls, located 25.7 and 41.8 miles upstream from Port Jervis.

A minimum year-round flow of 1,000 cfs at the Callicoon gage is considered desirable to maintain a suitable environment for fish and wildlife. Such a flow at the Callicoon gage would inject a measure of stability into the system thus encouraging production of coldwater fishery from Hancock to Callicoon and warmwater fishery from Narrowsburg to Port Jervis. A mixed warm and coldwater fishery would result between Callicoon and Narrowsburg.

Recreation and Aesthetics

The Delaware River flows in a meandering course through a comparatively narrow, steep sided valley of tranquil scenic beauty separating the Catskill Mountains of New York from the Pocono Mountains of Pennsylvania. The river varies from 150 to 1,500 feet in width, but is most commonly in the 300-500 foot range. Average gradient is six feet per mile and riffle areas predominate over pool sections. These pools, or eddies, are generally short, between one quarter and three quarters of a mile in length. Riffle areas are gentle to moderate, between two to eight feet deep and pools are 17-22 feet deep. There are two exceptionally deep pools at Pond Eddy and Narrowsburg, which are 45 feet and 113 feet deep respectively. The stream bottom is mainly composed of gravel and rubble but in a few places bedrock is exposed. Except in times of flooding, the water is comparatively clean looking and clear.

Navigation today on the river is confined mainly to pleasure craft, especially canoes and kayaks, since at various sections of the river rapids prevent the passage of boats with deep drafts. The river reach from Hancock to Port Jervis, a distance of about 77 stream miles is of sufficient length for a week long canoe or float fishing trip. The best known white water stretch is the rather hazardous rapid just downstream from the bridge at Skinners Falls. Upstream releases from reservoirs on the East and West Branches, and the steep gradient combine to produce white water conditions sufficient to challenge the experienced canoeists during most of the season. The section of the river at Hawk's Nest has one of the steepest gradients and some of the longest and swiftest runs. The river provides excellent opportunities for canoeing, boating and fishing with the water depths through the summer months usually adequate.

The river reach extending from the confluence of the East and West Branches of the Delaware River below Hancock to Sparrowbush, a distance of 72.7 miles is being studied for inclusion in the National Wild, Scenic and Recreational Rivers System(8). The identified reach has been divided into five sections, two of which are classified as scenic and three as recreational, as follows:

SECTION		CLASSIFICATION
I.	Confluence of East and West Branches to half mile below Lordville, N.Y. (9.8 miles)	Recreational
II.	One half mile below Lordville to one and one quarter miles above Callicoon, N.Y. (15.8 miles)	Scenic
III.	One and one quarter miles above Callicoon to the lower limits of Narrowsburg, N.Y. (16.7 miles)	Recreational
IV.	Lower limits of Narrowsburg to one mile below Westcolang, Pa. (9.3 miles)	Scenic
V.	One mile below Westcolang to Sparrow Bush, N.Y. (21.1 miles)	Recreational

American Canoe Association volunteers surveyed[3] the river from its confluence with the Mongaup River to Port Jervis on June 24, 1973. The discharge in the river at Port Jervis gage for that day was 3,000 cfs. The volunteers judged that the river would be canoeable with a flow of 1,850 cfs at the Port Jervis gage. A survey was also conducted by soliciting observations of the river from concerned local citizens and livery owners. Analysis of the data collected indicates the following minimum desirable flows for canoeing at different locations:

Gage Station Location	Desirable Minimum Flow (cfs)
Callicoon	1,600
Barryville	2,500
Port Jervis	4,300

Summary of Streamflow Needs for Environmental Quality

The environmental use or objective of the Delaware and corresponding best estimates of minimum releases are summarized as follows:

Environmental Use or Objective	Minimum Flow Requirement
Maintain Stream Standards	10 cfs
Fishery	
Habitat Requirements	1,000 cfs
Recreation and Aesthetics	1,000 cfs
Canoeing	
American Canoe Association Requirement	1,850 cfs at the Port Jervis gage
Requirements by concerned local citizens and livery owners	1,600 cfs at the Callicoon gage 2,500 cfs at the Barryville gage 4,300 cfs at the Port Jervis gage

TABLE III-1
Present and Future Waste Loadings
West Branch Delaware River

Area	1970 Population	1970 Sewage Quantity, mgd	1970 UOD lbs/day	1990 Population	1990 Sewage Quantity, mgd	1990 UOD lbs/day
Upper West Branch(above Cannonsville Reservoir)						
Stamford	1,286	0.31	103 1/	1,375	0.15	103 1/
Prospect Dairy	--	0.08	70	--	0.08	70
Hobart	531	0.06	12 2/	590	0.07	12 2/
Bloomville	210	0.02		250	0.03	
Parnett Packing	--	0.02	50 3/	--	0.02	50 3/
Delhi (inc. Dairymen's Coop)	3,017	0.30	316 3/	3,800	0.42	420 3/
SUNY-Delhi	--	0.225	306 3/	--	0.225	306 3/
Middletown Milk & Creamery, Deltown Foods, Inc.	--	0.32	1,364 3/	--	0.32	1,364 3/
Walton	3,744	0.50	69 4/	4,200	0.46	55 4/
Breakstone Foods	--	3.39	338 4/	--	3.39	338 4/
Hamden	140	0.01	10 3/	150	0.02	20 3/
Bovina Center	220	0.02	20 3/	250	0.03	30 3/
Delancey	160	0.02	20 3/	175	0.02	20 3/
Lower West Branch (below Cannonsville Reservoir)						
Deposit (including industrial waste)	2,062	0.30	338 3/	2,175	0.31	339 3/

1/ Based on 90 percent UOD removal
2/ Based on 96 percent UOD removal
3/ UOD based on 85 percent BOD, 50 percent NOD removal
4/ UOD based on 96 percent BOD, 87 percent NOD removal

TABLE III-2
Present and Future Waste Loadings
East Branch Delaware River

Area	1970 Population 1/	1970 Sewage Quantity, mgd	1970 UOD 2/ lbs/day	1990 Population 1/	1990 Sewage Quantity, mgd	1990 UOD 2/ lbs/day
Upper East Branch (above Pepacton Reservoir)						
Fleischmanns	2,000	0.20	220	2,500	0.28	310
Roxbury	1,000	0.10	110	1,300	0.15	170
Halcottsville	70	0.01	10	70	0.01	10
Margaretville	800	0.08	90	1,060	0.12	130
Andes	400	0.04	50	400	0.05	60
Lower East Branch (below Pepacton Reservoir)						
Downsville	800	0.08	90	900	0.10	110
Corbett	180	0.02	20	180	0.02	20
East Branch	150	0.02	20	150	0.02	20
Fishs Eddy	150	0.02	20	150	0.02	20
Hancock	1,700	0.03	340	2,500	0.44	490
Beaver Kill						
Livingston Manor	2,500	0.25	280	3,480	0.38	420
Roscoe	1,130	0.11	120	1,580	0.17	190
Cooks Falls	200	0.02	20	200	0.02	20

1/ Based on peak seasonal
2/ Ultimate oxygen demand based on 85 percent BOD removal and 50 percent NOD removal

TABLE III-3
Present and Future Waste
Loadings, Neversink River

Area	1970 Population	1970 Sewage Quantity, mgd 1/	1970 UOD lbs/day 2/	1990 Population	1990 Sewage Quantity, mgd 1/	1990 UOD lbs/day 2/
Upper Neversink						
Woodbourne Rehab. Center	900	0.09	100	1,500	0.17	190
Woodbourne (Domestic)	1,870	0.19	210	1,940	0.21	240
(Industrial)		0.01	160		0.02	310
Fallsburg	3,360	0.34	380	4,000	0.44	500
South Fallsburg (Domestic)	14,140	1.41	1,600	15,170	1.67	1,800
(Industrial)		0.02	200		0.02	200
Scattered	1,700	0.17	190	1,800	0.20	220
Sheldrake Stream-Evans Lake						
Loch Sheldrake	4,480	0.45	510	6,300	0.69	780
Loch Sheldrake Park	900	0.09	100	1,000	0.11	120
Divine Corners	560	0.06	60	620	0.07	70
Kiamesha Creek						
Monticello	15,000	1.50	1,700	19,700	2.17	2,450
Monticello South	2,410	0.24	270	3,140	0.35	390
Maplewood	450	0.05	50	680	0.08	80
Kiamesha Lake	8,820	0.88	1,000	10,570	1.17	1,300
Thompsonville	320	0.03	40	800	0.09	100
Lower Neversink						
Lake Louise Marie	930	0.09	100	1,780	0.20	220
Wanasink	510	0.05	60	840	0.09	110
Wolf Lake	1,280	0.13	150	2,270	0.25	280
Melody Lake	260	0.03	30	420	0.05	50
Rock Hill	660	0.07	70	920	0.10	110

1/ Based on peak seasonal
2/ Ultimate oxygen demand based on 85 percent BOD removal and 50 percent NOD removal

TABLE III-4
Present and Future Waste Loadings
Delaware River

Area	1970 Population 1/	1970 Sewage Quantity, mgd	1970 UOD 2/ lbs/day	1990 Population 1/	1990 Sewage Quantity, mgd	1990 UOD 2/ lbs/day
Delaware River						
Callicoon	880	0.09	100	1,250	0.14	150
Hortonville	630	0.06	60	900	0.09	100
Narrowsburg	730	0.01	80	1,280	0.14	150
Hunts Corner	120	0.01	10	180	0.02	20
Barryville	1,100	0.11	120	1,780	0.20	220
Callicoon Creek - East Branch						
Jeffersonville	700	0.07	80	900	0.09	100
Kohlertown	200	0.02	20	290	0.03	30
Youngsville	1,690	0.17	190	2,100	0.23	230
Halfway Brook						
Eldred	1,200	0.12	130	1,860	0.20	220
Ten Mile River						
Lake Huntington	1,440	0.14	160	2,150	0.24	270

1/ Based on peak seasonal
2/ Ultimate oxygen demand based on 85 percent BOD seasonal and 50 percent NOD removal

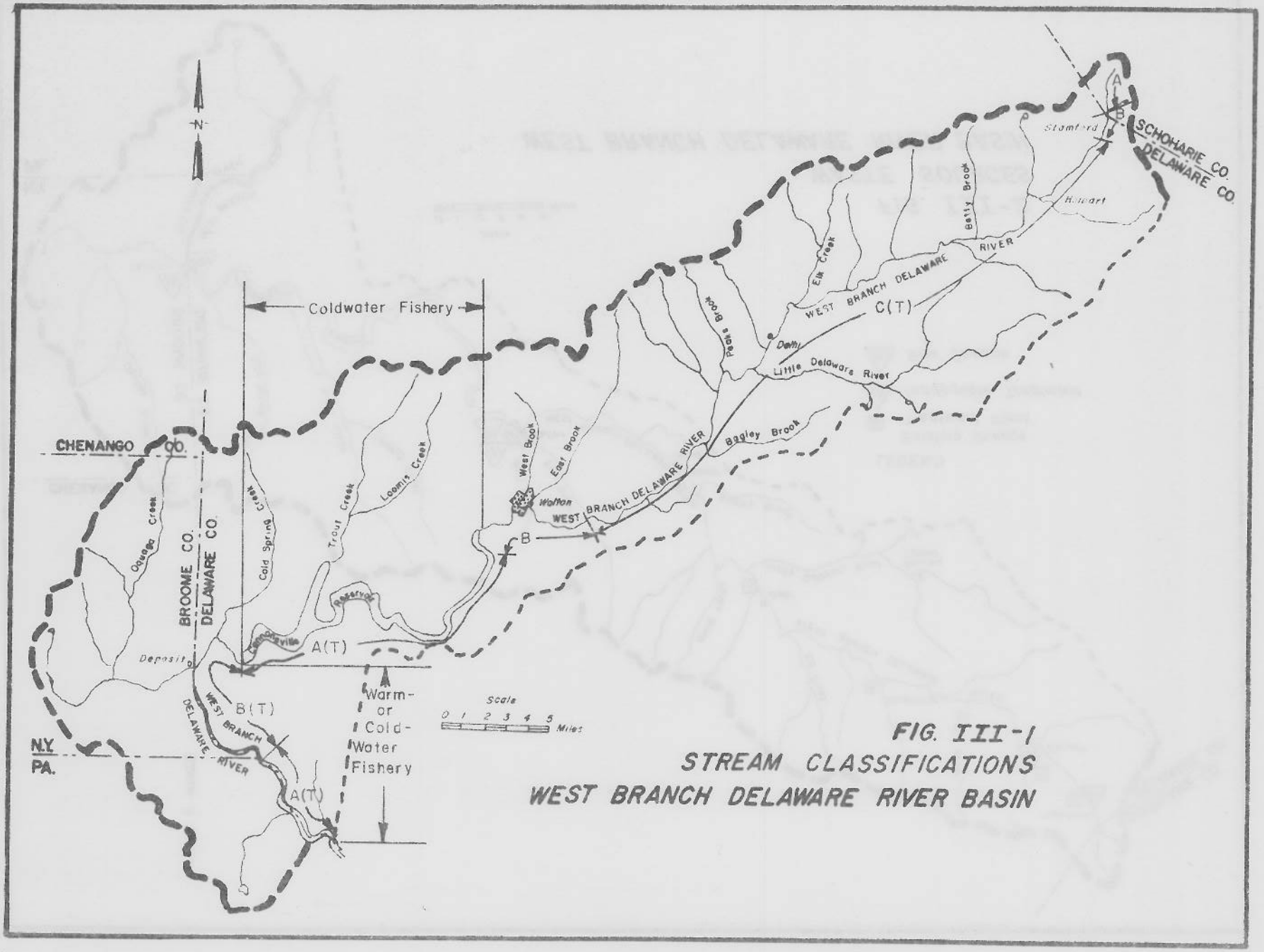

FIG. III-1
STREAM CLASSIFICATIONS
WEST BRANCH DELAWARE RIVER BASIN

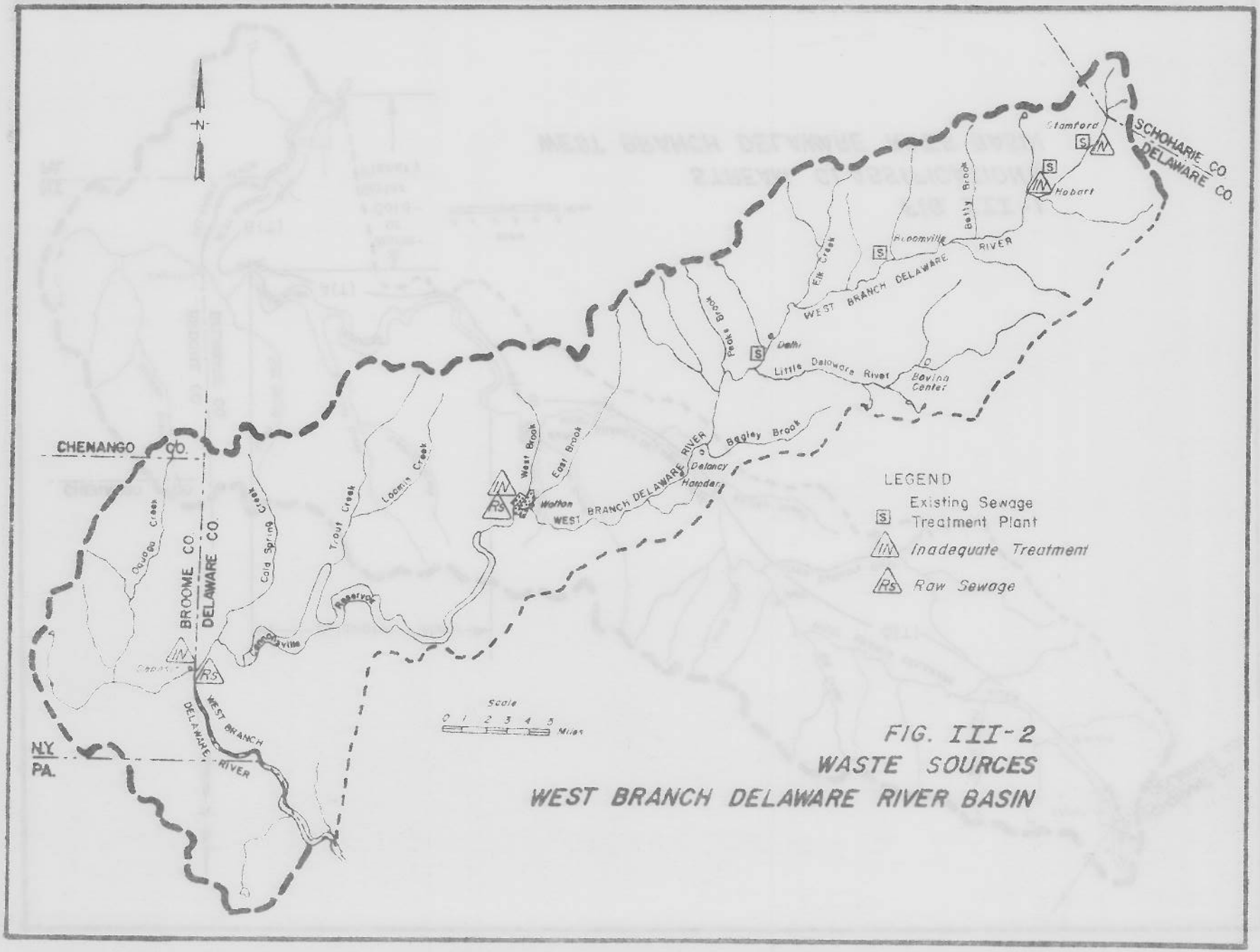

FIG. III-2
WASTE SOURCES
WEST BRANCH DELAWARE RIVER BASIN

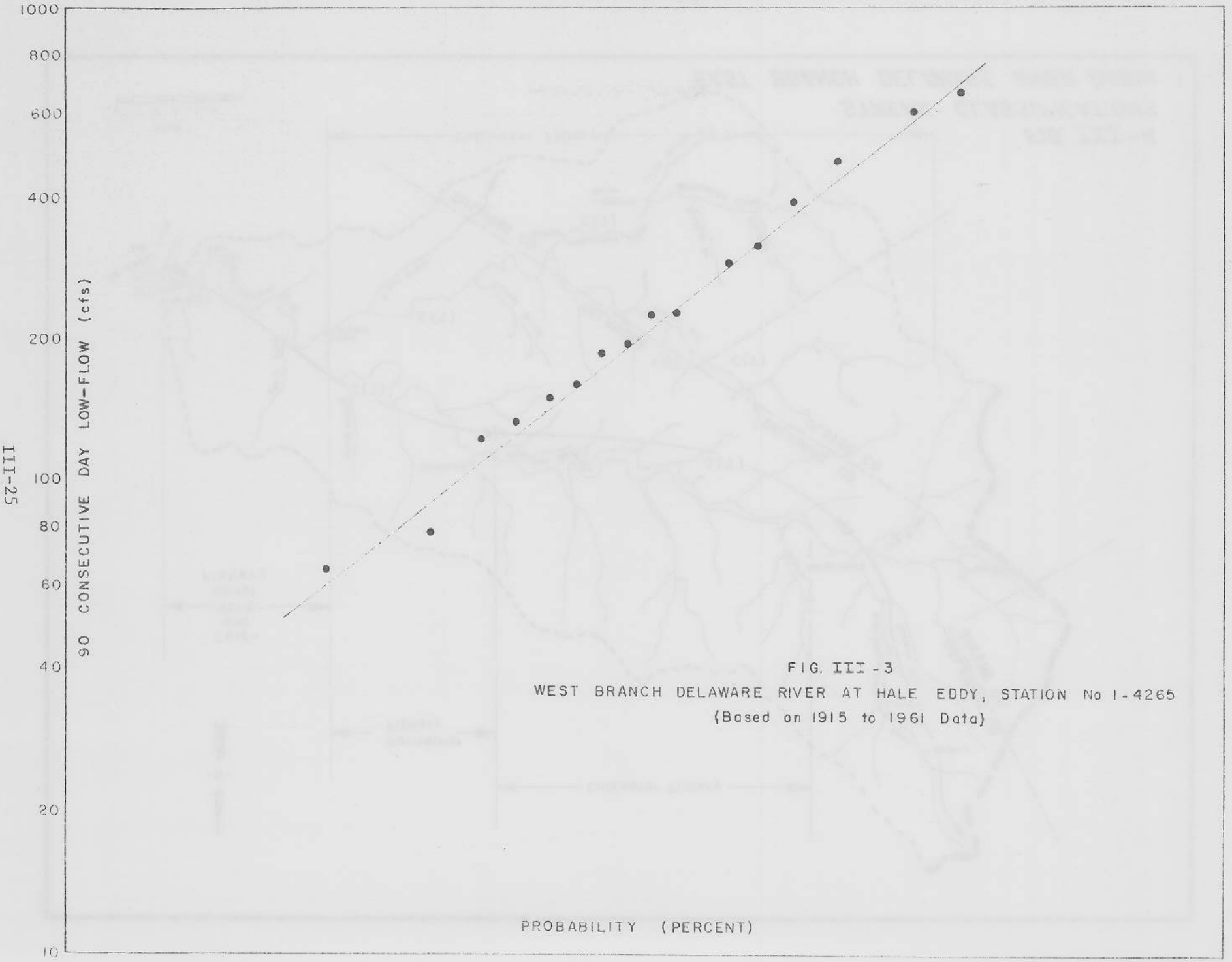

FIG. III - 3
WEST BRANCH DELAWARE RIVER AT HALE EDDY, STATION No 1-4265
(Based on 1915 to 1961 Data)

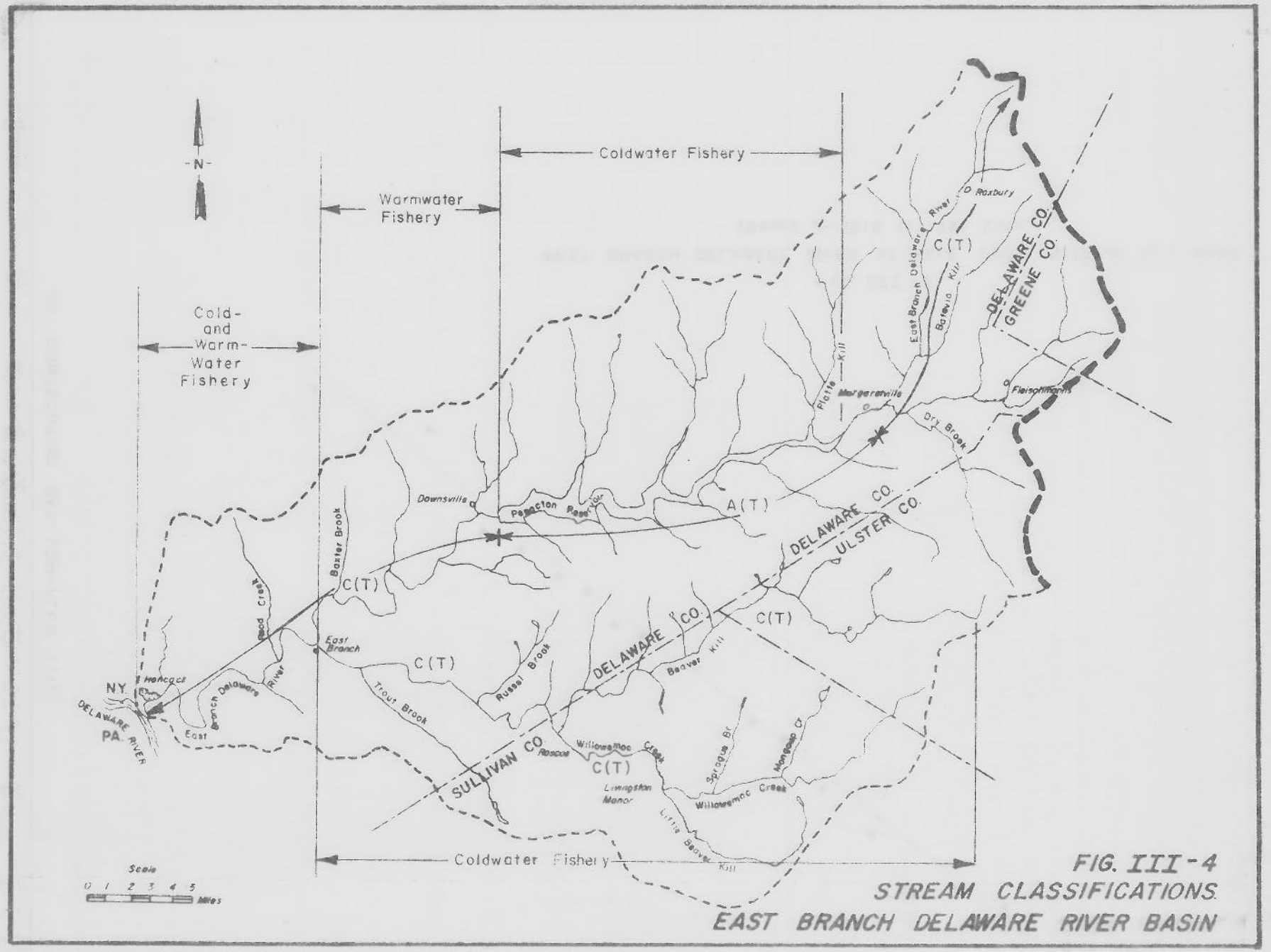

FIG. III-4
STREAM CLASSIFICATIONS
EAST BRANCH DELAWARE RIVER BASIN

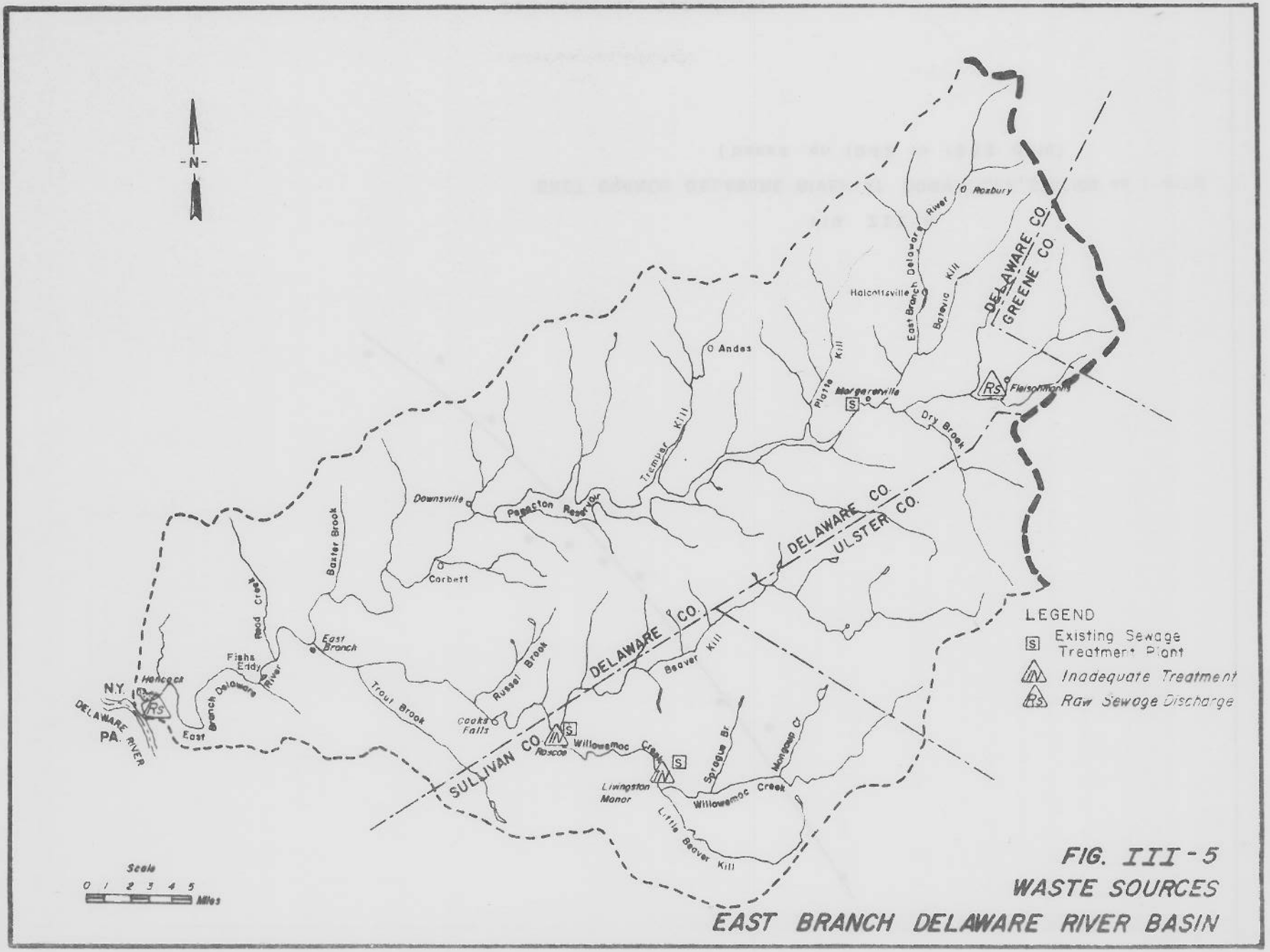

FIG. III-5
WASTE SOURCES
EAST BRANCH DELAWARE RIVER BASIN

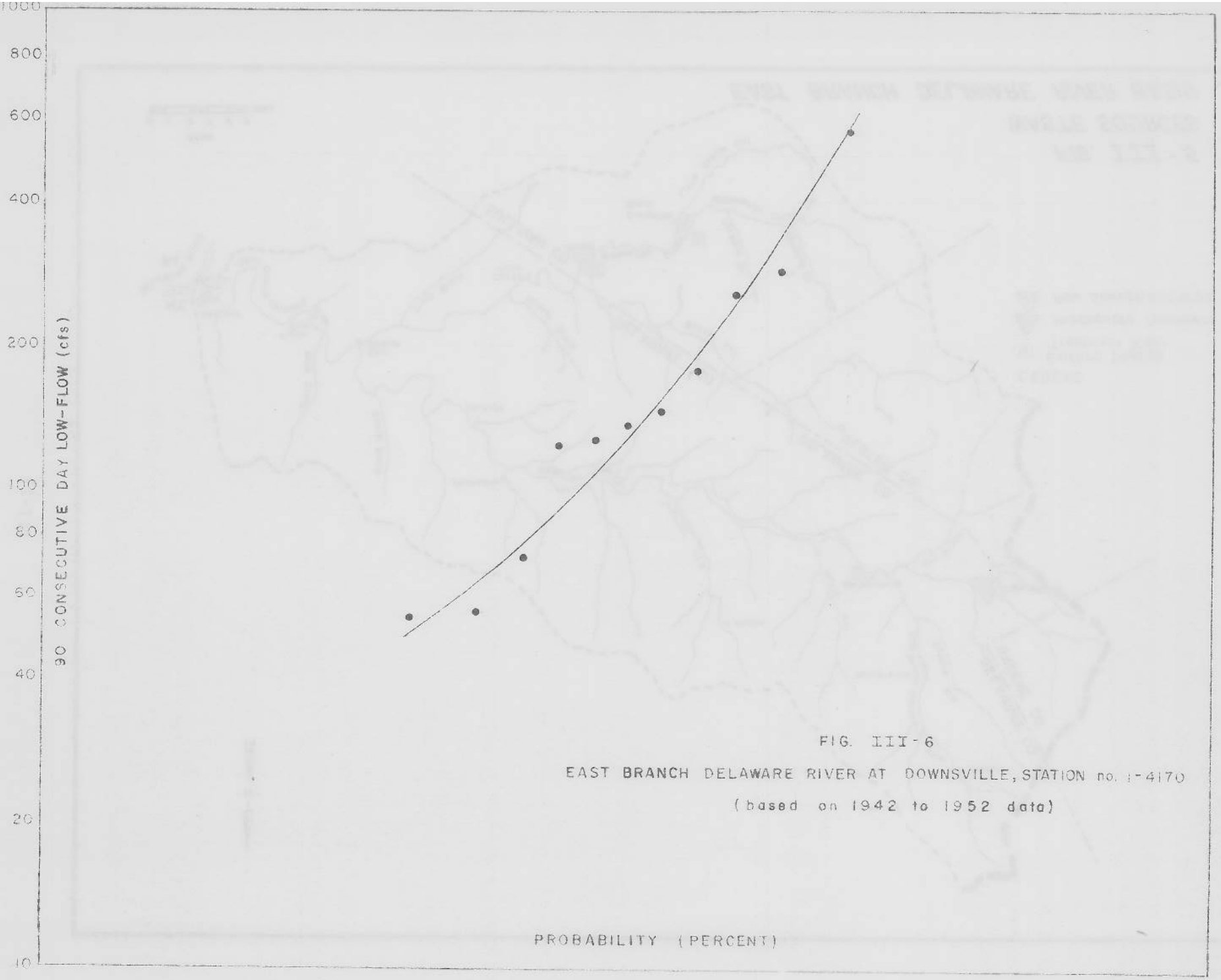

FIG. III-6

EAST BRANCH DELAWARE RIVER AT DOWNSVILLE, STATION no. 1-4170

(based on 1942 to 1952 data)

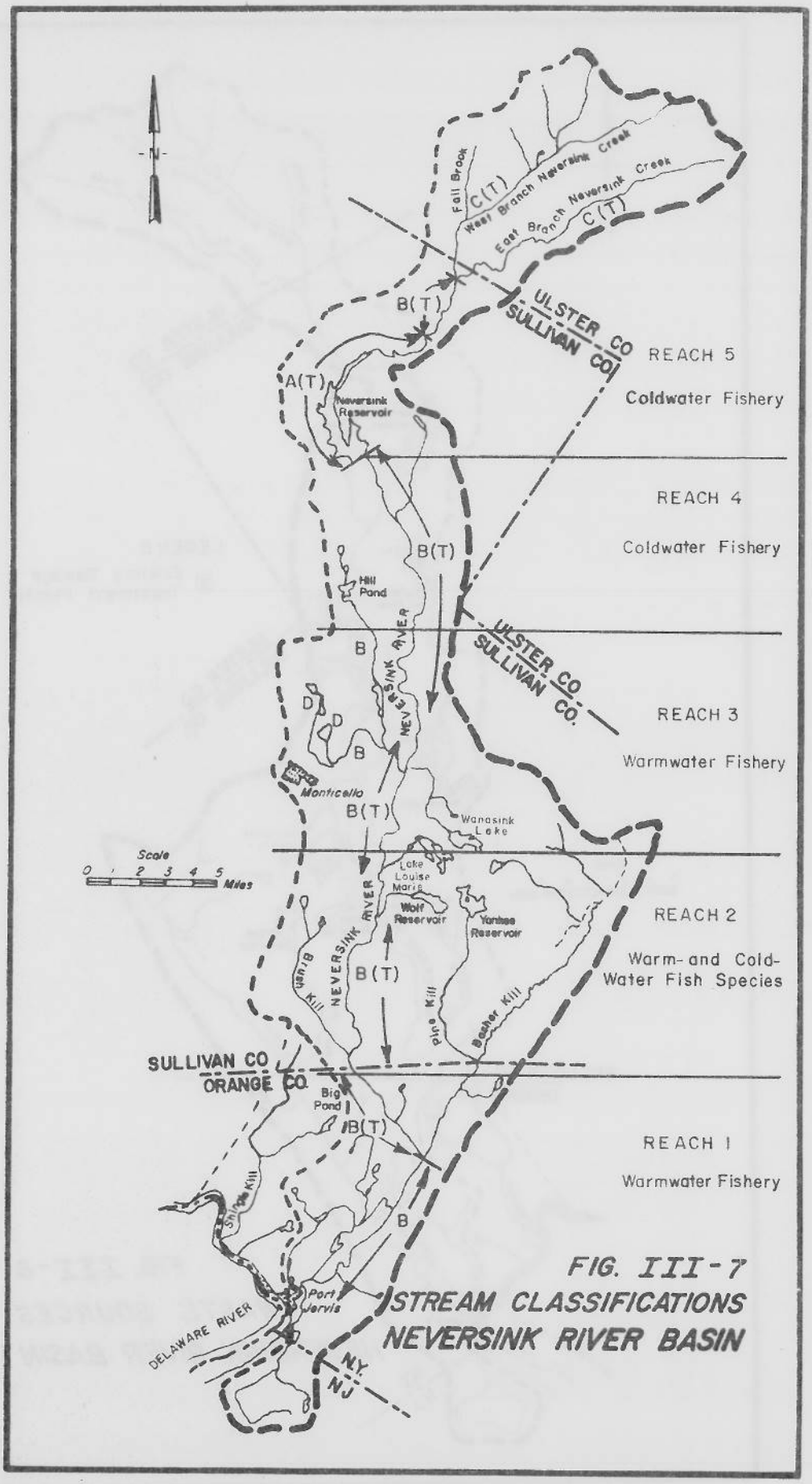

FIG. III-7
STREAM CLASSIFICATIONS
NEVERSINK RIVER BASIN

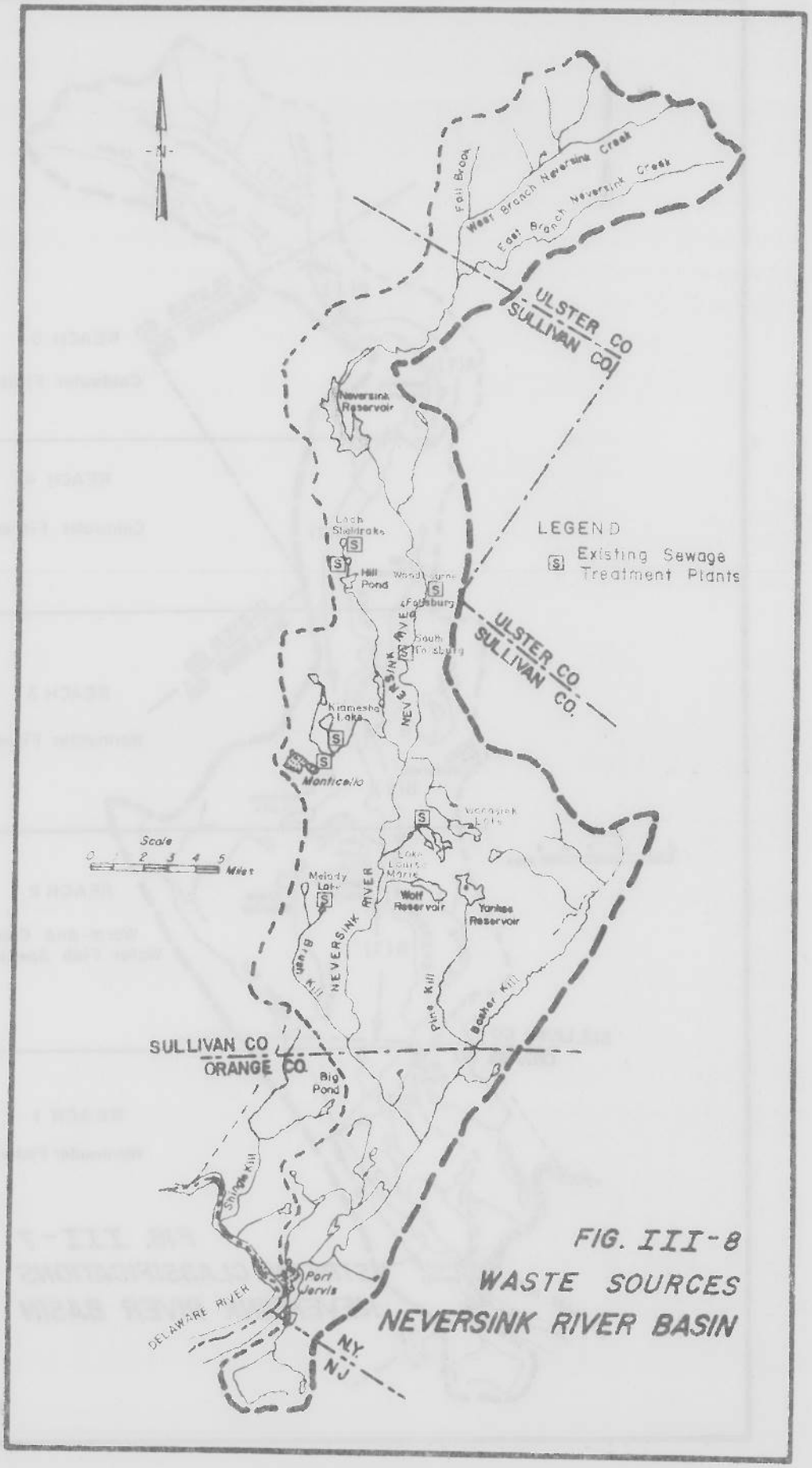

FIG. III-8
WASTE SOURCES
NEVERSINK RIVER BASIN

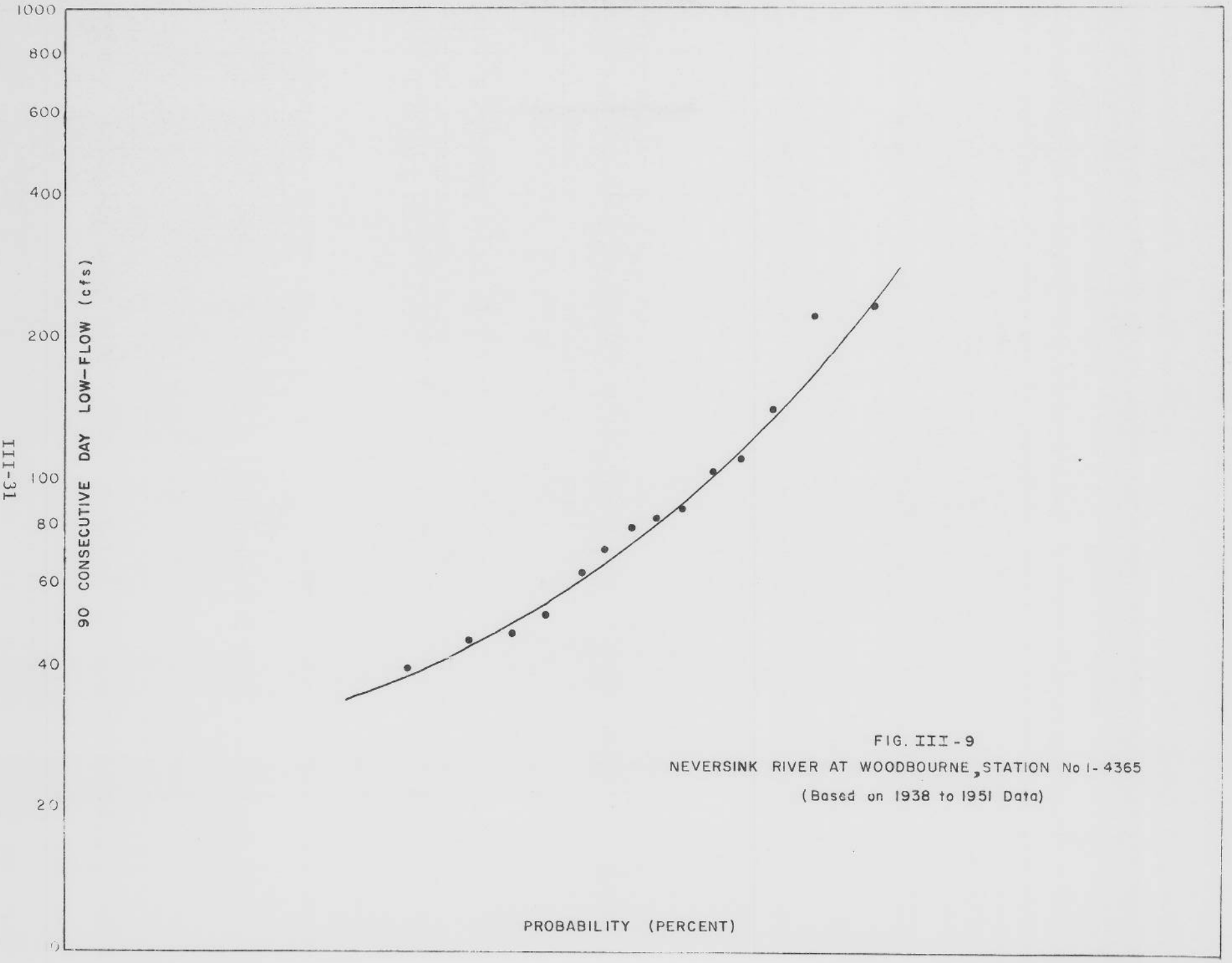

FIG. III-9

NEVERSINK RIVER AT WOODBOURNE, STATION No 1-4365

(Based on 1938 to 1951 Data)