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MUNICIPAL FINANCING OF WATER PROJECTS

FOR NORTHEASTERN NEW JERSEY

by

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INTRODUCTION

This dissertation is concerned with the financial aspects of investments for water supply systems. Rather than attempting theoretical generalizations, a case study is made for the municipalities of northern New Jersey. The present water supply system serving these communities poses serious economic, social and political problems due to the near exhaustion of its present capacity and/or functional abilities. The occurrence of droughts in the recent past and of pollution of the water sources -- permanently and in various forms -- have added to the present supply difficulties.

Several water supply projects, such as the Spruce Run - Round Valley reservoirs and the Tocks Island development on the Delaware River, will be completed and functioning by the year 1980. There remain, however, numerous unknowns.

One of the most crucial unknown factors at the present time is the future public investment volume. Likewise unprojected is the financial commitment of the municipalities for water supply projects in the northeastern counties during the years from 1980 to 2000. However, the problems are not solely related to the difference in the time period in the future.

The problems are, in fact, whether it is possible to devise a systematic analysis to establish the future financial burden and the concomitant future financial commitment of a specific localized body politique.

To establish such financial requirements a step-by-step procedure is needed. Hence, first, the total water requirements will be determined by the use of population and per capita consumption projections. These will serve as an index for the economic and social benefits and thus provide the economic justification for the projected public investment. Secondly, a projection of available water resources will be made, analyzing several projects which are considered for construction in the study area. These projects are designed to close the "gap" between use and availability during the 1980-2000 time period. The final step of the analysis will be the conversion of the technical data as they relate to the facilities and system components into financial data to arrive at capital outlay values.

In this dissertation, only the aggregate financial requirements will be established. In the process of establishing these requirements, specific relationships will be developed and discussed which would allow a subdivision of the totals so as to attribute them to local or regional areas.

Reports, articles and studies have indicated that the future trend is for state and local governments to assume an increasingly larger share of the total government activity. This may be partially reflected in the need for larger financial burdens and capital expenditures for the basic local governmental services. The water supply systems are one of these basic services performed by municipally-owned utilities in the case studied for nothern New Jersey. However, it is precisely with regard to these functions in recent years that Federal and state activities and programs have become

more important. Therefore, the interrelated multi-level form of financing has to be considered to determine the residual of the financial burden for the communities. In other words, the financial requirements for the municipalities are not solely determined by the technological and economic data of the future project, but also by the specific forms utilized in multi-level finance. Thus, this dissertation will include an analysis of the effects of the interaction of Federal, state and local financing programs in the specified area of public investment.

CHAPTER I

ASSUMPTIONS AND LIMITATIONS OF THE ANALYSIS

SUMMARY: This chapter will discuss the characteristics of water supply systems and the problems pertinent to northeastern New Jersey. It will also cover the assumptions and limitations of the analysis.

1.1 Research Approach

The major effort of this research project is the determination of the financial impact that may be imposed on the municipalities of northern New Jersey due to the construction of new water supply facilities. The study area encompasses the New Jersey counties of Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset, and Union. These eight counties are the New Jersey portion of the New York-New Jersey Standard Consolidated Area defined by the United States Bureau of the Budget and used by the Bureau of the Census and other agencies for statistical gathering purposes.[1] The first objective is to determine the physical quantities of water required for residential, commercial and industrial use during the next thirty years. It will then be necessary to determine the yield from ground and surface sources available at the present time in the study area. The yield is defined as that amount of water available from all resources at the present time rather than the amount or quantity of

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[1] U. S. Bureau of the Census, U. S. Census of Population: 1960. Vol. I, Characteristics of the Population, Part 34, New York (Washington: U. S. Government Printing Office, 1963), p. XIX.

water consumed at the present time.

1.1.2 Water Supply Systems

This section presents a summary of water systems as a background to the discussion of economic factors. There must be a source of water; whether the source is acceptable by chemical or health standards is another issue in the process of obtaining water. The source is represented in various forms: (1) Surface waters which are evidenced by rivers, streams and lakes; and (2) Ground waters which are underground storage areas and streams. Both these sources are available in their natural state and are added to or depleted by the cyclical behavior of a geophysical character. This includes climate, precipitation, and ground formation.

Once the source has been identified, the next problem is the transmission of the water to the area of use. This usually requires some network of water lines and the necessary pumping equipment and facilities that may be needed to effect the transmission. After the main transmission to an area has occurred, the need is then for a finer distribution or grid of water lines and mains to the individual users. In addition to this basic pattern of water supply, the necessary operations of purification and storage are required. The purification process may be extensive or rather limited, depending upon the condition of the water resources and the transmission environment. The storage requirements may be of a large capacity to technically and economically serve a large area as well as smaller type storage units for municipalities.

1.2 ASSUMPTIONS OF THE ANALYSIS

1.2.1 Projections

The analysis will be based upon population projections with the explicit notion that water supply requirements depend principally upon the number of future inhabitants of a region. Regions are to be under-

stood as including municipalities or areas. For convenience, per capita water consumption will be related to population projections. This does not mean that for any given number in the population the same water consumption quotient will result. Such a procedure should allow for a number of economic variables which are otherwise explicitly introduced into the water requirement function.

This definition allows to account for various other factors, such as those stressed by a study conducted in the San Francisco-Oakland area. The study concluded:

> . . . . that in the San Francisco-Oakland Metropolitan area there is a significant positive relationship between family income and residential water purchases both cross sectionally and overtime. This finding leads to the conclusion that family income is an important variable in the projection of future water demand in this area.[2]

Defining the quotient of per capita consumption as

$$w = \frac{W}{N}$$

where W = total water use over the region
N = population of the region,

it varies according to the projections of N over the region. The analysis will use the population projections of several sources in order to include the specific variables employed in each series.

In the analysis, the population series are employed for each five-year interval of the 1980-2000 study period. As an added safety factor for the estimated future water requirements, a ten per cent increment will be added to that series which has the highest value for the particular five-year interval.

1.2.2 Surface Water Development

Together with the population assumption, the other prime considera-

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[2] J. C. Headley, "The Relation of Family Income and Use of Water for Residential and Commercial Purposes in the San Francisco-Oakland Metropolitan Area," Land Economics, XXXIX (November, 1963), p. 448.

tion of the analysis is that future development of water resource projects will be predicated upon the expansion of surface rather than ground water developments. In New Jersey, the geographical area is divided into five ground water supply regions as shown in Figure I-1. The two provinces most directly concerned with this study are the Highlands and the Piedmont Plain. The Highlands Region has a ground water yield of only twenty to fifty gallons per minute and geologically is not suited for producing water supplies to support residential or industrial growth. The Piedmont Plain has a yield three to five times greater than the Highlands area, or has its ground water sources developed to a substantial degree. This area is the densely populated and industrialized northeastern region of the state. An analysis performed by the State of New Jersey indicates that the preponderance of industrial establishments such as printing and publishing, pulp and paper products, chemicals and other industrial categories are located in the northeast.[3] The counties of Bergen, Essex, Hudson and Union are those with a large concentration of industry. Additionally, the 1960 Census reports show that approximately two-thirds of the population of New Jersey are concentrated in the study area.[4]

The Inner Coastal Plain has a much greater yield than either of the two described regions. However, in the northern regions, a great deal of its potential of ground water supplies has been utilized and the major developments in this Plain will be in its southern areas.

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[3]State of New Jersey, Supply and Demand Factors of Industrial Land Use (Trenton, Department of Conservation and Economic Development, 1763), p. 44-77.

[4]U. S. Bureau of the Census, op. cit.

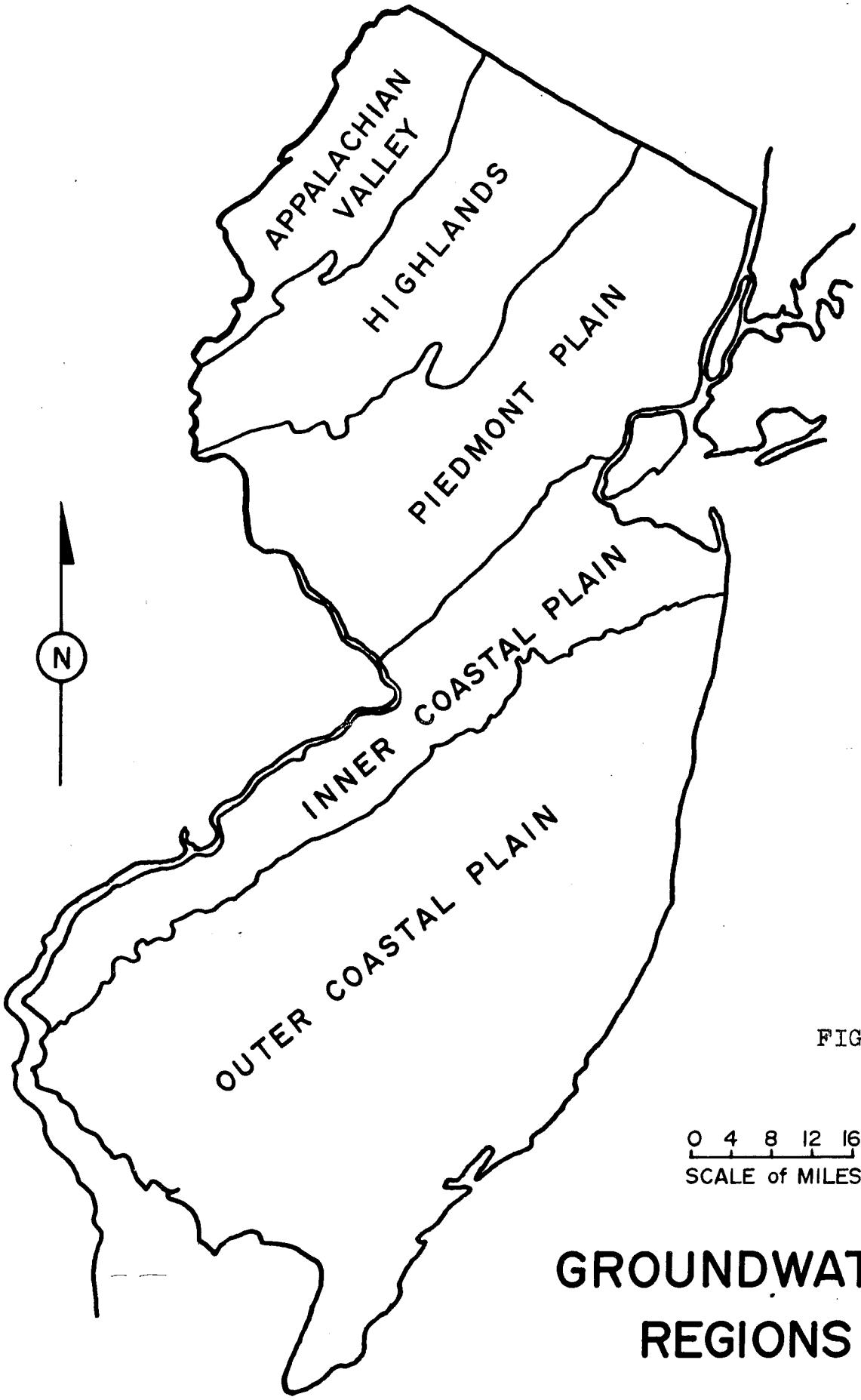

FIG. I-I

GROUNDWATER REGIONS

The reason for discussing the ground and surface water developments is that the required water systems would be drastically altered if there were large ground water supplies and consequently no storage requirements. The water could be pumped from areas of easy access and control to the areas of use. The cost of land acquisition and the necessary conditions of preparation of large areas of land for reservoir purposes, together with the political and social problems inherent in this type of an operation, could be avoided. Moreover, the cost of transmission and treatment would be greatly affected compared to requirements for surface water yields. In a report issued by the State of New Jersey, this particular point is also noted of most projects and expansions utilizing surface rather than ground water sources.[5]

1.2.3 Technology

Turning to the technology of water resource development, the assumption will be that the existing input-output relationships will be unchanged. In other words, no technological changes are expected or incorporated into the forecasts. This refers specifically to the equipments of pumps, motors and auxiliary equipments and the methods of construction used for water system components. While this constancy is applied to the supply side of the development picture, it must also be applied to the use or requirement side of water resources. Of particular interest are the demand requirements of industrial users as greater burdens are placed upon municipal supply facilities. While a large percentage of industrial water requirements is not used for process purposes but rather for cooling and washing procedures where pure potable water is not needed, the increasing use of water in this sector, due to population growth and new techniques of production, would indicate

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[5] State of New Jersey, New Jersey's Water Resources (Trenton, Department of Conservation and Economic Development, 1964), p. 40.

increasing demand requirements. However, as pointed out by Walter Picton, this increased need will be met by developing conservation practices and the increase of re-use water. For example, Billings states the important advances due to technology accomplished in the pulp and paper industry: "New mills use between 1/3 to 1/2 as much water per ton of pulp as the long established mills and we fully expect to reduce this further - considerably further - as technology advances."[7] Thus in effect, the technological impacts are assumed to cancel each other out leaving a net growth effect of population as the important element for consideration. These technological factors will bring about greater efficiencies of operation of the existing equipments. There will be re-design of operational equipments rather than the use of innovations.

1.2.4 Water Use

Viewing technology from another viewpoint, one must consider its implications upon the residential-commercial sector of the economy and the consequent demands upon the water facilities. For the northern New Jersey area, use of water due to technological innovations will be considered to be minimal with the major portion of increased use in water resources having taken place in the period from 1940-1970 when such items as car washes, water air-conditioning units were first introduced. During the period for this study, the 1980-2000 period, the increased use will be considered as following a decreasing rate of water resource requirement. The changes in these rates are discussed in the second

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[6] Walter Picton, Water Use in the United States, 1900-1980 Water and Sewerage Industry and Utilities Division, Business and Defense Services Administration, Department of Commerce, (Washington: U. S. Government Printing Office, 1960)

[7] R. M. Billings, "Cooperation Between Industry and the State in the Stream Improvement Program," Tappi, Vol. 45, No. 5 (May, 1962), p. 210A.

chapter of this thesis, in the Per Capita Water Use Projections section. Although appreciable growth will occur in most of the eight county areas in northern New Jersey during the study time period, it is assumed that the per capita consumption of water for the residential-commercial sector will increase slightly due to technological innovations in this sector.

Social custom and mores will be considered as a constant element in per capita consumption. For example, although changes in hygienic practices have produced radical changes in water consumption patterns in the past, occurrences of this type are of a long term nature. Since the study period is only twenty years in duration, the assumption of constancy in customs is justifiable.

1.2.5 Intergovernmental Aspects

One important area that will be explored in this study is the effects of Federal intergovernmental aid and the programs and policies inherent in the legislation that have been enacted by Congress and are in the process of implementation by various governmental agencies. Likewise, the programs and legislation enacted at the State level are beginning to have an important effect in the area of water resource development. As regards the time factor, most of these activities, both at the Federal and State level are in the beginning phases of specific project implementations. Therefore, the consequences of these activities have not as yet been fully developed. The future may bring important changes in some of the legislation with the role of either the Federal, State or local governments significantly altered from their present pursuits. Yet, it is precisely within the framework of this embryonic and developing activity that this analysis must be performed. Nevertheless, there is no justifiable expedient open other than to

pursue the analysis from a static viewpoint as regards the effects and results of the legislation and programs in force at the present time. This assumption could be true of most analyses. However, in view of the great deal of legislative activity dealing directly and indirectly with the water resource problem at all levels of governmental authority, some of the major activities could be either enlarged or discontinued within a short period of time. Where it is deemed appropriate, these possible occurrences will be elaborated upon in order to demonstrate their effects upon the presently existing framework of governmental aid and activity. The economic factors and the principles of public finance are the principal objectives of the analysis.

1.2.6 Distribution

An important element of a water supply system is the "grid" which is the network of mains and service lines to the individual users of water. The grid also is one of the most costly elements of a supply system entailing large capital expenditures. However, at the present time in northeastern New Jersey, new or additional mains and services are provided by either the builder or developer of a new residential or commercial area or by the individual property owner. In the instance of a land development, the builder includes this cost into the price established for the house or factory. As regards the individual property owner, the cost is borne solely by himself. Any municipality has the power, by statute[8] to issue assessment bonds for the installation of municipal services. The debt burden and servicing is laid upon the property owners served by the new or additional improvements. It does

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[8] See Appendix A.

not become a general municipal obligation.

Therefore, the analysis will not include a cost analysis of this portion of a water supply system. This assumption also does not include those special instances where municipalities, in order to promote their growth and development and to attract, for example, more industry, do undertake or subsidize projects which provide the necessary components of the grid.

1.3 LIMITATIONS OF THE ANALYSIS

1.3.1 Private Water Utilities

The water supply system existing in northeastern New Jersey is a composition of several different types of organizational entities of both public and private ownership.[9] In this geographical location, there are several large privately owned water companies which supply significant quantities of water to the area. These same companies, however, are subject to different statutory requirements and are regulated by the Public Utilities Commission of the State.[10] In this respect, the problems and programs associated with their development, management and operation are quite different from the same functional requirements faced by their municipal counterparts. However, due to their contribution of major quantities of water, the analysis will have to be cognizant of the extent to which these companies are capable to meet future demands placed upon their existing or contemplated facilities. Thus, the financial burden, as to levels of local public funds that are allocated for water supply projects, may be altered from their historical trends. It is evident

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[9]The commonly called "public utilities" are usually a mixture of both municipally organized departments within the local government as compared to those privately owned and managed investor owned utilities.

[10]The statutory requirements are discussed in Appendix A.

that due to the scope and complexity of the future problems associated with the financing and development of the private utilities, an entirely different analysis would be required to determine the capability of these entities. In order to resolve the impact of private participation upon the municipal burden, the technique which will be employed is the use of a range of alternatives. The basic assumption will be that the activities of the private companies will either follow their traditional patterns or some course between this level and a lower level of participation. In other words, the private utilities will not increase their percentage of water supply in northeastern New Jersey and will probably take a declining role in resource development. The reasons for this conclusion are predicated upon the increasing degree of Federal and State involvement in this area. The implications of this activity will be discussed in Chapter V. The analysis will be a discussion of municipal publicly operated utilities with the role of the private utility accounted for by alternative situations.

1.3.2 Data

The analyses performed in this paper will be dependent upon, in part, on disaggregated data. In the process of disaggregation, the analysis will be limited to the average values arrived at for the study area. This introduces a bias that in some instances can be accounted for by specific information on the study area. However, in some cases, this can not be validly accomplished as specific information concerning the study area is lacking.

Two instances of this problem are to be found in Chapter II, dealing with population, and in Chapter III, the analysis of land costs. The population data were disaggregated for the particular counties since

the information was available. In the case of the land costs, there are no residential or industrial land indices and average values were the only ones available.

1.3.3 Components for Water Systems

The analysis is limited to the static or present technological developments in the field of water supply systems. It is based on the concept that there will be no significant changes in the manner of storage, transmission and construction of water supply elements. As this study will discuss the time period to the year 2000, it can now be envisaged that nuclear methods for desalination may become an important water supply alternative. However, the art of desalination is changing rapidly. Thus, forecasting or ascertaining the characteristics of this type of project is a speculative undertaking at the present time. As for the present water systems, the storage and transmission elements are physically bound to constraints that appear to be difficult to alter significantly. The elements of pumping and purification may be changed by technological advances.

1.3.4 Bond Markets

The financing capability of municipalities will not take into consideration the ease or difficulty of the units in disposing of their bond issues. The limitations imposed upon this restriction will be resolved by the use of alternative interest rates. In a sense, there will be some interest rate to which the bonds will be subscribed. The effect will be to change the interest charges which may fluctuate. Therefore, the time of actual financing is the important consideration. Interest rates of specific values will be selected, and the analysis will be limited to the use of these rates for the time period to the year 2000.

This will preclude the complications that may enter an analysis which would be subjected to re-financing possibilities.

I.3.5 Relative Prices

The analyses performed in the dissertation will not consider factors which would change the ratio between user charges and cost elements. Thus, the assumption is made that for the study time period there will be no significant change in the price ratios as they prevail now. Consequently, it will be assumed that the direct price and income elasticity for water will also not be significantly different. The family income relationship to water consumption was discussed in section 1.2.1, Projections. However, prices depend upon specific government policies. This contingency upon fiscal policy actions may invalidate the assumption. By the same token, it is not possible to predict what actual future fiscal programs may affect water prices. It is only possible to conjecture the impact under specific hypotheses, as will be discussed in section V.5.4, Rate Structures.

The assumption of the stability of relative prices does not imply that the diversity of water rates [11] which presently exists will necessarily prevail in the future.

11. Public Service Research, American Directory of Water Utilities, Volume II, (Plainfield, Public Service Research, 1968).

CHAPTER II

PROJECTED USE AND AVAILABILITY ANALYSIS

SUMMARY: An analysis is performed of the projected use of water resources by the residential, commercial and industrial sectors of the economy in Northeastern New Jersey during the 1980-2000 time period. Similarly, the availability of water resources for the same area and time period is analyzed. The results are summarized in a graphical solution depicting the time when water resources will be depleted using present technology.

II.1 Population Projects

Any study undertaken to develop projections for future requirements of consumption items in general, and water in particular, must consider the population data for the particular area or region. The task becomes exceedingly difficult, when one attempts to project requirements well into the future, such as this study intends to do by advancing to the year 2000. The first approach to the problem was to survey the projected data that had been published by several agencies. These will now be discussed briefly.

II.1.1 New Jersey Department of Conservation and Economic Development Projections

This series of population projections[1] was estimated for each of the counties in the State of New Jersey and was calculated in five year

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[1]Research and Statistics Section, "Estimated Population Projections" Division of Economic Development, New Jersey Department of Conservation and Economic Development, Trenton, New Jersey, 1967.

intervals from 1965 to 2000. The work was performed by the Research and Statistics Section of the above-mentioned department and was issued as a single document. An inquiry was made as to the elements combined in the estimated figures. It was determined that the Census Bureau data formed the basic source of the estimation procedure with variations provided by a knowledge of county conditions and historical precedent. Other than the single fact sheet and the informal inquiry, there was no published methodology for the population projection series.

II.1.2 United States Army Corps of Engineers, New York District Projections

This set of projections first appeared in a study performed on water supply and quality control in the Passaic River Basin by the United States Department of the Interior.[2] For the purposes of this paper, the New York District updated the series and provided a new tentative series[3] of projections in five year intervals, whereas the original set was in twenty year intervals. The original source information for this set was also the 1960 Census Bureau data for the various counties. In addition, the methodology for developing the projected figures was based upon the constraints delineated in the "ring" concept for the Tri-State Metropolitan Region of New Jersey, New York, and Connecticut as proposed by the Regional Plan Association. These constraints and conditions, which were attributed to the areas on the circumference of the New York City core area were used in combination with the

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[2] U. S. Department of the Interior. Water Supply and Water Quality Control Study, Passaic River Basin, New Jersey-New York Federal Pollution Control Administration, Metuchen, New Jersey 1967.

[3] New York District, "Tentative Population Projections for Northeastern New Jersey," New York, U. S. Army Corps of Engineers, 1967).

indexes of industrial and consumer activity, the patterns of land zoning and other factors, such as migration rates, to compile the series of data. The resulting population projections for each ring and for each year were apportioned among the constituent counties in accordance with the distribution factors pertinent to the particular ring and county. The rings were based upon New York City as a central core with rings of counties about this core.

The two series just described were the only ones that were available for the counties included in the study area and projected in five year intervals to the year two thousand. In addition to these series, there were estimates available for the study area by other agencies, but these estimates ended at 1985.

II.1.3 The Port of New York Authority Projections[4]

This report contains a series of county projections, made in five year intervals up to the year 1985. The prime factors entering into this series of data were population data, housing, land use and industrial activity in the various counties. There were also considered in the forecasts the characteristics of the labor force, household size and age groupings.

The methodology for this series was based upon a combination of several auxiliary studies for the elements mentioned above. For example, the total population for the region was developed from a projection based on Census Series II-B data, which was formulated by the U. S. Census Bureau and assumed certain migration and fertility occurrences with regards to household projections for each of the counties in the study

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[4]The Port of New York Authority, The Next Twenty Years, a forecast of Population and Jobs in the New York-New Jersey-Connecticut Metropolitan Region, 1965-1985 (New York, The Port of New York Authority, 1966).

area. The 1960 Census of Housing was employed to obtain a factor which was then used in conjunction with a forecast of households. The household forecast had been developed from Census Bureau fertility assumptions.[5]

II.1.4 Regional Plan Association Projections

The projections used in this analysis were derived from a regional model developed by the Harvard Study[6] of the New York Metropolitan Region and were subsequently changed due to the results of the 1960 Census. The apportionment of the regional data into county projections was based on three criteria; namely, accessibility to employment, local development conditions and zoned capacity of vacant land in regards to the accessibility factor. An accessibility index was computed which was a function of the time-distance relationship between various points. One important assumption of the analysis was that the over-all population of the built-up Core would not increase and that the region's population increase together with any outmigration would be absorbed on vacant land. Thus the importance of the accessibility index was evident by this restrictive assumption.

II.1.5 Senate Select Committee Projections

Another set of projections had been prepared by the United States Select Committee on National Water Resources,[7] which established estimates based on regional river basin populations and then considered different

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[5]Regional Plan Association, Spread City, Projections of Development Trends and the Issues They Pose: The Tri-State New York Metropolitan Region, 1960-1985, Bulletin 100 (New York, Regional Plan Association, 1962), p. 8.

[6]R. Vernon, Metropolis 1985 (Cambridge, Harvard University Press, 1960).

[7]U.S. Congress, Senate, Water Resource Activities in the United States, 86th Congress, 2nd Sess., 1960, Committee Print No. 5.

sets of fertility data to derive series for standard metropolitan statistical areas. One area that data were presented for, is New York-Northeastern New Jersey. Data were also developed in the report for urban populations by water resource region based upon different migration assumptions. However, there were no county projections specifically given, although some studies had taken these data and together with certain assumptions, had apportioned the population on a county basis.

II.1.6 TAMS[8] and Bergen County Projections[9]

The TAMS and Bergen County projections have been used for many years in New Jersey. However, the projections and studies were made over ten years ago. New data for population projections have been developed by the State of New Jersey and the Corps of Engineers. The TAMS and Bergen County population projections are presented in Tables II-1 and 11-2. The inclusion of this information into the dissertation is for the purpose of providing the population projections for informative reasons and indicating their consideration for the analysis in this section.

II.1.7 Analysis

The Corps of Engineers and the State of New Jersey projections which were described for the counties in the study area, have been plotted and are shown in Appendix B. The data are shown in Tables II-3 and II-4. Starting with the year 1980, a band of values representing 10% and 20% of the highest and lowest values for each five year period of the data to the year 2000 have also been indicated on the same graphs.

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[8] Tippetts-Abbett-McCarthy-Stratton, Survey of New Jersey Water Resource Development. Legislative Commission on Water Supply, State of New Jersey, December, 1955.

[9] Bergen County Water Study Committee, Report on the Present and Future Water Supply of Bergen County, New Jersey. Bergen County, April, 1957.

TABLE II-1

TAMS POPULATION PROJECTIONS
(in thousands)

County	1960	1970	1980	1990	2000
Bergen	715	880	990	1,070	1,140
Essex	1,000	1,060	1,120	1,140	1,150
Hudson	645	640	630	630	620
Middlesex	350	440	510	570	620
Morris	220	270	310	340	370
Passaic	375	410	460	500	530
Somerset	135	170	200	220	240
Union	470	540	600	650	690
Total	3,910	4,410	4,820	5,120	5,360

Source: Tippetts-Abbett-McCarthy-Stratton Report, p. IV-3

TABLE II-2

BERGEN COUNTY POPULATION PROJECTIONS

Year	Population	Per Cent Increase
1950	539,139	--
1960	772,300	43.1
1970	889,000	15.1
1980	961,900	8.2
1990	1,002,900	4.3
2000	1,020,600	1.8

Source: Bergen County Water Study Committee Report, p. 30.

TABLE II-3

POPULATION PROJECTIONS OF THE STUDY AREA
BY COUNTY (A)

	Year						(in thousands)
County	1970	1975	1980	1985	1990	1995	2000
Bergen	939.4	1030.8	1128.8	1197.4	1270.2	1347.4	1429.9
Essex	961.7	981.4	1002.3	1020.7	1038.5	1058.6	1078.7
Hudson	593.8	585.5	576.7	581.5	586.4	591.3	596.1
Middlesex	626.8	753.4	895.1	980.1	1073.2	1175.2	1286.8
Morris	382.4	462.3	552.2	605.8	664.6	729.1	798.8
Passaic	465.1	497.4	531.7	557.2	583.9	611.9	641.3
Somerset	209.7	253.1	306.2	336.1	368.9	404.9	444.0
Union	575.2	614.3	655.2	686.0	718.2	752.0	787.6

Source: (A) Tentative estimates, U. S. Army Corps of Engineers, New York District

TABLE II-4

POPULATION PROJECTIONS OF THE STUDY AREA
BY COUNTY (B)

	Year						(in thousands)
County	1970	1975	1980	1985	1990	1995	2000
Bergen	950.0	1026.0	1093.7	1153.9	1209.2	1264.9	1320.5
Essex	973.4	992.9	1009.8	1023.9	1036.2	1045.5	1053.9
Hudson	606.0	609.0	512.1	618.2	625.6	638.1	652.2
Middlesex	636.0	747.3	860.9	972.8	1076.9	1174.9	1268.9
Morris	396.1	470.6	547.8	630.0	716.9	807.9	887.1
Passaic	483.2	515.6	545.0	582.1	662.8	669.5	719.0
Somerset	224.0	269.9	319.8	374.5	432.2	483.6	532.0
Union	603.1	648.3	690.4	724.9	760.1	795.3	827.1

Source: (B) Estimated population projections, research and statistics section - Division of Economic Development, New Jersey Department of Conservation and Economic Development, Trenton, New Jersey.

It is the intent of this study to propose several series of values to any of the variables under consideration rather than select one series upon which future action is to be based. The reasons for this are extremely important.

Firstly, the population projections and other projections that will be considered in this study form the foundation for any future decisions and requirements. Yet these very series of data are suspect immediately, due to the complexity, of the inter-relationship between the variables that enter these projections and the geographical smallness of the study area.[10] For example, the in and out migration factors are dependent upon the total metropolitan area rather than Northern New Jersey. Another factor of concern was that the projections considered will reach out to the year 2000. According to Siegel:

> It should be recognized also, however, that the error of forecasts increases considerably as the length of the forecast period increases and that, in general, forecasts extending more than 15 or so years ahead, are subject to such substantial error that they are hardly adequate guides for carrying out practical programs.[11]

The Senate Select Committee[12] encountered this difficulty in obtaining projections from the U. S. Bureau of the Census for the Committee report on population projections and economic assumptions. The result was the previously mentioned point of the Census Bureau supplying multiple functional relationships represented by several series of data with high and low values.

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[10] J. S. Siegel, "Forecasting the Population of Small Areas," Land Economics, XXIX, (February, 1953), p. 81.

[11] Ibid., p. 83.

[12] U. S. Congress, Senate, Select Committee on National Water Resources, 1960, Committee Print No. 5.

Of the two sets of data to the year 2000, the Corps of Engineers and the New Jersey Department of Conservation and Economic Development projections, there appears to be no valid method for combining them and obtaining a trend line. This would necessitate many more assumptions to allow for the combining of the data and the fitting of a trend line. For this reason, the technique of allowing for alternative occurrences of population values is employed which uses the 10% and 20% factors applied to the data. It is necessary to be aware of the possible variation in results which may be obtained in the future.

The reason that the band of values was placed on the year starting with 1980 was that any effective action on large water supply projects may involve a time lapse that could be between ten to twenty years. Therefore, any work which would begin in the formative stage of planning about 1968-1970 would require approximately ten years at best until a completion could be expected. The Senate Select Committee on National Water Resources was cognizant of this fact in the preparation of their report which was initially to cover the period up to 1980. However, the Committee made the following comment: "Because of the magnitude and complexity of many water resource projects, periods of from 10 to 20 years or more between authorization and completion, are not uncommon."[13]

Evidently some projects were and will be in various stages of development at all times in the study time period.

II.1.8 Municipal Population Calculation

Population projections have been given for the study area and

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[13] Ibid., p. 2.

for the individual counties. However, the ability of each municipality to forecast its water requirements depends upon a small area projection method. There are two such methods which have been developed and which will have data relevant to New Jersey municipalities. The inclusion of this material is for informative purposes.

II.1.8.1 Hierarchy of Urban Centers

The hierarchy of urban centers method employs the use of functional differences between various areas in an attempt to establish regional centers and their spheres of influence. This concept leads to the establishment of various levels of regional influence and thus the use of the hierarchy terminology. For example, the community classification as a center is dependent upon factors such as commercial and industrial facilities, transportation and communications, cultural facilities, entertainment facilities, etc. A model building technique is used wherein certain population densities are specified and projections made for future regional needs. The criteria for the classification of the regional centers and the integration of the various parameters is discussed in "The Setting for Regional Planning in New Jersey."[14] Based on this concept of urban centers and a hierarchy of regions, population projections were made for two regional classifications. This information has been disaggregated to the municipal level in some cases and the projections have been made to the year 1980.[15] Using these projec-

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[14] State of New Jersey, The Setting for Regional Planning in New Jersey, (Trenton, Department of Conservation and Economic Development, 1961).

[15] State of New Jersey, The Residential Development of New Jersey (Trenton, Division of State and Regional Planning, 1964).

tions and the variables incorporated in the regional center concept, models can be developed for future population estimation.

II. 1.8.2 Quadratic Regression Method

A method has been developed by Newling[16] which describes the rise and decline of population density at a core region by the assumption that the logarithm of central density is a quadratic function of time. The relationship suggested by Newling is the following:

$$\ln Do_{,t} = \ln Do_{,o} + mt - nt^2$$

$\ln Do_{,t}$ = the logarithm of the central density at time t

$\ln Do_{,o}$ = the logarithm of the central density at time t = 0

m = a measure of the initial instantaneous rate of growth of the central density with time

n = a measure of the rate of change of the rate of growth with the passage of time

The method has been applied to the historical data of two cities and good agreement with the model results were obtained.[17] With the aid of a computer program and the historical data for a municipality, projections can be made. At the present time, regressions for municipalities in New Jersey are being developed, using this model, at the New Jersey Water Resources Center at New Brunswick. Due to the conciseness of the results obtained with this technique, it is preferable to the hierarchy concept with its requirements for many variables.

11.2 Per Capita Water Use Projections

11.2.1 Tams[18]

The intent of this section was to obtain projections of future

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[16] R. E. Newling, "Urban Populations: The Mathematics of Structure and Process," paper presented at the annual meeting of the American Geographers Association, St. Louis, Mo., April 1967.

[17] Ibid., p. 16.

[18] Tippetts-Abbett-McCarthy-Stratton, op. cit.

water requirements as determined by per capita demand. Several sources had been used repeatedly for the northern New Jersey region in making per capita projections. These two sources are the TAMS and Bergen County[19] reports. Although the population figures were estimated by numbers of consumers rather than by the actual population, the first report developed its data from population figures and actual water consumption. The TAMS report included a table of per capita consumption of public potable water for all of the New Jersey regions.[20] The values are given for the years 1954 and 2000 and divided into an industrial and domestic and other non-industrial categories. A total Northeastern region value was given for 1954 as 125 gallons per capita per day and 135 gallons per capita per day for the year 2000. For the industrial category, the usage was given as 69 gpcd for 1954 as compared to 68 gpcd for the year 2000. However, the domestic and other use category is projected to go from 56 gpcd in 1954 to 67 gpcd in the year 2000. The counties included in the Northeastern region were the same eight counties included in the study area of this report. The various values were obtained from information supplied to the Division of Water Policy and Supply of the New Jersey Department of Conservation and Economic Development, by an industrial survey conducted by the TAMS firm and from historical trends upon which estimates were forecast. In conjunction with this data, the report also contained a projection of county consumption to the year 2000 with the values given for the two categories

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[19] Bergen County Water Study Committee, op. cit.

[20] Ibid., p. IV-17.

previously mentioned.[21] The per capita information was obtained from these data whose sources of estimation were the same as the per capita determination. A summary of the per capita projections of this section and subsequent ones under section headings II-2 is given in Table II-9.

II.2.2 Bergen County Study

Another study which has served as a guidepost for water requirement projections in northern New Jersey is the Bergen County Water Supply Report.[22] This report contained comprehensive information regarding supply and demand conditions present in the county in 1955 and projections of water requirements to the year 2000. The report was based on records of each of the water utilities, both public and private, which provided service within the county. Therefore, the source material offered a firm basis for projection.[23] The report had a series of probable future water requirements of both the residential-commercial and industrial sectors to the year 2000. By combining both projection values at the year 2000, a per capita consumption figure of approximately 123 gpcd is obtained. This value will be used as a measure with which to check the average value for the entire region. The same type of calculation with the data gave a value of approximately 87 gpcd for the year 1950. The projected data were based in part on historical usage,

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[21] At this point, a key will be given to the abbreviations used frequently throughout the dissertation. One abbreviation has been introduced in this section.

gpcd = gallons per capita per day
mgd = million gallons daily

Both these abbreviations are commonly used in the water resources field. The number of days used in a yearly calculation would be 365 days.

[22] Bergen County Water Study Committee, op. cit.

[23] Of course, this assumes that the normal errors of collecting, tabulating and recording data were present, regardless of the nature of the source.

analysis of probable land development and contemporary water requirements. The information available from different parts of the county differed in certain respects as to completeness. Thus, the composite county picture depended upon certain estimations of data notwithstanding the detailed nature of the analysis which was available for a comparatively small area of observation.

The two series just discussed were published over ten years ago and based upon information of a still earlier time period. In researching this particular area of the study for per capita projections, two recent reports were available which included the desired data. However, certain limitations of the data were immediately evident.

II.2.3 Rutgers Public Policy Forum Paper[24]

This paper attempted to present an analysis of future requirements for water in northeastern New Jersey and used as its source material, the Bureau of the Census population projections for New Jersey, which was then apportioned to arrive at the northern Jersey values. The source material used for the per capita projections is taken from the TAMS report. Therefore, the paper presented data which were based on the TAMS evaluation as a method for obtaining a reasonable quantitative set of values upon which to base its analysis. However, the paper did not update this information and consequently, for purposes of this study, there was no per capita projections which would be of a timely origin. Also, the paper uses a population technique of employing the Census data for New Jersey and then assumed that 67% of the population would continue

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[24] Samuel D. Faust, Future Quantity and Quality Demand Upon Water Resources of New Jersey. A report presented at the Rutgers Public Policy Forum (New Brunswick: Rutgers - The State University, January, 1966)

to be concentrated in northern New Jersey. Thus, the untimeliness of the 1955 TAMS study and disaggregation of the data limited its effective use and the acceptance of its conclusions as a guide for the quantitative purpose of this analysis.

II.2.4 Federal Water Pollution Control Administration Study[25]

This study derived its per capita use projections from the analysis of the two major sectors of classification, namely, the residential-commercial sector and the industrial sector. The per capita values for 1962 were obtained from records of the total water usage of the study area. The study area in this survey included, in addition to the eight northeastern New Jersey counties, Rockland County in New York State. It must be realized that the inclusion of Rockland County may lead to a minor distortion of the average since it was not a highly populated or industrialized area in the early 1960's but was one of the fastest growing counties in the Metropolitan area, as indicated by estimates of the past five years and the projections of various agencies. However, its 1960 population was approximately 3% of the study area which precluded any serious distortion of the results.[26]

The water use data for the area for the year 1962 were based on the Public Health Service Inventory report of the area, data obtained on usage from the State of New Jersey and U. S. Geological Survey records on

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[25] Federal Water Pollution Control Administration, Water Supply and Water Quality Control Study, Passaic River Basin, New Jersey-New York, (Metuchen, New Jersey, U. S. Department of the Interior, May 1967)

[26] This statement is based upon the assumption made in the population projection analysis which is that population is the important or prime variable to consider for water use projections rather than other variables such as income.

basin divisions of water supply. Thus, combining these sources of total usage with the population values for the area, a per capita usage of 135 gpcd was obtained. The population data used for the analysis were supplied by the U. S. Army Corps of Engineers, New York District. As stated in the population projection section of this report, the series had been revised and tentative new values are given in Table II-3. The new values are very close to the original values and vary from them only by approximately ¼ of 1%.

The projections developed for the study area give a per capita use for the residential-commercial sector of 95 gpcd for 1980 and 105 gpcd for the year 2000. These results were obtained from historical water use records of the State of New Jersey which indicated that, whereas the yearly increase for total water consumption was 4-5 gpcd in the early forties, it reached an increase of approximately 0.5 gpcd by the early sixties. The study then assumed that the results of the Bergen County Committee report were indicative of the study area and used the approximate value of 75 gpcd as stated in that report for 1960. Thus the projection from 1960 to 1980 went from 75 gpcd to 95 gpcd for constant yearly increase of 1 gpcd and the subsequent 0.5 gpcd from 1980 to 2000.[27] Projections were also given of the future percentage of industrial, municipality supplied process water together with projections of the Recirculation ratio.[28] For example, if the Gross Water Needs are 100 units and the Total Water Intake is 20 units, this would result in

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[27] FWPCA, op. cit., p. VII-12.

[28] This ratio is defined in the report as

$$R = \frac{\text{Gross Water Needs-Total-Water-Intake}}{\text{Total Water Intake}}$$

a Recirculation ratio of 4 or the re-use of the original water intake by 4 times. Calculations based upon these data and the population projections in the report indicated a per capita requirement of 158 gpcd by 1980 and a 170 gpcd by the year 2000. These values were shown as average municipal water demand in million gallons daily versus a time base of years in the FWPCA report.[29]

II. 2.5 Bureau of Water Resources Memorandum[30]

The report had a series of per capita consumption values for the years 1940 through 2020. As will be discussed in section II.5.3, these projected use requirements will be met by projects constructed by governmental rather than private organizations. The values were obtained by using population projections for the region, which included the eight counties of the study areas plus portions of Hunterdon County. The following are the public demand projections for the years 1980-2000:

YEAR	GPCD
1980	160
1990	185
2000	212

Assuming a linear relationship between the change in consumption versus time, there is a 2.4 gpcd yearly increase for the period from 1980-1990 and 2.7 gpcd for the period 1990-2000. The components of these projections for the public supply included the residential-commercial requirement and the industrial-publicly supplied sector. In addition, the

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[29] FWPCA, op. cit., p. VII-14.

[30] R. E. Cyphers, Memorandum Re: Projections of Population, Water Demand and Water Resources for Region I, (paper presented by State of New Jersey, Bureau of Water Resources at Meeting of the Delaware River Basin Commission, Trenton, New Jersey, January 8, 1968)

publicly supplied portion is composed of both the private and municipally owned utilities share of the future requirements.

II.3 Industrial Water Use Projections

An important sector of water use was the industrial demand placed upon local municipal supplies. Actually this demand was only a part of the complete water requirements of industry since industry is partly self-supplied and also, reuse portions of the water employed in their processes. The purpose of this section is to investigate specific projections of industrial water demand and to use these projections as a basis for estimation of total water requirements.

II.3.1 New Jersey Manufacturing Industries Survey[31]

In 1962, a survey was conducted by the consulting firm of Arthur L. Sherman for the State of New Jersey. Questionnaires were sent to 667 plants throughout the State requesting information as to the annual quantity of water used in 1950, 1955, and 1960. It also requested that the water use be broken into the categories of purchased and self-supplied quantities and projections be made for the years 1970 and 1980.

Responses were received from 476 plants, which employed a total of 336,265 workers or 42% of the State estimated total of 797,929 workers. The data were categorized for each of the counties in New Jersey. One restriction placed upon the survey was that the questionnaire would not be sent to plants with less than 200 employees. It is difficult to determine the type of distortion this restriction introduced into the survey.

The results of the survey for the year 1980 are given in Table II-5.

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[31] State of New Jersey, Report, Present and Prospective Use of Water by the Manufacturing Industries of New Jersey (Trenton, Department of Conservation and Economics Development, 1963) Water Resources Circular II.

TABLE II - 5

PROJECTED INDUSTRIAL WATER REQUIREMENTS FOR 1980
FROM MUNICIPAL SOURCES

(Millions of Gallons Per Year)

County	N. J. Survey
Bergen	14,700
Essex	29,000
Hudson	15,000
Middlesex	13,200
Morris	2,170
Passaic	12,700
Somerset	1,250
Union	21,700

Source: Report, Present and Prospective Use of Water by the Manufacturing Industries of New Jersey, Exhibit A.

TABLE II - 6

PROJECTED REQUIREMENTS FOR INDUSTRIAL WATER
NORTHEASTERN NEW JERSEY COUNTIES

Year	Self-Supplied (M.G.D.)	Purchased (M.G.D.)
1980	392	300
2000	460	400

Source: Rutgers Forum Report

II.3.2 Rutgers Public Policy Forum Projections

Projections were made for industrial requirements in the self-supplied and purchased categories. The projections were made in ten year intervals from 1950 to the year 2000.[32] The basis for the projection was the previously described New Jersey Survey report. The projections for the year 2000 were original to the Faust report. A summary of these projections is given in Table II-6.

The northeastern counties included in the projections were the same eight counties under study in this analysis. In analyzing these projections, it is found that the requirements for public supplies will be 43 to 54 per cent of the industrial needs. This is a result of the small industrial supply potential due to technical restrictions and geographical limitations. However, the industrial requirements may be partially fulfilled by increased re-circulation ratios and technical advances in process use of water.

II.3.3 Bureau of Water Resources Memorandum[33]

This report projects the requirements for industrial self-supplied water. It is based on the report of the New Jersey Survey, which was discussed in an earlier section of the chapter.[34] The per capita and total daily requirements were as follows:

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[32] Faust, op. cit., p. 10.

[33] R. E. Cyphers, op. cit.

[34] State of New Jersey, Report, Present and Prospective Use of Water by the Manufacturing Industries of New Jersey, op. cit.

Year	GPCD	MGD
1980	68	393
2000	56	416

These values are virtually identical to the Rutgers Forum Figures for 1980, which were also based upon the New Jersey survey report. Both values for the year 2000 are also in close agreement, considering they were independent estimates. The memorandum does not give projections for the industrial non-self supplied category. It must be noted that water for the distribution systems of municipalities will come from private and municipally owned water utilities.

There is another important property of the area for which the projection was made. The area is called "Region I" and includes the eight counties under study as well as that portion of Hunterdon County within the Raritan River Basin. This would tend to distort the values obtainable as compared to the other estimates, since the geographical areas are not identical. A comparison is made of the data in Table II-8.

11.4 Projected Use Analysis

The analysis proceeds in the following manner. The total water requirement needed each five year period from 1980 through 2000 is determined by aggregating for each county in the study area the quantity obtained from population times per capita consumption. The State of New Jersey and the Corps of Engineers population series are used. The population values employed are the upper range of the 10% increment to the highest value of the series for each five year period. The population curves are in Appendix B. The per capita consumption values are obtained from a synthesis of the various sector requirements. The per capita summary is given in Table II-11.

II.4.1 Population Projections

The following table is a summation of the projections which were made on a county basis.

TABLE II - 7

POPULATION PROJECTIONS FOR NORTHEASTERN NEW JERSEY
(IN THOUSANDS)

Year	±10% Variation	±20% Variation
1980	6329.2	6905.2
1985	6743.1	7355.1
1990	7194.5	7867.5
1995	7374.3	8373.3
2000	8154.8	8896.8

The 10 and 20 per cent columns represent the upper values of the range placed on the projected series for each county in the study area. In several counties the New Jersey State Department of Conservation and Economic Development series are the high projections. The other set of projections used in the estimates were provided by the New York District, U. S. Army Corps of Engineers.

As discussed in the population projection section, estimates for the future are subject to large variations. This factor was explored in the Siegel paper[35] and is one reason for using the 10 and 20 per cent bands. Additionally, it is impossible to determine which series of projected values should be selected from among several studies. For this reason, the series of each source is accepted as a standard

[35] J. S. Siegel, op. cit.

and is used as the base upon which the bands are placed. This procedure is in agreement with the assumption of Chapter I, where population projections were discussed in relation to their dependency upon many variables. The variation in projections from different agencies is emphasized by the inclusion of the Port of New York Authority and the Regional Plan Association estimates to the year 1985.

The projected values given in Table II-7 are for the positive or increased range of the band. The lesser estimated values are not considered in the determination of the total water requirement. There are several reasons for this approach. The 10% increment is used as a safety factor upon the highest value of the projected series for each five year period. Secondly, there are other variables, such as labor mobility, land use patterns and consumer trends, that could induce large variations in the projected requirements. Again, as in the previous statement, the 10% increment is assumed to be a safety factor for each of the many variables pertinent to the problem.

Although both the 10 and 20 per cent variations are given, only the 10% series is used for determining the future water needs. This is not to preclude the possibility of variations of 20, 30 or 50 per cent occurring. In that event, the time scale for necessary action would either be greatly shortened or lengthened, depending upon the direction of the shift.

11.4.2 Per Capita Consumption

The per capita consumption values are used as the multiplication factor in determining future water requirements. The first step required is a synthesis of the data obtained for the various sectors. The data obtained from each of the studies previously analyzed are presented in

the following table.

TABLE II - 8

PER CAPITA CONSUMPTION BY USE CATEGORY
IN NORTHEASTERN NEW JERSEY

Year	TAMS[a]			FWPCA[b]		BWRM[c]
	I	II	III	I	II III	I II III
	(GPCD)			(GPCD)		(GPCD)
1980				63	95	68
1990						63
2000	68	67		65	105	56

a. Tippetts - Abbett - McCarthy - Stratton Report
b. Federal Water Pollution Control Administration Report
c. Bureau of Water Resources Memorandum

The symbols I, II, and III represent the following categories: I Industrial Self-Supplied; II Industrial-Public Supply; III Residential-Commercial Supply.

The Bureau of Water Resources Memorandum also includes per capita consumption projections for total public supply (this is Category II and III in the table) and irrigation consumption. For the years 1980 and 2000, the FWPCA gives a total public supply requirement of 158 and 170 gpcd. The Bureau report for the same years projects a demand of 160 and 212 gpcd for the public supply. However, the report does not separate these values into categories. The TAMS report projects a 135 gpcd demand for the year 2000. Therefore, the summary for Table II-8 and the above reports is as follows:

TABLE II - 9

TOTAL PUBLIC WATER REQUIREMENTS[a]

Year	FWPCA	BWRM	TAM	Bergen County
1980	158	160		
2000	170	212	135	123

a. In gpcd

The Bergen County report projects a requirement of 123 gpcd for the year 2000. Although both the TAMS and Bergen County estimates are close to each other, they are well below the other agency estimates. Obviously, the difference in time between the two sets of projections, the first set in the early 1950's and the latter in the middle 1960's, accounts for the gap. The analysis, therefore, proceeds with a discussion of the FWPCA and the BWRM projections.

Analyzing Tables II-8 and II-9, one important point is evident. The BWRM report projects a total value for public water requirements. This series is obtained by per capita consumption projections which do not delineate the requirements of the industrial-public supply and the residential-commercial sectors. The FWPCA projections are based on an analysis of the industrial-public supply sector. This analysis uses the data of the Census of Manufacturers[36] and the technique developed by Lawson[37] to arrive at separate projections for industrial-public supply needs. The projections of total requirements for 1980 are

[36] U. S. Department of Commerce, Bureau of the Census, op. cit.

[37] B. Lawson, Industrial Water Use, Northeastern United States (Ithaca, Cornell University Resources Center, 1967).

approximately equal in both series. This is reasonable since the 1980 time period is approximately twelve years from the dates of both reports. The capability of responsible public agencies to project this time span into the future is a necessity. Therefore, it is to be expected that both projections would be close together. However, in projecting the year 2000, the normal trend conditions may become distorted or new trends may evolve due to many variables.

The series developed by the FWPCA will be utilized for the purposes of this paper. The FWPCA report has considered the income of the study area residents[38] in its residential-commercial sector. It has also conducted separate analyses for its industrial-public supply category.[39] The importance of this type of analysis is demonstrated in the Lawson paper. An example is given of the historical trend of water use in the pulp and paper industry. Normally, the trend in this industry would have predicated a seven-fold increase in the water requirements by the year 2000. Actually, due to technical innovation, the requirements were to be reduced by one-third in a five year span and still further reductions will occur by the year 2000. The FWPCA report has included an estimation of the variation in the recirculation ratio, which will, in part, account for technological change. However, as with the population projections, this analysis places a positive increment on the FWPCA series. This is accomplished by using the values given for total public

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[38] FWPCA, op. cit., p. VII-11.

[39] Ibid., p. VII-12-13.

supply for 1980. For the 2000 value, a positive increment of 10% is used. This is tantamount to accepting the 1980 value and increasing the 2000 value. For the yearly values of five year intervals between 1980 and 2000, it is assumed that the relationship is linear. The following table gives the series that is arrived at by these calculations.

TABLE II - 10

TOTAL PUBLIC SUPPLY REQUIREMENTS

Year	GPCD
1980	158
1985	165.5
1990	173
1995	180.5
2000	187

These values, together with the population series in Table II-7, are the total public supply requirements portion for the projected use curve plotted in Figure II-1. The use of present water technology is assumed. However, two additional sectors must be included in the projected use curve: the irrigation water and the industrial self-supplied sector. Both of these series are obtained from the BWRM report.

The irrigation values are small and have the following projections for the 1980-2000 period:

1980 - 9 gpcd 1990 - 10 gpcd 2000 - 9 gpcd

The industry self-supplied values are given for each ten year period and indicate a declining per capita usage.[40] This is the same

[40] In the water resource field, water use in all sectors is expressed in per capita values.

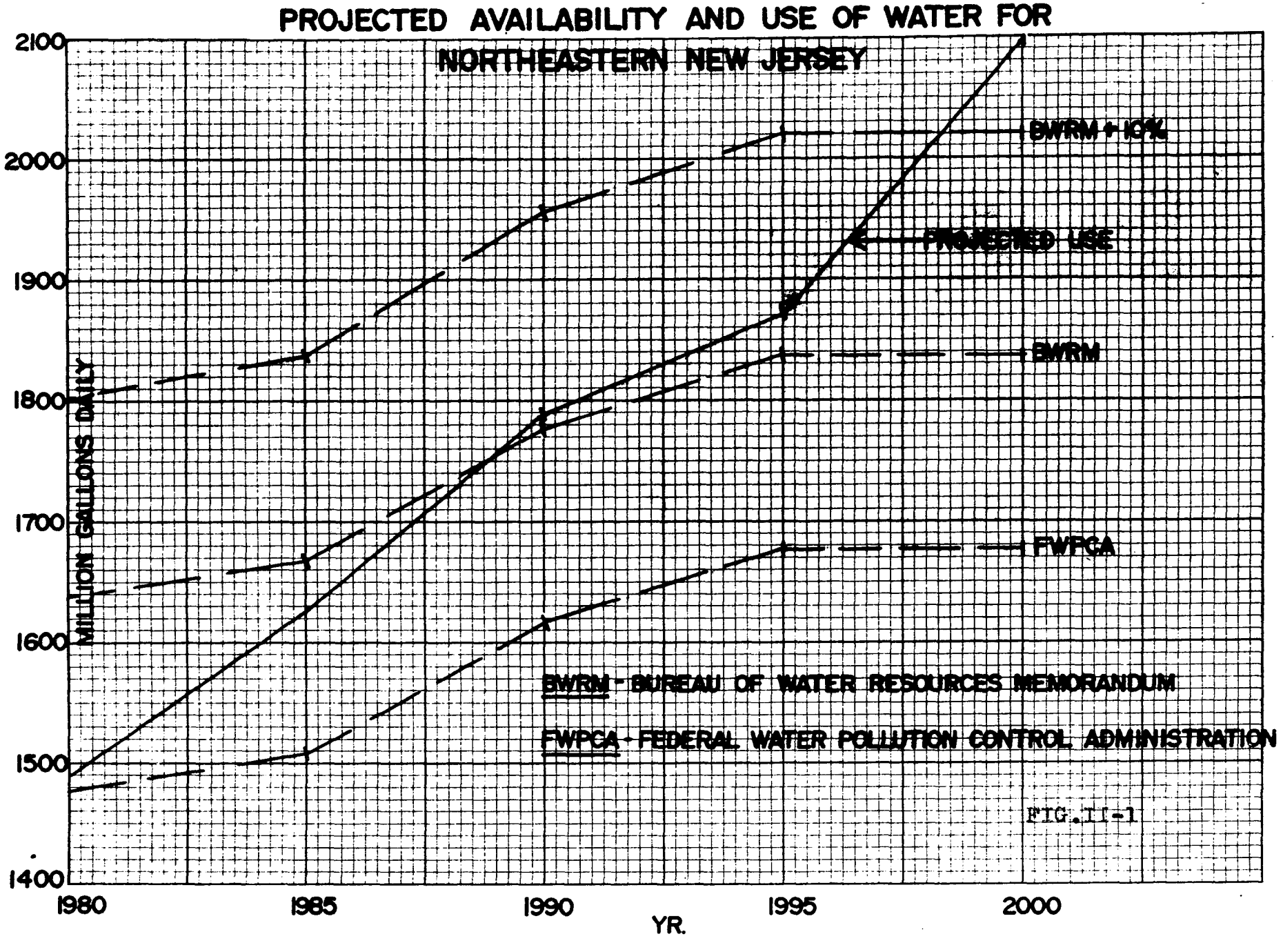

FIG. II-1

characteristic shown by the other analyses. This is due to the fact that industrial self-supply is limited in relation to the public supplies and therefore consumption will be correspondingly lower.

The industrial self-supply requirement has been calculated in the following manner. As in the public supply calculation, the value for 1980 has not been changed. A positive 10% increment has been added to the year 2000 value and the value between 1980 and 2000 have been interpolated linearly. Although the function may not be linear, the magnitude of 6 mgd, which represents less than 3% of the total requirement, could not appreciably distort the results.

The total per capita consumption requirement is shown in Table II-11. The total water projected use for the eight counties is shown in Figure II-1. The projected use curve is obtained by multiplication of the per capita consumption requirement with the projected population for the study area.

II.5 Projected Availability of Water

The previous section described the projected use of water resources in the study area. This section describes the projected availability of water or the future developed yield. The yield is obtained from projects and other developments in the area in order to meet the future use requirements.

The analysis performed in this section is dependent upon three studies, which are described in detail.

11.5.1 Northeastern United States Water Supply Study Analysis

The basis for the NEWS[41] is a report published by the Public Health

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[41] Northeastern United States Water Supply Study, North Atlantic Division, U. S. Army Corps of Engineers

TABLE II - 11

PER CAPITA CONSUMPTION REQUIREMENT TOTAL FOR
NORTHEASTERN NEW JERSEY
(IN GPCD)

Year	Public Requirements	Industrial Self-Supply Requirements	Irrigation Requirements	Total Requirements
1980	158	68	9	235
1985	165.5	66.5	9	241
1990	173	65	10	248
1995	180.5	63.5	9	253
2000	187	62	9	258

Service.[42] The report contains information from each state in the country concerning facilities serving populations of one hundred or more. The information supplied in this inventory consists of items including estimated population served, ownership, source of supply, safe yield, type of treatment and distribution storage. The analysis of this report revealed several limitations of the data which could significantly alter the results. The limitations are discussed in the next sections.

II.5.1.1 Generalized Entries

Many of the entries in the Inventory data had yield notations of "unlimited" or "unknown". There were instances of the use of the term "non-applicable" for the yield category. In these cases, the average daily consumption was used as a proxy for the yield. In actuality, an abundance of the resource might have been the true situation. Although this type of entry was not prevalent, the absolute difference between a deficit and a surplus indication would allow for a substantial error in the particular case. If the plant capacity was 5% below demand requirements and developed yield was 20% above facility handling capability, a 25% error would exist.

II.5.1.2 Double Counting

When utilities in a given area obtain their water from a common source, and the total yield of the common source is listed for each of the utilities, an obvious case of double counting exists. The data were corrected for this occurence whenever possible; however, it was not

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[42] U. S. Department of Health, Education and Welfare, 1963 Inventory, Municipal Water Facilities (Washington, U. S. Government Printing Office, 1963), Region II

possible to make such corrections in all doubtful cases. This type of error was found in the analysis of another region. Four withdrawals were made at approximately the same point along the Potomac River near Washington, D. C.;[43] yet, the yield was given as the same value for each of the withdrawal points. This procedure gives the result of a smaller deficit or a fictitious surplus.

II.5.1.3 Yield Source

There was no indication in the Inventory listing as to whether the yield came from an impoundment or from low flows in a stream. Therefore, no determination could be made as to an average or a minimum value for the yield. For example, an impoundment would result in an average yield. This in effect could also cause the particular area to give a deficit indication where a surplus might exist if readings were obtained from low stream flows.

Taking these factors into account and correcting the data wherever possible, the NEWS analysis obtained the results shown in Table II-12.

Another analysis was conducted of the study area by the Department of the Interior. This study, which was referred to previously, was performed under contract to the New York District of the Army Corps of Engineers. It had been completed prior to the NEWS analysis.[44]

II.5.2 FWPCA Study

This analysis used as its sources of information the Public Health Service Municipal Water Facilities Inventory, the New Jersey Water

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[43] U. S. Public Health Service, 1963 Inventory, Municipal Water Facilities (Washington: U. S. Government Printing Office, 1964), Region II, p. 2.

[44] Federal Water Pollution Control Administration, Northeast Region, op. cit., pp. VII-5 - VII-14.

Resources Circular II and the Bergen County report. These reports have been discussed previously. In addition, reports of New Jersey stream flows and Morris County studies were included in the analysis.

TABLE II - 12

NEWS YIELD ANALYSIS
(TENTATIVE)

County	Yield (in M.G.D.)
Bergen	143,004
Essex	115,820
Hudson	81,200
Middlesex	65,333
Morris	45,671
Passaic	195,876
Somerset	17,084
Union	47,900
Total	711,888

II.5.2.1 Yield Sources

The study performed an investigation of the surface and ground water yields and future developments to the year 1970. The potential availability was analyzed for the four major river basins; namely, the Passaic, Raritan, Hackensack and Delaware.

11.5.2.1.1 Passaic Basin

The Passaic River Basin, with the completion of Longwood Valley Reservoir and the Saddle River project, has a total surface water yield of 366 mgd. Although the surface and ground water sources have been

extensively developed, there is still the potential for future ground water development in Morris, Bergen and Passaic Counties. It is estimated that the yield from ground water will be approximately 132 mgd.

11.5.2.1.2 Raritan Basin

The Raritan River Basin has the potential for significant increases in yield. The presently developed surface water yield is 235 mgd. This includes 190 mgd from Spruce Run - Round Valley. There are proposed projects, such as the Six Mile Run Reservoir, which would increase the yield by 40 mgd. The developed ground water facilities have a yield of approximately 80 mgd.

11.5.2.1.3 Hackensack Basin

The basin has been extensively developed as regards both surface and ground water sources. The present yield from surface water storage is 80 mgd. The ground water yield is estimated at 7 mgd. There is a small potential remaining from the presently developed ground water facilities.

II.5.2.1.4 Delaware Basin

The main yield anticipated from this basin is the future withdrawal of 300 mgd from the proposed Tocks Island Reservoir. In addition, the Delaware - Raritan Canal system provides a yield of 50 mgd. There is no anticipated ground water yield from this river basin.

The results of the FWPCA yield analysis are summarized in Table II-13. The Rahway River yields are included in the descriptive material with the Raritan Basin. The totals for ground and surface yield in Table II-13 are 219 and 1,071 mgd, respectively. The projections of the supply availability performed by the FWPCA indicate that a total of 1290 mgd

will be developed by 1970.

TABLE II - 13

RIVER BASIN DEVELOPED AND PROPOSED YIELDS

River Basin	Ground Yield (In million gallons daily)	Surface Yield
Passaic	132	366
Raritan	80	268
Rahway		7
Hackensack	7	80
Delaware		350
Totals	219	1,071

Source: FWPCA Study, p. VII-8

11.5.3 Bureau of Water Resources Memorandum[46]

The memorandum lists the presently available water resources in the study area. The values given in the report also include surface water yields from those portions of Hunterdon County which are within the Raritan River Basin.

The memorandum lists the developed sources of water prior to 1965 and during the 1965-1970 time period. The total developed yield stated for the year 1965 is 1051 mgd. The total estimated yield for the year 1970 is 1084 mgd. This value is appreciably less than the

[45] FWPCA, op. cit., Figure VII-2.

[46] BWCA, op. cit., Table I

1290 mgd projected by the FWPCA for 1970. A comparison was made of the constituent projects of each of the studies, revealing several obvious differences in the two sets of projections.

The FWPCA report includes in its projections for 1970 the yield of Spruce Run - Round Valley, Six Mile Run and Tocks Island projects. Only the Spruce Run - Round Valley yield is included in the BWRM study. To compare the two estimates made by the FWPCA and BWRM reports for the year 1970, 40 mgd yield for Six Mile Run and 300 mgd yield for Tocks Island should be deducted from the FWPCA estimate. The reason for this procedure is that these two projects are not included in the BWRM estimate. The FWPCA estimate is therefore 950 mgd yield as compared to the BWRM result of 1084 mgd.

Reviewing the estimates to the year 2000, other differences between the two studies become apparent. The BWRM report includes a detailed listing of the developed and potential sources of water. The FWPCA report contains a partial listing of water projects. The FWPCA did not estimate as large a yield from ground water as did the BWRM. Also, the FWPCA report did not include several future projects which are part of the BWRM estimate. These projects are:

1. North and South Branch confluence of the Raritan River - 50 mgd.

2. Washington Valley Reservoir on the Whippany River - 10 mgd

3. Two Bridges and Millington Reservoirs in the Passaic Valley - 75 mgd

4. South River Barrier Dam and Storage; Crab Island Reservoir - 60 mgd

Therefore, adding the sum of these surface water projects plus the difference in ground water yield to the FWPCA total of 1290 mgd, a value of 1677 mgd is obtained. The comparable value for the BWRM report is 1837 mgd. These figures are within 10% of each other. Considering the number of different variables present in both these estimates, their proximity to each other is significant. For the supply curve in Figure II-1, these two series are plotted with the following time profile:

TABLE II - 14

DEVELOPED YIELD IN NORTHEASTERN NEW JERSEY

Year	Supply FWPCA	BWRM
1980	1479	1639
1985	1508	1668
1990	1617	1777
1995	1677	1837
2000	1677	1837

The reason a 10% band is not placed on these two series, as was done in the population projections, is that the amount of water physically available is limited by the earth formation, ground water sources and climactic conditions of the area. It would be meaningless to develop projections for more water when this is simply technically not possible. However, it is possible that the accuracy of the flow measurements and precipitation levels in the area may vary. Instruments may not be adjusted or calibrated properly and errors of entry and computation may

occur in records. Therefore, to provide for alternative solutions to the yield problem, the assumption is made that the FWPCA series is the lower range of a band and a 10% increment is placed over the BWRM series. The 10% range is to account for the inaccuracies of measurement and computation. From Figure II-1, the lower range is shown to give an unavailability or shortage of water for the years 1978-1980. The upper range with a 10% increment indicates a sufficient availability until the years 1998-2000.

CHAPTER III

CAPITAL OUTLAY ANALYSIS

SUMMARY: The capital outlay per unit of water is determined for each component of a water system. The typical relative outlay for each component of a system is determined to be:

Reservoir	41.8%
Pumping	4.7%
Treatment	37.2%
Transmission	16.3%

The chapter also includes a determination of the operation, maintenance and replacement requirements for a water system.

III Discussion and Model

This analysis provides the values for transforming the physical units of water required for future use in the study area into a monetary sum. One of the major assumptions of the analysis is that future new yields will be developed from surface rather than ground sources. In addition, the expectation is that the present technology of water systems will continue to be used. The intent of this analysis is to obtain an average value for the capital cost of a unit quantity of water. This is the only approach feasible since water projects are of a specific and peculiar nature and by simply analyzing several projects, one could not establish a definitive result. The guidelines for the analysis are predicated upon surveys conducted by various organizations in which costs and proportions of costs among the constituent elements of a system have

been determined by sampling techniques. Specific projects and parts of systems in northern New Jersey are analyzed to ascertain whether their average values selected are compatible with general regional values. Where specific examples are available, they are used to complement the regional or average data.

The basis for the analysis is formally stated by the following model:

CAPITAL OUTLAY MODEL

III-1. $O_T = O_R + O_P + O_C + O_X$

Where O_T = total capital outlays per unit yield per unit distance

O_R = reservoir capital outlays per unit yield

O_P = pumping station capital outlays per unit yield

O_C = water treatment capital outlays per unit yield

O_X = transmission capital outlays per unit distance

III-2. $O_R = f_1(M)$

Where M = reservoir capacity in acre-feet

The yield-storage relationship is $M - \log_e Y$

Where Y = yield in million gallons daily

III-3. $O_R = f_1 (\log_e Y)$

III-4. $O_P = f_1(Q, H)$

Where Q = pump capacity per unit of yield

H = pumping head or pressure differential

III-5. $O_C = f_3(A, D)$

Where A = treatment plant capacity

D = number of water treatment methods required

III-6. $O_X = O_X^D + O_{XS}$

Where O_{XD} = transmission capital outlays due to topography and distance

O_{XS} = transmission capital outlays due to pipe size

III-6A. $O_{XD} = f_4(H, L, T)$

Where H = pressure differential

L = length of pipeline

T = land usage of terrain

III-6B $O_{XS} = \arctan (V - n)$

Where V = diameter of the pipeline

n is to equal discrete values of V at which a break occurs in the function. The break or discontinuity is caused by the requirement for different types of equipment to accommodate large pipe sizes.

Therefore,

III-7. $O_X = f_4(H, L, T) + \arctan (V - n)$

Equation III-1 becomes

III-8. $O_T = f_1 (\log_e Y) + f_2(Q, H) + f_3(A, D) + f_4(H, L, T) + \arctan (V - n)$

III.1 Outlays for Storage

The Senate Select Committee on Water Resources[1] conducted a study of the outlays for storage, which included factors such as the price of land, the expenditures for relocating people, physical char-

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[1] U. S. Congress, Senate, Select Committee on National Water Resources, Water Supply and Demand, 80th Cong., 2nd Sess., 1960, Print No. 32.

acteristics of the dam site, capacity of the area behind the dam and the technological aspects of dam construction. The study then classified the reservoirs according to the physiography of sites and the location of sites in a water resource region. An outlay-size relationship was then established to derive construction expenditure schedules, which were obtained for each region. For the northern New Jersey area, the following values were obtained from expenditure curves:[2]

TABLE III - 1

RESERVOIR CAPACITY - AVERAGE OUTLAY

Capacity of Reservoir (Acre-Feet)	Average Outlay Per Acre Foot (In Dollars)
20,000	$171
50,000	144
100,000	127
200,000	109
500,000	90
1,000,000	80

a. Values are given in 1954 dollars

Another source of outlay data for reservoirs is a study performed by the New York State Conservation Department.[3] The study is of the Susquehanna River Basin, which is assumed to be in the regional considerations of the northern New Jersey area. The analysis used in the New York

[2] Ibid., p. 60.

[3] New York State, Needs and Capabilities for Multi-Purpose Water Resources Development of the Susquehanna River Basin in New York, Storage Potential Appendix. (Division of Water Resources, Conservation Department, 1966)

report was based upon a detailed study performed by the U. S. Army Engineers, Baltimore District. The analysis is given in the Baltimore District Susquehanna River Basin Report.[4] The following is an example of the detail provided in the investigation. The unit outlay for highway relocation was obtained for interstate (four-lane) highways, two-lane highways of a primary, secondary and gravel nature. Each category was then considered for flat, rolling and mountainous terrain.[5]

The Army Engineers' report develops a set of expenditure versus storage curves based upon the analysis of reservoirs in the basin area. The following table is derived from this set of curves:

TABLE III - 2

RESERVOIR CAPACITY - AVERAGE OUTLAY[a]

Capacity of Reservoir (Acre-Feet)	Average Outlay Per Acre Foot (In Dollars)
5,000	$1,200
10,000	700
20,000	450
50,000	240
100,000	160

a. Values are in 1966 dollars

The first objective is to determine whether there is any compatibility of the two sets of estimates. As noted in each of the tables,

[4] North Atlantic Division, Storage Potential in the Susquehanna River Basin, Sub-Study No. SS-CE-1, (U. S. Army Engineer Dist., Baltimore, 1966)

[5] Ibid., p. 6.

the regional costs developed by the Senate Committee are in 1954 dollars while the Susquehanna report is in 1966 dollars. The problem, therefore, is to obtain an index number for comparison purposes. This introduces certain difficulties since storage or reservoir projects are of a special type of construction. Several functions normally assume a much larger weight than in the composition of an index for conventional construction activities. For example, there would be a large effort required for earth-moving operations when comparing a reservoir project with a bridge or road project. One index that has been commonly used by the Army Corps of Engineers in estimating the costs for these many reservoir projects is the Engineering News Record - Road Construction Cost Index.[6]

The ENR has three components: materials, skilled and non-skilled labor. The weighting is performed according to U. S. annual production of representative materials and the number of skilled and non-skilled non-farm laborers. The materials selected are those such as steel, lumber and cement, which are non-regional in character and reflect the trend in the economy and the price structures. Therefore, the ENR provides a basis for comparison of projects in the same regional area without the expectation of a large degree of distortion of the results. It is evident that one of the main components in storage projects is not included in a construction index and this is the land component,[7]

Using the "Annual Average" ENR for 1954 and 1966, the following values are obtained:

1954	627.96
1966	1020.95

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[6]"Road Construction Index," Engineering News Record, March 16, 1967, p. 87-166.

[7]Ibid., p. 87-88.

The relationship gives a multiple of 1.63 for the construction outlays of 1966 as compared to 1954.

III.1.1 Land Outlays

An estimate is required for the weighting of land outlays in relation to total outlays of a reservoir project. Two projects are evaluated. The first is based upon an estimate prepared by the Baltimore District, Army Corps of Engineers, for the Tocks Island Reservoir. In evaluating the component elements of this project for the outlay of land in relation to total outlays, those items of a multiple-purpose nature are excluded, such as fish and wild life facilities and recreation facilities. The reason is that the analysis is concerned solely with storage outlays. Using this criterion, it is found that the land outlays are approximately 35% of the total estimated project outlay.[8] The second project analyzed is the Point View Reservoir built by the Passaic Valley Water Commission. Based upon bids submitted in 1962 and land acquisitions during 1960, 1961 and 1962, the land outlays were approximately 69% of the total project outlay. Therefore, the land outlays are an element of considerable weight in a outlay index for reservoirs. Unfortunately, indices of land values are not availble other than the index prepared by the Department of Agriculture for the variation in farm land values.

A survey was conducted by the Corps of Engineers, North Atlantic Division, of real estate brokers in the towns of Dover, Newton and Hackettstown, New Jersey. The consensus of the various estimates given by these sources was that real estate values for unimproved land

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[8] Total project outlay is used for total outlays of storage alone. It excludes the other functional elements of pumping, etc.

in northwestern New Jersey had risen approximately 35% from 1954 to 1966. Although no survey was taken of the Susquehanna Basin in southwestern New York, it is assumed that an increase in New Jersey would be greater than in the latter region due to New Jersey's proximity to the New York Metropolitan Area. A comparison of Tables III-1 and III-2 indicates that for 50,000 acre-feet size reservoirs, the data are compatible when the 1.63 index factor is applied. An outlay of $232 per acre-foot is obtained from the Senate study as compared to $240 per acre-foot from the Army Engineers' report. However, the data are not in as good agreement for the larger or smaller sized reservoirs. For example, the following values are obtained:

Size (Acre-feet)	Senate (Average Outlay in 1966 Dollars per Acre-Foot)	Army Engineers (Average Outlay in 1966 Dollars per Acre-Foot)
20,000	280	450
100,000	207	160

One source of difference between the data is the greater non-linear relationship in the Army values as compared to those of the Senate. The Army values are for a specific river basin while the other set are for the northeastern United States. Therefore, it is to be expected that a larger variation might occur within one subset of a population.

III. 1.2 Yield

The storage capacity of the various size reservoirs in terms of yield is shown in Figure III-1. The data are obtained from the Senate Report.[9] These data are used in the determination of the average outlay

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[9] Senate Select Committee on National Water Resources, op. cit., p. 62-63.

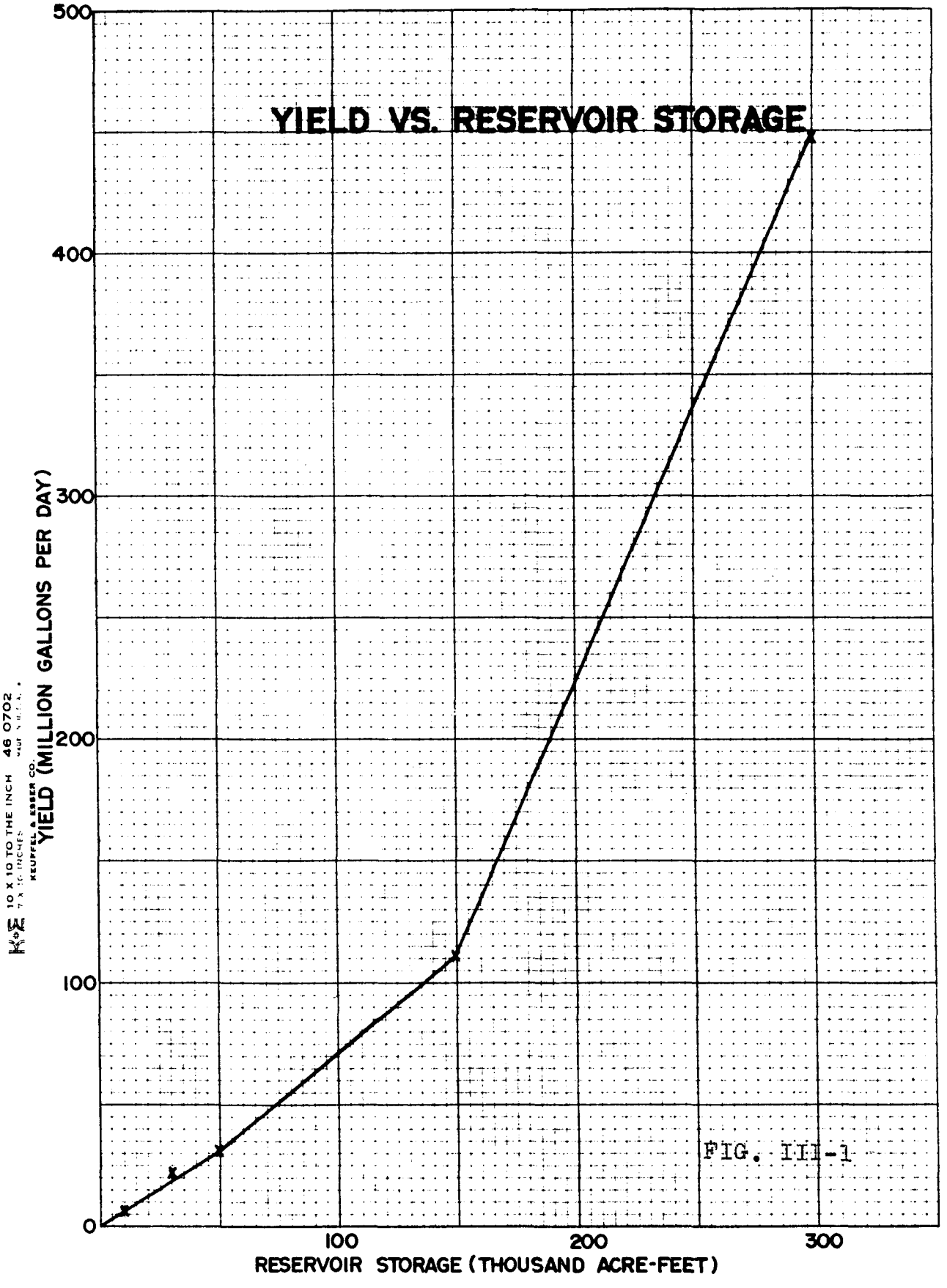
YIELD VS. RESERVOIR STORAGE
YIELD (MILLION GALLONS PER DAY)
RESERVOIR STORAGE (THOUSAND ACRE-FEET)
0
100
200
300
400
500
100
200
300
10 X 10 TO THE INCH 46 0702
KEUFFEL & ESSER CO.

FIG. III-1

TABLE III - 3

DELAWARE AND HUDSON REGION CAPACITY - YIELD RELATIONSHIP

Class (Thousand) Acre-Feet) Mid Range	Cumulative Capacity Thousand Acre-Feet	Cumulative Flow Million Gallons Per Day	M. G. D. [a]
300	14,500	21,600	447
150	18,850	24,800	111
50	26,100	29,200	30
30	27,550	30,200	21
10	29,000	31,100	6

Source: Senate Select Committee on National Water Resources

a. Derived data

per unit of yield. The capacity value in the Table is the mid-range of each reservoir class. The data for the curve are given in Table III-3. As can be seen from the curve, the yield is a non-linear function of storage capacity and exhibits an increasing relationship.

Table III-4 provides the relationship between capacity and outlay per unit of yield. It is obtained from the data in the Senate Select Committee report.[10] The mid-range value of the reservoir classes is used as a representative size.

TABLE III - 4

STORAGE - CAPITAL OUTLAY RELATIONSHIP
(1966 Dollars)

Reservoir Capacity - Acre Feet (Mid-Range)	Outlay/M.G.D. - Dollars
10,000	$305,000
30,000	228,000
50,000	211,000
150,000	143,000
300,000	95,900

Capital outlay per unit of yield will be dependent upon the size of the future storage facilities. Estimates of future facilities as to size distribution are included in the Senate report and are used as the basis for future size determination. There are two distributions given in the report. One distribution lists the reservoirs for the year

[10] Senate Select Committee on National Water Resources, op. cit., p. 58-64.

1954 by size class. The other gives a distribution for the 2000 period. The number is listed in percentages.[11] Both distributions are for the Delaware and Hudson region. These distributions are compared in Table III-5.

As shown in the table, there appears to be a shift towards the large size storage facility. However, since these are data relating to a large region, there are distortions when analyzing the specific northern New Jersey area. The topography and land available make it impossible to construct a 1,500 thousand acre-foot size reservoir in New Jersey. In a paper[12] presented at Rutgers University in 1966, an inventory was presented of available sites for reservoirs in northern New Jersey. The inventory indicated that, with the exception of the Tocks Island site, the remaining sites would be in lower class categories. Therefore, the distribution in Table III-5 would shift in greater proportion to the 10-80 thousand acre-feet classes. An examination of Figure III-1 indicates that the yield for the 10-80 classes of reservoir size is approximately 10-70 mgd. In this range of sizes, the yield approaches a linear relationship. The average of the two yields is used for this analysis or a value of 40 mgd. To allow for a range of alternatives, this value is varied by 20% to give a range of 32-48 mgd.

Using Figure III-1 and Table III-4, the average outlay for storage per million gallons daily is approximately $220,000 for the range

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[11] Senate Select Committee on National Water Resources, op. cit., p. 57-58.

[12] D. J. Kroech, Reservoir Site Capacity is Running Out in New Jersey. Paper presented at the Rutgers Public Policy Forum, Rutgers University, New Brunswick, New Jersey, January 11, 1966.

TABLE III - 5

COMPARISON OF RESERVOIR SIZES IN DELAWARE-HUDSON REGION
BETWEEN 1954 and 2000
(Thousand Acre-Feet)

Class (Mid-point)*	1954 (Actual) Per Cent)	2000 (Estimated) (Per Cent)	Change (Per Cent)
10	5.1	5.0	-0.1
30	8.8	5.0	-3.8
50	1.3	10.0	+8.7
80	12.8	15.0	+2.2
150	18.0	15.0	-3.0
300	0.0	10.0	+ 10.0
700	56.0	20.0	-36.0
1,500	0.0	20.0	+20.0

* The mid-point represents the value obtained from averaging the lower and upper range values.

32-48 mgd. With a band of 20% placed on this value, a range of $176,000 to $264,000 per mgd is obtained as the capital expenditure required for storage.

The same figure and table can be used to determine the storage capital outlays for reservoirs in the 150,000 and 300,000 acre-foot class. For example, from Figure III-1, 150,000 acre-feet gives a yield of approximately 200 mgd. Using the value of $143,000 per mgd from Table III-4, the capital outlay of $28,600,000 is obtained for this class of reservoir. In a similar manner, the capital outlay is obtained for the 300,000 acre-foot class. This value is $95,000 per mgd or approximately $49,000,000 as a total capital outlay. The following is the unit outlay summary:

TABLE III - 6

CAPITAL OUTLAY OF UNIT YIELD
(1966 Dollars)

Class (Yield in Mgd)	Unit Outlay (Dollars/Mgd)	
	High	Low
32-48	$264,000	$176,000
408-612	110,000	90,000

III.2 Outlays for Pumping

One of the components associated with a water system which is vital to its performance is the pumping equipment. The main considerations in the design of pumping facilities are the quantity of water which must be accommodated and the pressure differential or head against which the pumps must operate. Two of the elements which determine the

head are the elevation differences between the source of water and the pumping station and the length of transmission mains between these two entities. As to the length of transmissions, the variables of terrain and pipe construction are important.

Pumping stations are constructed in stages with the initial structure containing the electrical, mechanical, and instrumentation equipment. The pumps are added in stages as the capacity of the station is increased to meet additional supply requirements. The large disparity that may result from differences in capacity as compared to differences in system head will distort particular estimates for various stations. For example, using estimates made by the Corps of Engineers, New York District, a station with a capacity of 120 mgd and operating against a 685 foot head would require approximately $56,000 per mgd while another station with approximately three times the capacity and a head of 200 feet (compared to the previous 685) would require an outlay of about $10,000 per mgd. According to engineering practice, the capacity is usually designed as to permit three times the average daily requirement.[13] However, in northeastern New Jersey there are ratios as high as five-to-one for large systems with several flow controls. It is the smaller drainage basins with one control that more closely approximate the three-to-one ratio. For example, totaling the outlays for structure and pumps, the Round Valley pumping station approximates an outlay of $11,000 to $12,000 per mgd. The Point View Reservoir pumping station required approximately $18,000

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[13] W. Fair and J. Geyer, Elements of Water Supply and Waste-Water Disposal (New York: J. Wiley, 1961), p. 27.

per mgd. These two examples are the extremes of the capacity ratios where Round Valley is greater and Point View less than three-to-one. Additionally, there are many qualifying items of a technical nature which can substantially alter the estimates or outlays for a particular project, such as whether the installation is an on or off river facility.

The summary of the capital outlays for pumping is based upon a range of values. The values are given below for a 20% band around the average outlays given previously.

TABLE III - 7

CAPITAL OUTLAYS PER PUMPED UNIT
(1966 Dollars)

Pump Capacity / Average Capacity	Capital Outlays (In Dollars/MGD)	
	High	Low
5:1	$14,000	$ 9,600
3:1	21,000	14,400

III.3 Outlays for Purification

III.3.1 Treatment

The assumption is made that treatment of water supplies is required of most major sources. Whether anti-pollution programs will have an important effect on this element is a moot point at this time. The New York District of the Corps of Engineers conducted a survey of the Delaware-Hudson region. Their determination was that the capital outlay for a treatment plant would be approximately $250,000

per mgd of water treated. The plant's elements included chemical mixers and provisions for coagulation, sedimentation, filtration and post-chlorination. Usually, the treatment plant is built in stages, with new stages added when existing capacity reaches its limits. The estimate was made on the basis of a plant capacity of 5 mgd or more. The survey did not obtain values for low capacity treatment plants.

III.3.2 Intake

Another item associated with purification plants is the intake structure or the manner in which the plant obtains water for processing. The outlay for this structure varies greatly, depending whether the source is from a river or a lake and the physical construction required to convey and divert the water to the plant proper. On occasion, when a dam is built, the intake device is constructed together with the general project and the outlays form part of the general required funds. In estimating the requirements for an intake structure on a natural body of water, the outlay is readily obtained. For example, in obtaining water from the Hudson River at one installation, a crib and conduit were estimated at approximately $425,000. This estimate was based on the depth and width characteristics of the Hudson River. At another installation with a shallow, narrow body of water, the intake structure outlay was $200,000 or approximately one-half the Hudson estimate. If the level of pollution is different in both bodies of water, the intake outlays will vary due to this factor. This analysis weights the estimates equally and selects the value of $300,000 as the average

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[14] U. S. Army Corps of Engineers, "Memorandum: Costs of Water Supply Elements," (New York, New York District, 1967), p. 1.

outlay. With a 20% band, a high outlay of $360,000 and a low outlay of $240,000 are obtained.

III.4 Transmission

The physical path of the transmission mains and the quantity of water per unit of time that is required to be transported are the two important technical considerations in main design. First, there is the problem of whether pumping is required or gravity flow will occur. Then there is the problem of laying the pipes or mains in the ground. The required discharge of water and its velocity, on the other hand, determine the cross-sectional area of the required conduit. This relationship is:

$$A = \frac{Q}{V}$$

where A = cross-sectional area of conduit in square feet

Q = discharge in cubic feet per second

V = velocity in feet per second

It can be seen from this relationship that the size of the conduit is determined by the required flow, which in turn effects the physical placement of the conduit along its path. For example, the larger the conduit, the larger the required excavation, and thus a shoring requirement is more costly.

A set of curves[15] has been developed by the New York District, Army Corps of Engineers, which depicts the outlays for installing transmission mains as a function of the pipe diameter. The distinction between the two curves of the set is based upon the assumption that the

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[15] Ibid., p. 11.

average outlay will decline with longer transmission lines. This is probably a valid assumption for the range of lengths shown in the curve, that of approximately a mile and one-half to seven miles. The curves are shown in Figure III-2. The outlay includes the provision for concrete pipe, required excavation and backfill, shoring, topsoil, seeding and permanent and temporary land easements. The outlay is also based upon the physical path of the line occuring in a rural area. The curves indicate a declining average outlay as the diameter of the pipe becomes larger. This might not be realistic.

For example, if one were to assume that the pipe were laid near the surface of the ground, the cross-sectional area of an excavation would be the diameter-of-the-pipe across by the diameter-of-the-pipe deep. A five foot diameter pipe would thus have a cross sectional area of 25 square feet. If a nine foot diameter pipe is selected, the cross sectional area would be 81 square feet. Therefore, the earth moving operations would be more than three times the requirement for a five foot pipe. The requirements for equipment to transport and manipulate a nine foot versus a five foot pipe would be much greater. The curves are probably valid for a narrow range of pipe diameters with discontinuities occuring every few feet of increased diameter.

There is another consideration inherent in the curves and denoted for each one. This is the length of the transmission line.

The longer line is depicted as a lower curve since it is assumed there are economies of scale. The operational equipment has a large fixed cost which gives a lower unit cost as the number of units is increased. It is also assumed that lower unit costs are

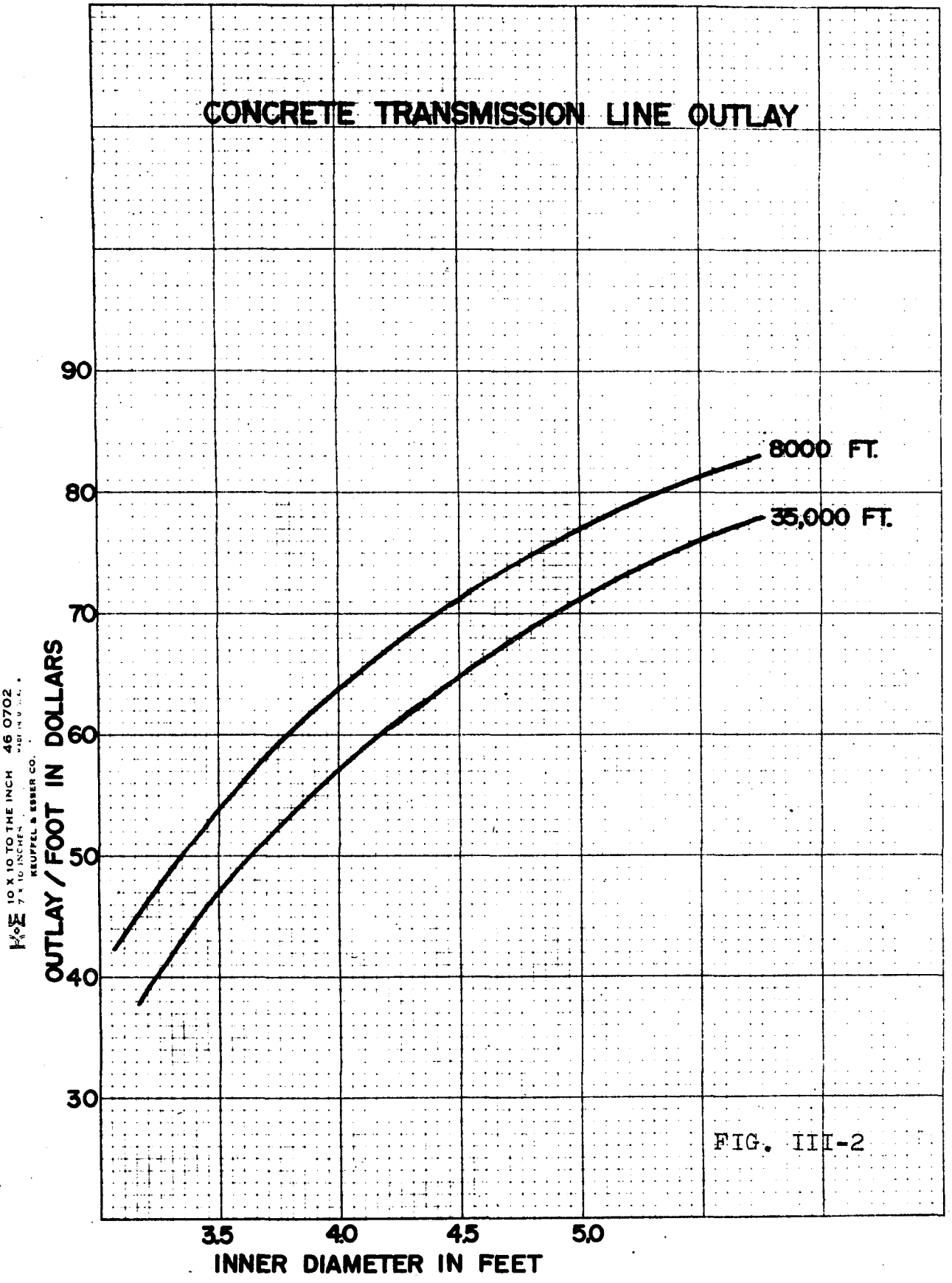
CONCRETE TRANSMISSION LINE OUTLAY
8000 FT.
35,000 FT.
OUTLAY / FOOT IN DOLLARS
90
80
70
60
50
40
30
3.5
4.0
4.5
5.0
INNER DIAMETER IN FEET
K&E 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES
KEUFFEL & ESSER CO.

FIG. III-2

obtained by the purchase of larger amounts of pipe.

Another important assumption is that new pipelines would be laid in areas where the land had not been developed. The requirement of easements and the restoration of the traversed area would thus be relatively inexpensive. It is anticipated that most future transmission lines will be routed through improved and unimproved areas. As the growth of population and industry occur in northeastern New Jersey, the rural areas will shrink in proportion to the total land use categories. The pipelines will become more expensive due to the type of land classification through which they are positioned. This factor is accounted for in the cost calculations performed in Chapter IV. Two streams of expenditures are analyzed; one for a concurrent land and construction expenditure and another for pre-project land expenditures.

In summary, transmission lines may in the future differ substantially from their historic outlays. The physical size of the lines may be appreciably increased as the storage areas become larger. This will necessitate the transmission of large volumes of water; hence, the larger pipeline. The length of the lines will increase as the trend of regional, rather than local, supplies of water become more prevalent. Also, the lines will probably run through land that has been substantially developed and thus the outlays associated with the physical installation of the mains will greatly increase.

Based upon the previous discussion, it is assumed that new water system facilities constructed from the year 1980 through 2000 will have the following characteristics:

1. Larger yield storage facilities than were exemplified by the historical distributions.

2. Consequently, larger diameter transmission lines will be required.

3. Longer transmission lines will be required.

4. Routing of the lines will be through relatively more expensive property than in the past.

A rationale of Item 2 is based upon the developed and proposed storage areas in northern New Jersey. For example, the Spruce Run - Round Valley facilities will yield over 150 mgd and the proposed Tocks Island complex will yield approximately 300 mgd. Thus the requirement for transporting large volumes of water by larger cross-sectional area pipelines.

The newer and proposed water storage facilities will be in the western regions of the study area. However, the required demand will still be in the heavily populated industrial eastern rings about the New York core. Therefore, the transmission lengths will be increased from an old range of 3 to 15 miles to a new range of 5 to 30 miles. These ranges do not include the municipalities adjacent to the water storage areas. In these instances, the transmission distance would obviously be minimal.

Future yield requirements in northern New Jersey will be fulfilled by different size categories of reservoirs. One category will be those storage areas that are developed within the state. These will tend to be relatively small in size. An inventory[16] of sites within New Jersey indicates that the average yield available is 40 mgd. This class of reservoirs is assumed to serve a specific area and thus require short

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[16] D. J. Kroech, op. cit.

transmission lines. The other type of reservoir developments will be those that serve a regional or interstate area. The transmission lines for this category will be longer and wider. The tendency toward regional development for northern New Jersey is exemplified by the Tocks Island project and the proposed Hudson River Valley Commission.[17]

It is assumed that a five foot diameter pipe with a length of 35,000 feet or approximately seven miles is representative of the lower class capacity storage reservoirs. Referring to Figure III-2, a concrete transmission line with these measurements has a unit outlay of $70 per foot. Using the same figure guide, an approximation can be made for a twenty-five mile transmission line with a diameter of six to seven feet. It is assumed that economies of scale due to purchases and manufacture of the pipe are cancelled by the higher outlays associated with the route of the line and the pipe size. Therefore, the 35,000 foot curve is still used as a basis for unit outlay determination. Extrapolating the curve into the six to seven foot range, an average value of $82 per foot is obtained. This value and the small pipe size value are calculated with a 20% band. Table III-8 contains a summary of the results. The table also shows the total capital outlay necessary for different lengths of pipeline.

III.4.1 Force Mains

The section on pumping outlays stated that expenditures for a project would depend upon whether the facility was an on or off river type. It is equally important in transmission whether a large pressure differential is required to pump out of a storage area or whether gravity

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[17] "Three Member Panel Urged for Hudson," New York Times, December 17, 1967, p. 32.

TABLE III - 8

CAPITAL OUTLAY FOR UNIT TRANSMISSION
(1966 Dollars)

Line Length (miles)	Diameter (feet)	Unit Outlay Low ($/ft)	Unit Outlay High ($/ft)	Total Capital Outlay Low (million dollars)	Total Capital Outlay High (million dollars)
7	4-5	56	84	2.1	3.1
25	6-7	65	99	8.5	13

flow can be depended on. Thus, the terrain over which transmission occurs is an important factor in the type of required line. A report[18] prepared by the Business and Defense Services Administration states that a marked trend has taken place towards pressure pipes. It also indicates that the pipes are increasing in cross-sectional area. The force main or pressure pipe is more costly than a gravity flow pipe. The Round Valley force main, which brought water to the reservoir from Hamden had an expenditure of approximately $300 per foot. The Point View project, which has a force main of 42 inches in diameter compared to Round Valley's 108 inches, required approximately $122 per foot.

In the determination of transmission outlays, it is necessary to consider the extent of pressure pipeline installation. This characteristic is highly variable and is dependent upon the topography between the source and the destination of the water. Using the Point View and Spruce Run - Round Valley projects as samples of the northeastern New Jersey area, an approximation of 15% of total capital outlays is

[18] U. S. Department of Commerce, Size and Regional Trends for Pressure Pipes in Water and Sewage Systems Business and Defense Services Administration (Washington: U. S. Government Printing Office, 1967)

estimated. This value is based on the length of force main as a percentage of total main length.

III.4.2 Booster Pumping Requirements

In transmitting water from its source to the area of use it is probable that quantities are withdrawn from the line along its path. These quantities serve the participant municipalities of the water system. The pumping capability of the main pump station is not sufficient to serve these additional distribution systems. Supplementary pump stations are required for these services. These outlays should be included in the transmission outlays of mains and feeder lines to the various places of use. An estimate of the capital outlay might be the $21,600 per mgd, which was determined previously for a pump installation. For example, if a municipality withdrew 5 mgd from the transmission line, it would require a booster station outlay of $108,000. This value is subject to the particular characteristics of the local distribution system and varies with the technical requirements of each area. The figure of $108,000 represents the outlay of obtaining a pressure equal to that of the main transmission line.

III.5 Operation, Maintenance and Replacement Requirements

The material developed in this portion of the analysis is derived from information supplied by the New York District Office and the North Atlantic Division Offices[19] of the United States Army Corps of Engineers. The information is in the form of Corps records and surveys taken by the Corps in its involvement with various projects. This section is a

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[19] U. S. Army Corps of Engineers, Project Justification Sheet for Reservoirs (New York, North Atlantic Division, 1967)

supplement to the capital outlay analysis and forms the basis upon which a complete financial burden of both capital and OMR[20] outlays can be estimated by a municipality.

III.5.1 Storage

The Corps of Engineers is responsible for the OMR expenditures for many flood control and multiple-purpose reservoirs in the New York - New Jersey region. These projects are Corps-built and serviced facilities. An analysis is made of the budgets of reservoirs which ranged in size from 7,950 to 124,000 acre-feet. The average yearly outlay for storage OMR, in 1966 prices, is $50,000. This includes the services of a dam tender, an assistant and the part-time services of a maintenance crew of fourteen men. The duties of the men include such tasks as painting, part replacement, lawn care and debris removal. The outlays also include the necessary materials such as paints, tools and small parts of an electrical or mechanical nature.

The replacements outlays considered in the expenditures are for the usual items of normal maintenance. These would include units of small value, whose service life would require periodic replacement. Switches, cables, tools, small motors, etc. are items that would be included in this category. The funds for these items are budgeted on a yearly basis and usually expended in the same year.

III.5.2 Pumping and Purification

The treatment plant and pump station are considered as one installation. For maintenance expenditures, an estimate of 1% of capital outlay is a typical value.[21] For example, if a plant requires a capital

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[20] OMR: Operation, Maintenance and Replacement

[21] Memorandum: Costs of Water Supply Elements, op. cit., p. 17.

TABLE III-9

TREATMENT-PUMPING STATION PERSONNEL REQUIREMENTS AND SALARIES
(1966=100)

Personnel Category	8 M.G.D. Plant	Personnel Category	35 M.G.D.Plant
1 Supervisor	$ 9,600	1 Chief Engineer	$ 12,000
1 Chemist	8,500	Purification	
		1 Supervisor	10,000
4 Operators @ $6000	24,000	1 Ass't Supervisor	9,000
		2 Secretaries @ $5000	10,000
8 Laborer Mechanics @ 5000	40,000	2 Instrumentation men @ $7000	14,000
		4 Operators @ $7000	28,000
1 Janitor	3,500	4 Ass't Operators @ $6500	26,000
		15 Laborer Mechanics @ $6000	90,000
Total	$85,600	1 Custodian	5,000
		Pumping	
		1 Supervisor	9,000
		4 Operators @ $7000	28,000
		Laboratory	
		1 Chemist	10,000
		3 Technicians @ $6000	18,000
		1 Aide	5,000
		Total	$274,000

expenditure of $4,000,000 it is estimated that this OMR requirement would be $40,000 per year.

III.5.2.1 Personnel Requirements

The necessity for licensed and qualified personnel is a major requirement for the operation and maintenance of a treatment and pump installation. In the case of a municipal utility, some individuals may perform multiple services in various departments. Therefore, it is not appropriate to charge their services totally against the water system. The numbers and types of people required depend upon the size of the plant. A typical schedule of personnel requirements and salaries for two differently sized plants is presented in Table III-9. The salary rates for the same type of position are different due to the skill requirements of the larger installation. The salaries are based on yearly rates. The total personnel expenditure requires a factor to account for the general administrative overhead and expenses such as vacations, sick benefits, etc. This factor is dependent upon the respective municipality and its personnel benefits and relationships. From Table III-9, it can be seen that the requirements may be built up in increments as the plant capacity is increased from a low to a higher level. The 8 mgd personnel schedule is the example of a nucleus which can be easily expanded.

III.5.2.2 Power Requirements

An important item necessary for the operation of pumping stations is the electric energy. In certain projects, the energy is derived from the installation itself by the use of turbines and hydroelectric techniques. However, the assumption is made that the municipality will purchase its power from an outside source. The basic equation for the

determination of the required wattage is derived as follows:

Let Q = average daily demand for water in mgd

h = head in feet (elevation head plus friction losses)

Convert mgd to cfs (cubic feet per second) by multiplying by 1.54

Thus cfs = 1.54 cfs/mgd x Q mgd = 1.54 Q cfs

The next step is to convert the requirements into horse power [22]

$$\text{Horsepower} = \frac{62.4 \frac{\text{lb}}{\text{ft}^3} \times 1.54\ Q\ \text{cfs} \times h\ \text{ft}}{550 \frac{\text{ft lb}}{\text{sec}} \times 0.7} = 0.249\ Qh\ \text{hp}$$

where 62.4 lb/ft^3 is the weight of a cubic foot of water

550 ft. lb/sec is the conversion factor to horsepower

0.7 is the efficiency factor

Now the horsepower required is converted to kilowatts.

The equation is

$$\text{Kilowatts} = \frac{0.249\ Qh\ \text{hp} \times 0.746 \frac{\text{kw}}{\text{hp}}}{0.8} = 0.233\ Qh\ \text{kw}$$

where 0.746 (kw/hp) is the conversion factor to kilowatts

0.8 is the efficiency factor

A typical rate schedule for the New York - New Jersey region indicates that a 40 mgd plant would expend power at a rate of [23] $4000/mgd/year. The cost would, in addition to the pump requirements, include the treatment plant machinery operation, lighting, controls and related devices.

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[22] E. Hausmann and E. Slack, Physics (New York: VanNostrand, 1946), p. 138.

[23] Memorandum: Costs of Water Supply Elements, op. cit., p. 22.

This equation is readily used since Q and h are obtainable for each particular project. Thus, with the kilowatt equation and rate schedule, the electric power expenditures can be determined.

III.5.2.3 Chemical Outlays

When a full treatment plant is required, there is also the need for chemicals. The amount of chemicals employed varies with the water condition and the extensiveness of the required treatment. The outlays are also dependent upon the quantity purchased and the transportation requirements. A value for the required chemicals used in treating Hudson River water was obtained from purchase records. The average yearly expenditure for chemicals was $3,100 per mgd.[24] Thus, if a treatment facility has a capacity of 30 mgd, its yearly outlay for chemicals would be approximately $93,000. This value is in 1966 dollars and is based upon the condition of the Hudson River water prior to any anti-pollution efforts.

III.6 Outlay Summary

Table III-10 is a summary sheet of the capital outlay items of the northeastern New Jersey area. The elements of force mains, intake structures and booster pump stations are in the summary form in Table III-10-S.

From the discussion in the previous sections, it can be seen that the treatment expenditures are subject to a wide range of values. There may be the case where the pumping and treatment are combined due to a minimum requirement of water processing. In other instances the treatment outlays will be very high due to the content of the water

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[24] Ibid., p. 15.

TABLE III-10

SUMMARY OF CAPITAL OUTLAYS FOR WATER SYSTEM ELEMENTS
(In 1966 Dollars)

Element		Capital Outlay	
1. Reservoir (Yield in MGD)		High	Low
32-48		$264,000/MGD	$176,000/MGD
408-612		$110,000/MGD	$ 90,000/MGD
2. Pumping Station (Peak/Average Ratio)			
5:1		$ 16,600/MGD	$ 11,000/MGD
3:1		$ 24,800/MGD	$ 16,600/MGD
3. Treatment (Degree of Requirement)			
Full		$300,000/MGD	$200,000/MGD
Minimal		$ 30,000/MGD	$ 20,000/MGD
4. Transmission (Length and Pipe Size)			
Length (Miles)	Diameter (Feet)		
7	4-5	$ 84/foot	$ 56/foot
25	6-7	$ 99/foot	$ 65/foot

TABLE III - 10 - S

SUMMARY OF CAPITAL OUTLAYS FOR SUPPLEMENTARY WATER SYSTEM ELEMENTS
(IN 1966 DOLLARS)

Element	Capital Outlay	
	High	Low
1. Force Mains	$200/ft	$122/ft
2. Intake Structure*	$360,000/structure	$240,000/structure
3. Booster Pump Stations	$24,000/mgd	$16,000/mgd

* Not as part of a reservoir

source. This is probably the case in the northeastern New Jersey area where the streams and rivers are subjected to a large amount of pollution.

The capital outlays are for goods and services and should not be construed as simply the material expenditures for a project. Items included in these estimates are expenditures for planning, engineering, legal, administrative and other service type activities. The provision for these services prior to actual construction procedures is an important factor in several of the intergovernmental aid programs discussed in Chapter V.

III.7 Survey Outlay Comparison

Each year, the staff of Water and Wastes Engineering conducts a survey of budgeted expenditures for water supply facilities. The survey for 1966 obtained responses from 188 water supply facilities which serve a population of approximately 45 million people. The results of the survey[25] are summarized as follows:

Source of supply	7.6%	
Transmission	31.1	Percentages of Total System Expenditures
Pumping	3.9	
Treatment	15.0	

The remainder of the expenditures are for items such as mains, booster stations, meters, hydrants and other projects.

The survey indicates that the transmission expenditure represents a large portion of the total system outlay. This would be the case where

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[25] Staff Report, "1966 Survey Data: Percent Distribution for Water Supply Expenditures," Water and Wastes Engineering, April 1966, p. 35-36.

the lines are long or the installation expensive. The survey and the summary sheet values are not in agreement as to each category of expenditures. The following are several factors which may have distorted the results of the survey.

There is no indication in the article whether the planned expenditures represent any size classifications. The expenditures for transmission may represent one size class of system and the expenditures for treatment and pumping another size class. In addition, the frequency of the component parts expenditures may be concentrated in one or two classes. This would bias any results and give a distorted or skewed distribution. And lastly, the survey results did not separate system requirements on a geographical basis. If particular sized elements were unique to one region, the entire survey would be biased. This situation does hold true for storage capacity.

A report[26] by the American Water Works Association contains a historical summary of component expenditures. This report suffers from the same generalizations as the above referenced survey. It is evident that the water resource field, which is characterized by peculiar and unique project requirements, is susceptible to wide variations in results between regional and national averages.

The values obtained from this analysis reflect the actual outlays which would be incurred in northeastern New Jersey. A foundation has been presented upon which future estimates may be made. The generalizations of the summary sheet and the range of values presented lend themselves to adaptation for the cost appraisal of future projects in the study area.

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[26]Staff Report, "The Water Utility Industry in the United States," Journal of the American Water Works Association, July, 1966, p. 767-785.

CHAPTER IV

CAPITAL COSTS

SUMMARY: In Chapter II, the use and availability of water were projected for the study area. Chapter III, Capital Outlay, dealt with the per unit capital requirements for water availability, i.e. water production capacity. This chapter translates the results of the last two chapters into a total capital cost requirement for northeastern New Jersey during the 1980-2000 time period.

IV Water Requirements

IV.1 Discussion

There are two projects contemplated for the northeastern New Jersey area during the 1980-2000 time period.[1] These two projects will be based on present water supply technology. The need for these projects was shown in Figure II-1, Projected Water Use and Availability for Northeastern New Jersey.

In order to meet the projected water needs from 1980 to 1998, an increase of 198 mgd will be required in the study area. This estimate is obtained from the Supply analysis performed in Chapter II and summarized in Table II-10. It was estimated that 63 mgd will be obtained from ground water sources, leaving a surface water requirement of 135 mgd.

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[1] R. E. Cyphers, op. cit., p. 3.

The 63 mgd ground water will be obtained from three sources. It is assumed that the privately owned utilities in the study area will develop 20 mgd of ground water. The remaining 43 mgd will be supplied by the irrigational and industrial self-supply activities.

As stated in Section II.5, Supply, the 198 mgd was the requirement determined by considering the present and future water projects for the northeastern New Jersey area.

IV.2 Future Water Projects

IV.2.1 Passaic Valley Program

The Passaic Valley Program is a multiple-purpose project, proposed by the United States Army Corps of Engineers, for the Passaic Basin.[2] The program will consist of two reservoirs which will, in total, yield 75 mgd.[3] Using the time base established by Table II-10, Chapter II, this project would be completed by 1990.

IV.2.2 Crab Island Project

The Crab Island Project will entail the construction of a tidal dam across the Raritan River. This will be done to prevent the water from becoming additionally contaminated by the ocean salt content. The source of water will be the use of the Raritan River flow of approximately 60 mgd.[4] There will be no true reservoir or storage facility. The project, which will be in Middlesex County, will have provisions for flood control, recreation and wildlife activities. According to

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[2] R. E. Cyphers, op. cit., p.2.

[3] Ibid., p. 2.

[4] Ibid., p.

the time schedule of Table II-10, Chapter II, the developed yield of this project will be available in 1995.

IV.3 Capital Cost Alternatives

The water systems required for the two projects may be obtained by capital expenditures occurring in alternative time sequences. The analysis in this section first determines the capital outlay of the systems by determining their component requirements. The individual parts are then summed to obtain the total required outlay.

In discussing a firm's present and future demand of goods and services, the important variables to be considered are price, quantity of goods and services purchased and the interest rate.[5] Likewise, the amount of investment undertaken by a municipality may depend on the rates charged and quantities of goods and services provided during a time period and the interest rate. These three variables are important determinants of the investment process.[6] The primary issue is whether a municipality should make expenditures for items far in advance of their productive process. The purpose is to determine which expenditure stream will give a municipality its desired level of capital outlay at least cost.

Schneider terms the capital outlays preceding the productive process as, ". . . the investment related to the process of production."[7]

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[5] W. J. L. Ryan, Price Theory (New York: Macmillan, 1958), p. 159.

[6] In addition, the social benefits are important determinants of the investment process. However, this analysis will not make a determination of these benefits other than by indicating the quantity of water required in the study area. The reader is referred to the cost-benefit literature for other approaches to the problem.

[7] E. Schneider, Pricing and Equilibrium (New York: Macmillan, 1962), p. 198.

Before production can be initiated, there must be a period or periods of planning and expenditures for the constituents of the productive process. Capital costs for a project must be calculated from the time expenditures are made for a facility until the time that operations commence and an output is obtained. Therefore, the total capital cost for a project will be dependent upon the time sequence of expenditures for components.

IV.3.1 Land Acquisition, Planning and Construction Costs

This section determines the capital costs for the projects previously described in Sections IV.2.1 and IV.2.2. The assumptions made in this series of calculations are that a) there will be no previous investment for any of the water system components prior to the start of the project, b) the project expenditures will occur in a prescribed manner during the land acquisition planning and construction period.

The cost relationships are developed in the following manner:

C_j = capital outlay for the jth period

where $j = 1, 2, \ldots, n$.

The capital cost for each expenditure period is the capital outlay compounded from the expenditure period to the time of the project completion, i.e. C_{c_j}.

IV.1 Thus $C_{c_j} = C_j (1 + i)^x$

where $x = 1,2,\ldots,n$.

i = interest rate

The total capital cost would be

$$\text{IV.2} \quad T_{cc} = \sum_{j=1}^{n} C_j (1 + i)^x$$

where when j=1, then x=1 and when j=n, then x=n.

In this analysis, the outlay periods are taken in yearly intervals and the compounding is performed on a quarterly basis. Thus, the relationship is:

when j=1, then x=4 and when j=n, then x =4n.

IV.3.1.1 Capital Outlay Calculations for Passaic Valley and Crab Island Projects

The calculations of capital outlay requirements for the Passaic Valley and Crab Island projects are based upon the analysis of Chapter III and the contents of Table III-10. This Table is the capital outlay summary for the various elements of a water system. The values selected from the Table are based upon several assumptions.

First, the two projects have yields of 75 and 60 mgd. These values are closest to the 32-48 mgd yield category for reservoirs listed in the Table. The reservoir capital outlay required for this category is $264,000/mgd. Therefore this value is used for calculating the storage requirement for the two projects. Although the Crab Island project does not contain a true storage capacity, it is assumed to require the same outlay as a reservoir. The Crab Island yield will be obtained directly from the river prior to a tidal dam. There may, at times, be some back-up of the river waters due to the dam. However, the dam will be provided to primarily protect the river water from salt contamination.

Secondly, the pumping station and water treatment requirements are taken from the Table as $300,000/mgd. The assumption is that full

treatment of the water will be necessary and that the pumping function will be combined with the treatment plant.

Lastly, the transmission requirements are assumed as two seven mile lines for Passaic Valley and two seven mile lines for Crab Island. In total, there will be the need for four seven mile lines for the transmission requirements of the two projects. From Table III-10, the capital outlay of $84/ft is used for these components.

The capital outlay calculations for the two projects are given in Table IV-1. The Table also gives the values for two different time streams for the planning and construction of the projects. The streams are for five years for Crab Island and nine years for Passaic Valley[8] and are compounded at rates of four and six percent. The six percent rate is the present legal limit in New Jersey at which municipal bonds may be financed,[9] and the four percent rate is to allow for a variation in the rate over time.

Aside from the statutory limitations on the interest rate, there are more important economic reasons for the selection of these values. Due to the tax exempt features of municipal bonds, this interest rate variation has fulfilled the optimility conditions for the private subjective time preference rate as described by Baumol.[10] In addition, the externalities imputed to water supply projects, to-

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[8]Preliminary Estimates, New York District Office, U. S. Army Corps of Engineers.

[9]Section 40A:2-14, New Jersey Statutes.

[10]W. J. Baumol, "On the Social Rate of Discount," American Economic Review, September, 1968, p. 788-802.

gether with the relative absence of risk for these projects compared to private undertakings, give a higher rate of return than the selected four to six percent. Therefore, the interest rate variation chosen for comparison might also allow for efficiency in the allocation of resources between public and private needs.

The five and nine year duration of projects for the land acquisition and construction stages is also representative of United States Army Corps of Engineer completion times. An investigation was performed, using the Corps of Engineer Annual Reports[11] of the past twenty years, to determine the time lengths of water supply projects and their expenditure patterns. As a result of the analysis, which included such projects as the Bear Creek Reservoir in Pennsylvania and the Mad River Reservoir in Connecticut, the following outlay patterns were developed for each outlay stream:

SCHEDULE OF OUTLAYS FOR 5 AND 9
YEAR OUTLAY PATTERNS
(In Percent)

5 Year	9 Year
3	3
47	5
30	20
15	40
5	20
	8
	2
	1
	1

[11]United States Army, "Annual Report of the Chief of Engineers." Civil Works Activities (Washington: U.S. Government Printing Office, 1945-1966).

This schedule of expenditures for projects was used in determining the costs given in Table IV-1.

It is interesting to note that outlay patterns were not considered or brought forth for discussion in a recent Congressional hearing.[12] The entire efforts of the committee were directed towards the use of a proper and uniform interest rate for all governmental calculations of cost-benefit relationships. However, equally as important is the assumed expenditure pattern for a project. Distortions in the expenditure stream could easily alter the total costs of a project and therefore make comparisons between related or alternative activities dependent upon the theoretical pattern. The interest rate would then be subverted in its importance.

IV.3.2 Pre-Project, Planning and Construction Outlays

In the previous section, the outlay process was considered from the planning through the construction periods of a project. There was no cognizance given to the possibility of pre-project expenditure for one or more of the components of a water system. However, pre-project investments have been undertaken in the past by the New Jersey Green Acres Acquisition Program and the proposed Blue Waters Program may be instituted. Both of these programs are fully discussed in Chapter V, Sections V.4.2.2.2 and V.6.2. Before compounding the total outlays for the projects, an examination is required of the system components for pre-project characteristics.

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[12] U. S. Congress, "Interest Rate Guidelines for Federal Decision-making," Joint Economic Committee, 90th Congress, S.2, Jan. 29, 1968.

TABLE IV-1

CAPITAL OUTLAY CALCULATION - ONE OUTLAY

(1966 Dollars)

Function	Quantity	Unit Outlay	Total Estimated Outlay (Unadjusted)
Storage	135 mgd	$264,000/mgd	$35,640,000
Treatment & Pumping	135 mgd	$300,000/mgd	40,500,000
Transmission	126,720 ft	$84/ft	10,644,480
			$86,784,480

CAPITAL OUTLAY REQUIREMENTS FOR PASSAIC VALLEY PROGRAM: $48,213,600
CAPITAL OUTLAY REQUIREMENTS FOR CRAB ISLAND PROJECT: $38,570,880

Land Acquisition, Planning and Construction Stages: Capital Cost

	9 Years		5 Years	
	4%	6%	4%	6%
Passaic Valley	80,543,737	109,493,073	--	--
Crab Island	--	--	54,151,970	66,162,568
Totals	$80,543,737	$109,493,073	$54,151,970	$66,162,568

An investment for transmission lines for water systems, prior to the actual development of a project, would, for many reasons, be a speculative undertaking. Firstly, the requirements of an area for a project may change with time and thus bring about the cancellation of the project. If a project is not cancelled, its capacity and area of service may be altered and again the transmission needs would be different. Secondly, there is no way of predicting the physical development of an area as to its content of residential, commercial and industrial use. In other words, the determination of which sites would have factories, shops or homes erected on them would be a difficult task. Naturally, as the time of a project approaches its initial stages, the uncertainty of the transmission requirements would be diminished.

The requirements for treatment and pumping facilities would not be considered prior to the commencement of a project and the installation of transmission lines. Even if the facilities could be maintained in proper working condition, the degree of treatment and the amount of pumping would be dependent upon the water purity and the topographical profile of the transmission path. Therefore, this type of outlay would not normally occur as a pre-project requirement.

The remaining element in the system is the storage requirement and the acquisition of land. Land in northeastern New Jersey, as well as other heavily industrialized and populated areas, has increased in value as large tracts are developed for industrial and residential purposes. The increase in land values is dependent upon whether general development occurs or whether the land is developed for a specific

purpose. For example, as the Tocks Island project along the Delaware River became publicized, the project land, as well as land in its immediate vicinity, increased in value. Similarly, when land is developed for new industrial parks and residential and commercial activities due to the regular outgrowth or enlargement of an area, land values usually rise in multiples of several hundred percent in a five to ten year period.[13] However, it is evident that from among the several components of a water system, the storage facility and the required land would be a reasonable place for pre-project investment activity.

In the previous section, the capital outlay relationships were developed with the assumption that there would not be pre-project investments. With the consideration of pre-project land acquisition, there are now two outlay phases. The first is for planning and construction. The total capital cost for this phase is equation IV.2 or

$$T_{cc} = \sum_{1}^{n} C_j \quad (1 + i)^x$$

The second outlay phase is for the acquisition of land prior to the planning and construction period. The cost relationship is developed as follows:

C_a = the capital outlay for land in the ath period

where a=the number of periods in the pre-project investment time, but not including the planning and construction stages.

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[13] Real Estate Division, Planning Division, North Atlantic District, "Realty Historical Files," U. S. Army Corps of Engineers, New York, N. Y., 1960-1968.

IV.3 Therefore $C_{ca} = C_a \quad (1 + i)^a$

where C_{ca} = compounded capital outlay or capital cost for the ath period

i = interest rate

However, the land expenditure must not only be compounded through the pre-project phase, but also through the planning and construction periods. Therefore,

IV.4 $C_{ct} = C_a \ (1 + i)^{a + x}$

where C_{ct} = total capital cost for land

IV.5 and $T_{DC} = \sum_{1}^{n} C_j \ (1 + i)^x + C_a \ (1 + i)^{a + x}$

where T_{DC} = total capital cost for a project

It is also assumed that the land outlay will occur in a lump sum in the first pre-project investment period.

IV.3.2.1 Capital Outlay Calculations for Passaic Valley and Crab Island Projects Including Pre-Project Investment

The calculations of this section are based upon two capital outlay occurrences. The first is for the planning and construction requirement and the second is for the pre-project acquisition of land. The relationship developed in equation IV.5 is used for the determination of the cost requirements. The capital outlays for the water system elements are obtained from Table III-10. However, for the calculations of this section, it is necessary to separate the land requirement per mgd from the storage value given in the Table.

In section III.1.1, Land Costs, Chapter III, Capital Outlay Analysis, the percentage of land outlays to total outlays for a reservoir varied from 35 percent for Tocks Island to 69 percent for Point View. In the calculations, it is assumed that the land investment for the two projects is approximately 70 percent of the storage requirement. The same interest rates and assumptions ued in Table IV-1 hold for Table IV-2.

TABLE IV-2

CAPITAL OUTLAY CALCULATION - TWO OUTLAYS

(1966 Dollars)

Function	Quantity	Unit Outlay	Total Estimated Outlay (Unadjusted)
Land	135 mgd	$182,160/mgd	$24,591,600
Storage - Land	135 mgd	$ 81,840/mgd	11,048,400
Treatment + Pumping	135 mgd	$300,000/mgd	40,500,000
Transmission	126,720 ft.	$84/ft.	10,644,480
			$86,784,480

CAPITAL OUTLAY REQUIREMENTS FOR PASSAIC VALLEY PROGRAM: $48,213,600

CAPITAL OUTLAY REQUIREMENTS FOR CRAB ISLAND PROJECT: $38,570,880

	Planning and Construction Stages: Capital Cost			
	9 Years		5 Years	
	4%	6%	4%	6%
Passaic Valley	43,720,766	49,190,733	--	--
Crab Island	--	--	31,515,697	33,653,031
	Pre-Project Stage: Capital Cost			
Passaic Valley	29,102,792	42,357,665	--	--
Crab Island	--	--	19,855,804	26,703,199
Totals	$72,823,558	$91,548,398	$51,371,501	$60,356,230

The expenditures required for the public water system projects have been computed in a manner similar to any private investment process. However, in the case of the municipal water system investments, there are social benefits which also accrue to the projects. The assumption of the analysis has been that the per capita requirements for water are an adequate indication of these benefits. Thus a necessary level of production has been determined with its concomitant capital outlay. The important consideration was to determine how the capital outlays could be accomplished at the least cost.

The primary factor in this cost, other than the interest rate, is the time path of the expenditures. A comparison of Tables IV-1 and IV-2 indicate that the pre-project acquisition of land results in lower costs. This result is due to the assumption that the interest rate is lower than the rate of increase of land values. In other words, the cost of holding land for a period of time would be less than its increased market valuation over the same period. A desirable condition would be to contract the expenditure stream and place the project into production without being delayed by the comparatively small expenditures towards the completion. This method of obtaining a project output before its final stage is completed will be utilized in the New York World Trade Center. By the use of construction techniques not previously employed, the floors of the buildings will be put to use in a sequential manner as other floors are constructed on top of them. As discussed in Chapter III, this stage type construction is used in water projects for expansion purposes of the pumping and purification plants. However, the initial outlays for water system components seem constrained by the present day technology. In multiple purpose projects, it may be possible to utilize recreational and boating facilities prior to the completion of the entire project.

CHAPTER V

FINANCING OF CAPITAL REQUIREMENTS

SUMMARY: This chapter describes the organizational structure for the operation and financing of municipal water utilities in New Jersey. Additionally, other sources of capital funds from State and Federal levels are discussed. The implications of the various financing arrangements are analyzed.

V.1 Water Supply Organizations in New Jersey

The following sub-sections will briefly describe the financing procedures and operational structure of the water supply organizations in New Jersey. The intent of this material is to provide the description of the methods by which water utilities in New Jersey have previously financed their activities.

V.1.1 Municipally-Owned Public Utilities

The municipally-owned and operated water utilities are usually managed and supervised by a separate department within the governmental framework of the municipality. The head of the department is responsible for the operation and maintenance of the facilities while the financial structure of the utility falls within the jurisdiction of the general municipal structure. However, it is required that the municipality keep separate accounting records entitled "Water Utility Fund,"[1] and documents for the utility.

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[1] Section 40A: 4-62, Title 40A, New Jersey Statutes.

In New Jersey, the funds needed by the utilities for acquisition or expansion of a system are obtained by the issuance of general obligation bonds of the serial type.[2] Under certain circumstances, assessment bonds[3] are issued; however, they are rarely used. The bonds are backed by the full taxing powers of the municipality and by statute are the prime obligation of the community. Another characteristic of the bonds is that they are generally held by large financial and institutional investors rather than by individuals. The reason for this situation is the low yield-tax exempt characteristics of the bonds.

V.I.2 Privately-Owned Public Utilities

The private utilities are organized and operated, firstly, under the laws and regulations of the State of New Jersey, which apply to any corporate entity doing business in the State, and, secondly, there is further supervision and regulation of the utilities by the Public Utilities Commission of the state. The Commission maintains statutory control over the rates and all plans and activities of the utilities.

The instruments used to capitalize and finance the activities of the companies are similar to those used by any private entity; namely, the issuance of common stock of various categories (e. g. preferred, cumulative) and bonds and debentures.[4] The bonds most commonly issued are first mortgage instruments of the straight line payment type.

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[2]Section 40A: 2-3, New Jersey Statutes.

[3]Section 40A: 2-14, New Jersey Statutes.

[4]Section 40: 3-8-10, New Jersey Statues.

V.I.3 Joint Municipal Utilities

Under the statutes of New Jersey, two or more municipalities may join together to form a commission.[5] It is then the responsibility of the commission to perform the administrative, operational and maintenance activities required for adequate and safe water supplies for the participating municipalities. In the northern New Jersey area, the Passaic Valley Water Commission is the only organization of this type. It is the joint responsibility of the municipalities of Paterson, Passaic and Clifton.

The responsibility is shared by the individual municipalities as to the financing originally required to purchase the privately-owned waterworks. Any new financing requirements are met by the issuance of general obligation bonds on the part of each municipality. An agreement between the municipalities specifies the share of the debt each will assume and the representation each will have on a Board of Commissioners for the utility. The Passaic Valley Water Commission operates a complete system of source, storage, transmission, purification and distribution.

V.I.4 Water Supply Districts

The statutes of New Jersey created two water supply districts by geographical designation.[6] The district for the northeast is administratively operated by an agency known as the North Jersey District Water Supply Commission. The responsibility of the districts is to furnish an adequate supply of water for the municipalities within its jurisdiction which request its assistance. It cannot require

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[5] Section 40: 62-101, New Jersey Statutes.

[6] Section 58: 5-1, New Jersey Statutes.

municipalities to participate in its operations. Any municipality may apply to the commission for a supply of water. Then, there are negotiations between the commission and the municipality or municipalities for the sharing of the cost of the requested water supply installations.

V.2 Municipal Sources of Funds for Water Project Investments

As stated in the beginning of this chapter, municipal water utility financing has been underwritten by general obligation bonds. The legal requirements for this type of financing and the related statutes of the State are given in Appendix A, section A.1.2. The cost of operation, maintenance and replacement functions, together with the principal and interest payments for the bonds, is met by user charges placed on water services. This procedure of operation meets the requirements of the statutory rule for self-liquidation financing of a utility. Theoretically, there is no statutory limitation as to the amount of indebtedness a municipality can assume for self-liquidating financing of a utility, providing the utility operates at a surplus. However, the statutes require that if a deficit of any magnitude should occur, the entire utility debt must be included in the municipality's indebtedness.[7] Therefore, in practicality, those who underwrite and subscribe to municipal bonds, whether for the general municipal operations or for special purpose financing, carefully evaluate the total municipal financial condition. The general obligation bond has been the only financial instrument for financing of municipal water systems in New Jersey.[8]

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[7]Section 40A: 2-48, New Jersey Statutes.

[8]Section 40A: 2-3, and Comments, New Jersey Statutes.

There is also the provision in the New Jersey Statutes for the re-issuance of bonds in order for municipalities to avail themselves of changes in interest rates. In addition, the municipalities have the power to issue short-term instruments. These are called bond anticipation notes and can be issued for a maximum period of one year. The intent of the notes is to allow for progress on a water system or other project before the formal approval of a bond issue by the voters in an area. Usually the bond issue, when formally approved, has an amount, included in its total value, to account for the anticipation notes.

There is another relevant characteristic of municipal financing procedures in New Jersey. When a bond issue is approved by a popular referendum, there is no requirement for the municipality to immediately undertake the bond issue. Many of the municipalities have bond issue authorizations, which have not been exercised. The bonds are not issued due to reasons which may be technical or political. The amount of bond authorization, together with a description of the bond purpose, is listed in a statement in the capital section of the "Water Utility Fund."

In recent years, another type of financial instrument has been used by municipalities which have organized special districts and authorities. These instruments are the non-guaranteed revenue bonds. The intent of this type of bond is to enable the municipalities to circumvent their legal debt restrictions.[9] Non-guaranteed revenue bonds are not included within the debt limitations of a municipality

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[9] John H. Allen, "Municipal Debt Curbs Are Decried," New York Times, December 24, 1967, p. 1.

since the risk is borne by the bondholders and not the municipality. If there should be a default in the amount or number of debt servicing payments, the bondholders have no recourse other than to accept whatever payments are available.

In summary, the general obligation bond, which is backed by the taxing power of the municipality and is a debt responsibility of the taxpayers, is the main instrument used in New Jersey for utility financing.[10] At the present time, due to statutory requirements, the non-guaranteed bond cannot be used by individual New Jersey municipalities for financing purposes.

V.2.1 Funds for Re-Investment Purposes

The municipal utilities in New Jersey may budget each year for capital outlays. These funds, once specifically designated for this capital account, cannot be used for purposes other than capital expenditures. If the funds were allowed to accumulate over the life of a project or a water system, they would provide an appreciable reserve for re-investment purposes. However, there are several drawbacks, which preclude the building up of a large reserve in the funds.

The fund can be used for contingency purposes and the usual replacement of capital stock which occurs during normal use. In fact, one of the determining elements of the amount placed in the budget is the yearly estimate of replacement and contingency needs. In the event the funds are not expended during their budgeted time period, there is no requirement that new funds be added each year. Also, if a particular governing body of a municipality should decide to accu-

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[10] Section 40A: 2-3, New Jersey Statutes.

mulate funds for a specific capital expenditure in the future, there is no binding requirement upon succeeding bodies to follow the same course of action.[11]

There is another aspect of municipal utility operation which allows for funds to be transferred between the utility and the general municipal accounts.[12] This may occur when the utility operates at a deficit and the municipality is required to provide financial support. If the utility should incur surpluses, these may be appropriated by the municipality for its general operation. In that event, the utility budget for the new year may either be reduced due to the previous year's experience or it may be continued at the same level. If there should be continuing surpluses, the municipality may also use these funds for general municipal operating purposes. The utility may balance its financial operations by budgetory procedures or by changing the water rate schedules.

There is another fund in the utility capital section, entitled "Capital Surplus." This fund is an accumulation of small accounts that are not expended from bond issues. Its magnitude could be large for a short period of time when a project is in a transient or temporarily halted stage of construction. Nevertheless, the capital surplus account would not be a source of funds for the financing of new expenditures programs.

In practice, the financial operation of the municipal water utilities is such as not to provide for future capital requirements. When new amounts of funds are required, the bond issue is the sole

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[11]Section 40A: 2-22, New Jersey Statutes.

[12]Section 40A: 2-48, New Jersey Statutes.

substantial and main provider of the necessary capital. Although there may be an accumulation in the capital reserve account, the political and technical uncertainties of the utilities operation makes this, at best, an uncertain source of investment capital. The magnitude of the capital surplus account precludes it from becoming a source of investment funds. Therefore, both by intent and operational procedures, there is no accumulation of funds within the municipal utility accounts.

V.3 State and Federal Sources of Funds for Municipal Water Projects

V.3.1 General Discussion of State Activities

The State of New Jersey did not directly accept the responsibility for the development of water system components until the Spruce Run - Round Valley project. Although the various state agencies were responsible for the technical evaluation and approval of all local water projects, their function was mainly a supervisory one. Not until difficulties arose in water supply requirements due to drought conditions of the early 1950's, did the State act to fill an evident gap in planning and development functions. Aside from the agencies responsible for water supply, other state agencies which are concerned with the general planning and development of the state, have taken an active part in the planning requirements.

V.3.1.1 State Bonds

The major state bond issue in the area of water supply has been the "Water Bond Act of 1958." The bonds are serial, general, obligation bonds which are backed by the full faith and credit of the State of New Jersey. The principal and interest payments are to be met by user charges for the water supply. The entire mechanism for the approval and administration of the bond act and the funds realized therefrom, are

analogous to the requirements of municipal bond financing.

A "Water Bond Fund" has been organized for the purpose of separating the financial affairs of the water supply facilities from the other state functions. There is also a provision in the Act for transferring a Water Fund surplus into the General State Fund. This transfer may be accomplished only when sufficient funds have been accumulated within the Water Fund to meet interest and bond maturity payments for two years into the future. Similarly, funds will be transferred from the General to the Water Fund when bond obligations cannot be met. This is analogous to the municipal bond financing arrangements. It also precludes, as in the case for municipalities, the accumulation of large reserve funds which might be used for new future capital requirements. The "Water Supply Law" and "Water Bond Act" are discussed in detail in section V.4.2.2.1.

Other State legislation which will have a major effect on future financial requirements for both the State and the municipalities are the "New Jersey Green Acres Land Acquisition Act of 1961," and the "New Jersey Green Acres Bond Act of 1961."[13] The intent of the legislation was to acquire lands in the State for future use as recreational facilities and the development of natural resources. The state government thus acted to secure these lands before private and industrial developments made their future acquisition too costly or impractical. Among those purposes enumerated in the legislation for which the land is to be used, the pertinent ones to this analysis are water reserves

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[13] General Assembly Nos. 540 and 541, Official Copy Reprints, New Jersey Green Acres Land Acquisition and Bonds Acts of 1961 (Trenton, 1961).

and reservoirs.

The financing for sites purchased throughout the state was obtained by use of the Green Acres Bond Act. This act provided for $40 million to be used by the state for direct acquisition of property. An additional $20 million was provided for matching grants of 50% of land costs to municipalities for their land purchases. The bonds were general obligation bonds of the State of New Jersey. They had a maturity period of thirty-five years, serial payment provisions and their interest rate could not exceed 4%. At the present time, the entire bond issue has been employed for acquisition purposes. The acquired land will be used for recreational facilities, park development, water resources development and land reserves for development of facilities such as airports.

Since there will be no revenue from user charges until the lands have been developed, the funds to meet the interest and principal payments on the bonds are obtained in the following manner:

For the interest payments, the funds are obtained in a prescribed order:[14]

1. Revenues derived from fees and charges for use of other State parks and recreational facilities.

If these revenues are not sufficient to meet the interest payments, the following sources of funds are to be used:

2. Revenues derived from the tax collected under the Corporation Business Tax Act of 1945, as amended and supplemented.

3. Assessments on each of the municipalities in the State.

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[14] Ibid., p. 3.

The assessments are to be in the form of a tax on real and personal property in each municipality.

The principal payments for the bonds are to be provided for by the General Fund of the State. In the event there are not sufficient monies in this Fund, then the remainder is to be obtained by an assessment against every municipality.[15] The manner of assessment is the same as for the interest payment requirements.

V.3.2 General Discussion of Federal Activities

The Federal government's participation in water supply activities has, historically, been in multiple-purpose developments of river basins. The prime activity has been in flood control projects with the activities of power development, water supply and recreation taking secondary consideration. Not until the River and Harbor Act of 1958[16] was it the declared intention of the Congress that water supply become an additional objective of projects constructed by the Corps of Engineers. With the re-occurrence in the 1960's of drought conditions throughout the northeastern area of the United States, Congress authorized the Northeastern United States Water Supply Study.[17] Specifically, the legislation provides for the planning of water supply projects in the Northeast. It also requires that provisions be made for Federal participation in the financing of projects undertaken by state and local governments.

The remaining Federal programs relating to water supply are

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[15] Ibid., p. 4.

[16] Public Law 85-500, 85th Congress, 5.3910, July 3, 1958.

[17] Public Law 89-298, 89th Congress, 5.2300, October 27, 1965.

those which indirectly provide funds or financial support. These programs are the Housing and Urban Development Act and the Economic Development Act, which are discussed in sections V.4.3.2.3 and V.4.3.4. Water supply is of minor importance in these programs.

V.3.2.1 Federal Financing Arrangements

There are several methods by which the Federal government financially participates in major water supply projects. These are discussed in relation to the type of project which is proposed for construction.

V.3.2.1.1 Multiple Purpose Projects

The Federal government, by building storage facilities and dams for multiple-purpose use, provides a costly element in the water supply system. In those instances where water supply provision is made in a Federal project, a cost sharing arrangement is negotiated with the potential users. Thus, the effect of this type of project is for a cost-sharing basis between the Federal and state or local governments. In the past, the percentage of the cost borne by the Federal government has been substantial.[18] Additionally, the state or local governments obtain the benefits of flood control and recreational facilities.

V.3.2.1.2 Cooperative Projects

This type of project is presently in the planning stages by the Corps of Engineers. The authority for this activity is Public Law 89-298, which instituted the Northeastern United States Water Supply Study. The Law stipulates that the financial arrangements should be

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[18] Public Law 85-500, op. cit., p. 1.

based upon a cost sharing concept. However, since these projects will primarily be concerned with water supply requirements, the proportionate share borne by the states or municipalities would probably be larger. Where the projects also include multiple purpose activities, the larger percentage of the cost would again shift towards the Federal government.

V.3.2.1.3 Assistance Projects

The Federal government provides funds for water supply systems under a variety of programs; mainly for the objectives of rural and urban development and growth and welfare considerations. The aid is in the form of direct grants, cost-sharing, loans and the advancement of funds with contingent conditions. In addition, funds are allocated for planning and research activities. The bulk of the funds is keyed to the economic conditions of a particular area. The amounts of the grants and cost-sharing arrangements are dependent upon indicators of unemployment and per capita income. These programs are described in section V.4.3.

In the sections above, which delineate the types of projects for which Federal participation is an important financial element, there is a common factor, namely the financing arrangement employed by the Federal government. First, each type of program or project has funds appropriated by Congress. These funds are for the implementation of the programs in all the states and/or municipalities of the country. One of the assumptions made in Chapter I, section 1.2.5, was that there would be sufficient funds for the carrying out of various objectives. Evidently, as the benefits and advantages derived from these Federal programs are recognized by the various state and local governments

throughout the country, a period of insufficient funds for the programs may occur. A lag may develop between the time of initial allocation of funds and the time when funds are appropriated in required amounts.

The Federal participation, as regards the financial mechanism, is simply the payment of funds to the beneficiaries of the Congressional appropriations. The payments may be made in a lump sum or spread over a period of several years to coincide with the construction time of the project. There are several acts discussed in section V.4.3 in which discretionary powers, as to implementation and payment of funds, are left to a particular government official. For example, the official may deny certain applications or, once funds have been approved, there may be the requirement for performance results on the part of the municipality. The performance results would be based on such actions as the timely planning and the meeting of construction schedules. In New Jersey, the administration of planning loans and grants is performed, on behalf of the Federal government, by the State's Department of Conservation and Economic Development.

V.4 State and Federal Programs for Intergovernmental Aid for Water Projects

V.4.1 Discussion

The municipalities in New Jersey receive financial assistance from the Federal government in the form of loans or grants-in-aid. The State of New Jersey, on the other hand, has constructed specific portions of a water system. This section will describe the various programs in effect at both levels of government activity as they specifically apply to water supply. In section V.5 the effects of these various programs will be analysed.

A water supply system of storage, purification, transmission and distribution requires the planning and integration of projects within the total requirements of the municipality and the region in which it is located, as well as the usual operation, maintenance and replacement functions. Therefore, the aid factor will first be discussed by an examination of the State of New Jersey's activity in water supply. Water supply is one of several government services that are considered to obtain significant spillover benefits on a level between the local and regional geographic area.[19] The residential and industrial benefits accruing to one municipality, because of water resource sufficiency, will also enhance its social and economic relationships with other areas within its spatial influence.

Therefore, it would seem appropriate that the state play an important role in this particular area. Since this study is concerned with the problem of water supply financing as regards municipalities, the effects of state participation at this level will be discussed without considering the complex interactions of the various regional commissions and authorities of an interstate nature. The implications of regional activity will be discussed in the next chapter.

V.4.2 State Activity

This section describes the State programs which are for planning activities and the provision of water supply projects.

V.4.2.1 Planning

V.4.2.1.1 Continuing Planning Program

One of the important functions which the State of New Jersey seeks

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[19] G. F. Break, Intergovernmental Fiscal Relations in the United States (Washington, D.C.: The Brookings Institution, 1967), p. 69.

to support with both technical and financial assistance is a "Continuing Planning Program."[20] This is an effort to continually update and review a municipality's master plan. The state will make planning loans to the local community for a period of five years. If the community funds a sixth year of planning at its expense, the loans are considered as grants. If the planning activity is discontinued during the six year period, the loans must be repaid.[21] The amounts of the aid depend upon community size or whether a county or region is participating in the program.[22] This program provides the incentive for the adoption by the municipality of planning efforts for a more effective approach to its basic problems of physical growth and future expansion. Included in the master plan and thus aided by the state program are the planning objectives and the resultant requirements for public services and facilities and the budgeting of capital expenditures. The future water system additions or expansions assume an important position in these activities. Therefore, this portion of the financial burden will be effectively lightened by the state aid for this particular phase of the planning effort. Whether the municipality achieves this objective in a formal, planned and efficient manner is the problem of local administrations.

In addition to the financial assistance, the state provides information, literature and technical support to any municipality desiring these services.[23] The main requirement placed on the municipality is

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[20]Division of State and Regional Planning, Program of Assistance for Continuing Planning (Trenton: Department of Conservation and Economic Development, State of New Jersey, 1966), p. 2.

[21]Ibid., p. 2.

[22]Ibid., p. 2.

[23]Ibid., p. 5.

that a cognizant board or agency, capable of professional planning activities, be established within the community and that it function within the existing statutory framework.[24]

V.4.2.1.2 New Jersey Water Research and Development Commission

The state has also created a "New Jersey Water Research and Development Commission" by legislation passed in 1958. The prime duty of the Commission is to plan for the long-range requirements of water supply to the various local and county areas within the state. The objectives are to recommend sites for the purposes of reservoirs which can be developed to provide adequate storage facilities for the future. Therefore, the future planning task of site selection and resource adequacy of the storage area has been assumed by the state for the benefit of its municipalities.

V.4.2.2 Financial Funds for Water Projects

V.4.2.2.1 New Jersey Water Supply Law and Water Bond Act

In 1958, the State Legislature of New Jersey passed legislation that may be the initial step in an effort by the State to assume responsibility for an increasing participation in water supply system development and construction. The two pieces of legislation called the "New Jersey Water Supply Law, 1958"[25] and the "New Jersey Water Bond Act, 1958"[26] established a basic policy with respect to assistance. The

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[24] Ibid., p. 5.

[25] Senate of the State of New Jersey No. 145, Official Copy Reprint, New Jersey Water Supply Law (State of New Jersey, Trenton, 1958).

[26] Senate of the State of New Jersey No. 146, Official Copy Reprint, New Jersey Water Bond Act, 1958 (State of New Jersey, Trenton, 1958).

Supply Law specifically states that the state should, through one of its agencies, "Plan, design, develop, acquire, construct, and place in operation and maintain"[27] reservoirs at Spruce Run and Round Valley. The two reservoirs are located in Hunterdon County. The funds for such purposes were to be obtained from the companion Water Bond Act. The justification for the legislation is stated as:

> . . . there is an immediate need for a new major supply of water to meet the present acute water requirements in the northeastern metropolitan counties and the Raritan Valley, areas which directly and indirectly affect the commerce and prosperity of the entire State.[28]

with an accompanying declaration to broadly justify the entire concept. It is quoted as follows: " . . . this act is intended to protect and secure the public health and welfare and shall be liberally construed to effect the purposes thereof."[29]

Thus, the state became a leader and prime force for a major portion of water supply system development and construction. Usually, the reservoir, together with ancillary facilities, tends to be one of the more expensive components to construct.

The Water Bond Act provided the funds for this new activity on the part of the state. The bonds were general obligation instruments of the serial type which had the full faith and credit of the State of New Jersey.[30] The total sum specified for the bond issue was $45,850,000.

Primarily, the requirements of interest payments and the dis-

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[27]Water Supply Law, op. cit., p. 6.

[28]Water Supply Law, op. cit., p. 2.

[29]Water Supply Law, op. cit., p. 15.

[30]Water Supply Law, op. cit., p. 6.

charging of the principal of the bonds are to be met by the net revenues which are derived from the operation of the water supply facilities. The revenues are to be obtained from user charges or rates placed upon water sold from the projects. There is a crucial statement in the Water Supply Law which is:

> The aggregate revenue produced by such rates shall, so far as practicable, be limited to costs to the State of operation and maintenance and of debt service and to the reimbursement of the State Treasury of the amount of operating deficits, including annual payments of principal and interest, previously incurred by the State.[31]

Thus, the intent is for the State to operate the projects in the manner of self-liquidation enterprises. Similarly, the operations will not produce a surplus other than to account for a previously established deficit. This is the same principle underlying the operation of the municipal utilities and detailed in Title 40A, New Jersey Statutes.

The financial affairs of the various municipalities were affected by this pioneering legislation on the part of the State. Effectively, the State would construct and operate a major element in a water supply system, namely, as stated in the legislation,[32] the storage requirement.

V.4.2.2.2 State Green Acres Program

The voters of the State, in 1961, approved the Green Acres Acquisition Program,[33] for the purchase of undeveloped land. Although

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[31] Water Supply Law, op. cit., p. 10.

[32] Water Supply Law, op. cit., p. 2.

[33] General Assembly No. 540, New Jersey Green Acres Land Acquisition Act, 1961 (State of New Jersey, Trenton, 1961).

the multiple intent of the Program upon recreational, historic, and natural factors of the land cannot be relegated to a secondary level, the impact upon acquisition of reservoir sites and preservation of potential water supply sources is of great importance. Not only may reservoir sites be lost for water supply purposes, but the land cost may become prohibitive in the future. This point is demonstrated in a report describing reservoir sites which have been lost or endangered due to other types of development of the land area.[34] For example, the Central Basin site in Essex and Morris Counties and the Chimeny Rock site in Somerset County were lost to industrial and residential land uses. There had been no previous acquisition program by any agency to preserve these sites. The Program provides for matching grants on a fifty-fifty basis to municipalities and counties and also provides for funds to be used independently by the State for its own programs of acquisition.[35]

Through various programs, the State of New Jersey has undertaken the basic requirements of storage for water supply systems. The results have been the direct actions of site selection and reservoir construction in Spruce Run - Round Valley and the multiple purpose Green Acres Program. By the planning assistance given to municipalities as well as its own planning, the State has provided the leadership for expanded storage facilities. The proportion of new storage areas, which

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[34] Department of Conservation and Economic Development, Setting for the New Jersey State Development Plan (Trenton: State of New Jersey, 1966), p. 9.

[35] General Assembly No. 540, op. cit., p. 2.

will be developed by the State, is uncertain at the present time.

V.4.3 Federal Activity

This section describes the water supply project and planning programs supported by the Federal government.

V.4.3.1 Planning

V.4.3.1.1 Housing Act of 1954

The Federal aid to municipalities for planning purposes falls into two categories. Firstly, there is assistance for general master planning at the local level, which is provided for under Section 701 of the Housing Act of 1954,[36] as amended. Secondly, there is assistance for planning for specific public works projects as described in Section 702 of the 1954 Housing Act,[37] as amended. Both of these provisions are important in their indirect and direct implications. The reason is that a master or overall plan is required for certain types of Federal aid which may be secured under another Act to be described in section V.4.3.2.4.

Eligibility, under the master planning provision, requires that the population of the municipality be less than 50,000 or that the municipality be in a county or area designated by the Area Redevelopment Administration[38] as a labor surplus area. In the first instance, the Federal government will pay up to two-thirds of the planning costs

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[36] Public Law 560, 83rd Congress, H. 1738, August 2, 1954.

[37] Ibid.

[38] The Area Redevelopment Act has been replaced by the Public Works and Economic Development Act of 1965.

and in the second case, up to three-quarters of the cost. Locally, the aid program is administered by the Department of Conservation and Economic Development.[39]

The second section of the Housing Act which provides assistance for planning purposes is specifically oriented towards public works projects. Funds are available for preliminary or final planning, One of the conditions of the loan arrangement is that the project is undertaken within a reasonable period of time. The applicant, which may be any non-Federal public agency, must demonstrate the legal and jurisdictional authority to undertake and complete the project and to have title to the required land.[40] Due to New Jersey State Law, Federal aid of this nature must be reviewed for compliance with all state statutes. The Department of Conservation and Economic Development has been designated as the agency to confer the necessary approval. The loans must be repaid in one lump sum to the Federal government once actual construction has started upon the project. There are no interest charges for the loan if construction starts within a five year period. The funds for repayment are usually made from the total funds authorized by a municipality or other entity for the project. The intent of Section 702 is expressed in the following manner:

> Normally, a public agency may not spend local funds for planning a project until the funds required for construction have been authorized by the local governing body. Thus it is often difficult to

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[39] New Jersey State Department of Conservation and Economic Development, Local Planning Assistance Program (Trenton: State of New Jersey, 1965), p. 1.

[40] Section 58:5-65, New Jersey Statutes.

plan projects in advance . . .

As of January 1965, more than three hundred municipalities or other entities in the State had participated in the Local Planning Assistance Program.[42] The quantitative assistance given to municipalities for public works planning in the northeastern New Jersey region for the period 1950-1960 is given in Technical Report No. 1 issued by the New Jersey State Department of Conservation and Economic Development.[43] These are the projects approved under Section 702 of the 1954 Housing Act. Approximately 15% of the approved planning loans were made for water projects. Table V-1 lists the aid to New Jersey municipalities for water projects since 1960.

Other assistance may also be obtained for planning under Section 314, the Demonstration Program of the 1954 Housing Act. This program will furnish grants to cover up to two-thirds of a planning or renewal study. Both programs were primarily intended for urban renewal aid to communities. Thus, many of the older municipalities in northeastern New Jersey would be able to avail themselves of this assistance which may also include as part of the general plans the requirements for water supply services. The older communities will be able to receive planning assistance for water services provided that they meet the general requirements for urban renewal specified in the legislation.

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[41] New Jersey State Department of Conservation and Economic Development, Assistance for Public Works Planning (Trenton: State of New Jersey, 1963), p. 1.

[42] Local Planning Assistance Program, op. cit., p. 1.

[43] Department of Conservation and Economic Development, Technical Report No. 1, Urban Renewal and Federal Programs, 1950-1960 (Trenton: State of New Jersey, 1963), p. 45.

TABLE V-1

APPROVED APPLICATIONS FOR FEDERAL ASSISTANCE FOR PUBLIC WORKS PLANNING SINCE 1960, NORTHEASTERN NEW JERSEY

County	Municipality	Project	Estimated Project Outlay	Amount Requested for Planning	State Certification
Essex	Caldwell Township	Water Supply	$ 800,000	$ 17,225	August 8, 1963
	Fairfield Borough	Water Supply and Distribution	780,000	21,064	March 18, 1965
Hudson	Hoboken City	Water System	3,449,915	78,000	March 25, 1966
Middlesex	So. Brunswick Municipal Utilities Authority	Water System	1,120,000	44,770	July 19, 1960
	No. Brunswick Township	Water Treatment Plant	1,458,000	63,000	September 15, 1960
	New Brunswick City	Water Treatment Plant	2,715,000	102,000	February 28, 1966
Morris	Randolph Township	Water Supply	615,000	17,140	September 27, 1961
	East Hanover Township	Water Supply and Distribution	1,269,000	51,800	May 7, 1962

TABLE V-1 (Cont'd)

County	Municipality	Project	Estimated Project Outlay	Amount Requested	State Certification
Passaic	Passaic Valley Water Commission	Water Treatment Plant	$5,485,000	$ 73,000	October 31, 1960
	Passaic Valley Water Commission	Aqueduct	2,878,000	102,750	June 28, 1963
	West Milford Township Municipal Utilities Authority	Water Facilities	1,101,625	49,500	September 22, 1964
	West Milford Township Municipal Utilities Authority	Water Facilities	1,065,237	46,390	September 22, 1964
	Wanaque Borough	Water Supply	300,000	13,500	January 29, 1965
	Ringwood Borough	Water Supply	760,500	14,875	March 29, 1966
	Wanaque	Water Supply	400,000	22,900	March 15, 1967

Source: Department of Community Affairs, State of New Jersey

V.4.3.1.2 Water Resources Planning Act

The Federal government took cognizance of the regional aspects of water supply and related land resources by Congressional passage of the Water Resources Planning Act.[44] The Act establishes a Water Resources Council whose duties are to assess the adequacy of regional water supplies and the measures taken by the various levels of government in coordinating and effectuating the numerous policies and programs in existence. It is also the responsibility of the Council to evaluate and report on the proposed programs and actions of the river basin commissions, which are created by Presidential authorization under Title II of the Act.[45] It is the purpose of the river basin commissions to join with the states in studies and activities that are necessary to evaluate the objective of the Act; the coordinated and orderly development of water resources. To alleviate the financial burden placed on the states for this additional planning requirement, funds are available to each of the participating states. The funds are direct grants whose sum is dependent upon the population and land area of the state; in no instance may the grant exceed 50% of the total cost of the planning program.[46]

V.4.3.1.3 Water Resources Act

Congress enacted the "Water Resources Act of 1964"[47] for the

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[44] Public Law 89-90, 89th Congress, S. 21, July 22, 1965.

[45] Ibid., p. 3.

[46] Ibid., p. 4.

[47] Public Law 88-379, 88th Congress, S. 2 July 17, 1964.

purpose of promoting research in the area of water resources. The Act calls for establishment in each of the states of a water research institute which is to be located at a college or university in the state. The duties of the institution are to plan and conduct studies and experiments related to water resources and to consider the various effects of economic, legal, social, engineering, recreational, biological, geographic and ecological elements. The Federal government will match funds on a dollar-for-dollar basis for specific research projects.[48] Additionally, funds are made available for research projects by institutions other than state institutes. Rutgers is the designated state institute for water resources research in New Jersey.

V.4.3.2 Water Projects

V.4.3.2.1 Northeastern United States Water Supply Study

Various legislation has been enacted which deals with the financial problems of water system development that must be faced by local areas. The first act to be discussed is one of the most general in scope as to proposed aid for metropolitan centers and for specific aid to the northeastern section of the United States. An important section of the legislation, known as Title I, Northeastern United States Water Supply,[49] states the need of adequate water supplies for the metropolitan centers of the country as a vital factor in their future welfare and prosperity. The legislation specifies that the Secretary of the Army is authorized to plan for the long-range water requirements of the Northeast. The program is to be administered by the Office of the Chief of Army Engineers. Plans are to be made jointly with state and local

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[48] Ibid., p. 3.

[49] Public Law 89-288, op. cit.

agencies and are to provide for a suitable arrangement for state and local financial participation. The objective of the Act is the ultimate construction of major river basin reservoirs, conveyance facilities between these reservoirs, and major purification facilities. The aim is to implement the following subsection:

> (b) The Secretary of the Army, acting through the Chief of Engineers, shall construct, operate, and maintain these reservoirs, conveyance facilities, and purification facilities, which are recommended in the plan prepared in accordance with subsection (a) of this section, which are specifically authorized by law enacted after the date of enactment of this Act.[50]

Thus, this legislation specifically calls for Federal involvement by the Army Corps of Engineers for the sole purpose of water supply, where previously this organization only participated in water supply projects which were part of multiple purpose programs. The area of multiple purpose projects is one in which Federal assistance has been of importance in the past and undoubtedly will perform the same role in the future.

Public Law 89-298 contains a Title II, Section 217(a) which states that in areas designated eligible for financial assistance under the Public Works and Economic Development Act of 1965 and where the United States Army Corps of Engineers undertakes various types of projects pertaining to rivers, harbors and waterways, the Secretary of Commerce may purchase evidence of indebtedness (bonds) and authorize loans for a period not exceeding fifty years.[51] Thus, if in the construction of a flood control project certain storage reservoirs are

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[50] Ibid., this subsection (a) is the first section of Title I, whose main points have just been delineated.

[51] Ibid., p. 3.

desired by municipalities within the area, financing would be available under this section of the law. The bond and loan provisions serve a two-fold purpose. First, they provide for local participation in a water project, and second, should the municipality experience difficulty in obtaining flotation of its bonds, the Federal government may assist by purchasing the issue.

V.4.3.2.2. River and Harbor Act of 1958

The first legislation to specifically declare Congressional policy concerning water supplies for domestic and industrial uses was Title III of the River and Harbor Act of 1958.[52] It states that although water supply is primarily a state and local responsibility the Federal government should participate and cooperate with state and local interests in developing water supplies where Federal navigation, flood control or multiple purpose projects are constructed. The Act provides for additional storage capacity in reservoirs to be constructed by the Corps of Engineers and it requires that the states or local interests

> . . . give reasonable assurances that they will contract for the use of storage for anticipated future demands within a period of time which will permit paying out the costs allocated to water supply within the life of the project.[53]

The Act then stipulates the terms and conditions for repayment by the local or state units to the Federal government, of costs incurred for water supply purposes. This section of the Act was difficult to interpret due to the phrase "reasonable assurances." Therefore, in the Federal Water Pollution Control Act Amendments of 1961,[54] Congress

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[52]Public Law 85-500, op. cit.

[53]Ibid., p. 23.

[54]United States Congress, Senate Committee on Public Works, S. Report, 87-353.

stipulated that although reasonable assurances from participants were still required, the Federal agency undertaking the multiple purposes project could include the additional water supply capacity without commitments from the water supply participants.

V.4.3.2.3 Housing and Urban Development Act of 1965

The analysis will now turn to those areas of aid availability which are predicated upon the economic conditions of an area rather than its technological or geographical environment which necessitates flood control and multiple purpose projects.

Under the Housing and Urban Development Act of 1965,[55] Congress passed a comprehensive program of assistance to localities. The Act states that Federal grants are available to local governmental bodies " . . . to construct adequate basic water and sewer facilities needed to promote the efficient and orderly growth and development of communities."[56]

Section 702 (a) of the Act states that Housing and Home Finance Administrator is authorized to make grants to local bodies for specific basic water facilities. The basic water facilities are stated as including works for the storage, treatment, purification, and distribution of water. Section 702 (b) authorizes grants in the amount of 50% of the development cost of the project. Under grants for neighborhood facilities, Section 703 (a) and (b) authorize the Housing and Home Finance Administrator to make grants up to two-thirds the cost of a specific project. Where the project is located in a redevelopment area

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[55] Public Law 89-117, 89th Contress, H. R. 7984, August 10, 1965.

[56] Ibid., p. 40.

designated as such under the Area Redevelopment Act, the amount of the grant may be up to three-quarters of the project cost. To assist in the area of land acquisition on a timely basis, Section 704 of the Act provides for interest free loans for a period not exceeding five years.[57] Recognizing the needs and requirements of its communities, the Federal government has the authority to assist and encourage local development of water facilities. There is no special requirement placed upon the communities as to status or economic condition. The only requirement is their ability to adequately plan and conduct in a timely and expeditious manner the specific projects to be constructed under the Act. If these requirements are not met, the Administrator may stipulate that part or all of the aid given be repaid to the government.[58]

V.4.3.2.4 Public Works and Economic Development Act of 1965

Another act, which relates to the economic conditions present in an area at a specific time, is the Public Works and Economic Development Act of 1965. The preamble of the Act is the following:

> An Act to provide grants for public works and development facilities, other financial assistance and the planning and coordination used to alleviate conditions of substantial and persistent unemployment and underemployment in economically distressed areas and regions.[59]

Under Title I of the Act, any state or political subdivision in it, may be eligible for direct grants up to fifty per cent of the cost of designated projects. These projects must fulfill the requirement of providing opportunities for long-range employment benefits. One of the

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[57] Ibid., p. 41.

[58] Ibid., p. 42.

[59] Public Law 89-136, 89th Congress, S. 1648, August 26, 1965.

prerequisites for obtaining such assistance is an overall economic development program for the area and that the projects requiring aid be consistent with such a program.[60] This factor stresses the value and inherent necessity for the planning aid previously discussed in this section. Also included under Title I is provision for supplementary grants for programs in areas which have previously received Federal grants-in-aid under the 1965 Act but cannot meet their matching requirements. Within the framework of a series of requirements, which consider such elements as the severity and duration of rates of unemployment and the income levels of families within an area, additional grants may be made of up to eighty percent of a project cost. The aid is available for a broad definition of project scope as to include:

> . . . acquisition or development of land and improvements for public works, public service, or development facility usage, and the acquisition, construction, rehabilitation, alteration, expansion, or improvement of such facilities, including related machinery and equipment . . .[61]

Under Title II of the 1965 Act, the Secretary of Commerce is authorized to make loans for public works projects and also to purchase evidence of indebtedness. One important restriction which applies to both Title I and II is that no funds, whether for grants or loans, are to be made available for a municipal utility which would compete with an existing privately owned utility.[62] This restriction may be set aside when there is a probable future need for additional facilities and the

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[60] Ibid., p. 2.

[61] Ibid., p. 1.

[62] Ibid., p. 3.

private utility does not or can not meet the future requirements by new or expansionary programs. Title III also provides for technical assistance, research and information on the part of the Federal government. The Federal government, in conjunction with various agencies and public and private entities, may also plan, conduct feasibility studies, and furnish management and operational assistance for the economic growth of the study areas.[63] For these purposes, grants-in-aid to State and local units may be provided for by the Secretary of Commerce with terms and conditions he may deem appropriate. The Act, formally itemizes the requirements as to unemployment and income that must be present in an area or district to make it eligible under the terms of the Act. For example, where the rate of unemployment is six percent or more for an area, the Secretary of Labor shall designate it as a redevelopment area. Also, where the rate of unemployment is a) fifty percent above the national average for three out of four preceding calendar years, b) seventy-five percent above the national average for two out of three preceding calendar years or c) one hundred percent above the national average for one of the two preceding calendar years, the area shall be designated as eligible for aid.[64] The income requirement for eligibility is that the median family income cannot exceed forty percent of the national median, as determined by the most recent statistics for the area.[65] Only one

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[63] Ibid., p. 7.

[64] Ibid., p. 9.

[65] Ibid.,

of the above described criteria must be fulfilled for an area to receive the necessary designation.

V.4.2.2.5 Consolidated Farmers Home Administration Act of 1961

The aid program described thus far have been concerned with the conditions of urban and industrialized areas. However, there is legislation in effect entitled "The Consolidated Farmers Home Administration Act of 1961."[66] The requirements for receiving aid are that the area must not be part of an urban complex and a municipality's population must not exceed 5,500. The project for which aid is sought must conform to a state approval plan for the area. The aid may be in the form of a grant which can be as high as fifty percent of the costs of the project or loans may be made at a maximum of five percent interest for a period not to exceed forty years.[67] There is also a limitation of the total indebtedness that a municipality may carry, and which in effect restricts the amount of aid available under the Act. The types of projects which may receive authorizations cover the complete requirements of a water supply system.[68]

V.4.4 Summary

The preceding discussion has described the various legislative acts and programs that now exist at the state and Federal level for assisting in water resource development and supply. The Federal Government and the particular agencies involved in the administration of the

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[66] Public Law 87-128 as amended; 7 U.S.C. 1921.

[67] Ibid., p. 2.

[68] Ibid., p. 4.

various programs and acts realize that some overlapping of jurisdiction or authority may occur.[69] Therefore, there is a referral review system which now exists between the Department of Housing and Urban Development; the Department of Health, Education and Welfare and the Department of Agriculture in order to determine which of them might best accept primary responsibility for any application. The programs are directed towards projects which are dependent upon specific conditions existing in a locality or area. There appears to be a great deal of Federal activity in the area of water supply, and of particular significance is the fact that there seems to be no multi-purpose qualifications attached to the programs which are of recent vintage.

The purposes of intergovernmental programs are to accomplish either one of three objectives. First, the allocation of resources will be determined by the expenditures at both the Federal and local levels. These expenditures will lead to differences in the allocation of resources and the amount of public services available in each locality. However, the important point in the allocation process is that it ". . . should be permitted to differ between states, depending on the preferences of their citizens."[70]

This effect will occur as certain areas undertake greater expenditures than other regions and are in a position to obtain larger amounts of funds for matching grant purposes.

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[69]Advisory Commission On Intergovernmental Relations, Fiscal Balance In the American Federal System, Vol. 1. (Washington: U. S. Government Printing Office, 1967), p. 16.

[70]R. A. Musgrave, The Theory of Public Finance (New York: McGraw-Hill, 1959), p. 181.

Second, the distribution aspects of both Federal and local programs may not achieve similar patterns. The situation could lead to a non-equilibrating mechanism due to continual adjustments by both Federal and local governments as they attempt to compensate for the other's actions.[71] According to Musgrave, the primary responsibility for distribution objectives should be set at the Federal level. In this instance also, the Federal requirements for meeting distribution efforts are clearly defined in the various programs.

Lastly, the stabilization efforts of a government necessitate a coordinated policy for an entire country. Therefore, individual actions for the various programs can be halted or mitigated by the amount of funds appropriated by Congress.

There are other problems associated with intergovernmental aid and the programs it supports. There is a tendency for a shifting of state-local responsibilities to the Federal level.[72] Additionally, Federal programs have, in the past, become vested interests of certain areas (e. g. agricultural and forest preservation services). This condition has brought the situation where " . . . not a single federal-grant program for a continuing function of state or local governments has been terminated."[73]

The stabilizing effect of intergovernmental aid programs is also subject to practical limitations. The private sector may be the most important factor in a dynamic situation facing an economy. Therefore,

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[71] Ibid., p. 182.

[72] W. J. Shultz and C. L. Harriss, American Public Finance (Englewood Cliffs: Prentice Hall, 1965), p. 447.

[73] Ibid.,

public works or similar programs may not have the desired effects by either instituting or discontinuing their construction. Slichter suggests,

> In view of the many obstacles to using public spending to offset fluctuations in private spending, the achievement of stability must depend upon success in greatly reducing the fluctuations in private spending.[74]

In addition, State and local governments have a significant role to play in stabilization policy.[75]

Table V-2 summarizes the types of aid available under the various programs described in the chapter. For those programs bearing the Indirect designation, aid is not directly available to municipalities. The aid either comes through an intermediary, such as the state, or the aid of a general nature (e. g. Water Resources Planning and Research Acts).

The total amount appropriated nationally for 1967 grants under the Housing and Urban Development Act and the Consolidated Farmers Home Administration Act were $100,000,000[76] and $26,000,000[77] respectively. Under the Economic Development Act, $290,000,000 was appropriated for 1967.[78] The Housing and Farmers Development appropriations are for

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[74] S. H. Slichter, "The Economics of Public Works," reprinted in Readings in Fiscal Policy, edited by A. Smithies and J. K. Butlers (Homewood: R. D. Irwin, 1955), p. 49.

[75] S. Engerman, "Regional Aspects of Stabilization Policy," Essays in Fiscal Federalism, edited by R. A. Musgrave (Washington: Brookings Institution, 1965), p. 56.

[76] Congressional Quarterly Weekly Report, Congressional Quarterly, No. 41, October 7, 1966, p. 2489.

[77] "1969" Budget Estimate," United States Department of Agriculture, (Washington, D. C.: February, 1968).

[78] Congressional Quarterly Weekly Report, Congressional Quarterly, No. 43, October 28, 1966, p. 2632.

TABLE V-2

FEDERAL AND STATE AID TO MUNICIPALITIES FOR WATER PROJECTS

Legislation or Program	Planning			System or Component			Research		
	Loans	Grants	Indirect	Loans	Grants	Indirect	Loans	Grants	Indirect
State									
Continuing Planning Program		X							X
New Jersey Water Research and Development Commission									
New Jersey Water Supply Law						X			
New Jersey Water Bond Act						X			
Green Acres Acquisition Program						X			
Federal									
Housing Act of 1954	X	X							
Northeastern United States Water Supply Act			X	X		X			
River and Harbor Act of 1958						X			
Federal Water Pollution Control Act Amendments of 1961						X			
Housing and Urban Development Act of 1965				X	X				
Public Works and Economic Development Act of 1965				X	X				
Consolidated Farmers Home Administration Act of 1961				X	X				
Water Resources Planning Act								X	X
Water Resources Planning Act							X	X[1]	X

1. Matching Funds; dollar for dollar basis

specific water projects and developments. The water supply requirements for the Economic Development appropriations are not delineated separately as in the other appropriations. The reason for stating these amounts is to use the present level of funding as a perspective for future requirements.

V.4.5 Small Sample Survey for Determining Municipal Participation in Intergovernmental Aid Programs

A survey was conducted of several municipalities in north-eastern New Jersey during the summer of 1967. The objective of this survey was to determine whether intergovernmental aid had been an important factor in the financial activities of municipal water utilities. A question sheet was designed and is shown in EXHIBIT-1. The sheet was mailed to ten water utilities throughout the northern portion of the state. Questionnaires were not sent to Warren or Sussex counties, since their river basins do not lie within the study area.

The ten utilities were chosen for certain characteristics. Firstly, the largest municipal utilities, as regards quantity of water supplied and the number of customers or population served were selected from each county. These large utilities accounted for water services to thirty to sixty percent of their county's population. Some utilities are merely seasonal suppliers of water to resort areas, while others provide for a small population. Their capital stock is small and the requirement for future investment is negligible. On the other hand, the large utilities have definite requirements for the supply of present and future water needs. If they were to continue in their historical pattern, huge outlays will be required for reservoirs, pumping and treatment stations and transmission lines. Several water utilities were also sent questionnaires although they were not the largest in the area. The

EXHIBIT V-1

QUESTION SHEET

1. Since 1950, has your municipality received any Federal, State or county aid for water supply* projects?

2. If the answer to question 1 is yes, please give for each project:

a. Nature of project
b. Agency or agencies giving the aid**
c. Law or Act under which aid was authorized
d. Date aid was secured
e. Total dollar amount of the project
f. Amount obtained by aid

* Water supply is to include storage, transmission, distribution, facilities, etc.

** Aid is defined as direct grant, shared cost, loan, etc.

Note: If your municipality has not received any aid in the past, the simple response of NONE to question 1 is all that is required.

intent in this case was to determine whether size was the important factor in obtaining aid.

The question sheet was mailed to the following municipalities:

City of Newark	City of Perth Amboy
City of Elizabeth	Borough of Manville
Town of Morristown	Borough of Totowa
City of Jersey City	City of Trenton
City of New Brunswick	Township of Parsippany-Troy Hills

The main question asked of these municipalities was as follows:

Since 1950, has your municipality received any Federal, state or county aid for water supply projects?

Aid was defined in the questionnaire as a direct grant, shared cost, loan, etc. The water supply project was defined to include facilities for storage, transmission and distribution. All of the municipalities responded to the questionnaire. With the exception of New Brunswick, all replied in the negative. The conclusion can therefore be made that as of 1967, intergovernmental aid was insignificant in municipal water utility financing.

New Brunswick had applied to the Department of Housing and Urban Development for planning funds. These funds were required to design a new addition to their system's filtration plant. The funds were specifically requested under Section 702 of the 1954 Housing Act, as amended, which provides for public works planning assistance. Although the initial application was filed in December 1965 and the application received the approval of all necessary state agencies, as of August 1967, Federal approval had not been received.

There may be another reason why the New Brunswick application has not received the necessary approval. Recently, the funds available for planning have not been sufficient to meet the total national

demand of the municipalities. In an administrative procedure, the Federal government has asked the cognizant state agencies, who must first approve any application, to institute a priority system. The problem then becomes one of ascertaining the particular goals of an overall planning concept for a region.

An interview was also conducted with the only joint municipal water utility in New Jersey. This utility, the Passaic Valley Water Commission, filed an application in 1960 for a grant to assist in the construction of a gravity water filtration plant at Little Falls. The aid was requested from the Community Facilities Administration of the Housing and Home Finance Agency.[79] A grant was received in the amount of 15% of the $7 million cost of the plant. The items of cost covered were planning fees, counsel fees and engineering and construction expenditures.

An analysis of the information obtained from the survey results in the following conclusions:

1. The sampling results indicate that those municipalities serving the majority of the population in the study area are not active in securing Federal aid for water projects.

2. The survey also disclosed that many of the municipalities involved in the sampling had no intention of obtaining any aid in the immediate future. This information was unsolicited and given by the municipalities in their response.

3. The one municipal utility that was interviewed, the

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[79]This is now the U.S. Department of Housing and Urban Development.

Passaic Valley Water Commission, had obtained a grant for a water project. The utility had not experienced any difficulty in the process required for securing the funds.

4. One municipality, New Brunswick, was having difficulty in obtaining a grant for planning purposes.

In a study made by the Congressional Quarterly on "State Allocations of Federal Aid" (this includes all categories of aid and not only water supply project grants), the State of New Jersey, on a per capita basis, ranked last of all the states in the receipt of Federal grants.[80] The highest state was Alaska with $420 per capita; New Jersey received $40 per capita. The study was for the year 1965 and did not categorize the grants as to particular functions or programs.

V. 4.6 Determination of Municipal Share of Outlays for Federal Projects

The Passaic Valley program and Crab Island project described in Chapter IV are in the category of "Federal multiple-purpose projects." This means that uses other than the water supply function will be made of the project. Whenever a multiple-purpose project is constructed by the Federal government, a percentage of the outlays for the facility are allocated to the municipalities which will use the resources. The method used in determining the portion of total capital outlays for the multiple-purpose project which will be borne by the localities is the "separate costs, remaining benefits procedure."[81] The following is a summary of the steps in this type of calculation:

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[80] Congressional Quarterly Weekly Reports, Congressional Quarterly, No. 12, March 24, 1967, p. 449.

[81] Committee on Public Works, op. cit., p. 29.

1. The benefits of each specific function, such as water supply or recreation, of the project are determined.

2. The separable cost of each specific function is determined.

3. For each specific function, the separable cost is subtracted from each benefit, leaving a remaining benefit value.

4. The joint total cost is then determined.

5. The percentage of the function remaining benefits such as water supply to the total remaining benefits is determined.

6. This percentage for water supply is then the percentage of total joint costs which are allocated as the municipal share of the burden.

As regards step 1, the benefits are determined by

> . . . all the net identifiable increases or gains, either in the form of tangible goods and services, or as intangibles, and either primary or secondary, which result from conditions with the project as compared to conditions without the project.[82]

For water supply projects, the value of goods and services which would be produced by an alternative source in the absence of the project is taken as the primary benefits. Normally, the market price of the goods and services could be used as a measure of the benefits. However, in water supply there is the regulation of water rates and the absence of a competitive market operation and thus a distortion of the rate of substitution in consumption.

The separable cost of each specific function is determined by estimating the cost of a single purpose project which would furnish the same output as the multiple-purpose project would furnish for the function.

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[82]Office of the Chief of Engineers, Laws and Procedures Governing Conduct of the Civil Works Program (Washington: Department of the Army, 1959), p. 19.

V.5 Analysis of Financing Methods

In a report presented by the Advisory Commission on Intergovernmental Relations,[83] several criteria were established. The purpose of these criteria is to provide a basis for establishing the financial feasibility in a governmental unit operating or supplying a particular function and service. The pertinent criteria are:

a. Spillover Minimization (Maximization)
b. Scale Economy Maximization
c. Geographical Area Sufficiency

The criteria require that for a municipality the control of the service or function lie within its jurisdiction and not require its constituency to support or subsidize an adjacent area or group. There is also the need for a scale of operation of sufficient output or size so as to achieve a low unit cost. This is particularly true of water systems which have a relatively high fixed cost to variable cost ratio. As a corollary to the last two criteria, the geographical area of operation and service should be large enough physically in order that the objectives be realized.

The spillover minimization is the criterion applicable to local governments. However, in the case of Federal or state participation in projects, the desirability is for spillover maximization and the accrual of benefits to as many municipalities as possible.

The implications of cost-benefit analysis have been considered for the analysis in this section.[84] However, the assumption is made that the benefits derived from equal quantities of water would be

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[83] Advisory Commission on Intergovernmental Relations, Performance of Urban Functions; Local and Area Wide. (Washington: D. C., 1963), M-21 Revised, p. 41.

[84] A. Post and R. Turvey, "Cost-Benefit Analysis, A Survey," The Economic Journal, December, 1965.

identical and therefore the relevant consideration for comparison is the cost of a project. The cost analysis has been performed in Chapter IV.

V. 5.1 Municipal Financing Implications

In New Jersey, the municipal water utilities are operated as self-liquidating enterprises. This fact means that the revenues from the sale of water are to be sufficient to service the debt incurred in financing the systems, and also to provide for the operational, maintenance and replacement costs of the utilities. The sums for new or additional projects are obtained by loan financing in the form of general obligation bonds. Therefore, is loan financing the proper method of obtaining water utility capital outlays?

First, the municipal water utility investment substitutes government activity for private investment. Thus, the municipal investment furnishes private benefits. This fact is sufficient to negate any general tax financing arrangement for this type of service unless a compulsory increase in the savings - investment proportion of the Gross National Product is considered socially desirable. However, there is another reason which is equally as important.

If sales or excise taxes are levied for the financing of a project, the present and future rate of substitution in consumption would be altered, thus leading to distortions in the market. The burden for a large capital outlay for public facilities is cushioned in relation to current consumption: ". . . if the resources are withdrawn from private capital formation. This is accomplished by the use of loan finance."[85]

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[85] R. A. Musgrave, op. cit., p. 559.

The purchase of bonds or debt financing is voluntarily accomplished and produces no distortion in the marketplace. Those who purchase the utility bonds have no feeling of a burden or assumption of a particular responsibility.[86]

There are two principles which are vitally important in public debt finance practice. These are the pay-as-you-use and intergeneration equity concepts.[87] These concepts are applicable to projects of a durable nature where large initial expenditures must be made. The pay-as-you-use principle is implemented by loan financing which properly distributes the payments of durable items over generations. The concept of intergeneration equity is also achieved as the new facilities will be used and paid for by generations of taxpayers.

As discussed in section V.1.1, the municipal utilities in New Jersey are operated with separate funds or accounts. This procedure is necessary to keep the payments for the utilities apart from the general budget and thus implement the pay-as-you-use and intergeneration principles.[88] It is important to note that the financing of the utilities at the municipal level in New Jersey follows the principles just discussed. Loan financing, pay-as-you-use finance, intergeneration equity and separate budget accounts are all accepted practice and enforced by statute.[89] In fact, the general obligation bond is specified by

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[86] J. M. Buchanan, Public Principles of Public Debt (Homewood: R. D. Irwin, 1958), p. 35.

[87] R. A. Musgrave, op. cit., p. 559-565.

[88] Ibid., 569.

[89] Appendix A.

statute to be retired in straight line or equal payments over the length of its term.

V.5.2 State Financing Implications

The water system activities of the State of New Jersey are divided into two categories. There are those projects which the State has undertaken on behalf of its inhabitants. This type of activity is exemplified by the Spruce-Run-Round Valley reservoirs. Secondly, the state has provided assistance in the planning area to its municipalities. As an additional activity, the state has secured lands for future use by a variety of projects; water storage is one possible use. The state will also be able to fulfill the requirements for spillover maximization and economies of scale due to its large jurisdictional area. For the same reason, the geographical area sufficiency criterion can be met more easily at the state rather than the local level of government.

The state financing of its projects duplicates exactly the procedures and methods followed by the municipalities. Therefore, the same concepts of pay-as-you use, intergeneration equity and separate budget accounts are observed in these undertakings. There is one interesting aspect in the manner of obtaining funds to pay for the Green Acres Acquisition[90] program which merits discussion.

The Green Acres program was designed to obtain lands for future use in activities such as parks, hunting, fishing, boating and water storage. Loan financing was arranged by the issuance of general obligation bonds. Since the acquisitions have not been placed in

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[90] Green Acres Acquisition Bonds, op. cit.

immediate use, there is no source of revenue from the land with which to meet the loan burden. The bond act specifies that the first source of funds shall be from fees and funds collected from the presently operating state parks and recreational facilities.[91] It appears that this manner of obtaining funds is proper for the financing of projects which are to be utilized by specific users.

A park or recreational facility of the type proposed by the Green Acres program fulfills the needs of a portion of the constituency of the state and represents a specific benefit to certain inhabitants. Therefore, the facility benefits primarily those who use it. It is proper that the debt-servicing of this type of activity be accomplished by the funds obtained by fees.[92] If the project or facility provides for indirect social benefits and a deficit should occur in its operation, then there would be justification in supporting its operation with funds from the general governmental budget. This type of operation does occur for many public facilities.

The other activity engaged in by the state is the intergovernmental aid provided to its municipalities in the form of planning and research assistance. As noted in Chapter IV, Cost Analysis, the planning stages constitute an important phase of any project. Since the state supplies part of this cost without charge to the municipalities, a distortion is produced in the rates of substitution of consumption and production. The projects are infra-structure investments and should be

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[91] Ibid., p. 4.

[92] H. M. Groves, Financing Government (New York: Holt, Rinehart and Winston, 1964), p. 409.

financed by loan arrangements for each project rather than taxation unless there are spillover effects and thus the necessity for cost dispersion. Financing by taxation accomplishes a redistribution of resources which is not the seeming intent of the planning programs.

V.5.3 Federal Financing Implications

The Federal government has provided for water projects by various programs and acts which financially aid the States and municipalities in three ways. Firstly, there are the loan programs which provide funds at below market interest rates or supplement market sources of funds at market rates.[93] Secondly, there are the direct grants to the participating organization.[94] These grants take the form of lump sum payments or cost-sharing arrangements which are dependent upon certain formulae. Lastly, there are the multiple purpose programs of the Federal government which provide for water supply features.[95] Although the municipalities are required to bear the cost of this feature, the cost is usually below the requirements of a municipal single purpose project which furnishes the same amount of water.

The effects of the Federal loan programs are identical to the arrangement for municipal financing of self-liquidating utilities which had been and is presently employed in New Jersey. In those instances where the interest payments would be below market rates, this would represent a subsidy to the municipality and a form of redistributional

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[93] Economic Development Act of 1965, op. cit.

[94] Housing and Urban Development Act, op. cit.

[95] River and Harbor Act, op. cit.

activity. A similar analysis holds for the third method described above, the multiple purpose arrangement. Again, the municipality would finance its share of the project costs for water supply by the usual cost arrangements. The benefits accruing to the municipality in the form of lower investment requirements due to the joint functional nature of the projects would also be a form of subsidy and a consequent redistributional effect.

It is in the second method of intergovernmental aid or the grant technique that the public finance principles of pay-as-you-use and intergeneration equity are not observed. Since water projects are infra-structure investments, the financing of their requirements should be by loan arrangements rather than funds obtained by taxation. Therefore, the Federal aid may distort desirable debt arrangements by giving tax revenue via the grant process to municipalities. Thus, at the Federal level there appears to be an incorrect allocation of resources. Where there are specific programs which are based upon redistributional considerations, such as the Economic Development Act,[96] the grant or cost sharing arrangement is a proper technique for this type of activity. Otherwise, the grant has brought to the national level distortions in the rates of substitution between consumption and production together with non-adherence to pay-as-you-use and inter-generation equity principles.

V.5.4 Rate Structures

User charges for water is the means by which municipal utilities obtain the funds required for debt servicing and the operation, maintenance

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[96] Economic Development Act of 1965, op. cit., p. 3.

and replacement functions of their service. The user charges are in the form of rates for various quantities of water and different types of water services.

> . . . whether an enterprise is private and unregulated, private and regulated, or public, the condition that marginal cost should be set equal to price is the desirable solution from the point of view of economic efficiency considerations . . . [97]

The municipal water utilities in New Jersey operate in a self-liquidating manner. This means that they must obtain sufficient revenues from the sale of water to meet the utility debt servicing requirements and the operation, maintenance and replacement costs. However, it is possible that at a single price per unit of water, there may not be sufficient purchases to account for the required utility revenue. The municipal water utilities in New Jersey have instituted a rate structure which involves price discrimination. Residential water rates and commercial-industrial water rates are different. The price determination rate structure is easily adaptable to water services since the markets are separable and have different demand elasticities. Also, the cost of separating the markets is small.

There is a consensus of opinion [98] in the water utility field that most municipalities operate at a point where their average cost curve is declining. Therefore, the marginal cost curve would be below the average cost curve and a price equal to marginal cost would mean that there is a deficit operation. As a solution to this deficit operation, the price discrimination practice is used. Therefore, the utilities are not operating under optimal economic efficiency conditions,

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[97] J. Hirschleifer, J. DeHaven, and J. Milliman, Water Supply (Chicago: University of Chicago Press, 1966), p. 59.

[98] Ibid., p. 89.

since marginal values in use are not everywhere equal.

The actual rate structure is determined by the self-liquidating and operational requirements of the utility. Where the intergovernmental aid activities affect these requirements, the rate structure will also be altered. Thus, the aid program may tend to produce greater distortions of economic efficiency than presently exist if they result in lowered water rates and greater deviation from marginal costs.

V.6 Future Programs for Financing Water Projects

V.6.1 Federal Programs

The major Federal involvement in those water projects, which are designed to increase water supplies, will depend upon the results of the Northeastern United States Water Supply Study. It stipulates that the Federal Government should cooperate with state and local agencies in the preparation of plans for future water resource development. In addition to reservoir construction, the plans may include transmission lines or conveyances between river basins and the design of purification facilities. It is also intended that the Federal government will construct, operate and maintain these water system elements. Therefore, the future financial burden, at all levels of government in the study area, will depend upon the cost-sharing arrangements enacted into law. As in other matters resolved at the Federal level, this may depend upon many variables outside the water resource field.

The remaining projects to be constructed in future developments will in all likelihood be continuations of present flood control and multiple-purpose programs.

There are several techniques which have been proposed for allocating Federal aid to the state-local level. It is possible that some form of one of the following methods may be used in the future.

A type of grant which has been proposed for future use in aiding states and local governments is the block grant. A block grant is a fixed annual amount of funds which would be given to a state by the Federal government.[99] The control of the funds uses would be left to the states. Thus, the Federal government would relieve the financial burden of the states and not exercise control of their decision-making process. Since water supply projects are one type of activity that New Jersey participates in with its localities, large block grants from the Federal government level would, directly or indirectly, be an important financial factor. The criterion upon which the amount of the block grant would be based depends on the economic objective of the Federal government. It could be a means for implementing distribution policies by providing for larger grants to the poorer states.

A variation of the block grant concept is the consolidated grants-in-aid proposal. The consolidated method would be a compromise solution to the unrestricted general grant or a block grant and the matching, functional grant.[100] In this method, the Federal government would pool all funds allocated for various programs. Then, using some formula, the funds would be distributed to each state without provision

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[99] D. Eckstein, Public Finance (New York: Prentice-Hall, 1964), p. 39.

[100] G. Breck, Intergovernmental Fiscal Relations in the United States (Washington: Brookings Institution, 1967), p. 157.

as to the allotment for specific projects. Thus, the decision for allocation of funds would be at the state-local level and not under Federal control.

The main argument against this type of assistance is that the purposes for which the Federal government funds were allocated would not necessarily coincide with the uses to which the state would put the funds. Although the aggregate sum received by the state would be dependent upon specific percentage allocations from the various programs, the states would not be obligated to expend the funds for these programs in these same percentages. In effect, the decision-making process at the Federal level could be frustrated at the state level. For example, the financial requirements of water projects could be greatly reduced at the state level with the use of the grants. Thus, the self-liquidating method of water rate determination would result in lower rates and non-marginal cost pricing. This result may be directly contrary to Federal policy concerning water rates.

Another more generalized approach to the problem of intergovernmental aid is the revenue-sharing plan. The plan, "would distribute a specified portion of the Federal individual income tax to the states each year on a per capita basis, with next to no strings attached."[101]

The "no strings" phrase refers to the use to which the states might put the funds. However, to prevent a state from lowering its fiscal effort, the amount of revenue shares would be conditional upon its relative fiscal performance. The per capita revenue sharing would

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[101] W. W. Heller, New Dimensions of Political Economy (Cambridge: Harvard University Press, 1966), p. 145.

have an interstate equalization effect since the shares would not be dependent upon income origin. One most important concept envisioned by Heller is the revitalization of the states by the shifting of responsibility and control from the Federal level. Additionally, " . . . revenue sharing would provide a dependable flow of Federal funds in a form that would enlarge,not restrict, the options of state and local decision makers."[102]

Contrary to popular political polemic, the new proposals or techniques for intergovernmental aid from the Federal level appear to strongly suggest local control and decentralization of authority. This fact has been true even with the common conditional grants-in-aid method which has been in effect for many years.[103]

The adherence to pay-as-you-use and intergeneration equity principles will depend upon the way the various grants are expended at the local level. If aid funds are expended for capital outlay projects in a periodic manner, year after year, as if normal investment activity were occurring, then the aid would serve to alleviate the burden by equal and timely reductions of project financial requirements. This type of budgeting of aid funds would preserve the intergeneration principles. However, if in receiving financial aid, a state or locality would allocate from this sum, the total or major requirements for a project within a short span of time, then the pay-as-you-use and intergeneration principles would be violated. It is significant to note

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[102] Ibid., p. 169.

[103] J. A. Peckman, Federal Tax Policy (Washington: Brookings Institution, 1966), p. 227.

that neither Eckstein, Break or Heller give consideration in their discussion to these principles in relation to investment programs.

V.6.2 State Programs

One of the future programs advocated by the New Jersey Department of Conservation and Economic Development is a "Blue Acres Acquisition" operation.[104] The program's objective is for the state to acquire sites for reservoir construction well in advance of contemplated utilization of the land. This program is similar in concept to the state's Green Acres program. However, the Green Acres objective was to obtain land for recreational and sporting uses in addition to water resource development. The Blue Acres program is intended for the purchase of lands which have the geographical characteristics required for reservoir development.

Sites would be obtained in a relatively underdeveloped condition and would be preserved from future residential or industrial use. Once land has been placed into a developed category, its use for reservoir purposes is prohibitive due to physical and economic constraints. Realizing that land acquired for this purpose will deny municipalities and/or counties potential tax revenue, the proposed program recommends compensatory payments to the communities.

The Blue Acre proposals include the state assuming the responsibility for the transmission function of water from the storage areas to the local distribution grids. This proposal is a result of the difficulties experienced in the Spruce Run - Round Valley project.

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[104] R. A. Roe, "New Jersey's Water Crisis," New Jersey Municipalities (March 1967), p. 8-10.

During the drought years of the 1960's, there were available quantities of water in the Spruce Run system; however, there were no transmission lines to the northeastern New Jersey area from the reservoir. Although there are no provisions in the program for purification and pumping facilities, these elements would probably be included if the storage and transmission proposals are accepted. Thus, the state would assume complete financial responsibility for the entire water system with the exception of local distribution or the grid. It is possible that the state would receive future Federal aid for the program. In that event, the financial requirements would be alleviated to the extent of the Federal assistance. However, the municipal involvement would probably be severely limited due to the state's experience with the Spruce Run - Round Valley program. For that project, joint municipal action has been virtually impossible to achieve.

The Blue Acres program proposes that the state participate in sharing the financial burden of the local distribution system by grants-in-aid. This would be provided on a fifty-fifty state-municipal matching basis. One means of financing the program could be accomplished in a manner similar to the Green Acres Acquisition Act and Bond Act.[105] The State would issue general obligation bonds and arrange for the allocation of funds. It is premature at this time to determine the basis upon which the state grants would be allocated. This certainly would be one method of implementing local decision making processes. Additionally, the allocation priorities would be established by those

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[105] Green Acres Bond and Acquisition Act, op. cit., p. 2.

most directly responsible for future growth and welfare.

Another method that could be employed at the state level would be an additional charge per unit to the normally arrived at rate for water supply. The revenue derived from this charge could then be dedicated or "earmarked" for water supply projects in the state. The process of earmarking might not be a desirable procedure in New Jersey, which has shown a decline in the percentage of earmarked tax collections.[106] Evidently, earmarked tax collections do not increase at the same rate as other taxes. Nevertheless, as state activity in the water supply area increased, there would be an increase in the revenue derived from this type of tax.

This type of revenue producing arrangement has been suggested by Neuner[107] as a means of securing funds for capital investment in water utilities. The municipal utilities are monopolies which are subject to the same optimizing conditions. While the municipal utilities are not constrained by profit maximizing desires, they are constrained by revenue producing requirements for self-liquidation purposes. A unit tax or sales tax would reduce profit, output level and increase price. However, contrary to the tax loss per unit experienced by the monopolist, the municipal utility would retain the tax revenue. Thus, depending upon the demand and cost functions facing the municipal utility,[108] the proposal may increase total municipal utility income.

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[106] Tax Foundation, Earmarked State Taxes, Research Pub. No. 2, (New York State Tax Foundation, 1965), p. 12.

[107] E. J. Neuner, "Innovations in Financing Municipal Utilities," Journal of the American Water Works Association, May 1965.

[108] J. M. Henderson and R. E. Quandt, Microeconomic Theory (New York: McGraw-Hill, 1958), p. 166-175.

Under all conditions, a lump sum tax would increase a municipal utility's total revenue; but it also reinforces the distortions present on the rate structure.

It is interesting to note that Neuner recognized the fact that there were no accumulated reserves available in the municipal water utility accounts and he suggests the accumulation or equity building fund as a novel approach to municipal utility financing practice.

V.6.3 Municipal Programs

As of this date, certain municipalities in northeastern New Jersey are pursuing projects of rather restricted regional benefit.[109] It is not the intent of this paper to state that the activities of this nature will undoubtedly be severely constrained in the 1980-2000 time period. This curtailment of water resource programs by individual municipalities will be due to the technological requirements for future projects, the increased Federal and state involvement and the magnitude of the projects. For example, the Crab Island project will probably be undertaken by a joint utility commission which will seek to maximize the overall benefits of the projects. Therefore, the ability of individual municipalities obtaining advantages for their sole benefit will be mitigated. It is probable that future municipal programs will be confined to the responsibility for the administration and control of the local distribution system or grids.

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[109] "Round Valley Water Years," Newark News, July 20, 1968, p. 3.

CHAPTER VI - CONCLUSION

VI.1 Water Use and Availability Results

The per capita projections of water consumption rely mainly on the technological factors influencing both the residential and industrial sectors. The analysis has considered these factors and the particular technological characteristics of northern New Jersey in relation to water consumption. The results of the various projected series also depend upon the social and moral customs; it is assumed that those of the present will prevail in the future.

Using the per capita, water consumption and the population projections developed in this dissertation, a time of exhaustion of available water supplies during the study period, 1980-2000, was determined. The results indicate that the critical years would be between 1990 and 2000. This finding is in agreement with a study [1] conducted by the State of New Jersey. Considering the independent nature of both analyses, this is a significant result.

Referring again to the fact that previous water system projects have required as much as 10 to 15 years from the planning stage to the operational reality, the desirability of expeditious efforts in northeastern New Jersey is self-evident.

There are several methods by which quantities of water can be obtained in amounts exceeding the present local basin yield. The most obvious techniques are:

a. Increase of available yield by adequate systems management
b. Inter-basin transfer of water
c. Desalination of water
d. Re-use of water

1. R. E. Cyphers, op. cit.

It is also possible that water management methods and inter-basin transfer of water may require additional storage developments. This would lead to an expansion of the projected financial requirements for the study area. However, the application of these methods are indeterminate at the present and should be considered as innovations requiring new analyses and investigations.

VI.2 Cost Analysis Results

The cost analysis dealt with two related problems. First, there was the necessity for obtaining some basis of determining the capital outlays for water systems. Due to the unique characteristics of water system projects, the results were obtained as a range of values for the system elements. Within the range of the developed values, the capital outlays of a complete system were estimated. The qualifications and assumptions for each of the values have been given. Where a project element deviates greatly from this set of assumptions, new values may be determined by extensions to the analysis. A model has depicted the important variables of water systems (e.g., the increase in diameter of a transmission line) and their capital outlay relationships. The capital outlay values obtained are dependent upon the continuation of the technology used in present water system elements. Therefore, unless new methods of laying transmission lines or constructing reservoirs are developed, the capital outlay analysis results should prove workable to the year 2000.

The capital outlay information was used to obtain estimates of capital costs for several proposed water projects in northeastern New Jersey. The projects may be undertaken during the 1980-2000 time period. The dissertation has also formulated a schedule of capital outlays as a function of

time. This expenditure stream, together with the interest rate selected, is one of the important determinants of project costs. A comparison has been made of various expenditure patterns for water system components.

The second portion of the analysis concerned itself with the operational, maintenance and replacement requirements of a water system. Although this result is not directly related to the capital needs of municipalities, it does enable the determination of the yearly budget for a water utility. As with the capital outlay estimates, these values are based upon the technology of present day systems.

VI.3 Individual Municipal Requirements

Using the projection techniques developed above, individual municipalities may obtain a forecast of their future financial requirements. The individual municipality has the advantage of knowing which corrective factors may be introduced into its normal or historical trends of population growth and per capita consumption of water. For example, a new industry may locate in a previously rural municipality and the industry may be one which is particularly dependent upon process water. There may be physical or social characteristics of a municipality that would prevent the undertaking of new or expansionary water projects.

It is due to these conditions that the judgment, knowledge and experience of the local administration are necessary for decision-making purposes. It would seem that with the planning funds and programs now in existence, local governments have an opportunity to assume responsibility for their future requirements and economic development.

VI.4 Aggregate Municipal Burden

The present method of financing New Jersey municipal activities for the purposes of water utility construction and operation is the issuance and selling of bonds. The tax-exempt features of the general obligation bonds have made them an attractive investment device for those in the higher income tax brackets. The carrying of the debt burden by the utility is accomplished by the user charges for the water.

The analysis of municipal finance methods indicate that municipal capital requirements may be higher in the future with the paradoxical result of lower rates for water. This factor is due to the large percentages of capital costs that will be borne by other than local governments. As self-liquidating entities, the water utilities will have less of a debt burden and thus lower revenues and lower rates will be required for debt servicing. However, the main controversy in the water resource field today is that the water rates are too low due to non-adherence to economic principles.[1] The discriminatory rates, the non-marginal cost pricing of water and the use of improper interest rates in calculating costs are several of the factors producing distortions. It is contended that water demands would not occur beyond available supply if a competitive market mechanism were operative.[2] This would happen without the economy being restricted in its requirements for necessary goods and services and the reasonable use of water by the population.

1. Hirshleiffer, J., DeHaven, J., and Milliman, J., "Water Supply," (Chicago, University of Chicago Press, 1966), p. 108.

2. Kneese, A. and Smith, W. C., "Water Research," (Baltimore, Maryland, Johns Hopkins Press, 1966), p. 284.

The implications of future assistance by Federal and state governments for municipal water supply may, in fact, cause water rates to be lowered. This condition would result if less of a financial burden were placed on the communities and if the present statutes for determination of user charges are continued. The consequences may be contrary to the policies that are advocated by economists in the water resource area. The allocations process, outside the municipal government, may bring about a further weakening in the present rationing mechanism which would lead to further waste. It is a situation which may prove to be a problem of major significance. For in contrast to the municipal utility systems, there are private utility systems serving large numbers of individuals and businesses in northeastern New Jersey. These utilities would find themselves competing against increased governmental financial contributions to municipal systems and lowered water rates. This might be an insurmountable combination for even the most efficient private utility. The impact of proper cost accounting, as given in Chapter IV, raises questions beyond the scope of this disseration.

VI.5 Future Governmental Activity

In addition to the participation of Federal and state governments in past and present water supply activities, future programs may completely alter the municipal financial role. At the Federal level, there are several legislative actions, pending before committees, that would consolidate all water resources in the country under one agency's control. The intent of these proposals is to consolidate jurisdictional control with the physical functioning of water systems. For example, many regions in the United

States maintain separate organizations or agencies for water supply and waste disposal. This situation, can conceivably lead to severe pollution effects with the subsequent decline in the capability of both systems to function properly. A meaningful program must be developed in New Jersey, as elsewhere, between the needs of the communities for pure water and their requirements for waste disposal. The present method of rivers and streams providing the means of transferring waste material will not be a feasible procedure for the future. Therefore, the present proposals before Congress to consolidate all water resource functions may receive the necessary support for future passage.

The State of New Jersey appears determined to participate in providing the storage and transmission components of proposed water supply projects. Even at a lower governmental level, the county, there has been a proposal for county reservoir systems. This may lead to a future amalgamation of the many utilities within each county. There have been good results from this type of operation elsewhere in the United States.[1] At the municipal level, the prime function in the future will be responsibility for water distribution within the locality. If each municipality strove to construct its own water system in the future, duplication and consequent waste and inefficiency may result throughout the study area.

1. Cessna, P. A., "A County Water System Proved Best," The American City, February, 1967.

VI.6 Results of the Research

There are several findings and conclusions that can be drawn as a result of this dissertation.

1. Population projections and per capita consumption data have been analyzed and combined into a total water requirement. The results indicate that the present technical method of supplying water for northeastern New Jersey will be exhausted by the middle of the last decade in the 20th century. If certain combinations of population, consumption and precipitation should occur, this exhaustion of additional water supply will occur at least ten years earlier.

2. A capital outlay model for water systems in the northeastern sector of the United States, and New Jersey in particular, has been developed. The model assumes the present state of technology for future projects in the 1980-2000 time period. Utilizing the model, the capital outlay requirements for northeastern New Jersey have been estimated. In addition, the capital costs for these outlays have been determined for several alternative expenditure patterns and interest rates.

3. In recognition of the urgent need for water resources, the Federal and state governments have instituted programs to provide assistance for future municipal water supply projects. This involvement may bring substantial financial resources into the region. Consequently, the burden will partially shift from the municipal to the Federal and state levels. As this burden shifts the State and municipalities will incur less new debt and hence lowered debt servicing requirements.

4. The future user charges or rates to consumers will be lower than the present ones if the Federal aid continues at an adequate level and if the practice of gearing user charges to local debt-servicing is continued.

The possibility of improperly reduced water rates is directly contrary to the advocation by many authorities in the water resources field that water rates should be based on marginal costs so as to assure optimality in resource allocation. One might even contend that such pricing, given an adequately large direct price elasticity, might equilibrate the available amount of water with the demand without the need for additional facilities. The investigation of this eventuality, which undoubtedly would postpone the period of resource exhaustion, is outside the limitations of this dissertation.

5. The proliferation of aid programs at various levels of government will lead to a conflict of objectives. Unless there is a certain degree of coordination developed between different levels of government, the intention of re-distributional activities will be mitigated.

APPENDIX A

The material included in this appendix is from the New Jersey Statutes Annotated, Revised, 1937 and the Revised Statutes Cumulative Supplement. The quoted numbers of the various sections have the following key: For example 40:62-49 refers to Title 40, Chapter 62, Section 49.

A.1 Municipally Owned Public Utilities

A.1.1 Method of Supplying Water (40:62-49)

The municipality may obtain water supplies by

a. Contract with the District Board of Water Supply in which it is situated.

b. Contract with any other municipality or municipalities.

c. Contract with any water company or companies or joint action with other municipalities and water companies.

d. Purchasing or leasing any water works or water supply.

e. Constructing water works by acquisition of lands, water rights and flowage.

However, before any of these methods other than contracts can be made operative, the question must be placed before the voters of the municipality, at a special election or the next succeeding general election, as to the acquisition or purchase of manners of supply (40:62-50). The municipality may then issue its bonds for the purpose of financing the course of action decided upon by the voters

(40:62-57). The municipality may also, once it has a water works, increase its capacity without any referendum (40:62-59).

For any municipality that does not have a water works or water system and requires a supply of water, it may construct extensions to existing water supply systems and raise the funds for this purpose in the manner of assessments as collected for any local improvement (40:62-60).

To this stage, the steps have been outlined by which a municipality may obtain water supplies within its own framework and the manner by which it may finance the requirements.

The municipality also has the power to create and establish, by ordinance, a water district (40:62-96). This in effect is the operation of the water works or water system as a separate utility. The water district may be financed by notes or bonds (40:62-100) or assessments in the manner of any local improvement against the real estate benefiting from the water district (40:62-101).

As regards the expense of operation and maintenance and the issuance of bond obligations, these expenses are to be made by taxes levied on the property in the water district (40:62-102). Any contract regarding the water district and the distribution and maintenance of the water system and supply of water may also provide for the collection of rental charges from the users of the water supply (40:62-104).

There is one more pertinent item concerning this concept of a separate utility or district:

> 40:62-106. Consolidation of Water and Sewer Systems. Any municipality owning its water and sewer systems and operating the same as separate utilities may by ordinance consolidate said water and sewer systems and operate the same as one utility and under one head or body.

This section admits of the possibility of joint action as regards the pollution problem confronting many areas.

A.1.2 Method of Financing Water Supplies

The pertinent legal framework for this function lies within the Local Bond Law Chapters of Title 40A Municipalities and Counties of the New Jersey Statutes Annotated. There are certain definitions used in the text that are now quoted:

> "bond ordinance" means an ordinance adopted as herein provided by the governing body of a local unit authorizing obligations;
> "equalized valuation basis" of a local unit means the average for the last 3 preceding years of the sum total of
> a. the aggregate equalized valuation of real property together with improvements, as certified in the Table of Equalized Valuations by the Director of the Division of Taxation in the Department of the Treasury, on October 1 of each year, pursuant to Chapter 86 of the laws of 1954 and,
> b. the assessed valuation of Class II railroad property as set forth in the Table of Equalized Valuations referred to in "a" above.

The equalized valuation technique obtains a ratio between assessment values on property and actual sales values of the same property.

In the previous sections of the statutes where reference was made to the issuing of bonds, the sections gave reference to Title 40 as the means of legally financing such instruments.

Under section 40A:2-3, any municipality may borrow money and issue obligations for financing any purpose for which it has authority to do so or is required by law to do so. However, there are limitations to this power expressed in section 40A:2-6 which states that no bond ordinance shall be adopted if it appears that the net debt for the case of a municipality will exceed 3 1/2% of the average equalized valuations of the taxable real estate, together with improvements for the past three years. There is a section 40A:2-7 which allows for exceptions to the

debt limitation as in cases of emergency or questions of public health. For the purposes of examining the financial flexibility and capability of municipalities in their water requirements efforts, there is one paragraph of section 40A:2-7 that is extremely important and is wholly quoted:

> A bond ordinance may be finally adopted notwithstanding section 40:2-6 (Debt limitations) if such ordinance authorizes obligations solely for one of the following: . . . . . .
>
> d. Purposes permitted by this chapter, if the local government board shall have caused its consent to be endorsed upon a certified copy of the bond ordinance as passed upon first readings which consent said local governments board shall cause to be so endorsed thereon, if it shall be satisfied and shall have determined that each of the purposes or improvements for which such obligations are authorized are in the public interest and are for the health, welfare, convenience or betterment of the inhabitants of such local unit, and that the amounts to be expended for each of the purposes or improvements to be financed pursuant to such bond ordinance are not unreasonable or exorbitant and that the issuance of such obligations will not materially impair the credit of such local unit or substantially reduce its ability to pay punctually the principal of and interest on its debts and to supply other essential public improvements and services.

This section thus allows for a reasonable deviation from the restrictiveness of the debt limitation statute. The local government board will be explored further on in this exposition.

It was previously stated that a municipality may issue bond (40:62-57). This section also describes the uses to which revenue derived from the operation of a water plant must be devoted to in order of importance:

> a. Payment of interest or any indebtedness incurred in purchasing the plant;
>
> b. Payment of any installment or partial payment of any indebtedness which is due or payable;
>
> c. Operating expenses, including necessary extensions; and
>
> d. General municipal purposes (40:62-57).

The statutes specifically determine the debt limitations or the remaining borrowing power at any particular time. This figure is obtained

for municipalities from 40A:2-6 which specifies that net debt shall not exceed 3 1/2%. This percentage is used in conjunction with the value of equalized valuation defined in 40A:2-2 and the net debt figure obtained from "40A:2-42 Supplemental Debt Statement" to arrive at the remaining borrowing power. Thus 40A:2-42 determines the net debt with the use of 40A:2-43, gross debt and 40A:2-44, deductions from gross debt. The calculation would then be as follows:

3 1/2% of Equalized Valuation Basis
Minus Net debt = Gross debt - deductions
equals Remaining Borrowing Power

One other factor is extremely important in the determination of deductions from gross debt. Item c in 40A:2-45, that the municipal public utility does not incur a deficit. If a deficit is obtained from a self-liquidating utility, the deficit "shall be capitalized at 5% and the capital sum so determined shall not be deductible from the gross debt (40A:2-48).

Another method of obtaining financial support for improvements in a municipality is the issuance of "assessment bonds" and the manner to do so is detailed in section 40A:2-14 (Local improvement obligations). Basically the cost of the local improvement is assessed against the property benefiting from the improvement and the funds are secured through the issuance of bonds.

The municipality may also issue "refunding bonds" by an ordinance similar to a bond ordinance for a variety of uses including paying, funding or refunding outstanding bonds. Also the local government board may determine that a refunding bond ordinance "is in the public interest and is based upon a sound financial plan for equalizing or reducing the debt service of a local unit." (40A:2-54) Special

Refunding Program)

The municipality also has available for its financial use short term instruments which are designated as "bond anticipation notes" and may be issued for a period of one year. There are also "capital notes" which may be issued for periods of five years and may not exceed a stated value. Both of these instruments are fully explained in section 40A:2-8. (Short term financing).

A.2 Privately Owned Public Utilities

A.2.1 Method of Organization

A water company may be organized by a group of individuals, the majority of whom reside in the state, for the purpose of providing a waterworks for a municipality. The municipality shall not have more than fifteen thousand inhabitants. (48:19-1) For larger communities, the company must have been in existence, whether in a corporate form or a practical working entity, prior to March twenty-second, 1934. (48:19-8). The proposed corporation is also required to file a certificate of incorporation which must contain such items as the amount of capital stock and the proposed management. (48:19-2). The proposed corporation must also obtain the approval of the municipality which it intends to serve as well as the approval of the state water policy commission. (48:19-23)

A.2.2 Method of Financing

The corporations which are privately owned public utilities are subject to the statutes effecting all corporations and described in Title 14, Corporations, General, as well as the additional statutes in Title 48, Public Utilities. Specifically, under Title 48, the public utilities may issue stocks and bonds of various values and maturities

as well as transfer said securities provided that prior approval is obtained from the board of Public Utility Commissioners. (40:3-8-10) This requirement holds true for the increase of capital stock by the company. (48:19-11) As regards the issuance of bonds, the interest rate is fixed by statute at a maximum of 6%. (48:19-12)

A.3.1 Method of Organization

The governing body of two or more municipalities who are intent upon acquiring privately owned waterworks, may apply to a Supreme Court Justice for the appointment of a commission. This commission will then either purchase or acquire by condemnation the water works which previously supplied the municipalities with water. (40:62-109) The commission shall not consist of more than five members who are residents of the municipalities making application for the appointment of a commission (40:62-110).

A.3.2 Method of Financing

In order to obtain funds for the initial cost of acquisition of a waterworks which is to be under the administrative and operational control of a commission, the municipalities creating the commission have two alternatives. Firstly, they may issue bonds jointly in the names of all the participating municipalities. Secondly, the bonds may be issued on an individual municipal basis for an amount equal to each municipality of a proportionate share of the cost. In both instances, the bonds are of a general obligation type and are subject to the same requirements and regulations as any other municipal bond issue. (40:62-121)

Once the commission has been established, additional financing

requirements for any improvement, or enlargement or maintenance of the waterworks may be obtained by bond issues. The bond issues must be for a specific project and each municipality is responsible for the proportionate share of a bond issue. The amount realized from the sale of the bonds is paid to the commission. Prior to the issuance of any bonds.

> Said bonds shall not be sold except with its approval by the commission and with its approval of the maturities of and rates of interest payable on said bonds.
>
> Such consent and approval may be given by resolution of the commission and shall be and constitute a formal assumption by the commission of said bonds, and the interest thereon. (40:62-126)

However, the bonds are the responsibility of each municipality as regards its share of the indebtedness and any deficit or default of payment must be assumed as the responsibility of each municipality.

A.4 Water Supply Districts

A.4.1 Method of Organization

The State of New Jersey was divided into two water supply districts in 1916 and the districts are continued by statute in section 58:5-1. The water supply districts are to be administered by a commission (58:5-3) and the name of the commission for northern New Jersey shall be the North Jersey District Water Supply Commission (58:5-5). The commission thus organized is deemed to be a corporate body with all of the power and responsibilities implied in this type of entity. (58:5-7)

A.4.2 Method of Financing

The commission may secure financing in either one of two ways. Firstly, the cost of the water supply to be fulfilled by the Commission

may be charged against the municipalities requesting said water supplies in proportion to the amount of water contracted for each municipality (58:5-22) The individual municipalities themselves may meet their cost of the water supply projects by issuing bonds or notes or other temporary obligations (58:5-28) Secondly, the commission has the power to issue bonds on its own behalf for any of the projects it may undertake (58:5-43) All the bonds of the commission are tax exempt as well as the revenues with which the interest payments are derived from. (58:5-55) Another important factor in the financing arrangements is that the commission has authorization to

> accept grants of funds, grants of material and property from the United States of America, its agencies or instrumentalities, and may comply with any rules or regulations pertaining thereto. (58:5-7.1)

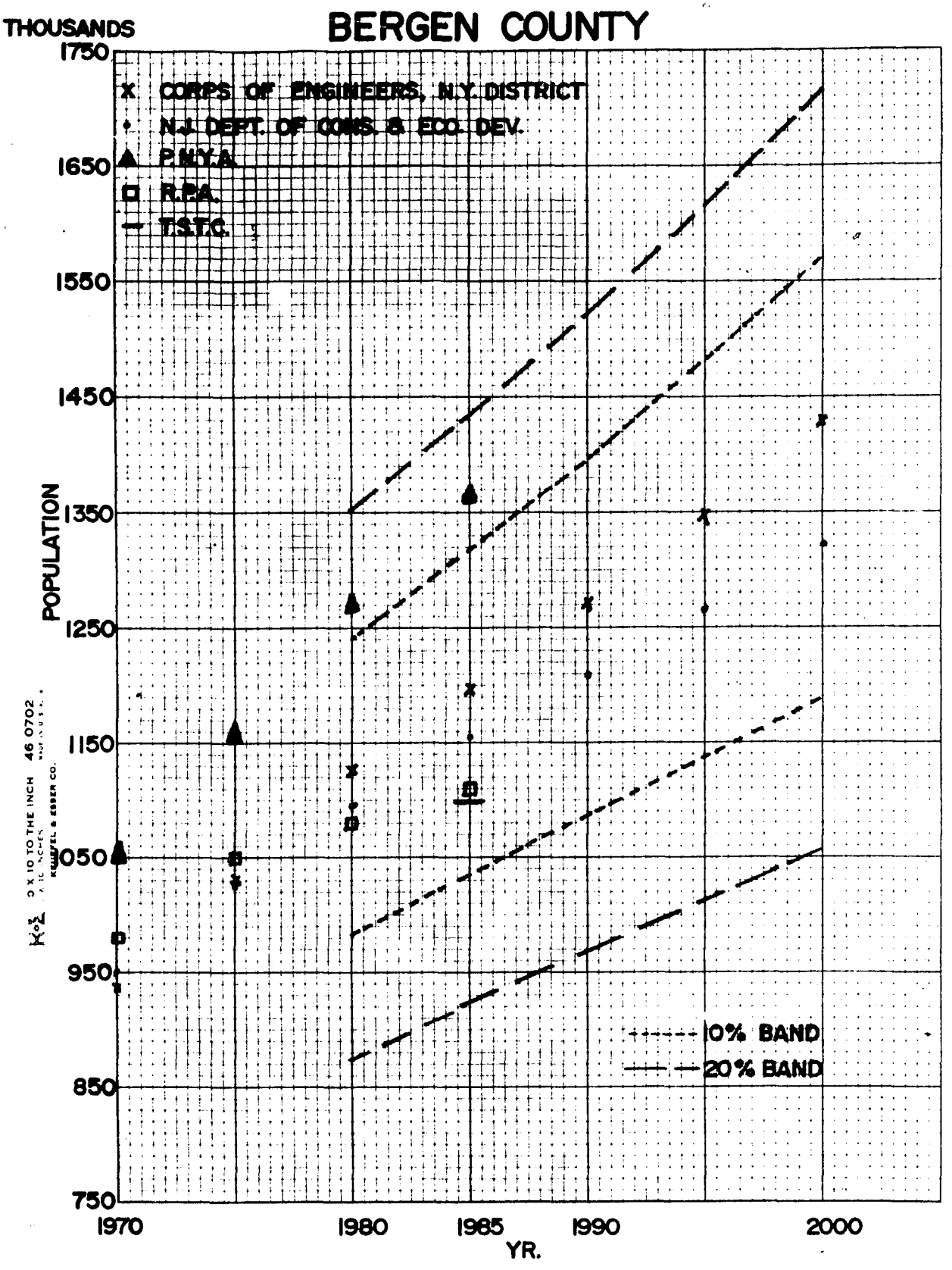
BERGEN COUNTY
THOUSANDS
1750
1650
1550
1450
1350
1250
1150
1050
950
850
750
POPULATION
X CORPS OF ENGINEERS, N.Y. DISTRICT
N.J. DEPT. OF COMS. & ECO. DEV.
P.N.Y.A.
R.P.A.
T.S.T.C.
10% BAND
20% BAND
1970
1980
1985
1990
2000
YR.

FIG. B-1

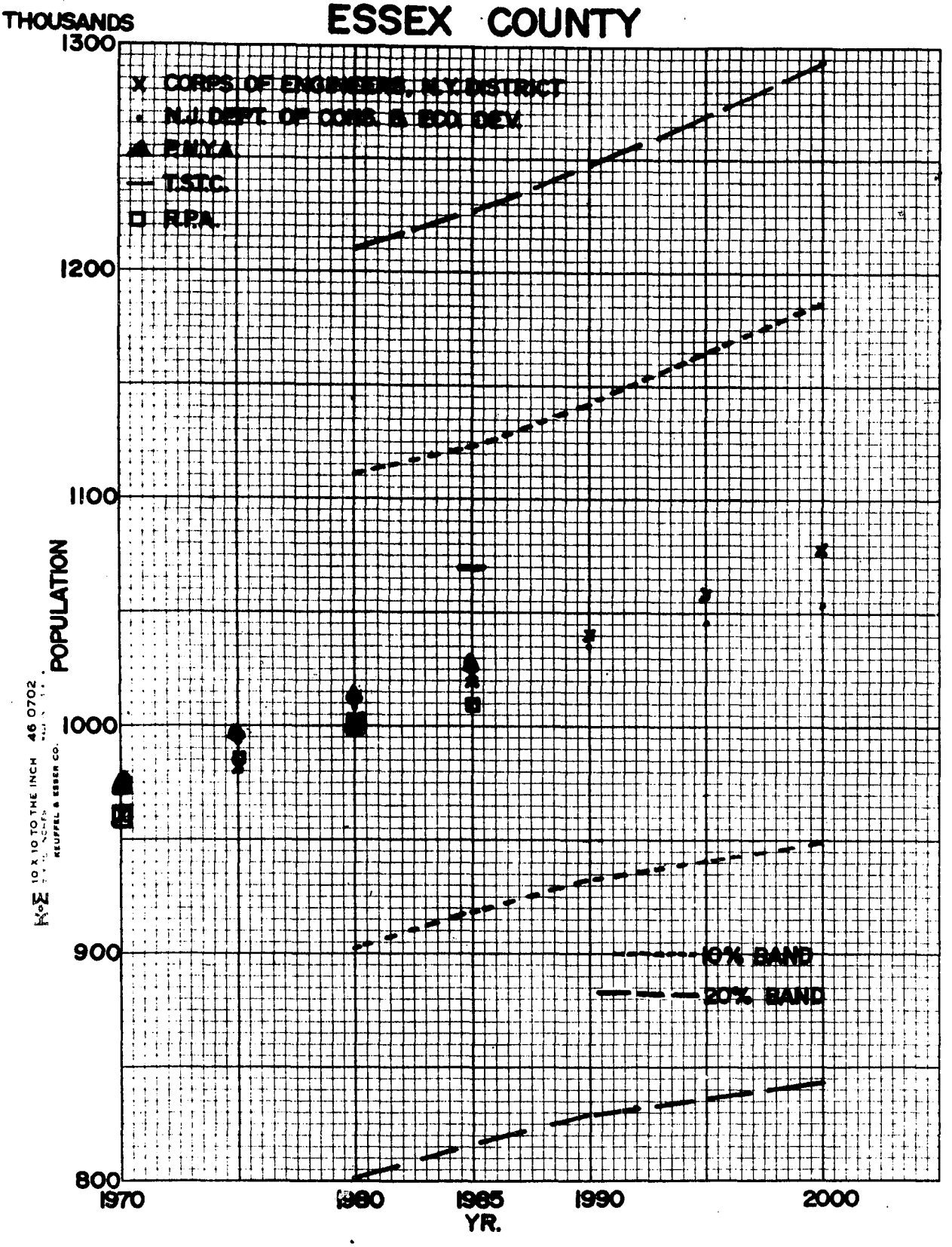
ESSEX COUNTY
THOUSANDS
1300
1200
1100
1000
900
800
POPULATION
X CORPS OF ENGINEERS, N.Y. DISTRICT
N.J. DEPT. OF COMM. & ECO. DEV.
P.M.Y.A.
T.S.I.C.
R.P.A.
10% BAND
20% BAND
1970
1980
1985
1990
2000
YR.
46 0702
10 X 10 TO THE INCH
KEUFFEL & ESSER CO.

FIG. B-2

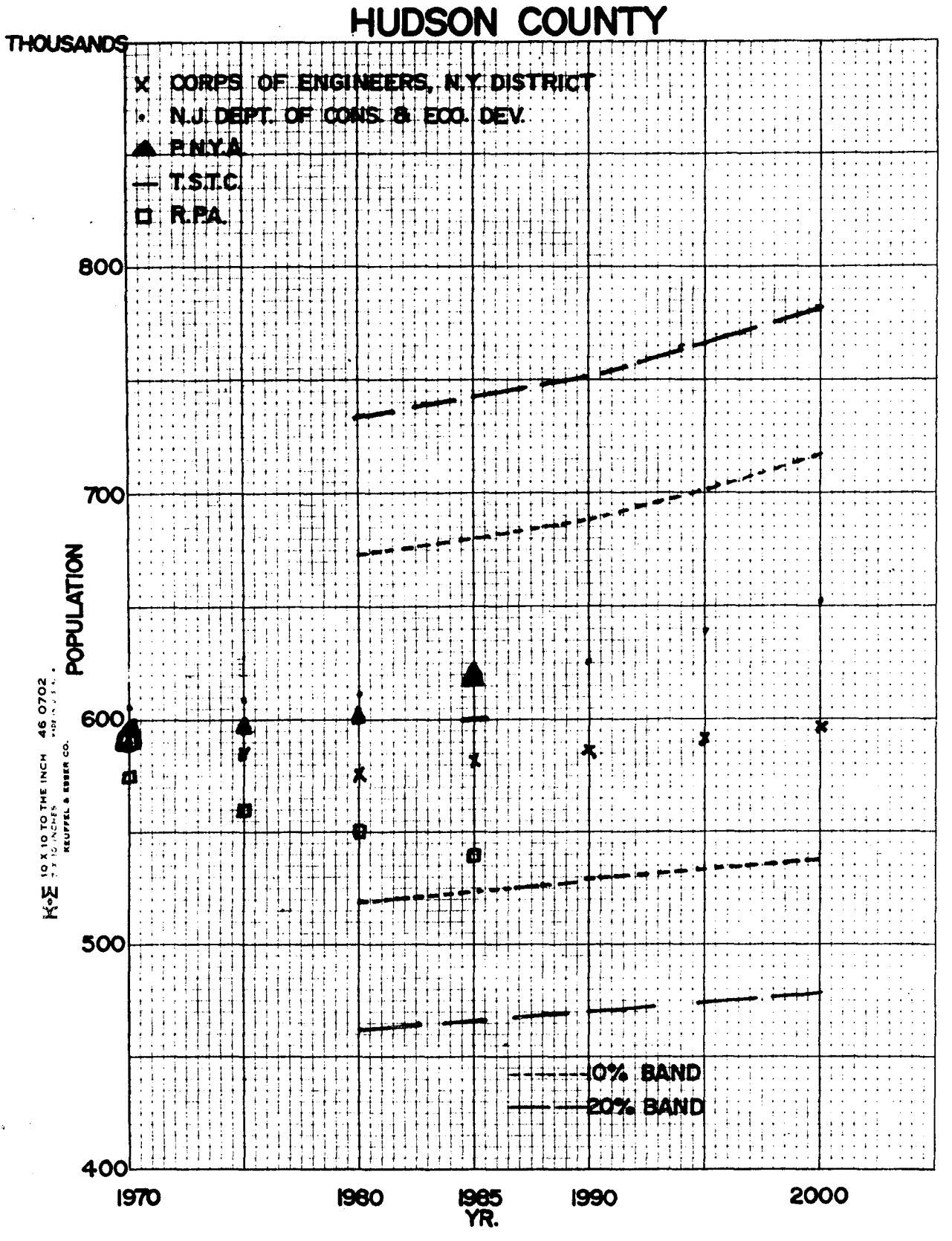
HUDSON COUNTY
THOUSANDS
X CORPS OF ENGINEERS, N.Y. DISTRICT
• N.J. DEPT. OF CONS. & ECO. DEV.
▲ P.N.Y.A.
— T.S.T.C.
□ R.P.A.
800
700
600
500
400
POPULATION
10% BAND
20% BAND
1970
1980
1985
1990
2000
YR.
KEUFFEL & ESSER CO.

FIG. B-3

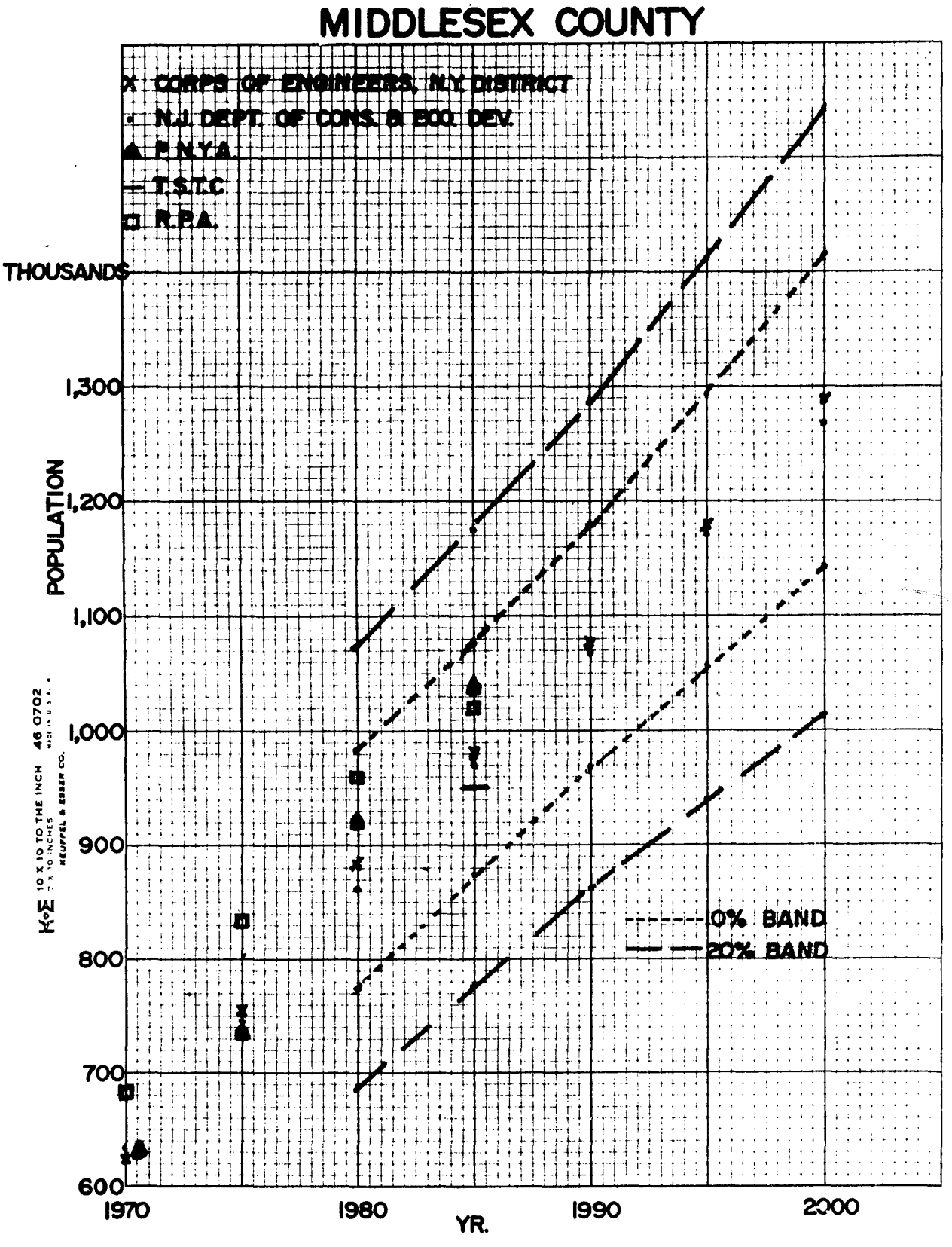
MIDDLESEX COUNTY
X CORPS OF ENGINEERS, N.Y. DISTRICT
• N.J. DEPT. OF CONS. & ECO. DEV.
▲ P.N.Y.A.
— T.S.T.C.
□ R.P.A.
THOUSANDS
POPULATION
1,300
1,200
1,100
1,000
900
800
700
600
1970
1980
1990
2000
YR.
10% BAND
20% BAND
KOE 10 X 10 TO THE INCH 46 0702
KEUFFEL & ESSER CO.

FIG. B-4

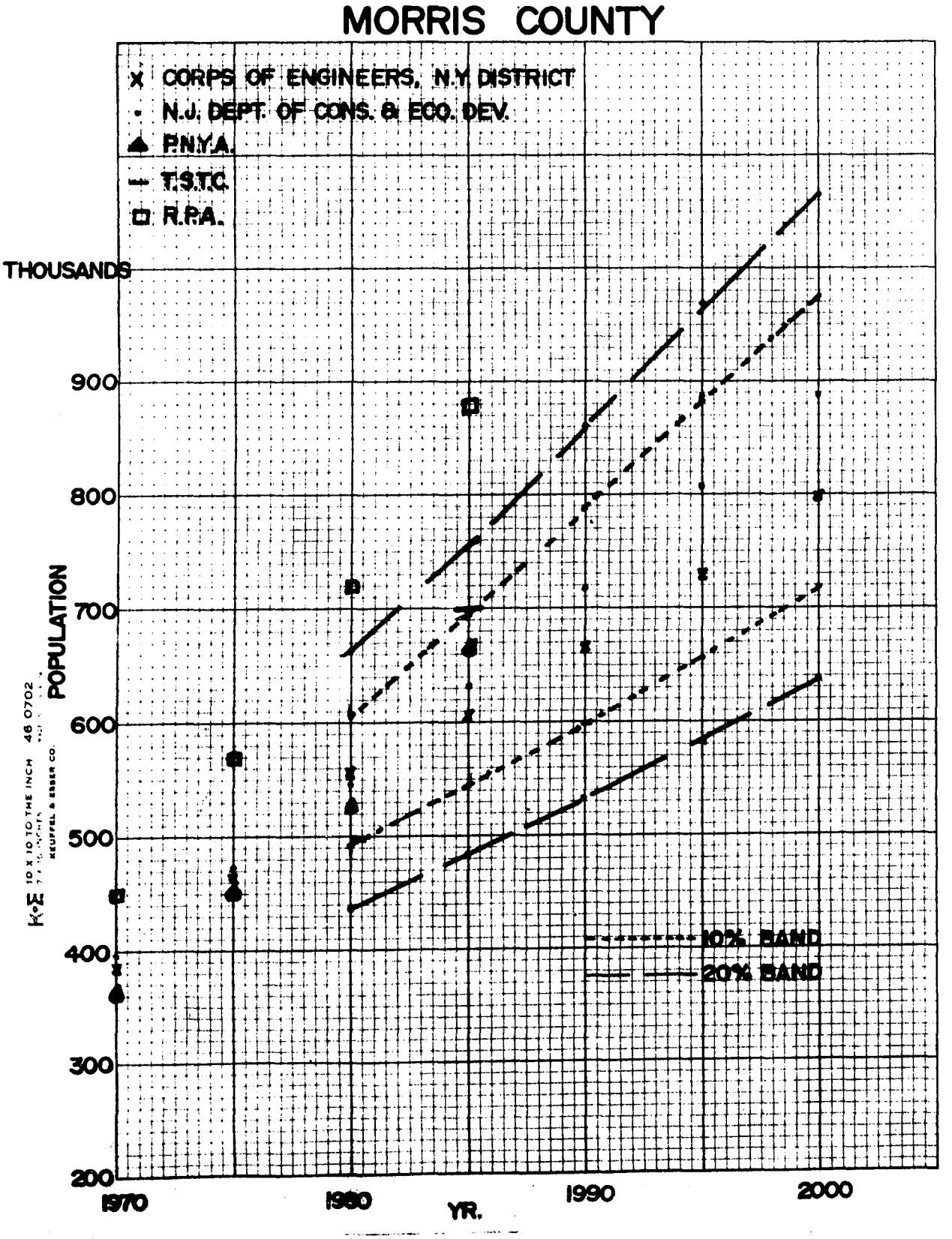
MORRIS COUNTY
X CORPS OF ENGINEERS, N.Y. DISTRICT
• N.J. DEPT. OF CONS. & ECO. DEV.
▲ P.N.Y.A.
— T.S.T.C.
□ R.P.A.
THOUSANDS
900
800
700
600
500
400
300
200
POPULATION
1970
1980
1990
2000
YR.
10% BAND
20% BAND

FIG. B-5

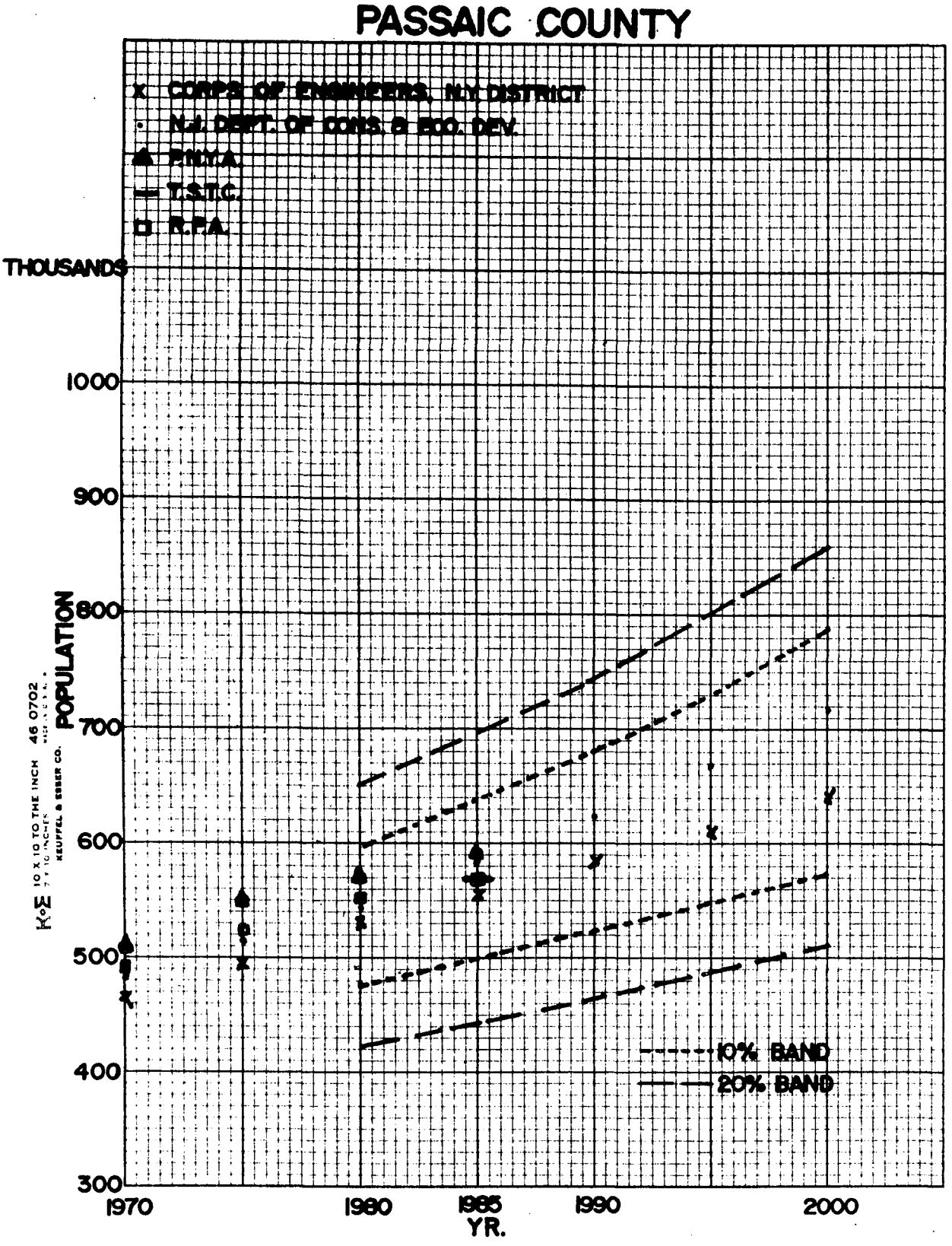
PASSAIC COUNTY
x CORPS OF ENGINEERS, NY DISTRICT
• N.J. DEPT. OF CONS. & ECO. DEV.
▲ P.N.Y.A.
— T.S.T.C.
□ R.P.A.
THOUSANDS
1000
900
800
700
600
500
400
300
POPULATION
1970
1980
1985
1990
2000
YR.
10% BAND
20% BAND
K&E 10 X 10 TO THE INCH 46 0702
KEUFFEL & ESSER CO.

FIG. B-6

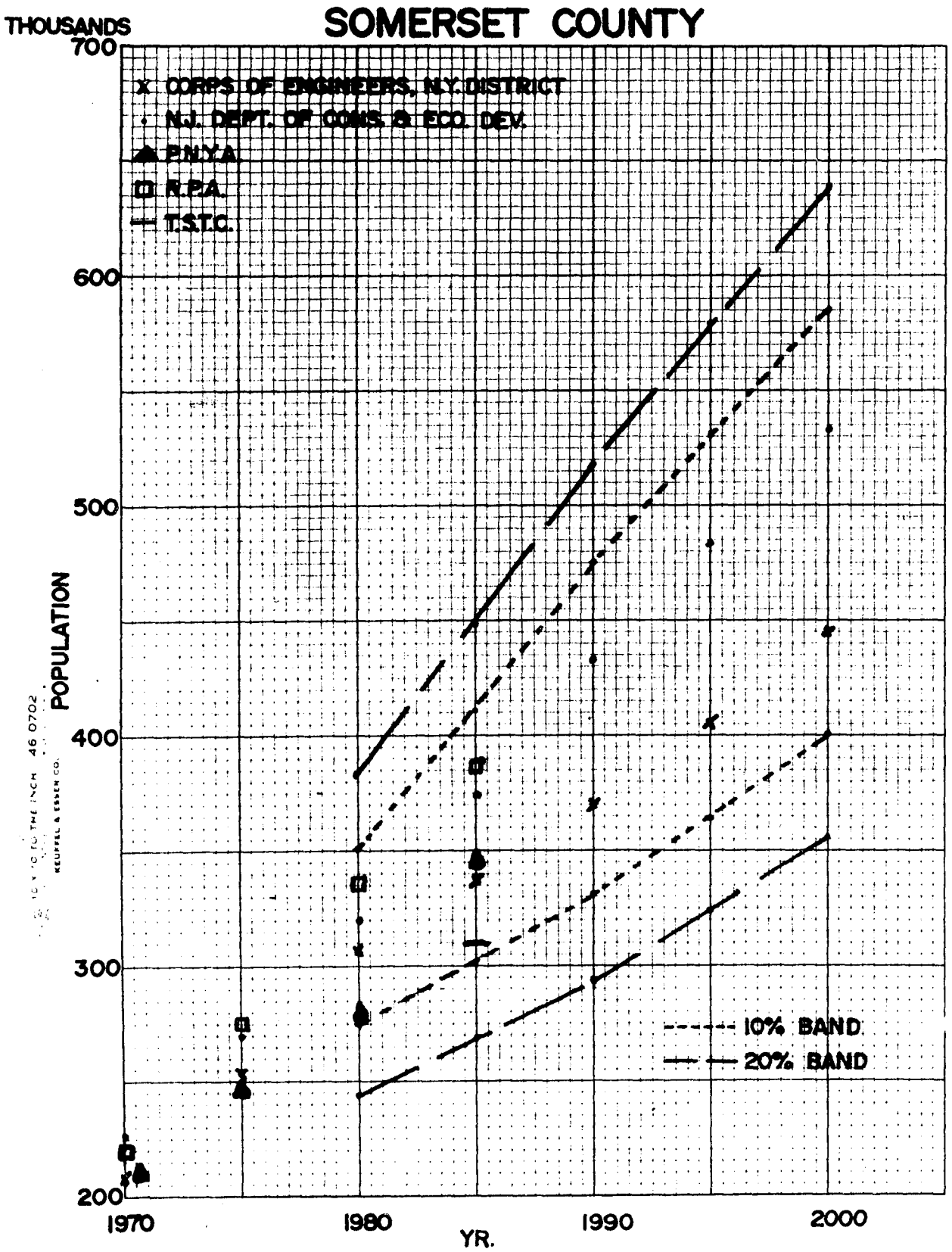
SOMERSET COUNTY
THOUSANDS
700
600
500
400
300
200
POPULATION
X CORPS OF ENGINEERS, N.Y. DISTRICT
• N.J. DEPT. OF CONS. & ECO. DEV.
▲ P.N.Y.A.
□ R.P.A.
— T.S.T.C.
10% BAND
20% BAND
1970
1980
1990
2000
YR.

FIG. B-7

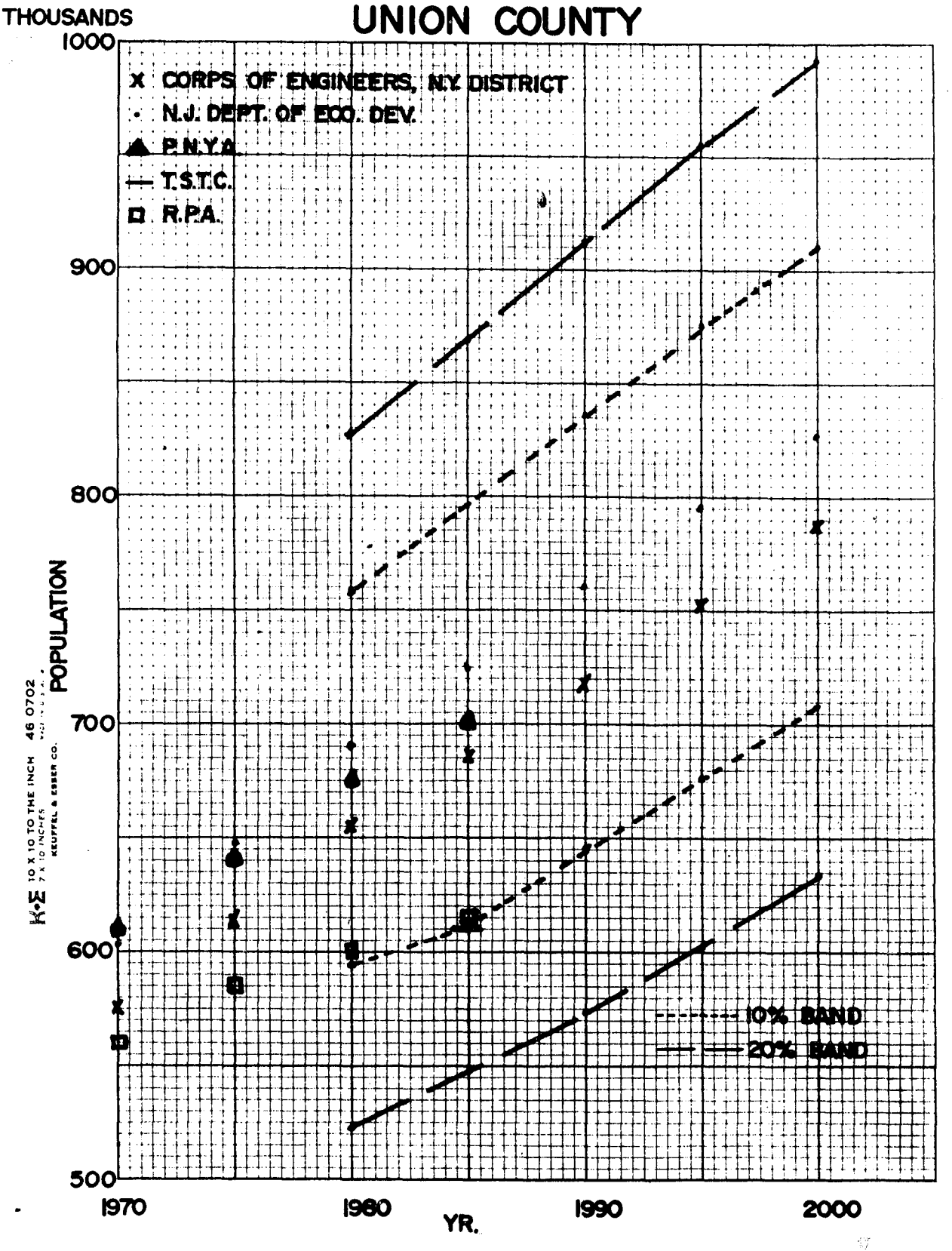
UNION COUNTY
THOUSANDS
1000
900
800
700
600
500
POPULATION
X CORPS OF ENGINEERS, N.Y. DISTRICT
N.J. DEPT. OF ECO. DEV.
P.N.Y.A.
T.S.T.C.
R.P.A.
10% BAND
20% BAND
1970
1980
1990
2000
YR.
KEUFFEL & ESSER CO. 46 0702
10 X 10 TO THE INCH
7 X 10 INCHES

FIG. B-9

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