WATER QUALITY INVENTORY
Annual Statewide Assessment

(Condensed)

Submitted in Compliance with PL 92-500: Section 305(b) — April, 1975

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

STATE OF NEW JERSEY
WATER QUALITY INVENTORY
SECTION 305(b) REPORT
APRIL, 1975

TABLE OF CONTENTS

PREFACE

This report was prepared by the N.J.D.E.P., with data and other inputs from the Division of Water Resources and other State and Federal Agencies. It was prepared pursuant to Section 305(b) of the 1972 Federal Water Pollution Control Act Amendments (Public Law 920500), which calls for a report which shall:

> "describe the specific quality, during 1973...of all navigable waters and the waters of the contiguous zone,"
> "include an inventory of all point sources of discharge... of pollutants" into these waters, and
> "identify specifically those navigable waters, the quality of which is adequate now, or will be adequate (by 1977, 1983, or beyond) to provide for the protection and propagation of... shellfish, fish, and wildlife, and allow recreational activities in and on the water."

The report is organized to answer five questions:

1. What is the quality of New Jersey waters today, particularly in our priority basins and priority segments, and where and how has the program made a difference in the last 5 years?

2. What uses of the water are possible today, and what uses will New Jersey waters support when the provisions of the Act are implemented to the extent technically or economically attainable?

3. In what places will these future intended uses differ from the goals of fishable, swimmable waters intended in the Act?

4. What will it cost to achieve these future intended uses?

5. Where and to what extent are nonpoint sources going to prevent our meeting intended uses? How can they be controlled, and how much would it cost?

This 1975 report was produced primarily by New Jersey DEP's Water Resources Planning & Management Element, using data collected by New Jersey DEP, other Federal Agencies and consultants, and incorporating problem assessments prepared by the Division, County Planning Agencies and Interstate Agencies. It is the first in a series of reports to be produced each year by the State and as directed by Section 305(b) of the 1972 Act.

In 1973 EPA and the States started a number of new activities to collect the stream quality and effluent data necessary to implement the 1972 Act, and to report to Congress and the public.

This report marks the first systematic analysis of the quantitative impact of water pollution on a state wide level. As such, it is only a beginning. The report focuses on 8 major watersheds, approximately 1300 point sources, and major problem areas in 21 Counties. In future years the state will provide more comprehensive data.

WATER QUALITY INVENTORY, SECTION 305 (b)

SUMMARY REPORT

Introduction

The water quality inventory and analysis report required by Section 305(b) of the Federal Water Pollution Control Act Amendments of 1972 calls for a state-wide assessment of water quality problems as part of the annual water pollution control program submission to EPA (Section 106 of the Act). The Act requires that the states prepare these assessments and report them through EPA directly to Congress. New Jersey will submit its report to EPA by April 1975.

One purpose of the report is to determine whether significant changes in water quality - hence water uses - have occurred during the past 5 years as a consequence of the State's water pollution control program. In addition, the report is intended to provide information during the next 5 years as to the impact of the State program on water quality and uses, especially as to whether the 1983 goals expressed in the Act (all waters to be suitable for fishing and swimming) will be met. This will also require an analysis of the technology required and the costs identified in order to meet the stated goals. EPA has suggested that at this time New Jersey should provide approximate assessments of its major rivers without committing significant time or resources to the project.

Following a careful analysis of available water quality (STORET) data which has been accumulated during the past decade, we have concluded that, with certain exceptions in the Raritan and Passaic Rivers and the Delaware River estuary, these data are not sufficiently adequate to permit an objective statistical analysis to be made. This situation will be remedied through the implementation during FY 75 and continuing in FY 76 of a recently developed water quality monitoring program. The objective of this program is to be able to determine the quality of our waters - especially improvements resulting from the implementation of the billion dollar water pollution abatement construction program now underway.

The following is a summary report of the water quality assessments, current conditions and expected changes. The detailed report including data, charts, analyses, etc. is available at the Division of Water Resources office, for public examination.

Stream Quality Objectives

Two primary goals of the Act are to provide best practicable waste treatment technology by 1977, and to provide water quality, wherever attainable, necessary for fishable and swimmable water uses. New Jersey's goals are compatible with those of the Act. The New Jersey Surface Water Quality Standards, adopted

December 2, 1974, establish the future uses and water quality objectives for all of the State's waters. These Standards will be reviewed periodically and may be revised.

At this time, all fresh and coastal waters of the State and most tidal waters are intended to be fishable and swimmable. However, these objectives will not be completely achievable in some areas without the application of advanced treatment technology. These areas are classified as "water quality limited" and include the following waters:

Freshwater Passaic
Urban Passaic
Arthur Kill Tributaries
Raritan River
Raritan Bay Tributaries
Atlantic Coast - Coastal and Inland Waters
Delaware River Zones 2, 3, 4, & 5 Mainstem & Tributaries
Delaware Zone 1 & 6 Tributaries
Wallkill River.

On July 26, 1973, the Department requested that EPA exempt certain tidal waters classified as TW-3 located in the New York-New Jersey Metropolitan area excluding, as a designated use, the propagation of fish. A similar exemption request was made to EPA for the metropolitan area portion of the Delaware River Estuary. The exemptions sought, and allowed by EPA on August 8, 1973, involved the establishment of minimum allowable dissolved oxygen levels ranging from 3.0 to 3.5 mg/l which is below the 4.0 mg/l established by EPA - thus excluding, as a designated use, the propagation of fish populations. Additionally, for both TW-2 and TW-3 waters, recreation <u>in</u> the water including swimming (primary contact recreation) is <u>not</u> an established use and objective. The required quality level for swimming is related essentially to bacterial concentration in recognition of the fact that ingèstion of water is likely. However, these waters, which constitute less than two percent (2%) of the State's surface water resources, must still be made clean enough for recreation, maintenance of fish populations, the migration of anadromous fish, and the maintenance of wildlife and other reasonable uses. In other words, they will be fishable. The exemptions were based upon extensive scientific studies which found that it would not be technologically feasible to achieve the dissolved oxygen objective of 4.0 mg/l. The bacterial concentrations necessary for swimmable waters will not be achievable because control or elimination of combined sewer overflows is not feasible. The exemptions granted by EPA are temporary and are subject to review within three years as required by Section 303(c) of the Federal Water Pollution Control Act Amendments of 1972. These areas will not meet the goals of the act even if the most stringent advanced wastewater treatment technology is applied.

Included in this group are the following areas:

Urban Passaic-Hackensack
Hudson River, Upper N.Y. Bay
Arthur Kill and Tributaries
Delaware River Zone 3 & 4, Mainstem and Tributaries and Zone 2 & 5 Mainstem

Surface Water Uses

The current uses of the State's waters that are possible today are summarized in the chart on page 4. The chart illustrates the situation in each of the watershed regions. The chart simplifies the complexity of water uses. Because a use is indicated in a particular watershed does not mean that it is a use throughout the watershed. For example, in many of the estuarine waters, discharges from treatment plants necessitate that shellfish harvesting areas be closed. Likewise in certain reaches of the freshwater Passaic River, swimming may be possible while in other reaches the effluent from waste treatment plants may preclude such a use.

CURRENT WATER USE CHART

The current uses are based on actual examination of the area. The usage chart is keyed as follows:

A. Major Freshwater Water Supply
B. Shellfish Industry
C. Primary Contact Recreation
D. Water Supply (Other than A above)
E. Propagation of Fish
F. Secondary Contact Recreation
G. Maintenance of Fish
H. Discharge from Treatment Plants - Industrial and Municipal
I. Discharge from Storm Sewers
J. Discharge from Combined Sewers

				CURRENT WATER USES						
WATERSHEDS	A	B	C	D	E	F	G	H	I	J
Northeast										
Freshwater Passaic River	X		X	X	X	X	X	X	X	
Urban Passaic River, Hackensack River				X	X	X	X	X	X	X
Hudson River, Upper New York Bay					X	X	X	X	X	X
Arthur Kill						X	X	X	X	X
Arthur Kill Tributaries				X	X	X	X	X	X	
Raritan Basin										
North and South Branch	X		X	X	X	X	X	X	X	
Millstone and Lower Raritan River			X	X	X	X	X	X	X	X
Raritan Bay			X		X	X	X	X	X	
Raritan Bay Tributaries		X	X		X	X	X	X	X	
Coast - North of Atlantic County										
Estuarine Waters (TW-1)		X	X	X	X	X	X	X	X	
Freshwaters (FW-1, FW-2, FW-3)			X	X	X	X	X	X	X	
Offshore Coastal Waters (CW-2)					X	X	X	X		
Near Shore Coastal Waters (CW-1)			X		X	X	X	X	X	
Coast - South of Ocean County										
Estuarine Waters (TW-1)		X	X	X	X	X	X	X	X	X
Freshwaters (FW-1, FW-2, FW-3)			X	X	X	X	X	X	X	
Offshore Waters (CW-2)						X	X	X		
Near Shore Coastal Waters (CW-1)			X		X	X	X		X	
Delaware River Basin										
Zone 6, Delaware Bay		X	X		X	X	X			
Tributaries			X	X	X	X	X	X	X	
Zone 5, Main Stem					X	X	X	X	X	
Tributaries			X	X	X	X	X	X	X	
Zone 4, Main Stem				X		X	X	X	X	X
Tributaries				X	X	X	X	X	X	
Zone 3, Main Stem				X		X	X	X	X	X
Tributaries				X	X	X	X	X	X	
Zone 2, Main Stem			X	X	X	X	X	X	X	X
Tributaries			X	X	X	X	X	X	X	
Zone 1, Main Stem	X		X	X	X	X	X	X	X	
Tributaries			X		X	X	X	X	X	
Wallkill Basin			X	X	X	X	X	X	X	

The chart indicates clearly that New Jersey's waters serve and will contine to serve multiple beneficial uses. It also indicates that certain uses, including the discharge of treated effluent, may be detrimental to other uses if not managed properly. The sewage treatment construction grant funds are directed towards solving these problems.

To a less obvious extent but equally important are wastewaters discharged from urban and suburban areas through the existing network of storm sewers. These strom waters cleanse the urban and suburban areas. The storm sewer network protects against local street flooding. At the same time the storm sewer discharges increase the flooding potential and may jeopardize beneficial uses downstream. These problems involve land uses and storm water collection facilities. Recent areawide planning designations made by the Governor will help to initiate studies of control strategies for storm water treatment and related land use management.

Lastly, the interrelationships between surface waters and ground waters, fresh and saline waters must be emphasized. While different watersheds have received different use designations, most fresh waters will become intermixed with sea water in our estuaries before entering the Atlantic Ocean. In addition, throughout the State, replenishment and maintenance of our groundwaters depends on the freshwaters that enter our aquifers through streambeds and aquifer recharge areas.

Of greatest significance to the citizens of New Jersey is maintenance and enhancement of water quality for their recreational uses, their daily water supply needs and their economic well-being. Only through an ongoing State water resource planning and management program and the assistance, support and participation of concerned public and private interests and governmental units will our limited water resources be available for the continued beneficial uses of all.

Water Quality Assessments

A. Northeast-Metropolitan Area

The Northeast Metropolitan area takes on two distinct characteristics:

1. Industrialized and urbanized region.
2. The suburban - rural area.

The urban area includes the watersheds of the Hudson River, Arthur Kill, Newark Bay, Lower Passaic and Hackensack Rivers. Wastewater discharges in this area amount to over one billion gallons per day of inadequately treated domestic and industrial wastes. These wastewaters, combined with extensive urban runoff, including combined sewers, have caused extensive water quality degradation. This is evidenced by depressed dissolved oxygen levels and high bacteria concentrations throughout the area. The urban area is also experiencing problems of landfill leaching, thermal pollution, sludge handling and disposal and industrial discharges with high organic and heavy metal wastes that affect municipal treatment processes.

The suburban-rural areas comprise the watershed of the fresh water Passaic River and its tributaries. Extensive data indicates that the quality of streams in the fresh water Passaic area has been deteriorating over the past 30 years. Organic loads to the River has been increasing, while at the same time, dissolved oxygen levels have been declining. Stream modeling data shows depressed dissolved oxygen levels along most of the Passaic River above Dundee Dam at Little Falls. In total, nearly 70% (37 miles) of the main stem of the Passaic River above Dundee Dam and nearly 50% (3 miles) of the Whippany River do not meet water quality standards. Data also shows bacteria counts to be increasing. These conditions reflect the influence of non-point and point source pollution and also the result of diversion of fresh waters for water supply purposes.

The high quality rural headwaters serve as major sources of potable water for the urban area supplying about 560 million gallons of water each day. These diversions to the urban area significantly reduce the assimilative capacities of the streams in the freshwater Passaic.

B. Raritan River Basin

The Raritan River Basin, comprising 1105 square miles in central New Jersey, is the second largest within the State, exceeded only by the Delaware River Basin.

In general, the waters of basin, except for the Millstone and the main stem of the Raritan River below Manville is of good quality. Some areas of local pollution, as indicated by low dissolved oxygen and high BOD, nutrient levels, and coliform bacteria have been reported. These areas are normally in the vicinity of municipal wastwater treatment plant discharges. A comparison of chemical analyses of water samples collected in the 1920's with those collected during recent periods suggest that the concentration of sulfates, chlorides and nitrates in the river system above Manville have increased in time reflecting increased wastewater discharges and nutrient levels in agricultural runoff.

An upward trend in dissolved solids, particularly in the Millstone River, has been noted. The cause for this occurrence has not been determined to date. This condition could be caused by either increases in non-point pollution or a reduction in stream flows.

Analyses of dissolved-oxygen data collected on the Raritan and Millstone Rivers at Manville indicate that prior to the late 1960's both streams were undersaturated. However, subsequent to the late 1960's, oxygen content in general increased to supersaturated levels. The upward trend and super-saturated levels of dissolved oxygen for both streams during recent years, suggest that an enriched nutrient condition exists and that photosynthetic processes are affecting water quality.

A comparison of data collected during 1957-61 and 1966-70, indicates an increase in oxygen levels in the Raritan River above Manville during April to September period while little or no variation was found in the Millstone River. This improvement in the Raritan River may reflect the generally better quality water achieved by reservoir releases upstream.

The Raritan River main stem below Manville flows through an extensive urban and industrial area. Municipal and industrial wastewater discharges and urban runoff greatly influence the river's quality in this area. The concentrations of most constituents in this section of the river were generally higher than observed in other parts of the basin.

C. Atlantic Coastal Basin

The Atlantic Coastal Basin is characterized as follows:

* Offshore waters beyond mean low tide.

* Estuarine and other tidal waters.

* Inland fresh waters.

The offshore waters comprise the major recreational resource of the State and currently supports a multibillion dollar tourist industry. Bacterial samplings over a number of years reveal waters of high quality for swimming purposes.

Extensive recreational and commercial fishing takes place throughout the area. There are a number of significant treated wastewater discharges in the north coastal waters.

Water quality problems have been experienced periodically including the occurrance of "red tide" over the past several years. This phenomenon is currently under study by the Division of Water Resources with the Sandy Hook Marine Laboratory of the U.S. Department of Commerce providing technical and other support. Occasionally these bathing beaches are subject to occurrences including sludge-like material, garbage and oil. Investigations are carried out to determine why these conditions occur.

Ocean shellfish harvesting control measures were recently established by the U.S. Food and Drug Adminstration. The area open to harvesting has increased in one year by 1600 acres. The total acreage under state control exceeds 230,000 acres.

The estuarine and tidal waters of this basin are also major recreation areas. There are numerous small wastewater treatment plants discharging into the rivers and then to the estuaries. These discharges and those from South Jersey shore municipalities have resulted in shellfish area closures in estuarine waters.

However, New Jersey still has been able to supply almost 25% of the nation's supply of shellfish with a market value in excess of 30 million dollars. The total non-ocean growing areas, open to harvesting, have decreased by 10% since 1967. The impact of pollution upon this industry can be severe since shellfish require waters of the highest quality. Of the 400,000 acres of shellfish growing areas (non-ocean) in New Jersey, almost 75% are open for harvesting purposes.

The area comprising inland fresh waters is, in general, sparsely populated. Because of low density population in most of the area, cesspools and septic tanks are commonly used. Leaching of contaminants into the underlying aquifer could pose localized potential threats to groundwater quality. This inland area is underlain by an aquifer capable of supplying vast amounts of potable water for many years in the future. However, because of its low buffering capacity and the fact that the water is contained within porous sand, it is very susceptible to pollution. Infiltration of surface waters through sand is rapid and few impurities are filtered out. Rapid residential development and the resultant surface water runoff as a consequence of this growth can be expected to affect the quality of groundwater. The quality of water resources in the inland area can be better assessed by providing for groundwater quality monitoring to supplement the present surface water quality monitoring program.

Delaware River Basin

The quality of the surface waters within the Delaware Basin in New Jersey varies substantially between sub-basins, within sub-basins and is dependent, in part, upon changing conditions such as temperature, stream flows, etc. The quality of the fresh water portion of the Delaware River (Zone 1) is such that it is suitable for all uses. However, once the river becomes tidal, water quality conditions become poor or marginal. This is especially significant in the 85 mile reach of the River from Trenton to Hope Creek (Lower Alloways Creek Township N.J.). This occurs as a consequence of the discharge from inadequate wastewater treatment facilities, storm and combined sewers and from non-point sources of pollution. The area comprises the heaviest concentrations of population and industry in the Delaware River Basin.

Recent studies seem to indicate that some deterioration in quality, which occurs from time to time in certain portions of Zone 2 of the Delaware Estuary, may be influenced by the entry of phytophankton and also to organic detritus which are related to the presence of aquatic plants in Zone 1.

Many of the tributaries to the Delaware River in Zones 2, 3 and 4 (Mercer, Burlington, Camden, and Gloucester Counties) are experiencing heavy pollution loads from inadequate wastewater treatment plants and non-point sources. All the streams show very high nutrient levels, high fecal coliform counts, and significant dissolved oxygen depletions. Non-point sources within the area comprise agricultural runoff in the headwaters and urban runoff from storm and combined sewers. A substantial industrial pollution problem exists because of the large and diversified industrial operations in the area.

The recent abandonment of a number of inadequate municipal treatment facilities in the Woodbury-Mantua Creek area, as a consequence of the completion of the Gloucester County Sewerage Authority project, should lead to improvement in quality of these waterways. This will be the subject of intensive surveys to confirm the extent of recovery in quality when conditions have stabilized.

E. Non-Point Pollution Discussion

Non-point pollution sources are significant in most of the developed river basins in New Jersey. It has been determined, by mathematical modeling analyses that non-point sources of pollution are significant in Zone 1 of the Delaware River, the Big Timber, Cooper and Pennsuaken Creeks and the Great Egg Harbor, Passaic and Raritan Rivers. Further study is necessary to identify the quantitative impacts from non-point pollution sources in relationship to point sources of pollution. Non-point source may be associated with organic detritus from marshes, benthic deposition from the treatment plants, agriculture, construction, urban runoff and land disposal of pollutants. It is anticipated that much of the non-point pollution will be identified and managed as a consequence of the development of areawide waste treatment planning, pursuant to the provision of section 208 of the Federal Water Pollution Control Act Amendments of 1972.

DEP has submitted a proposal to EPA Region II to establish an urban runoff pilot control project which is intended for national application. The objective of the study is to identify and determine optimum implementation techniques to control or alleviate non-point pollution. The study has recently been approved by EPA and work will be initiated shortly.

Costs of Achieving 1983 goals of the Act, PL 92-500

An estimate of the costs to achieve the 1983 goals of the act can be roughly seen in the results of the 1974 "Needs" Survey, Cost Estimates for Construction of Publicly-Owned Wastewater Treatment Facilities.

The 1974 "Needs" Survey was undertaken as a joint State-EPA venture in compliance with Section 4 of PL 93-243, January 2, 1974. It was under guidelines for the 1973 Survey and for updating 1973 reported cost estimates, necessary to reflect changed conditions. The purpose was to obtain a comprehensive estimate of the total cost of meeting the goals of the FWPCA, PL92-500 and of estimating these costs State-by-State as a possible basis for the allocation of construction funds authorized after FY 1975.

II. EXPLANATION OF THE SURVEY

The 1974 Survey asked the States to report their cost estimates in the five major categories used in the 1973 Survey plus one new one for treatment and/or control of stormwaters. Two of these categories were divided for the 1974 Survey. The categories are briefly described below:

Category I - This includes costs for facilities which would provide a legally required level of "secondary treatment", or "best practicable wastewater treatment technology (BPWTT)"or greater levels of BOD removal. For the purpose of the Survey, BPWTT and secondary treatment were to be considered synonymous.

Category II - Costs reported in this category are for treatment facilities that must achieve more stringent levels of treatment. This requirement exists where water quality standards require removal of such pollutants as phosphorous, ammonia, nitrates, or organic substances.

Category IIIA - This includes costs for correction of sewer system infiltration/inflow problems. Costs were reported for an I/I system analysis and for the more detailed Sewer System Evaluation Survey as defined by rules and regulations for PL 92-500 and for construction needed to effect the correction.

Category III-B - Requirements for replacement and/or major rehabilitation of existing sewage collection systems are reported in this category. Costs were to be reported if the corrective actions were necessary to the total integrity of the system. Major rehabilitation is considered extensive repair of existing sewers beyond the scope of normal maintenance programs.

Category IVA - This category consists of costs for construction of collector sewer systems designed to correct violations caused by raw discharges, seepage to waters from septic tanks and the like, and/or to comply with Federal, State or local actions.

Category IVB - This category consists of costs of ne interceptor sewers and transmission pumping stations necessary for the bulk transport of wastewaters.

Category V - Costs reported for this category are to prevent periodic bypassing of untreated wastes from combined sewers to an extent violating water quality standards or effluent limitations. It does not include treatment and/or control of stormwaters.

Category VI - States were also asked to make a rough estimate in a sixth category, "Treatment and/or Control of Stormwaters". This includes the costs of abating pollution from stormwater run-off channelled through sewers and other conveyances used only for such run-off. The costs of abating pollution from stormwater channelled through combined sewers which also carry sewage are included in Category V.

Category VI was added so the Survey would provide an estimate of all eligible facility costs, as explicitly required by Public Law 93-243.

State Summary

	Cost (Millions of 1973 Dollars)
Total	12,164
Cat. I	1,061
II	666
II-A	211
III-B	168
IV-A	685
IV-B	909
V	909
VI	7,554

Report on Category VI

State of New Jersey

The State of New Jersey at first attempted to assess Category VI on a facility basis. After the return of approximately the first 100 forms, the submissions under Category VI were analysed. The following conclusions were then drawn:

1. For each form there was a different method of achieving a cost figure for category VI.

2. Costs per acre were about $8,000.

3. Needs were reported for treatment works, conveyance systems, effluent disposal lines, erosion control and other control techniques.

4. The people filling out the form had no real comprehension of what was expected.

Because of these conclusions it was decided to do the Category VI assessment on a statewide basis by the simplest method available. The simplest method was sought due to the fact that any complicated method could not be used with any guaranteed results.

The method chosen was based upon EPA guidance. Simply, we assessed $6,000 per urban acre. The urban acres were determined by analyzing the projected 1990 density for all incorporated municipalities in the State. All having a density over 1,000 persons per square mile were considered urban.

EPA guidance indicated that $2,000 to $4,000 was an appropriate figure for treatment costs. Since our facility costs were running high we chose the $4,000 figure. State wide analyses of existing storm water conveyance systems showed a high need for interceptors to deliver storm water to treatment centers, to construct new drainage systems, and to rehabilitate old systems. For this reason $2,000 per acre was chosen for related needs other than treatment works.

The State total needs for Category VI is $7,553,740,800. There were no studies for specific areas or sub-areas or authorities, all of these costs are included in the Statewide assessment.

STATE OF NEW JERSEY

CATEGORY VI

Summary Sheet for the
Treatment and Control of Stormwater

County	# of Applicable Municipalities	Area sq. miles	Area acres	Costs For Treatment Collection & Outfalls
ATLANTIC	10	44.91	28,742.4	$172,454,400
BERGEN	65	195.57	125,164.8	750,988,800
BURLINGTON	22	118.24	75,673.6	464,041,600
CAMDEN	31	113.58	72,691.2	436,147,200
CAPE MAY	6	13.46	8,614.4	51,686,400
CUMBERLAND	1	6.5	4,150	24,960,000
ESSEX	22	127.44	81,561.6	489,369,600
GLOUCESTER	14	87.61	56,070.4	336,422,400
HUDSON	12	46.42	29,708.8	178,252,800
HUNTERDON	10	11.85	7,584	45,504,000
MERCER	11	178.46	114,214.4	585,286,400
MIDDLESEX	21	203.02	129,932.8	779,596,800
MONMOUTH	43	159.6	102,144	612,864,000
MORRIS	27	177.88	113,843.2	683,059,200
OCEAN	22	114.82	73,484.8	440,908,800
PASSAIC	14	86.21	55,174.4	331,046,400
SALEM	4	39.51	25,286.4	151,718,400
SOMERSET	12	102.80	65,792	394,752,000
SUSSEX	8	24.91	15,942.4	95,654,400
UNION	21	102.03	65,875.2	395,251,200
WARREN	5	11.40	7,296.0	43,776,000
TOTAL	381	1,967.12	1,258,956.8	7,553,740,800

Additional costs will undoubtedly be incurred to control agricultural runoff and other non-point sources of pollution. The lack of available data in this area is covered elsewhere.

The past five years have seen 10 new plants become operational. The following plants have been completed and their costs are listed:

Gloucester County	$35,519,000
Millville	2,812,000
Bayshore Regional S.A.	18,063,000
Middletown Township	13,939,000
Northeast Monmouth	24,456,000
Northwest Bergen	13,600,000
Clinton	1,800,000
Hackettstown	3,042,000
Rahway Valley	19,058,000
Somerset-Raritan	4,500,000
Total	$136,789,000

Other new plants are under construction and in design stages at this time. The impact of these new plants on water quality will be seen in future reports.

ANALYSIS OF SURFACE WATER QUALITY MONITORING DATA

Water quality was evaluated by reviewing STORET* data summaries of samples collected by the US Geological Survey and the State of New Jersey during the past 17 years. Over 200 sites were sampled throughout the State. These stations were divided into 37 groups corresponding to surface water classes within the 26 planning segments in the State (see Station Inventory in the Appendix). The surface water class subdivisions of each segment are based on the New Jersey Surface Water Classification System defined in New Jersey Surface Water Quality Standards, December 1974, and the Classification of New Jersey Trout Streams by the New Jersey Division of Fish, Game and Shellfisheries, February 1973. The definitions extracted from these two documents appear at the end of this section. In each segment where sampling stations were maintained by the above agencies, summarized data (see Appendix) were compared to Surface Water Quality Criteria listed in Table I .

Time periods for summarizing this data were chosen to include a large base of background (1958-1967) data and a recent 5 year record (1968-1972) for comparing to the present (1973-1974) water quality data. Each time period was divided into two empirical "seasons" (May 15 - September 30), thus, the means for temperature dependent parameters, i.e. D.O. and fecal coliforms, are derived from less variable data.

The means for the two "seasonal" periods and the gross values for the 1973-1974 period of analysis were compared to the seven parameters in Table I .

Interpretation of these results and their relevance appears in the discussion, however, it must be remembered that the changes in water quality described in this report reflect changes in climate as well as quantity and quality of wastewater discharges and surface runoff. However, stream flow data is not readily available for determining correlations related to flow rather than time.

*The water quality data base maintained by EPA.

Surface Water Class Definitions

Class FW-1:

Fresh waters, including rivers, streams, lakes or other bodies of water which, because of their clarity, color, scenic setting, or other characteristic of aesthetic value or unique special interest, have been designated by authorized State agencies in conformance with laws pertaining to the use of private lands, to be set aside for posterity to represent the natural aquatic environment and its associated biota.

Class FW-2:

i. Fresh surface waters approved as sources of public water supply. These waters shall be suitable for public potable water supply after such treatment as shall be required by law or regulation.

ii. These waters shall also be suitable for the maintenance, migration and propagation of the natural and established biota; and for primary contact recreation; industrial and agricultural water supply and any other reasonable uses.

Class FW-3:

Fresh surface waters suitable for the maintenance, migration and propagation of the natural and established biota; and for primary contact recreation; industrial and agricultural water supply and any other reasonable uses.

Class TW-1:

i. Tidal waters approved as sources of public water supply. These waters shall be suitable for public potable water supply after such treatment as shall be required by law or regulation.

ii. These waters shall be suitable for shellfish harvesting where permitted.

iii. These waters shall also be suitable for the maintenance, migration and propagation of the natural and established biota; and for primary contact recreation; industrial and agricultural water supply and any other reasonable uses.

Class TW-2:

i. Tidal waters approved as sources of public water supply. These waters shall be suitable for public potable water supply after such treatment as shall be required by law or regulation.

ii. These waters shall also be suitable for secondary contact recreation; the propagation and maintenance of fish populations; the migration of anadromous fish; the maintenance of wildlife and other reasonable uses.

Class TW-3:

Tidal waters suitable for secondary contact recreation; the maintenance of fish populations; the migration of anadromous fish; the maintenance of wildlife and other reasonable uses.

Trout Production Waters Waters that are used by trout for spawning and/or nursery purposes during their first summer or which are considered to have high potential for such pending the correction of short term environmental alterations.

Trout Maintenance Waters Waters that in fact support trout throughout the year or which have high potential for such pending the correction of short term environmental alterations.

Non-trout Waters Waters that, because of their physical and/or chemical and/or biotic characteristics, are not suitable for trout but which, in general, are suitable for a wide variety of other fish species.

E72:C:010901-010903

TABLE I
Surface Water Quality Criteria

Parameter \ Surface Water Quality Classif.	FW2.P	FW2.M	FW2.N	FW3.M	FW3.N	TW1.N	TW2
Dissolved oxygen[1], mg/l	7.0	5.0	4.0	5.0	4.0	4.0	4.0
Turbidity (30 day ave.)[1] J.T.U.	20	20	20	20	20	25	25
pH[1], S.U.	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Fecal coliform (log mean)[1] MPN	200	200	200	200	200	200	770
Suspended Solids[2], mg/l	80	80	80	80	80	80	80
Ammonia[3] (NH_3-N mg/l)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total phosphate (PO_4)[4] mg/l	0.3	0.3	0.3	0.3	0.3	0.3	0.3

P-Trout production M-Trout maintenance N-Non-Trout waters

1. N.J.D.E.P. Surface Water Quality Standards, 1974.
2. Limit for maintenance of freshwater aquatic life, Proposed Criteria for Water Quality, Volume I, U.S.EPA--(304a criteria).
3. Limit for public freshwater supply, 304a criteria.
4. Limit for recreational waters, 304a criteria. This limit has recently been abandoned but the value is used in this report for illustrative purposes. The N.J. Standard for phosphate is 0.15 mg/l PO_4, however this is limited to input into lakes and impoundments.

Northeast Metropolitan Area

General - The location of the Northeast Metropolitan Study Area is shown on the map on the following page. The 1533 square mile area is densely populated and heavily industrialized. Development ranges from suburban/rural in some areas of the stream headwaters to urban/industrial near major downstream waterways. Water resources in the area are composed of water supply reservoirs, fresh-water streams, estuaries, and large estuarine bays.

Geography - The Passaic Area is made up of 1325 square miles in New Jersey and 208 square miles in New York. The area is located primarily in the Piedmont Lowland Province and the New England Upland Province. Topography ranges to generally flat areas near the estuarine water bodies to hilly/mountainous in some headwater areas.

Included in the area in New Jersey would be all of Bergen, Passaic, Hudson, and Essex Counties, 69% of Morris, 18% of Somerset, and 6% of Sussex Counties, 53% of Union and 10% of Middlesex.

Hydrography - The headwaters of the area contain numerous impoundments; these reservoirs serve as water supply sources to the urbanized Northeastern Metropolitan Area. The major basins included in the area are:

a) Passaic River Basin
b) Hackensack River Basin
c) Newark Bay, Arthur Kill, Kill Van Kull Complex (including Rahway and Elizabeth River Basins)
d) Hudson River Basin and Upper New York Bay

The utilization of surface waters in the study area is of major significance with respect to present and future water quality. In the Passaic, Hackensack, and Rahway River systems there are some 20 diversions of stream flow to water supply uses. In the Hackensack River Basin these diversions at times have caused conditions of zero fresh-water inflow to the downstream 22 miles of estuary. A similar situation occurs in the Passaic Basin although flow is not completely eliminated. This major limitation of flow seriously reduces the assimilative capacities of these segments of the rivers and limits the beneficial uses of these water bodies. The following table shows the degree of flow regulation in the fresh-water sub-basins.

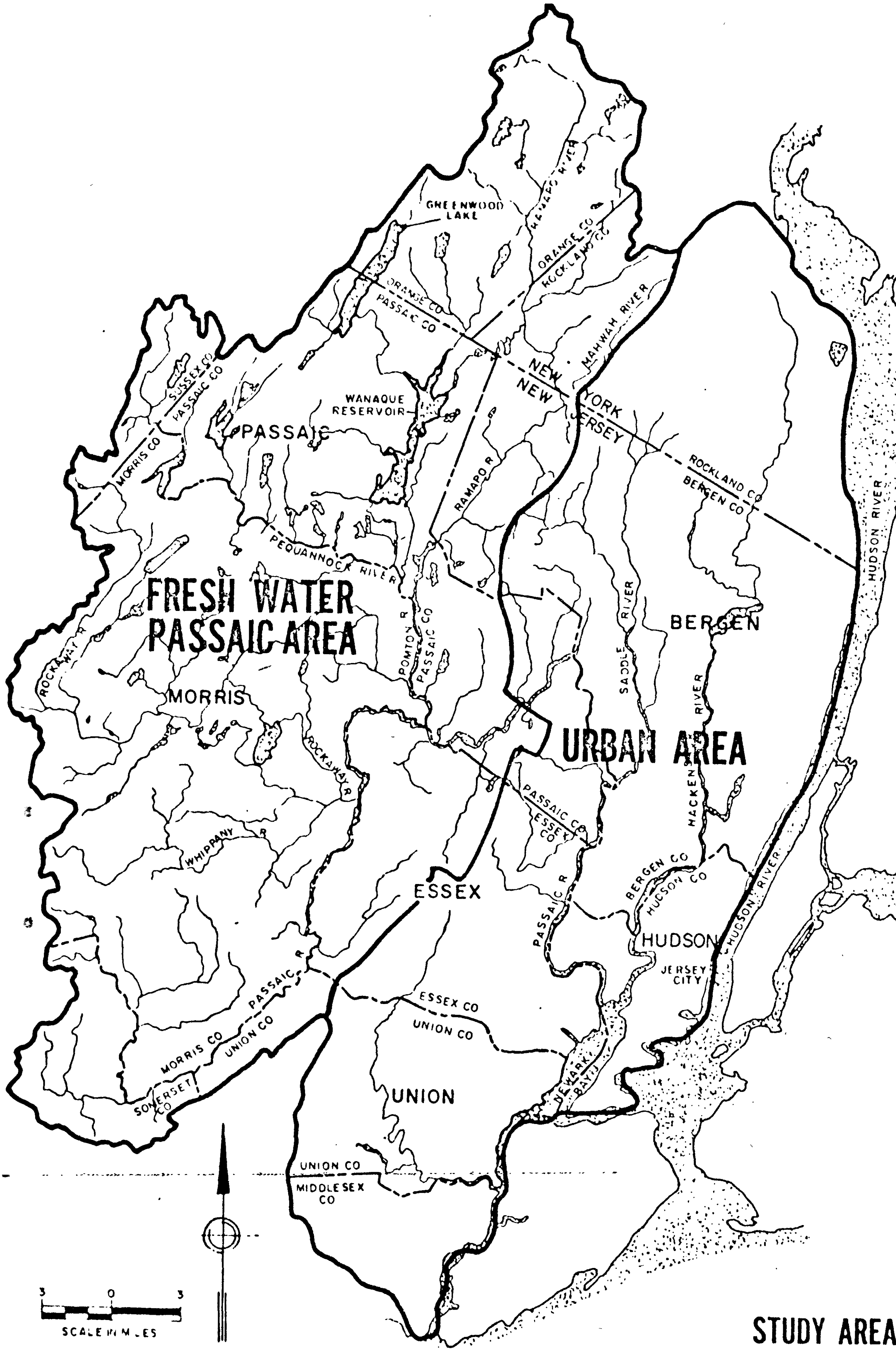

GREENWOOD LAKE
RAMAPO RIVER
ORANGE CO
ROCKLAND CO
PASSAIC CO
SUSSEX CO
MORRIS CO
MAHWAH RIVER
NEW YORK
NEW JERSEY
WANAQUE RESERVOIR
PASSAIC
RAMAPO R
ROCKLAND CO
BERGEN CO
PEQUANNOCK RIVER
FRESH WATER
PASSAIC AREA
POMTON R
PASSAIC R
SADDLE RIVER
BERGEN
HUDSON RIVER
ROCKAWAY R
MORRIS
URBAN AREA
HACKENSACK RIVER
ESSEX CO
WHIPPANY R
ESSEX
HUDSON CO
HUDSON
JERSEY CITY
UNION CO
NEWARK BAY
SOMERSET CO
UNION
MIDDLESEX CO
SCALE IN MILES
STUDY AREA

TABLE II

DEGREE OF FLOW REGULATION IN SUB-BASINS OF NORTHEAST REGION

Drainage Basin	Drainage Area (sq. miles)	Degree of Flow Regulation
PASSAIC		
Ramapo	160	Low (1 diversion)
Wanaque	108	High (1 reservoir - 1 lake)
Pequannock	85	High (5 reservoirs)
Pompton	355*	Low (1 diversion)
Rockaway	133	High (2 reservoirs)
Whippany	72	Low (1 reservoir)
Upper Passaic	202	Low (2 diversions)
Saddle River	55	Low (1 diversion)
HACKENSACK		
Fresh-water Hackensack	113	High (4 reservoirs)
RAHWAY & ELIZABETH		
Elizabeth	23	None
Rahway	84	Low (1 indirect diversion)

*including Pequannock, Wanaque and Ramapo

A capsule summary of each of the major river basins follows:

a. Passaic River Basin - The 762 square miles above Little Falls of the total 935 square mile drainage area of the Passaic River Basin has reached a high degree of development for water supply. On-channel reservoirs with a total storage capacity of 56.7 billion gallons control 278 square miles of the upper basin watershed to develop a safe yield of some 212 MGD. For the 484 square miles of drainage area uncontrolled by on-channel reservoirs, pumped storage impoundments of 5.8 billion gallons, in addition to the capacity provided by Wanaque Reservoir and the diversion facilities at Little Falls, provide an additional dependable supply of 107.5 MGD. Except for relatively small in-basin use, the 320+ MGD of water developed in the Passaic Basin above Little Falls is diverted for single-purpose use below Little Falls or outside of the Passaic Basin.

Below Little Falls, the quantity and quality of the Passaic River water is inadequate for further use as a source of public supply. At Little Falls, there are no release requirements for low flow control of the Lower Passaic River. Below Dundee Dam the tidal action from Newark Bay controls water quality and quantity.

b. Hackensack River Basin - The Hackensack River Basin, located in the States of New York and New Jersey, has a drainage area of 113 square miles above the Oradell Reservoir and a total drainage area of 202 square miles at its mouth at Newark Bay. Four reservoirs with a total capacity of 12.7 billion gallons provide a safe yield of 80 MGD to meet the needs of Bergen County's population. Releases from Oradell Reservoir for downstream low flow control are not required. Consequently, the quality and quantity of water in Lower Hackensack is controlled by Tidal flushing action, and various waste sources.

c. Newark Bay, Kill Van Kull and Arthur Kill - These estuarine water bodies serve as integral components of the New York Harbor Complex. Their apparent large volumes of water, coupled with tidal flushing action, made these water bodies particularly attractive for disposal of treated effluents. Fresh-water tributaries to Arthur Kill (primarily Rahway and Elizabeth Rivers) have small drainage areas and consequently minimal fresh-water flows.

d. Hudson River and Upper New York Bay - The Hudson River terminates in Upper New York Bay; and although relatively little drainage area discharges directly to the Hudson River, a large amount of inadequately treated wastewater from New Jersey is released into this tidal segment of the Hudson River.

Demography - The Northeast area is contiguous, covering a large portion of three SMSA's: Newark, Jersey City, and Paterson-Clifton-Passaic. The total population is approximately 3,800,000; the density averages 3,400 per square mile, ranging from 42,000 per square mile in West New York to 60 per square mile in Sussex County. This represents 53% of New Jersey's total population concentrated on only 15% of its land. Future development of this area will cause even greater density of population and industry.

Development - The Northeast area covers all of four counties, portions of seven other counties, and at least 181 municipalities. It has been a case of sizable population increases, intensive land use, and over-building which has given a concrete nature to the land. As gateway to the world's greatest market concentrations, the Northeast area has to carry tremendous transportation loads on the New Jersey Turnpike, Routes 22, 1, 9, 46, 80, the Garden State Parkway; at Teterboro and Newark Airports; on the Penn-Central and numerous other railroads; at the Ports of Newark and Elizabeth. It is the busiest transportation network in the State, if not the entire country.

All of Bergen, Hudson, and Essex Counties are heavily developed (excluding the Meadowlands). Union and Middlesex Counties are also heavily used residential, commercial, and industrial centers. Passaic County is urban in the south, but only beginning to expand in the north. In Morris and Somerset Counties the complexion is primarily residential, yet both are enticing to industry and commerce for the future. Thus, it can be seen that the Northeast area takes on three distinctive characteristics:

1. The heavily industrialized urban region close to New York City, where the water serves as an inexpensive mode of transportation and a dumping ground for industrial and human wastes.

2. The suburban area of 25 years ago has now been developed to the extent where its densities equal or exceed the former urban area.

3. The rural headwaters area where water is a precious resource which provides potable water supply for much of the entire study area.

The result of development has been a multitude of sewage treatment plants, some 149 of which try to protect the vulnerable headwaters, and others, which merely route the wastes of hundreds of industries and millions of people to Newark Bay, Arthur Kill, and Upper New York Bay.

One last physical description necessary is that of the Hackensack Meadowlands, which covers upwards of 15,000 acres. Now primarily tidal marsh being utilized as the world's largest solid waste dumping ground, the Hackensack Meadowlands are beginning to face the prospect of development due to its proximity with New York City and the major population and industrial centers of New Jersey.

Wastewater Problems - The Northeast Area is experiencing the gamut of water quality problems which plague many of our metropolitan areas. Wastewater related problems include inadequate treatment enormous quantities of industrial waste, sludge management, and combined sewer and other non-point pollution.

Other wastewater problems encountered in the Study Area are summarized as follows:

Problem	Comments
Land fill and Thermal Pollution	Many areas near streams with uncontrolled dumping; leaching of these fill areas may be major pollution load. Thermal pollution is a problem especially in heavily industrialized areas.
Sludge Management	Severe problem in heavily urbanized areas; present practice of ocean barging may not be an accaptable long-range solution.
Industry	This area is one of the most heavily industrialized areas in the country. Organic and heavy metal loadings are problems with both treatment plants and pretreatment facilities.

Water Supply Problems - Closely linked with wastewater problems are the serious water supply problems existing in the (a) Area. Water is piped from reservoirs in the headwater areas to the heavily developed areas near estuarial waters in order to satisfy the urban area's vast water supply needs. By piping the water instead of allowing it to flow in the stream, waste assimilative capacities are diminished.

The following table demonstrates that water supply withdrawals are, in some instances, exceeding safe yields.

WATER COMPANY DIVERSIONS

Water Purveyor	1971 Diversions (MGD)	Safe Yield (MGD)
Commonwealth Water Co.	21.5(1)	25.1

Water Purveyor	1971 Diversions (MGD)	Safe Yield (MGD)
Elizabethtown Water Co.	106.5	120.5
Hackensack Water Co.	87.6(1)	77
Middlesex Water Co.	23.1	33
Jersey City Water Dept.	66.5(1)	66
Newark Water Dept. (2)	64.8(1)	50
New Brunswick Water Dept.	14.1	20
North Jersey Dist. Water Supply Com. (3)	108.5(1)	94
Passaic Valley Water Com. (4)	51.7	75
Perth Amboy Water Dept.	10.4	20.5

Notes:

(1) Exceeded safe yield

(2) Pequannock supply only; also obtained water from Wanaque Reservoir

(3) Owns and operates Wanaque Reservoir; composed of following members:

Owner	% Ownership	Rights	1971 Diversion
Newark	40.5	42.12	43.5
PVWC	37.75	39.26	37.2
Kearney	12.0	12.48	10.0
Montclair	5.0	5.2	5.2
Bloomfield	4.0	4.16	-
Glen Ridge	0.75	0.78	0.8
			108.5

(4) Passaic supply only; also obtained water from Wanaque Reservoir

The water supply situation is important for a number of reasons:

1. Water supply diversions decrease stream flow and thus diminish waste assimilative capacity

2. Lack of water supply may limit area growth

3. Water shortage will tend to encourage recycle and conservation efforts and thus affect wastewater production

TABLE III

An important aspect linked closely with water supply is the relatively large number of reservoirs in the (a) Area. Discharges are usually diverted around reservoirs when possible; however, land runoff from developing areas should be studied for their effect on reservoir water quality. The following table presents information on area impoundments.

RESERVOIRS & IMPOUNDMENTS

Reservoir	River	Capacity (bil. gal.)	Drainage (Sq. Mi.)
Canoe Brook	Passic River & Canoe Brook	2.81	111
Oradell	Hackensack	2.85	45.6
Woodcliff Lake	Hackensack	.9	20.0
Deforest (N.Y.)	Hackensack	5.6	26.8
Lake Tappan	Hackensack	3.5	22.6
Robinsons Branch	Rahway	.26	21.6
Boonton	Rockaway	7.6	91
Split Rock	Rockaway	3.3	5
Wanaque	Wanaque	29.5	90.4
Canistear	Pequannock	2.4	5.6
Oak Ridge	Pequannock	3.9	21.7
Clinton	Pequannock	3.5	10.5
Echo Lake	Pequannock	2.0	4.6
Charlottesburg	Pequannock	3.0	18.4
Macopin (Intake)	Pequannock	.032	2.9
Lawrence Brook	Lawrence Brook	1	45
Point View	Pompton	3	122

Segment 01 Freshwater Passaic

The FW-2M waters are recorded with five stations in the upstream reaches of the Wanaque, Pequannock, Pompton and Belcher's Creek. The quarterly monitoring data on these waters indicate good quality with all parameters, except PO_4, being well within the standards set for the area. The significant changes, with time, noted are turbidity and BOD. This can be seen in the tables of data.

The FW-2N waters are grouped for the purposes of data display, however a better measure of current quality and trends can be seen in the following excerpts from "Preliminary Basin Plan for the Freshwater Passaic Area" prepared by Betz Environmental Engineers, Inc., Dec., 1974

Monitoring and Surveillance (40 CFR 131, Subpart D)

Numerous agencies have kept records of water quality in the Freshwater Area. Anderson (1973) reports that long-term records, many extending back to the 1920's, have been collected by:

1. Passaic Valley Water Commission (PVWC)
2. North Jersey District Water Supply Commission
3. Jersey City's Water Department
4. Newark's Division of Water Supply

Some basic stream-quality records have also been collected by the DEP, EPA and USGS. In the future, USGS funds for monitoring stations may be limited to flow data.

Long term water quality trends are provided in figures III-2, III-3, and III-4 (Anderson, 1973). The quality of streams in the Freshwater Area is shown to be deteriorating over the past 30 years. Biochemical Oxygen Demand (BOD) has been increasing while at the same time, dissolved oxygen levels in the stream have been declining (Fig. III-2). Levels of dissolved solids, hardness, sulfate, and chlorides have also increased over recent years (Fig. III-3). Decreasing ratios of ammonia to nitrate suggest nitrification may also be exerting an oxygen demand on the streams. Fig. III-4 indicates that the general trend in coliform-bacteria counts is upward. This increase is another indication of the increasing wastewater discharges into the Area.

In addition to the stream quality monitoring discussed above, PVWC monitors wastewater discharges in an effort to protect the quality of its water supply. These are usually not periodic inspections and/or sampling but are efforts to document alleged violations. Hence, PVWC data tends to indicate upset or spill condition, not average conditions, and cannot be effectively used as a predictive tool.

Water Quality Modeling (40 CFR 131,304(C))

A predictive mathematic model was used by the DEP to determine total maximum daily loadings. The DEP initially selected an EPA computer program for the steady-state water quality simulation of a stream network designated SNSIMI/2 (EPA, April, 1974), and then made modifications to the program to increase the flexibility of inputs and outputs. The principal water quality parameters considered in this modeling study were dissolved oxygen (DO), carbonaceous BOD (CBOD), and nitrogenous BOD (NBOD). Since the Freshwater Areas are non-tidal, the dispersion effect was considered negligible. To smooth out the natural occurring random variations in a stream, the concentration on any substance under consideration was assumed to be uniform and steady in the vertical and lateral dimensions of any cross-sectional area in the stream. The temporal variation was assumed to be negligible.

The spatial distribution of steady-state NBOD, CBOD, and DO deficit (D) was defined mathematically as follows:

$$0 = -u\frac{dN}{dx} - K_nN + W_n \qquad (1)$$

$$0 = -u\frac{dL}{dx} - K_cL + W_c \qquad (2)$$

$$0 = -u\frac{dD}{dx} - K_aD + K_dL + K_nN - P + R + B \qquad (3)$$

Where:

D = dissolved oxygen deficit, $C_s - C$

u = stream velocity

K_a = reaeration coefficient

K_c = CBOD removal coefficient

K_n = NBOD removal coefficient

K_d = CBOD deoxygenation coefficient

L = carbonaceous BOD concentration

N = nitrogenous BOD concentration

P = photosynthesis

R = respiration

B = benthic oxygen demand

W_c = CBOD bank load

W_n = NBOD bank load

C_s = saturated dissolved oxygen concentration

C = dissolved oxygen concentration

x = distance along stream from beginning of section

The coefficient of equations (1) - (3) were assumed to be constant with respect to distance. If any of the coefficients were space variable, the river system would be segmented and equation (1) - (3) was applicable to each of the segments. Substitution and integration of equations (1) - (3) yielded:

$$N = N_o \exp\left(-\frac{K_n}{u} x\right) + \frac{W_n}{K_n}\left[1 - \exp\left(-\frac{K_n}{u} x\right)\right] \qquad (4)$$

$$L = L_o \exp\left(-\frac{K_c}{u} x\right) + \frac{W_c}{K_r}\left[1 - \exp\left(-\frac{K_c}{u} x\right)\right] \qquad (5)$$

$$D = D_o \exp\left(-\frac{K_a}{u} x\right) + \frac{K_d}{(K_a - K_c)}\left(L_o - \frac{W_c}{}\right)\left[\exp\left(-\frac{K_c}{u} x\right) - \exp\left(-\frac{K_a}{u} x\right)\right] + \frac{K_n}{(K_a - K_n)}\left(N_o - \frac{W_n}{K_n}\right)\left[\exp\left(-\frac{K_n}{u} x\right) - \exp\left(-\frac{K_a}{u} x\right)\right] + \frac{W_c \frac{K_d}{K_c} + (W_n - P + R + B)}{K_a}\left[1 - \exp\left(-\frac{K_a}{u} x\right)\right] \qquad (6)$$

By applying equations (4) - (6), the concentration distributions in each segment were solved analytically. Mass balances were applied to the junction of segments including tributary inputs, waste inputs, and major changes of physical characteristics.

The river system was segmented by giving consideration to tributary inputs, wastewater inputs, river geometry, and hydraulic factors. In addition, segmentation is required for all changes in reaction rates, reaeration rates, benthic demands, photosynthesis variations, and background loads. All the parameters in equations (1) to (3) are assumed to be constant at each segment.

The solution of the model for each concentration distribution starts from the upstream segment. Mass balance is then applied to the solved segment and its succeeding segment. This procedure is applied until every segment is solved, thereby yielding a continuous profile.

A total number of 48 modeling segments were required for this study area, in which 8 segments were for the Upper Passaic River from its confluence with the Dead River to its confluence with the Whippany River, 9 segments for the Whippany River, 4 segments for the Rockaway River, 21 segments for the Mid Passaic River from its confluence with the Whippany River to Dundee Dam, 4 segments for the Pompton River, and 1 segment for the Singac Brook.

Separate verifications were made of the Upper Passaic River System and the Mid Passaic River System. The Upper Passaic River System includes the Upper Passaic River above Pine Brook, the Rockaway River, and the Whippany River. The Mid Passaic River System includes the Pompton River and the Passaic River between Pine Brook and Dundee Dam. These two verified systems were then projected to a 7-day-10-year low flow condition and linked together as the Freshwater Passaic River System. The downstream conditions generated from the Upper Passaic River System were automatically input as upstream boundaries to the Mid Passaic River System.

The verification of the Freshwater Passaic River System consists of the following steps:

a) Defining the relationship between water quality parameters and the factors affecting a particular one.

b) Defining the segmentation of the stream based on tributary inputs, wastewater discharges, geometric and hydraulic factors.

c) Developing full understanding of the stream length channel geometry, flow patterns, and the general hydrologic features for each segment.

d) Evaluating the system parameters (e.g. reaeration rates, reaction rates, waste discharges, tributary inputs, uniform bank loadings, benthic demands, and photosynthesis) for each segment.

e) Formulating a water quality model.

f) Comparing the computer simulations of water quality distributions with field data.

g) Re-evaluating the system parameters over a range of environmental conditions (e.g., different flow regimes and temperature).

The effects of existing and projected future discharges on dissolved oxygen levels can be seen in Figures III-7, III-8, and III-9. The main stem of the Passaic (Figure III-7) has an average DO concentration less than 4.0 mg/l at its confluence with the Dead River (milepoint 0.0). The Passaic DO level slightly improves until wastewater from the Passaic-Sterling facility drives the level down to about 3.2 mg/l by river mile 9.0. The average D.O. level recovers downstream of the New Providence WWTP and for about a 3 mile stretch meets the water quality standards. The Madison-Chatham facility depresses the D.O. level below 5.0 mg/l standard once again and the level continues to drop as the stream receives Florham Pk. and Livingston effluents, and the highly polluted Whippany River (milepoint 26). The model profile suggests that the stream may experience anerobic conditions around milepoint 34 before starting to recover. The stream continues to recover, partially due to its confluence with the more highly oxygenated Pompton River near milepoint 39. The stream reaches a D.O. level of around 7.0 mg/l before the effluent from Totowa-West Paterson limits the recovery.

The Whippany DO profile (Figure III-8) indicates that D.O. levels in the stream's headwaters more than meet stream standards. However, the wastewaters from Morristown and Whippany Paper Board (milepoints 3 and 5.5 respectively) depress the D.O. level below the DEP standard of 5.0 mg/l. The profile continues to decline for another 4 miles, suggesting the presence of non-point sources in this reach. At milepoint 10.5 the effluent from the Hanover Sewerage Authority adds to the D.O.'s downward trend. The profile indicates that the D.O. level is nearly 2.0 when the stream receives Parsippany-Troy Hills wastes.

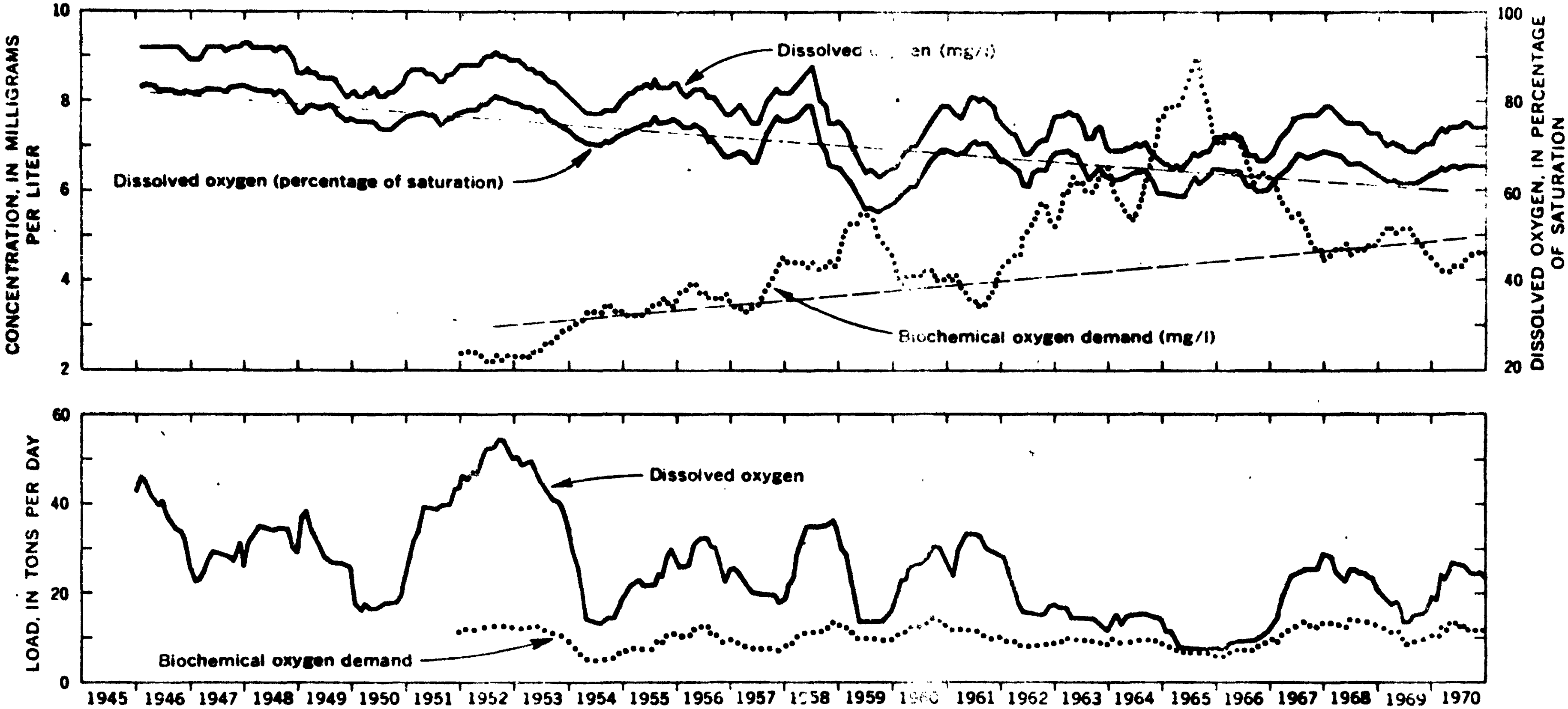
The Rockaway Profile (Figure III-9), like the Whippany, exhibits satisfactory initial D.O. levels. However, the one significant discharger, Rockaway Valley Regional Sewage Authority (milepoint 0.0) and unidentified non-point sources near Sharkey's Dump depress the DO below the standard of 5 mg/l. Figures III-7, III-8, and III-9 also provide model projections of 1985 loadings using levels of treatment, and will be discussed in Section IV.A. and VI.A.

In summary, nearly 70% of the mainstem of the Passaic and nearly 50% of the Whippany River do not meet water quality standards. It is evident that significant problem areas exist in the Freshwater Area.

E70:C:010789, C3, C4, C14, C15

Figure III-2

Long Term Biochemical Characteristics

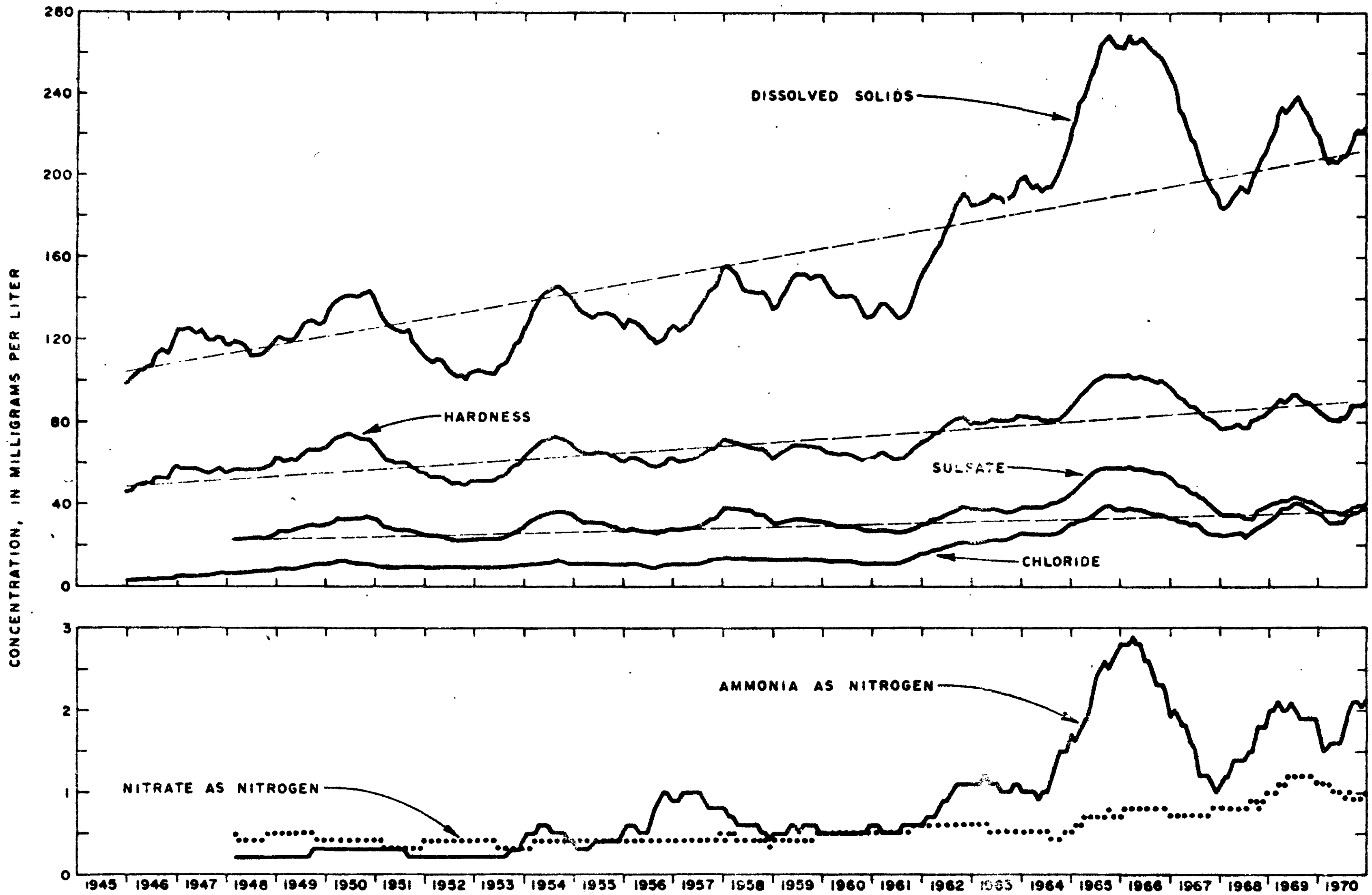


Twelve-month moving average of DO and BOD, Passaic River at Little Falls. Dashed line indicates general trend. (Based on analyses by the Passaic Valley Water Comm.)

(Anderson, 1973)

Figure III-3

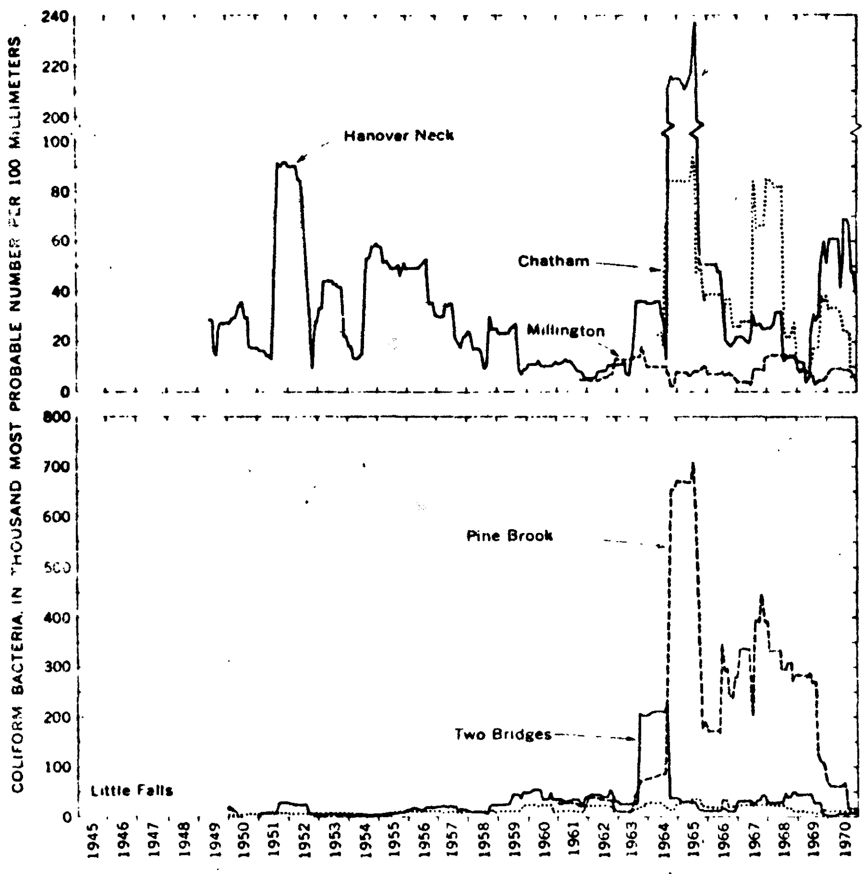
Long Term Chemical Characteristics



Twelve-month moving average of the concentrations of several chemical-quality parameters, Passaic River at Little Falls. Dashed line indicates apparent general trend. (Based on analyses by the Passaic Valley Water Comm.)

Figure III-4

Long Term Coliform Levels



— Twelve-month moving averages of coliform-bacteria counts at several sampling sites on the Passaic River. (Based on analyses by the Passaic Valley Water Comm.)

(Anderson, 1973)

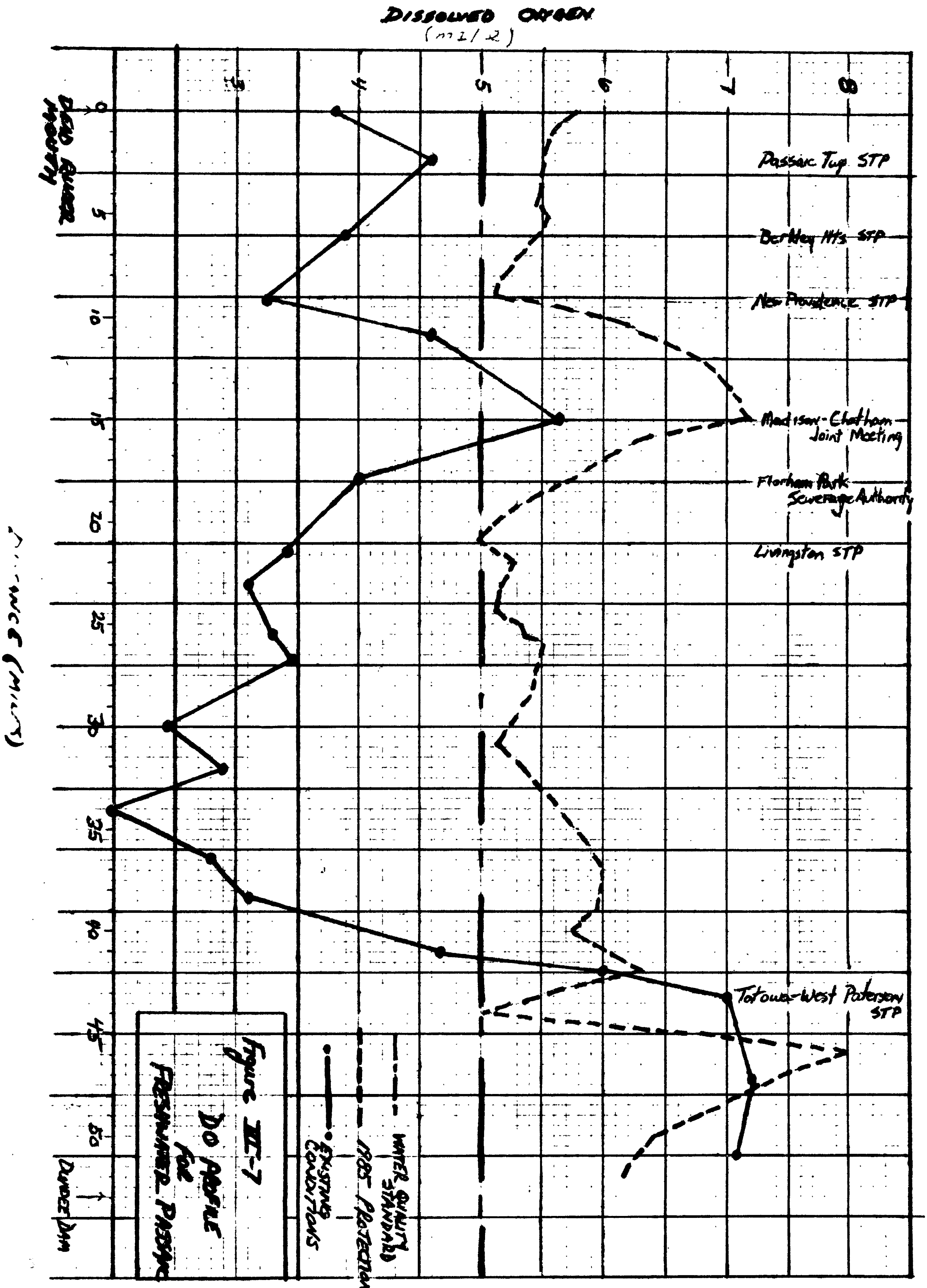


Figure III-7
DO PROFILE FOR FRESHWATER PASSAIC

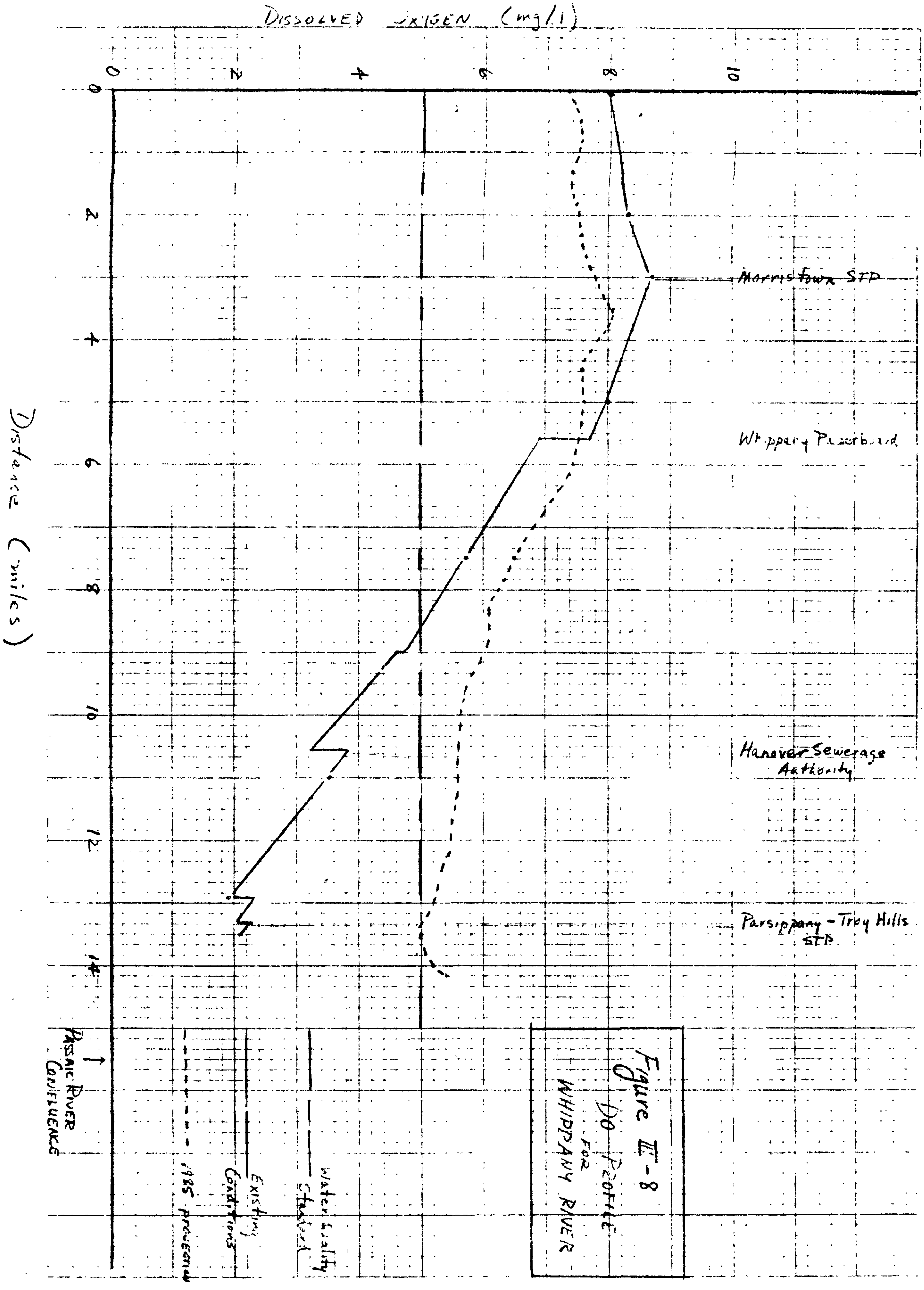


Figure III-8 DO Profile for Whippany River

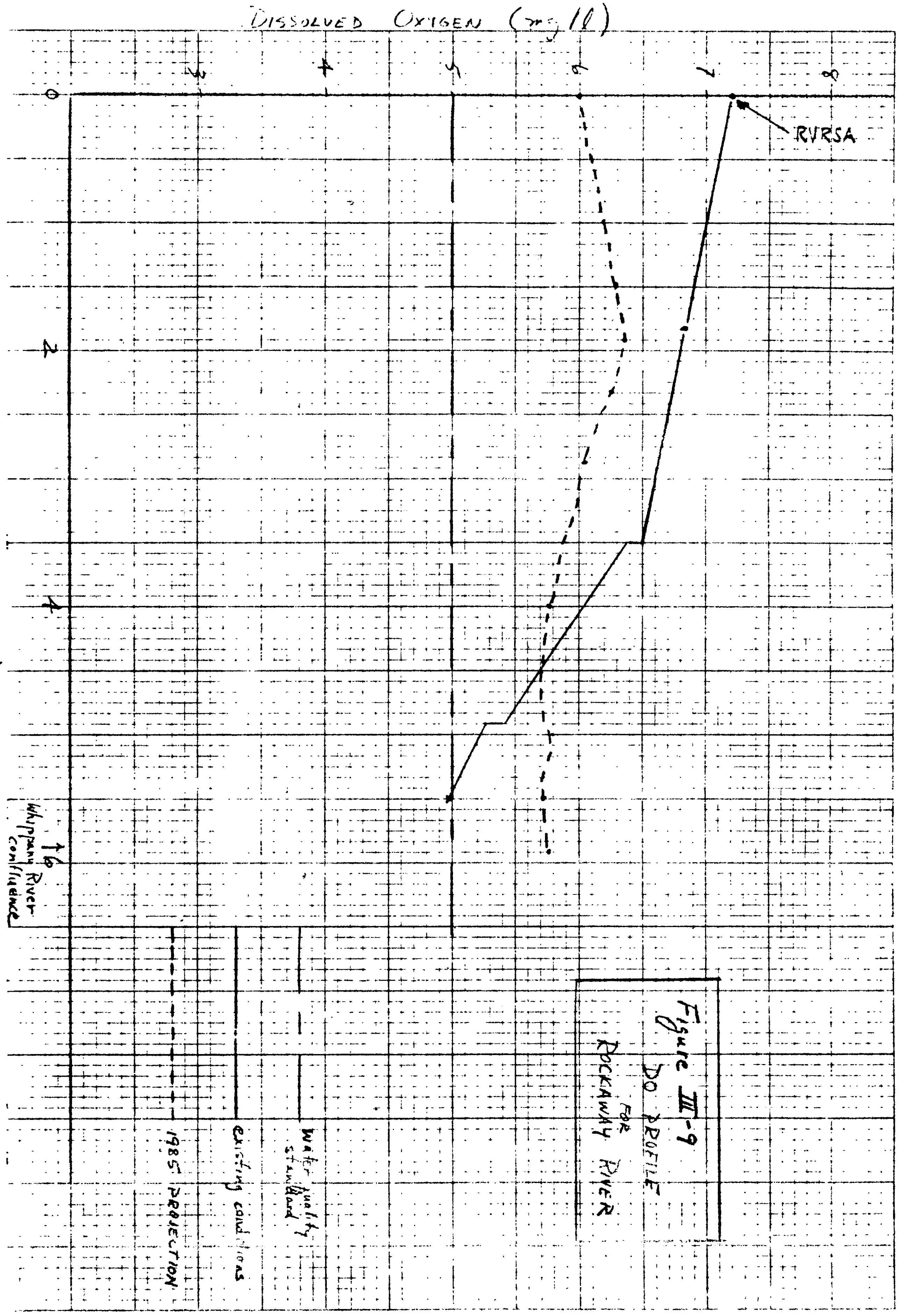


Figure III-9
DO PROFILE
FOR
ROCKAWAY RIVER

DISCUSSION OF DATA

Segment 02 Urban Passaic - Hackensack River

There are five stream classifications in this segment being recorded by the ambient monitoring network. These are: FW-2M, FW-2N, FW-3M, FW-3N and TW-2N. An analysis of the data show the FW-2M waters to have high fecal coliform and phosphate levels. The data available does not show any significant change of quality with time. These waters are in the Saddle River and Sprout Brook.

The FW-2N waters are mostly in the freshwater Passaic below Little Falls and the Hackensack River. The long term data supplied by ambient monitoring, shows water of generally good quality, with no significant change over time. A model of this area prepared by Betz Environmental Engineers, Inc. shows water of poor overall quality. This is from intensive summer sampling and is a more accurate measure of current quality than ambient monitoring. This model is currently being computerized and will be available soon.

The FW-3M waters are recorded by one station in the Saddle River and the data is shown. The lack of data prevents an effective analysis of water quality.

The FW-3N waters are recorded by several stations in Saddle River, Peckman's Brook, and other. No changes with time are shown by the data. The data does show high BOD (5 mg/l) fecal coliform, ammonia and phosphate.

The tidal waters, TW-1N and TW-2N are recorded by only three stations in the Passaic and Hackensack Rivers. The data does show water of very poor quality, however a better measure will be shown in the Betz model, when available.

Segment 05 Arthur Kill Tributaries

There are five ambient monitoring stations in this area, two in the Elizabeth River and three in the Rahway River drainage. Both basins show high fecal coliform levels and the Elizabeth River shows D.O. values which, while averaging above standard, may experience many instances of sub-standard conditions. The high non-filterable residue, during the early time periods, cannot be explained at present. Also, to be noted is the high BOD (8.5 mg/l) in the Elizabeth River data.

Raritan River Basin

The Raritan River Basin is New Jersey's largest intrastate surface watershed. The basin comprises parts of Morris, Somerset, Hunterdon, Mercer, Middlesex, and Monmouth Counties. The drainage area of this water shed is approximately 1,100 square miles. Within the basin, there are six sub-basins. All of the sub-basins eventually drain into a mainstem reach which is about 30 miles long. The mainstem section extends from the River's mouth at Raritan Bay up to the confluence of the north and south branches. The six sub-basins in upstream order are:

Sub-Basin	Area(Sq. Miles)	River Mile Location
South River	135	left - 8.6
Lawrence Brook	43.4	left - 10.1
Green Brook	50.2	Right - 20.4
Millstone River	281	left - 22.9
North Branch	190	Right - 31.1
South Branch	279	left - 31.1

Topography in the basin varies from the hills of the northwestern area to the gently rolling coastal plains in the southeastern section.

The South Branch has its origin in Morris County at the downstream end of Budd Lake. It flows southwesterly through Long Valley until it reaches Clinton. The course then changes to southeasterly as the river flows by the reservoirs of Round Valley and Spruce Run. These two reservoirs work as a unit to provide water for municipal water supply and for low flow augmentation. The South Branch flows to its confluence with the North Branch just west of the town of Raritan in Somerset County. Major tributaries to the South Branch are Drakes Brook, Spruce Run, Cakespoulin Creek, Neshanic River, Pleasant Run, and Holland Brook. They comprise 151 square miles of the South Branch watershed.

Upstream water quality is excellent, although because of malfunctioning septic systems or inadequate sewage treatment plant discharges, some localized water quality degradation does occur. Many of the tributaries to the South Branch are designated for trout production and trout maintenance. The net result is that as residential development moves into the area, unless the development is compatible with the water uses and the sewage treatment facilities provide advanced wastewater treatment, neither water supply nor recreational uses will be protected.

The North Branch also has its headwaters in Morris County. The North Branch itself starts just west of Mendham at the mouth of India Brook. The North Branch follows a southerly course to its confluence with the South Branch. Major tributaries to the North Branch are Peapack Brook, Lammington River (Black River), and Chambers Brook. They account for 121 square miles of the North Branch watershed.

The Millstone River, from its headwaters in Monmouth County, flows in a northerly direction through Mercer and Somerset counties to its confluence with the Raritan mainstem, east of Manville. The tributaries of Cranbury Brook, Stony Brook, Bedens Brook, Six Mile Run, and Royce Brook make up 154.3 square miles of the Millstone River drainage area.

The Green Brook and Lawrence Brook Basins both have their origin in Middlesex County. The Green Brook drains 50.2 square miles of land on the northern side of the mainstem. It enters the mainstem at Bound Brook, several miles upstream from Fieldville Dam. Fieldville Dam is located 17.3 miles from the mouth of the mainstem and is the limit of the tidal section of the Raritan River. The Lawrence Brook drains 43.4 square miles on the southern side of the mainstem. Its confluence with the mainstem is several miles east of New Brunswick in the tidal section of the mainstem.

South River drains the southeastern most portion of the Raritan Basin. The South River headwaters are in Monmouth County. The South River flows northerly to a confluence with the Raritan near the town of South River. The tributaries of the Matchaponix Brook, Manalapan Brook, Deep Run, and Tennant Brook drain 114.6 square miles of the South River drainage area.

The average discharge for 31 years at the Bound Brook gaging station is 1,162 cfs. Bound Brook is the last fresh water gaging station on the mainstem. Low flow standards have been set for three gaging stations in the basin. These flow values are:

1) 40 MGD at Stanton - South Branch

2) 70 MGD at Manville - mainstem

3) 90 MGD at Bound Brook - mainstem

These flow requirements have been developed to maintain minimum downstream flow values in the Basin. The Bound Brook flow requirement of 90 MGD is the stream flowrate, after necessary water supply diversions have been made. Established New Jersey policy is based, in part, upon two factors:

1) development of upstream reservoirs must provide compensating releases to augment flows downstream; and

2) low flow augmentation is important to relieve high concentrations of sanitary and industrial wastes in the lower portions of the basin.

The Raritan River Basin has a number of unique problems and characteristics. The entire Basin is undergoing accelerated population growth. Requirements for water supply and dilution waters for treated wastewater effluent are critical. In addition there are large industrial effluent discharges in the mainstem of the Raritan River.

The headwaters of the South Branch, Lammington River, North Branch, and Millstone River are all in areas of rapid population growth and land development. This situation is some what different from typical development trends in which residential and industrial build-up occurs first in downstream areas where dilution waters are greater. As a result, relatively large amounts of treated effluent wastewater, compared to stream flows available for dilution, are discharged into the waterways.

The Millstone River, aside from the problems of existing and projected wastewater disposal, is narrow and slow moving and subject to flash flood. This is because the Stony Brook and Lower Millstone watersheds are underlain with shale formations that have low water storage and infiltration capacities. On the other hand, the Upper Millstone area is underlain with unconsolidated sediments and therefore is not subject to flash flooding and has a more dependable water supply.

Water quality surveys along the Millstone River indicate excessive silt, phosphate and nitrogen from agricultural runoff and leaching of fertilizers. The resultant increase in stream biota cause large diurnal fluctuations in dissolved oxygen in the River.

The Raritan Basin has been segmented, for planning purposes into the following areas:

Segment	Population, 1970
Upstream Raritan River	236,000
Lower Raritan River	675,000
Raritan Bay	---
Raritan Bay Tributaries	204,900

The Raritan Bay tributaries extend from Cheesequake Creek easterly to Sandy Hook Bay. It includes Shrewsbury River. Navesink River, Swimming River, and the Towns of Long Branch, Matawan, South Amboy, and Keyport.

E70:P:B1,2,3

Segment 06, 07   Raritan River Basin

The data from the ambient monitoring network is available for reference purposes. A better measure of water quality in this basin can be seen in the following excerpts from a report by Peter W. Anderson and Samuel O. Faust "Water Quality and Streamflow Characteristics, Raritan River Basin, New Jersey", USGS, June, 1974.

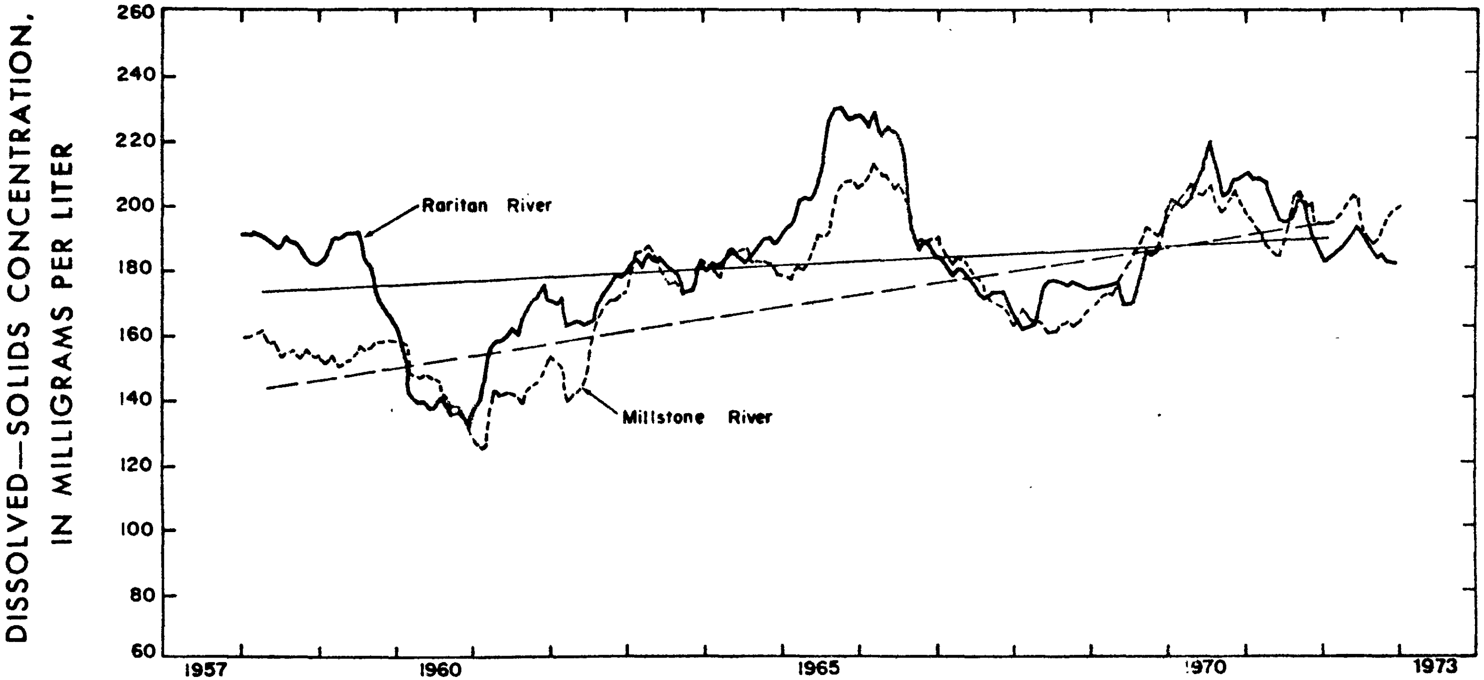


Figure 15.--Trend analyses, based on twelve-month moving averages, of dissolved-solids content, Raritan and Millstone Rivers near Manville. (Based on chemical analyses by the Elizabethtown Water Co.).

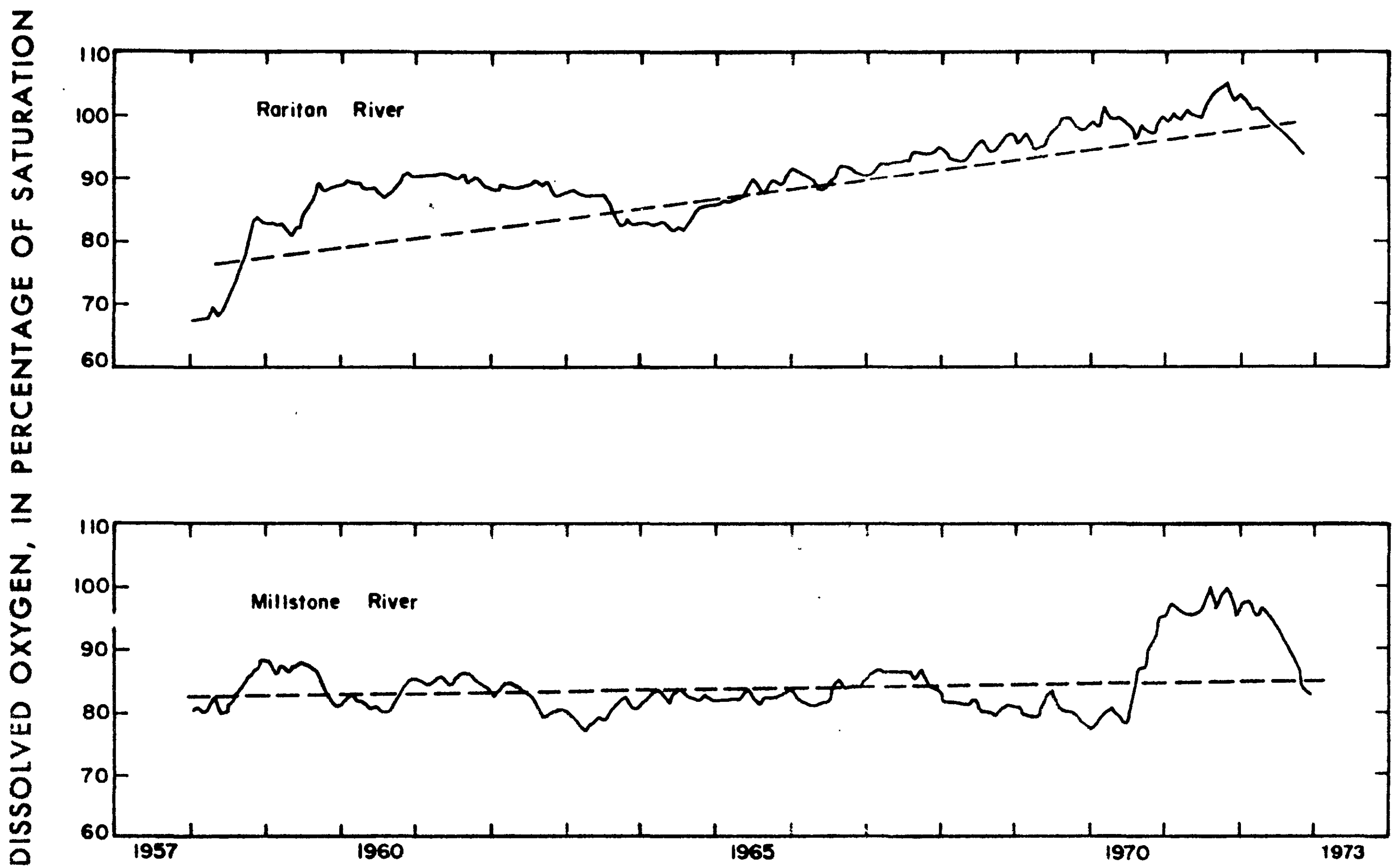


Figure 18.--Trend analyses, based on 12 month averages, of dissolved-oxygen concentration, Raritan and Millstone Rivers near Manville. (Based on chemical analyses by the Elizabethtown Water Co.)

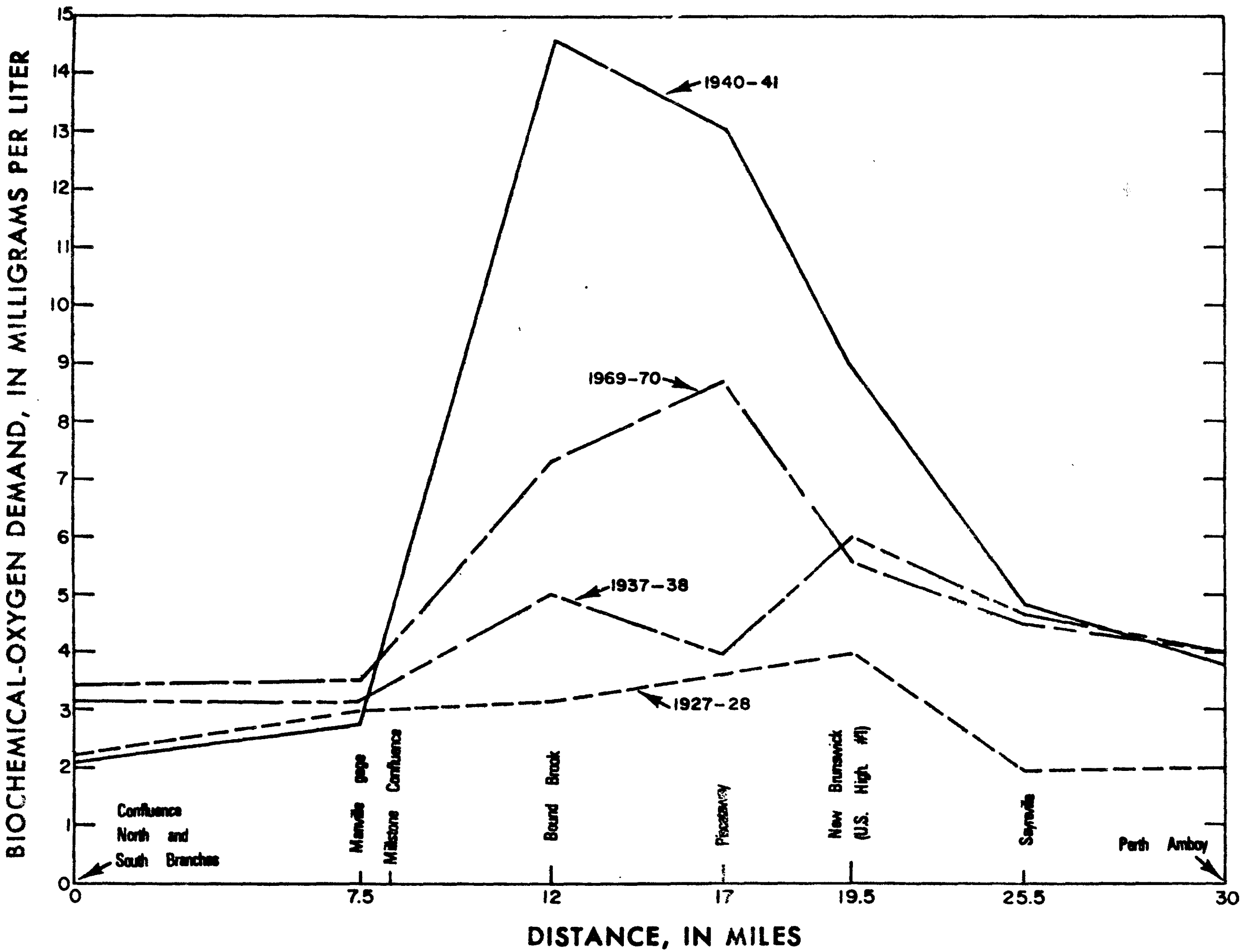


Figure 22.--Time comparison of the average BOD and DO values during four stream surveys in the Raritan River basin.

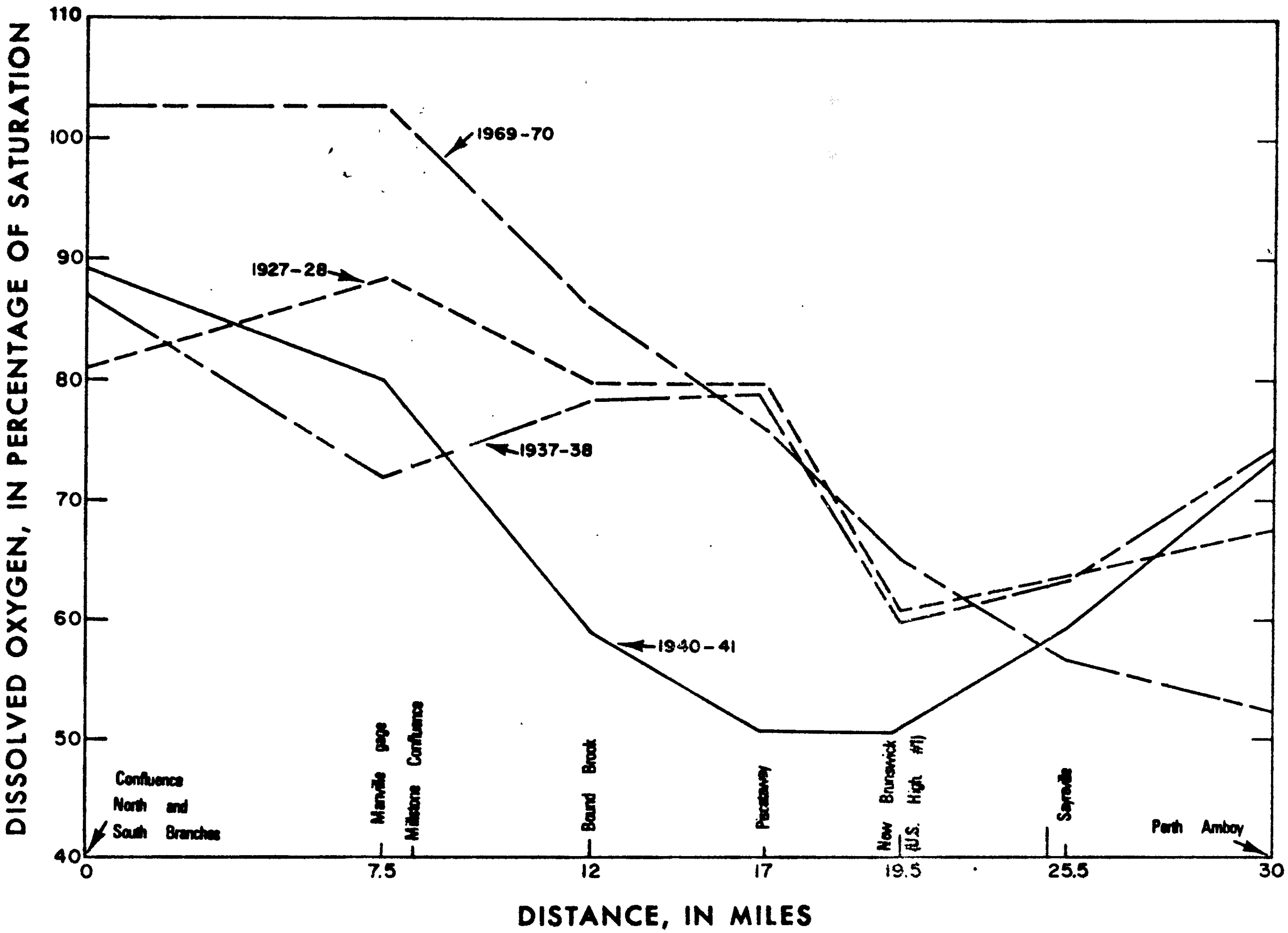


Figure 22.--Continued

DISCUSSION

The Raritan River basin comprising 1,105 mi^2 (2,862 km^2) in central New Jersey is the second largest within the State, exceeded only by the Delaware River basin (2,345 mi^2 or 6,074 km^2 in New Jersey).

Some recreational and agricultural water uses are found in the basin above Manville. However, the river system is used mainly as a source of water supply for both public and industrail needs and as a medium for the disposal of municipal and industrial waste waters. In 1972, three of six water-supply purveyors in the basin withdrew water from basin streams or the adjacent Delaware and Raritan Canal at or below Manville. These three purveyors diverted about 95 percent of the total 120 mgd (5.26 m^3/s) diverted basinwide. Similarly, 37 of 126 municipal and industrial waste-water treatment plants in 1972 used the basin streams at or below Manville for disposal of treated effluents, discharging about 80 percent of the total 150 mgd (6.57 m^3/s) basinwide. Projected population increases suggest a continued expansion in the demands upon the basin's water resources. To meet these present and future demands, efficient and prudent water-resource management is indicated.

Precipitation in the basin is ample (Dunlap, 1966, p.19) and averages 47 in (120 cm) per year, or roughly 3-5 in (8-12 cm) per month. Four general trends were noted in precipitation patterns during the period of study (1955-72). Precipitation was slightly less than normal between 1955 and late 1961; was extremely deficient during 1962-66; returned to slightly less than normal between late 1966 and 1971; and recovered to above normal after late 1971.

Trends in streamflow are illustrated for eight gaging stations on the Raritan River main stem and its three major tributary systems, the South Branch Raritan River, the North Branch Raritan River, and the Millstone River. In general, the highest 12-month average flow were observed in 1952, concurrent with the maximum annual precipitation during the study period, whereas the lowest were observed in 1965, concurrent with the minimum annual precipitation. A direct relation between precipitation and streamflow is evident. A general trend toward decreasing flows during 1955 and 1970 is attributed to the general pattern of less than normal precipitation.

A generalized plot of dissolved-solids concentration and streamflow, for five sampling sites on the main stem and three major tributaries, illustrates the inverse relation that exists. Inverse relations also were found to exist between streamflow and clacium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and hardness. Suspended sediment and dissolved oxygen were observed to have direct relations, while iron, fluoride, and nitrate, showed little or no significant relation with flow.

For water-quality evaluation, the Raritan River basin was divided into three general regions of similar water quality on the basis of predominant chemical constituents and dissolved solids, as measured during low streamflow of over 50 sampling sites. Because, under natural conditions, the major part of low streamflow in gaining streams is caused by ground-water inflow, the mapped water types normally reflect the chemical quality of ground-water inflow.

A comparison of the chemical-quality map with physiographic boundaries indicates that in most areas of the basin chemical weathering in the geologic environment is the predominant factor influencing stream quality. However, man's activities along the main stem below Manville have altered the natural solute-solvent relation in this area.

The predominant cations found in the basin's streams during low flow are calcium plus mangnesium; usually exceeding 60 percent of the total cations. In two of the three regions, that is in streams draining the Piedmont Lowland and Inner Coastal Plain, the predominant anions are those associated with salinity. Sulfate is the major anionic component, with lesser amounts of chloride, nitrate, and fluoride. Bicarbonate is predominant in the remaining region, that is in streams draining the New England Upland. Dissolved solids throughout the basin during low flow generally range from 40 to 200 mg/l, but occasionally are higher in areas where man's activities have altered the chemistry of the stream waters. The highest dissolved solids during low flow generally are found in streams draining the Piedmont Lowland (75-200 mg/l) and the lowest in those draining the Inner Coastal Plain (40-75 mg/l).

Average annual suspended-sediment yields of basin streams range from 25 to 500 tons/mi^2 (10-200 tons/km^2). The highest yields are found in streams draining the Piedmont Lowland (75-500 tons/mi^2 or 25-200 tons/km^2) and the lowest in those draining the Inner Coastal Plain (50-150 tons/mi^2 20-60 tons/km2). Streams draining the New England Upland part of the basin are estimated to transport 25-150 tons/mi^2 (10-60 tons/km^2) of suspended material annually.

In general, the water quality of basin streams above Manville and in most tributary streams below Manville is good for most industrial, domestic, and recreational uses. Some areas of local pollution, as indicated by low dissovled oxygen and high biochemical-oxygen demand, nutrient levels, and coliform bacteria counts, have been reported. These areas are normally in the vicinity of municipal waste-water treatment plant discharge. A comparison of chemical analyses of water samples collected in the 1920's with those collected during the study period suggest that the concentration per unit of discharge of sulfate, chloride, and nitrate in the river system above Manville have increased significantly, reflecting increased waste-water discharge and nutrient levels in agricultural runoff.

Although an upward trend in dissolved solids with time is apparent from moving-average curves (fig. 15), particularly on the Millstone River, comparison of these curves with a similar plot of streamflow indicates that the rising trend may be related to the concurrent decrease in discharge. Linear-regression analysis of dissolved solids and log streamflow was used to test the trend in dissolved solids per unit volume of water. If regressions of 2-year groups of the data are compared, dissolved-solids content in the Millstone River at Manville is shown to increase with time, particularly at low streamflow. For example, at 100 ft^3/s (2.83 m^3/s) the Millstone River is estimated to have transported 13 percent more dissolved solids in 1969-70 than in 1957-58. However, in a similar comparison of the Raritan River, no significant trend is apparent.

The absence of a trend in dissolved solids on the Raritan River was assumed to be due to augmentation of flows during low-flow periods with generally better quality water from Spruce Run Reservoir subsequent to 1964. A comparison of data collected on the Raritan River during 1957-61 and 1966-70, grouped by calendar quarters, indicated an increase of 16 percent in dissolved solids during January to March at a flow of 100 ft^3/s (2.83 m^3/s). Similarly, a decrease of 17 and 13 percent is estimated for the second and third quarters, respectively, at the same flow. No change is estimated for October to December. In the Millstone River an increase of 43, 17, 12, and 29 percent in dissolved solids was indicated in the first, second, third, and fourth calendar quarters, respectively. The reduction in dissolved-solids content per unit of flow during the second and third quarters on the Raritan River can be attributed to the dilution provided by reservoir releases, particularly in July through October. Without the releases, an increase in dissolved solids, similar to the observed on the Millstone River, might be expected.

Moving-average analyses of dissolved-oxygen data (fig. 18) collected on these two rivers at Manville indicate that prior to the late 1960's both streams were undersaturated. Thus, the rate of oxygen consuption through biochemcial decomposition organic matter exceeded the rate at which oxygen was replenished in the hydrologic system through such processes as reaeration and photosynthesis. However, subsequent to the late 1960's oxygen content on an average increased to supersaturated levels. The upward trend and supersaturated levels of dissolved oxygen shown on both streams during recent years suggest that an enriched nutrient condition exists and the photosynthetic processes are producing a pseudoimprovement.

The upward trends also may be related either to increased atmospheric reaeration rates at generally higher streamflow rates (fig. 6) in the period subsequent to the late 1960's or to flow augmentation in the Raritan River. However, linear-regression models based on biannually grouped data, of oxygen levels and streamflow showed little or no significant time trend on either river at flow rate above 100 ft^3/s (2.83 m^3s). There seems to be an improvement with time in oxygen levels at low flows on the Raritan River. For example, prior to 1963 dissolved-oxygen content was less that 6.6 mg/l at 50 ft^3/s (1.42 m^3/s) and greater than 6.6 mg/l subsequent to 1963. A comparison of data collected during 1957-61 and 1966-70, based on a regression of quarterly grouped data, indicates an increase in oxygen content in the Raritan River during April to September and possibly during the last quarter, while little or no variation was indicated for the Millstone River. This improvement, as was noted earlier with respect to dissolved solids, may reflect the generally better quality water and dilution of nonconservative pollutants by reservoir releases upstream.

The Raritan River main stem below Manville flows through a rather large urban and industrial complex. In addition, it is tidal below New Brunswick Municipal and industrial waste-water discharges and urban runoff greatly influence the river's quality in this area. The centrations of most constituents were generally higher than observed in other parts of the basin. For example, the dissolved solids at Manville ranges from 90 to 464 mg/l, phenolic materials from 2.5 to 22 ug/l, orthoposphate from 0.0 to 0.93 mg/l, and coliform bacteria from 6 to 13,300 colonies per 100 ml. At the head of tide near South Bound Brook dissolved solids ranged from 96 to 1,520 mg/l, phenolic materials from 3.0 to 312 ug/l, orthoposphates from 0.00 to 2.3 mg/l, and coliform bacteria from 1,100 to 100,000 colonies per 100 ml.

A general deterioration in quality also is indicated by dissolved-oxygen and biochemical-oxygen demand data (fig. 22) between Manville and Perth Amboy. The biochemical-oxygen demand in 1969-70 increased downstream from an average 5.6 mg/l at Manville to 9.0 mg/l at Fieldville dam, and thence decreased to 5.1 mg/l at Perth Amboy. The dissolved-oxygen content receded from an average 104 percent of saturation at Manville to 75 percent at Fieldville dam, and 51 percent at Perth Amboy.

Previous investigators (Rudolfs and Heukelekian, 1942, Cole, 1968) have reported (1) a general deterioration in quality on the main stem between Manville and Perth Amboy since the mid-1920's particularly in the late 1930's and early 1940's, (2) an improvement in 1958 upon the construction of trunk sewer by the Middlesex County Sewerage Authority, and (3) a further decline during recent years due to increased waste-water discharges and urban runoff.

Also presented in the report are the results of several time-of-travel measurements within the basin. These measurements allow the determination of reasonable estimates of the traveltime required for soluble contaminants to pass through particular parts of the river system during varying flow conditions. For example, during medium flow conditions the peak concentration of a contaminant introduced into the river system at Clinton on the South Branch Raritan River would be expected to travel the 34 mi. (55 km) to the head of tide at Fieldville dam near South Bound Brook in approximately 126 hr., while at high flow traveltime would be reduced to about 73 hr. Observed velocities during field measurements were variable and ranged from 1.62 ft/s (49 cm/s) on the main stem and the North Branch Raritan River to 0.063 ft/s (2 cm/s) through Carnegie Lake. A general decrease in velocity downstream was noted during each individual measurement, reflecting the lesser channel slopes, the broadening and deepening of the channel, and, in some, reaches, the ponding effect of small dams.

Atlantic Coast - North

The New Jersey Coast - North covers all that area draining directly into the Atlantic Ocean or bays with an outlet into the Atlantic Ocean. It extends along the coast from North 39° 28.5' latitude to North 40° 16.8' latitude, or from Little Egg Inlet to a point just south of the City of Long Branch. The drainage area covers portions of the New Jersey counties of Monmouth and Ocean. The large towns in the area are Asbury Park, Toms River and numerous coastal resort towns. The population of these coastal towns totals 813,000. The remaining inland areas are sparcely populated with a total 65,000.

The sub-basins in the drainage area include the Shark River, and Manasquan River, both of which drain directly into the ocean, the Metedeconk River, Toms River, and numerous small streams which drain into Barnegat Bay. Barnegat Inlet provides an outlet for these streams into the ocean.

The area is composed mostly of unconsolidated sands, gravels, clays, silts and marls of Cretecoefus and Tertiary Ages. The topography of the area is flat, rising to 150 ft., average elevation, inland. The coarse beds of these deposits contain considerable volumes of groundwater.

An internationally famous resort area, the "Jersey Shore", attracts millions of tourists and vacationers throughout the year. During the summer season, the overall population of the ocean counties swells to more than triple its winter size. In many shore communities, seasonal population increases can range up to 20:1. This seasonal variation highlights the importance of the tourist trade to the region's economy.

The drainage area is delineated by three water classifications; FW, which are the inland freshwater areas, TW, which are the tidal portions of the streams and bays, and CW, which are the waters, off shore from the mean low tide line. A more detailed delineation can be seen in the data summaries.

In general, most of the municipal and institutional water supply systems in the region are small, with the primary source being ground water. Only one system utilizes surface water: the Monmouth Consolidated Water Company. In addition, there are many rural domestic water supply sources (individual wells and other systems) located throughout the area. Ground water is also the primary source for these supplies. For certain shore communities, water consumption can increase more than 1000 per cent during peak summer periods.

Industrial water use from municipal systems in the area for process and cooling purposes is significant. The major self-supplied industry within the area, Toms River Chemical Corporation, uses approximately 5 mgd of ground water and 13 mgd of river water. Power plants located along the coast utilize large volumes of sea water for cooling purposes.

Some water is used for crop irrigation in the area. The major portion of this water is taken from streams.

The Jersey coastal area is one of the primary summer recreational areas for the northeastern United States. Major water related recreational activities include: bathing, boating, sport fishing and, to a lesser degree, waterfowl hunting.

Recreational bathing can be described as a major water use in much of the New Jersey Atlantic Coast region. Bathing beaches and facilities are located along the ocean front and portions of the intra coastal waterway. As a resort area, much of the region's economy derives from association with forms of recreation, with bathing being perhaps the prinicipal factor.

The Jersey coastal region is one of the principal sport fishing centers in the nation. In this area are some of the largest fleets of charter and party boats leaving eastern ports. The most frequently fished species caught by party boats are porgies and seabass. Charter boats troll the ocean up to 12 miles at sea, or even further in some cases, seeking tuna, blue fish, albacore and striped bass.

The shellfish industry in New Jersey is a significant national industry. New Jersey shellfish account for about 25% of the national market of clams, oysters, crabs, and lobster. The areas open to shellfish harvesting have decreased about 10% since 1967. The following table shows the changes in the shellfish areas in the bays and estuaries (excludes ocean areas).

TABLE IV

Shellfish Growing Areas (Acreage)

Totals as of:	Open	Fully Closed	Special Restricted	Seasonal	Total
Jan., 1967	313,760	77,221	-	1871	392,852
Jan., 1968	313,068	77,653	-	2131	392,852
April, 1968	312,822	77,899	-	2131	392,852
Nov., 1968	312,937	77,784	-	2131	392,852
July, 1969	298,110	69,966	20,426	4530	392,852
Jan., 1971	295,513	68,592	23,478	5209	392,852
Jan., 1972	293,235	70,390	23,478	5209	392,852
Jan., 1973	289,053	73,464	25,723	4612	392,852
Jan., 1974	284,185	74,012	27,243	7412	392,852
1974 Ocean, total	143,150	86,650			230,400
1. Sandy Hook Beach Haven]	70,800				
2. Atlantic City	2600				
3. Cape May	13,250				
1975	144,750	85,650			

Domestic sewage from municipal, institutional and federal facilities comprise the greatest source of pollution within the Jersey Coastal area. Many of these sewage systems are subjected to large seasonal load variations, which are due to an increase in the resident and transient population during the summer recreational period. These point sources are found in the respective discharge file in the following tables.

Industrial water pollution in the area is a relatively minor problem in comparison to municipal point sources of pollution, since most of the industry in the State is located in areas north and west of the coastal region. The few industries in the area contribute process water, BOD, metal wastes, and cooling water to the areas pollution.

Recreational boating can represent a significant source of pollution, particularly from the standpoint of pathogenic bacteria. Over 300,000 boats are registered within a few hours drive of the Jersey coast area, indicating the potential impact of pollution from this source. The development of marinas and associate facilities, (presently in excess of 100 launch ramps and 18,000 marine berths) to meet present and future recreational boating needs will intensify the pollution problem.

Water quality may be adversely affected by a variety of other land and water uses. Agricultural activities within the area result in chemicals spread over the land surface being washed into surface water or percolated into ground water aquifers. Another source of pollution is dredging, which can result in a re-suspension of accumulated organic sludges and silt. In addition, uncontrolled dredging may result in the formation of significant holes in the bottom of a bay, thereby increasing detention time and circulation of the water and the subsequent flushing of the system.

And finally, probably the most significant source of pollution, not previously discussed in detail is the discharge of domestic, and, to a much lesser extent, industrial waste to the ground. In excess of 100,000 homes within the Atlantic Coastal area are served by cesspools or septic tanks. Leaching of contaminants may constitute a significant source of pollution. Also, in addition to the sewage plants that dispose of wastes into the ground, some food processing firms dispose of their waste via spray irrigation.

Many of the above problems and conditions relate to the entire Atlantic Coast region (north and south) and so will not be repeated elsewhere.

Significant Drainages
Atlantic Coast - North

Drainage	Area (sq. miles)
Forked River	25.8
Cedar Creek	53.4
Toms River	191.0
Metedeconk River	89.1
Manasquan River	81.8
Shark River	23.0

E70:M:C13,18,16,9&3

DISCUSSION OF DATA

Atlantic Coast - North

Segment 10 - North Atlantic Coastal Waters

The FW-2N waters of this segment are recorded with only one station, at the Manasquan River. The high fecal coliform levels are questionable because of the small number of samples used.

The other waters in this segment are well covered by monitoring stations, especially the TW-1N waters. The FW-3N data show elevated nutrient levels and summer D.O. values approaching the standard. This indicates waters of questionable quality, however, more extensive data is needed to isolate causes and general quality.

The TW-1N waters are of good overall quality. The data shows all parameters, except PO_4 to be well within standard. No significant changes, with time, are noted. The low pH values are considered to be natural conditions in this area.

Segment 11 - North Atlantic Inland Waters

Only three monitoring stations are located in this area. The data available, indicate water of good quality.

Segment 12 - North Atlantic CW-2 Waters

No stations in this area were available for this report. The 23 estuarine and 17 ocean sampling points are only one year old, and have yet to be analyzed or adopted for STORET entry. A data base is currently being provided for these samples and will be available soon.

Atlantic Coast-South

The New Jersey Coast-South includes all that area along the coast from North 39° 28.5' lat. to North 38° 55.9' or from Little Egg Inlet to Cape May Point. It covers portions of the New Jersey counties of Burlington, Atlantic, Cape May, Cumberland, Gloucester and Camden. The major towns in the area are Atlantic City, Wildwood, and Cape May. The population of the coastal area is 607,000 and the inland area is 88,200. The following subbasins are included in the area:

Sub-basin	Area (S.M.)
Tuchahoe	102.0
Great Egg Harbor	347.0
Absecon Creek	26.4
Mullica	569.0

The description of the Atlantic Coast-North region is generally applicable to the Southern area. The one system which uses surface water as a potable water supply in this area is the Atlantic City Water Company.

A major difference, is that the headwaters of the Great Egg Harbor River intrude into some of the more populated areas of South Jersey near Berlin Twp. in Camden County. These headwaters become polluted from sanitary waste from municipal treatment plants. The waters then follow a course through sparsely populated areas in South-Central Jersey in an area known as the "Pine Barrens".

The term refers to the predominant trees in the vast forests that cover the area and to the quality of the soils below, which are too sandy and acid to be good for farming. Although New Jersey has the heaviest population density of any state, huge segments of the pines - as the Pine Barrens are often called - have no people in them at all, and the few towns in the central forest are extremely small. Technically - that is, by their geological and botanical dimensions - the Pine Barrens cover 1875 square miles, or about a fourth of the state. This area is, nonetheless much larger than most of the national parks in the United States.

The surface water in the area is generally acidic, ranging from pH 4.0 to 5.5. The hardness and solids content is extremely low because of the underlying silica rich soils. Much of the water is highly colored because of the high organic content picked up in the pines. After heavy rains, the water is extremely clear, picking up very little silt from the sandy stream beds.

Because percolation into ground water occurs at a rapid rate, pollutants do not carry far. A system of ground water monitoring sites would be a better measurement of pollution in this area. However, because of the cost of ground water monitoring, this type of sampling will not be scheduled for the immediate future.

Atlantic Coast - South

Segment 13 Coastal Waters

There are three monitoring stations in the TW-1N water at Absecon Creek, Tuckahoe River and Bass River. The data show water of good quality with the exception of higher-than standard fecal coliform levels. The low pH values show the naturally acidic nature of the waters in the Atlantic Basin. The changing D.O. levels shown by the data may not be significant because of the highly variable nature of this parameter. Intensive surveys or modeling of this area will pinpoint the cause for this variation.

The data, from stations located in the FW-3N and TW-1N waters of this area, reflect high quality water untouched by human activities. This reflects the low population levels of the Inland area and slow development.

DELAWARE RIVER ZONES 5 & 6

The Delaware River Basin covers the entire area extending from longitude 74°41'45", latitude 41°21'20", South to longitude 74°56'10", latitude 38°55'35", or from the New York-New Jersey border to the tip of Cape May extending into the Delaware Bay. This covers all of the area along the western coast of New Jersey draining directly into the Delaware River. The drainage area covers several counties; Cape May, Salem, Gloucester, Burlington, Cumberland, Hunterdon, Mercer, Warren and Sussex.

The drainage area is further divided into zones, basins and sub-basins. The zones have been established by the Delaware River Basin Commission and are as follows:

<u>ZONE 1c</u>- is that part of the Delaware River extending from the U.S. routes 6 and 209 bridge at Port Jervis, New York, river mile 254.75, to Tocks Island, river mile 2.7.0.

<u>ZONE 1d</u>- is that part of the Delaware River extending from Tocks Island, river mile 217.0, to river mile 185.0, above Easton, Pennsylvania.

<u>ZONE 1e</u>- is that part of the Delaware River extending from river mile 185.0, above Easton, Pa., to the head of tidewater at Trenton, New Jersey, river mile 133.4 (Trenton-Morrisville toll bridge).

<u>ZONE 2</u>- is that part of the Delaware River extending from the head of tidewater at Trenton, New Jersey, river mile 133.4, to river mile 108.4, below the mouth of Pennypack Creek, including the tidal portions of the tributaries thereof.

<u>ZONE 3</u>- is that part of the Delaware River extending from river mile 108.4, to river mile 95.0 below the mouth of Big Timber Creek, including the tidal portions of the tributaries thereof.

<u>ZONE 4</u>- is that part of the Delaware River extending from river mile 95.0, to river mile 78.8, the Pennsylvania-Delaware boundary line, including the tidal portions of the tributaries thereof.

<u>ZONE 5</u>- is that part of the Delaware river extending from river mile 78.8, to river mile 48.2, Liston Point, including the tidal portions of the tributaries thereof.

<u>ZONE 6</u>- is that part of the Delaware Bay extending from river mile 48.2, to river mile 0.0, the Atlantic Ocean, including the tidal portions of the tributaries thereof.

The Delaware River drainage area is also divided into major planning basins which were established by the Department of Environmental Protection, Division of Water Resources. For the Delaware River drainage area there are four designated planning basins:

Planning Basin #8 is equivelent to D.R.B.C. zone #1, and is further sub-divided into minor drainage basins; Shimmer's Brook, Flat Brook, Vancampens Brook, Paulins-Kill, Delawanna Creek, Musconetcong River, and Locatong Creek.

Planning basin #7 is equivelant to D.R.B.C. zone #2 and is also subdivided into sub-basins; Assunpink Creek, Duck Creek, Crosswicks Creek, Blacks Creek, Crafts Creek, Assuncunk Creek, and Mill Creek.

Planning basin #6, encompases both zones #3 & #4 of the Delaware including the following drainage basins; Rancocas Creek, Pompeston Creek, Pennsauken R., Baldwin Run, Coopers Creek, Newton Creek, Big Timber Creek, Woodbury Creek, Mantua Creek, Repaupo Creek, Racoon Creek, and Maple Swamp.

The final planning basin, #5, includes both zones #5 & #6 of the Delaware. The drainage basins in this area are; Oldman's Creek, Whooping Creek, Salem Creek, Miles Creek, Mill Creek, Alloways Stow Creek, Cohansey R., Dividing Creek, Maurice River (Manantico Creek and Manumuskin Creek), and Dennis Creek.

The Delaware Bay provided an outlet for these streams into the ocean.

Zones 5 & 6 of the Delaware River encompase Selam, Cumberland, and Cape May counties.

The surface water classification for zones 5 & 6 consists mainly of TW-1 waters, and FW-3 waters. However, there are some small designated FW-1 waters occupying state land throughout the area.

Zones 5 & 6 are composed mostly of the Cape May Formation and of Cohansey Sand from the Miocene period. The Cape May formation consists largely of low terraces and plains of gravel and sand, with come clay. This merges into stratified drift in the Delaware and Raritan valleys. The Cohansey sand is incorporated chiefly of quartz sand with local beds of clay and gravel (from the miocene or pliocene periods). There are some beds of Bridgeton Formation consisting of gravel and sand, in part solidified by iron oxide. There is also some Kirkwood Sand consisting of fine micaceous sands with local beds of dark clay. Sediments of the cretaceous age are found only in the subsurface and contain several aquifers, however most of the cretaceous sediments are deposited in marine environments and contain saline water which is not presently used. In Cumberland County there are two mineral resources which are presently economical to extract and in fact have been the backbone of the county's economy.

The topography of this area is generally flat ranging from sea level to 20 feet throughout most of Cape May and Cumberland counties. Entering Salem County the topography is generally level, from sea level to 40 feet, with some inland heights of up to 140 feet.

The shellfish industry in New Jersey including the Delaware Bay provided a significant volume of the national production. Although oyster harvesting in Delaware Bay has been greatly reduced during the past years due to MSX disease. However, natural beds have increased in acreage between 1967 and today, and the severity of the disease now appears to be less drastic. The Delaware bay area is extremely active in shellfish production, however some areas are condemned due to pollution. In the Cape May county area the waters just off shore of the land extending from Fishing Creek down to the southern most tip of Cape May are condemned. The Bay is productive up to the Cohansey River, however all waters upstream of the Cohansey River are condemned. In addition the estuarine portion of Cohansey Creek and Maurice River are condemned for shellfishing as a result of the treatment plant discharges and localized inadequate septic systems.

CAPE MAY COUNTY

Cape May County is a great tourist attraction and due to this fact, extreme seasonal fluctuations of population occur.

	permanent non-summer	summer
POPULATION 1970	60,000	550,000
POPULATION 1980 (projected)	90,000	625,000

average daily flow	NON-SUMMER	SUMMER
WASTEWATER 1970	3M.G.D.	23 M.G.D.
WASTEWATER 1980	5M.G.D.	27 M.G.D.

Surface waters are Cape May County's most valuable natural resource. The marine and estuarine resources of the region are abundant, diverse and of high quality. At least 240 species of invertebrates and 200 species of finfish are known from near shore and estuarine waters. The areas where these species originally were discovered are of international scientific significance and are environmental quality monuments. These water resources are closely related to the socioeconomic resources of the county because of their inevitable value to tourism and life style.

Water-oriented recreational activities, lodging and food services, boating services, and other recreation and tourist oriented businesses are in important source of income for Cape May County. Sportfishing facilities are utilized by many of the summer visitors to the county. It can clearly be seen that Cape May's socioeconomic condition is dependent upon the clean water and healthful environment of the county to attract visitors.

Inadequately treated disposal effluent from sewage treatment facilities are the major cause of water pollution in Cape May County. In 12 localities classified throughout the county by the County Department of Health as "problem areas", the water is polluted also by large individual on-site disposal units or by concentrations of small units. This is primarily the result of facilities that are improperly sited in high water table areas. There are 3 major areas on the Delaware Bay side of Cape May County with, or without adequate sewage treatment; Reeds Beach, Dias Creek and Pierce's Point.

Pollution Source	# of Sources
Reeds Beach	90
Dias Creek	8
Pierce's Point	40

CUMBERLAND COUNTY

Cumberland County lies in the extreme south central agricultural and coastal portion of the state. The county is bounded by the counties of Salem, Gloucester, Atlantic, and Cape May. The county is also bounded on the South by 38 miles of Delaware Bay shoreline. The count's 14 municipalities occupy 502.4 square miles. Cumberland County's population as of 1970 was in excess of 121,40 people, and the projected population for 1980 is in the range of between 139 and 149 thousand people.

Generally, the quality of ground water in Cumberland County varies with depth. Most of the relatively poor quality ground water is salty and occurs in 3 prinicipal zones: 1) At shallow depths of less than 100 ft., along the tidal flats and tributary estuaries, 2) At depths of 200 to greater than 750 ft. at Greenwich and Brighton-Port Morris area respectively and 3) At depths of greater than 1000 ft. throughout portions of the County. The good quality water occurs throughout the county in upper water bearing sand and gravel strata formation.

The adverse effects of improper waste disposal can be seen in shallow aquifers throughout certain portions of Cumberland County. There are increasing concentrations of nitrate, chloride and dissolved solids in water from shallow wells indicating probable contaminations from waste sources such as; local contamination of ground water supplies from improper disposal of wastes and poor management of sanitary land-fill operations.

Cumberland County, which is more highly dependent upon ground water than any of the other counties in Zones 5 & 6, has a total ground water usage of 60 M.G.D.

URBAN USE (including domestic commercial and industrial)	16.5 M.G.D.
DOMESTIC USE (outside of urban area)	2.9 M.G.D.
INDUSTRIAL USE (outside of urban area)	23.4 M.G.D.
IRRIGATION	16.7 M.G.D.
LIVESTOCK	0.2 M.G.D.

Cumberland County has 13 wastewater treatment systems. The type of wastewater treatment provided varies from advanced treatment spray irrigation, and lagooning. Three of the wastewater treatment systems are significant.

The Bridgeton sewage treatment plant on the west bank of the Cohansey River provided secondary treatment for about 3.5 million gallons per day of industrial and domestic wastewater. Industrial flows account for approximately 45% of the total daily average and while recieving some pretreatment, are inadequately treated at the municipal plant. The Millville sewage treatment plant provides secondary treatment for 5 million gallons of individual and domestic wastewater every day. The plant has experienced severe operational difficulties, most of which are problems related to structural failures, and have been corrected. The Landis sewage treatment plant in Vineland provides 5 million gallons per day of primary treatment plant capacity.

During the harvesting season, both the Bridgeton and Landis plants receive large amounts of canning wastewater.

There are two major tidal river systems forming drainage basins in this area. Both systems generally flow from north to south. The Cohansey River, Originating in Salem County drains most of the western part of the county and empties into Delaware Bay. The second river, being the Maurice, originates primarily in Gloucester County and drains most of the eastern portion of Cumberland County on its way to Delaware Bay. The mouth of both rivers are considerable swampy, and the Delaware Bay shore is in environmentally unique salt marsh, an area of low, poorly drained land.

The Maurice River drainage area covers a total area of approximately 386.4 square miles and consists of several tributaries and other smaller creeks in the same area. The Cohansey River covers a total area of approximately 105.4 square miles and also has several tributaries.

o

SALEM COUNTY

Salem County relies heavily upon chemical and allied products, and upon agriculture. There are a total of 15 municipalities making up a population of 60,346 people in 1970, and a projected 69,343 people by 1980.

Throughout Salem County groundwater resources have generally been untapped or underdeveloped.

There has been a problem in Salem County with a failure in the septic systems. Population density has increased to such an extent that the soil's assimilative capacity can no longer handle the increased sewage flow without producing health and pollution problems. Failure to properly maintain on-site systems has shortened their lives and resulted in increased loads on the soils capacity resulting in contamination problems.

There are 5 municipal and 3 private industrial sewage disposal systems in Salem County. Three introduce effluent directly into the Delaware River, and two utilize the Salem River. The total municipal wastewater production, as of 1970, came to 2.92 M.G.D. The industrial flows were 101 M.G.D.

There are four major drainage areas in Salem County one of which, Oldmans Creek, actually forms a large part of the Salem-Gloucester County border.

The first, Stow Creek, covers an area of 41.57 square miles. It travels from northwest to southeast as it meanders through a large portion of extremely flat Bayside Meadowlands. Stow drains the south-eastern coastal area of Salem County.

Alloways Creek covers an area of 54.45 square miles. It drains much of the south-central portion of Salem County on its way to the Delaware River. The municipality of Salem derives its surface water from Alloways Creek.

The Salem River is somewhat of a different situation, in that it drains an area of geologically different terrain in the western portion of Salem County. This geologic situation is not indicitive of the general description given for zones 5 and 6, but is instead indentical to the geology of zones 3 and 4. The Salem River covers an area of 113.6 square miles and is the major drainage of Salem County. There are several sewage treatment plants introducing effluents directly into the Salem River. It is important to understand that the Salem River is the only river in Salem County which directly recieves effluents. Also, Dupont, a major surface water user extracts 11.0 M.G.D. from the Salem River.

AJ:P:B6-12

DISCUSSION OF DATA

Segment 17 Tributaries to Delaware River Zone 5

Water quality in this area of FW-3N waters is sampled at two stations on the Salem River. The data indicates several trends, however the need for further sampling is the only conclusion that can be drawn from the limited amount of data.

Parameters which should be considered because of their relation to important intakes (11 MGD) and discharges on the Salem River include (1) elevated but improving values of phosphate, (2) high fecal coliform levels, and (3) increasing summer dissolved oxygen concentrations.

Flow diversion and non-point sources should also be elevated for their effects on turbidity and the above mentioned parameters.

Segment 19 Tributaries to Delaware River Zone 6

Data is available for two water classes in this segment. In the FW-3N class, data indicates high quality waters. Except for fecal coliform levels, good water quality also exists in the TW-1N waters which are represented by only two stations. Important to the interpretation of this data is the fact that no sampling stations exist below the discharges of the Millville plant on the Maurice River and the Bridgeton plant on the Cohansey River.

Intensive survey data collected during the summer of 1974 for modeling these rivers, indicates large diurnal variation in D.O. with values dropping below 1 mg/l during the early morning hours in the lower reaches of the FW-3 waters. More can be said about this unsatisfactory condition when modeling has been completed.

Such variation is not evident in the data available for inclusion in this report. This fact must be considered when evaluating water quality where intensive survey data is not available.

The surface water classification for zones 2, 3 and 4 varies somewhat. There are both tidal and non-tidal considerations beginning with zone 2. Zone 2 has two major classifications with TW-1 waters along the river and estuarine portions of streams and FW-2 classifications on inland waters.

Zone 3 also has two classifications, in this zone the tidal waters are classed as TW-2, while the inland waters remain FW-2.

Zone 4 changes both classifications with TW-2 tidal waters, and FW-3 inland waters.

At no point in the three zones 2, 3 and 4 are there any FW-1 waters.

The geology in the three zones is the same throughout and can be dealt with generally. The area consists of two sediments, creta0 ceous and non-glacial quaternay.

There are five formations of Cretaceaus Sediments:

Merchantville Clay - black sandy clay, usually glauconitic.
Woodbury Clay - black to dove colored clay, ususally non-glauconitic.
Navesink Marl - dark green glauconitic marl with shell bed at the base.
Englishtown Sand - white and yellow sand with little mica and glauconite, and local thin layers of clay.

There are two formations, the Cape May and Pensauken formations of the non-glacial quaternary sediemtns.

Cape May Formation - low tenacio and plains of gravel and sand, with some clay.
Pensauken Formation - gravel and sand on higher terraces, capping hills and divides and covering some plains.

Mercer County consists of thirteen municipalities with a population of 303,968 in 1970, and a projected 349,083 people by 1980. The population is predicted to increase by 40 to 50% between 1970-2000.

Mercer County is presently served by two major sources of water supply, the Delaware River and groundwater aquifers. The Trenton Water Works handles 35 MGD of Delaware River water, and supplies approximately 70% of the populations water requirements in Mercer County. The remaining population derives its water from wells. 18% of the people draw water from 45 wells which comes to an average daily demand of about 5.0 MGD. 13% of the population draws from individual domestic wells. There are also about 30 other wells for industry and irrigation. The quantity of groundwater in Mercer County is presently satisfactory and the quality is from good to excellent.

The wastewater of about 150 (25%) of the industrial establishments can be considered to be directly amenable to municipal waste treatment. However, the wastewater of the remaining 450 (75%) industrial establishments would require some degree of industrial pre-treatment before compatability with municipal wastewater could be assured. There are in total seven municipal and thirteen non municipal sewage treatment plants in Mercer County. Although the non-municipal plants contribute less than 1 MGD they are still potential source of pollution problems. Industrial pollution problems are associated with direct industrial discharges and with industrial discharges through a storm and sewer system.

There are two major watersheds in the Delaware Basin portion of Mercer County, the Assunpink Creek drainage and the Crosswicks Creek drainage.

a) <u>Assunpink Creek</u>

As it flows through Trenton, the Assunpink Creek has exceptionally high fecal coliform values. In the fresh water portion, the values range form 80-5420 MPN/100 ml, while in the tidal portion, the range is froom 2400-34,800 MPN/100 ml. These values exceed both DEP and DRBC standards. Contravention of fecal coliforms standards were found frequently in the samples in the fresh water portion and in all the samples in the tidal portion.

In addition, the Assunpink Creek has high nutrient concentrations with maximum values of 5.0 mg/l for nitrates and 8.0 mg/l for orthophosphates being recorded. This nutrient loading may be due in part to the effluent discharged into the upper reaches of the Creek by the Ewing-Lawrence sewage treatment plant or from various non-point sources such as urban runoff, on-site disposal in the headwaters, or overflows occurring in the Pond Run interceptor of the Hamilton Township sewer system.

An intensive water quality survey conducted on Assunpink Creek during 1974 has established the importance of unidentified thermal and organic pollution sources. Non-point sources of pollution are as significant as point sources of pollution in causing water quality standards contraventions.

b) Crosswicks Creek

The Crosswicks Creek is classified as TW-1 in the tidal portion which extends eastward from the Delaware River to the town of Crosswicks. Its classification then changes to FW-2 in the remaining fresh water portion of the creek. Fecal coliforms at the DEP sampling point on the Crosswicks Creek ranged from a minimum of 79 MPN.100 ml to a maximum of 9,200 MPN/100 ml with contravention occurring frequently. Both nitrates and orthophosphate concentrations were high in number of the samples taken.

In a study done by the Academy of Natural Science in 1973, (1) evidence of organic enrichment was noted in the Crosswicks Creek. Analysis of the plankton and benthos showed evidence of the rotifer Keratella Cochlearis, oligochaete worms, common leaches, asselote isopods and free living flatworms. In the very shallow portion of the creek Melosira Varians was noted; this is a common organism under organically rich conditions.

An intensive water quality survey on Crosswicks Creek indicates that non-point sources of pollution are as significant as point sources in causing contravention of water quality standards.

c) Delaware River

The Delaware River in Zone 2, below the falls at Trenton, exhibits coliform counts above DRBC standards. Dissolved oxygen decreases rapidly immediately below the head of tide, dispite a supersaturated dissolved oxygen condition of the Trenton, N.J. falls. There are large benthic sludge deposits to depts as great as 15 feet in this area. D.O. levels recover several miles below the head of tide before decreasing again in the Philadelphia stretch of the river. A final D.O. increase is noted below Marcus Hook, Pa. Water quality vacillates considerably as a function of the season of the year with lowest quality conditions being recorded in the period June to September.

Preliminary findings of intensive water quality surveys and water quality models indicate that point and non-point sources of pollution are significant in Zone 2. Water quality modelling completed during the Delaware Estuary Comprehensive Study provides the basis for present allocations of carbonaceous oxygen demanding waste loads into the mainstem in Zone 2.

The Burlington-Gloucester-Camden complex is part of the Philadelphia standard metropolitan statistical area. Substantial concentrations of population and manufacturing production are situated in this area.

A 1970 census population indicates that 952,000 people resided in the designated area (1,370 square miles). Both the population and the manufacturing activity are within and around Camden City, and adjacent to the Delaware River in adjoining counties. Approximately 80% of the population is concentrated in theis urbanzied area.

County	Population 1970	Projected Population 1980	Number of Manufacturing Establishments
Burlington	323,132	383,816	530
Camden	456,291	491,482	1,056
Gloucester	172,681	208,556	295

Ground water quantity is adequate, however there are quality problems. Ground water pollution constitutes a complex problem in the urbanized area because of salt water intrusion from the estuarine portion of the Delaware River. Industrial waste disposal has degraded groundwater quality in this area.

The three county area is served by both municipal and non-municipal treatment facilities. All together there are 79 municipal treatment facilities and 28 non-municipal facilities. The non-municipal wastewater accounts for less than 1.5 MGD. About 50% or 38 MGD of the municipal flow is discharged directly to the Delaware River mainstem zones 3 and 4. Forty percent of the remaining flow enters into Pensauken Creek (13 MGD) and Cooper River (11 MGD).

The Pensauken Watershed also has over 45% of the non-municipal flow, coming from 13 plants and constituting approximately 0.35 MGD. About 0.45 MGD of the non-municipal waste is directly discharged to the mainstem of the Delaware River (Zone 2).

Urban storm drainage from combined and separate sewers in the urbanized areas degrades water quality. Intensive water quality surveys on the Pensauken, Cooper, Big Timber and Crosswicks indicate that the non-point sources contribute substantial pollution loads, causing contravention of water quality standards.

A substantial industrial pollution problem exists because of the large and diversified industrial establishment in the area. The existing loads are presently allocated on the mainstem of the Delaware River.

As a result of the surveys and analysis, models were formulated and effluent limitations more stringent than best practical treatment ha been set on the Rancocas Creek. Water quality is generally good in t headwaters although dissolved oxygen values as low as 4.2 mg/l and phosphate concentrations as high as 28.0 mg/l have been recorded. Coliform levels increase sharply in the area of Mt. Holly and recorde values of fecal coliform in the south branch have exceeded those in t Mt. Holly area. Below the confluence of the north and south branches dissolved oxygen values below standards have been recorded.

Within Camden County, intensive water quality surveys on the Big Timber, Pennsauken Creeks and the Cooper River have been completed. Each of these watersheds is characterized as urban or suburban in nature. There are numberous small impoundments on the mainstems and several larger lakes in each of the non-estuaring portions of the watershed. Each watershed has between eight and thirteen municipal sewage treatment plants scattered between the headwaters and the tidal reaches.

On the Cooper River water quality survey data substantiates that BOD5 values are at or above 5 mg/l and dissolved oxygen levels are below standards. Phosphorous and ammonia levels are consistently above 1 mg/l and 4 mg/l respectively. Within a downstream of impoundments the chlorophyll 'a' values exceed 50 and 100 mg/l and demonstrate the eutrophied state of these waters. STORET records indicate minimum dissolved oxygen values of 0.6 mg/l, and numerous high coliform counts. Nitrate concentrations exceed 23 mg/l at one station, as opposed to a maximum of only 5.0 mg/l further downstream. Phosphate levels at upstream stations reach about 10.8 mg/l.

The Pennsauken Creek water quality survey data substantiates similar dissolved oxygen and phosphorous contraventions as on the Cooper River. STORET data records indicate phosphate values of 21.0 mg/l. Dissolved oxygen values as low as 1.4 mg/l have been recorded on the mainstem.

While the Big Timber Creek water quality survey data does not indicate water quality degradation as serious as in the Cooper or Pennsauken Creek, BOD5 values are consistently between 2 and 5 mg/l. Coliform counts and dissolved oxygen values recorded in the south branch upstream from its confluence with the north branch fail to meet standards. Ammonia levels as high as 15.0 mg/l have been reached in the north branch. Coliforms in the north branch exceed standards, and the dissolved oxygen has reached a recorded minimum of 1.6 mg/l.

Because wastewater loads from point sources constituted as much as 50% of streamflow during the field surveys, some inhibition by toxic wastes might have decreased BOD5 values. Nevertheless attempts at formulating models on eahc of these waterways indicate the non-point or unidentified pollution sources are as significant or more significant than point sources in causing violations of dissolved oxygen standards. Future studies must establish the relative importance of specific point and non-point sources as well as the causes of eutrophication.

Delaware River Basin Zone 1

Zone 1 of the Delaware River consists of 5 counties; Sussex, Warren, Hunterdon, Somerset, and Mercer Counties. These counties are then further subdivided into drainage basins, Shimmers Brook, Flat Brook, Cancampens Brook, Paulins Kill, Delawanna Creek, Pequest, Lopatcong Creek, Pohatcong, Musconetcong River and Lockatong Creek.

Since zone #1 does cover a large area the geology undergoes many changes, as well as topography and it therefore becomes necessary to break it up and discuss it by area.

The Surface water for all of zone 1 is classified as FW2 waters. There are however, some FW1 classified waters on state land in portions of Sussex and Warren County.

Sussex County consists of 24 municipalities with a population of 77,975 as of 1970, and a projected population of 85m245 people in 1974. This region of the state remains a major recreational area, although a definite trend towards permanent employment has become apparent during the last decade.

In Sussex County there are 4 major drainage basins draining portions of the county, however only one, the Flat Brook R. drainage enters the mainstem of the Delaware River in Sussex County. The Musconetcon River, Paulins Kill and Pequest River all drain Sussex County but pass over its border to Warren County where they then empty into the Delaware River.

The Big Flat Brook drainage basin covers a land area of about 33.0 square miles. The topography in this area begins at about 500 ft. along the river and rises to 1,400 ft. in the Stokes Forest State Park area.

The Paulins Kill drainage covers an area of approximately 177.4 square miles.

The Pequest River drainage covers an area of over 158 square miles, 46 square miles of which actually occupy Sussex land. The geology in this drainage area consists of Brunswick Shale Formation, Franklin Limestone Bedrock and Gneissic Bedrock formation. The configuration of the land in the Brunswick Shale Formation varies from rolling, gentle hills to sharp crested ridges running from a South Westerly to North Easterly direction. The Franklin Limestone forms along a low valley largely covered with glacial drift, while the Gneissic Bedrock is characterized by rugged hills and monumental narrow ridges.

The topography along the Pequest varies anywhere from 400 feet above sea level to over 1,000 feet.

Most of the water supply in Sussex comes from deep wells. The only sewage treatment plant in the Sussex Portion of the Pequest is St. Paul's abbey package treatment plant.

There is a sewage treatment plant for the Pequest centered at Belvidere, however mostly on-site septic disposal systems are used.

The Musconetcong River is the major outlet of Lake Hopatcong, which has a watershed of 25.4 sq. miles. The Musconetcong covers portions of 4 counties;

Sussex	35 sq. miles
Morris	42 sq. miles
Warren	50 sq. miles
Hunterdon	25 sq. miles

The total Musconetcong drainage area covers an area of 152 square miles. The portion within Sussex County, covers the entire Boroughs of Hopatcong and Stanhope, and portions of Byram and Sparta Townships, covering an area of 34.92 square miles.

The geology of the Musconetcong basin consists of Gneissic bedrock composed of Lossee, Byram and Pochuck gneisses. These are dense, hard rock composed of a large variety of minerals in a characteris-ally banded structure. The land farm is characterized by high, rugged, rock hills and ridges separated by deep valleys.

The area rises from 200 feet above sea level to 900 feet.

Warren County itself consists of 23 municipalities with a population of 74,105 people as of 1970, and a projected population of 77,045 by 1974.

There are 5 sewage treatment plants dealing with the water in this area. Three of these systems are municipal systems and two are private owned serving residential developments;

Paulins Kill Sewer Authority	Blairstown
Pohatcong Sewer Authority	Washington Borough
Pequest Sewer Authority	Belvidere
Lopatcong Sewer Authority	Phillipsburg
Musconetcong	Hackettstown

There are five major drainage basins within Warren County and which actually enter the Delaware in Warren County. These are the Paulins Kill, Pequest River and Musconetcong River which have already been discussed. The remaining two drainage areas are the Pohatcong Creek and Lopatcong Creek. The Pohatcong Creek covers a drainage area.

Hunterdon County consists of 26 municipalities with a population, as of 1970, of 70,000. The projected population for 1974 is approximately 73,940 people.

Wells are the major source of available water to Hunterdon County residents. At present, water reserves in the county are more than adequate to serve the counties needs. In addition, recently completed state $H_{2}0$ resources conservation projects, Spruce Run and Round Valley further enhance water potential.

Sewage is handled largely by individual septic tanks. There are however, 4 public sewage treatment plants; Frenchtown, Lambertville, Flemington and Sergeantsville.

Flemington Sewage Treatment Plant	Bushkill Creek
Lambertville Sewage Treatment Plant	Delaware River
Frenchtown Sewage Treatment Plant	Delaware River
Sergeantsville Sewage Treatment Plant	Wickecheoke Creek

At present the individual septic systems are adequate. Hunterdon County has become an extremely important recreational area due to the development of Round Valley & Spruce Run reservoirs.

Somerset County makes up only a small portion of the zone 1 portion of the Delaware River basin. Somerset consists of 21 municipalities with a total population of 199,030 as of 1970, and a projected 205,620 for 1974.

The major drainage for Hunterdon and Somerset Counties is the Lockacong drainage area which consists of numerous small creeks along the Delaware and which empty directly into the Delaware River.

The topography in the Hunterdon-Somerset area varies from between 200 to 400+ feet.

SEGMENT 25 Tributaries to Delaware River Zone 1

All sampling stations in this segment are located in trout maintenance and production FW-1 and FW-2 waters. As expected for trout waters, D.O. and clarity are excellent. However, owing to significant agricultural activity and large number of septic tanks, non-point source studies should be conducted to identify localized problems of high fecal coliform levels and phosphate inducted eutrophication so that such problems can be identified and corrected in their early stages.

Wallkill River Basin

The Wallkill River basin study area is located in Sussex County and a small portion of Passaic County in Northwest New Jersey, and is bounded to the north by New York's Orange County. It has an area of 211 square miles and encompasses 12 municipalities, either totally or in part. Lying slightly beyond the New York Metropolitan area, the basin is approximately 50 miles from New York City.

The New Jersey portion of the Wallkill River watershed forms the headwaters of the greater Wallkill basin, a minor basin of the Hudson River system. The New Jersey portion of the Wallkill system is comprised of three subbasins, the minor Wallkill, the Papakating, and the Pochuck. Basins bounding the study area include the Flatbrook and Paulinskill to the west, the Musconetcong and Pequest to the south, (all of which are subbasins in the Delaware system), and the Pequannock and Rockaway to the east, (subbasins of the Passaic system). (subbasins of the Passaic system).

There are two physiographical provinces associated with the study area; the Highlands Province, and the Appalachian Ridge and Valley Province.

The Highlands Province, situated in the eastern portion of the basin, is characterized by a rugged topography exhibiting local relief of 200 to 800 feet in the steep-sided ridges and valleys of the Hamburg Mountains. The highest peak in this province is 1496 feet in Vernon Township. The region is generally underlain with Precambrian crystalline rock with glacial drift present locally.

The Applachian Ridge and Valley Province is characterized by high ridges and associated broad valleys. Kittatinny Mountain comprises the northwest divide of the basin. This formation, composed of extremely resistant Shawangunk conglomerate, reaches a maximum height of 1800 feet in High Point State Park, the highest point in New Jersey. Kittatinny Valley is a series of rolling hills and valleys underlain with the easily erodible Martinsburg shale formation. Ridges and valleys in both provinces display a distinct northeast-southwest trend.

Survey of Existing Conditions

Socio-Economic Characteristics of the Basin

The Wallkill River Basin may be characterized as a rural setting with small towns, agricultural activity in the rolling countryside, and a limited amount of industry situated within the towns.

The population of the basin was relatively stable for many years until the 1950's and 1960's. Then, several forces combined to produce a high rate of growth in the Wallkill Basin and the surrounding area. These forces include:

1. The outward expansion of the New York metropolitan area with the suburban growth that occurred in many parts of the nation during that period. (The Wallkill Basin may be considered as part of the extreme westerly fringe of the New York metropolitan region);

2. An increased desire on the part of the public to live in areas of scenic beauty and a willingness to commute longer distances in order to attain this;

3. The development and growth of the leisure industry in the area, including the establishment of ski slopes in the mid-60's, the opening of a resort hotel in 1971, and the development of a National Recreation Area in the nearby Delaware Water Gap. This growth in the recreation industry has produced jobs and stimulated economic growth, including such secondary effects as the construction of motels and roadside stands;

4. Construction of new roads, most importantly Interstate 80, which links the metropolitan area to Sussex County, and Route 15, which provides quick access from Interstate 80 directly to the Wallkill Valley. From an estimated population of 17,800 in 1950, the basin reached 22,000 in 1960 and 33,000 in 1970, a near-doubling in 20 years. About three quarters of the growth is attributable to in-migration, and the remainder to natural increase.

The growth in population means development of more and more land, and generation of increasing amounts of wastewaters, most of which are ultimately discharged into the waterways of the basin. In general, the pattern of development in the Wallkill Basin is of three types:

(1) The older towns, including Ogdensburg, Franklin, Hamburg, and Sussex, which have higher densities and contain residential, industrial, and commercial land uses;

(2) The clusters around the lakes, which are also of a high density, but are almost exclusively residential; and

(3) Suburban development, which is of a lower density, is found along the roads and in open areas, and consists of single-family subdivisions, trailor parks, and commercial and industrial uses. It is the latter type of development which exemplifies the recent growth in the Wallkill Basin and much of it has occurred in Sparta, Vernon and Wantage Townships.

Of the 134,000 acres of land in the Wallkill Basin, it is estimated that 31,000 are in residential uses, 9,000 in commercial and industrial, 11,000 in public and quasi-public, and the remaining 83,000 are woodland and fields. Although much of this remaining land is not suitable for development because of slope, soils or flood-prone characteristics, in terms of land resources alone, the Wallkill Basin could accommodate considerable growth. The desire and allowance for such growth, however, must be carefully balanced with the limitations of the environment to absorb increased growth. The indications are that the environment of the Wallkill Basin is particularly sensitive to urban growth.

SEGMENT 26 Wallkill River Basin

Data shows that the FW-3N waters of this segment have significant fecal coliform and phosphate levels which probably result from non-point sources which, as in many segments, have not received adequate attention.

Hazardous Material Spills and Fish Kills

A discussion of water quality and treatment plant discharges would be incomplete without a discussion of hazardous material spills and fish kills.

The numbers of oil and hazardous materials spills reported to the Department has increased steadily in the past four years:

	No.
1974	546
1973	493
1972	193
1971	53

A breakdown of the number of spills by product is shown in the following table A.

The gallonage of these spills is increasing over time and is reported as follows:

	Gallons	#with unknown gallonage
1974*	1,194,666 & 390 tons solids	79
1973	2,124,185	171
1972	1,813,895	61
1971	159,994	36

* Up to June 30, 1974

Table V

OIL AND HAZARDOUS MATERIAL SPILLS

NUMBER OF SPILLS BY PRODUCT

PRODUCT	1971	1972	1973	1974*
Gasoline	4	21	39	22
Kerosine	2	3	3	3
Aviation Fuel	1	4	3	0
#2	7	25	80	24
#4		15	14	6
#5		1	2	0
#6	7	35	63	26
Diesel	3	7	22	9
Motor Oil	2	9	8	8
Asphalt	1	3	10	3
Sludge	2	5	1	2
Miscellaneous Oil		22	119	47
Crude	1	7	26	13
Mineral Spirits		2	1	0
Miscellaneous Chemicals		12	45	14
Food Products			4	3
Unknown	19	22	13	27
Paint			6	2
Dye			2	4
Trash			1	1
Cement			1	0
Solvent			4	3
Petro Wax			2	0
JP-4			3	4
Asphalt Kerosene			2	0
Salt (NaCl)				1
J.P.5				1
Insulation				1
Sewage			1	
Polluted H_2O			1	
Formaldehyde			1	
Unknown				
	53	193	493	223

*To end of June 1974

Fish kills, usually the result of man's activities, have killed an estimated 4.9 million fish since 1960, when regular record keeping was begun. A breakdown b cause can be seen in the following table:

Table VI

FISH KILL SUMMARY BY SOURCE OF POLLUTION -- 1973

SOURCE OF POLLUTION	TOTAL REPORTS	REPORTED NO. OF REPORTS	FISH KILLED NO. OF FISH
Agricultural			
Insecticides	17	17	34,400
Fertilizers	1	1	250
Manure-Silage Drainage	1	1	200
Subtotal	19	19	34,850
Industrial			
Mining	2	1	1,000
Food Products	11	11	13,290
Paper Products	2	2	5,100
Chemicals	23	20	56,123
Petroleum	2	1	400
Metals	8	6	22,450
Combinations	3	3	6,050
Other	16	15	12,500
Subtotal	67	59	116,913
Municipal			
Sewerage Systems	29	23	69,000
Refuse Disposal	3	2	2,600
Water Systems	3	2	1,112
Swimming Pool	3	3	750
Power	6	5	1,847,450
Subtotal	44	35	1,920,912
Transportation			
Rail	1	1	4,650
Truck	16	15	14,600
Barge or Boat			
Pipeline	4	3	715
Subtotal	21	19	19,965
Other Operations:	44	41	2,023,310
Unknown	112	96	775,884
Total	307	269	4,891,834

As can be seen, the major single cause of fish kills are power plant effluents, cooling water, with municipal sewerage systems and industrial chemicals far behind, in second and third place.

TABLE VII

FISH KILLS REPORTED

Year	#with known cause	#with unknown cause
1970	29	12
1971	28	13
1972	22	8
1973	45	15

Hazardous material spills and fish kills are becoming an increasing problem in New Jersey. Since an ambient monitoring network requires samples to be taken with a minimum frequency of monthly,spills only have an 8% chance of being detected. Because of this, spills will not generally be reflected in the monitoring data, especially since past monitoring occured at quarterly intervals.

Because of increasing population and expanding development, combined with the State's need for more energy (power plants) these spills and fish kills cannot be expected to diminish. Based on past history, New Jersey can expect over 500 spills and almost 50 fish kills in 1975.

TABLE VIII

DISCHARGE FILE SUMMARY

Segment	1974 # Plants	In Compliance 1973	In Compliance 1974	Flow, MGD (Ave.) 1973	Flow, MGD (Ave.) 1974
Freshwater Passaic	120	28	30	53.119	52.051
Urban Passaic, Hackensack	40	6	6	161.983	156.502
Hudson River Upper N. Y. Bay	11	1	1	320.750	326.417
Arthur Kill	7	0	1	189.870	154.231
Arthur Kill Tribs.	5	1	1	333.313	331.153
Upstream Raritan	102	62	74	72.120	62.912
Lower Raritan	17	7	10	4.823	4.631
Raritan Bay	9	0	0	95.800	84.337
Raritan Bay Tribs.	29	8	10	11.603	10.970
North Atlantic Coastal Waters	45	16	3	37.071	37.768
North Atlantic Inland Waters	20	10	3	3.715	3.955
North Atlantic CW-2 Waters	3	2	3	11.400	11.900
South Atlantic Coastal Waters	28	5	3	39.864	41.323
South Atlantic Inland Waters	19	7	4	3.534	3.682
South Atlantic CW-2 Waters	0	0	0	0	0
Delaware Zone 5 Main	8	0	0	3.563	2.853
Delaware Zone 5 Tribs.	5	1	2	0.920	0.820
Delaware Zone 6 Main	0	0	0	0	0
Delaware Zone 6 Tribs.	13	2	0	6.952	7.072
Delaware Zone 3 & 4 Main	17	0	2	83.996	90.636
Delaware Zone 3 & 4 Tribs.	56	6	8	28.635	29.479
Delaware Zone 2 Main	20	5	9	32.049	30.116
Delaware Zone 2 Tribs.	44	8	7	55.114	31.839
Delaware Zone 1 Main	11	4	6	17.277	20.585
Delaware Zone 1 Tribs.	46	18	22	6.911	7.335
Wallkill River - All	19	8	4	0.458	0.575
TOTALS	688	185	187	1,574.84	1,503.14

DELAWARE RIVER BASIN COMMISSION 305b REPORT

DELAWARE RIVER MAIN STEM

Table of Contents

Water Quality Inventory

DELAWARE RIVER
Main Stem

(305(b) Report)

Introduction

Purpose and Scope

Section 305(b) of P.L. 92-500 requires submission of a water quality inventory, which includes a description of the current status of water quality, an assessment of water uses, the status and costs of point source pollution abatement, and the nature and extent of non-point sources of pollutants. This report addresses these issues for the main stem of the Delaware River, extending from the confluence of the East and West Branches at Hancock, New York to the mouth of Delaware Bay between Cape May, New Jersey and Cape Henlopen, Delaware.

Delaware River and Basin

The Delaware River (Figure 1) is an interstate river and it is an interstate boundary for its entire length: between New York and Pennsylvania in its upper reaches, then between pennsylvania and New Jersey, and between New Jersey and Delaware in its lower reaches. The Delaware River drains an area of 12,765 square miles encompassing parts of the four states of New York, Pennsylvania, New Jersey, and Delaware. It rises in the Catskill Mountains of New York and the Poconos of Pennsylvania and then flows for approximately 100 miles below Hancock through terrain that is generally mountainous, emerging through the Delaware Water Gap into more rolling open country. Eighty miles below, the river becomes tidal at Trenton, New Jersey and then it flows for 135 miles through the estuary and Delaware Bay to the Atlantic Ocean. About 7 million people live within the basin with the heaviest concentrations along the upper estuary encompassing the Trenton, New Jersey, Philadelphia, Pennsylvania, Camden, New Jersey, and Wilmington, Delaware metropolitan area. Lesser concentrations occur along the lower reaches of the Leghigh and Schuylkill Rivers, the two principal tributaries of the Delaware.

Water quality standards for the Delaware River provide for maintenance and propagation of fish and other aquatic life and primary contact recreation except for the cnetral portion of the Delaware Estuary. In that reach, approximately 50 miles in length, standards provide for maintenance of fish and other aquatic life and secondary contact recreation.

Segment Classifications

For purposes of water quality management, the Delaware River has been divided into six water quality zones (Figure 1). Zone 1 extends from Hancock, New York to the head of tide at Trenton, New Jersey. It, in turn, has been divided into five subzones, Zones 1A, 1B, 1C, 1D, and 1E. Zones 2 through 5 encompass the Delaware River Estuary from Trenton, New Jersey to the head of Delaware Bay at Liston Point, Delaware, and Zone 6 is Delaware Bay. Zones 1 and 6 are "effluent quality limited" segments, that is, minimum effluent requirements including secondary treatment for municipal wastes are sufficient to achieve and maintain water quality standards. Zones 2 through 5 are "water quality limited" segments where more stringent effluent limits are required, based on allocations of assimilative capacity, to achieve water quality standards.

Non-tidal Delaware River

The quality of the non-tidal Delaware River, which extends from Hancock, New York to Trenton, New Jersey, ranges from excellent to good and is suitable for all uses.

Dissolved Oxygen

Dissolved oxygen concentrations in the Delaware River in the vicinity of Hancock, New York, range from 8 to 14 mg/l. Figure 3 presents dissolved oxygen data obtained on the East and West Branches about a mile and a quarter upstream of their confluence. These values are representative of conditions in the upper reaches of the Delaware River. At Port Jervis (Figure 4) dissolved oxygen ranges from 8 to more than 12 mg/l.

In the reach from the Delaware Water Gap to Trenton, New Jersey(1), dissolved oxygen concentrations are generally at or near saturation with small depressions occurring in local areas, such as the Easton-Phillipsburg area. However, in the summer there are diurnal variations between 2 to 5 mg/l, which cause occasional early morning minimum dissolved oxygen concentrations less than 5 mg/l near Riegelsville and Trenton, New Jersey. Figure 5 summarizes dissolved oxygen data for July and August for the Delaware River at Trenton, New Jersey.

Fecal Coliform

Concentrations of bacterial indicator organisms are generally satisfactory. The one noteworthy exception is the reach downstream from the Easton-Phillipsburg area where loads, principally from the Lehigh River and two municipal treatment plants, contribute to high fecal coliform bacteria concentrations (1). Fecal coliform data obtained at Riegelsville, New Jersey (Figure 6), about 10 miles downstream from Easton, indicate that concentrations in a significant number of samples were in excess of 200/100 ml. At Trenton, New Jersey (Figure 7) concentrations greater than 200/100 ml occurred also, but less frequently than at Riegelsville.

Other Parameters

The concentration of total nitrogen at Port Jervis (Figure 8) ranges from 0.4 to about 1 mg/l, and from nearly zero to 3 mg/l at Trenton (Figure 9).

Concentrations of total phosphorus at Port Jervis (Figure 10) show a decreasing trend during the period 1971 to 1974. The concentration averaged 0.06 mg/l as P in 1971 and 0.02 mg/l during 1973-74. At Trenton (Figure 11) concentrations of total phosphorus generally remained constant over the past five years at about 0.01 to 0.02 mg/l.

Delaware River Estuary

The Delaware River Estuary extends from the head of tide at Trenton, New Jersey to Liston Point, Delaware (Figure 12). The quality of the estuary, particularly in the Philadelphia-Camden to Wilmington area, is seriously degraded as a result of inadequate treatment facilities for municipal and industrial waste discharges.

Dissolved Oxygen

Data on dissolved oxygen in samples obtained by boat during the period 1967 through 1974 at eight stations in the Delaware River Estuary are presented in Figures 13-20. At Fieldsboro (Figure 13) except in 1969, dissolved oxygen was always at or about 5 mg/l. At Bristol, (Figure 14) minimum dissolved oxygen levels during the critical summer period generally ranged from 3 and 4 mg/l. Similar values were observed at Toresdale (Figure 15).

At the Ben Franklin Bridge (Figure 16), Paulsboro (Figure 17) and Marcus Hook (Figure 18) stations, during the critical summer periods near zero values of dissolved oxygen were frequently evident. However, in 1972, 1973, and 1974, there was a marked shortening in the duration of critical low values of dissolved oxygen. There was also a small but noticeable increase in the minimum levels observed.

At New Castle (Figure 19), and Reedy Island (Figure 20), there was also a shortening of the duration of the period of low dissolved oxygen as well as moderate increases in the minimum values observed.

Overall, dissolved oxygen criteria continue not to be met in almost all of the Delaware River Estuary. However, over the period 1969 to 1974, there has been a significant decrease in the duration of low levels of dissolved oxygen and a small increase in the minimum values observed in the part of the estuary where the seasonal summer sag is most severe. This is believed due at least in part to the upgrading of waste management for a number of smaller discharges, particularly industrial facilities. There has also been improvement in the average dissolved oxygen during the anadromous fish migration seasons. This improvement has been accompanied by reports of greatly increased numbers of migrating shad.

Recent studies (1) seem to indicate that the less serious deterioration in quality which occurs from time to time in the vicinity of Bristol, Pennsylvania, may be influenced by the characteristics of the Delaware River entering the estuary at Trenton, New Jersey, related to aquatic plants and phytoplankton above Trenton.

Fecal Coliform

High fecal coliform concentrations continue to be observed throughout the estuary (Figures 21 through 28). These result from the discharge of municipal wastes without disinfection and overflows from combined sewers. Sharp increases in concentrations of fecal coliform in late 1973 and in 1974 at stations in the upper reaches of the estuary, particularly at Fieldsboro (Figure 21) and Bristol (Figure 22) are attributed to the illegal discharge of raw sludge by a municipality just at the upstream limit of the estuary which has since been abated.

Other Parameters

Concentrations of ammonia have changed very little during the period 1967 to 1974 (Figures 29 through 36), averaging about 0.5 mg/l as nitrogen in the upper reaches in Zone 2 and averaging about 1.0 mg/l in the central and lower reaches.

Concentrations of phosphate (See Figures 37 through 44) appear to have decreased significantly in recent years. In the late 1960's concentrations ranged from 0.5 mg/l to more than 2.0 mg/l as PO_4 while early in the 1970's concentrations appear to have averaged about 0.5 mg/l.

Delaware Bay

Water quality in the Delaware Bay is generally considered to be good. However, there are some problem areas.

Dissolved Oxygen

Dissolved oxygen data obtained at three stations in the upper reaches of Delaware Bay are presented in Figures 45 through 52. Most values obtained were 5 mg/l or greater, with an occasional value between 4 and 5 mg/l. However, a significantly lower concentration was observed at Ship Johns Light in September of 1974.

Total Coliform

Concentrations of total coliform in excess of levels permitted by water quality standards for shellfishing waters are observed regularly. Figure 53 presents total coliform data obtained near Ship Johns Light in the upper reaches of the Bay.

High coliform levels in and near shellfishing areas in the Delaware Bay area have resulted in these areas being condemned for the taking of shellfish. Areas which might be affected by waste outfalls have also been closed as a precautionary measure even though high coliform levels have not been observed. A map showing areas closed in 1973 and 1974 is presented in Figure 54. These do not include additional areas closed by the New Jersey Department of Environmental Protection on a seasonal basis from May 1 through October 31.

Water Pollution Control Programs

In the Delaware River Basin all waste sources must receive a minimum of secondary treatment prior to discharge to Basin waters. Where these levels of treatment are not sufficient to achieve and maintain water quality standards, more stringent treatment requirements can be imposed by the Commission, based on allocations of the capacity of the receiving waters to assimilate waste discharges. Currently minimum treatment levels are sufficient to meet water quality standards in the non-tidal Delaware River above Trenton and in the Delaware Bay.

Allocation Program

In the Delaware River Estuary, encompassing Zones 2, 3, 4, and 5, on allocation program is necessary in order to achieve and maintain studies (2) the assimilative capacity of each zone was determined. After setting aside a small reserve in each zone, the remaining capacity was apportioned among waste discharges in that zone based on the concept of equal waste reduction by all discharges in a zone. Allocations to individual discharges are made without regard to political boundaries but are based on the need of the discharger to dispose of wastewater after adequate treatment in relation to the similar needs of other discharges and the capacity of the receiving waters. In 1968, allocations were issued to approximately 90 waste dischargers to the Delaware Estuary.

Status of Abatement Program

In cooperation with the state pollution control agencies, each discharger receiving an allocation in 1968 was sent a pollution abatement order. As of May 1974, 15 industries and 14 municipalities had completed their facilities and were in conformance wth these orders. This represented over 30 percent of the number of discharges, but their total discharge was less than 7 percent of the permissible load, and therefore the estuary has shown little response. Early in 1975 two major facilities completed their abatement programs. One of these is the City of Wilmington, the first major municipal facility in the estuary to do so. The other is a major industry. These two facilities account for about 5 percent of the allocated total, so that the 31 facilities now in compliance account for about 12 percent of the permissible load.

Of the approximately 60 dischargers remaining, 16 are on schedule and could be in compliance toward the end of calendar year 1975. These represent about 13 percent of the total permissible load, and include several large industries in the chemical and petrochemical field. Three-quarters of the remaining 44 are municipalities, including Camden, New Jersey and the City of Philadelphia. These facilities may not be in compliance until 1980. The load imposed on the estuary by the City of Philadelphia is very large; the city has been given more than 40 percent of the assimilative capacity of the estuary. It is clear therefore, that the substantial improvements in dissolved oxygen levels needed for compliance with water quality standards is not anticipated until the end of this decade or possibly in the early 1980's.

Abatement Costs

Costs to construct wastewater management facilities needed to meet requirements are estimated to total $786,600,000. This includes $94,300,000 already spent on facilities which were started since 1969 and have been completed. The remaining $692,300,000 are for facilities either now under construction or being planned.

More than 85 percent of these costs, totaling $681,700,000, are for facilities in the Delaware River Estuary. The cost of facilities completed is less than 10 percent of this amount, leaving more than $600,000,000 in construction costs for facilities either underway or planned.

These cost data are presented in Figure 55. They were compiled from the Commissions's Project Review Docket files and from

EPA's 1974 Municiapl Needs Survey. They represent the costs of industrial waste management facilities, municipal treatment facilities, and interceptors necessary to implement regionalization.

Non-Point Sources and Other Problems

Non-tidal Delaware River

Studies (1) have indicated that in the non-tidal portion of the Delaware River, where stream quality generally meets or is better than water quality standards, the major pollution loads imposed on the river are from non-point sources. These results from natural as well as some man-made causes.

Delaware River Estuary

Previous studies (2) have indicated that 25 percent of the oxygen demand exerted in the Delaware Estuary is attributable to the background loads entering from tributaries, combined sewer overflows, and sludge deposits. The goals of the current abatement program can be attained without abatement of these loads, which are currently not subject to practical means of control.

Salinity

Within the tidal Delaware River, the intrusion of seawater has resulted in chloride levels which make the waters unacceptable for use as municipal supplies. This intrusion is due to the natural variations in tide, wind, and natural flow of freshwater. However, it can be controlled to some extent by augmenting low stream flows.

Overview

Where the Delaware River is currently of good quality, most pollution loads result from non-point sources. In the Delaware River Estuary, which is heavily polluted, both natural and man-made sources of non-point pollution are relatively minor and will not have an impact on achieving the dissolved oxygen goals of current abatement programs. As point sources of pollution in the estuary are upgraded, the relative effects of the non-point sources will become greater.

Summary and Conclusions

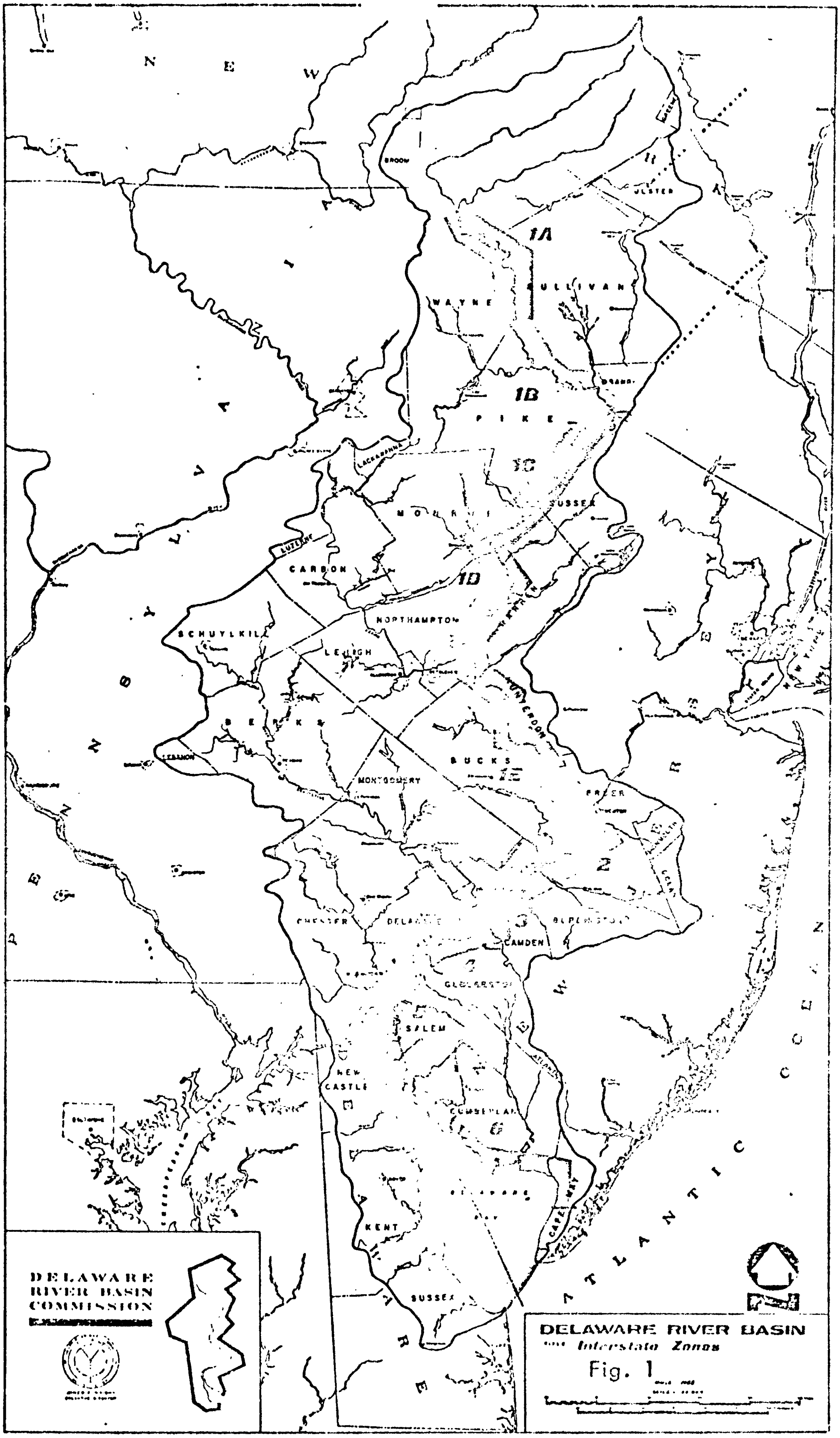
For most of its length, water quality of the main stem of the Delaware River ranges from good to excellent. However, water quality in the Delaware River Estuary is seriously degraded due to the impact of municipal and industrial waste discharges in the region encompassing the Trenton, Philadelphia, Camden, and Wilmington metropolitan areas. Current abatement programs are designed to upgrade the quality of this reach to meet water quality standards. Concurrently, it is necessary to continue programs to preserve and enhance the quality of the Delaware River where it is currently satisfactory.

While these efforts must be continued, recent studies have revealed several additional water quality problem areas. These include the impact of the quality of the LeHigh River on Zone 1, the occurrence of high fecal coliform concentrations in the Delaware River above Trenton, and occasional low dissolved oxygen levels in the upper reaches of Delaware Bay. These will be subject to continued investigation and study in the near future. Further, non-point sources of pollution will be receiving increased attention.

References

1. "Time Variable Water Quality Analyses and Related Studies of the Delaware River, Port Jervis to Trenton," prepared by Hydroscience, Inc., for the Delaware River Basin Commission (Jan. 1975).

2. Wright, J.F., and Porges, R., "Water Quality Planning and Management Experiences of the Delaware River Basin Commission", Proc. Fifth Intl. Conf. on Water Poll. Res., San Francisco, Calif. (1970).


DELAWARE RIVER BASIN COMMISSION
DELAWARE RIVER BASIN
Interstate Zones
Fig. 1
ATLANTIC OCEAN
1A
1B
1C
1D
1E
2
3
4
5
6
WAYNE
SULLIVAN
PIKE
MONROE
SUSSEX
CARBON
LUZERNE
LACKAWANNA
NORTHAMPTON
SCHUYLKILL
LEHIGH
BERKS
LEBANON
BUCKS
MONTGOMERY
HUNTERDON
CHESTER
DELAWARE
CAMDEN
GLOUCESTER
SALEM
NEW CASTLE
CUMBERLAND
KENT
SUSSEX
CAPE MAY
ULSTER
BROOME

INTERSTATE SANITATION COMMISSION

305(b) REPORT

ARTHUR KILL - NEW YORK BAY

RARITAN BAY

I. Introduction

New Jersey surface waters located within the New Jersey-New York Metropolitan Area form part of the jurisdiction of the Interstate Sanitation Commission.

The Commission's programs for the improvement of these waters in conjunction with the States include the following:

(1) establishment and attainment of minimum dissolved oxygen requirements for all surface waters;

(2) establishment of necessary pollutant removals for discharges into District waters;

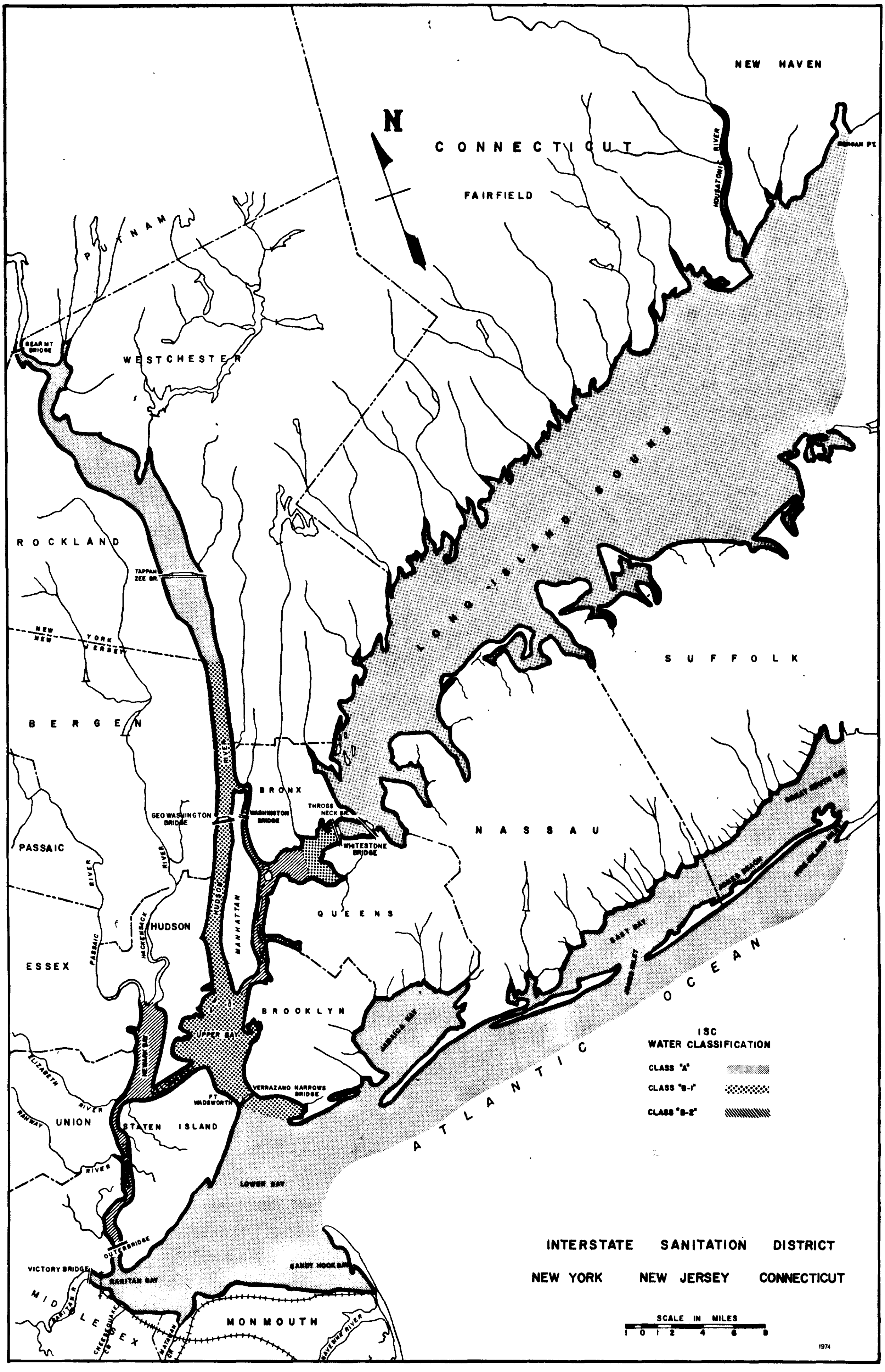
(3) monitoring of surface waters by the analysis of samples obtained from continuous automatic sampling stations and regularly scheduled boat surveys;

(4) routine sampling and analysis of municipal and industrial dischargers in order to determine whether Compact requirements are being met; and

(5) assistance to the States and the U.S. EPA for NPDES compliance monitoring.

The waters described in this report and shown on the map on the following page are:

ISC Class A Waters-N.J. TW1 Waters:	Sandy Hook Bay Raritan River Raritan Bay
ISC Class B-1 Waters-N.J. TW2 Waters:	Hudson River Upper New York Bay Arthur Kill South of the Outerbridge Crossing
ISC Class B-2 Waters-N.J. TW3 Waters:	Kill Van Kull Newark Bay Arthur Kill North of the Outerbridge Crossing


NEW HAVEN
CONNECTICUT
FAIRFIELD
N
PUTNAM
WESTCHESTER
ROCKLAND
BERGEN
PASSAIC
HUDSON
ESSEX
UNION
STATEN ISLAND
BRONX
MANHATTAN
QUEENS
BROOKLYN
NASSAU
SUFFOLK
MONMOUTH
LONG ISLAND SOUND
HUDSON RIVER
HOUSATONIC RIVER
TAPPAN ZEE BR.
GEO WASHINGTON BRIDGE
WASHINGTON BRIDGE
THROGS NECK BR.
WHITESTONE BRIDGE
VERRAZANO NARROWS BRIDGE
FT WADSWORTH
UPPER BAY
LOWER BAY
RARITAN BAY
SANDY HOOK BAY
JAMAICA BAY
EAST BAY
GREAT SOUTH BAY
ATLANTIC OCEAN
OUTERBRIDGE
VICTORY BRIDGE
ISC
WATER CLASSIFICATION
CLASS "A"
CLASS "B-1"
CLASS "B-2"
INTERSTATE SANITATION DISTRICT
NEW YORK NEW JERSEY CONNECTICUT
SCALE IN MILES
0 1 2 4 6 8
1974

The water classes and uses desribed below were promulgated by the Interstate Sanitation Commission and are compatible with New Jersey's classifications and uses.

Class A Waters - Suitable for primary contact recreation and in designated areas for shellfish harvesting.

Class B-1 Waters - Suitable for fishing and secondary contact recreation.

Class B-2 Waters - Suitable for fish survival, passage of anadramous fish and for any other reasonable purposes compatible with their use for navigation.

II. Extent of Water Pollution

The condition of the waters of this area varies from good to poor. Primary municipal treatment plants that provide inadequate pollutant removals, combined sewers that pour raw sewage into the waterways during heavy rainfalls, and large concentrations of both heavy metals and oil from inadequately treated municipal and industrial discharges all combine to degrade the quality of the District's waters.

The table on the following page gives a summary of raw and treated sewage discharging into the Interstate Sanitation District from New Jersey municipal treatment plants. The table shows that all raw discharges have been eliminated. Furthermore, although only 38 million gallons per day (6.8%) of the total discharge of 558 MGD currently receives secondary treatment, all remaining primary plants are in some stage of upgrading to secondary treatment.

The evaluation of the water quality has been determined from the following and is discussed after the data presentation.

(1) Graphs of the seasonal variation of dissolved oxygen, temperature, pH, and conductivity derived from three ISC remote automatic water quality monitors located within New Jersey waters.

(2) Pollutant parameters such as dissolved oxygen, heavy metals, nutrients, temperature, etc., derived from the analysis of samples obtained from ISC boat runs "A" and "B".

SUMMARY OF RAW AND TREATED SEWAGE
DISCHARGING INTO THE
INTERSTATE SANITATION DISTRICT WATERS
FROM NEW JERSEY PLANTS

Year	Population Served	Raw	Screening, Imhoff & Septic Tank	Primary	Secondary	Total Treated	Total Sewage
1936	1,526,000	89	2	146	0	148	237
1954	2,280,000	62	.6	258	0	259	321
1959	2,821,000	0	0	394	0	394	394
1969	4,639,000	0	0	517	0	517	517
1974	4,713,000	0	0	520	38	558	558

NOTE: ALL FLOWS ARE MILLION GALLONS PER DAY.

The boat survey data is obtained once per month in the winter and twice per month in the summer. The parameters measured and their frequency are being designed to follow the guidelines as recently suggested in the Federal Register.

The effects of the pollutant contributions are especially pronouned during the summer months when coliform levels are high and dissolved oxygen concentrations are low.

An example of this effect of the various pollutant loadings in the condition of the Arthur Kill. Dissolved oxygen levels contained in this industrially laden waterway often drop to zero during the summer and average less than 1 mg/l for several months at a time. The Arthur Kill is an ISC B-2 and N.J. TW-3 waterway and as such requires a minimum dissolved oxygen concentration of 3 parts per millio Aggravating these conditions are thermal discharges from power plants and industries that usually raise the Kill's water temperature to approximately 85°F or more during the summer, thereby thermally overloading the waterway. This temperatu increase accelerates the rate of oxygen uptake by bacteria and further depletes the maximum concentration that can be utilized to stabilize the continuous influx c organic matter.

The Raritan River (mouth), on the other hand, is a Class A waterway and although it is superior in quality to the Arthur Kill, the same general conditions affect it but to a lesser degree. This is primarily due to the better exchange of its water with that of the Atlantic Ocean. Here, as in the Kill, the progression of the summer months sees continuously rising temperatures accompanied by a corresponding drop in oxygen levels.

The dissolved oxygen of Raritan Bay-Sandy Hook Bay falls below 3 parts per million in the extreme western portion and recovers to the required minimum of 5 parts only with the onset of cold winter weather.

In conclusion, it can be stated that regardless of the specific water classification, during the summer months, conditions worsen in many areas to the point where minimum required dissolved oxygen levels are not attained. This situation along with increased coliform levels render many of the waters unsuitable for their intended uses.

The data presented above is for the most part from 1974. A review of representative data available from previous years indicates that no appreciable changes have occurred in the receiving waters during this time. This is not surprising since with only a few exceptions, no large scale municipal or industrial waste treatment plants have yet been completed to treat effluents discharging into these waters and until these plants are completed (estimated to be yb 1981), no appreciable improvement should be expected.

III. CURRENT WATER USES

III. Current Water Uses and Conditions

Uses

Sandy Hook Bay

(1) navigation
(2) primary contact recreation
(3) fishing
(4) passage of anadramous fish

Raritan River/Raritan Bay

(1) navigation
(2) passage of anadramous fish
(3) fishing
(4) secondary contact recreation
(5) primary contact recreation in certain areas

Hudson River

(1) navigation
(2) secondary contact recreation
(3) fishing
(4) passage of anadramous fish

Upper New York Bay

(1) navigation
(2) secondary contact recreation
(3) fishing
(4) passage of anadramous fish

Kill Van Kull

(1) navigation
(2) passage of anadramous fish

Newark Bay

(1) navigation
(2) passage of anadramous fish

Arthur Kill

(1) navigation
(2) passage of anadramous fish

Conditions

The averages given on the following tables are obtained from boat survey sampling stations (expcet for pH which is from remote monitors) within the waterway. Use of these waterway averages should be approached with extreme caution because of the large range of the data at each station and also because of the variation from station to station, and the relatively few values that comprise the average.

An example of the possible misleading nature of this information is readily seen when reviewing the Arthur Kill data. The dissolved oxygen level for the summer of 1974 obtained from the continuous monitor located at Con Edison averaged approximately 0.4 mg/l with many values dropping as low as 0 mg/l.

The boat survey data (derived from 3 data values), on the other hand, at point AK 7 (essentially the same location as the monitor) indicates the average of these values to be 1.2 mg/l. The error is further compounded when the four boat sampling stations for the Arthur Kill are averaged to yield a mean dissolved oxygen level for the summer of 2.4 mg/l.

Thus, it can be seen that averaging can be very misleading and obscure the problem.

IV. Future Uses of the Waters

The future uses of the waters will more nearly approach their classifications compared to today's uses. Although secondary treatment of municipal sewage will eventually replace the current level of primary treatment, its effectiveness may be overshadowed by the following factors:

(1) Combined sewers will still discharge untreated sewage into the waters during heavy rains.

(2) If stringent pretreatment standards are not adopted and strictly enforced, large amounts of oils and heavy metals from industrial users will still be discharged into the receiving waters.

(3) The heavy concentration of both population and industry along certain narrow, confined waterways such as the Arthur Kill and Kill Van Kull contribute such large quantities of waste that even when secondary treatment is completed only 3 mg/l of dissolved oxygen will be achieved in B-2 (TW3) waters.

Secondary treatment, adequate pretreatment, and Best Practical Treatment Technology, if universally applied, should render such stretches of water as Lower Bay, Raritan Bay, and Sandy Hook Bay more suitable for fishing and swimming. Another means for opening up miles of beaches would be to build short dikes out from Ft. Wadsworth, Staten Island, and Nortons Point, Brooklyn, to divert the flow from New Jersey and New York treatment plants through The Narrows away from beaches more nearly straight-out-to-sea. However, no practical amount of treatment technology will improve the Arthur Kill, Kill Van Kull, and Newark Bay to the point where these waters will be able to be raised to 4 or 5 mg/l of dissolved oxygen.

V. Control Actions and Costs

Although many of the waters of this District will never be able to be used for swimming, it is essential to stem the tide of any further deterioration in their quality. As the population and industrial capacity of this region continue to grow, the surrounding waters will be required to meet the increased demands placed upon them. The ability of many of the waters to assimilate waste material and thermal discharges has already been exceeded for a considerable portion of the year.

However, the planning and construction of secondary treatment plants throughout the region and the universal application of Best Practical Treatment Technology to industrial discharges constitute a program capable of rendering the District waterways aesthetically appealing and viable for both public and commercial users. It must be kept in mind, however, that much of the effectiveness of both secondary treatment and BPT Technology will be negated unless a conscientious effort is directed toward abating the following forms of pollution:

(1) combined sewers
(2) heavy metals
(3) sludge
(4) oily wastes

(1) Combined Sewers - Very little advantage will be gained by having secondary treatment plants exist alongside uncontrolled combined sewers. Whereas the treatment plant will provide a high degree of pollutant removal, and discharge an effluent

with minimal bacterial contamination, heavy rains will cause regulators to bypass raw sewage and industrial wastes directly into the waterways. The heavy flows that occur during rainfall scour the sewers and carry off vast quantities of solids, heavy metals, and oils that have settled out in the conduits during dry weather. Since these wastes receive no treatment whatsoever, their bacterial count is high and this tends to negate the chlorine usage on the part of the waste treatment plant.

It is therefore quite obvious that even though secondary treatment represents a major step forward in pollution abatement, the existence of combined sewers prevents it from being as effective as it should be. Mitigation of the effects of combined sewers may well reach into the billions of dollars.

(2) Heavy Metals - Heavy metals represent a particularly toxic group of elements that are discharged in large concentrations by many industries. Their effectiveness in causing pollution is twofold.

During dry weather, much of the metal content of an industrial waste never reaches a treatment plant because the metals simply settle out of solution and increase in concentration. During heavy rains, they are scoured from the sewer where they were deposited and are swept directly into a watercourse. On the other hand, those metals that reach the treatment plant are only minimally removed and also lower biological treatment efficiency.

If these problems associated with heavy metals are to be avoided, a systematic program of pretreatment of industrial wastes must be adopted. By calling upon industry to remove the metallic content of their wastes prior to discharging them into a municipal sewer, the problem can be eliminated at the source.

(3) Sludge - As treatment plant efficiencies increase and secondary treatment plants come on-stream, ever greater quantities of solids will result from wastewater treatment. It is estimated that the sludge volume will triple. Because of the concentration of treatment plants in the New Jersey-New York Metropolitan Area, the amount of this sludge that must be disposed of daily has already reached large proportions.

Recognizing a need to deal with this problem, the Interstate Sanitation Commission, in coordination with the States, is now conducting a sludge management program, the results of which will suggest viable and effective measures to deal with the tons of sludge created daily by treatment plants in the New Jersey-New York Metropolitan Area.

4) Oily Wastes - Because of its location and concentration of population, the Northeast region of the United States has an enormous need for petroleum products, especially heating oils and gasoline. As a result of this, the area is the scene of an extensive concentration of oil refineries, oil terminals, and a product transportation system that includes ships, trucks, and trains. Because of the need to handle both crude and refined products on so vast a scale, the opportunities for loss are significant; and the petroleum products that find their way into the receiving waterways of the District contribute a substantial pollutant load.

In order to restore the quality of the waterways, all inadequately treated oil laden wastes must be eliminated. For this reason, the State of New Jersey and the Interstate Sanitation Commission have adopted effluent requirements of no more than 1 mg/l of oil. The costs to reach this requirement are modest.

Let's protect our earth

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION