Water For The
21st Century:
The Vital Resource

NEW JERSEY
STATEWIDE WATER SUPPLY PLAN

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The mission of the New Jersey Department of Environmental Protection is to conserve, protect, enhance, restore and manage our environment for present and future generations. We strive to prevent pollution; ensure the efficient use of safe, environmentally sound and reliable energy resources; provide opportunities for recreation and enjoyment of natural and historical resources; and promote a hea**lthy and sustainable ecosystem.**

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ACRONYMS

1982 Plan	NJ Statewide Water Supply Master Plan
ASR	Aquifer Storage and Recovery
Bond Fund	1981 Water Supply Bond Act
BPU	Board of Public Utilities
CUPR	Center for Urban Policy Research
DCA	Department of Community Affairs
DRBC	Delaware River Basin Commission
gpcd	gallons per capita per day
MGD	million gallons per day
NJDEP	NJ Department of Environmental Protection
NJGS	New Jersey Geological Survey
NJPDES	NJ Pollutant Discharge Elimination System

NJSWSP	1995 NJ Statewide Water Supply Plan
PAC	Public Advisory Committee
planning areas	Regional Water Resource Planning Areas
PRM	Potomac-Raritan-Magothy
SDRP	State Development and Redevelopment Plan
SRF	State Revolving Fund
USEPA	US Environmental Protection Agency
USGS	US Geological Survey
WBM	Water Balance Model
WHPA	Well Head Protection Area
WHPP	Well Head Protection Program
WSAC	Water Supply Advisory Council
WSCA	Water Supply Critical Area
WSMA	Water Supply Management Act
WTR	Water Treatment Residuals

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EXECUTIVE SUMMARY

New Jersey's waters belong to its residents, held in trust and managed for them by the State of New Jersey. New Jersey receives in excess of 40 inches of annual precipitation, on average, providing water for recreation, a large population, one of the nation's largest industrial concentrations, and aquatic life that requires a regular flow of clean water. Most of the State has viable ground and surface water supplies (see **Chapter Two**). However, even plentiful precipitation does not guarantee that droughts will not cause major water supply disruptions or that aquifers cannot be depleted. To ensure that New Jersey could cope with all foreseeable water needs and droughts, the Water Supply Management Act and the Water Supply Bond Act (Bond Fund) were approved in 1981, establishing a management framework and a source of public funding -- $350 million -- to help fulfill it. The Department of Environmental Protection (NJDEP) was entrusted with primary responsibility for both acts.

NJDEP in 1982 adopted the first New Jersey Statewide Water Supply Master Plan (1982 Plan), as required by the Water Supply Management Act. The 1982 Plan included major recommendations to improve surface water supply capacity (primarily in northeastern and central New Jersey), ensure proper maintenance of aging water supply infrastructure, investigate the status of major aquifers and plan for future water supply needs. As required by the Water Supply Bond Act, the 1982 Plan also determined which public water supply efforts were eligible for funding from the Bond Fund.

New Jersey has taken great strides to improve its water supplies based on the 1982 Plan. The Wanaque South Project/Monksville Reservoir and the rehabilitation of the Delaware & Raritan Canal provided major supply increases. The Manasquan Reservoir in Monmouth County, three major pipelines in the Central Passaic River Basin and Middlesex County, and the Tri-County Project near Camden provide surface waters to replace stressed aquifer supplies, based on research and feasibility studies funded by the Bond Fund. Scores of water supply systems have been upgraded using low-interest loans from the Bond Fund. Much more is known about New Jersey's aquifers and significant efforts are in progress to protect these supplies, again supported by the Bond Fund. In short, the 1982 Plan has been a major success for New Jersey.

Based on successes of the 1982 Plan and recognizing that available supplies, projected needs for water supplies, development trends and knowledge regarding ecological water needs and water management concepts were changing, NJDEP began to develop a new plan. This New Jersey Statewide Water Supply Plan (NJSWSP) was developed by the NJDEP with the invaluable assistance of three consulting firms,[1] the Water Supply Advisory Council (WSAC) and its Public Advisory Committee (PAC). The NJSWSP constitutes a complete revision and replacement of the 1982 Plan.

<u>Comparing Water Supply Availability and Demand</u>
Estimates of New Jersey's available water, including individual surface water supplies and regional ground water availability, are fundamental to water supply planning. To improve the NJDEP's ability to identify potential water shortfalls, the state was divided into twenty-three Regional Water Resource Planning Areas (planning areas) based on surface watersheds.[2] Future versions of the NJSWSP will also be watershed-based, using a system of watersheds and watershed management areas newly developed for New Jersey's Watershed Management Strategy.

The water availability estimates (see **Chapter Three)** are critical tools for water supply planning. However, they are still <u>estimates</u>. Surface and ground water supply yields are based on the supply's ability to provide water throughout periods of stress -- these "safe" or "dependable" yields will change if different levels of "stresses" are assumed. Still, surface water "safe yields" are relatively well known. In contrast, too little is known even now about the state's aquifers to fully define ground water availability. Therefore, the NJSWSP uses "planning thresholds" based on known aquifer stress but recognizes that better assessments are needed. Finally, yields can increase or decrease if water is transported from one watershed to another. The NJSWSP measured these "interbasin transfers" or "depletive water uses" for the first time.

The total safe yield of surface water supplies in New Jersey is approximately 850 million gallons per day (MGD). Based on the planning thresholds, available ground water is approximately 900 MGD. Assuming that these values are fairly independent (i.e., the use of ground water below the planning thresholds does not affect surface water yields significantly or *vice versa*), **the total estimated yields are approximately 1,750 MGD**. However, these estimates must be used with great cautionfor several major reasons:
The estimates of available ground water may be somewhat inaccurate;
Ground water and surface water <u>are</u> interrelated;

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[1]CH2M HILL served as the prime consultant for this project, with Metcalf & Eddy, Inc. and New Jersey First as subcontractors.
[2]Watersheds are defined as the land area from which water flows as a stream or river through a single outlet point. New Jersey has over 100 watersheds, which were aggregated into 23 areas for the NJSWSP.

The use of ground water may be constrained by existing development or contamination threats;
The method of water supply development and use can reduce the yields below optimum levels;
Statewide statistics do not reflect whether available water is located near the point of demand. Significant regional or local deficits can be masked by statewide estimates.

The next step is to estimate recent (1990) water demand and to project demand through the planning period of 1990 to 2040 (see **Chapter Four**). The 1990 demand was approximately 1,500 MGD. **The 2040 demand is projected to be 1,790 MGD**. Although any projections beyond twenty years or so are clearly questionable, the demands provide useful "benchmarks" for planning because the protection of water sources and the development of new supplies can often take decades. Water supply planning must look well beyond our current ability to predict population or demand trends.

Estimates of current or future deficits or surplus supplies are derived from results of the two previous chapters (see **Chapter Five**). Deficit analyses are a critical tool in water supply planning, providing a target for planning. Where deficits are forecast, improved data may provide a sufficient explanation, or there may be a need for increased conservation, improved management, new supplies or some combination. However, even where no deficits are forecast many supply issues may exist such as more localized supply deficits, aging infrastructure or pollution threats.

Several regions are highlighted in Chapter Five.
Northeastern New Jersey provides clear evidence of one major success for the 1982 Plan. With three new water supplies, no regional deficits are forecast based on the model used. The Hackensack and Lower Passaic/Rahway River areas will likely experience increased use of supplies from the Upper Passaic area, according to projections, but those supplies are available. However, extreme caution is necessary in this region, which is the most highly and densely populated area of New Jersey. The projections need to be continually checked against new data, and improved modeling is needed. Conservation and integrated reservoir management will still be needed during drought periods. Sub-regional issues such as ground water depletion will also be a continuing concern in this area. Still, the water supply situation has greatly improved since 1982.

The **South River watershed and the Camden metropolitan area** were confirmed as problem areas due to depleted aquifers. Both were recently the focus of new supply construction that will greatly ease the aquifer stress over time. However, the extent of aquifer depletion and anticipated growth (especially in the Camden area) make continued monitoring of these regions critical.

The **Toms River and Metedeconk Creek watersheds** of Ocean County have been identified as a significant long-term concern, primarily because the area relies heavily on ground water supplies and is projected to nearly double in population during the planning period. Ground water research supported through the Bond Fund is seeking more accurate estimates of ground water availability in this area.

The **Maurice River watershed** in Cumberland County was identified as an area of concern for the first time. Surface water supplies could be disrupted by droughts. Ground water provides nearly all water supplies. Salt water intrusion from the Delaware Bay and deeper ground water units is a concern, as is existing ground water pollution. Based on preliminary results, ground water research was begun in the area using the Bond Fund to better assess the ground water availability.

Finally, the **Cape May peninsula** was also confirmed as an area of concern. Salt water intrusion to aquifers at the tip of Cape May is occurring, and the county's projected growth will result in significant demand increases. Considerable aquifer research has been supported through the Bond Fund and local governments, providing valuable information to address these issues.

<u>Statewide Water Supply Initiatives</u>
The consultant reports, recent studies funded or developed by the NJDEP and other agencies, evolving water management concepts and the results of Chapters Three through Five provide support for a wide range of statewide and regional recommendations in **Chapter Six**. Some are management initiatives that

prevent or delay deficits, while others are capital project initiatives that will provide additional supplies. Most of the statewide initiatives are addressed in more detail **in Chapters Seven through Nine** (on water supply resource management, water allocation and infrastructure development and management).

Statewide management initiatives include the following:

Water Resources Protection -- Given the large and growing population of New Jersey and the spread of development across water supply watersheds and aquifers, more emphasis on watershed-based pollution control and aquifer recharge protection is absolutely necessary. Specific recommendations include:
Efforts to protect surface and ground water supplies should be integrated with a broader effort in watershed-based water resources management, including wastewater management. A partnership is required among state, county and municipal governments and agencies, water purveyors and wastewater dischargers and all other major interests to implement watershed management efforts. The Bond Fund should be one funding source for this effort, in proportion to the water supply protection benefits
Aquifer recharge and well head protection efforts should continue, including the mapping of recharge areas and well head protection areas for public community water supply wells, and the provision of assistance to local efforts
A long-term revenue source should be developed to fund the acquisition of critical water supply protection lands, both for ground and surface water supplies. In the interim, $20 million should be allocated from the Bond Fund for loans

Water Supply Management -- The existing water allocation program will be a key component of any effort to improve water supply management. Balancing allocations among water users, proper accounting for water used, and improved coordination among water users to stretch supplies during droughts will all be necessary.
Innovative methods of supply management should be encouraged, including integrated management of reservoir systems for drought management, conjunctive use of multiple water supplies, use of aquifers in Water Supply Critical Areas during drought periods, and streamlined permitting for alternative technologies such as Aquifer Storage and Recovery
The definition and methodology for determining surface water “safe yields” and ground water “dependable yields” must be assessed and revised if necessary to take into account better understanding of surface and ground water interactions, new technologies, conjunctive water use and system interconnections
Watershed management policy must be developed and implemented that includes specific objectives for instream flow maintenance to protect aquatic habitats and other uses, the ranking of water uses to clearly establish policy on the relative rights to water during drought periods, and the discouragement of depletive water uses that reduce safe yields, especially in regions that do or may face deficits
Drought management planning should be updated to address the potential for short but severe droughts and other scenarios that might disrupt supplies

Water Conservation -- Conservation has two facets. First, water should not be wasted at any time. Improved, long-term conservation reduces stress on aquifers, aquatic ecosystems and water supplies that are near capacity. Second, conservation during drought is a critical aspect of drought management. New Jersey, as with other states, cannot afford to finance water supplies large enough to ensure that water use may continue unabated during droughts.
Water conservation should be included in all water resource planning and management, with increased emphasis on industrial, landscaping, agricultural and residential settings, including education and incentives
Structural water conservation should be preferred over nonstructural methods for long-term conservation (i.e., other than drought periods), with availability of Bond Fund loans for structural water conservation projects
Water-conserving rate structures should be encouraged through regulatory and incentive mechanisms
Wastewater reuse is a viable but underutilized form of water conservation that should be increased. Indirect reuse is appropriate for most water uses, while direct reuse is appropriate for certain industrial and agricultural uses but not for drinking water supplies

Water Delivery Management -- The Safe Drinking Water Act helps ensure that water supply systems are capable of delivering sufficient water of acceptable quality to all their customers. While the major water suppliers are capable generally of providing such service on a regular basis, small systems have a history of operational and public health problems. Efforts are needed to reduce the number of poorly-managed systems, both new and existing. Continued assistance for the improvement of existing systems (both treatment and delivery) is recommended.
The Rehabilitation Loan Program should be continued in its current form, supported by the Bond Fund at a rate of $10 million per year, but expanded in scope to include loans for: treatment to address surface water contamination problems; new treatment facilities needed to comply with Safe Drinking Water Standards; and rehabilitation of treatment facilities. A priority should be placed on distressed cities and "Centers" as defined by the State Development and Redevelopment Plan. Such funds should not be made available to non-viable water systems
The Interconnections Loan Program should be continued, but funds should not be available for interconnection projects that result in the discontinuation or elimination of any existing, usable interconnection or water supply source
The Loan Program should be made available for all costs related to the Small Water Company Takeover Act by any local government, if action is taken by the Board of Public Utilities (BPU) to improve implementation of the Act
Consideration should be given to establishing a capitalization program (providing zero interest Bond Fund loans matched by market rate loans) for larger projects to stretch the availability of public funds
A water supply infrastructure needs survey should be developed based on existing efforts
An analysis of improved methods to manage water treatment plant residuals (sludge) should be conducted

Chapter Six also points out that although investor-owned water purveyors serve 42% of New Jersey's residents, only publicly-owned systems are eligible for low-interest loans from the Bond Fund. Limited loans are available from the Economic Development Administration, but even so the customers of investor-owned purveyors pay their own financing costs and help pay for Bond Fund loans to other systems. A mechanism for balancing the benefits to all water supply customers should be developed and implemented.

Regional Water Supply Initiatives
Chapter Six recommends special action, beyond the statewide management initiatives, in a number of regions to address acute or long-term projected deficits and other management concerns.

Upper Passaic, Lower Passaic/Rahway and Hackensack River Watersheds -- Although no deficits are projected during the planning period, this region provides water to 45 percent of New Jersey's population. Caution is needed to ensure that future deficits are avoided. Recommendations include:
Develop detailed simulation water supply model for the region, including the ability to test various system management and drought scenarios
Protect existing water supplies through watershed-based management as a priority due to the high concentration of water supplies in the region
Address sub-regional water supply shortages, such as in excessively used aquifers

Raritan and South River Watersheds -- These two regions are closely linked by surface water supply lines. Population growth results in a projected deficit close to the end of the planning horizon. Recommendations include:
Conjunctive use of ground water (especially increasing such efforts in the South River watershed) and surface water supplies should be explored
Structural water conservation could slow the need for new supplies and should be pursued
The Kingston Quarry Reservoir or Confluence Pumping Station are preferred options when new supplies are needed

Manasquan, Metedeconk and Toms River Watersheds -- Strong population growth, especially within the Toms River watershed, is projected to result in sizable water supply deficits within the planning period. Recommendations include:
A detailed assessment of ground water availability should be conducted to provide better deficit estimates

Optimization of water resources through aggressive water conservation and improved placement of water supply wells are needed to reduce aquifer stress
The feasibility and viability of conjunctive use of ground and surface waters, and of interconnections among the watersheds (including the Manasquan Reservoir) should be analyzed

Rancocas Creek and Camden Area Delaware Tributary Watersheds -- Southern Burlington County, Camden County and much of Gloucester County are included within Water Supply Critical Area No.2 and must reduce the existing stress on the Potomac-Raritan-Magothy (PRM) aquifer system. Growth projections, though not extremely high, emphasize the need for:
Connection with the Tri-County Water Supply Project to reduce the PRM aquifer use by many municipalities
Careful analysis, development and protection of alternative water supplies in areas that the Tri-County Project is not currently expected to serve, such as the Cohansey Aquifer in the southern part of this region

Salem, Cohansey and Maurice River Watersheds -- The Maurice River watershed is estimated to have an existing water supply deficit. Alternative supplies are constrained by ecological concerns and the potential for salt water intrusion. The Salem and Cohansey River watersheds are potential supply areas. Recommendations for the combined region include:
Assess need for and the economic and human health impacts of reducing or halting surface water withdrawals during drought periods
Assess ground water availability to better define projected deficits, analyze the potential using ground water to offset deficits and develop supplies as appropriate
Encourage the affected counties to create an advisory regional water supply council to coordinate local actions

Cape May Coastal Watershed -- Current and future stresses on this region's aquifers must be reduced, as significant surface water supplies are unlikely. Recommendations include:
Water conservation, both for the tourism industry and year-round uses, is critical to reduce aquifer stresses
Emphasis should be placed on well head and aquifer recharge protection to protect the quality and quantity of unconfined aquifers
Analysis, selection and development of alternative supplies conducted on a regional level to optimize use of existing and future supplies

Future Steps for the NJ Statewide Water Supply Plan
The major recommendations of Chapters Three through Nine are summarized in **Chapter Ten**. This chapter also includes the 1996 Statewide Water Supply Plan Action Program, which allocates Bond Funds for the purposes supported by the NJSWSP. The Water Supply Management Act and the Water Supply Bond Act require that any appropriations of Bond Funds must be for purposes listed in the Statewide Water Supply Plan Action Program. The Water Supply Advisory Council (WSAC) will help the NJDEP ensure that the NJSWSP recommendations and initiatives are accomplished in a timely fashion and provide recommendations for modifications and updates.

The NJDEP intends to periodically update the NJSWSP as needed to make minor changes in the 1996 Statewide Water Supply Plan Action Program. An extensive revision of the NJSWSP is planned within the next five to seven years. The revision will reflect new population and demand projections, improved understanding of regional water supply issues, progress made in implementing this NJSWSP and new recommendations for future action.

CHAPTER ONE

INTRODUCTION

A. General Introduction to New Jersey Statewide Water Supply Plan

This document constitutes the first complete revision to the original NJ Statewide Water Supply Master Plan (1982 Plan); it is designated the New Jersey Statewide Water Supply Plan (NJSWSP). This plan addresses major initiatives necessary to properly manage the water resources of the State and ensure an adequate supply and quality of water for the citizens of New Jersey. It seeks to build on the 1982 Plan, with a greater awareness and understanding of the resource and environment around us. The NJSWSP reflects current knowledge and changed circumstances related to new technologies for diagnosing water availability, the interrelationship of surface and ground water, the effects of inter-basin transfers, ecological risks, and water quality. Many of these advances have taken place since the completion of the original 1982 Plan; some were the direct result of recommendations made in that document. In addition to estimating water demands and availability through the year 2040, the objective of the NJSWSP is to incorporate these factors into decision making for water supply management. The 1982 Plan made very general estimates of available ground water, but these estimates placed minimal consideration on the undesirable effects of stream flow depletion and saltwater intrusion. Effective water supply planning and management require a knowledge of the amount of water available for a given surface and ground water system and forecasts of demands on these resources.

The overall procedure for developing the NJSWSP was to determine available surface and ground water supply, current water demands, projected water demands for a 50 year planning horizon, and determine projected water deficits or surpluses to the year 2040 for each of 23 Regional Water Resource Planning Areas (planning areas) within the State. This effort by consultants to the New Jersey Department of Environmental Protection (NJDEP) included tracking interbasin transfers and depletive water uses for each of these 23 watershed-based areas. Alternative management initiatives and projects were developed that, when implemented, would help New Jersey meet the projected deficits and protect available supplies from pollution or waste. Special attention was given to public involvement throughout the project, especially during the development of water supply management alternatives. A general analysis of the financial, institutional and environmental effects of the recommended alternatives was prepared based on available information. In addition, existing watershed and aquifer protection programs were analyzed and recommendations made for improvement. The detailed results of this process are available from the NJDEP (see Appendix E). Conclusions and recommendations are addressed in this NJSWSP and summarized in Chapter 10, the water supply action program. Most of the background reports and analyses were developed by CH2M Hill (prime contractor), Metcalf and Eddy, and NJ First, the consulting firms selected by the NJDEP through an open bidding process.

B. Overview of Water Supply Planning in New Jersey

New Jersey is the nation's most densely populated state, hence the State's resources and quality of life are sensitive to existing development and to unplanned or poorly planned growth and development. New Jersey's water supplies are very complex due to the diverse surface and ground water supply sources. This situation creates specific problems that have a limited number of possible solutions. As the population and economic activity of New Jersey grow, so does the demand for water. These demands, however, must be addressed in a context of competing uses and our responsibility to the ecosystem. Increasing environmental awareness and more stringent regulatory policies constrain potential options because of engineering, social, financial and environmental factors. Out-migration from urban areas has resulted in a continued encroachment upon the State's aquifers and reservoir watersheds. The growing acknowledgment that surface and ground water supplies are an interrelated resource adds to the challenge facing New Jersey water managers.

New Jersey has responded to increasing water demands over the decades through a number of planning studies that were then followed by water supply development projects, primarily for surface water sources. The most recent statewide planning effort resulted in the 1982 Plan, which recommended a variety of surface water supply projects that subsequently have been completed. It also recommended loan programs for water supply system upgrades and replacement, feasibility studies and ground water research. The loan programs, feasibility studies and ground water projects have been funded primarily from the Bond Fund of $350 million. Water supply development projects have been funded by the Bond Fund and also from both non-State public and private-sector financing.

Water supply planning also occurs at the regional level through studies conducted by the NJDEP and various water purveyors. Planning also occurs at the county, local and site specific level pertaining to the development of local water supplies, in reaction to locally perceived needs and regulatory requirements.

C. Major Legislative Mandates That Affect Water Supply Planning

New Jersey has a history of planning for and managing its water supplies, and has enacted strong laws to allocate, develop, manage and protect water resources and water supply infrastructure. The major legislative mandates listed below provided the State with extensive legal tools to ensure appropriate management of its water supplies with consideration of social, financial and environmental goals. These laws are fundamentally based on the legal doctrine in New Jersey that all surface and ground water belong to the public and are managed in trust for them by the State of New Jersey.

TABLE 1.1
MAJOR LEGISLATIVE MANDATES

MANDATES	DESCRIPTION OF THE MANDATE
Water Supply Management Act (N.J.S.A. 58:1A-1 et. seq.)	This Act (P.L. 1981, c.262) prescribes that the water resources of the State are public assets of the State held in trust for its citizens and that these water resources are to be planned for and managed as a common resource to ensure an adequate and safe supply of water to accommodate present and future water supply needs. The Act mandates the development and periodic update of this plan. The Water Supply Management Act Rules (N.J.A.C. 7:19-6.1 et. seq.) were adopted by the Department to implement the objectives of the Act. The rules mandate water supply planning, regulation of water withdrawal, and the construction of water systems.
Water Supply Bond Act of 1981	This Act (P.L. 1981, Chapter 261) authorized the creation of a general obligation debt of the State of New Jersey in the amount of $350,000,000.00 for the purpose of loans for State or local projects to rehabilitate, repair or consolidate antiquated, damaged or inadequately operating water supply facilities and to plan, design, acquire and construct various State water supply facilities. The NJSWSP (and its predecessor, the 1982 Plan) represents the planning mechanism by which the state defines its water needs. Inclusion in the NJSWSP is a prerequisite for the expenditure of funds under the Water Supply Bond Act of 1981 for projects and studies. The Act was modified in 1983 to allow for ground water and other studies that need not be repaid as loans unless they result in a capital project that is funded by a Water Bond Fund loan.
New Jersey Water Supply Authority Act (N.J.S.A. 58:1B-1 et. seq.)	This Act established the New Jersey Water Supply Authority as a public body agency vested with the power to directly and indirectly design, acquire, construct, maintain and operate water supply projects, consistent with the NJSWSP.
Safe Drinking Water Act (N.J.S.A. 58:12A-4c et. seq.)	This Act (P.L. 1977, c.224, as amended) mandates that public water supplies conform with the Drinking Water Quality Standards and accompanying regulations (N.J.A.C. 7:10-1.1 through 7.3) by which the State will assure the provision of safe drinking water to the consumer, with enforcement responsibility under the Federal Safe Drinking Water Act (P.L. 93-523, 42 USC 300 et. seq.). The Safe Drinking Water Act also governs the Department review and approval of the design and construction of public community, non-public and public non-community water systems.
Water Pollution Control Act (N.J.S.A. 58:10A-1 et. seq.)	This Act authorizes adoption of water quality standards, and mandates regulation of existing or potential discharges to ground water, surface water or the land surface such that the discharge might flow to such waters.
Small Water Company Takeover Act (1981 N.J.S.A. 58:11-59 et. seq.)	This Act mandates that any company, purveyor or entity, other than a governmental agency that provides water for human consumption and which regularly serves less than 1,000 customers (connections) and is unable to comply with a Departmental order concerning water quality or supply will be subject to a public hearing held to determine what actions and expenditures are required for correction, including acquisition of the failing company.
Water Quality Planning Act (N.J.S.A. 58:11A-1 et. seq.)	This Act mandates the development, adoption and modification of a statewide water quality management plan and areawide water quality management plans, and authorizes the development of county water quality management plans. Its provisions are implemented through the Water Quality Management Planning rules at N.J.A.C. 7:15.
Water Supply Privatization Act (1993 N.J.S.A. 58:26 1-18)	An act concerning long term contracts between local government units and private firms for the provision of water supply facilities and water supply services, establishing a procedure for the negotiating, awarding, and review of these contracts. The Act provides an alternative means of funding the construction and operation of these facilities.

Subsurface and Percolating Waters Act (1981 N.J.S.A. 58:4A-28 et seq.)	The act mandates construction standards and a permit program for the drilling of wells and the closure of abandoned wells.
North and South Jersey Water Supply Districts (1916 N.J.S.A. 58:5-1 et seq.)	This act was created for the purpose of dividing municipal water supplies into two districts to advance and achieve water supplies that are pure in quality and economically and prudently managed.
State Board of Public Utilities (1991 N.J.S.A. 48:1 et seq.)	This act regulates water rates of public purveyors within the State of New Jersey who sell water beyond the boundaries of the provider municipality. The BPU also oversees private utility operations to ensure that adequate service is provided to the customers at a reasonable price and allowing a reasonable return to the private entity.

D. Overview of Original 1982 Plan

1. Major Issues Leading to Plan Development and Updates

One of the major issues that lead to the development of the 1982 Plan was the realization that the economic health of the State was dependent on the wise development, protection and overall management of the State's water resources. The preparation of the 1982 Plan was authorized in 1975, begun in December 1976, and completed in 1982. The planning effort was also related to the drought of the 1960's and subsequent analysis of New Jersey's water supplies. An association of five consulting firms was selected to prepare the technical reports and provide recommendations for the 1982 Plan. The advice of an Advisory Council of "acclaimed water supply experts was secured to critique the various work outputs." The consultants provided the NJDEP with a series of sub-task reports that the NJDEP reviewed and disseminated to the public for their input, in addition to holding various public meetings to solicit comments.

The final product, the 1982 Plan, assessed the existing water supply conditions in relation to water supply availability and water supply management for six large regions and provided a strategy that included management goals and steps so that the water managers of the State could meet these goals. The water demand projections of the 1982 Plan were prepared to the year 2020. The 1982 Plan focused on the most urgent needs of the time and outlined a five-year Action Program for addressing recommended surface water system development projects and programs for the satisfaction of the State's water supply needs. A goal was outlined for water supply managers to provide a safe and sufficient supply of water for the present and foreseeable future through the efficient use of the existing systems and supplies, with clearly defined management responsibilities and financial accountability at all levels.

A series of Statewide Water Supply Master Plan Updates (1983, 1985, 1987, 1988, 1991 and 1993) and progress reports were published to improve the 1982 Plan and report on the State's successes and reassessments of water supply issues. The updates periodically evaluated changing needs and redirected or initiated new activities as a modification to the 1982 Plan.

The 1983 Update enumerated seven modifications to the 1982 Plan. Among them was a recommendation that the State exercise special controls on areas that were determined to have adverse water supply conditions (i.e., the Water Supply Critical Areas program). The 1985 Update authorized a major revision of the 1982 Plan and a variety of ground water availability studies. The 1987 Update focused on the concept of a fair and equitable charging scheme for financing water supply and low flow augmentation in the Delaware River Basin. The fourth update in 1988 added funding allocations for a "Well Head Protection" program to meet the requirements of federal law. The 1991 Update authorized a regional water supply/infrastructure planning study to evaluate whether municipalities and water purveyors were sufficiently coordinating water demand and infrastructure development. The 1993 Update authorized two amendments to the Action Program: the Aquifer Recharge Mapping Program and additional moneys appropriated to the Water Supply Infrastructure Rehabilitation Loan Program.

2. Major Policy Recommendations

The major recommendations from the 1982 Plan’s Action Program emphasized that surface water supply development projects be implemented and made operational as soon as possible with allotted moneys from the Bond Fund. Also recommended were the following programs and projects:

- priority rehabilitation of inadequate water supply systems
- interconnection testing and priority improvements

- Delaware and Raritan Canal improvements
- a Raritan-Passaic Pipeline
- consolidation of inadequate small water systems
- development of drought and emergency response plans, and
- implementation of water conservation practices.

3. Implementation Progress

The 1993 NJ Statewide Water Supply Plan Action Program summarized below indicates authorizations and expenditures from the Bond Fund of the $350 million to date. The following is a detailed breakdown of the funds allocated and appropriated for the various programs. In addition, the Action Program shows funding commitments from other sources.

TABLE 1.2

1993 NJ STATEWIDE WATER SUPPLY PLAN ACTION PROGRAM
(in millions of dollars)

PROJECTS/PROGRAMS	1981 Water Supply Bond		Commitment From Other Funding Sources
	Allocated	Appropriated	
MAJOR CAPITAL CONSTRUCTION PROJECTS			
1. Delaware and Raritan Canal Improvements (a)	20.55	20.55	
2. Wanaque South including Monksville Reservoir (b)	42.0	50.0	101.0
3. Manasquan Reservoir (c)	72.0	72.0	
4. F.E. Walter Reservoir Modification (d)	10.5	0	114.0
5. Merrill Creek Reservoir (e)			217.0
6. Tri-County Water Supply Project (f)			170.0
7. Water Supply for South River Area (f,g)			40.0
WATER RESOURCES EVALUATIONS			
8. Feasibility Studies (h)	20.0	15.731	0.42
9. Ground Water Studies (i)	19.65	18.35	3.9
10. Regional Water Resources Evaluations (j)	9.0	3.1	
WATERSHED AND AQUIFER PROTECTION			
11. Well Head Protection (k)	3.0	1.7	
12. Demonstration Projects and Other Studies	8.0	2.3	
STATE AND REGIONAL WATER SUPPLY PLANNING			
13. Water Conservation	1.6	1.125	
14. Water Management Planning	2.0	0.95	
15. Master Plan Revision (l)	1.75	1.75	
16. Special Water Treatment Study	0.6	0.6	
PURVEYOR INFRASTRUCTURE LOAN PROGRAMS			
17. Water Supply Infrastructure Rehabilitation	120.0	100.691	
18. Interconnection Testing and Improvements	15.0	8.068	
19. Polluted Well fields and Inadequate Small Systems	25.0	25.0	
20. Miscellaneous Appropriation		8.0	

1981 WATER SUPPLY BOND AMOUNT:
$350,000,000
AMOUNT APPROPRIATED:
$323,760,515
AMOUNT EXPENDED/OBLIGATED AS OF 3/31/93:
$242,122,975
REPAID LOANS AS OF 3/31/93: $62,289,535

FOOTNOTES:

(a) This project was completed in 1985.

(b) A line item appropriation of $8 million was approved in the FY92 budget by the Legislature to fund other categories.

(c) This project was completed in 1990.

(d) The US. Army Corps of Engineers will develop water supply storage in the F.E.Walter Reservoir, with the Delaware River Basin Commission (DRBC) serving as the non-federal sponsor and the three lower basin states financing the expansion through water charges. A $10 million loan from the Bond Fund will contribute to financing the capital cost of this project. There is also needed $500,000 for administrative costs for New Jersey's participation in this and other aspects of the "Good Faith" agreement, from the Bond Fund. The $10 million loan will be repaid through DRBC water charges. The Pompton Reservoir Modification Project (estimated cost: approximately $59 million) is being held in abeyance.

(e) The Merrill Creek Reservoir Project was constructed by the Merrill Creek Owners Group and completed in 1989.

(f) These projects will be funded by local water purveyors.

(g) An interim portion of this project has been completed.

(h) Feasibility studies include but are not limited to: Northwest Mercer County Regional Area (Hopewell-Pennington Regional Area); Cape May County Regional Area; Buried Valley Aquifer Systems; Evaluation of contaminated well fields and alternate supplies; South River Basin Area (complete); Camden Metropolitan Area (complete); Atlantic County Regional Area (complete); Ocean County Regional Area; consolidations and extensions of service; Low Flow Augmentation of Delaware River (one study complete); Eastern Raritan Basin Area (complete); Hudson main stem; Environmental study of effect of water supply withdrawals on estuaries. Because of special problems, the State may also undertake exploratory analyses and studies. A small portion of these funds may be used to match US. Army Corps of Engineers Planning Assistance Program (ACOEPAP) monies. To date, funding in the amount of $420,000 has been committed by the ACOEPAP.

(i) Ground water studies include but are not limited to: Vincentown Aquifer; Mount Laurel-Wenonah Aquifer; Germany Flats Buried Valley Aquifer; and the Buried Valley Aquifer Systems. Includes hard rock and offshore drilling. The cost estimate includes monitoring network coverage. To date, funding in the amount of $8.2 million has been committed to the USGS Cooperative Agreement Program.

(j) Previously named "County Shallow Aquifer Plans." A small portion of these funds may be used to match ACOEPAP monies.

(k) Previously named "Wellhead and Aquifer Protection."

(l) Required by law (P.L. 1981, c. 261).

E. Major Issues Leading to The NJSWSP Process

One major issue leading to the development of the NJSWSP was the increased emphasis placed on ground water as a water supply source, its vulnerability and the need for a management strategy for aquifer systems. The 1982 Plan emphasized management of surface water resources, via large scale infrastructure projects. In the NJSWSP, ground water and surface water are considered an integrated resource because of their interrelationships -- development of one affects the other. A second major concern was the need to reassess water supplies, demands and deficits in light of changing demographics and improved knowledge of water availability. Other issues leading to the NJSWSP process were: quality verses quantity of water supplies, the problems associated with depletive water use and potential resultant base flow reductions and acceleration of saltwater intrusion, different definitions of safe yield, dependable yield and water availability and uncertainties in these terms, and the need to balance human water supply needs with those of the ecosystem.

1. New Planning Horizon of 2040

The planning horizon of 2040 was selected for the NJSWSP, with a baseline year of 1990. Water availability for surface and ground water systems and regional demands, water supply deficits and surpluses were projected for each five year period through the year 2010 and then every ten years through the year 2040. The fifty year time frame allows for a sufficient duration to assess and respond to the magnitude and timing of any projected water deficits. Population projections to the year 2010 were developed by Rutgers University, Center for Urban Policy Research and then extended to the year 2040 by the consultant team.

2. Changing Demographics and Projections

The State's population is projected to increase over the next fifty years from 7.7 million in 1990 to 8.25 million in 2010 and 9.0 million in 2040. Originally projected by the 1982 Plan to reach 9.0 million by 2010, this lower rate of growth still reflects a major flow of population from urban and core suburban areas to outer suburban and rural areas over the fifty year period. The demographics of the State's population are a fundamental issue in the identification and projection of local, regional and statewide water supply needs over time. Even though the demographic projections in the NJSWSP will be subject to change over time, the NJSWSP was prepared to identify key problems and water supply needs of the planning areas based on various population scenarios. One challenge facing the water managers of the State will be to economically deliver water of potable quality to the increasing, decentralized suburban population. Although some counties are projected to lose population by 2040, households, housing and water demand are still projected to increase in most.

3. Increased Knowledge of Limits on Ground Water Supplies

Water supply studies initiated as part of the original 1982 Plan have increased our knowledge of the limits of ground water supplies and emphasized that surface and ground waters are one resource. The methodology developed as part of this plan allows for an assessment of each planning area with this interrelationship in mind. The assessment of availability will serve as a "trigger" for when more detailed scrutiny of additional allocations for water and proactive water supply planning are necessary.

4. Impacts of Pollution on Local Water Supplies

The quality of New Jersey's surface and ground waters is generally adequate outside of the most urbanized areas, but a number of local and sub-regional problems exist. These include point and non-point sources of pollution, saltwater intrusion into aquifers, and hazardous waste pollution. The planning process has focused on how to safeguard existing and future water supplies in the NJSWSP by implementing a watershed and aquifer protection program, while also estimating water supply losses due to existing hazardous waste sites.

5. State Development and Redevelopment Plan

Following the adoption of the NJ State Planning Act in 1986, the State Development and Redevelopment Plan (SDRP) for New Jersey was adopted June 12, 1992. The NJSWSP development process included consideration of the impacts of this plan on water supply needs and availability. The SDRP establishes a management guide which emphasizes the redevelopment of existing urban centers and the efficient development of suburban corridors and centers. Its focus is to limit the need for costly new public infrastructure over large areas by favoring more economical development and redevelopment; however, the NJSWSP predicts continued growth in the suburban areas. Adoption of the SDRP and its State and local implementation will facilitate water supply planning in general, but many water supply issues will exist regardless of SDRP implementation.

6. Pinelands Comprehensive Management Plan

The Pinelands Commission was established under the Pineland Protection Act (N.J.S.A. 13:18A-1 et seq., 1979) to protect the Pinelands. The Comprehensive Management Plan adopted pursuant to the Act regulates development in the Pinelands by setting minimum standards for land uses within the specified Pinelands Management Areas. Residential and other development is limited and focused in certain areas to protect existing unique, natural, ecological, agricultural, and horticultural resources. A separate law (an amendment to the Water Supply Management Act) prohibits the transfer of Pinelands water more than 10 miles from the borders of the Pinelands area. The Pinelands Commission and the NJDEP have entered into a formal agreement regarding the development of new water supplies from the unconfined aquifers of the area. Since many of the southern planning areas are partially in the Pinelands, there will be a continuing need to conduct integrated planning.

7. Infrastructure Development and Maintenance

Infrastructure development and maintenance concerns were central to the 1982 Plan. Over $240 million were expended on new reservoirs, pump stations, pipelines, dredging the Delaware & Raritan canal, interconnections and system rehabilitations. The NJSWSP likewise allocates funds to invest in regional solutions to meet future water supply needs. The Municipal Sector Study-Phase 1 completed by the NJDEP in 1991 to assess the impacts of environmental regulation on communities in New Jersey, stated that "compliance with the Safe Drinking water Regulations is expected to cost an average of $4.5 million for each water system". The Bond Fund will provide one important source of low-interest loans to meet these needs. The report also indicated that approximately $1 billion will be invested by private water companies over the next five years. New Jersey is unusual in that a large percentage of public water supply capacity is investor- owned.

F. Description of NJSWSP Process

The NJSWSP was developed in several discrete, systematic steps, each summarized below.

1. Data and Projections Development

Water supply availability was quantified and characterized for the various water resources in the 23 planning areas. Data on water availability and estimated water demand were compiled in a computer data base and maps for each planning area. Current purveyor demands were used to determine the purveyor-supplied combined Residential, Industrial and Commercial (RIC) demands for each purveyor, municipality, county and region, based on the years 1986 through 1988 to include both wet and dry years. The current per capita use was then determined and projected to the year 2040. The self-supplied population's current per capita use was also estimated and projected to the year 2040. Also included in the data base were demands of self-supplied commercial, industrial and agricultural users.

2. Computer-Based Water Balance Models

The combined water supply and demand data bases were used to create a Water Balance Model (WBM) for each planning area. This model was developed to allow the NJDEP to easily update data on the demand for and availability of water for each planning area. The WBM serves as an effective tool to help schedule the implementation of specific water supply actions identified in the NJSWSP.

3. Analysis of Water Deficits and Surpluses

An analysis of water deficits and surpluses in each of the planning areas was performed by the consultant team and the NJDEP. The analysis employed an inflow/outflow model in each of the 23 planning areas, in which recharge and surface water safe yields were balanced against in-basin demands, out-of-basin transfers and reuse within the basin. The identification of deficits consisted of determining the total water available for each planning area and county and then determining the demand for each planning area and county for the years 1990, 1995, 2000, 2005, 2010, 2020, 2030, and 2040. Comparisons of supply versus demand yielded estimated deficits for each period.

4. Alternatives Analysis

The water supply alternatives analysis identified water supply options capable of meeting future demands through non-structural and structural alternatives for augmenting supply or reducing demand in each of the planning areas. Alternatives analysis emphasizes optimum management of existing regional supplies, not just the identification of new supply alternatives. New information garnered from completed water supply studies was incorporated in the planning process.

The major focus is on water supply alternatives and strategies capable of protecting and augmenting the regional water supply whenever possible instead of developing a new water supply. This approach may also include maintenance and rehabilitation of systems as well as conservation measures for consumers through education and rate setting measures. However, new supplies will be required in some planning areas. Conjunctive use, multi-aquifer use, reservoirs, interconnections, desalination, relocation of well fields, saltwater barrier wells, aquifer storage and recovery, and flood skimming of surface water bodies are alternatives that may be utilized by the water purveyors of the State to extend water supplies.

5. Watershed and Aquifer Protection Program

The consultant team analysed various existing programs geared towards water supply protection and reviewed ways to integrate them for improvement and protection of the water supplies of the State. One objective of the NJSWSP is to develop a broader strategy to protect and manage all major water supply resources so as to minimize supply losses and treatment costs. The recommendations include water supply source protection, improving the water allocation process, water conservation implementation and enforcement of sound land use policies.

6. Development of Draft and Final NJSWSP

A Draft NJSWSP was released in September, 1995 and offerred for public review and comment until 22 November 1996. Subsequent to the close of the public comment period, the NJDEP consulted with the Water Supply Advisory Council (WSAC) and its Public Advisory Committee regarding appropriate modifications to the draft plan. The result is this final NJSWSP approvedby the NJDEP Commissioner.

7. Public Participation Process

The public participation process is an integral part of the NJSWSP. The seven member Water Supply Advisory Council (WSAC) formed pursuant to the Water Supply Management Act serves to advise the Commissioner of the NJDEP in the NJSWSP process and other water supply topics. Members of the WSAC are nominated by the Governor and confirmed by the New Jersey State Senate. To assist them in their review process, the WSAC cooperated with the NJDEP in the formation of a Public Advisory Committee (PAC) and an Interagency Committee, which met on a regular basis with the WSAC and the NJDEP regarding NJSWSP development. The PAC and the WSAC itself are broadly representative, including representatives of water users, water purveyors, environmental organizations, agriculture, industry, universities and the general public. Consultant task reports for the NJSWSP as well as the draft NJSWSP were distributed for review and comment to the WSAC and committees. NJDEP also formed an internal committee representing all water-supply related elements of the NJDEP to review draft consultant reports and draft the NJSWSP.

G. Process for Future NJSWSP

The next comprehensive NJSWSP will be developed shortly after the year 2000, to address requirements of the Water Supply Management Act that there be periodic updates of this NJSWSP. It is anticipated that subsequent Updates and the future NJSWSP will build upon the data base of this NJSWSP as well as the proactive strategies embodied in this document. Our knowledge and analytical capabilities related to issues of balancing human water needs with that of ecosystem, ground water behavior, optimization of water uses, and so on, grow every year. Water supply planning is undergoing a transition where emphasis will be placed on extending existing supplies as long as possible through monitoring, management and protection. Future Updates and NJSWSP’s will emphasize watershed-based planning and management and the interconnection between water supply and water quality management and land use management.

For this NJSWSP, the NJDEP utilized 23 planning areas to develop and analyze water availability, demand, deficit, and population projections statewide. The planning areas are all based on surface watershed boundaries, rather than political boundaries, to reflect the nature of water resources. As the NJSWSP proceeded toward completion, the NJDEP gained a great deal of knowledge about watershed planning. The NJDEP has since revised its watershed boundaries to include 97 watersheds, 20 watershed management areas (using aggregated watersheds) and 5 water regions (using aggregated watershed management areas). This new system evolved from the 23 planning areas used in this document, and will be used in the upcoming Watershed Management Strategy. Future revisions to the NJSWSP will utilize these new designations.

CHAPTER TWO

HYDROLOGY AND HYDROGEOLOGY OF THE STATE

A. Introduction

In New Jersey, approximately 28 percent of the annual water withdrawals are from ground water sources, while the remaining 72 percent are from surface water sources. For drinking water supplies, 49 percent of the population is dependent on ground water and 51 percent on surface water. During the course of history in New Jersey, development patterns have had a major influence on changing water supply demands, availability of water supplies for many uses and the development of infrastructure to meet water supply needs.

The substantial migration from urban centers over the last several decades has resulted in suburban development in much of the State. While the public is well aware of the water sources that supply urban centers, many of the regional supplies that the suburbs have recently begun to utilize are little known to the public, especially the ground water resources. In order to ensure that these resources are not overdrafted, it is necessary to estimate the amount of water that can be diverted from them. This Chapter briefly describes the hydrology of New Jersey. Much of the hydrologic information and the concepts found in this chapter, as well as from several other sources, are utilized in Chapter 3 to estimate water availability for the planning areas.

B. Geology and Topography

The ratio of ground water versus surface water withdrawals is highly variable between planning areas because of differences in geology, topography and proximity to major water bodies. Consequently, southern New Jersey is more dependent on ground water supplies and northern New Jersey is more dependent on surface water. The inherent geological characteristics determine the relative underground storage of water, while natural topography influences the viability of water storage in above-ground reservoirs.

Variations in rock type and geologic history of different regions of the state have created four different physiographic provinces with unique surface topographies: the Coastal Plain, Piedmont, Highlands and Valley and Ridge provinces. Each province consists of different types of consolidated (i.e., rocks) and unconsolidated (i.e., sand, gravel and silt) deposits with characteristic properties (Figure 2.1). In northern New Jersey, parts of the Piedmont, Highlands and Valley and Ridge are covered by glacial deposits. Each of the physiographic provinces as well as the glacial deposits are associated with characteristic aquifer units and ground water flow types. The major aquifer units within these physiographic provinces will be discussed later in this chapter.

C. Precipitation Rates and Patterns

The physiographic provinces of the state provide a pattern for the geographic distribution of precipitation throughout the state. Annual precipitation ranges from 40 inches in the southeast to 52 inches in the north-central mountains, following a general pattern where the greatest rainfall is in northern New Jersey. The state averages approximately 44 inches per year (Figure 2.2). Precipitation does not exhibit a significant seasonal pattern, being distributed fairly uniformly throughout the year. While precipitation is relatively even throughout the year, evapotranspiration (ET) is by far the highest during the warmer months. This

FIGURE 2.1

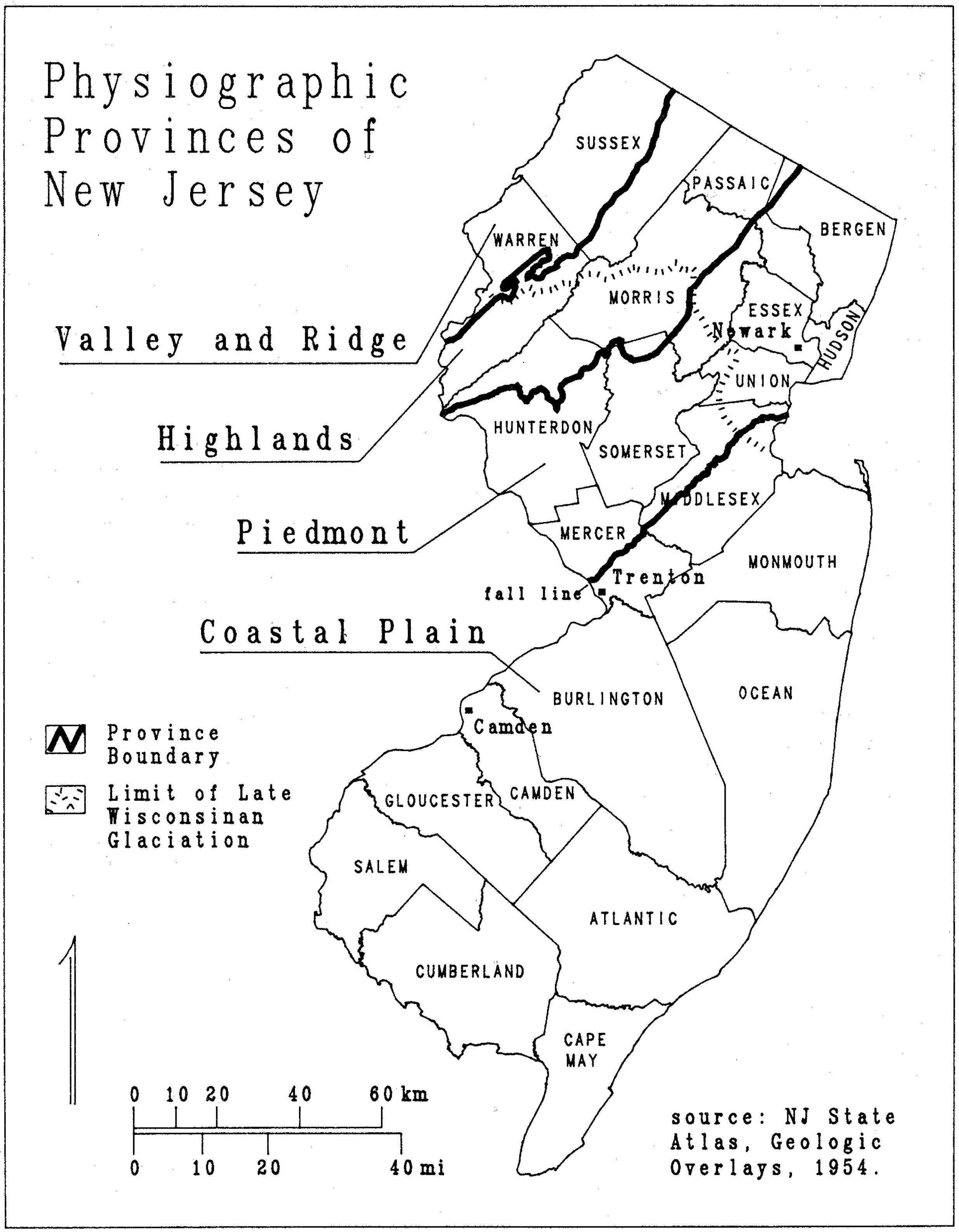
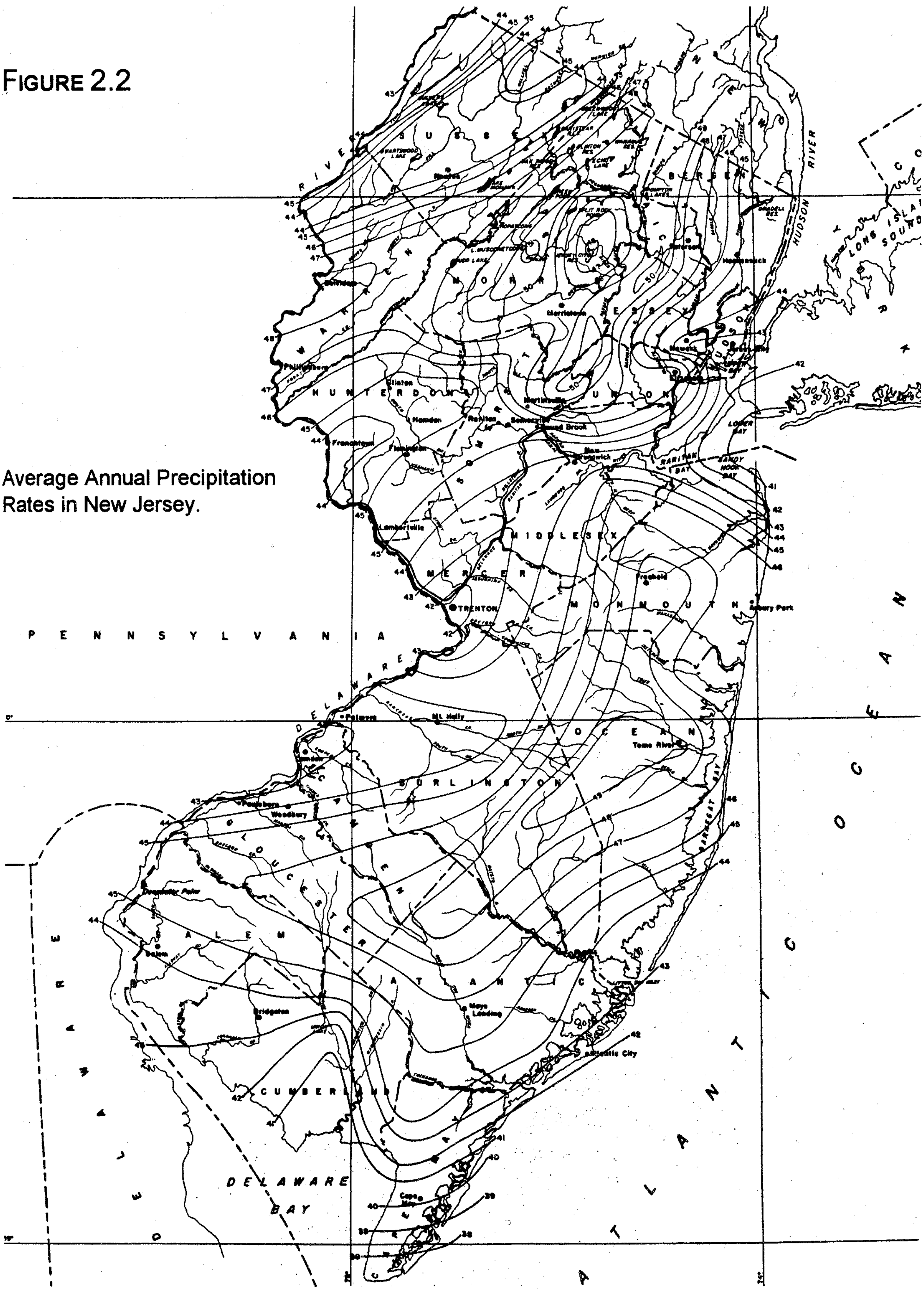

Physiographic Provinces of New Jersey
Valley and Ridge
Highlands
Piedmont
Coastal Plain
fall line
Province Boundary
Limit of Late Wisconsinan Glaciation
SUSSEX
PASSAIC
BERGEN
WARREN
MORRIS
ESSEX
Newark
HUDSON
UNION
HUNTERDON
SOMERSET
MIDDLESEX
MERCER
MONMOUTH
Trenton
BURLINGTON
OCEAN
Camden
GLOUCESTER
CAMDEN
SALEM
ATLANTIC
CUMBERLAND
CAPE MAY
0 10 20 40 60 km
0 10 20 40 mi
source: NJ State Atlas, Geologic Overlays, 1954.

FIGURE 2.2



Average Annual Precipitation Rates in New Jersey.

New Jersey Department of Environmental Protection
Division of Water Resources

Generalized Stratigraphic Table for New Jersey

FIGURE 2.3

Era	System	Series	Stratigraphic unit		Predominant lithology	Aquifer name or hydrogeologic characteristics	
CENOZOIC	Quaternary	Holocene	alluvial, coastal, marsh, and eolian deposits		sand, gravel, silt, mud, and peat	Under water-table conditions at most locations	
CENOZOIC	Quaternary	Pleistocene	COASTAL AREAS: Wisconsinan alluvium, Cape May Formation, colluvium	INLAND, NORTHERN NEW JERSEY: Wisconsinan and pre-Wisconsinan alluvial, colluvial, glacial, lacustrine, and eolian deposits	sand, gravel, silt, clay (statewide), till and till-like deposits (northern New Jersey)	Includes glacial buried-valley aquifers and Cape May aquifer system/Holly Beach aquifer	
CENOZOIC	Tertiary	Miocene	Pensauken Formation		sand, clayey silt	Under water-table conditions at most locations	
CENOZOIC	Tertiary	Miocene	Bridgeton Formation		sand, clayey silt	Under water-table conditions at most locations	
CENOZOIC	Tertiary	Miocene	Beacon Hill Gravel		gravel, sand	Under water-table conditions at most locations	
CENOZOIC	Tertiary	Miocene	Cohansey Sand		sand, some clayey silt	Kirkwood-Cohansey aquifer system	
CENOZOIC	Tertiary	Miocene	Kirkwood Formation		sand, gravel, clayey silt	confining unit	
						Rio Grande water-bearing zone	
						confining unit	
						Atlantic City 800-foot sand	
CENOZOIC	Tertiary	Oligocene	ACGS beta unit		sand, some glauconitic sand	composite confining unit	Piney Point aquifer
CENOZOIC	Tertiary	Oligocene	Mays Landing unit		sand, some glauconitic sand	composite confining unit	
CENOZOIC	Tertiary	Eocene	Shark River Formation		clayey silt, fine quartz sand, glauconitic sand	composite confining unit	
CENOZOIC	Tertiary	Eocene	Manasquan Formation		clayey silt, fine quartz sand, glauconitic sand	composite confining unit	
CENOZOIC	Tertiary	Paleocene	Vincentown Formation		sand, clayey silt, glauconite sand, calcarenite	composite confining unit	Vincentown aquifer
CENOZOIC	Tertiary	Paleocene	Hornerstown Formation		glauconitic sand	composite confining unit	
MESOZOIC	Cretaceous	Upper Cretaceous	Tinton Sand		sand, glauconitic sand	composite confining unit	
MESOZOIC	Cretaceous	Upper Cretaceous	Red Bank Sand		sand, clayey silt, some glauconite sand	composite confining unit	Red Bank Sand
MESOZOIC	Cretaceous	Upper Cretaceous	Navesink Formation		glauconite sand	composite confining unit	
MESOZOIC	Cretaceous	Upper Cretaceous	Mount Laurel Sand		sand	Wenonah-Mount Laurel aquifer	
MESOZOIC	Cretaceous	Upper Cretaceous	Wenonah Formation		silty sand, some glauconite	Marshalltown-Wenonah confining unit	
MESOZOIC	Cretaceous	Upper Cretaceous	Marshalltown Formation		clayey silt, glauconitic sand	Marshalltown-Wenonah confining unit	
MESOZOIC	Cretaceous	Upper Cretaceous	Englishtown Formation		sand, clayey silt	Englishtown aquifer system	
MESOZOIC	Cretaceous	Upper Cretaceous	Woodbury Clay		clayey silt	Merchantville-Woodbury confining unit	
MESOZOIC	Cretaceous	Upper Cretaceous	Merchantville Formation		clayey silt, glauconitic sand	Merchantville-Woodbury confining unit	
MESOZOIC	Cretaceous	Upper Cretaceous	Magothy Formation		sand, clayey silt	Potomac-Raritan-Magothy aquifer system	upper aquifer
						Potomac-Raritan-Magothy aquifer system	confining unit
MESOZOIC	Cretaceous	Upper Cretaceous	Raritan Formation		sand, clayey silt	Potomac-Raritan-Magothy aquifer system	middle aquifer
MESOZOIC	Cretaceous	Lower Cretaceous	Potomac Group		gravel, sand, silt, clay	Potomac-Raritan-Magothy aquifer system	confining unit
						Potomac-Raritan-Magothy aquifer system	lower aquifer
MESOZOIC	Jurassic	Lower Jurassic	Newark Supergroup, Brunswick Group	Boonton Formation	sandstone, siltstone, shale, conglomerate	Ground water occurs along bedding surfaces, joints, faults, intergranular spaces, and other openings	
MESOZOIC	Jurassic	Lower Jurassic	Newark Supergroup, Brunswick Group	Hook Mountain Basalt	basalt		
MESOZOIC	Jurassic	Lower Jurassic	Newark Supergroup, Brunswick Group	Towaco Formation	sandstone, siltstone, shale, conglomerate		
MESOZOIC	Jurassic	Lower Jurassic	Newark Supergroup, Brunswick Group	Preakness Basalt	basalt, intercalated sedimentary rock		
MESOZOIC	Jurassic	Lower Jurassic	Newark Supergroup, Brunswick Group	Feltville Formation	sandstone, siltstone, shale, conglomerate, limestone -		
MESOZOIC	Jurassic	Lower Jurassic	Newark Supergroup, Brunswick Group	Orange Mountain Basalt; diabase intrusives	basalt; diabase		
MESOZOIC	Triassic	Upper Triassic	Newark Supergroup, Brunswick Group	Passaic Formation	sandstone, siltstone, shale, conglomerate		
MESOZOIC	Triassic	Upper Triassic	Newark Supergroup	Lockatong Formation	siltstone, mudstone, sandstone, shale		
MESOZOIC	Triassic	Upper Triassic	Newark Supergroup	Stockton Formation	arkosic sandstone, siltstone, shale, conglomerate		

Era	System	Group	VALLEY AND RIDGE: Stratigraphic unit	VALLEY AND RIDGE: Predominant lithology	GREEN POND MOUNTAIN REGION: Stratigraphic unit	GREEN POND MOUNTAIN REGION: Predominant lithology	Hydrogeologic characteristics
PALEOZOIC	Devonian				Skunnemunk Conglomerate	conglomerate	Ground water occurs along bedding surfaces, joints, faults, intergranular spaces, solution cavities, and other openings
PALEOZOIC	Devonian				Bellvale Sandstone	sandstone, siltstone, shale	
PALEOZOIC	Devonian		Marcellus Shale	shale, siltstone	Cornwall Shale	shale, siltstone	
PALEOZOIC	Devonian		Buttermilk Falls Limestone	argillaceous limestone	Kanouse Sandstone	conglomeratic sandstone, siltstone	
PALEOZOIC	Devonian		Schoharie Formation	calcareous siltstone			
PALEOZOIC	Devonian		Esopus Formation	siltstone, sandstone	Esopus Formation	siltstone, sandstone	
PALEOZOIC	Devonian	Oriskany Group	Ridgely Sandstone	sandstone, calcareous conglomerate	Connelly Conglomerate	conglomeratic quartzite	
PALEOZOIC	Devonian	Oriskany Group	Shriver Chert	shale, siltstone, chert			
PALEOZOIC	Devonian	Oriskany Group	Glenerie Formation	limestone			
PALEOZOIC	Devonian	Helderburg Group	Port Ewen Shale	calcareous shale, siltstone			
PALEOZOIC	Devonian	Helderburg Group	Minisink Limestone	limestone, calcareous shale			
PALEOZOIC	Devonian	Helderburg Group	New Scotland Formation	calcareous silty shale			
PALEOZOIC	Devonian	Helderburg Group	Coeymans Formation	limestone, sandstone, conglomerate			
PALEOZOIC	Devonian		Rondout Formation	limestone, calcareous shale, dolomite			
PALEOZOIC	Silurian		Decker Formation	calcareous sandstone, sandy limestone	Berkshire Valley Formation	calcareous siltstone, silty dolomite, sandstone	
PALEOZOIC	Silurian		Bossardville Limestone	argillaceous, partly dolomitic limestone			
PALEOZOIC	Silurian		Poxono Island Formation	calcareous shale, dolomite	Poxono Island Formation	calcareous shale, dolomite	
PALEOZOIC	Silurian		Bloomsburg Red Beds	shale, siltstone, sandstone	Longwood Shale	shale, siltstone	
PALEOZOIC	Silurian		Shawangunk Formation	conglomeratic quartzite	Green Pond Conglomerate	conglomeratic quartzite, siltstone	

Era	System	Series	Stratigraphic unit			Predominant lithology	Hydrogeologic characteristics
PALEOZOIC	Ordovician	Upper Ordovician	Beemerville intrusive complex			nepheline syenite, intrusive alkalic igneous rocks	Ground water occurs along bedding surfaces, joints, faults, solution cavities, intergranular spaces, and other openings
PALEOZOIC	Ordovician	Upper Ordovician	Martinsburg Formation			slate, siltstone, graywacke	
PALEOZOIC	Ordovician	Middle Ordovician	Jacksonburg Limestone		Jutland klippe units (not part of Kittatinny Supergroup)	limestone, argillaceous limestone; shale, limestone, chert (Jutland)	
PALEOZOIC	Ordovician	Lower Ordovician	Kittatinny Supergroup	Beekmantown Group: Ontelaunee Formation		dolomite, limestone (Ontelaunee, Epler)	
PALEOZOIC	Ordovician	Lower Ordovician	Kittatinny Supergroup	Beekmantown Group: Epler Formation			
PALEOZOIC	Ordovician	Lower Ordovician	Kittatinny Supergroup	Beekmantown Group: Rickenbach Dolomite		sandy dolomite (Rickenbach)	
PALEOZOIC	Cambrian	Upper Cambrian	Kittatinny Supergroup	Allentown Dolomite		dolomite, calcareous sandstone	
PALEOZOIC	Cambrian	Middle Cambrian	Kittatinny Supergroup	Leithsville Formation		dolomite, calcareous shale	
PALEOZOIC	Cambrian	Lower Cambrian	Hardyston Quartzite			arkosic quartzite, conglomerate (Hardyston)	
?	Ordovician (?) Cambrian (?) Late Proterozoic (?)		Manhattan Schist, Wissahickon Formation, serpentinite, Chickies Quartzite			sillimanite-garnet-muscovite-biotite schist (Manhattan); schist, metagraywacke, amphibolite, altered ultramafics (Wissahickon); highly sheared serpentinite preserving few original igneous structures; quartz-sericite schist, conglomerate (Chickies)	Ground water occurs in joints, faults, foliation surfaces, solution cavities, and other openings
PROTEROZOIC	Late Proterozoic (?)		Chestnut Hill Formation			greenschist-grade metasedimentary and metavolcanic (?) rock	
PROTEROZOIC	Middle Proterozoic		Byram Intrusive Suite, Lake Hopatcong Intrusive Suite, Mount Eve Granite			granite, quartz syenite, syenite, quartz monzonite, monzonite, and granodiorite	
PROTEROZOIC	Middle Proterozoic		metasedimentary rocks			quartzofeldspathic and calcareous metasedimentary rocks including the Franklin and Wildcat Marbles	
PROTEROZOIC	Middle Proterozoic		Losee Metamorphic Suite			highly sodic gneissic and granitoid rocks; amphibolite	

This table is a generalized guide to stratigraphic and aquifer nomenclature in common usage in New Jersey as of 1990. Due to space limitations, it does not include member names, facies names, or less commonly used aquifer names. In addition, it does not include stratigraphic terms and concepts to be introduced as part of the NJ Geological Survey/US Geological Survey COGEOMAP project. The discussion on the back provides a very brief geographic and tectonic context. References were chosen favoring detail specific to New Jersey and recent publication rather than original work. For this reason, informal publications and summary papers are included.

FIGURE 2.4

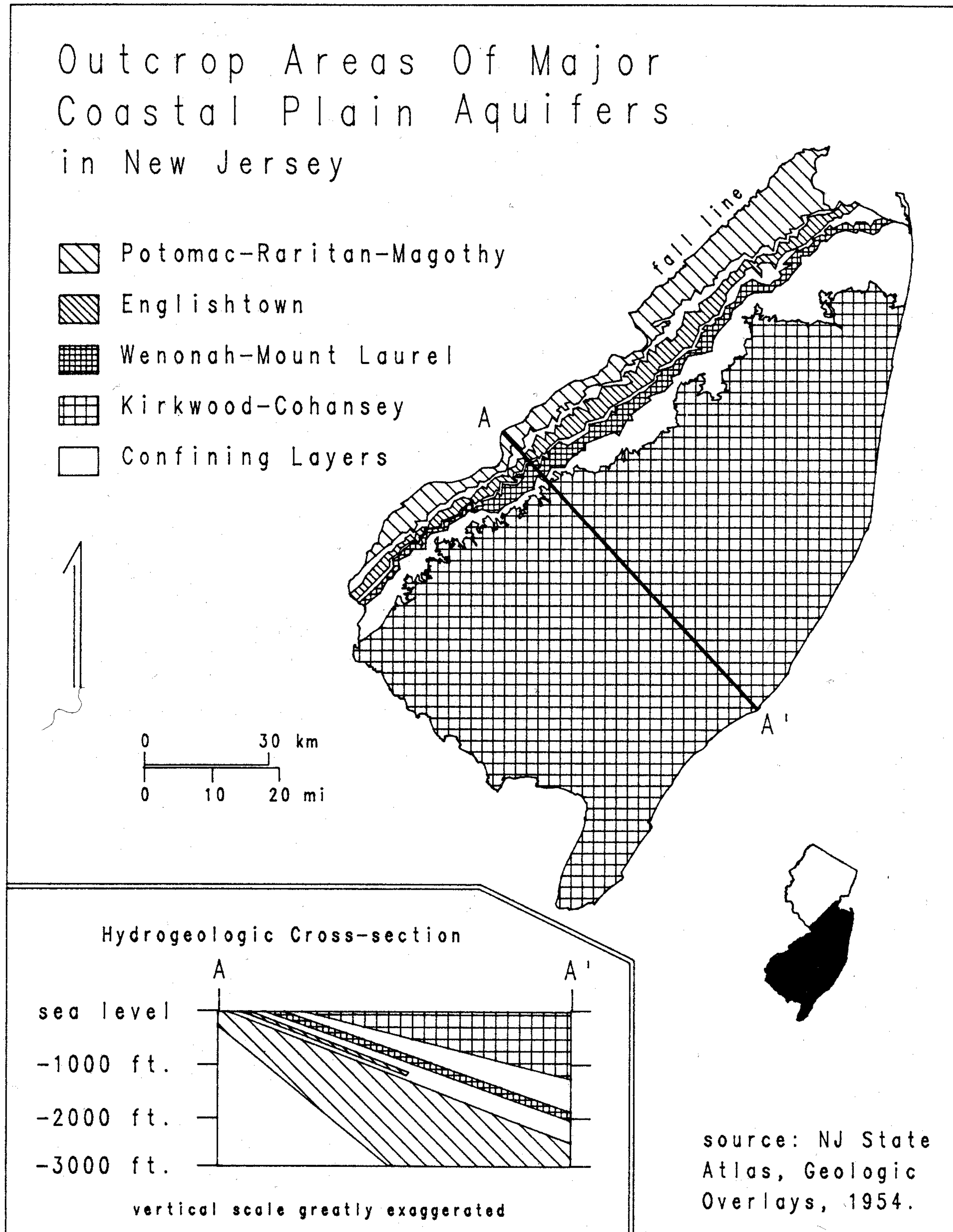
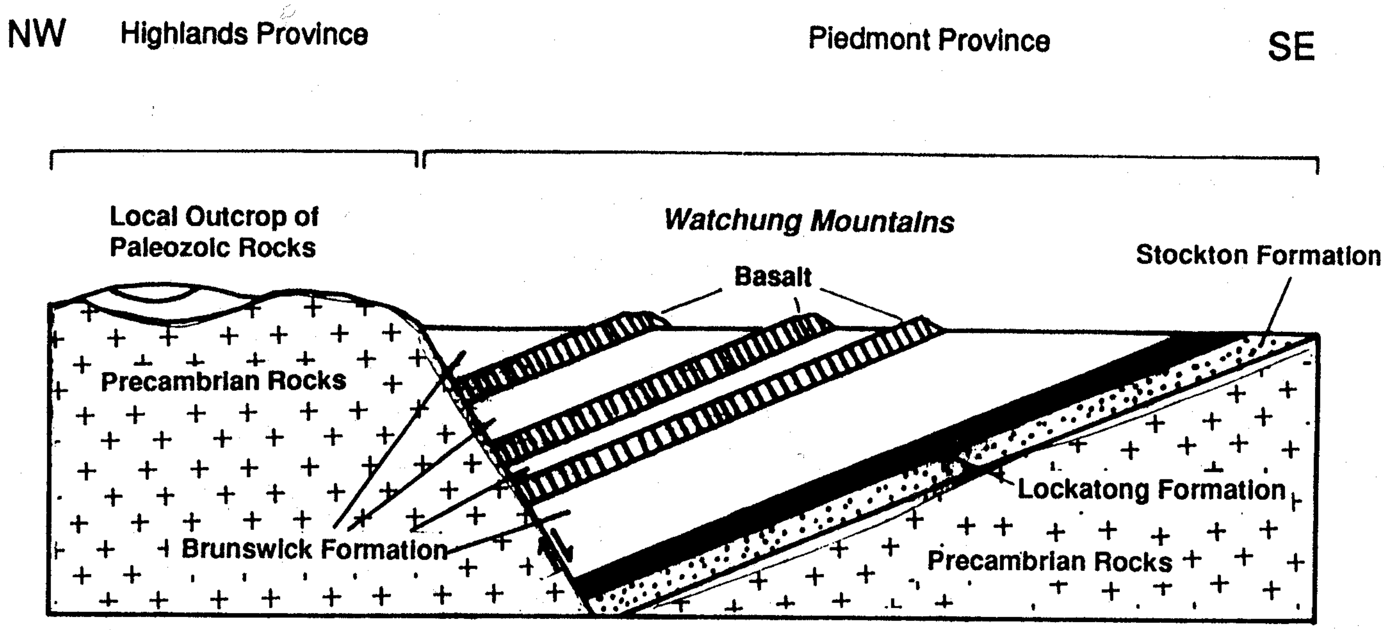

Outcrop Areas Of Major Coastal Plain Aquifers in New Jersey
Potomac-Raritan-Magothy
Englishtown
Wenonah-Mount Laurel
Kirkwood-Cohansey
Confining Layers
fall line
A
A'
0
30 km
0
10
20 mi
Hydrogeologic Cross-section
A
A'
sea level
-1000 ft.
-2000 ft.
-3000 ft.
vertical scale greatly exaggerated
source: NJ State Atlas, Geologic Overlays, 1954.

FIGURE 2.5



Generalized NW-SE Cross-Section through the Piedmont and Highlands Provinces

Notes: Not to scale
Geology has been highly simplified

phenomena results in significant reductions in stream flow during this time and compounds the effects of drought. Runoff varies both geographically and seasonally in the state, with March and April exhibiting periods of highest runoff. Generally, northern New Jersey has a greater amount of runoff than southern New Jersey due to high slopes, thin soils with lower infiltration rates and larger amounts of snow in winter months.

D. Major Aquifers of the Physiographic Provinces of New Jersey

Figure 2.3 provides a generalized stratigraphic framework of the major geologic units of the State.

1. Coastal Plain

The Coastal Plain, which covers southern New Jersey, is the largest of the provinces covering about 4500 square miles, or about 60% of the State's land area. In cross section, it is a wedge shaped sequence of unconsolidated sediments composed of sand, gravel, silt and clay which thickens to the southeast. The sequence is composed of four major aquifer systems separated by clay or silt layers which act as confining or semi-confining barriers to separate them. The outcrop areas of major coastal plain aquifers are shown in Figure 2.4 (from bottom to top and oldest to youngest): the Potomac-Raritan-Magothy (also referred to as the Lower, Middle and Upper aquifers), Englishtown, Wenonah/Mount Laurel, and Kirkwood-Cohansey. The Kirkwood and Cohansey are separated in some locations by an uncontinuous clay layer and joined in others. Since these are unconsolidated sediments, water migrates through natural channels and pore spaces between the aquifer sediments. Contrary to earlier presumptions, many of these aquifers (other than the Cohansey) do not receive the majority of water through their recharge areas under current pumping conditions. Instead, recently conducted investigations are concluding that in many of these systems water leaks from one aquifer to the overlying or underlying aquifer through the intervening layers of clays and silts, indicating that an interconnection between aquifer units occurs regionally or locally based upon hydraulics and the varying thickness of the confining unit. While recharge to the confined aquifers is higher per unit area through their recharge areas, those recharge areas are generally much smaller than the full extent of the aquifer. However, this relationship varies depending on proximity to the recharge area.

2. Piedmont

The Piedmont covers about 1650 square miles or 20% of the state's land area. A cross section of this province is depicted in Figure 2.5 which is composed of consolidated shales, siltstones, sandstones, conglomerates and igneous rocks. The sedimentary units comprise the Stockton and Lockatong Formations and the Brunswick Group. Other formations in the Piedmont which have limited water bearing potential include igneous diabase sill deposits (including that of the Palisades Sill and the Sourlands Mountains) and basalt flows which comprise the Watchung Mountains. Water movement in the consolidated rocks is primarily through channels called joints, bedding planes and fractures which were created by the original deposition and movement of the rock formations. This type of flow allows relatively limited movement of water through the aquifer system, though some wells in the Brunswick Group can produce large volumes of water. Formations of the Piedmont are hydraulically connected with local streams, where they are not covered by semiconfining glacial deposits.

3. Highlands

The Highlands Province covers about 900 square miles or about 12% of the state's land area. The rocks consist of Precambrian gneisses, igneous rocks and the Green Pond Outlier, a belt of Paleozoic age sedimentary rocks. Some of these formations are among the oldest in New Jersey. The Vernon, Hamburg, Sparta, Pequest, Phillipsburg-Washington, Riegelsville, Bloomsburg-Hackettstown, Spruce Run and Peapack-Gladstone valleys are all part of the Highlands Province and are underlain by Paleozoic rocks (Figure 2.6). Similar to the Piedmont, water movement is primarily through joints, fractures and in particular through bedding planes in the formations on a very local scale. The Precambrian aquifers do not generally produce large yields, except near streams or where wells intercept major fault zones and are often are hydraulically connected with surface waters.

4. Valley and Ridge

The Valley and Ridge Province consists of folded and faulted Paleozoic sedimentary rocks. This province is located in the northwest corner of New Jersey and covers about 580 square miles or about 7% of the state's land area. The ground water flow is primarily through bedding planes, fractures and joints. The sandstones and shales of the Valley and Ridge are relatively unproductive aquifers, except for domestic use, because yield is limited to fracturing and weathering. Some of the carbonate formations (eg. limestone) permit flow where water has dissolved channels in the limestone called solution channels. The limestone units in this province are more productive than the shale and sandstone units due to their ability to store and transmit water in solution channels and represent some of the state's most prolific aquifers. In some areas, there is a strong interconnection between the formations of the Valley and Ridge Province and local streams and significant interflow may occur. In other areas, the interconnection is poor. Figure 2.6 depicts “Bedrock Aquifers of the Northern Physiographic Provinces”.

5. Glacial Deposits

Glacial deposits consist of unconsolidated stratified (layered) and unstratified (mixed) deposits of gravel, sand, silt and clay. The thickest glacial deposits generally occur in New Jersey north of the Wisconsonan terminal moraine line which extends from Perth Amboy through Morristown to Belvidere. North of this line, upland areas are generally covered by a thin layer of discontinuous glacial till (unstratified, mixed sediments), usually less than 50 feet thick. The valleys are filled with stratified drift and lake bed sediments that comprise aquifers and confining units, sometimes up to 300 feet thick. Glacial aquifers supply important quantities of water in Northern New Jersey. These buried valley (or valley-fill) aquifers are frequently the main local water supply sources. Many wells which draw from the underlying aquifer are extensively recharged by streams flowing on top of the glacial deposits.

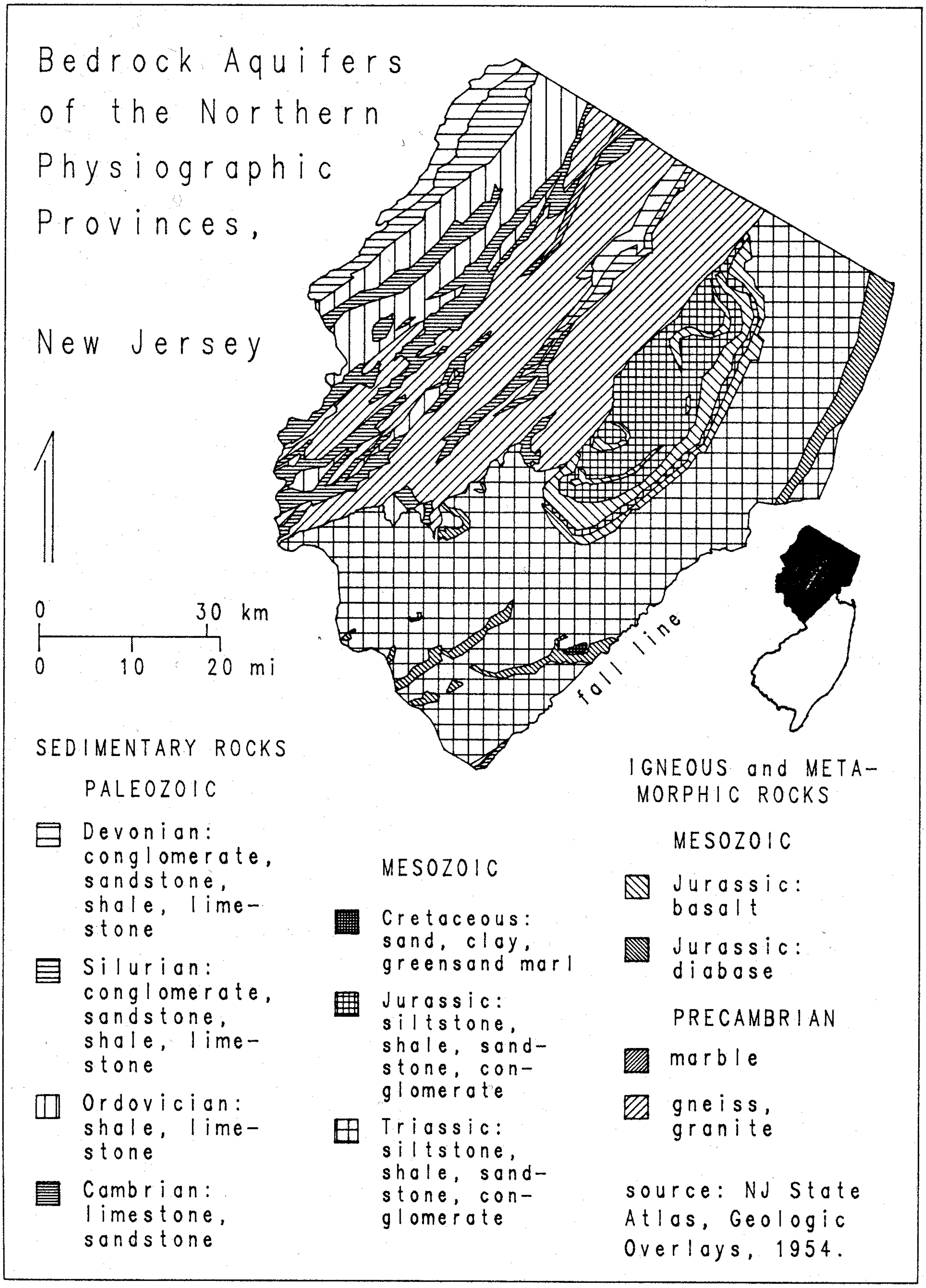
E. Major Surface Water Resources of New Jersey

The State of New Jersey has 6,450 miles of rivers (both inter- and intra-state), 24,000 acres of public lakes, 900,000 acres of freshwater and tidal wetlands, 120 miles of ocean coastline, and 420 miles of estuarine coastline (NJDEP, 1988 and Figure 2.7). Many rivers presently supply water to a variety of users throughout the state, or have been considered for future use (Task 2 Report, Water Supply Baseline Data Development and Analyses, CH2M Hill, November 1992).

1. Interstate Rivers

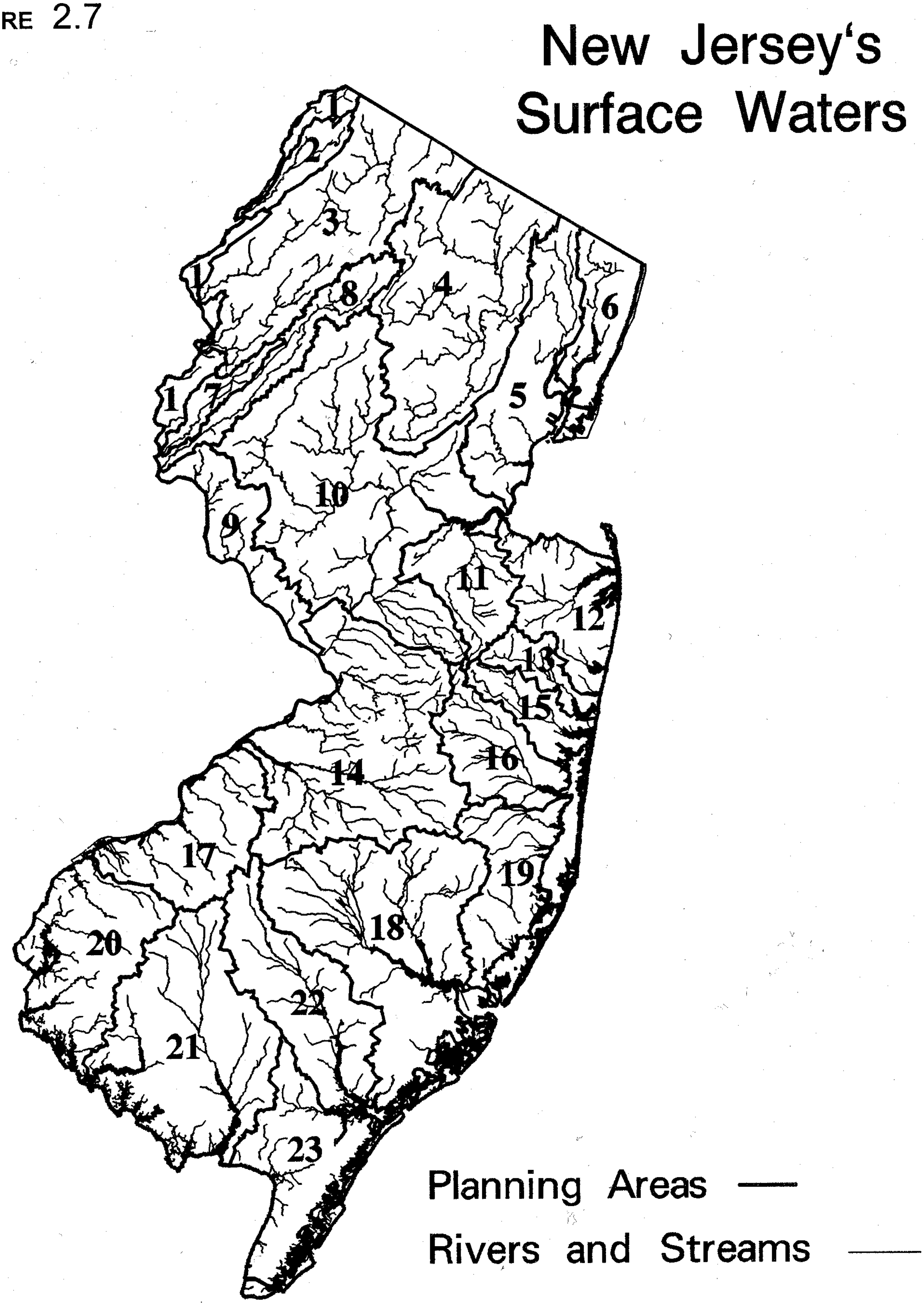
The Hudson River is currently being evaluated for future use by New York City. Its lower reaches are not currently used by New York State or New Jersey as a water supply. New Jersey is assessing whether it should participate in the interstate use of this supply. The Hudson would have to be tapped north of the Tappan Zee Bridge in lower New York State in order to avoid tidal salt water. By statute, New York's consent would be required before water can be exported.

FIGURE 2.6



Bedrock Aquifers of the Northern Physiographic Provinces,
New Jersey
0 30 km
0 10 20 mi
fall line
SEDIMENTARY ROCKS
PALEOZOIC
Devonian: conglomerate, sandstone, shale, limestone
Silurian: conglomerate, sandstone, shale, limestone
Ordovician: shale, limestone
Cambrian: limestone, sandstone
MESOZOIC
Cretaceous: sand, clay, greensand marl
Jurassic: siltstone, shale, sandstone, conglomerate
Triassic: siltstone, shale, sandstone, conglomerate
IGNEOUS and METAMORPHIC ROCKS
MESOZOIC
Jurassic: basalt
Jurassic: diabase
PRECAMBRIAN
marble
gneiss, granite
source: NJ State Atlas, Geologic Overlays, 1954.

FIGURE 2.7


New Jersey's
Surface Waters
1
2
3
1
8
4
6
1
7
5
10
9
11
12
13
15
16
14
17
19
18
20
22
21
23
Planning Areas
Rivers and Streams

In addition, New Jersey purveyors extensively utilize four rivers that drain from southern New York State into New Jersey. They are the Hackensack, Saddle, Ramapo, and Wanaque rivers. Lastly, limited use is made of the Walkill River in New Jersey, which has its headwaters in New Jersey and drains into New York.

New Jersey has limited riparian rights to the Delaware River via the Delaware and Raritan Canal through an interstate compact and it is a member of the Delaware River Basin Commission. In addition, several municipalities divert water from the Delaware, and a regional pipeline being constructed by the N.J. American Water Company will divert Delaware River water in Burlington County to most communities in Burlington, Camden and Gloucester Counties affected by Water Supply Critical Area #2. Such in-basin use is considered generally non-depletive, as the wastewater from these municipalities is discharged back to the Delaware River.

2. Intrastate Rivers

New Jersey is heavily dependent on intrastate surface waters and their associated reservoirs in the northern and central parts of the state. The most extensively used river is the Passaic and its tributaries, followed by the Raritan and Hackensack rivers. The geography of northern and central New Jersey is conducive to reservoir development with its valleys and ridges. Southern New Jersey's geography on the other hand, will not permit the extensive development of surface water storage facilities and it is envisioned that this region will continue to rely primarily on ground water and the Delaware River to meet its water supply needs (though some reservoirs have been constructed that either rely heavily on long levees or are relatively shallow). In-state rivers will play a larger role in this region over time as limitations to ground water increase because of the potential for saltwater intrusion. The conjunctive use of both supplies will increase in importance.

F. Selection of Planning Areas

The state has been divided into 23 regional water resource planning areas for water supply planning purposes. These planning areas are groupings of surface watersheds (Figure 2.8). Throughout this NJSWSP, reference is made to the interrelated water resources within these planning areas and the Water Balance Model (WBM) that is employed to assess water availability in these planning areas. The planning areas do include both ground and surface water resources within their boundaries, recognizing the integrated nature of the resource. Both shallow and confined aquifers which occur in the planning area are included.

The following steps were used for identification of base water sources which formed the final planning area boundaries:

started with the watershed drainage area map of New Jersey;

looked at the availability and status of stream gauging stations that could be used to confirm recharge estimates previously developed;

considered existing studies that focused on some of the watersheds;

considered receiving water bodies for drainage from the watersheds, recognizing the need to assess the impact of water use upstream on receiving bodies, such as the Atlantic estuaries;

NAMES AND NUMBERS OF THE 23 REGIONAL WATER RESOURCE PLANNING AREAS (RWRPAs)	
RWRPA #	NAME
1	Middle Delaware River
2	Flat Brook
3	Walkill/Pequest Rivers/Paulins Kill
4	Upper Passaic River and Tributaries
5	Lower Passaic/Rahway Rivers
6	Hackensack River
7	Pohatcong River
8	Musconetcong River
9	Trenton Delaware Tributaries
10	Raritan River
11	South River
12	Navesink/Swimming Rivers
13	Manasquan River
14	Rancocas River
15	Metedeconk River
16	Toms River
17	Camden Delaware Tributaries
18	Mullica River
19	Atlantic Coastal
20	Salem River
21	Maurice River
22	Great Egg Harbor River
23	Cape May Coastal

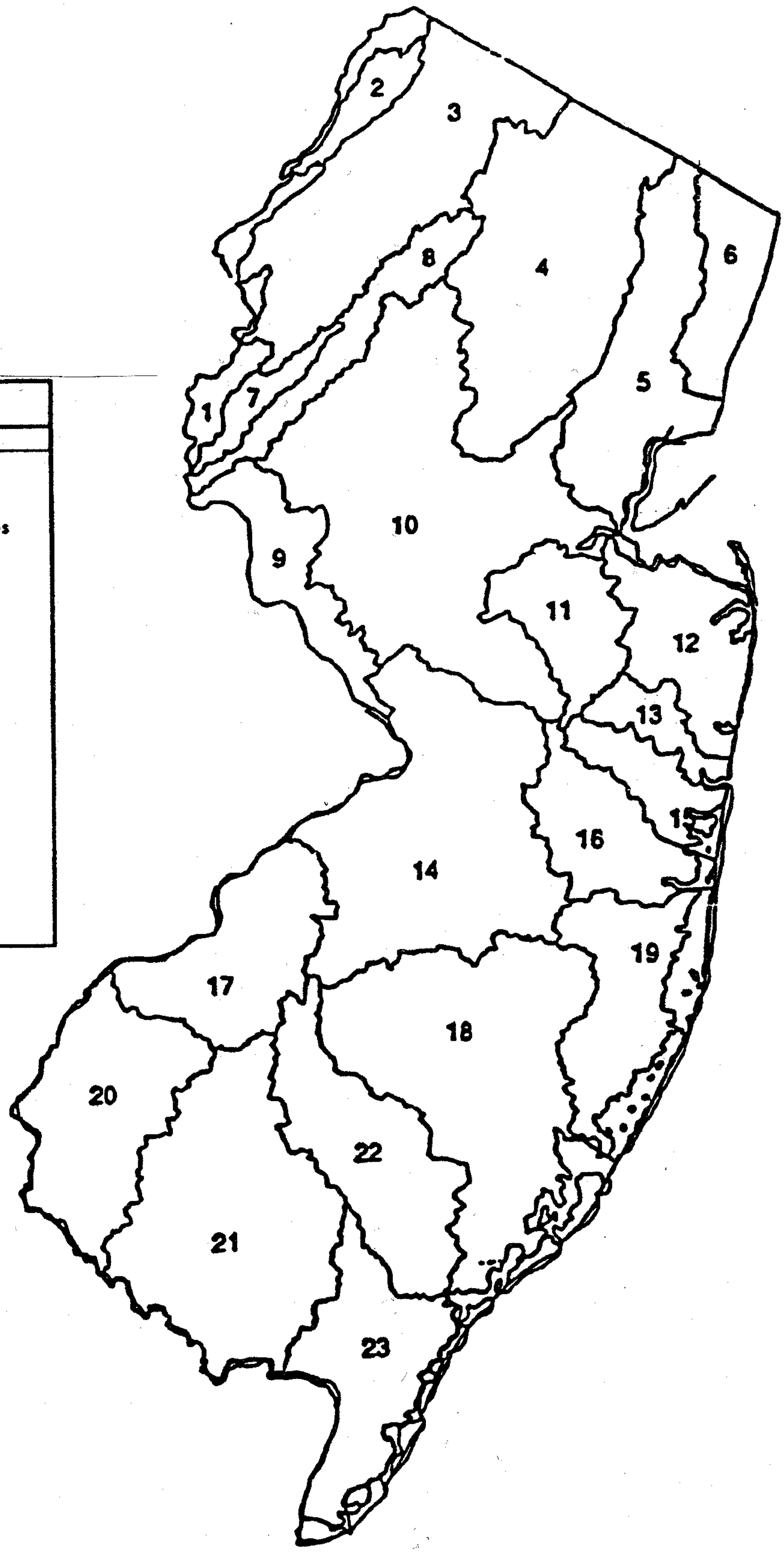


FIGURE 2.8

REGIONAL WATER RESOURCES PLANNING AREAS (RWRPAs)

compared the watershed map to the geological map of the state to potentially use geology as a criteria for subdividing or grouping the basins;

considered existing and planned regional water resources investigations such as the shallow aquifer studies; and

considered population centers.

In order to facilitate ease in discussing and listing information and also for developing the Depletive Water Use database, the planning areas were given numbers from 1 to 23 starting at the most northwestern portion of New Jersey (Sussex County) to the southern most portion (Cape May County). The boundaries of the planning areas are shown in Figure 2.8 with the associated names and numbers of the planning areas for easy reference.

G. The Hydrologic Cycle and Its Relationship to Planning Areas

A basic understanding of the hydrologic cycle and its processes is critical to understanding how these planning areas were defined and how water availability was estimated in this plan. The hydrologic cycle is the endless circulation of water between the earth and its atmosphere. It is composed of many interrelated sub-cycles of various areal extent. Within the cycle, the amount of water entering will always be equal to the amount leaving. Although these amounts may be the same in the long term, changing precipitation patterns and human activities can alter the distribution and timing of this water flow as it makes its way through the various paths from lands' surface to the ocean and atmosphere.

Figure 2.9(a) is a basic illustration of the general paths of hydrologic cycle under pre-development conditions. As shown, the majority of inflow (precipitation) is "recycled" quickly back into the atmosphere through evapotranspiration (ET). The second largest inflow component is ground water. The majority of recharge in the ground water flow path later becomes baseflow (the continuous stream flow that is not related to precipitation) or flows underground to the ocean at the saltwater/freshwater interface. In certain confined aquifers, such as in the Coastal Plain and portions of the Piedmont, a small amount of unconfined aquifer recharge flows under or infiltrates the confining unit and eventually flows into the ocean at the interface. Table 2.1 shows the estimated ground water recharge for each of the 23 planning areas. Added up, recharge into the aquifer is equal to outflow from the aquifer. The third inflow component is surface runoff (precipitation that moves across the land surface to streams that occurs during and immediately after a precipitation event).

The flow paths of the hydrologic cycle can be altered and interrupted through human activities, primarily water use, wastewater management and development (Figure 2.9(b)). Essentially, substantial water development results in the creation of a new artificial flow path consisting of water supply/wastewater infrastructure that "bypasses" the natural flow paths. It is important to note that an artificial change to the hydrologic cycle becomes part of that cycle. For this reason, this plan focuses on depletive use, where water is removed from one part of the cycle and transferred to another, so that reuse within the original area is not possible.

Changes in the distribution of water in the hydrologic cycle are the major focus for water supply planning. Water supply planning seeks to:

define the water inflow along the various flow paths of the hydrologic cycle of a given geographic area during a "worst-case" low precipitation period;

project the amount of water that can be withdrawn for human purposes from any one or combination of these flow paths;

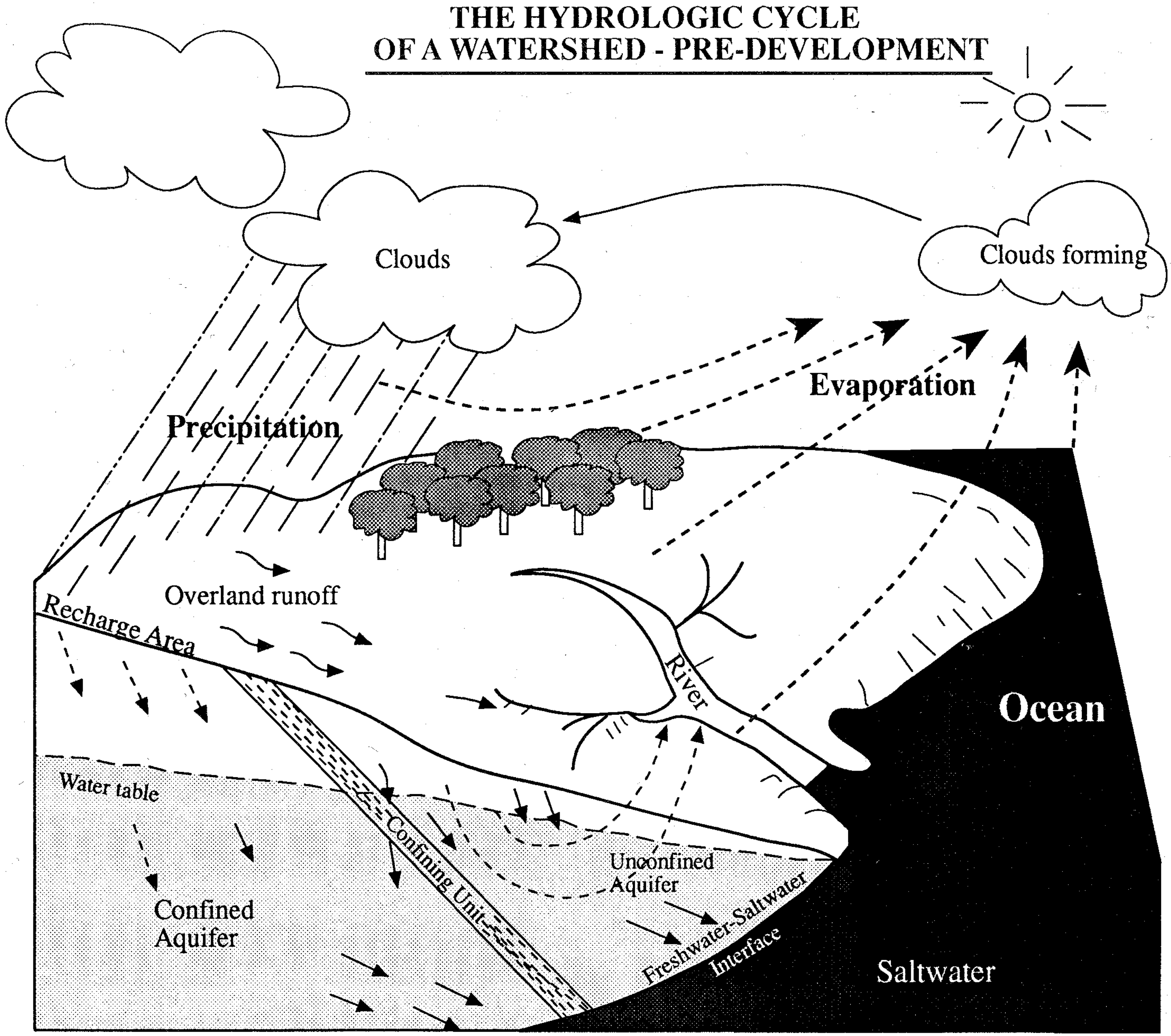

THE HYDROLOGIC CYCLE
OF A WATERSHED - PRE-DEVELOPMENT
Clouds
Clouds forming
Evaporation
Precipitation
Overland runoff
Recharge Area
River
Ocean
Water table
Confining Unit
Unconfined
Aquifer
Confined
Aquifer
Freshwater-Saltwater
Interface
Saltwater

Figure 2.9 (a)

TABLE 2.1 *Recharge Estimates for Planning Areas (RWRPA)*

RWRPA Number	RWRPA Name	Total Recharge (mgd)	Recharge (inches)
1	Middle Delaware River	100	17
2	Flat Brook	51	16
3	Walkill/Pequest River	431	17
4	Upper Passaic Pompton/Ramapo River	471	16
5	Lower Passaic/Rahway River	236	15
6	Hackensack River	109	15
7	Pohatcong River	49	18
8	Musconetcong River	134	18
9	Trenton Delaware Tributaries	88	10
10	Raritan River	554	13
11	South River	124	15
12	Navesink/Swimming Rivers	185	16
13	Manasquan River	74	19
14	Rancocas Creek	540	16
15	Metedeconk River	111	21
16	Toms River	200	21
17	Camden Delaware Tributaries	217	16
18	Mullica River	635	19
19	Atlantic Coastal	250	21
20	Salem River	296	17
21	Maurice River	540	19
22	Great Egg Harbor River	311	19
23	Cape May Coastal	290	19
	Total	**5995**	

THE HYDROLOGIC CYCLE
OF A WATERSHED - DEVELOPMENT

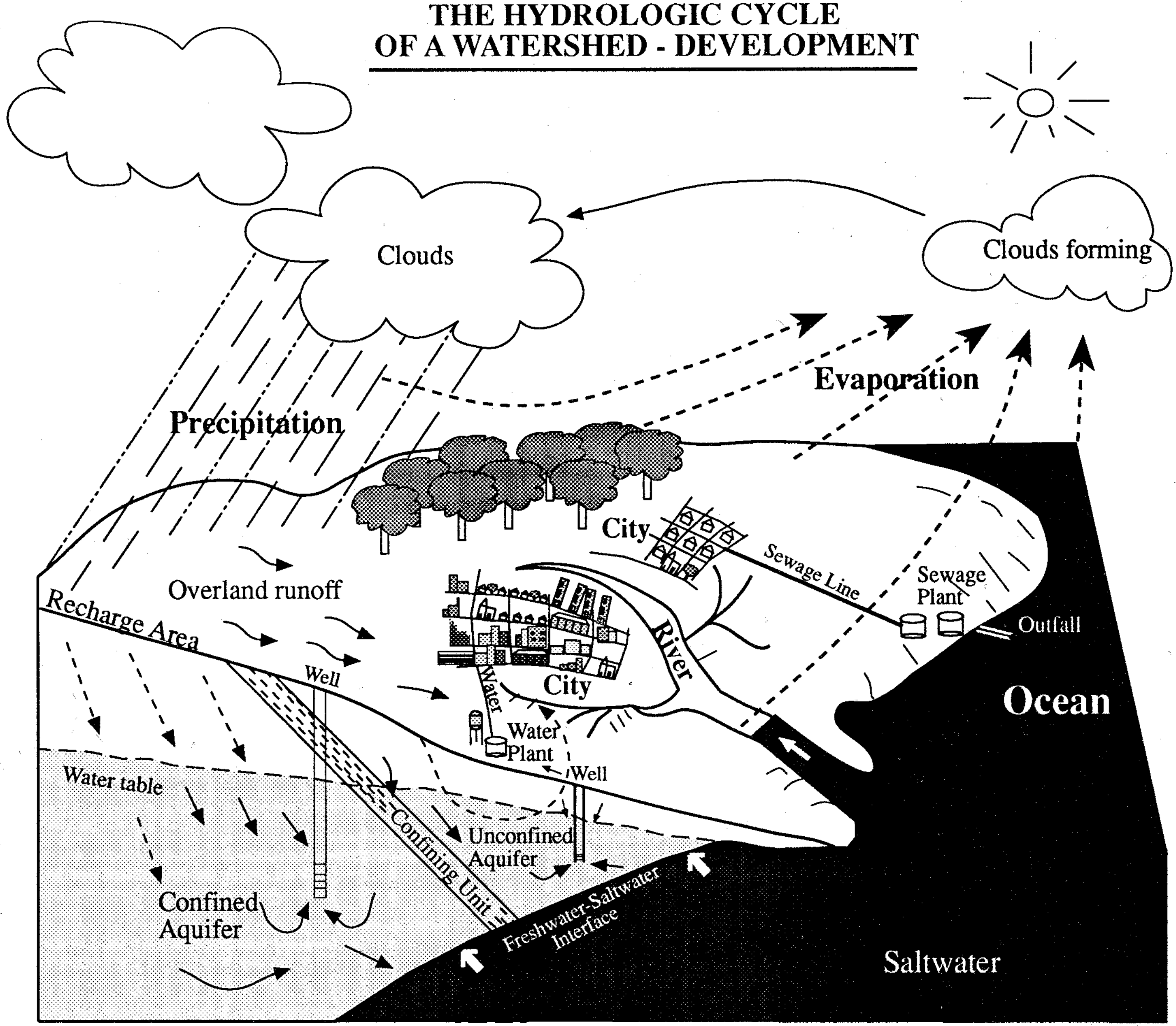


Figure 2.9 (b)

estimate if there will be sufficient outflow remaining in the flow path for other users, including that needed to maintain stream baseflow, retard saltwater from entering aquifers or moving up estuaries, and allowing for a healthy ecosystem while recognizing that reductions of water from withdrawals from any one of the flow paths affects the other flow paths.

In the NJSWSP, inflow into the major flow paths of the hydrologic cycle is analyzed for each of the 23 planning areas and demand is compared against inflow. Finally, a determination is made if these flow paths can support these demands without causing undesirable effects. This information is placed into the WBM for continuing monitoring and analysis.

Figure 2.9(b) illustrates depletive use in the post-development scenario for a hypothetical planning area. Large amounts of water withdrawn from the flow path of any one system and placed into the artificial flow path will reduce outflow from the flow path of that system as well as that from other natural paths. Large amounts of stream flow removed for potable or industrial supply that are not returned near the point of withdrawal will reduce stream flow levels. This could increase the amount of water that could drain by gravity from a shallow aquifer into a stream downstream of the intake. With less freshwater available as a retardant, more saltwater will advance up the estuary. The timing of these flow diversions is also important. The purpose of surface water reservoirs, for instance, is to allow the storage of water during high flow episodes when all uses can be satisfied or more than satisfied, for release to water supply systems and streams during times when flows are naturally low. If, on the other hand, surface water supply withdrawals are not backed by storage facilities (known as “stipulated” withdrawals), the stream flow depletion could occur at harmful times, reducing the flow available to the ecosystem or other water users.

If substantial amounts of shallow aquifer water are diverted and not "recycled" back into this system, less of this water is available to make up stream baseflow during drought, maintain lake levels, discharge to wetlands and the ocean, or to infiltrate down into the lower confined aquifers. If confined aquifer withdrawals are major, water is induced into these aquifers over time from the aquifers overlying or underlying them (induced leakage). If the other aquifers are unable to compensate for the loss of storage within the confined aquifer, saltwater will advance toward the wells as the cone of depression created by pumping declines below sea level. Therefore, salt water intrusion can occur in both the confined and unconfined systems if they are near salt water sources. (If not, the aquifers can literally be drained of water). It is for this reason that this plan treats all the flow paths as one system. An analysis of these flow paths is summarized in Chapter 3.

Changes to the landscape by development can also alter the various flow paths of the hydrologic cycle. The high proportion of impervious cover that accompanies high density urban/suburban development increases runoff and reduces recharge rates, leaving less water to enter the ground to sustain the baseflow of local streams. Dense development and significant impervious cover will also result in increased non-point sources of pollution to local ground water sources and downstream surface water users. Leaky drainage and sewerage collection systems may also serve to reduce the flow of water to the shallow aquifers, further reducing baseflow.

CHAPTER THREE

ESTIMATING AND PROJECTING THE AVAILABILITY OF WATER

A. Background

The primary objective of this chapter is to summarize the methodologies used to quantify water availability for each of the water supply planning areas in New Jersey. This information is the first component of the Water Balance Model (WBM) developed by the consultant team. The WBM, as described later in this chapter, is based on certain analytical assumptions and will need to be periodically updated as additional, and more reliable, data are collected. It will also need to be refined as our knowledge of the dynamics of the hydrologic cycle is expanded.

The second component of the WBM is current and future demand within each water supply planning area. A summary of the latter component can be found in Chapter 4. In Chapter 5, demand is compared against availability in order to estimate if a planning area will be in surplus or deficit during the planning period from 1990 to 2040.

Water availability has been estimated for the regional water supplies within each of the 23 planning areas. The development of these estimates was a combined effort of the consultants, NJDEP and the U.S. Geological Survey. As described in Chapter 2, the planning areas reflect hydrologic boundaries, including single or multiple watersheds. By determining current water availability for these areas, New Jersey can proactively plan to reduce the risk that these supplies will be overdrafted.

The estimation of water availability has grown more complex over time. Legitimate questions have been raised regarding both methods and modeling assumptions for estimating surface and ground water supplies, the inter-relationship between these two resources, the impacts on water supplies caused by regional sewer systems, and the complex inter-relationship of withdrawals and their effects on the ecosystem. Innovative water management techniques such as conjunctive use (where multiple surface and ground water supplies are drawn upon at different times to supply the same water user) and wastewater re-use confound old definitions of water availability. These same techniques are allowing water managers to select optimum use approaches and strategies that "enhance" water availability. This chapter describes how the NJDEP estimates water availability for the NJSWSP, explores some of these uncertainties and other critical issues, and provides recommendations for further analysis.

B. The Problem of Definitions

The water supply profession uses a variety of terms to describe how much water is available for consumption. The most common term is safe yield, but others include dependable yield, facility safe (or dependable) yield, and water availability. In each case, the definitions include consideration of the effects of water withdrawals on other water users (e.g., agriculture and industries) and uses (e.g., ecosystems, recreation). The definitions also include assumptions regarding the patterns of precipitation, the relationship between surface and ground water flows, ground water recharge, and water use patterns. Some of these considerations and assumptions are analyzed in chapters Seven and Eight. This plan uses the following definitions for water availability:

Safe Yield -- applied to surface water resources to define the water yield (in million gallons per day, or MGD) maintainable by a surface water system (e.g., reservoir or run-of-the-river intake, the latter being a withdrawal point from a stream that is not directly related to <u>on-stream</u> reservoir storage) continuously throughout a repetition of the most severe drought of record for the relevant watershed, after compliance with requirements for maintaining minimum passing flows, assuming no significant changes in upstream activities that would result in a reduction in stream flow during a repitition of the drought of record.

Dependable Yield [3]-- applied to ground water resources to define the water yield maintainable by a ground water system during projected future conditions, including both a repetition of the most severe drought of record and long-term withdrawal rates, without creating undesirable effects. It should be noted that for major aquifers, drought conditions may cause temporary stresses due to abnormal water demands, but not actually cause an exceedance of the long-term dependable yield (i.e., demand would not be greater than long-term ground water availability). Smaller aquifers, however, can actually be over stressed by demands during drought conditions. Because dependable yield values are not available in all regions of New Jersey, a percentage of ground water recharge was chosen, for planning purposes, to serve as a surrogate value for the dependable yield of aquifers. This percentage is considered a "planning threshold" for the state's ground water resources. These values should not be used as the actual dependable yields, which will be derived over time through research. The yield values also may not reflect more localized conditions, such as stream flow effects due to major pumping centers in shallow aquifers.

Facility Dependable Yield of Surface and Ground Water -- means the yield of water by a water supply system (using ground water, surface water or both) that is available continuously throughout a repetition of the most severe drought of record, without causing undesirable effects as defined above. The combination of facility dependable yields in a region may be less or more than the relevant safe and dependable yields due to infrastructure constraints, impacts of one facility on another, or other reasons.

Water Availability -- applied to the combined surface and ground water resources in a region, means the sum total of safe yields and dependable yields in that region. Two types of water availability are used. "Total" water availability reflects the resources of the region with no consideration of interbasin transfers of raw or treated water. "Net" water availability is total water availability as modified by such transfers.

C. The Assumptions and Limitations of Availability Estimates

Several assumptions are clearly noted in the above definitions regarding water availability and several often related issues surface as a result, including:

1. Use of the Drought of Record

The definitions assume that the "worst case" scenario for water availability is the most severe drought of record. In New Jersey, this scenario generally corresponds to the major drought of the early 1960's. However, except perhaps for a few watersheds with long-term records, insufficient long-term precipitation records exist to prove that the 1960's drought is the worst we can expect in the future. Thus, there is an unknown risk level. For most of the state, the NJDEP selects this drought as the "drought of record" based on its severity and duration. The ability of the State's water supplies to withstand a drought significantly worse than the 1960's has not been investigated. It is also possible that a shorter but more severe drought may cause the depletion of water availability even though the same supplies would withstand a repeated drought of record. A re-evaluation of how safe yield is estimated is merited, as well as the development of optimum drought management strategies for periods of extreme low precipitation. Consideration will be given to employing various drought frequencies, probabilities and severities. Emphasis will be made on ensuring that there are proven demand management schemes available that minimize vulnerability during critical periods. The optimal strategy is one that balances the often conflicting considerations of economics and the public welfare and safety.

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[3]It should be noted that water resource managers in other states, as well as in other parts of the world, sometimes use the term dependable yield as an estimate of surface water availablity. For purposes of this document, the term "dependable yield" will only be used when describing ground water availability.

2. Depletive Water Use

The term *safe yield* assumes that the flow of water into reservoirs or intakes will maintain the same historical pattern if the drought of record is repeated. However, activities within a drainage basin can potentially increase or decrease historical stream discharge during identical droughts and consequently affect safe yield. For instance, the withdrawal of ground water may have undesirable effects (which is an implicit assumption in the definition of dependable yield), one of which is the reduction of ground water flow to streams (called "baseflow") above surface water withdrawal points, or downstream where passing flows could be affected.

Ground water withdrawals may <u>increase</u> drought stream flow (if the treated sewage effluent is discharged above the intake) or <u>decrease</u> it (if the water is removed from the watershed or discharged downstream of the intake). The two assumptions are in potential conflict. Likewise, surface water withdrawals may affect safe yield of downstream facilities if the water is removed from the watershed. Or, the abandonment of a wastewater treatment plant discharge above an intake may reduce the yield if that discharge made up a portion of the in-stream flow used to estimate the yield.

Last, the replacement of individual septic systems with regional sewerage collection systems that discharge to a neighboring waterway can reduce stream flow (McAuley, 1993). The above-described removal of water from a region is defined as a **depletive water use**.[4] Ground water and surface diversions that capture and store water during low stream flow periods for various uses and release it back into the region during high flow conditions have similar effects, that is, water is removed from the stream during the most critical period. Reservoir withdrawals are generally non-depletive in the sense that these withdrawals occur when streamflow is above certain passing flow requirements, and therefore do not affect critical low flow periods.

3. Impact of Development

Stream flow may also be affected by the development of the upstream watershed. Water that historically recharged ground water resources and later discharged to local streams may be diverted to surface water as instantaneous runoff from impermeable surfaces. This process tends to reduce stream baseflow and make streams more "flashy" with higher peak flows after precipitation events. The ultimate effect on safe yields is not fully known. More runoff into reservoirs during drought periods may offset reductions in baseflow to some extent, especially during short droughts. However, over longer droughts the loss of baseflow to streams will probably reduce reservoir yields. In addition, "leaky" regional sewerage and stormwater collection systems potentially can reduce stream baseflow by capturing ground water as infiltration. Ground water availability can also be reduced by substantial development over aquifer recharge areas. Last, from a quality perspective, water availability can be affected by poor quality water originating from dense and/or improperly managed land uses (see Chapter 7).

4. Cumulative Effects of Local Water Supply Decisions

The mode in which a regional water supply is developed can play a crucial role in the amount of water that is available over the long-term. Essentially, well planned water supply development that considers future demand will enhance water availability, while unplanned, piecemeal development will likely be to the detriment of availability. For instance, highly concentrated ground water withdrawals located near the saltwater/freshwater interface will potentially reduce the "sustainability" of an aquifer, as compared to strategically placed wells that are located so as to minimize the potential for saltwater intrusion. The same

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[4] Please note, the Delaware River Basin Commission's definition of depletive water use is somewhat different than the definition used in this report, as this report does not include all "consumptive" uses of water such as evaporation from power plant cooling systems that also deplete water resources.

point can be made with regard to the localized drawdown of unconfined aquifers that may result in individual well failure or interference between wells, reducing the total yield of an aquifer. These scenarios result from the commonplace decision to locate water withdrawals, especially wells, as close to demand as possible; this mode of water supply development may impair long-term water availability. In contrast, well planned and coordinated water supply development can increase water availability toward the theoretical maximum.

5. Saltwater Intrusion

The "undesirable effects" noted in the dependable yield definition vary according to the aquifer involved, and are in any case difficult to quantify. For some aquifers, especially the confined systems near coastal areas, saltwater intrusion is the primary factor. At what point should saltwater intrusion become a limitation of ground water withdrawals in order for the resource to be considered a sustainable supply? Recommendations vary from five years (the average length of time between water allocation permit renewals) to twenty years (a common schedule for new, major water supply facilities) to fifty years (the planning horizon for the NJSWSP) to an infinite period (because these confined aquifers cannot be relied upon indefinitely; they are not "perpetual"). As described above, our understanding of ground water has advanced over the last decade. Preliminary research findings lead to the conclusion that the active life of confined aquifers can be greatly extended if well fields are located an adequate distance from the saltwater front, even under heavy use (USGS, 1993) or if they are recharged with water from another source (e.g. “skimming” surface water during high flow periods). It is also clear that intrusion is a natural condition of coastal confined aquifers, due to sea-level rise over thousands of years time (0.01 ft per year, according to Meisler and others, 1985), but that it is exacerbated by new withdrawals. This plan assumes that saltwater intrusion is not a public policy issue unless: (1) it is predicted to impair public water supply wells within the planning horizon; or (2) an increasing reliance on aquifers subject to saltwater intrusion creates the potential for major economic disruption past the planning horizon (i.e., no alternative sources are reasonably available for anticipated demands).

6. Stream Depletion

For shallow aquifers, stream base flow reduction is often the primary factor of concern (unless well fields are near the saltwater/freshwater interface, where intrusion might be the primary factor). Recent investigations in two buried valley aquifers of northern New Jersey are concluding that depletive ground water withdrawals may cause an equal reduction in stream flow during **average** base flow conditions where an efficient hydraulic connection exists between the aquifer and the waterway (Nicholson, McAuley, Barringer and Gordon, 1992; Gordon, 1992). That being the case, such withdrawals would reduce drought of record flows and, in fact, may cause these conditions to prematurely occur and even extend these conditions. These effects are difficult to document because streamflow gauging stations are relatively few in number and generally placed on larger streams, where localized streamflow reductions could be masked by flows from other sub-watersheds. Ecological monitoring that could identify impacts of streamflow reduction has not existed for a sufficiently long period, and other causes of ecological impairment may often mask effects caused by streamflow changes.

7. Changes in Downstream Needs

The passing flows mandated for surface water intakes (established as a flow either at which "run-of-the-river" withdrawals must cease, or below which make-up water is required from an on-stream reservoir) also are tied to the desire to mitigate "undesirable effects." The definition of these effects is being refined over time. Historically, the primary concerns were the maintenance of stream flow for downstream users and to repel salinity, and for the dilution of sewage or treated wastewater discharges. Downstream water users and effluent dilution are still concerns, although enormous improvements have been made in wastewater treatment facilities. For wastewater discharges, state permits allow certain discharges based upon an assumptions regarding the frequency and duration of water flows during drought. Major stream flow and water quality changes will affect these permittees, stream ecosystems, downstream users and the public at large.

8. Ecological Concerns

The impact of water withdrawals on ecosystems, whether in-stream or near-stream (e.g. wetlands) is a relatively recent concern and little documented, especially in humid states such as New Jersey. These impacts are difficult to identify or quantify, in part due to the natural variability of ecosystems. Unlike the determination of surface water safe yield, for which hydrologic data is provided by stream flow, ecological needs are also affected by water quality in an complex manner that is species-dependent. Near-stream impacts are even more difficult to determine because of the added complexity of the ground water/surface water interrelationship. The NJDEP has required that new withdrawals (e.g. Manasquan Reservoir, Brick Township Municipal Utilities Authority) be preceded by extensive environmental assessments and continuous monitoring whenever the withdrawal rates are thought to be large enough to impair aquatic ecosystems and those species dependent on these systems. Due to the potential for stream flow depletion this policy will be continued and may include similar requirements for proposed allocations that plan to withdraw substantial ground water from the shallow aquifer systems.

As more is learned from in situ continuous monitoring and ongoing research in New Jersey and in other states, the NJDEP may consider the development of general thresholds that link withdrawals with the specific freshwater-dependent ecological resources potentially affected by significant diversions. Consideration will be given whereby new water allocations will be allowed to incrementally increase withdrawals after a review of continuous monitoring data warrants such an increase. Since numerous smaller withdrawals can potentially have the same effects as a large single withdrawal, consideration will be provided to applying these thresholds in overall watersheds. It is envisioned that these thresholds will be in the form of stream flow and wetland maintenance. Water quality thresholds may need to be integrated into these efforts since quality degradation can have similar or worse effects on ecosystems as that caused by reductions in freshwater.

9. Indirect Wastewater Re-use/Conjunctive Water Use

Wastewater re-use and conjunctive water use are becoming major management options (see Chapters 6-8). The safe yield and dependable yield definitions include implicit assumptions that: (1) water always flows downstream and is not returned upstream of the intake point from which it came; and (2) facilities use either ground or surface water, but not both. While generally true, major exceptions are occurring. In the Passaic River Basin, NJ-American Water Company has constructed a pipeline that can transfer up to 25 MGD of water from the Passaic Valley Water Commission facility in Little Falls <u>upstream</u> to the NJ-American facility in Millburn Township. Water will thus move many times through that stretch of the Passaic River (assuming that it is discharged in the Upper Passaic after conversion to treated wastewater).

Conjunctive use has major potential to increase the long-term viability of expensive surface water supplies. Increasingly often, surface water supplies are used when available (i.e., during wet months) with ground water providing more of the supply in the dry months. Alternatively, surface water may meet average demand while ground water could meet peak demand. Of course, conjunctive water use is only viable when the ground water diversion does not substantially reduce streamflow upon which the surface water supply depends. The combination of the two supplies forces a modification of water availability estimates, both regionally and for individual systems. The NJDEP has begun to require some major conjunctive use systems to prepare new estimates of their system's facility dependable yield, where a yield has not yet been established.

10. Water Conservation

Not included in the safe yield definition, but critical in practice, is the utilization of demand reduction during drought. When drought conditions are imminent, purveyors often utilize various forms of reductions in demand as a "buffer" to extend supply. Temporary water conservation measures are the most frequently used form of demand reduction. Recent "structural" conservation initiatives such as low flow toilets and showerheads may reduce this buffer to some degree, as may other additional measures that are anticipated in the future. Further analysis is needed; perhaps water savings in the form of conservation needs to be segregated from that needed during drought. For instance, treated wastewater that is discharged upstream of reservoir intakes makes up a significant fraction of total Passaic River flow at Little Falls during drought. If the sewage plants receive water that initially comes from the reservoirs, indoor structural conservation will be of little benefit or may have even negative impacts. A hypothetical example would include the implemention of low flush toilet retrofit programs in municipalities that are Passaic Valley Water Commission (PVWC) customers, and which also discharge their treated wastewater upstream of the PVWC water treatment facility. There is a need to comprehensively understand the various water resources in the planning areas prior to mandating and implementing aggressive water conservation in order to be effective. This example ignores water quality considerations; these most certainly must be included in the analysis. On the other hand, reducing outdoor consumptive use and unaccounted for water is wise drought management. Conservation is discussed in detail in Chapter 7.

D. Reliability in Estimating Water Availability

Reliability is an important issue when developing water availability estimates. Such estimates have regulatory implications, helping the NJDEP determine how much water is available, where and when. In addition to the assumptions and related methodological issues raised above, the estimates are bounded by issues of data accuracy and adequacy, and analytical reliability. As data and analyses improve, the range of uncertainty decreases. Thus, information plays a vital role in managing the balance between availability and demand. Though the primary rivers that are used for water supply have extensive stream flow gauging stations, many other smaller or less-used streams and rivers do not. And, those streams that have gauging stations may not show accurate historical information of true natural stream flow, as sewage plants have come on or gone off line over time, farmers may have stopped pumping water from the stream, or depletive uses may have increased throughout the period of record. Precipitation estimates are based on a relatively limited number of stations. Drought estimates are based on a few events over a relatively short period. Ground water studies that seek to accurately quantify aquifer yields and characteristics are relatively recent, expensive and regional in scale. In short, all parties must rely on statistical analysis of various levels of confidence to make use of the data, and must rely on planning assumptions where data are lacking. It is extremely important that all interests recognize the dynamic nature of water availability estimates. They are not yet definitive and will change over time as new concepts, models and research are developed.

Clearly, the most satisfactory estimates currently available are the safe yields of surface water supplies; estimates are much coarser regarding regional aquifers and conjunctive use systems. However, even where estimates are fairly well established, a five percent change could have a major impact on decisions to build water supply facilities costing tens of millions of dollars.

E. "Water Availability" as a Policy Statement

The NJSWSP establishes a planning framework that identifies potential water supply problems and public issues, and then proposes activities to address those problems and issues. The activities may be specific projects, management initiatives or programs, or they may be issue-specific planning processes. The priorities for these activities are tightly linked to water supply deficit forecasts, which are again tightly linked to the estimates of water availability.

Therefore, **the water availability estimates included within this document are essentially statements of policy for regional and statewide water supply planning and program development purposes**. However, they are categorically not statements of policy regarding site-specific regulatory decisions. Rather, they will serve as one of many sources of information for regulatory decisions, along with site-specific data and the regulatory requirements of the NJDEP. Further, they are subject to modification over time as new data, models and interpretations become available. As demand approaches the water availability estimates described in this chapter, comprehensive assessments will be made to more definitively estimate yield.

F. Water Availability and The Hydrologic Cycle

The hydrologic cycle shown in Chapter 2 is a useful tool in describing general water availability in that it illustrates: a) the various inflow/outflow paths that water continuously takes between the land and the ocean and the atmosphere, b) the interconnection of these paths, and c) the undesirable effects that can result if an imbalance is created in any path. Other than the evapotranspiration component, the flow paths of the hydrologic cycle within the State's major watersheds represent our regional water supplies. It is for this reason that the NJDEP elected to use watershed groupings as the basis for estimated water availability.

The water availability implications of the relatively new artificial flow path consisting of the water and wastewater infrastructure can be significant. Water moved from a region as wastewater (and sometimes as raw water if not previously stored in surface water reservoirs) can reduce the amount of water in the natural flow paths during critical periods. When natural flows are substantially reduced, there is less water remaining to maintain stream baseflow, retard the saltwater/freshwater interface from advancing in to estuaries and aquifers, and a greater potential to impair freshwater-dependent ecosystems. On the other hand, water used and then restored to the natural system (in a usable location and quality either in the same or another watershed) is again available for use. The Water Balance Model is based upon this concept. It must be noted, however, that billions of gallons of water enter and leave the natural flow paths every day on average; as such, considerable amounts are available to human use without resulting in these negative impacts.

G. Estimating Water Availability

The estimation of water supply availability is concurrently dependent upon where and how the resource is developed and upon defining "acceptable" impacts. The five primary factors are:

1) water inflow available from the hydrologic cycle (i.e., precipitation that becomes either ground or surface water), including seasonal fluctuations of inflow;
2) the quality of the inflow;
3) the location of the diversion(s) with respect to special water supply concerns (e.g. saltwater/freshwater interface or a reservoir);
4) the amount of outflow necessary to support other uses (e.g., water supply, ecological): and
5) the quality of the outflow.

Optimizing the various combinations of these factors can substantially increase water availability for human purposes toward a theoretical maximum. This chapter discusses the quantitative aspects of water availability; quality limitations on availability are primarily discussed in Chapters 6 and 7.

In the most simplistic terms and without the quality considerations, water availability is limited by the amount of **flow** from the hydrologic cycle that can be taken and yet leave sufficient supplies for other uses and users.

For instance, an in-stream reservoir located in the upper reaches of a watershed will yield less water than one in the lower reaches, because there is less water to capture at the higher point. A recent study of the Raritan River basin concluded that the yield of the upstream reservoir system there could be increased by 53 MGD by installing an intake about seven miles downstream from the present intake (with a transmission line back up to the reservoirs) in order to take advantage of the increased outflow at the lower location (Hazens & Sawyer, 1992).

The conjunctive use of a reservoir and aquifers offer significant potential to synergistically increase overall water availability, as discussed above. It is estimated that an additional 15 MGD could be made available in planning area 13 if the Manasquan Reservoir could be used in conjunction with regional aquifers or with ground and surface water supplies located outside of the Manasquan River watershed (CH2M Hill, 1993).

The conjunctive use of multiple aquifers that are largely unconnected within a planning area may enhance water availability, as well. The most direct option is for utilization of a shallow aquifer during normal precipitation periods, and of confined wells located far from the saltwater/freshwater interface during dry periods. Using just one of the aquifers may result in too large a reduction in outflow with its consequent undesirable effects.

H. Methodology for Estimating Water Availability

This section describes the methodology used to quantify water availability for the 23 planning areas and the results. Figure 2.8 in Chapter 2 displays a map of the planning areas for reference.

1. Surface Water

As previously described, surface water availability is defined in terms of safe yield. Essentially, the definition implies that if a watershed does not have a reservoir or an alternate water supply available, then that watershed does not have a safe yield. In such a case, continued pumpage from the basin would reduce stream flow below historic or desiredlevels during a repeat of the drought of record. This situation does not apply where surface water is withdrawn and returned to the same approximate location without depletive losses.

In most cases in New Jersey, surface water safe yield is provided through reservoir storage. The river's natural flow provides the majority of water to the purveyor's customers, either directly from intakes on the river or indirectly through releases or withdrawals from the reservoir. During drought periods, reservoir releases in some cases must be made to also augment natural flows to meet a maintenance flow requirement.

Most of the state's reservoir systems are located in the northern part of the state where the topography with its ridges and valleys is most conducive to the construction of reservoirs; they provide the major supply for northeastern New Jersey. The topography of southern New Jersey is either slightly rolling or flat; there are few opportunities for reservoir construction.

An inventory of the planning areas with established safe yields is shown in Table 3.1. As shown, the combined surface water safe yield of all the State's planning areas is about 853 MGD. (Additional supplies exist in the form of "non-depletive" withdrawals that are returned to the river from which they are drawn.) These yields represent the surface water component of total available water for the applicable planning areas and have been incorporated into the WBM for further analysis. A complete inventory of all New Jersey surface water facilities and other data can be found in the consultant's Task 2 Report, referenced in Appendix D in the back of this document.

This inventory does not include the substantial Delaware River surface water supplies managed by the Delaware River Basin Commission (DRBC) except for that provided to the Raritan Basin via the Delaware and Raritan Canal through planning area 9, and those used by water supply systems along the Delaware River that discharge back to the river basin. Reservoirs with storage capacities of up to 150 billion gallons of water have been constructed throughout the Delaware River Basin for water supply purposes. These storage facilities provide flow augmentation to the Delaware River during drought, primarily to retard the saltfront from migrating to Philadelphia's primary potable supply intake and the recharge area of the Potomac-Raritan-Magothy aquifer (as well as to maintain water quality standards). While water supplies are available to New Jersey planning areas draining into the freshwater portion of the Delaware River (such as the Tri-County Project), DRBC's regulatory program would strongly discourage new substantial allocations that are depletive in nature unless offsetting storage is provided, existing uses are proportionately reduced by conservation or abandonment, or the new water supply is offset by water imported from outside the Delaware Basin in order to meet the flow maintenance requirements. Future revisions to this plan will consider restraints to the DRBC drought management plan to provide additional water for depletive water uses.

TABLE 3.1 *Available Water by Planning Area* *(all values are in million gallons per day-MGD)*

RWRPA Number	RWRPA Name	Total Recharge	Available Ground Water	Surface Water Yields	Total Available Water	Interbasin Transfer (-)Out (+)In	Net Available Water
1	Middle Delaware River	100.3	20.1	0.0	20.1	-1.1	19.0
2	Flat Brook	50.5	10.1	0.0	10.1	0.0	10.1
3	Walkill/Pequest River	430.7	86.1	2.4	88.5	2.8	91.3
4	Upper Passaic Pompton/Ramapo River	471.0	94.3	406.2	500.5	-281.0	219.5
5	Lower Passaic/Rahway River	235.8	47.2	8.9	56.1	306.8	362.9
6	Hackensack River	108.7	21.7	74.0	95.7	51.2	146.9
7	Pohatcong River	48.9	9.8	0.0	9.8	0.9	10.7
8	Musconetcong River	134.1	26.8	0.0	26.8	1.8	28.6
9	Trenton Delaware Tributaries	87.6	17.6	66.0	83.6	-66.7	16.9
10	Raritan River	554.0	110.5	160.0	270.5	-57.3	213.2
11	South River	124.3	24.7	8.0	32.7	23.8	56.5
12	Navesink/Swimming Rivers	185.3	31.6	32.6	64.2	11.6	75.8
13	Manasquan River	73.7	9.1	30.0	39.1	-13.0	26.1
14	Rancocas Creek	539.8	82.6	52.2	134.8	1.5	136.3
15	Metedeconk River	111.3	11.2	0.0	11.2	0.2	11.4
16	Toms River	200.0	20.0	0.0	20.0	1.9	21.9
17	Camden Delaware Tributaries	217.0	36.8	0.0	36.8	11.7	48.5
18	Mullica River	634.5	63.5	9.3	72.8	1.1	73.9
19	Atlantic Coastal	249.6	25.0	0.0	25.0	0.3	25.3
20	Salem River	296.2	40.3	3.0	43.3	0.0	43.3
21	Maurice River	540.4	54.0	0.0	54.0	0.0	54.0
22	Great Egg Harbor River	311.4	31.1	0.0	31.1	0.6	31.7
23	Cape May Coastal	289.8	29.0	0.0	29.0	2.8	31.8
	Total	**5994.9**	**903.1**	**852.6**	**1755.7**	**-0.0**	**1755.7**

Footnotes:
- *Total Recharge - estimated long-term, average recharge to acquifers.*
- *Available Ground Water - estimated percentage (10%-20%) of total ground water recharge available for water supply below planning threshold.*
- *Surface Water Yields - amount of surface water continuously available throughout a repetition of drought of record.*
- *Total Available Water - sum of available ground water and surface water yields.*
- *Interbasin Transfer - 1990 net amount of water entering or leaving planning area through purveyor interconnections.*
- *Net Available Water - sum of total available water plus/minus interbasin transfers.*

(data based on years of record from 1986 to 1988).

2. Ground Water

Estimating ground water availability is complex. In order to be precise, expensive and time-intensive geohydrologic investigations must be conducted. While such studies exist for some areas, uniform coverage is not available. Also, the assumptions of "acceptable impacts" varies among these studies or was not considered, so that some of these studies cannot be compared to one another. (Where comprehensive investigations have been previously conducted, reference is made in Chapter 6.) The NJDEP therefore developed and utilized a simplified methodology to estimate total available ground water for each of the 23 planning areas.

The methodology employs the concept inherent to the hydrologic cycle; that is, inflow into a ground water system is equal to outflow, over time. In other words, natural recharge is equal to natural discharge. Natural recharge is that amount of annual rainfall that flows into the aquifer. Natural discharge is that amount that flows out of the aquifer to streams, lakes, wetlands and beneath the ocean making up the baseflow of streams, maintaining lake levels and wetlands, and retarding the advance of saltwater into estuaries and aquifers. The amount of natural recharge is substantial, estimated by the NJDEP to be almost 6 billion gallons per day, on average. The NJDEP estimated unconfined aquifer recharge for each of the planning areas using stream base flow separation analysis that employed a 30-year period of record as well as rates that were documented during previously conducted investigations. The approach considered the inter-connection between the shallow and confined aquifers. The U.S. Geological Survey (USGS) employed an existing model to estimate the interrelationship between the unconfined and confined aquifers in southern New Jersey, as well as the relationship between the confined aquifers themselves.

The next step was to determine how much of the recharge could be used without harmful, regional impacts. The NJDEP evaluated several planning areas that have undergone comprehensive geohydrologic investigations in an effort to estimate the threshold at which ground water supplies experience significant and unacceptable stresses. It was concluded that two "planning thresholds" would be employed. In most regions, the NJSWSP uses an assumption that twenty percent of natural recharge is available for human use without unacceptable regional impacts (although localized impacts are still possible); in the coastal regions, a ten percent value is used to address the potential for saltwater intrusion. The resulting values are used as surrogate values for the true dependable yield.

While these values are for planning purposes <u>only</u>, and are by no means a definitive statement of the dependable yields of the various planning areas, implicit in the concept is that a certain amount of ground water can be made available, if developed efficiently over the long-term, without undesirable regional effects. Table 3.1 provides the estimated natural recharge and available ground water values for each of the 23 planning areas and this information has been included in the WBM for assessment in upcoming chapters. Based on this methodology, significant amounts (900 MGD) of ground water are available for use.

Depletive demand is of importance because it does not return water to its natural flow path and natural outflow will hence be reduced. This situation is especially important with regard to ground water, where very limited artificial storage occurs (as opposed to the many surface water reservoirs) and may increase the potential for some of the impacts discussed above, especially those associated with stream flow depletion and saltwater intrusion. Of critical importance are depletive ground water withdrawals upstream of surface water intakes. If significant, such withdrawals may cause low flows to "prematurely" occur. Equally important are substantial ground water depletive demand near the freshwater/saltwater interface. Withdrawals of this type have a tendency to accelerate saltwater intrusion (Buxton, 1993 - oral communication).

3. Total Available Water

By combining the above surface water safe yields and applicable planning thresholds (10 or 20 percent of natural recharge depending on location) for ground water withdrawals, total available water is estimated for each planning area. These estimates are shown in Table 3.1 and represent the amount of water potentially available from sources within the planning area. The column next to total available water, "Interbasin Transfer," represents that amount of water entering or leaving the planning area via interconnections between purveyors. Such transfers are shown as positive values for net transfers in and as negative values for net transfers out of the planning areas. As follows logically, the sum of all interbasin transfers is zero. The "Net Available Water" is the arithmetic sum for each planning area and for the State of the total available water plus the total interbasin transfer, which is found in the final column. Combining the safe yield of the State's surface waters and ground water, a considerable amount of water (1.8 billion gallons daily) is available to meet our current and future water supply needs (recognizing all of the caveats discussed above). As previously described, new reservoirs and the implementation of optimum water use schemes can increase this amount, while inefficient supply development can reduce the amount of available water.

J. Issues for Future Analysis/Strategic Recommendations

There are numerous technical and legal issues that should be addressed to ensure sufficient understanding and quantification of water availability.

1. Land Use Development Impacts on Water Availability

The manner in which development occurs, where water is diverted and the location of treated wastewater discharges are perhaps the most significant factors affecting water supply availability. Development results in modifications to the inflow/outflow components of the hydrologic cycle and changes in water quality of these components. Described below are issues related to development and its impact upon water supplies and strategic recommendations that will help balance continued development with optimization of the State's regional water supplies.

<u>a. Water Supply/Water Quality Planning Integration</u>

Issue: As previously indicated, more than half of the water used in the State is used depletively; over 700 MGD (approximately 10 percent of rainfall that does not evaporate) is not used a second time either in the watershed of origination or any other watershed. These 700 MGD are removed from the system through ocean/bay discharges of treated wastewater. As depletive use increases, net water availability decreases because opportunities for indirect re-use are lost. The net result is that the need to seek alternate water supplies will occur sooner. The Delaware River Basin Commission (DRBC) serves as an excellent example of an agency that defers the need to seek alternate water supplies through integrated water supply and wastewater planning and management. The DRBC makes a concerted effort to ensure that wastewater originating from in-basin water supplies is discharged within the freshwater portion of the Delaware River basin. As such, the construction of additional costly reservoirs to retard the saltwater front in the Delaware estuary can be delayed, as compared to a situation where the wastewater was allowed to be depletively exported out of the basin. The Passaic, Hackensack and Raritan rivers are New Jersey examples where if the existing wastewater discharges were transferred out of the respective basins, water availability would be reduced. Depletive use may lead to other undesirable effects. Stream flow depletion upstream of a reservoir caused by substantial ground water withdrawals can reduce the safe yield of the reservoir. Wastewater discharges can cause water quality degradation if upstream depletive uses result in reduced dilution. Saltwater intrusion in aquifers and estuaries, and degradation of freshwater-dependent resources, are other examples of the freshwater-reduction effects of significant depletive uses. Last, water availability can be greatly affected by numerous land use activities that can degrade water quality. When water availability is limited by substantial depletive uses, water quality is paramount. Combined, these effects can erode long-term water availability.

Recommendation: There is a growing need to collectively evaluate the numerous activities that affect water quality and quantity of the State's regional water supplies. It is recommended that a “total water resources management approach” be adopted that allows for a continuous "inventorying" and evaluation of the activities' cumulative impacts on water supplies so as to extend these supplies and preempt other undesirable effects (see Chapter 7).

This approach would require several steps. First, estimates of water availability must be better defined, especially that for ground water. A refinement of the Water Resources Assessment Methodology (found in Task 2 Report, Water Supply Baseline Data Development and Analyses, November 1992) used in this chapter will be needed. Many ground water models have been completed by USGS and NJGS, and should be maintained and integrated into new assessments.

Second, better quantification of the factors affecting water availability will be needed, regarding water quality, wastewater management and depletive uses.

The third step is combine these factors into the NJSWSP “Water Balance Model” through the application of appropriate water management policies, so that improved assessments of water availability will be possible, and so that water quality management planning can incorporate more appropriate protection of water supplies.

b. Impacts of Hydrologic Modifications on Water Availability

Issue: Changes to the natural landscape that accompany development are known to have relatively profound effects to the local flow paths of the hydrologic cycle and, hence, overall water availability. Urban/suburban development with its reduced vegetation and high proportion of impervious cover leads to increased runoff during storms and decreased baseflow during drought. This is especially significant in water supply watershed lands, though the large amounts of open space still existing in most such watersheds has limited the impact to date. A further reduction in stream baseflow can occur from "leaky" stormwater drainage or sewerage collection systems, which may be intercepting water in the shallow aquifer that would otherwise be providing stream baseflow during low flow conditions. These "bypasses" of the hydrologic cycle caused by development, in conjunction with depletive use activities discussed above, can stress water supplies during low precipitation periods.

Recommendation: Better information is needed regarding the impact of increased runoff rates and decreased ground water recharge on water availability, and the potential for reducing such impacts. Regional and local stormwater management programs offer potential in maintaining stream levels during drought. If carefully designed, these facilities could also serve as ground water recharge facilities, augmenting stream flow during low precipitation periods. Water quality impacts must be considered. Pollution source reduction programs will be needed and, perhaps, even pre-treatment. Regional stormwater management in developing watersheds upstream of intakes could potentially increase safe yield. In addition, the evaluation should address the impact of changes in ground cover on evapotranspiration. These opportunities will be explored as a component of the NJDEP’s watershed-based approach. A two-prong investigation will also be conducted to define the potential problem of leaking drainage/sewerage infrastructure and the potential of integrating stormwater and stream augmentation management programs. If found to be significant, appropriate programs will be initiated to correct the problem. Planning thresholds will be developed and incorporated into the watershed-based approach.

c. Impacts of Mode of Water Supply Development on Availability

Issue: This chapter illustrated the relationship of the mode of water supply development and the long-term availability of water. The mode (location, timing, and resource used) of water development determines the sustainability of the supply, especially that of ground water. Often, water supplies have been developed as close as possible to existing local demand with very little coordination with other local communities and without consideration of the collective impact upon the water supply. The next chapter projects that the region anticipated to gain the most population in the State is along the coast, which depends heavily on confined and unconfined aquifers that are vulnerable to saltwater intrusion. Thus, the location of future pumping centers along the coast will be crucial to maintaining the long-term availability of its water supply. Left unchecked, municipalities will develop their own individual water supplies, without a great deal of consideration of the cumulative impact of all who utilize the same resource. Piecemeal, short-term actions such as the above contribute to a reduced "active life" of the state's regional water supplies. Long-term regional planning is needed to extend water supplies and reduce the cost of turning to alternate supplies.

Recommendation: The NJDEP has initiated research projects with the USGS to determine methods to optimize unconfined and confined aquifer yields through the proper placement of wells. The results of this work should be integrated into regional water development plans conducted by all municipalities in the planning areas, which would collectively conduct long-term water supply studies.[5] The studies will determine the water supply that they would utilize in the future, with an emphasis on sustainability. Water use optimization and water quality protection programs will be major components of each study. Such studies should occur at least 30 years prior to when the planning areas are anticipated to reach deficit conditions. This approach would insure that as many options possible remain available for future use. These studies would nurture a coordinated, systematic regional approach to the development of future water supplies. The NJDEP will also continue research on means to optimally develop water supplies, especially ground water.

2. Environmental Constraints on Water Availability

Issue: Many ecosystems are water-dependent and fairly sensitive to changes in freshwater flow, especially during the warmer months when biological activity and water demand are at their highest level. While it can be assumed that depletive use affects the ecosystem, scientists are just beginning to learn about the effects. And, it is suspected that there may be synergistic impacts related to water quality degradation, which can be expected where there is significant development and depletive use. Sufficient knowledge to allow protective management is necessary.

Recommendation: The NJDEP has initiated research to determine the hydrologic/ecological impacts associated with reduced freshwater flow. This effort should continue. Research has begun with the hydrologic component by estimating losses in freshwater flow to streams, sensitive estuaries and to wetlands as a result of depletive diversions. Once completed, research will be initiated into "translating" these freshwater losses into ecosystem impacts. And, as stated above, the NJDEP is initiating cross-program policies to reduce future depletive uses. Once completed, ecological impacts will be incorporated into the planning thresholds for water availability, and the allocation process for local impacts, probably in the form of stream flow and wetlands maintenance requirements for the various stream classification watersheds (see Chapter 8, Section C). Mitigation measures would be needed in order to exceed the threshold. Since water quality degradation may cause similar or worse impacts on ecosystems, parallel thresholds will be developed.

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[5] Wherever possible, water supply planning of this nature should be integrated with more comprehensive watershed-based planning to ensure that the planning is mutually supportive and that anticipated water supplies will be protected from water quality degradation.

3. Planning Thresholds Versus "Ground-Tested" Thresholds

Issue: A major decision regarding ground water availability was the use of two "planning thresholds" for availability, rather than area-specific thresholds. In most planning areas, the NJDEP assumed that twenty percent of the total ground water recharge to that planning area is available for human use. In coastal zone regions, a ten percent value was used. The remaining water is assumed to be necessary for other purposes, such as to reduce the potential for saltwater intrusion, for streamflow maintenance and the protection of aquatic ecosystems. Use of thresholds as described above are reasonable for long-term regional planning, but several factors must be addressed prior to their use when a planning area is near or into deficit conditions. Among them are the most appropriate targets for "unacceptable impacts," which will affect decisions regarding withdrawal location and the depletive nature of the diversions. Refinement of the planning thresholds through verifiable ground-tested methodologies is a major requirement for better water supply planning. A linkage between estimates for ground water availability and the extent of surface water supply use will also be important; where both surface water and ground water are used extensively, the total available water may be less than anticipated.

Recommendation: The NJDEP is proposing that additional analysis of the various ground water studies be conducted to better define future planning thresholds and site-specific local impacts of individual withdrawals, with the intent of applying the same methodologies to other planning areas, or portions of planning areas. As noted above, the NJDEP is beginning research to ascertain the impact of depletive ground water withdrawals on stream baseflow and saltwater intrusion in estuaries and aquifers, as well as the means to avoid harmful effects. This research will help estimate ground water availability and plan optimal development schemes .

Watershed or multi-watershed models will also be required for areas with extensive ground water use or projected deficits, to define regional water availability. The more general research described above will be incorporated into these models. Once formalized, these upper limits of ground water availability will serve as the basis for reviewing regional supply development and initiation of comprehensive water supply investigations if deficits are forecast.

4. Refinement of Availability Estimates for Surface Water and Conjunctive Use Supplies

Issue: The Water Balance Model currently does not account for situations where water is moved upstream in a watershed, used, treated and released for recapture by the same water supply facility. It also does not account for situations where multiple sources of water are used to provide a combined safe yield in excess of that provided by the component supplies. Improvements are necessary to account for the increased water availability represented by these supplies. However, research will be required to quantify the exact increases provided. The relationship may not be fully proportional.

Recommendation: The NJDEP should require major systems that rely on conjunctive water supplies to quantify the total system dependable yield and how that differs from the component safe and dependable yield. The NJDEP should incorporate within all relevant water supply models the results of such studies and also the impacts of water cycling to upstream locations.

5. Updating the Water Availability Data

Issue: The water availability component of the Water Balance Model (WBM) must be updated periodically to ensure that water availability estimates are current and thorough.

Recommendation: The NJDEP should update water availability data at least once a year and incorporate the results into the WBM.

6. Impacts of Water Quality on Safe Yield

Issue: The passing flows mandated for surface water intakes are often not only established to maintain certain low flow levels but also to mitigate "undesirable effects" that were being experienced, often decades ago. Historically, the primary concerns were the maintenance of streamflow for downstream water users, and the dilution of sewage from treatment plants that often used primary treatment at best. Significant improvement has been made to sewage treatment plants over the last two decades and the water quality component of previously established safe yields may warrant a re-evaluation in order to determine if yield can be increased by reducing presently required passing flows as a result of improved water quality. It should be noted here that passing flow requirements have historically been reduced by the NJDEP during a declared drought.

Recommendation: Purveyors should be able to petition the NJDEP for revisions to their previously established safe yields based on the conditions described below. Under this policy, the petition process will only be available to those purveyors that are anticipated to experience demands that exceed yield within 10 years. For the remainder of purveyors, the established yield should be maintained as a safety factor against droughts that are worse than those previously recorded, current and future depletive uses affecting drought of record stream flow, presently unquantifiable ecological concerns, and potential water quality degradation upstream of the intake as a result of future development. Funded and conducted by the applicable purveyors, studies could be undertaken to determine if their safe yields can be increased due to water quality improvements. Studies should evaluate future (20-year) conditions in their analysis, including:
1) further improvement of water quality from point sources;
2) impact of non-point sources;
3) current and depletive impacts to stream flow during drought; and
4) ecological impacts as a result of reduced drought flow.

Where passing flow requirements were established by the Legislature, the studies performed may provide a substantive basis for modification of the original statute.

7. Monitoring and Water Availability

Issue: Chapter 5 presents estimates of which planning areas will be in water supply deficit during the planning period. Regional monitoring of special water supply concerns (e.g., saltwater intrusion in aquifers and estuaries, stream depletion, declines in ground water levels, etc.) will be needed to more definitively estimate water availability, and to help project when a deficit will actually occur and when alternative water supply studies will be needed, especially for potentially overdrafted aquifers. Monitoring is needed to evaluate trends, serve as an "early warning" system, as well as to serve as baseline data for potential optimization schemes and alternative supplies.

Recommendation: In order to ensure that there will be adequate water supplies for those purveyors withdrawing or otherwise using water from planning areas that are anticipated to be in deficit conditions, it is recommended that the users that depend on these water supplies for potable and other purposes be relied upon for future regional monitoring needs in an equitable manner (Feasibility studies can be developed using the Bond Fund and then repayed by affected purveyors where capital projects are also funded by the Bond Fund). Monitoring plans would be a component of the regional plans discussed above and would be implemented well prior to anticipated deficit.

CHAPTER FOUR

ESTIMATING AND PROJECTING DEMANDS FOR WATER

A. Overview of the Projection Methodology

The fundamental step undertaken in estimating and projecting water demands in the NJSWSP is to quantify the current water demands for each of the 23 planning areas in the State. These demands for the planning areas were then projected throughout the planning period (1990-2040) using population forecasts and water use assumptions based on existing studies and past experience.

The three primary activities used in this task are as follows:

Determine the 1990 population and project it to the year 2040, disaggregated to the county, planning area, municipal and purveyor service area level.

Determine the total current demands (purveyor supplied, self-supplied residential, self-supplied industrial, self-supplied agricultural).[6]

Estimate future demands for the same four user categories by using population projections, estimated changes in per capita consumption and projected industrial and agricultural growth .

A comparison of current and future demands to the net available water is made in Chapter 5 in order to establish the existing and future water supply surplus or deficit within each planning area.

B. Basic Elements of Water Demand Projections

The projection analysis takes into account many different facets in order to quantify water demand in New Jersey for the 50 year planning period. Each facet plays an important role in determining future demands for the State. Some of the facets that were analyzed are: past and present population growth patterns; availability of the current water supply; increasing or decreasing demand rates; employment, land use and land availability; and the amount of water distributed through service connections or transferred into or out of a planning area.

1. Population and Economic Projections

In order to quantify water demands to the year 2040, population projections at the state, county, and municipal levels were determined. The existing populations of each municipality in the State were obtained from the results of the 1990 census. These population estimates were then used along with statewide estimates to project current and future demands for all of the 567 municipalities of the State.

New Jersey is the nation's most densely populated State with a population of 7.7 million in 1990 that is expected to increase to 8.3 million by the year 2010. The Regional Plan Association has estimated that more land has been developed in New Jersey in the 30 years from 1960 to 1990 than in the previous 300 years. The changes in development and employment patterns which the State has experienced over the past several decades have had significant impacts upon water availability and water systems infrastructure and financing requirements. These impacts have been most severely felt in the heavily urbanized areas which have experienced out migration and a loss of the water-intensive manufacturing base resulting in idle water

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[6] The average demands over the years 1986 through 1988 were used to represent the current demand for the year 1990.

capacity and a declining revenue base. In contrast, the service sector and its workforce have been increasing in suburban New Jersey, resulting in a transfer of demands from urban to exurban areas. Available population projections suggest that this trend generally will continue.

2. Usage Rate Estimates and Projections

Verification of current statewide water demand is crucial to developing rational estimates of future demand in New Jersey. The current demand (1990) serves as the base for the projections through the year 2040. Current demand was based on the average reported withdrawals from 1986-1988 for water users of the State that utilized 100,000 gallons per day or greater, plus an estimated amount of 1990 self-supplied residential withdrawals. These years were chosen because of data availability (for both demand and depletive water use) and the years' representation of both dry and wet years with respect to precipitation.

Total demand is comprised of two major components: purveyor supplied and self-supplied demand. Each of these components is the aggregate of as many as six smaller components: Residential, Industrial, Commercial, Agricultural, Unaccounted Loss, and combined Residential, Industrial and Commercial (RIC). The following is a brief summary of these demand components:

Residential Demand - portion of the water supply used by people in and around their dwelling units. Residential demand includes both interior (toilets, showers, sinks, washing machines, dishwashers) and exterior (landscape irrigation, automobile washing, filling of swimming pools) uses. Actual residential demand is difficult to quantify because of the usage accounting system that many purveyors utilize, as described below, and the lack of metering for self-supplied residential use.

Industrial Demand - portion of the water supply used by industry. Industrial water demand typically includes employee potable and sanitary facilities supplies; contact and/or non-contact equipment cooling supplies for product development and energy production; product and process supplies; heating, ventilation and air conditioning systems supply; and interior and exterior facility maintenance supply.

Commercial Demand - portion of the water supply required for commercial facilities, including shopping malls, business offices, banks, restaurants, laundromats and service-related businesses. Some purveyors include apartment buildings as commercial users instead of including them within the residential component.

Agricultural Demand - portion of the water supply used for farm uses such as livestock and the irrigation of crops. Agricultural use represents a significant use where water is lost to evaporation and transpiration.

Unaccounted Loss - difference between the actual purveyor withdrawal amount recorded by the meter and the total amount of delivered water metered at user connections. Unaccounted for loss exists in every water system of the state, and generally represents approximately 10-30 percent of the total water demand. Causes for this loss of water can be leaks, illegal or unmetered withdrawals, fire flow, treatment plant use, standpipe overflows, reservoir evaporation, illegal connections, and inaccurate customer and master meters. Such losses will be negligible for most self-supplied users. Most purveyors are unable to accurately specify which of the above causes represents the greatest portion of unaccounted loss. The Water Supply Management Act rules allow for unaccounted water losses up to 15 percent of withdrawals. However, it can be very difficult to achieve this level, especially in the urban areas of the State which have an aging infrastructure. A potential statewide goal of the NJDEP would be to have unaccounted water losses decrease to 10 percent of withdrawals.

RIC - purveyor demand which was not segregated into its residential, industrial, and commercial components due to the limitations of available data. This combination of data poses a major problem in identifying usage among the various categories of users and opportunities for reducing usage, such as water conservation initiatives. RIC demand figures were used to develop average per capita usage rates for the purveyor supplied customer base within each municipality because data were not uniformly available from purveyors that specified the individual use components.

3. Unaccounted Loss for Water Estimates and Projections

The NJDEP's Water Supply Element monitors the unaccounted loss for all Class 2 (serving 10,001 to 50,000 people) and Class 3 (serving greater than 50,000 people) water purveyors in the state. Since not all relevant data were provided from all of the purveyors, a weighted average was calculated for Class 2 and Class 3 purveyors by county. This average was then applied to all municipalities in that county. Updates to the Water Balance Model in the future can include refinements to these estimates.

As previously mentioned, unaccounted loss constitutes between 10 to 30 percent of a water system's total average demand. Many distribution systems reported less than 5 percent unaccounted-for-water, but this may be the result of unidentified inaccuracies in the basic data or differences in definitions. For this analysis, any system reporting levels of unaccounted-for-water of 5 percent or less was assumed to have unaccounted-for-water of 10 percent. Specific information on this subject can be found in the consultant's Task 3 Report, referenced in Appendix D in the back of this document.

C. Selection of Projections for the NJSWSP

Rutgers University, Center for Urban Policy Research (CUPR), as a consultant to the New Jersey Office of State Planning, prepared population and employment forecasts of each municipality in New Jersey to the year 2010 using three different models. These municipal populations were then extrapolated to the year 2040 by NJDEP's consultant team; detailed information can be reviewed in their Task 3 Report (see Appendix D). The projections took into account employment, land use, land availability and land regulations.

The three models identified as "Trendfit", "Planfit", and "Prefit", are defined as follows:

Trendfit - Projected individual municipality population according to historic growth and their ability to accommodate additional growth assuming a continuation of existing development densities.

Planfit - Modified projections based on applying an interpretation of certain policies of New Jersey's State Development and Redevelopment Plan (SDRP), as they may affect densities of new development in centers and environs in the various planning areas.

Prefit - Projected individual municipality population according to historic growth patterns without specific evaluation of available land to accommodate growth. This population trend has evidenced a decentralization of population away from the cities to suburban and more towards rural locations.

The "Prefit" model has been selected for use by the NJDEP in this NJSWSP to project the population and subsequent water demands of the State. Table 4.1 shows the population and corresponding demands of the twenty-three planning areas in the State from 1990 to 2040 using the Prefit model. The NJDEP intends to develop new demand projections when updated population projections are prepared by the Office of State Planning and other State agencies and are incorporated into the SDRP through the cross-acceptance process.

To the extent that more growth takes place in existing urban areas and in older suburban and rural towns, projected water demand may increase as per capita water use rates are significantly higher in urban areas due to larger system leaks, unmetered connections, more industrial and commercial demands, etc.

TABLE 4.1 Comparison of Demands Using Prefit Population Projections *(Demand values are in million gallons per day-MGD)*

RWRPA Number and Name		1990 Population	2010 Prefit Population	2010 Prefit Demand	2040 Prefit Population	2040 Prefit Demand
1	Middle Delaware River	32,460	37,125	14.2	43,493	15.2
2	Flat Brook	1,799	2,772	0.2	4,018	0.3
3	Walkill/Pequest River	123,725	178,327	28.3	246,056	35.7
4	Upper Passaic Pompton/Ramapo River	689,841	703,627	98.5	729,360	109.1
5	Lower Passaic/Rahway River	1,896,000	1,785,662	355.5	1,687,100	343.1
6	Hackensack River	981,966	987,373	162.8	996,326	170.4
7	Pohatcong River	22,265	24,994	4.0	28,069	4.5
8	Musconetcong River	48,017	58,613	6.7	73,266	8.1
9	Trenton Delaware Tributaries	25,931	32,222	3.1	40,692	3.8
10	Raritan River	769,425	880,517	141.2	1,010,807	164.2
11	South River	321,709	388,690	98.4	469,733	116.7
12	Navesink/Swimming Rivers	400,432	384,565	62.4	362,583	61.6
13	Manasquan River	90,788	103,506	15.2	115,074	18.0
14	Rancocas Creek	563,255	625,401	120.1	692,446	135.4
15	Metedeconk River	135,923	157,138	19.0	187,533	25.6
16	Toms River	204,672	282,926	48.7	368,948	62.4
17	Camden Delaware Tributaries	668,518	701,538	128.1	746,722	142.0
18	Mullica River	220,304	247,041	157.9	284,422	160.7
19	Atlantic Coastal	81,491	131,583	18.1	203,530	27.2
20	Salem River	69,163	72,437	34.2	77,464	35.4
21	Maurice River	191,097	215,219	71.8	247,840	76.8
22	Great Egg Harbor River	96,318	126,820	26.4	158,424	30.3
23	Cape May Coastal	95,089	122,101	32.6	159,306	39.0
	TOTAL	**7,730,188**	**8,250,197**	**1,647.3**	**8,933,212**	**1,785.6**

Footnotes:
- *Prefit - Projected individual municipality population according to historic growth patterns without specific evaluation of available land to accomodate growth.*
- *Demand - Total average demand per RWRPA.*

However, the projections in urban areas may be skewed due to the lack of individual residential, commercial and industrial demand data, so that demand changes caused by population increases or decreases are over-amplified.

In determining the 1990 total demand for each planning area, the 1990 population of the area was divided into its respective categories (purveyor supplied and self-supplied) and multiplied by the planning area's demand rate (gpcd) to determine the combined RIC demand and average residential demand. Each planning area's demand rate for purveyor supplied demand varies. It was assumed that the self-supplied residential use was 75 gpcd statewide. Unaccounted loss was determined by taking a percentage of the combined RIC amount. These demand amounts were then added to the average self-supplied industrial and agricultural demands in the planning area.

Total average demand and peak demand were determined for four of the six components of demand (RIC, self-supplied residential, self-supplied industrial, and self-supplied agricultural). The total average demand is the sum of the purveyor average demand, self-supplied average demand, average industrial demand and average agricultural demand. The determination of the peak demand required the use of observed monthly peaking factors. This information was provided in the quarterly water reports which purveyors submit to the NJDEP's Bureau of Water Allocation.

As shown in summary Table 4.2, total current (1990) average demand for the State of New Jersey is calculated to be about 1,499 MGD. The purveyor supplied portion is about 1,089 MGD (72.7%). The self-supplied residential, industrial and agricultural portions are about 79 MGD (5.3%), 175 MGD (11.7%) and 154 MGD (10.3%), respectively. The total current peak water demand for the State of New Jersey was calculated to be about 2,329 MGD. The large, self-supplied industrial cooling demands are not included in Table 4.2 because they are typically run-of-the-river, power plant cooling demands. This type of large industrial cooling demand generally lacks an identified safe yield water supply source. Water is mostly withdrawn and returned at nearly the same point in the river, often resulting in only a small percentage of depletive use. However, some industries do indeed result in substantial consumptive (evaporative) loss and further evaluation is necessary. These large surface water demands and other relevant demand information are shown in the Task 3 Report, referenced in Appendix D.

The demand amount for each planning area is only that demand which is utilized within the basin's boundaries. This demand amount does not take into account ground or surface water which is diverted in a specific planning area, and transferred to another planning area. Such transfers may occur through various contracts between purveyors or through service connections. Transfer amounts are shown in Table 3.1 in Chapter 3 and evaluated in Chapter 5.

D. Estimates of Water Demands Through the Year 2040

The projection of future water demands was based on previous studies, population projections, purveyor usage rates, self-supplied residential usage rates, self-supplied industrial demand, and self-supplied agricultural demand. The following is a brief discussion of these concepts.

1. Purveyor Usage Rate

Current purveyor supplied usage rates were calculated for each municipality after current demand was determined. Previous water use studies performed throughout the United States have indicated that usage rates typically increase slowly over time to a maximum value which is rarely exceeded.

The water demand projections have assumed that per capita consumption will increase by 0.5 gallons per capita per day (gpcd) per year until a maximum of 150 gpcd is reached in each municipality. This increase

TABLE 4.2 *1990 Surface and Ground Water Demands*

(all values are in million gallons per day-MGD)

RWRPA Number	*RWRPA Name*	*1990 Planning Area Demand* Surface	Ground	Total
1	Middle Delaware River	0.0	13.6	13.6
2	Flat Brook	0.0	0.1	0.1
3	Walkill/Pequest River	5.5	16.8	22.3
4	Upper Passaic Pompton/Ramapo River	19.3	72.3	91.6
5	Lower Passaic/Rahway River	326.1	45.8	371.9
6	Hackensack River	147.7	7.2	154.9
7	Pohatcong River	0.9	2.7	3.6
8	Musconetcong River	1.8	4.0	5.8
9	Trenton Delaware Tributaries	0.4	2.1	2.5
10	Raritan River	63.4	54.2	117.7
11	South River	33.7	50.1	83.7
12	Navesink/Swimming Rivers	42.5	19.8	62.3
13	Manasquan River	1.9	10.8	12.8
14	Rancocas Creek	56.1	44.7	100.8
15	Metedeconk River	1.4	13.7	15.0
16	Toms River	10.0	28.1	38.2
17	Camden Delaware Tributaries	13.4	105.0	118.4
18	Mullica River	39.6	90.1	129.7
19	Atlantic Coastal	0.3	11.9	12.2
20	Salem River	16.7	14.2	30.9
21	Maurice River	2.2	60.3	62.5
22	Great Egg Harbor River	1.5	19.5	20.9
23	Cape May Coastal	3.1	24.6	27.7
	TOTAL	**787.6**	**711.5**	**1499.1**

Footnotes:
- *1990 Planning Area Demand - estimated water demand.*
- *1990 Surplus/Deficit - estimated amount of water available for future water supply.*
- *1990 Depletive Use - estimated amount of water withdrawn, used for supply, and disposed of where no longer available again for area in question.*

(Data based on years of record from 1986 to 1988)

is by municipality, such that as population grows in each municipality, the aggregate change in usage rate varies by planning area depending on the relative growth in population of the various municipalities that make up a planning area. The NJDEP recognizes that per capita use will not uniformly increase in this manner (and in fact has remained stable in some quickly growing areas), but uses this usage rate assumption to develop a demand projection that is more likely high than low. Further, the demand projections do not initially take new water conservation activities into account. **The net effect is to most likely overestimate water demands.** As a result, areas with no projected deficit are highly unlikely to experience deficits and areas with projected deficits may in reality experience lower deficits.

2. Self-Supplied Residential Demand

The current portion of each municipality's population that is self-supplied was determined by using residential water supply well data from the 1980 Census and combining that with the NJDEP's database of domestic wells installed and/or replaced from 1980-1990 and current purveyor flows. (Information from the 1990 Census will be used in later updates.) Based upon available prior studies and professional judgement, the following two basic assumptions were used to estimate self-supplied residential demand:

Self-supplied residential water usage is generally lower than purveyor supplied usage for several reasons, particularly rural well and septic system disposal field limitations. Demand is assumed to remain at a constant demand rate of 75 gpcd for the entire planning period (1990-2040).

It is assumed that the percentage of the municipal population which is served by self-supplied residential wells will remain constant throughout the study period.

3. Industrial Demand

The economic trend of the State shows a decline in manufacturing and heavy industry and an increase in commercial and professional business. Although total production has actually increased, water-intensive manufacturing has declined and major conservation gains have been achieved by industries in New Jersey to reduce drought exposure and wastewater discharges. Therefore, it is estimated that self-supplied industrial demand should remain constant to the year 2040. However, there have been preliminary discussions regarding the construction of several co-generation plants, with an approximate demand of 1-2 mgd per plant, in the State. If the plans for these plants are implemented, there would be a subsequent increase in the industrial water demand numbers. To combat the increase in demand, a viable option may be for various plants to implement wastewater reuse.

4. Agricultural Demand

Since irrigated agricultural acres are increasing while total agricultural acres are decreasing, it is reasonable to assume that the declining number of agricultural acres will eventually result in a decline in the annual increase of irrigated acres. Therefore, it is assumed that the self-supplied irrigation demand will increase at 2 percent per year through the year 2000, then increase at one percent per year through the year 2010, and then remain constant to the year 2040.

E. Reliability Factors Related to the Projections

Estimated future populations and their consequent water supply needs are just that -- estimates. The development of projections is not an exact science, especially in a complex State like New Jersey. There are many factors that influence future populations and water demand, including: demographic, economic, sociopolitical, climatic and technological.

1. Demographics

Of the demographic factors, population has the most influence on water demand. The influx of people into an area not only increases the residential component of water demand, but also increases the industrial and commercial components as a result of the increased labor force and the need to provide goods and services to the increased population. Other demographic factors addressed indirectly by using the CUPR projections as the base for the population projections include: housing density, type of housing, household size, and irrigated land (lawn) area.

It must be realized that projections are generally less reliable as time passes. As mentioned before, population trends may change at any time during the 50 year planning period. Table 4.3 shows how the State's population has changed from past statewide studies (1955 Tippetts-Abbett-McCarthy-Stratton (TAMS) Study and the 1982 Plan) to this NJSWSP in the last 40 years. As such, a periodic monitoring initiative must be undertaken in each of the 23 planning areas of the state. This monitoring of a planning area will allow for more accurate conclusions to be drawn at a certain point in time. A careful accounting of present and future population is crucial to the precise development of water demands in New Jersey.

2. Economics

This factor is an important element in how much a region grows and where this growth occurs and is built into CUPR projections. A strong economy, which New Jersey enjoys over the long-term, is usually accompanied by more than average growth. However, much of New Jersey's growth is anticipated to be in the suburbs where, as previously discussed, this type of development can have harmful effects on the State's water supplies unless this growth is well planned from a regional water supply perspective and safeguards are implemented. This trend poses a potential conflict; while many would aspire to take residence in New Jersey's suburbs, unplanned development that impairs water supplies can give the impression of an undesirable quality of life, thus reducing the desirability of the suburbs.

3. Sociopolitical

Perhaps the greatest sociopolitical influence of future growth and consequent water demand would be the implementation of the State Development and Redevelopment Plan (SDRP). As alluded to earlier, the SDRP seeks to influence the patterns of future development. The implementation of the SDRP could alter the demand projections for various planning areas in the NJSWSP due to the change in predicted growth areas. This growth may cause an increase in water demand for existing water companies and also spur the development of small water companies and major interbasin transmission lines.

4. Climatic

Global warming theoretically could, in the decades or centuries to come, affect both water availability and demand. Warming might raise sea level and cause saltwater intrusion into the state's estuaries and aquifers. Extended warmer temperatures would substantially increase demand. It is, however, too early to formally act on this issue until debate over the theory evolves to consensus.

TABLE 4.3 *Comparison of Population Projections from the 1955 TAMS Study, The 1982 NJSWSMP and 1995 NJSWSP*

County	1990 Population			2000 Population			2010 Population		
	1955	1982	1995	1955	1982	1995	1955	1982	1995
Atlantic	180,000	307,200	224,300	190,000	311,900	238,600	n/a	n/a	253,000
Bergen	1,070,000	923,900	825,400	1,140,000	980,000	814,100	n/a	n/a	811,700
Burlington	310,000	380,000	395,100	340,000	460,900	412,500	n/a	n/a	433,100
Camden	480,000	579,100	502,800	510,000	629,600	516,900	n/a	n/a	536,900
Cape May	70,000	120,000	95,100	70,000	120,000	107,500	n/a	n/a	122,100
Cumberland	140,000	159,400	138,100	150,000	172,600	144,400	n/a	n/a	154,400
Essex	1,140,000	881,600	778,200	1,150,000	881,600	713,800	n/a	n/a	667,300
Gloucester	210,000	247,300	230,100	220,000	277,000	247,600	n/a	n/a	270,400
Hudson	630,000	597,100	553,100	620,000	610,000	563,300	n/a	n/a	575,100
Hunterdon	60,000	95,900	107,800	60,000	107,700	120,900	n/a	n/a	137,700
Mercer	370,000	380,000	325,800	390,000	410,400	340,200	n/a	n/a	363,300
Middlesex	570,000	730,000	671,800	620,000	820,000	702,100	n/a	n/a	753,300
Monmouth	400,000	568,600	553,100	430,000	620,000	560,200	n/a	n/a	568,500
Morris`	340,000	470,000	421,400	370,000	520,000	427,900	n/a	n/a	435,100
Ocean	150,000	483,300	433,200	170,000	487,700	509,900	n/a	n/a	583,800
Passaic	500,000	488,000	453,100	530,000	520,000	460,000	n/a	n/a	476,100
Salem	90,000	66,400	65,300	90,000	72,100	64,300	n/a	n/a	64,400
Somerset	220,000	249,500	240,300	240,000	280,000	259,600	n/a	n/a	283,500
Sussex	50,000	150,500	130,900	50,000	164,300	161,200	n/a	n/a	191,300
Union	650,000	520,500	493,800	690,000	520,500	478,700	n/a	n/a	464,500
Warren	70,000	93,900	91,600	70,000	100,100	97,300	n/a	n/a	104,600
Totals	**7,700,000**	**8,492,200**	**7,730,300**	**8,100,000**	**9,066,400**	**7,941,000**	**n/a**	**n/a**	**8,250,100**

Note:
All of the county population numbers for this table were rounded to the nearest hundred, therefore, the totals from this table may be somewhat different than Table 4.1.

5. Technological

Advances in technology could also potentially affect supply and demand. Desalination continues to become less expensive and is seriously being considered in Cape May County. Much progress is being made in the treatment of contaminants, possibly increasing water supply. Computer technology allows a better understanding of aquifers and surface water supplies which, in turn, allows for the development of water optimization schemes that can extend regional supplies. On the demand side, improved technology has significantly reduced water demand for power generation, manufacturing, irrigation and other uses such as residential plumbing devices. Low flow shower heads, toilets and more efficient appliances have all contributed to a stabilization or decline in per customer consumption where they have been fully implemented.

F. Issues for Future Analysis/Strategic Recommendations

The ability to project increases in population and consequent demands for water is most dependent on the available data base and knowledge of where future development will occur. Several issues have been raised in Chapter 4; below are recommendations to resolve those issues.

1. Adequacy of Water Use Data Base

Issue: The NJDEP needs to obtain more comprehensive water use data so that it can ascertain the nature of water usage problems and make better informed decisions on water use. Major deficiencies are lack of separated water use information for commercial, industrial and per capita residential and unaccounted water. The depletive or consumptive nature of water usage needs to be determined better.

Recommendation: The NJDEP should revise its regulations that deal with water use reporting in order to obtain more comprehensive data. Clear and uniform definitions should be implemented. The universe of purveyors and major water users needs to be expanded with respect to usage reporting. The NJSWSP projections may be adjusted accordingly in a revision if a more accurate reporting of water use shows an increase or decrease in per capita demand which would affect future demand in any of the State's planning areas.

2. Need for a Demand/Availability Data Base

Issue: The planning area and watersheds should serve as the basis for future water supply decisions. A comprehensive demand versus water supply availability data base has been developed for all the planning areas and the water supply concerns of the planning areas. Local government and major water users must be aware of the data base so that decisions at that level could consider these regional concerns. Further refinements to improve the probable accuracy and defensibility of projections and allow for sub-regional projections should be made by the NJDEP.

Recommendation: The NJDEP will improve the Water Balance Model data base to achieve these needs and actively coordinate with affected water users. Planning areas which are projected to be in deficit will receive first priority. The data base will be a component of the watershed-based approach that the NJDEP has recently initiated. It is envisioned that the NJDEP will develop a guidance manual for local decision-makers that suggests optimum strategies and techniques that can be used to develop and protect water supplies, based on local/regional considerations. The data base would be a component of the manual.

The NJDEP will work with the Office of State Planning and the Department of Community Affairs regarding the data base and how it could potentially be used to implement the water supply provisions of the

Municipal Land Use Law. This statute requires that proposed subdivision approvals consider the adequacy of the existing water supply. Although water supply follows development, the planning process should anticipate water supply needs so that the sustainability of various water supply resources can be prolonged.

The development of additional supplies in areas served by large investor-owned or large municipally owned water systems is generally not a problem. The problem lies with the areas of the State which are served by small water companies or small municipal water systems that do not focus on how their decisions regarding water/wastewater affect the entire watershed. The data base can perhaps be utilized for this purpose. Refinements and updates of the water demand projections will be linked with updates of the water availability estimates as described in Chapter 3.

3. Adoption of Policies Consistent with the SDRP

Issue: Population projections and consequent water demands will continue to be only estimates throughout the State in the absence of pre-determinations of where development will occur, and the nature (density) of that development. Development will continue to occur in a piecemeal fashion, to the detriment of long-term water supply availability.

Recommendation: The NJDEP should continue its work with the State Planning Commission and the Office of State Planning to develop methods by which existing and proposed water laws may support implementation of the formally adopted SDRP through coordination with the NJSWSP to implement the most appropriate methods. The formulation of policies to reinforce the SDRP or the proposal of various alternatives should be initiated to encourage development patterns consistent with the SDRP. This process would help ensure the orderly development and protection of the State's regional water supplies. In turn, future updates of the SDRP should give consideration to the NJSWSP in determining the areas of New Jersey most able to sustain cost-effective future growth in light of regional water supply constraints.

CHAPTER FIVE

COMPARING WATER AVAILABILITY AND DEMANDS

A. Overview of the Water Balance Model

As part of the overall water supply planning analysis undertaken in this NJSWSP, water supplies and demands were developed and compared using a computerized database/water balance model (WBM) for New Jersey.[7]

Rational water-related decisions should be based on knowledge of the amount of water available for a given ground and surface water system. One of the major objectives for this plan was to quantify the amount of water available and describe its characteristics for each of the 23 planning areas in New Jersey. Surface and ground water supply was quantified and characterized for each major river basin and placed in the WBM, as described in Chapter 3. A second, linked data base was compiled showing current and projected water demand for each planning area, as described in Chapter 4. This chapter describes the method by which supply and demand data bases were combined to determine the water supply surplus/deficit for each planning area over the 50 year planning period from 1990 to 2040, and the results of the deficit analysis.

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[7]The WBM was developed using MS-DOS compatible Lotus 1-2-3 release 3.1 computer software.

This combined data base completes the WBM for the State. The WBM is utilized to evaluate potential management initiatives and capital projects to address current and projected deficits.

The WBM was developed so that it can be routinely updated and refined as data on water availability, water demand, water and wastewater interbasin transfers and population projections change. The WBM can also serve as a useful tool in the evaluation and implementation of specific water supply actions identified in this NJSWSP and can also aid in more intensive future water supply planning. As specific alternatives are put into effect and projected data are replaced by actual data, the WBM can be used to evaluate project success and future water supply alternatives.

The WBM can be utilized as a planning tool and technique in a number of ways. For example, the WBM can determine if and when a planning area is in deficit. The WBM shows the net available water after interbasin transfers. These data are used to calculate if and when a planning area will be in deficit or surplus in the planning period from 1990 to 2040.

In addition, the depletive nature of water withdrawals and discharges in the planning area can be determined by referring to the WBM. This depletive water use information can be used as an indicator of water supply stress in the planning area. As an example, a planning area which is experiencing a deficit and also has a high percentage of depletive use may be able to lessen or even eliminate the deficit by changing the way the water in the planning area is discharged.

The numbers generated for the WBM are used only for planning purposes as indicators of potential problems in the various planning areas throughout the State. These estimates are not the result of an exact science, and therefore, should not be utilized as a definitive accounting of water availability and demand.

B. Regional Comparisons of Water Availability and Demands

1. Major Surface and Ground Water Sources

The existing major surface and ground water supply sources in New Jersey are listed in Table 5.1. The table shows these sources in order by planning area, with additional information for comparison purposes listing the relevant county(ies) and percent of the county located within the associated planning area.

2. Regional Comparisons

Chapter 3 estimated water availability. Surface water safe yield and ground water planning thresholds are illustrated in Table 3.1. After purveyor transfers are considered, net available water has been estimated. Theoretically, this is the amount of water available for each planning area. The 1990 water demands and projected water demands for the years 2010 and 2040 are compared to the net available water in Table 5.2. Differences were calculated and used to indicate the status of the water supply in each planning area. Table 5.2 also provides the 1990, 2010 and 2040 water balance summary for each of the 23 planning areas after projected demand has been subtracted from net available water. Below are the explanations of the headings utilized in Table 5.2. All terms are in million gallons per day (MGD).

Total Recharge - the estimated long-term, average recharge to the planning area's aquifers. Chapter 3 summarized the methodology by which these values were derived.

Available Ground Water - the estimated portion of total ground water recharge considered available for water supply purposes based upon the planning thresholds. Chapter 3 summarizes how these values were estimated.

TABLE 5.1

MAJOR WATER SUPPLY SOURCES BY RWRPA

RWRPA NUMBER	MAJOR SURFACE AND GROUND WATER SOURCES UTILIZED	% OF COUNTY IN RWRPA	COUNTY NAME
1	* Domestic wells - variety of aquifer systems	24	Warren
		9	Sussex
2	* Domestic wells - variety of aquifer systems	12	Sussex
3	* Domestic wells - variety of aquifer systems	68	Sussex
	* Wanaque, Monksville, Boonton, Oradell and	47	Warren
	Canoe Brook Reservoir Systems	4	Passaic
	* Pequannock Watershed		
4	* Domestic wells - variety of aquifer systems	76	Passaic
	* Wanaque, Monksville, Boonton, Oradell and	66	Morris
	Canoe Brook Reservoir Systems	36	Essex
	* Pequannock Watershed	16	Bergen
	* Brunswick formation wells	12	Somerset
	* Stratified Drift wells	11	Union
	* Buried Valley Aquifer wells	4	Sussex
	* Kittatinny formation wells		
	* Franklin formation wells		
5	* Wanaque, Monksville, Boonton, Oradell and	76	Union
	Canoe Brook Reservoir Systems	64	Essex
	* Pequannock Watershed	47	Hudson
	* Brunswick formation wells	31	Bergen
	* Stratified Drift wells	20	Passaic
	* Potomac-Raritan-Magothy formation wells	12	Middlesex
	* Stockton formation wells		
6	* Wanaque, Monksville, Boonton, Oradell and	53	Bergen
	Canoe Brook Reservoir Systems	53	Hudson
	* Pequannock Watershed		
7	* Domestic wells - variety of aquifer systems	16	Warren
8	* Domestic wells - variety of aquifer systems	13	Warren
	* Buried Valley Aquifer wells	9	Morris
	* Kittatinny formation wells	7	Sussex
	* Franklin formation wells	6	Hunterdon
9	* Domestic wells - variety of aquifer systems	33	Hunterdon
	* Delaware River	15	Mercer
	* Raritan River Basin		

RWRPA NUMBER	MAJOR SURFACE AND GROUND WATER SOURCES UTILIZED	% OF COUNTY IN RWRPA	COUNTY NAME
10	* Domestic wells - variety of aquifer systems	88	Somerset
	* Brunswick formation wells	61	Hunterdon
	* Potomac-Raritan-Magothy formation wells	46	Middlesex
	* Stockton formation wells	40	Mercer
	* Buried Valley Aquifer wells	25	Morris
	* Kittatinny formation wells	13	Union
	* Franklin formation wells	4	Monmouth
	* Spruce Run/Round Valley		
	* Delaware & Raritan Canal		
	* Delaware River		
	* Raritan River Basin		
11	* Domestic wells - variety of aquifer systems	37	Middlesex
	* Brunswick formation wells	12	Monmouth
	* Potomac-Raritan-Magothy formation wells		
	* Stockton formation wells		
	* Glendola, Swimming River and Manasquan Reservoir Systems		
12	* Domestic wells - variety of aquifer systems	48	Monmouth
	* Brunswick formation wells	5	Middlesex
	* Potomac-Raritan-Magothy formation wells		
	* Stockton formation wells		
	* Glendola, Swimming River and Manasquan Reservoir Systems		
13	* Domestic wells - variety of aquifer systems	16	Monmouth
	* Glendola, Swimming River and Manasquan Reservoir Systems	1	Ocean
14	* Domestic wells - variety of aquifer systems	55	Burlington
	* Potomac-Raritan-Magothy formation wells	45	Mercer
	* Delaware River	13	Monmouth
	* Raritan River Basin	10	Ocean
	* Wenonah-Mt. Laurel formation wells	2	Camden
	* Englishtown formation wells		
	* Cohansey formation wells		
	* Kirkwood formation wells		
15	* Domestic wells - variety of aquifer systems	13	Ocean
	* Potomac-Raritan-Magothy formation wells	6	Monmouth
	* Glendola, Swimming River and Manasquan Reservoir Systems		
	* Englishtown formation wells		
	* Cohansey formation wells		
	* Kirkwood formation wells		

RWRPA NUMBER	MAJOR SURFACE AND GROUND WATER SOURCES UTILIZED	% OF COUNTY IN RWRPA	COUNTY NAME
16	* Potomac-Raritan-Magothy formation wells	28	Ocean
	* Englishtown formation wells	1	Monmouth
	* Cohansey formation wells		
	* Kirkwood formation wells		
17	* Potomac-Raritan-Magothy formation wells	52	Camden
	* Wenonah-Mt. Laurel formation wells	39	Gloucester
	* Englishtown formation wells	6	Burlington
	* Cohansey formation wells		
18	* Potomac-Raritan-Magothy formation wells	52	Atlantic
	* Wenonah-Mt. Laurel formation wells	39	Burlington
	* Englishtown formation wells	28	Camden
	* Cohansey formation wells	4	Cape May
	* Kirkwood formation wells	2	Ocean
19	* Potomac-Raritan-Magothy formation wells	46	Ocean
	* Englishtown formation wells		
	* Cohansey formation wells		
	* Kirkwood formation wells		
20	* Potomac-Raritan-Magothy formation wells	77	Salem
	* Wenonah-Mt. Laurel formation wells	22	Gloucester
	* Englishtown formation wells	5	Cumberland
	* Cohansey formation wells		
	* Kirkwood formation wells		
21	* Potomac-Raritan-Magothy formation wells	87	Cumberland
	* Wenonah-Mt. Laurel formation wells	23	Salem
	* Englishtown formation wells	22	Gloucester
	* Cohansey formation wells	2	Atlantic
	* Kirkwood formation wells		
22	* Potomac-Raritan-Magothy formation wells	41	Atlantic
	* Wenonah-Mt. Laurel formation wells	18	Camden
	* Englishtown formation wells	17	Gloucester
	* Cohansey formation wells		
	* Kirkwood formation wells		
23	* Cohansey formation wells	96	Cape May
	* Kirkwood formation wells	8	Cumberland
	* Holly Beach formation wells	5	Atlantic

TABLE 5.2

NEW JERSEY STATEWIDE WATER SUPPLY PLAN

(ALL VALUES ARE IN MILLION GALLONS PER DAY -MGD)

RWRPA NUMBER	RWRPA NAME	TOTAL RECHARGE	AVAILABLE GROUND WATER	SURFACE WATER YIELDS	TOTAL AVAILABLE WATER	INTERBASIN TRANSFER (-)OUT (+)IN	NET AVAILABLE WATER	1990 PLANNING AREA DEMAND			1990 (+)SURPLUS (-)DEFICIT	2010 TOTAL DEMAND	2010 (+)SURPLUS (-)DEFICIT	2040 TOTAL DEMAND	2040 (+)SURPLUS (-)DEFICIT	1990 DEPLETIVE USE	
								SURFACE	GROUND	TOTAL						SURFACE	GROUND
1	Middle Delaware River	100.3	20.1	0.0	20.1	-1.1	19.0	0.0	13.6	13.6	5.4	14.2	4.8	15.2	3.8	0.1	0.2
2	Flat Brook	50.5	10.1	0.0	10.1	0.0	10.1	0.0	0.1	0.1	10.0	0.2	9.9	0.3	9.8	0.0	0.0
3	Walkill/Pequest River	430.7	86.1	2.4	88.5	2.8	91.3	5.5	16.8	22.3	69.0	28.3	63.0	35.7	55.6	0.1	1.8
4	Upper Passaic Pompton/Ramapo Rivers	471.0	94.3	406.2	500.5	-281.0	219.5	19.3	72.3	91.6	127.9	98.5	121.0	109.1	110.4	249.9	20.2
5	Lower Passaic/Rahway Rivers	235.8	47.2	8.9	56.1	306.8	362.9	326.1	45.8	371.9	-9.0	355.5	7.4	343.1	19.8	17.0	22.7
6	Hackensack River	108.7	21.7	74.0	95.7	51.2	146.9	147.7	7.2	154.9	-7.9	162.8	-15.8	170.4	-23.5	2.6	0.1
7	Pohatcong River	48.9	9.8	0.0	9.8	0.9	10.7	0.9	2.7	3.6	7.1	4.0	6.7	4.5	6.2	0.0	0.3
8	Musconetcong River	134.1	26.8	0.0	26.8	1.8	28.6	1.8	4.0	5.8	22.8	6.7	21.9	8.1	20.5	0.0	1.8
9	Trenton Delaware Tributaries	87.6	17.6	66.0	83.6	-66.7	16.9	0.4	2.1	2.5	14.4	3.1	13.8	3.8	13.1	0.0	0.1
10	Raritan River	554.0	110.5	160.0	270.5	-57.3	213.2	63.4	54.2	117.7	95.5	141.2	71.9	164.2	49.0	133.6	24.6
11	South River	124.3	24.7	8.0	32.7	23.8	56.5	33.7	50.1	83.7	-27.2	98.4	-41.9	116.7	-60.3	0.8	34.0
12	Navesink/Swimming Rivers	185.3	31.6	32.6	64.2	11.6	75.8	42.5	19.8	62.3	13.5	62.4	13.4	61.6	14.2	29.6	20.4
13	Manasquan River	73.7	9.1	30.0	39.1	-13.0	26.1	1.9	10.8	12.8	13.3	15.2	10.9	18.0	8.1	0.2	6.8
14	Rancocas Creek	539.8	82.6	52.2	134.8	1.5	136.3	56.1	44.7	100.8	35.5	120.1	16.3	135.4	0.9	9.7	2.9
15	Metedeconk River	111.3	11.2	0.0	11.2	0.2	11.4	1.4	13.7	15.0	-3.6	19.0	-7.6	25.6	-14.2	1.2	13.9
16	Toms River	200.0	20.0	0.0	20.0	1.9	21.9	10.0	28.1	38.2	-16.2	48.7	-26.8	62.4	-40.4	7.9	15.4
17	Camden Delaware Tributaries	217.0	36.8	0.0	36.8	11.7	48.5	13.4	105.0	118.4	-69.8	128.1	-79.6	142.0	-93.5	0.4	2.8
18	Mullica River	634.5	63.5	9.3	72.8	1.1	73.9	39.6	90.1	129.7	-55.8	157.9	-84.0	160.7	-86.8	20.9	49.1
19	Atlantic Coastal	249.6	25.0	0.0	25.0	0.3	25.3	0.3	11.9	12.2	13.1	18.1	7.2	27.2	-1.9	0.0	7.6
20	Salem River	296.2	40.3	3.0	43.3	0.0	43.3	16.7	14.2	30.9	12.4	34.2	9.1	35.4	7.9	12.8	9.9
21	Maurice River	540.4	54.0	0.0	54.0	0.0	54.0	2.2	60.3	62.5	-8.5	71.8	-17.8	76.8	-22.8	1.1	10.3
22	Great Egg Harbor River	311.4	31.1	0.0	31.1	0.6	31.7	1.5	19.5	20.9	10.8	26.4	5.3	30.3	1.4	0.4	3.9
23	Cape May Coastal	289.8	29.0	0.0	29.0	2.8	31.8	3.1	24.6	27.7	4.1	32.6	-0.8	39.0	-7.2	0.2	10.9
	TOTAL	5994.9	903.1	852.6	1755.7	-0.0	1755.7	787.6	711.5	1499.1	256.6	1647.3	108.4	1785.6	-29.9	488.5	259.6

FOOTNOTES:

Total Recharge - estimated long-term, average recharge to aquifers.
Available Ground Water - estimated percentage (10%-20%) of total ground water recharge available for water supply below planning threshold.
Surface Water Yields - amount surface water continuously available throughout a repetition of drought of record.
Total Available Water - sum of available ground water and surface water yields.
Interbasin Transfer - 1990 net amount of water entering or leaving planning area through purveyor interconnections.
Net Available Water - sum of total available water plus/minus interbasin transfers.
1990 Planning Area Demand - estimated water demand; 2010 and 2040 total demand follow two and four columns to the right.
1990 Surplus/Deficit - estimated amount of water available for future water supply; 2010 and 2040 surplus/deficit follow two and four columns to the right.
1990 Depletive Use - estimated amount of water withdrawn, used for supply, and disposed of where no longer available again for area in question.

(Data based on years of record from 1986 to 1988)

Surface Water Yields - the amount of surface water continuously available from a reservoir or other source throughout a repetition of drought of record (i.e., safe yields). If no value is given, the planning area does not have a storage facility or supplemental surface water supply source.

Total Available Water - total of "available ground water" and "surface water yields."

Interbasin Transfer - the 1990 net amount of water entering or leaving the planning area through purveyor interconnections. A negative sign implies a net loss; conversely, a positive sign implies a net gain. These amounts were held constant throughout the planning period, although in several cases there are existing contracts for higher levels of interbasin transfers.

Net Available Water - "total available water" plus or minus interbasin transfers. This is the theoretical amount of water available in the planning area to meet demands within or outside the planning area.

1990 Planning Area Demand - the estimated total average surface and ground water demand, individually and combined, in the planning area for the year 1990. Projected year **2010** and **2040 Total Demand** follow two and four columns to the right. Future demand is not shown as either surface or ground water since the selected source is unknown at this time. However, it can be assumed that existing surface water sources will remain for use through the planning period.

1990 Surplus/Deficit - the estimated amount of water available in the planning area for future water supply. Determined by subtracting 1990 Planning Area Demand from Net Available Water. An implied positive sign in front of the amount indicates that the planning area <u>may</u> possess surplus supplies for future use, while a negative sign <u>may</u> mean that the area is experiencing a water supply deficit. Projected year **2010** and **2040 Surplus/Deficit** follow two and four columns to the right. These amounts were arrived at by subtracting 2010 and 2040 Total Demand from Net Available Water, respectively.

1990 Depletive Use - the amount of water that is withdrawn from both the surface water (that have safe yields) and ground water resources of a planning area, used for water supply, and disposed of such that it can no longer be used again in that planning area. Depletive use is included in the table in order to determine if this type of water usage may be stressing a planning area's water supplies. While withdrawals that are depletive to one planning area could be discharged as treated wastewater in another planning area, the WBM is not currently configured to add such discharges to "net available water" but will be in future updates.

C. Data Interpretation

The values shown in Table 5.2 are not absolute. Rather, the table is one of the tools used in the screening of potential water supply problem areas. As previously indicated, other factors must be considered when evaluating regional water supplies, including the relative location of demands and supplies and the accessibility to supplies, the intensity and location of water supply withdrawals that may reduce water availability below the theoretical maximum levels, contractual obligations between purveyors and customers (bulk or retail) that may reserve available water to uses that are not currently drawing their full allocation, and regulatory requirements.

1. Masking of Intra-Planning Area Variability

The analysis for water availability and demand was watershed-based. The 23 planning areas (previously explained in Chapter 2) were used to evaluate the water supply situation in New Jersey. However, due to the scale at which the data were analyzed and the nature of the regional methodology used to assess water supplies, localized problems within the planning area may not be reflected in this analysis.

Concerns that need to be addressed through a more rigorous sub-regional analysis in some planning areas are related to streamflow depletion upstream of surface water intakes or passing flow gauging stations, numerous and densely located wells that individually pump less than 100,000 gallons per day, reduced dilution where sewage treatment plants discharge, local and intra-planning area water quality, localized variations in aquifer yields, and negative impacts to freshwater-dependent ecosystems. This level of analysis should occur either through local or purveyor initiative or as part of a broader watershed-based management effort.

Water quality is a consideration in assessing water supply availability in a planning area. Table 5.2 may show relatively large quantities of potentially available ground water, but significant portions of it may not be consumable without water treatment methods because of existing contamination, localized saltwater intrusion, etc. Lastly, the values represent ground water developed under optimum conditions. The locations for these optimum conditions may not be available due to development, environmental and regulatory restraints, land ownership, etc. For instance, much of the coastal planning areas appear to have substantial quantities of potentially available ground water. However, statutory and policy limitations on the use and exportation of water from the Pinelands National Reserve could reduce available water below the estimates shown.

2. Ground Water vs. Surface Water Deficits

Surface water development, interconnection and hydrologic study projects implemented as a result of the 1982 Plan have successfully addressed water supply needs in several key areas of the State for the near future. As compared to the water demand projections in the 1982 Plan, this 1995 NJSWSP's forecast is for a considerably smaller increase in needs over the next 30 years. For example, the 1982 Plan forecast statewide total purveyor water demands of approximately 1.28 billion gallons a day for the year 2005. The water demand projections developed as part of this NJSWSP indicate that this same quantity of water will not be required until 2040. Where water supply is based primarily on surface water sources, demands will be adequately served by existing surface water supplies well into the next century, assuming that current contracted water rights are used or there is ability to modify contracted transfers. Surface water safe yields are relatively well known and therefore there is considerable confidence regarding the availability of such supplies.

However, portions of the State served by ground water supplies in some cases will require additional, alternative or enhanced sources of water to meet existing or projected deficits. The ground water data are less certain than the surface water data. Where ground water is the primary source of water supply, much greater caution should be used in applying the data to policy decisions.

3. Masking of Inter-Planning Area Effects

Water supply source locations, wastewater treatment plant discharge locations and transfers of water between planning areas play an important role in water supply planning and inter-planning area effects on a region. For these reasons, it is important that planning areas be analyzed collectively, as well as individually, as in the case of planning areas 4, 5 and 6 (north-central and northeast New Jersey) and planning areas 10 and 11 (Raritan and South River watersheds).

For example, water supply wells located on the border of one planning area could indirectly be "pirating" water from the adjoining area through the shallow or confined aquifer system or surface water system. This scenario would have a negative impact on water supply for one planning area and a positive contribution to water supply in the other. Only a combined planning area analysis would show this particular masking of a water supply problem.

Another example of masking of inter-planning area effects on deep, confined aquifers is the scenario of a few water supply wells located near the saltfront tapping water for an area such as the South River planning area. It is not only the pumping of wells in this planning area that are causing saltwater intrusion (although they may accelerate it due to their close proximity); rather, pumping in at least five other neighboring planning areas could be cumulatively affecting the South River planning area. This would not necessarily show up as a water supply problem in the planning area by the literal interpretation of Table 5.1.

A third example of masking of inter-planning area effects deals with depletive water uses in one planning area which are then transferred to another, creating a surplus of water for one and possibly a deficit of water for the other. Here again, only a combined analysis would show this particular masking issue.

4. Implications of Depletive Water Uses

Depletive Water Use, as defined and discussed in Chapter 3, is the amount of surface or ground water withdrawn from a planning area, used for water supply and disposed of in a way that it can no longer be used again in that particular area. Depletive water use represent a new, artificial flow path of the hydrologic cycle.

From a regulatory perspective, base flow reductions to streams and lakes, the amount of water available to wetlands, and the amount of freshwater necessary to retard the movement of the saltwater front serve as the limiting criteria for managing New Jersey's water resources. The larger the depletive water use, the greater the potential for negative impacts to these resources as a result of reduced water flow through the natural water systems. This phenomena must be considered when evaluating the data in Table 5.2.

Table 5.2 illustrates that the planning areas characterized with the largest percentages of total depletive water use are the Metedeconk, Navesink/Swimming River, South River, Toms River, Atlantic Coastal, Manasquan and Raritan. Caution must be exercised when interpreting Table 5.2 since there are various factors that can mask the impacts, or non-impacts, of depletive water use.

First, depletive water use has to be compared to overall water availability of the source; the percentage of depletive water use could be high when compared to the diversion(s), but if the diversion(s) represents a small percentage of the source availability there may be no problem. Second, the location of the depletive water use may be a critical factor; what appears to be a minor percentage of depletive water use could actually represent a major water supply problem, such as for depletive water uses above surface water supply intakes or near the saltwater/freshwater interface. Third, the location of the discharge of the depletively used water supply is very important. Planning areas 14 and 17, which are Critical Water Supply Areas, show very minor amounts of depletive water use. This is because Table 5.2 considers discharges within planning areas non-depletive. These discharges are to the Delaware River, such that depletion of ground water supplies is masked by treated wastewater inputs to the river system. Appendix E provides a detailed analysis of depletive water use in all 23 planning areas statewide.

D. Analysis of Water Deficit and Surplus Projections

1. Current Supply Exceeded by the Year 2010

This analysis considers the eight planning areas that Table 5.2 illustrates are projected to be in water supply deficit by the year 2010. They are analyzed in the order of largest deficits first.

a. Camden Delaware Tributaries (Area # 17)

Table 5.2 indicates that this planning area has a 1990 water supply deficit of almost 70 MGD due to ground water withdrawals in excess of natural recharge. Induced recharge from the Delaware River is providing some of the flow, while declines in aquifer levels have been documented. However, it is anticipated that all major purveyors will fulfill the cutback requirements specified as part of Critical Water Supply Area # 2. Chapter 6 provides detailed recommendations to address this deficit, in addition to the current actions.

b. Mullica River (Area # 18)

This planning area is shown to have a present water supply deficit of 56 MGD, and the deficit is projected to increase to 84 MGD by the year 2010. Caution is indicated regarding these estimates and projections, however. The deficits are based heavily on assumptions regarding the depletive nature of agricultural withdrawals from ground water, and from surface water where no safe yields exist (called stipulated withdrawals). Some of the agricultural use data are highly questionable (both regarding withdrawal quantities and their consumptive nature) and must be verified. As concluded by a recent investigation, the users of the confined aquifer are not anticipated to experience saltwater intrusion in this planning area. However, potential baseflow reductions may be a problem as a result of the substantial pumpage of the unconfined aquifer in conjunction with stipulated agricultural surface water withdrawals, if they are verified and are sustained during drought periods. This situation merits further analysis.

c. South River (Area # 11)

There is a estimated deficit of 27 MGD in this planning area. However, this deficit reflects 1986-88 ground water withdrawal rates, which have been reduced greatly since that time through implementation of Critical Water Supply Area # 1 and the ability to transport Raritan River water through the Middlesex Water Company South River regional pipeline. Long-term deficits reflect increased demands caused by population growth. The next NJSWSP update should provide estimates reflecting the change in water supplies.

d. Metedeconk River (Area # 15) & Toms River (Area # 16)

Combined, these two planning areas show an estimated, present deficit of about 20 MGD which is projected to increase to 34 MGD in the next 20 years. Some of the purveyors presently use aquifers that are restricted by both Water Supply Critical Areas #1 and #2. These purveyors will need to seek other supplies, some of which have never been investigated to a large degree. Baseflow reductions to local streams may be a problem in the future. Purveyor water demand is largely depletive in nature. This region needs further assessment. Planning Area # 19 (Atlantic Coastal) might be a part of this assessment since it may be in deficit toward the end of the planning period.

e. Maurice River (Area # 21)

This planning area shows an estimated deficit of about 8 MGD, which is projected to double over the next 20 years as a result of anticipated growth. Large purveyor, agricultural and industrial ground water withdrawals are contributing to the potential deficit. Baseflow reductions to the Maurice River and its tributaries are possible impacts. Also, significant losses of ground water availability are projected due to contamination by substances that have secondary drinking water standards.

f. Hackensack River (Area # 6)

A relatively small 1990 deficit, if any, is estimated to exist. However, this deficit reflects surface water withdrawals during 1986-88, when the Hackensack Water Company was able to withdraw within the planning area at rates above safe yields due to sufficient river flows. Hackensack Water Company is part owner of the Wanaque South project and ample supplies should be available from that supply to meet future demands. In this case, combined analysis with Planning Areas 4 and 5 is necessary to overcome limitations of single-area analysis.

g. Cape May Coastal (Area #23)

Table 5.2 indicates this planning area is projected to face a water supply deficit in the year 2010. It can be concluded, however, that a much more localized deficit currently exists in the southern tip of Cape May County based on a recent investigation in this area. The investigation is nearing completion and alternatives are being actively evaluated.

h. Lower Passaic/Rahway Rivers (Area # 5)

Table 5.2 shows an estimated 1990 deficit of 9 MGD for this planning area. However, this region is projected to lose population over the next several decades and, as such, any existing deficits should be reduced/eliminated during this period. In addition, the adjacent planning area, the Upper Passaic, is capable of exporting substantial amounts of water to the planning area. Water supply systems in planning area 5 have ownership or contractual rights to safe yields in planning area 4 that exceed current and projected usage. As with planning area 6, a combined regional analysis is necessary to understand the projections.

Chapter 6 provides a more detailed examination of the planning areas, planning issues and recommendations for water supply management and protection to address projected deficits and other key water supply issues. Chapters 7 through 9 address more generic water supply issues that apply to multiple regions or a statewide context.

E. Maintenance of the Water Balance Model

As previously mentioned, the WBM was developed so that it can be routinely updated as data and projections change over time. The WBM will require updating and revising on a periodic basis. In addition, when dealing with such a large, complex data base as this one, revisions and corrections will also be necessary on a more day to day basis. As new data become available and new ways and methods of evaluating the data for water supply planning purposes, a need may be triggered for new WBM components or even new models to provide the necessary analytical tools for the proposed evaluation. The NJDEP will be responsible for any periodic modifications and changes as water demands and population projections are altered. For example, new population projections will be subjected to the State Development and Redevelopment Plan cross-acceptance process. Once adopted for State use, the NJDEP will then use these new projections to update the existing database in order to provide improved water supply planning data and information for the State.

F. Issues for Future Analysis/Strategic Recoomendations

Several issues are raised in this chapter. Many are interrelated with issues raised in previous chapters.

1. Changing Data and Needs

Issue: The employment of various population projections by various local or regional entities in order to predict water supplies and demands and the potential for water supply deficits and surpluses shows inconsistency when applied across the state.

Recommendation: A data management system needs to be developed that will simplify public access to NJSWSP data and interpretations. Currently, the WBM data base resides within the NJDEP's computers and utilizes Lotus 1-2-3 software to calculate and sort the various data layers which comprise the WBM. An operations manual has been prepared by the consultant team for the WBM. Listed in this manual are all of the specific file names and their functions, along with a description of the basic operating functions and file operations.

A reference guide checklist could be developed for easy public access and understanding of the WBM information which would list the various database files available along with a brief description. This checklist would allow the NJDEP to provide an efficient means of delivering information to all who request it. As the WBM becomes more and more refined, the structure of the WBM allows for improved water supply management in the State. The WBM is a tool to help form policy, initiatives and regulations.

2. Incorporation of Stipulated Surface Water Withdrawals in Analysis

Issue: The WBM should include stipulated surface water withdrawals (surface water uses that are not supported by storage, have no associated safe yield, and can be rescinded during droughts; thus stipulated by availability) in order to better estimate total water use and potential impacts. These withdrawals are required to terminate withdrawals during low flow conditions. However, the more of these types of withdrawals that are using a stream, the earlier that low flow conditions could occur. This process can affect downstream purveyors, sewage treatment plants and local ecosystems.

Recommendation: Future WBM refinements should take into consideration an analysis of stipulated water withdrawals. If the analysis concludes that large, single or numerous stipulated withdrawals will result in negative water supply or quality impacts, then a policy should be developed to address these issues.

3. Incorporation of "Masking Factors" Analysis in WBM

Issue: There are numerous factors that can "mask" the potential impacts of substantial water use and these factors need to be incorporated into the WBM analysis. Numerous local water supply problems can conclude in the need to implement expensive, and often depletive, regional water supply solutions. Prevention of local problems through improved management is needed, as well as local awareness.

Recommendation: The NJDEP is considering incorporating various water supply/quality/ecosystem features into an expanded assessment methodology/WBM that would avoid possible masking effects at both an inter and intra-regional level. This process will include the identification of possible "hotspots" as a tool to help the Bureau of Water Allocation procedures prevent future localized problems.

4. Incorporation of Water Cycling and Indirect Re-use Conditions

Issue: The WBM underestimates water availability in at least two ways. First, withdrawals that are depletive to one planning area may be discharged in a usable location in a second planning area. Second, water withdrawn at one point in a planning area may be cycled to users and discharges upstream of the original diversion location. The WBM does not add these flows to water availability for a planning area.

Recommendation: Develop a method to incorporate cycled and re-used water into the WBM to improve the accuracy of water availability estimates.

CHAPTER SIX

REGIONAL WATER SUPPLY INITIATIVES

A. Overview of General and Cross-Cutting Water Supply Initiatives

1. Background

Chapter 5 described the estimated water supply deficits and surpluses for the 23 planning areas throughout the state, based on the estimates of water availability from Chapter 3 and the estimates and projections of water demand from Chapter 4. This chapter describes the management initiatives and capital project initiatives necessary to address those deficits, plus many management initiatives necessary to improve the management and protection of all water supplies. These initiatives form a coordinated plan for the management, protection and development of New Jersey's water resources. Where it is believed that there are commonalities or needs shared by adjacent planning areas, these planning areas have been combined for analysis. When planning areas have been combined, they are collectively referred to as regions.

Management initiatives are (for the most part) non-structural steps taken to protect and conserve water supplies with the strategic goal of **preventing or delaying** deficits in all planning areas**,** and to **defer the need for capital projects** in specific planning areas. Included in this category are such programs as source water protection (including protection of surface water watersheds, public water supply wells and aquifer recharge areas), water conservation, depletive use reduction and other strategies that promote the wise utilization of New Jersey water supplies. Activities such as hydrologic investigations that quantify surface and ground water availability in planning areas suspected to be in or near estimated deficit fall into the management intiative category. Where capital projects are recommended, management initiatives will often be recommended that complement the project.

Capital project initiatives s are defined as capital-intensive structural measures needed between now and the year 2040 that provide additional water in specific planning areas in order to **eliminate or avoid** projected water supply deficits. Capital projects include such facilities as reservoirs, regional pipelines, new well fields, system rehabilitation, structural water conservation, etc. Precurser activities, such as feasibility studies, that conclude in construction of these types of facilities are included in the capital projects initiatives category. Where feasibility studies have not been previously conducted, there will be a broad discussion of **potential** capital projects. The purpose of this discussion is two-fold; first, to identify potential projects so that they may be considered by future water supply managers during the development of feasibility studies; and second, to suggest the possible acquisition of critical sites in the near future so that they are available in the long-term. Where applicable, costs have been estimated via previously conducted feasibility studies and implementation schedules are included. Also, the benefits that expected to be derived are presented.

Sub-Sections C through I discuss those individual or combined planning areas where there is reasonable potential that a capital project will be necessary during the planning period because of present or anticipated deficit conditions. Sub-Sections J through N discuss those individual or combined planning areas that are not expected to experience a water supply deficit during this planning period. Appropriate management initiatives will be proposed for these areas.

2. Management Initiatives

Management initiatives are designed to protect the **quality** of the State's water supplies as well as to ensure that there is an adequate **quantity** to meet present and future demands. These initiatives can be separated into four different categories:

- water resources protection,
- water supply management,
- water delivery management, and
- water conservation.

Each category, in turn, involves several sub-initiatives or sub-programs. For example, well head protection is a sub-program of the water resources protection management initiative. A brief description of each category is provided below; detailed discussions of each are found in Chapters 7 through 9. Where programs are critical to particular planning areas, the initiative and the reason(s) for their need are mentioned as a candidate for further evaluation during the discussion of that area. For example, if a planning area has potable intakes then water resource protection and water supply management programs will be specifically recommended so as to protect both the quantity and quality of the supply upstream of the intake. In other cases, they should be considered as potential statewide programs that will eventually be implemented, depending on public acceptance and available resources.

There is sometimes overlap among sub-programs because they fall into two management initiative categories. For example, aquifer recharge protection can fall under both the water resources (quality) protection and the water supply (quantity) management categories. There is sometimes overlap between management initiatives and capital projects. Water conservation is considered a management initiative when programs such as lawn irrigation odd/even days are instituted or when minimal capital funds are utilized. On the other hand, water conservation is considered a capital project when significant structural improvements are made throughout a planning area and capital funds (e.g., for water conservation devices) are employed.

All four categories, especially those that are associated with mangement of regional activities, will be integrated into the NJDEP's watershed-based management strategy. This will ensure a comprehensive approach to the management of the state's water supplies. Since most of these initiatives are in early phases of development, no cost estimates are provided. The benefits of the initiatives are as described below.

a. Water Resources Protection

These programs are designed for the protection of the **quality** of surface and ground water sources and include both existing and evolving activities. Essentially, the thrust of these programs is to ensure that water quality standards are maintained for the State's water resources, especially its water supplies. Existing NJDEP functions in this category consist of Water Quality Standards, New Jersey Pollutant Discharge Elimination System, Municipal Wastewater Assistance, Pollution Prevention, Site Remediation and

Enforcement, including the Water Watch groups. These functions direct much of their attention toward individual activities and facilities where there is the potential for violations of water quality standards.

Emerging programs or sub-initiatives are for the most part geared toward ensuring that the cumulative effects of numerous activities in particular geographic areas do not result in water quality degradation. Included are watershed management, well head protection, aquifer recharge protection, nonpoint source management and septic system management. The Municipal Land Use Law and State Development and Redevelopment Plan are evaluated in Chapter 7 with respect to their potential use in maintaining regional water quality.

b. Water Supply Management

Ensuring that adequate **quantity** is available within the surface or ground water resource in order to meet current and future demand is the primary objective of this category. In addition, this category ensures that over-use does not stress regional water supply availability. The primary existing NJDEP function is the water allocation program. This program is responsible for evaluating individual requests for surface and ground water supplies over 100,000 gallons per day (GPD), for most uses on a case-by-case basis, as well as over-seeing regional investigations that define water availability and solutions when availability is limited. Decisions on agricultural uses over this amount are made by the local agricultural extension agent. The Water Supply Critical Area Program also ensures that over-use does not reduce the sustainability of the State's supplies.

Emerging programs include primarily the recently initiated watershed management program. One of the functions of this program is the development of strategies for the integration of water quantity and quality. Examples include ensuring that depletive water uses do not reduce the availability of surface and ground water supplies, cause ecological degradation, or reduce the assimilative capabilities of the State's waterways. It will also ensure that wastewater management decisions do not impair water availability. This program will evaluate integration of the State Development and Redevelopment Plan and the Municipal Land Use Law within the watershed management initiative.

c. Water Conservation

This category is oriented toward reducing the unnecessary or wasteful use of water. Conservation can be separated into supply-side and demand-side initiatives. The former seeks to reduce water losses occurring within a purveyor transmission and distribution system and is capital-intensive, while the latter is directed at reducing usage by customers after the water has been delivered. While water conservation is generally a statewide program, there are various modes of conservation that are appropriate for some planning areas but not for others. The mode of conservation is highly dependent on the type of water use, when the water is used, etc. Thus, water conservation will be discussed as an initiative in some planning areas described below. Water conservation can also be directed toward particular classes of water users, such as agricultural and industrial use.[8]

This initiative will be directed primarily by the NJDEP, mostly through its Safe Drinking Water and Water Allocation programs. Presently, water conservation plans are required of all public water supply systems that hold water allocation permits. In addition, the Water Supply Rehabilitation Loan Program makes funds available to publicly-owned water purveyors experiencing large unaccounted-for water. The Department of Community Affairs will also play a major role as it is responsible for developing and implementing the

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[8] During the drought of the early 1980s and beyond, significant gains were made in reducing industrial demand, much of which remains permanent. Such conservation activities have a double benefit of reducing water use and also reducing wastewater output.

state's plumbing codes, which include water conservation provisions. The Board of Public Utilities is expected to play a larger role here as conservation may often be considered an option that can reduce the need for new capital facilities. The Delaware River Basin Commission will also be very involved since that entity is responsible for establishing water usage standards for those portions of New Jersey in the Delaware River watershed.

d. Water Delivery Management

Ensuring that both adequate **quantity** and **quality** is available at the **point of use** is the major goal of this category. Essentially, this goal is achieved by ensuring that water meets drinking water standards "at the tap" and that the distribution system is adequate to produce water of a suitable quantity to meet the needs of the customers, including public safety needs (i.e., adequate water pressure for fire fighting purposes). The Safe Drinking Water Program is primarily responsible for these activities through its oversight of Safe Drinking Water Standards, public water supply infrastructure permitting, well construction, interconnections, operation and maintenance, and Consolidation of Small Water Companies sub-intiatives. The latter is directed toward the acquisition of inadequately managed small water systems by larger, more viable public water systems (see Chapter 9).

3. Capital Project Initiatives

There are six types of basic capital water supply projects that are capable of providing additional water supply in the individual planning areas that are currently or are projected to be in deficit. It must be emphasized that the appropriate management initiatives should be implemented in conjunction with the project to ensure sufficient protection and effective management of the new supply. Discussed below is a description of each general alternative, including when particular alternatives are most appropriate.

a. Surface Water Supplies

Surface water is the most widely used water supply in the state, representing about 53 percent (788 MGD) of total withdrawals, not counting non-depletive industrial withdrawals that are mostly from surface waters as well. The northeastern, central, and Delaware River portions of New Jersey make the greatest use of this supply. Surface water availability is limited by the amount of passing flow required downstream of the withdrawal. Consequently, surface water can only be considered a "reliable" source supply when reservoirs or Aquifer Storage Recovery (ASR) systems are available to capture and store these supplies during periods of high runoff. Direct withdrawals can not be made from streams during low flow conditions without stressing the aquatic ecosystems. If reservoirs are unavailable, acceptable alternate sources may be utilized during this period.

Surface water will continue to be the major water supply for the regions described above, and will probably become more important for coastal New Jersey also as this area grows. Since the potential for reservoirs is limited in the coastal counties, conjunctive use of surface and ground water will likely play a major role in meeting future demand, possibly including recharging aquifers with treated surface water via ASR systems. It is important that preliminary planning be conducted in coastal counties regarding additional use of surface waters in order to ensure that this option is available when demand exceeds ground water availability, which is already occurring in some of the coastal planning areas.

Water quality maintenance and ensuring sufficient stream flow by minimizing upstream depletive water uses are major considerations regarding surface water. The question of depletive water use, and water rights in general, is addressed as a public policy issue in Chapter 8. Surface water availability is enhanced by:

developing the most downstream reach practicable to take advantage of the most drainage area, managing wastewater, including re-use, to sustain both intake waters and downstream passing flows, and implementing watershed management to protect water quality.

The cost of developing future surface water supplies is considered to be relatively high due to treatment and storage needs, and is anticipated to increase over the years as new drinking water standards are adopted. When used conjunctively with ground water, the capital and operating costs often are substantial because of the redundant infrastructure, including treatment, transmission and interconnection facilities.

b. Ground Water Supplies

The northwestern area and southern half of New Jersey rely primarily on ground water (ground water provided 712 MGD of statewide supplies in 1990). Surface water use in the south, however, is increasing in order to correct and compensate for the over-drafting of several of the regional confined aquifers. Ground water is used at locations where existing surface water distribution systems do not exist and where ground water is the preferred source. Ground water is found in both unconfined or confined aquifers.

Ground water availability can be extended when wells are installed an adequate distance from the saltwater/freshwater interface and (in shallow aquifers) from streams. Availability can also be extended by seasonally "resting" wells and turning to other supplies, such as surface water when there is sufficient flow or ASR systems that have been recharged with surface water supplies. For unconfined aquifers, stream flow depletion will be minimized if ground water withdrawals make up a relatively small fraction of recharge that flows into the aquifer. The use of unconfined aquifers should be complemented by well head and aquifer recharge protection programs in order to extend long-term availability. The delivered cost of ground water is generally low when compared to surface water due to reduced treatment needs, the close proximity of wells to demand, and the natural storage that is available to meet demand during drought. The cost of developing supplies in the future, however, is expected to increase due to limited availability, new drinking water standards, more comprehensive protection of these supplies, and the necessity in some areas of piping water from the most effective well or surface water intake sites to the service area to minimize undesirable effects.

c. Interconnection of Systems

Interconnections represent a linkage between the service areas of two separate purveyorsor a connection between two different water supply sources (e.g., conjunctive use of surface and ground water) within the same purveyor's service areas. Interconnections often can provide an overall increase in yield, as described in Chapter 7 (Integrated Water Supply Systems Management), or assist a purveyor during an emergency or a drought. Many interconnections have been made, especially during the last decade in response to the 1982 Plan. Interconnections are appropriate when the system demands of a purveyor increase, either permanently or intermittently, to a point of exceeding available supply. An interconnection with an adjacent purveyor that has surplus supplies is generally more cost-effective than developing new supplies or constructing additional storage, unless concerns rise regarding depletive water use impacts. In the event that raw water is exchanged between purveyors, water quality must be considered in order to ensure that the mixed product is treatable by the importing purveyor.

d. Conjunctive Water Use

Integrated use of multiple water sources is a recognized strategy that may significantly improve the yields of regional water supplies, especially in planning areas where demands are rapidly increasing and available supplies are being stressed. It has been estimated that use of local aquifers in conjunction with the

Manasquan Reservoir could increase the total system yield by 15 MGD. Conjunctive use in the form of surface and ground water and of multiple aquifers (including artificial recharge techniques) is anticipated to play a major role along the coast and perhaps in some of the buried valley aquifers in northern New Jersey. There is significant stream flow during low evapotranspiration months of which a small percentage could be stored in ASR systems. The same concerns and issues discussed above for ground and surface water apply to conjunctive use. In addition, surface and ground water typically have different source water chemistries; treatment process "flexibility" must be a consideration.

e. New and Improved Technologies

Many technologies have been used successfully in other parts of the United States and in other countries, but are in limited use or nonexistent in New Jersey. Among them are aquifer storage and recovery (ASR), direct waste water reuse, innovative treatment methods, and desalination. ASR is practiced by a few purveyors in Cape May, Camden and Monmouth counties. It is being evaluated in other areas along the coast, especially in conjunctive use modes. Development of conjunctive use/ASR facilities offers the inherent advantage of providing substantial quantities of water during low stream flow periods, naturally improved water quality due to the filtration capability of the aquifer medium, and reduced storage cost especially when compared against that of a surface water reservoir. Artificial recharge of clean storm water may also require further evaluation, especially in areas where stream base flow is a concern. Wastewater is presently indirectly re-used in the Delaware, Raritan and Passaic watersheds. There may be substantial opportunities to directly utilize highly treated wastewater for nonpotable purposes, such as irrigation or cooling water, or to indirectly use wastewater to augment in-stream passing flows, thus offering the potential for exploiting a "new" resource that can be substituted for existing sources. The overriding consideration in discharging significant quantities of wastewater upstream of potable intakes, and potentially increasing yield, is the net effect on source water quality. This issue is discussed in Chapter 7.

The NJDEP has recently initiated efforts to integrate water supply and wastewater management so as to reduce depletive water use as well as to promote reuse, where applicable. An evaluation will be made of the potential wastewater opportunities.

Some purveyors have recently installed newly introduced water treatment technologies. Prime among them is ozonation as a substitute for primary chlorination of drinking water, to reduce tri-halomethane generation. Ozonation is also considered more effective in removing protozoan contamination such as *Giardia* and *Cryptosporidium*. Several of New Jersey's major investor-owned water purveyors have installed or are planning the installation of ozonation systems. Equipment capable of extremely effective treatment can allow the use of water sources now not considered as available for water supply purposes. A pilot desalination plant has completed a successful operation in Cape May. A full-time plant is being seriously considered. Desalination has potential in the decades to come along the coast, especially as this technology becomes more cost-effective. Other new technologies will be necessary to mitigate ecological impacts, such as surface water intakes and dams that are capable of allowing the unimpeded upstream migration of fish. Finally, improved techniques for treating contaminated ground water will provide opportunities for renewed use of abandoned supply sources.

f. Water Conservation

"Structural" water conservation, when successful, allows existing water resources to be extended, reduces stresses to the environment, reduces energy costs and defers capital expenditures on both water supply and waste water infrastructure. This initiative consists of processes and programs for making more efficient use of existing supplies through structural, operational, economic and socio-political means. As a capital project, system rehabilitation is a major form of conservation that can reduce water losses; the retrofitting of homes with low flow toilets and showerheads can significantly reduce demand. In a sense, the potential to decrease water loss and demand can be considered a source of additional supply. It is reasonable to require that all future water supply feasibility studies comprehensively evaluate the cost-effectiveness of water conservation versus alternate water supplies in planning areas that experience deficit. In the event that conservation is less costly and at least as practical, the NJDEP anticipates expanding or focusing its water supply loan program in this direction. Chapters 7 and 9 discusses this concept in greater detail.

At present, a water conservation strategy is most appropriate for purveyors experiencing unaccounted for water uses of more than 20 percent or in regions with significant projected deficits or where depletive water uses are known to have impacts on water supplies or on freshwater-dependent ecological resources. However, aggressive water conservation will not be appropriate in all planning areas. Chapter 7 discusses in detail the various modes of water conservation and the NJDEP's recommendations on this topic.

B. Financial and Legal Resources for Implementation

New Jersey's growth and viability rests on having adequate and clean water resources to support the needs of the State's population. Therefore, it is incumbent on the State to continue to lead, through planning and financial assistance, water supply development. Without the state's direct financial involvement the success of statewide water supply development is uncertain and left to the financial capacities and desires of other entities.

Local government and private enterprise will remain key sources of capital financing for the state's water supply projects. As the appropriations from the Bond Fund begins to rely heavily on repayed loans it is not likely to be the exclusive funding source for future projects, nor has it been to date. Other funding sources are necessary, with the State identifying the areas that need capital financing in cooperation with water purveyors and local governments.

The areas and issues that should be addressed are what follows below. These issues need to be resolved as part of the State's capital investment strategy:

The State has utilized most of its available water resources due to the increasing demands and development within New Jersey. In addition, more stringent standards have been placed on these water supplies which increase the need for treatment. In a situation of this kind, the public must realize that the cost of delivered water will rise over time. The long-term provision of clean and sufficient water supplies for all users in a state with increasing population and developement densities will require additional funds and efforts. The public must understand that the development of replacement water supplies, the protection of existing water supplies and the treatment of drinking water to exacting standards all have cost implications.

Approximately 42% of the state's population is now served by investor-owned water systems and it is likely that this percentage will grow over time. In the case of large regional projects, investor-owned systems can participate or lead in providing these important facilities. These large projects do present a major investment challenge for investor-owned purveyors. Financial incentives could be provided to minimize these challenges, as occurred in the Wanaque South Project (a public-private partnership) and the Tri-County Project (which received economic development loans from the State).

A re-examination of the basis for excluding the investor-owned water purveyors from using Bond Funds should be undertaken. The NJDEP intends to investigate options by which funding would be available to all the water supply systems in the state. The primary constraint is federal tax laws. Under the current system, customers of investor-owned purveyors help pay the costs of loans to publicly-owned purveyors but do not directly benefit by access to the same loan program. The NJDEP should also examine how funds can be made available for non-loan efforts within the service areas of investor-owned systems that will indirectly support better water management by those systems. Examples include ground water and feasibility studies, planning and demonstration grants to public agencies, and loans to municipalities for conservation (where the investor-owned companies provide bulk water to publicly-owned systems).

An assessment should be made on having the Treasurer restructure the repayment schedule of the Bond Fund so that more of these annual payments can be recycled back into the loan funds. The accrued interest payments can be balanced across all years of the loan repayment period, instead of being weighted toward earlier years. This accelerated recycling of principal back into the Bond Fund could defer the date when a new bond issue might be contemplated.

Continued State support of major new facilities is important because of the high marginal cost of new supplies, especially while the yields are not fully committed. Because new water supplies take up to decades to develop, most supplies are built well in advance of demand, so that they are underutilized for long periods of time. Support for initial costs is important so that the total costs are spread over all facility users. This point also emphasizes the benefits of delaying new infrastructure needs through conservation.

NJDEP should determine preferred roles in providing funding options for water supply projects and what if any additional State level funding options should be created.

A needs survey should be conducted of small and large purveyors to determine their infrastructure and financial needs, based on existing work done in anticipation of a proposed amendment to the Federal Safe Drinking Water Act. The amendment would provide states with funds to establish a revolving loan fund to assist purveyors. This fund would supplement the State's current program.

Also as a possible funding source the NJDEP should examine all properties it has purchased for the development of future water supply and reassess the needs of those lands. If a careful review determines that these lands no longer are needed for water supply purposes title could be transferred to other NJDEP programs, which would reimburse the water supply program so that the funds can be put to other uses. However, such transfers should occur only when there is absolutely no reasonable potential that the lands will be needed for water supply purposes (unlikely to involve a great deal of land).

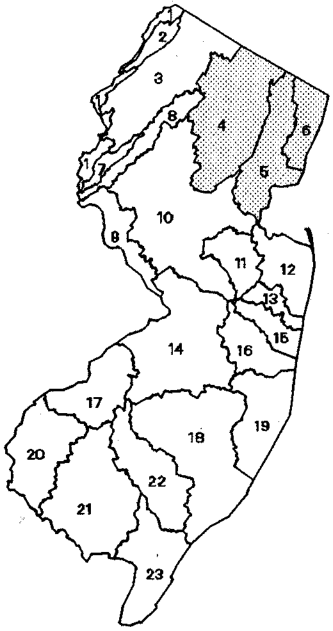
Consideration must be given to utilizing the remaining balance of the Bond Fund as efficiently and proactively as possible. The focus of use of remaining funds should be placed on extending existing water supplies as far as possible in an effort to defer costly capital construction projects, and to develop new supplies in growing regions as optimally as possible. Preventing overuse is vital on keeping cost down, as illustrated by the experiences of Water Supply Critical Areas 1 and 2.

RECOMMENDED INITIATIVES FOR PLANNING AREAS ANTICIPATED TO BE IN DEFICIT DURING THE PLANNING PERIOD

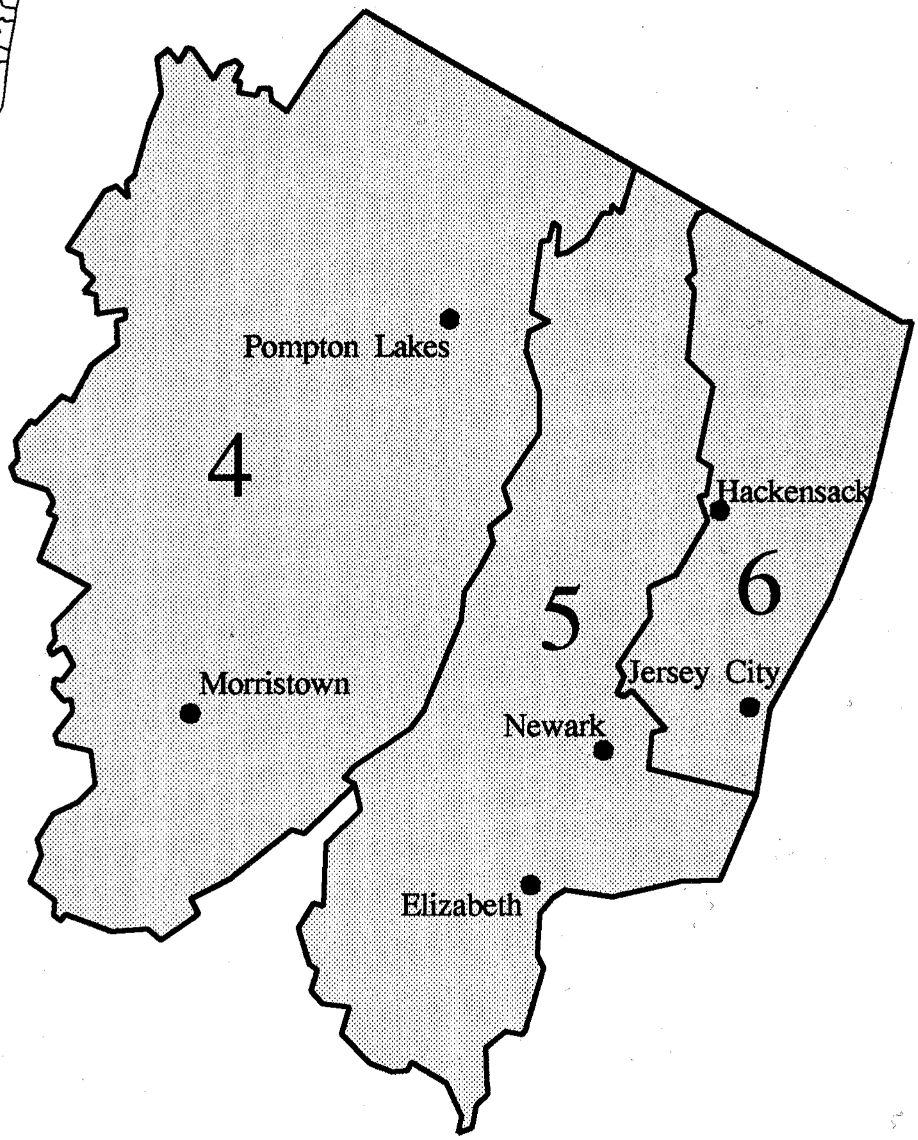
C. Initiatives for Planning Areas 4, 5 and 6 -- Upper Passaic, Lower Passaic/Rahway and Hackensack River Watersheds

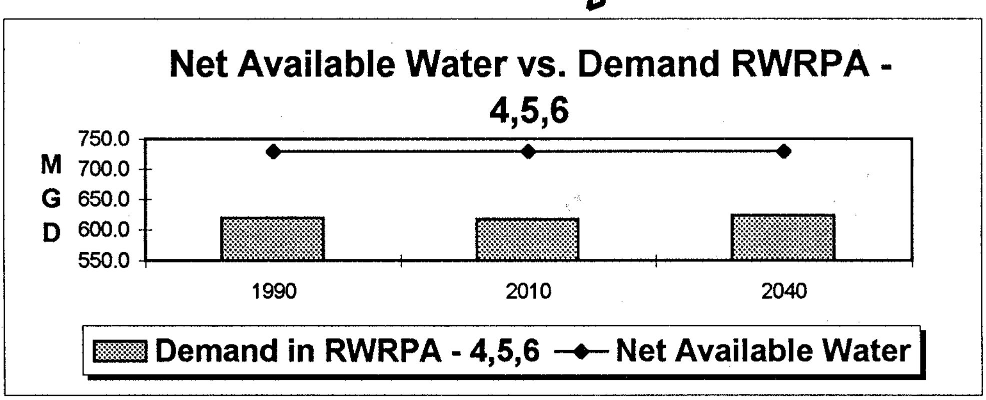
1. Description of Planning Areas

Planning areas 4, 5 and 6 have been combined in this chapter because the public water supply systems in this area have been extensively interconnected during the past decade in order to facilitate the transfer of water from one to the other. As a region, no deficits are projected through the planning period due to the recent construction of new surface water supplies. However, since the areas include 45 percent of the State's population, considerable caution and continuous attention to these three planning areas is appropriate. The projected planning area populations are:



RWRPA 4 Upper Passaic River and Tributaries
RWRPA 5 Lower Passaic/Rahway River
RWRPA 6 Hackensack River





Planning Area	**1990** Population	**2010** Population	**2040** Population
4-Upper Passaic River	690,000	704,000	729,000
5-Lower Passaic River	1,896,000	1,786,000	1,687,000
6-Hackensack River	982,000	987,000	996,000
TOTAL	3,568,000	3,477,000	3,412,000

The following table shows water availability (including "assumed" approximations of ground water availability), water demands, and estimated surpluses or deficits for each of the three planning areas:

Planning Area	Net Available Water	**1990** Water Demand	**1990** Surplus/ Deficit	**2010** Water Demand	**2010** Surplus/ Deficit	**2040** Water Demand	**2040** Surplus/ Deficit
4-Upper Passaic River	219 mgd	92 mgd	128 mgd	99 mgd	121 mgd	109 mgd	110 mgd
5-Lower Passaic River	363 mgd	372 mgd	-9 mgd	356 mgd	7 mgd	343 mgd	20 mgd
6-Hackensack River	147 mgd	155 mgd	-8 mgd	163 mgd	-16 mgd	170 mgd	-23 mgd
TOTAL	729 mgd	619 mgd	111 mgd	618 mgd	112 mgd	622 mgd	107 mgd

Although planning area 6 shows estimated deficits, these values do not reflect the water rights held by that area for water from planning area 4. The estimated deficits in that area are a result of ample water in the Hackensack River watershed during the 1986-88 period, which lowered the amount transfered from Planning Area 4. When supplies from all three planning areas are combined, the net effect is that no regional deficit exists or are projected. However, several sub-regional factors must be considered:

1. It is unlikely that signicant new ground water supplies will be developed in planning area 6, although the available water values include this possibility based on recharge rates;
2. Sub-regional ground water quality and quantity problems exist in planning area 4 which are masked by the regional data;
3. The effects of population declines on demands in planning area 5 may be overstated because the per capita water use rates are based on combined residential, industrial and commercial (RIC) data. If per capita residential water use data were available and used, the reduction in demands would most likely be lower;
4. Considerable surface water flows from New York State are incorporated into the available surface water safe yields for planning areas 4 and 5, but these flows are not assured by contract, compact or court order.

Planning area 4, the Upper Passaic River watershed, is the largest of the three areas, extending 622 square miles over Morris, Passaic, Essex, Bergen, Somerset, Sussex and Union counties, and terminating at Little Falls. Tributaries to the Upper Passaic River include the Whippany, Rockaway, Pequannock, Wanaque, Pompton and Ramapo rivers. The majority (72 MGD) of in-region demand is satisfied by the planning area's buried valley aquifer systems, despite the fact that this planning area possesses the largest surface water supplies (406 MGD) by far of any planning area. The Wanaque and Monksville Reservoir system, Pequannock Watershed (five reservoirs), and the Point View, Taylortown, Kakeout, Jersey City (Boonton), Splitrock, Clyde Potts, and Canoe Brook system reservoirs all are located in planning area 4, as is the Passaic Valley Water Commission and New Jersey-American Water Company surface water intakes on the Passaic River. The larger surface water storage systems primarily supply areas outside of planning area 4. The Monksville Reservoir and the Wanaque South pump station were partially funded by the Bond Fund to address projected deficits in planning areas 4, 5 and 6.

Chapter 3 estimated that there are 94 MGD of available ground water, for a total estimated available water supply of 500 MGD in planning area 4. Since 281 MGD was transferred to other planning areas in 1986-1988, net available water is thus estimated at 220 MGD. Since 92 MGD represents the current (1990) demand, a surplus of 128 MGD is estimated as being available. However, this "surplus" can only be understood in the context of planning areas 5 and 6, to which much of this water is already contracted. It should be noted also that while a large surplus does indeed exist, continued increases in ground water withdrawals may stress aquifers locally. Ground water investigations nearing completion in the upper Passaic and Rockaway River watersheds confirm this, showing significant declines in the water table and stream flow reductions in specific reaches where ground water is depletively withdrawn. The latter effect can reduce the safe yield of downstream surface water supply systems. Further assessment is necessary, however, to determine the net effect of depletive withdrawals and incoming interbasin transfers.

Planning area 5, the Lower Passaic/Rahway River watersheds, is the next largest of the three planning areas, covering 347 square miles that extend over Essex, Union, Bergen, Middlesex and Hudson Counties. The area includes the Passaic River Basin from Little Falls to its mouth at Newark Bay, and includes the Saddle, Rahway and Elizabeth Rivers.

The planning area had a 1990 population of 1,900,000 and it is projected to decrease to 1,800,000 in 2010, and further decrease to 1,700,000 by the year 2040. The 1990 water demand was 372 MGD (326 MGD from surface water) and it is projected to decrease to 356 MGD in 2010 and to 343 MGD in 2040 with diminishing population. The planning area only possesses surface water supplies of about 9 MGD (Rahway and Haledon)[9] and an estimated 47 MGD of ground water, for a total net supply of 56 MGD. As such, a net deficit of 317 MGD exists. This amount is largely negated, however, by interbasin transfers from the Upper Passaic and Raritan basins of 307 MGD, leaving a final deficit of 9 MGD. This deficit is easily satisfied by additional transfers for which ownership or contractual rights already exist. Since demand is expected to decrease, the planning area should begin to experience surpluses within the next decade or two. Of course, this would essentially be a "paper" surplus; purveyors will simply reduce the amount of water they import from adjacent planning areas. It must be emphasized that current ground water withdrawals (46 MGD) almost equals the estimated available ground water supplies; significant withdrawals exist upstream of the Hackensack Water Company's Saddle River intake. Further ground water development is unlikely. This will need to be assessed to determine if there are potential effects on projected surpluses.

Planning area 6, the Hackensack River watershed, extends from the southern New York border where the Hackensack River enters New Jersey to Newark Bay, including the New Jersey portion of the Hudson River area, and covers 164 square miles in Bergen and Hudson Counties. Water supply sources in the planning area consist of the Hackensack Water Company's Oradell Reservoir, Lake Tappan, Woodcliff Lake and deForest Lake. With the addition of 9 MGD from the Saddle River (planning area 5) the combined safe yield of these systems is 74 MGD. Ground water availability is estimated at 22 MGD, for an available water supply totaling 96 MGD. As of 1990, 51 MGD (net) was imported into the Hackensack River watershed, resulting in a net available supply of 147 MGD. Water demand in 1990 was 155 MGD; thus, an "internal" deficit of 8 MGD exists in the planning area. However, the Hackensack Water Company has contracted rights to about 40 MGD from the Wanaque South Project; approximately 10 MGD of this amount was being utilized as of the 1986-1988 period used in the model. The Hackensack Water Company generally draws more than the safe yield of the Hackensack reservoirs during average precipitation periods, but draws from the Wanaque South Project during drier periods. With this interconnection, the planning area in 1990 had an estimated surplus of about 22 MGD. Since the planning area's demand is projected to increase an additional 15 MGD by 2040, these two water supplies should be sufficient to meet the planning area's needs through the 50-year planning period. However, the actual availability of ground water in the area should be re-examined and projections adjusted accordingly.

2. Planning Issues

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[9] In addition, approximately 9 MGD is available to the Hackensack Water Company through its Saddle River intake in planning area 5, but the Water Balance Model shows this amount within planning area 6. The next NJSWSMP will properly allocate this safe yield.

Planning areas 4, 5 and 6 are extensively interrelated through an interconnection network that allows for the transfer of water between planning areas. While planning areas 5 and 6 are shown to be in "internal" deficit because of limited available supplies, these deficits can easily be satisfied by transfers through this network from planning area 4, which has a substantial surplus. In all three planning areas there is an available water supply of 652 MGD. With net interbasin transfers of 77 MGD from other planning areas (primarily planning area 10), 729 MGD is presently available. Current (1990) demand is about 619 MGD and year 2040 demand is anticipated to increase by only 3 MGD.

Consequently, the challenge is not expected to be in the form of major structural water supply projects; rather, it is essential that a number of programs be implemented to ensure that the existing water supplies are preserved and managed well into future. The apparent surplus is sensitive to changes in population (including that which may result upon implementation of the State Development and Redevelopment Plan), depletive water uses above water supply intakes and passing flow gauging stations, water quality, purveyor interconnection operational procedures, continuation importation of water from planning area 10, and sub-regional deficits (especially regarding some ground water areas) that could be resolved through use of current surplus supplies. There is also some evidence that the region's surplus may be vulnerable to relatively short but severe drought periods, as experienced during the summer and fall of 1993 and in 1995. Periodic reanalysis of these issues and population changes will be critical, especially as planning areas 5 and 6 are heavily dependent on water supplied from planning area 4.

3. Management Initiative Recommendations

a. Passaic/Hackensack Management/ Operation Simulation Model

It is of upmost importance to possess the most accurate estimates of water availability and to have a working knowledge of how improved operations can increase the region's ability to withstand droughts of various intensity as well as to maintain the region's water supply over the long-term. The 1960s drought generally is considered the most severe in this part of New Jersey. Many activities have taken place over the last three decades that could potentially increase or decrease stream flow conditions if a similar drought were to occur today. Among these activities are ground water withdrawals and wastewater discharges upstream of intakes and passing flow gauging stations. As previously suggested, also, there is no guarantee that the 1960's drought is the worse drought possible. There is also a need to determine if particular water quality improvements should be made that would allow for maximum utilization of existing water supplies. During lower flow periods when treated wastewater makes up an large fraction of river flow, for example, purveyors may turn to their reservoir water supply in order to keep treatment cost down. This may not be the optimum water supply from a quantity perspective, however.

It is thus recommended that a detailed model be developed of the Passaic and Hackensack Rivers which evaluates the region's storage facilities' capability to withstand various drought conditions and changing demand scenarios. The model should also include some means of assessing wastewater flows in the region in order to properly model available water resources. The model would employ changes in streamflow as a result of ground water withdrawals and increases and decreases in wastewater inputs. Concurrent with the development and testing of the model, it is suggested that an assessment be made of water quality improvements under various flow conditions in order to estimate if using particular supplies at particular periods could maximize overall supplies. Chapter 7 discusses some issues regarding wastewater treatment and water supply management that could have a major effect on both systems in this region, including issues of nitrates and ammonia in wastewater discharges. Potential improvements in management and operation, and water quality improvements, that could provide additional safeguards during these periods could be tested using such a model. Upon completion of the model, recommendations would follow regarding the magnitude and timing of any capital projects management initiatives that may be needed, as well as any specific water quality improvements.

Among the capital projects that may be considered are new interconnections within the region and with adjacent planning areas (such as planning area 10), sharing a Hudson River project with New York City (if initiated), increasing the size of existing storage facilities, constructing new storage facilities (including ASR systems in the buried valley aquifers), and direct and indirect wastewater re-use. Among the management initiatives to be evaluated are programs aimed at modifying demand and improving operations, such as water conservation, improved drought rule curves, depletive use reduction programs, and improved coordination among presently interconnected purveyors.

Costs - It is estimated that the data acquisition, monitoring, analysis, development and updating costs for the management model are approximately $500,000. In order to estimate potential stream flow depletion as a result of ground water withdrawals, existing ground water investigations would need to be re-evaluated and the associated costs are included above. It may be possible to link the development of this model with efforts by the North Jersey District Water Supply Commission and others.

Benefits - The benefits of this initiative are dependent on its findings. New interconnections could ease the impact of drought on local communities within the region. Improved management and operation may defer the need for additional expensive storage facilities. The importation of highly-treated wastewater upstream of an intake would result in increased surface water. The effects associated with the exportation of wastewater and depletive ground water withdrawals, as well as the discharge of improperly treated wastewater, above intakes would decrease the yield. The model would allow the NJDEP and affected purveyors to better deal with a severe drought.

Implementation Schedule - Two years, beginning in 1997.

b. Water Conservation

This management initiative could play a crucial role in ensuring that planning areas 4, 5 and 6 as a whole do not reach actual deficits and are capable of withstanding an intense drought. As such structural conservation deserves to be prioritized in this region. Since population growth is projected to be minimal, emphasis needs to be placed on retrofitting existing residences, some of which will occur without further government action as fixtures are replaced. Demand reductions could be significant because much of the development in these areas pre-dates New Jersey’s new plumbing codes for water conserving fixtures in homes. Also, in order to provide an adequate buffer during drought, there is a need to develop specific conservation measures capable of reducing demands at such time. The type of conservation measures most suitable for the particular circumstances of the planning areas are discussed in more detail in Chapter 7.

Costs - To be estimated after completion of the Passaic/Hackensack Management/Operation Simulation Model. Various modes of conservation will be a component that is simulated in the model.

Benefits - Deficit will be deferred, as will the need for additional facilities. Reduced ecological stresses. Fewer drought declarations.

Implementation Schedule - To be based upon the Passaic/Hackensack Management/Operation Simulation Model discussed above.

c. Water Resource Protection

There is a need to ensure that water quality upstream of the several potable water supply intakes in the region continues to be of suitable quality. A comprehensive watershed management program is warranted and should be prioritized above the intakes. Proposed legislation has been discussed in recent years that would provide the NJDEP with the authority to establish buffer zones around reservoirs and streams that feed these reservoirs, and to address pollution sources to water supply watersheds. Other draft legislation would focus on the protection and acquisition of certain source water protection areas. Because both the Hackensack River and the Passaic River are interstate waterbodies, there may be a need for the NJDEP to seek a memorandum of agreement with New York State Department of Environmental Conservation (NYSDEC) to protect water quality of those waters as New Jersey's watershed protection program is implemented in the three planning areas.

Watershed management is growing in importance in planning area 4 where considerable development is being proposed in the New York State portion (Sterling Forest) of the Wanaque River watershed. If built, potential water quality degradation may cause the need for additional treatment of these supplies. The NJDEP will coordinate with State Legislators in an effort to maintain this area in its currently undeveloped state in order to protect the water quality of the Wanaque/Monksville Reservoir system. This may evolve to a capital project if public funds are utilized to purchase these lands. The cost of purchasing the Sterling Forest has been estimated at $35 million. New Jersey has committed $10 million from the 1969 Water Conservation Bond as New Jersey’s share for buying the land, contingent upon similar commitments from New York and the Federal government. New Jersey Green Acres Bond and Passaic County funds have already been used to purchase the majority of the Sterling Forest property in Passaic County that drains into the Wanaque and Monksville Reservoirs.

There is also a large need to protect the quality of the region's ground water resources, especially in planning areas 4 and 5 where significant ground water withdrawals exist in a highly urbanized area. Well head and aquifer recharge protection programs and septic system management should be prioritized in the region. Failing septic systems have often resulted in the need to install depletive sewerage collection systems. The NJDEP is presently considering the development of a watershed management plan for a major portion of planning area 4.

Costs - Undetermined at this time. There is an existing allocation of $3.0 million for well head protection from the Bond Fund that should be maintained (see Chapter 7). State funding of up to $10 million has been committed to the purchase of Sterling Forest.

Benefits - Surface water quality will be maintained in the region's watersheds if a watershed management approach is implemented. Ground water quality will have an additional level of protection from current levels if proactive ground water programs are impemented. The cost of potable water treatment should remain stable.

Implementation Schedule - A comprehensive watershed management and ground water protection initiative should begin by 1996 (see Chapter 7.A). In addition, a pilot watershed project was initiated in late 1993 by NJDEP. The Whippany River watershed located in Morris County was selected to begin developing an integrated strategy for monitoring, protecting and managing water resources on a watershed basis. A Whippany River Watershed Management Plan is being developed through a collaborative process between the NJDEP and a representative group of “stakeholders” including county and local governments, regulated businesses and industries, environmental and civic groups and area residents.

Capital Project Initiative Recommendations

There are no capital project initiatives anticipated for the planning period of 1990 to 2040 at this time. The Passaic/Hackensack Management/Operations Simulation Model will be used to identify possible capital project needs.

D. Initiatives for Planning Areas 10 and 11 -- Raritan and South River Watersheds

1. Description of Planning Areas

These planning areas have been combined in recognition of existing interconnections and the effect on water supplies in the South River watershed due to Water Supply Critical Area #1 mandates. The projected planning area populations are:

Planning Area	**1990** Population	**2010** Population	**2040** Population
10-Raritan River	769,000	881,000	1,011,000
11-South River	322,000	389,000	470,000
TOTAL	1,091,000	1,270,000	1,481,000

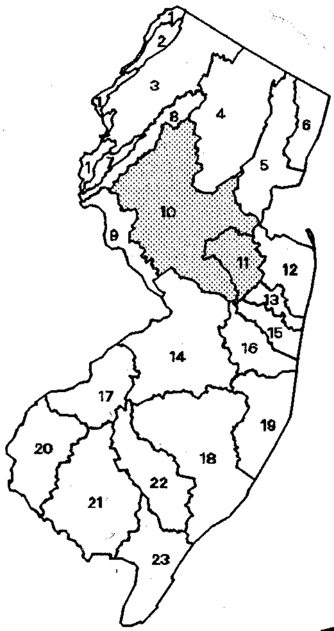
Planning area 10, the Raritan River watershed, is the largest single planning area. It is 925 square miles in size and incorporates portions of Hunterdon, Mercer, Middlesex, Monmouth, Morris, Somerset and Union Counties. The principle waterways are: the North and South Branches of the Raritan River, the Lamington River, the Millstone River, Lawrence Brook, and the Delaware and Raritan (D & R) Canal. The total current average water demand (1990) in the planning area is 118 MGD (64 MGD from surface water and 54 MGD from ground water). Approximately 72 percent is purveyor supplied and 12 percent is self-supplied residential. The remaining 16 percent is self-supplied industrial and agricultural demand.

It is estimated that planning area 10 has 110 MGD of available ground water and that the New Jersey Water Supply Authority's Raritan System has a surface water safe yield of 225 MGD for a total available water supply of 335 MGD. The 225 MGD is comprised of 160 MGD from the Spruce Run and Round Valley Reservoirs and 65 MGD from the D & R Canal (through an intake on the Delaware River in planning area 9). A net total of 122 MGD is transferred out of the planning area, therefore, the net available water for planning area 10 is 213 MGD.

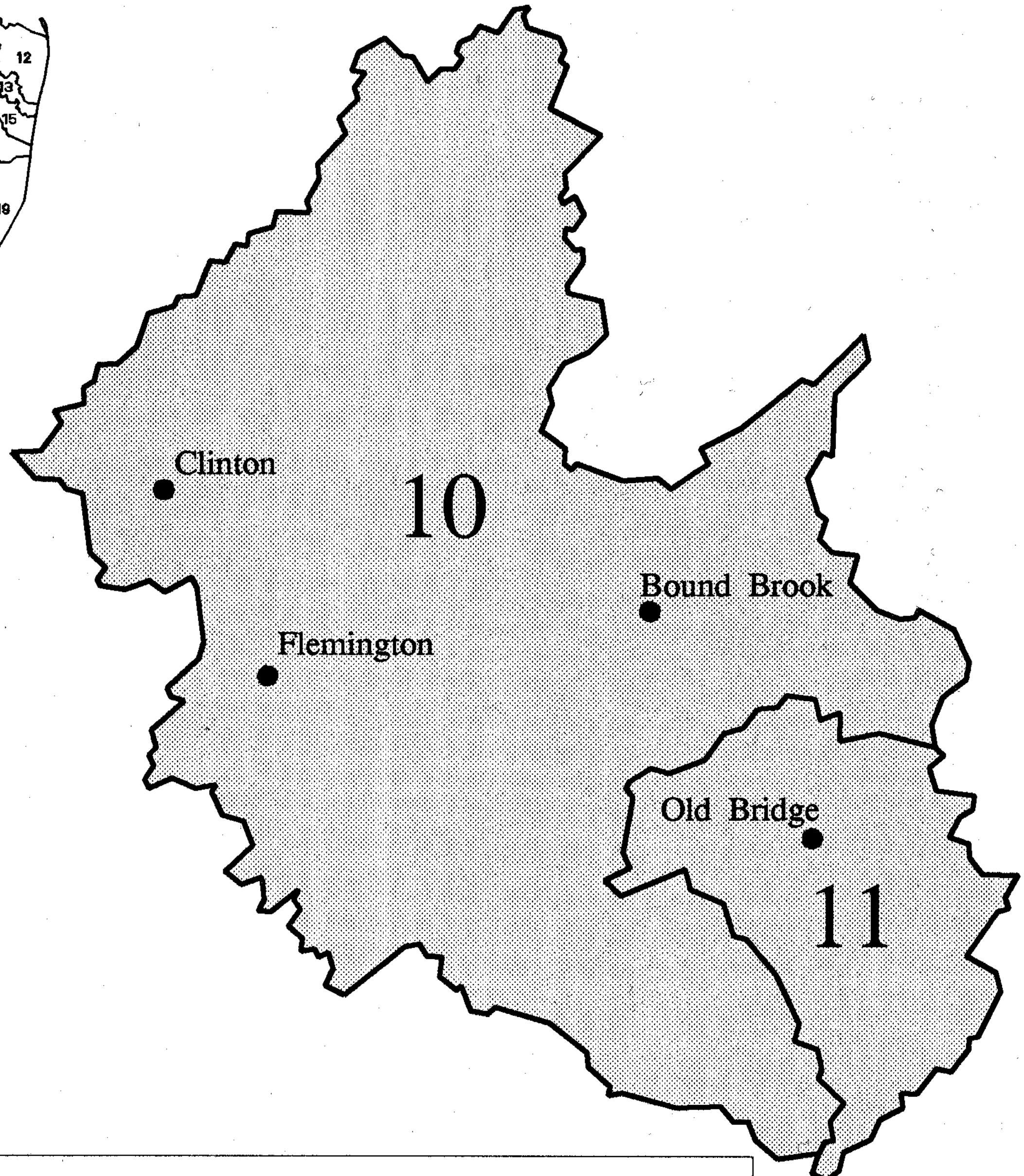
Planning area 11, the South River watershed, is 179 square miles in size and incorporates portions of Middlesex and Monmouth Counties. The watershed is a tributary to the Raritan River at Sayreville, a short distance upstream of the Raritan River's discharge to the Raritan Bay and the Arthur Kill. The total current average water demand (1990) in planning area 11 is 84 MGD (34 MGD from surface water and 50 MGD from ground water).[10] Approximately 75 percent is purveyor supplied and 22 percent is self-supplied industrial. The remaining 3 percent is self-supplied residential and agricultural demand.

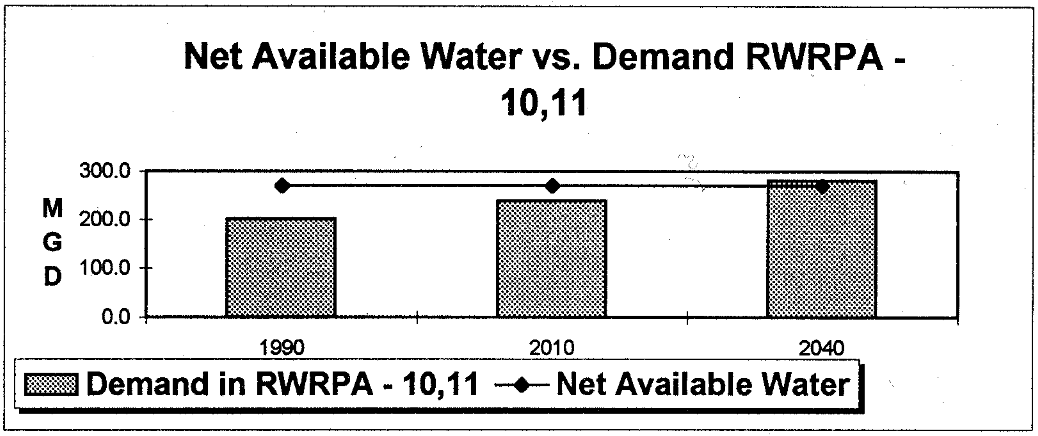
It is estimated that planning area 11 has 25 MGD of available ground water and 8 MGD of surface water safe yield for a total available water supply of 33 MGD. The 25 MGD estimate for ground water availability is especially important, when compared against 1990 ground water use of 50 MGD. The South River planning area is currently unable to adequately supply water to meet its own demands due to the lack of available resources. As indicated in Chapter 3, a water supply deficit situation existed in planning area 11 as of 1990. The planning area does not have a substantial developed surface water resource to utilize other than the Farrington Lake water supply, which is intermittently used for the most part by the City of New Brunswick and has a safe yield of only 8 MGD.

[10] These values have altered significantly since the 1986-1988 period used to estimate 1990 demands, due to a reduced reliance on ground water and increased surface water imports from planning area 10, in compliance with Critical Area No. 1 mandates.



RWRPA 10 Raritan River
RWRPA 11 South River





The following table summarizes the information for water availability, water demand, and surplus or deficit estimates for each of the two planning areas:

Planning Area	Net Available Water	**1990** Water Demand	**1990** Surplus/ Deficit	**2010** Water Demand	**2010** Surplus/ Deficit	**2040** Water Demand	**2040** Surplus/ Deficit
10 Raritan River	213 mgd	118 mgd	95 mgd	141 mgd	72 mgd	164 mgd	49 mgd
11 South River	56 mgd	84 mgd	-28 mgd	98 mgd	-42 mgd	117 mgd	-61 mgd
TOTAL	269 mgd	202 mgd	67 mgd	239 mgd	30 mgd	281 mgd	-12 mgd

Although planning area 11 shows an estimated deficit as of 1990, no regional deficit exists due to the surplus of surface water supplies in planning area 10, and a regional deficit is not projected to occur until very late in the planning period.

2. Planning Issues

Due to withdrawals from unconfined aquifers in comparison to recharge, and due to the findings of the USGS South River Ground Water Study, it is assumed that very little, if any, additional ground water is available in planning area 11 unless artificial recharge is used. Ground water use cutbacks of 50 percent have been mandated and implemented in this planning area since 1990.

The adjacent watershed, planning area 10, is projected to have a surplus of available water to meet its own demand needs through the planning period. As discussed in the *South River Basin Water Supply Study*, due to the close proximity of the Raritan Basin, existing interconnections and the completion of the Middlesex Water Company's regional pipeline, it is assumed that any increased demands in planning area 11 will be supplied by surface water from planning area 10 or by conservation, including and beyond the increased transfers to balance the ground water use reductions after 1990.

Planning area 10 also supplies a substantial amount of surface water to planning area 5 through existing service connections to help meet their demand needs. If there is an increase in the projected demands of planning area 5, there will be less water to be supplied to meet the projected growth in demand for planning area 11, thus triggering the implementation of a new water supply facility sooner than expected. In addition, planning area 10 provides water to planning area 4 for use in municipalities of the southwestern edge of that area.

3. General Recommendations

The NJDEP has projected that a new surface water supply will be required in the Raritan River watershed no sooner than the year 2039, to meet the combined demands of planning areas 10 and 11, and also exports to planning areas 4 and 5. If conservation methods are used aggressively in the two watersheds, it is possible that the need for a new surface water facility could be prolonged beyond the planning period. For a generic discussion of the water conservation program, see Chapter 6.A; for a more detailed discussion, see Chapter 7.B. The two planning areas may also require comprehensive depletive water use reduction initiatives.

The main objective of the F.E. Walter Reservoir Modification Project, located in Luzerne County, PA on the Lehigh River, would be to augment flow in the Delaware River mainstem to meet water supply and salinity objectives during low flow periods in order to deter the threat of salt water movement upstream from contaminating the Potomac-Raritan-Magothy Aquifer system. In addition, the implementation of the

F.E. Walter Reservoir Modification Project would provide an extra 20 MGD of safe yield to planning area 10 by supporting flows in the Delaware River that could be transferred to the Delaware and Raritan Canal and defer the need for a new surface water supply until sometime after this planning period. However, the F.E. Walter Reservoir Modification Project may not be implemented until a funding mechanism is authorized by a modification to the Delaware River Basin Compact.

4. Management Initiative Recommendations

a. Ground Water/Surface Water Management

A preliminary investigation of conjunctive water use of aquifers and ASR should take place. Available ground water in planning area 11 could be increased through the artificial recharge of Raritan surface water from high flow conditions. Planning area 11 could then use Raritan surface water in conjunction with its own stored ground water during drought conditions, which may increase the availability of water in both planning areas.

Costs - $100,000.

Benefits - Conjunctive water use is considered synergistic; the yields of two water sources used conjunctively would be greater than the yields of the sources used independently. Thus, the resource is able to be used for an extended period of time. Also, conjunctive water use delays the need for a capital-intensive project by using existing or proposed interconnections.

Implementation Schedule - 1999/2000.

b. Interconnections

A substantial amount of planning area 10's water is currently transferred through existing service connections to planning areas 4 and 5. An evaluation could be made to determine the feasibility of reducing these transfers of water while subsequently substituting that water with excess surface water from the Upper Passaic watershed as a method to delay a new surface water supply facility.

Costs - No cost will be incurred for this evaluation unless future monitoring shows a surplus of water in planning areas 4, 5 and 6.

Benefits - The potential exists that the initiation of such a project will defer the need for a water supply project in planning area 10 beyond the planning period.

Implementation Schedule - To be determined upon completion of the Passaic/Hackensack Management/Operation Simulation Model.

5. Capital Project Initiative Recommendations

a. Kingston Quarry Reservoir/Confluence Pumping Station

The Eastern Raritan Basin Water Supply Feasibility Study determined that the most cost-effective water supply project to be implemented in the planning areas is the Kingston Quarry Reservoir. This project was proposed by Trap Rock Industries, Inc. as the eventual reclamation plan for their rock quarry when operations cease. The quarry is located in Franklin Township, Somerset County, directly adjacent to the Delaware and Raritan Canal and Millstone River. The quarry would store unused Delaware and Raritan flows and high flows from the Millstone River. Water diversions from these two sources will flow by gravity into the reservoir and water storage releases will be pumped back to the Delaware and Raritan Canal. The reservoir would provide an additional safe yield of 65 MGD to planning area 10. This project is a viable option only if institutional issues can be resolved with Trap Rock Industries, Inc., the owner of the quarry. These issues include the legal terms of turning the site over to the State, guaranteeing a schedule for State acquisition, and providing the necessary reservoir storage volume at the required time of transference.

In the event that the Kingston Quarry is not ready to be converted to a storage facility before demand exceeds the existing yield of the Raritan River watershed, the second most cost-effective water supply project, the Confluence Pumping Station, will be implemented. This project would be located where the North Branch and the South Branch of the Raritan meet to form the mainstem of the Raritan River at the boundaries of Branchburg, Bridgewater and Hillsborough Townships in Somerset County. A 200 MGD intake and a pumping station would be located at this site in Branchburg Township which, along with a 12 mile long, 96 inch diameter force main, will convey water to the Round Valley Reservoir. The new force main would allow water to be pumped to Round Valley for storage and, conversely, allow Round Valley water to be released to the Raritan system farther downstream of the Confluence. The Confluence Pumping Station will provide an additional 53 MGD of safe yield to planning area 10. In both cases, the New Jersey Water Supply Authority (NJWSA) will be the project sponsor.

In either event, the Six Mile Run Reservoir site in Franklin Township, for which land has already been purchased and feasibility studies completed, should remain as a potential, viable water supply project for the 21st century. Public and private uses of these lands should not foreclose their use as a reservoir at any time.

Costs - Kingston Quarry Reservoir (estimated capital cost of $57 million or $0.88 million/MGD).

Confluence Pumping Station (estimated capital cost of $71 million or $1.34 million/MGD).

Benefits - If these projects are implemented (dependent upon previously-mentioned initiatives), the planning areas will have a sufficient supply of available water through the planning period of 1990 to 2040.

Implementation Schedule - The implementation of the Kingston Quarry Reservoir or the Confluence Pumping Station will be determined from continuous monitoring of the study area. The surface water demand will serve as "triggers" for when specific actions should be taken.

b. Water Conservation

Much of the development in planning areas 10 and 11 predates existing water conservation requirements of the State plumbing code. Retrofitting by homeowners is likely to take many decades. A program of aggressive water conservation through retrofitting and alternative landscape management could delay the need for a new surface water supply facility. The costs of such an initiative should be compared to the benefits of delaying the capital project.

Costs - $50,000 for feasibility study to compare costs and benefits of an aggressive structural water conservation program. Unknown costs for implementation.

Benefits - Delayed need for a new surface water supply project.

Implementation Schedule - 1999 feasibility study.

**E. Initiatives for Planning Areas 13, 15 and 16 --
Manasquan, Metedeconk and Toms River Watersheds**

1. Description of Planning Areas

Planning areas 13, 15 and 16 cover the east central portion of the state, including the Manasquan, Metedeconk and Toms River watersheds. The three planning areas are combined and analyzed together due to their proximity and shared water supply problems and potential solutions.[11]

Planning area 13, the Manasquan River watershed, is the smallest of the three, covering 82 square miles in Monmouth and Ocean Counties. Planning area 15, the Metedeconk River watershed, is 123 square miles in size and incorporates portions of Monmouth and Ocean Counties. The largest of the three planning areas is 16, the Toms River watershed, which extends over 209 square miles in Monmouth and Ocean Counties. The projected planning area populations are:

Planning Area	**1990** Population	**2010** Population	**2040** Population
13-Manasquan River	91,000	104,000	115,000
15-Metedeconk River	136,000	157,000	188,000
16-Toms River	205,000	283,000	369,000
TOTAL	432,000	544,000	672,000

The major surface water sources that supply this region are the Glendola and Swimming River Reservoirs (located in planning area 12), Manasquan Reservoir (an off-stream, pumped storage reservoir located in planning area 13), and the Metedeconk River (located in planning area 15). The Metedeconk River is only used when stream flows exceed the passing flow. The major aquifer systems utilized for water supply include the Englishtown, Cohansey, Kirkwood and Potomac-Raritan-Magothy formations. The 1990 water use from surface water sources in this region was approximately 13 MGD (all from planning area 13, as the Metedeconk River supply came on line in 1989 after the 1986-1988 period used to estimate 1990 demands). Water use from confined and unconfined aquifers was about 53 MGD.

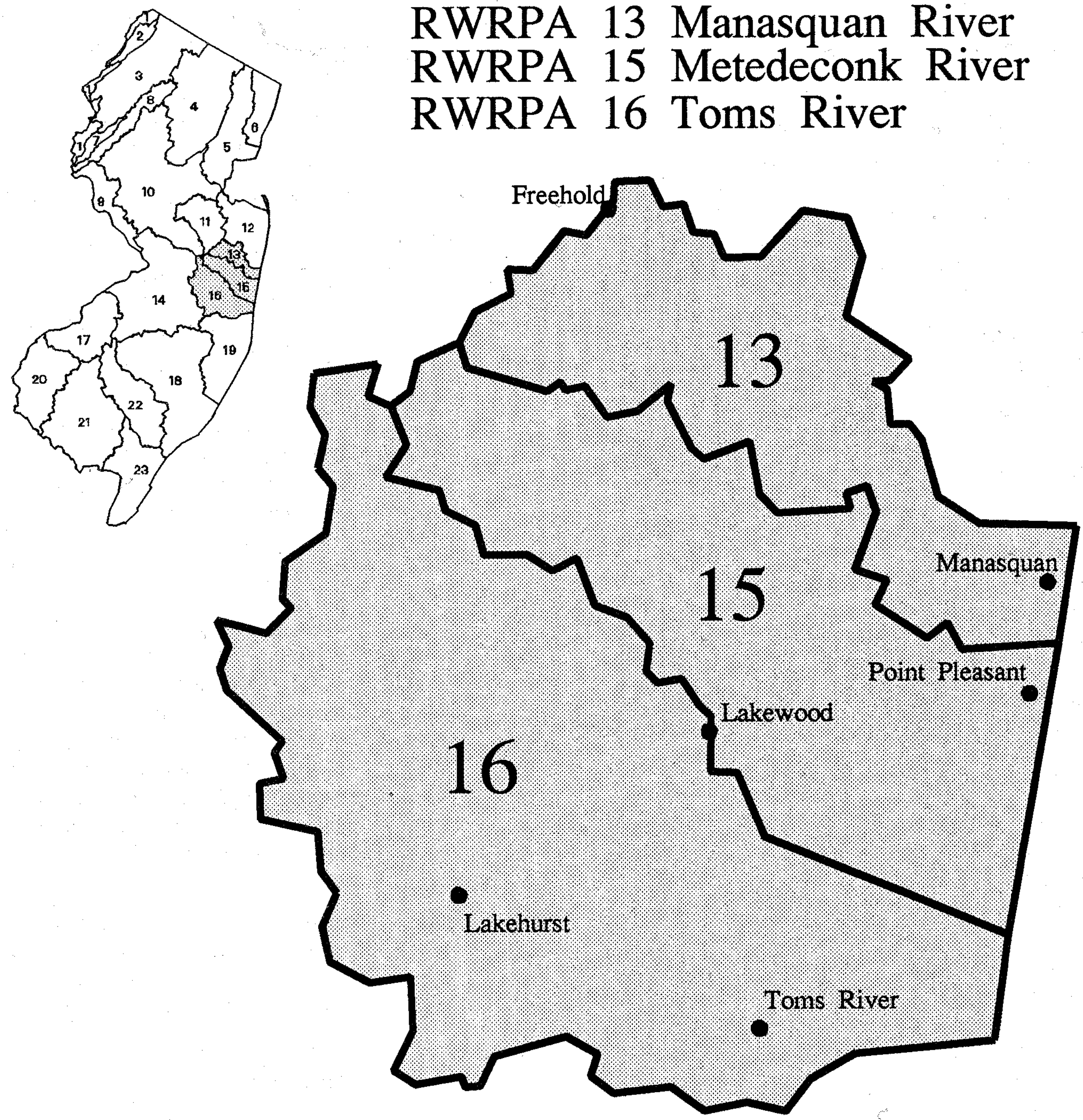
The following table shows water availability, water demand and surplus/deficit estimates for each of the three planning areas:

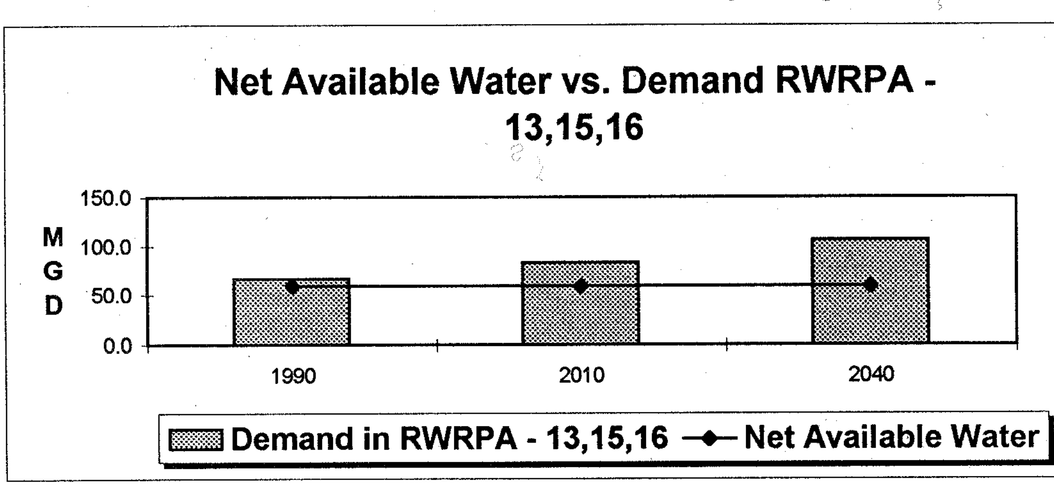
Planning Area	Net Available Water	**1990** Water Demand	**1990** Surplus/ Deficit	**2010** Water Demand	**2010** Surplus/ Deficit	**2040** Water Demand	**2040** Surplus/ Deficit
13 Manasquan River	26 mgd	13 mgd	13 mgd	15 mgd	11 mgd	18 mgd	8 mgd
15 Metedeconk River	11 mgd	15 mgd	-4 mgd	19 mgd	-8 mgd	26 mgd	-14 mgd
16 Toms River	22 mgd	38 mgd	-16 mgd	49 mgd	-27 mgd	62 mgd	-40 mgd

2. Planning Issues

[11] Planning area 12, the Navesink/Swimming River watershed, is also linked with planning area 13 due to the Water Supply Critical Area No. 1 provisions and the supplies provided from the Manasquan Reservoir. Planning area 12 also provides water to planning area 13. However, the primary issue in this section is the projected deficits in planning areas 15 and 16. Planning areas 12 and 13 are not projected to have a deficit, but planning area 12 is too distant to provide supplies to planning areas 15 and 16 and so is not included in this discussion.

RWRPA 13 Manasquan River
RWRPA 15 Metedeconk River
RWRPA 16 Toms River





Planning areas 15 and 16 have significant estimated water supply deficits projected which may require the implementation of new initiatives. Further complicating the picture is the fact that the combined planning areas are located partially or entirely in Water Supply Critical Area #1, where water supply reductions from confined aquifers have been mandated. The Water Supply Critical Areas program serves to limit, and in some cases reduce, the use of water from overdrafted aquifers. Another planning issue is a localized problem of saltwater intrusion in the Point Pleasant area on the coastal barrier islands. A large portion of planning area 16 is located within the New Jersey Pinelands, where restrictions have been placed on water withdrawals. Further stress will be placed on the water supply situation in the future, since it is estimated from projections in population that the region is expected to grow substantially through the planning period 1990 to 2040, as noted earlier in the table.

The region faces high peak water demands during summer months. Increasing the amount of water supplies drawn from shallow aquifers may cause streamflow depletion. Additional challenges facing the area include a lack of potential surface water reservoir sites and the fact that a majority of the area is proposed to be sewered. All regional wastewater treatment plants in this region discharge to the ocean. This represents a large scale depletive water use which may have long-term impacts on water supplies. The shallow aquifers in the area are also vulnerable to pollution due to the permeable soils which exist. In conclusion, this region is faced with critical challenges which need to be addressed.

A study completed by the USGS in 1977 in cooperation with the NJDEP entitled "Digital Computer Simulation Model of the Englishtown Aquifer in the Northern Coastal Plain of New Jersey" discussed this aquifer which supplies water for Monmouth and northern Ocean Counties. This report documents aquifer level declines of 140 feet in coastal areas.

Another USGS study completed in 1979, "Geohydrology and Digital-Simulation Model of the Farrington Aquifer in the Northern Coastal Plain of New Jersey" illustrated potential drawdown levels of the aquifer near Sayreville of greater than 150 feet by the year 2000.

A 1989 USGS study, "Simulated Effects of Future Withdrawals on Water Levels in the Northeastern Coastal Plain Aquifers of New Jersey" demonstrated the effects of increased and reduced withdrawals on the Wenonah-Mount Laurel, Englishtown, upper and middle PRM. The simulations showed that:
the reductions of withdrawals should cause significant recoveries of simulated water levels (as has occurred in reality);
unrestricted rates of withdrawal will cause major cones of depression;
the ground water system responds quickly to changes in withdrawals; and
withdrawals in one part of the system affect ground water levels and flow elsewhere in the system.

The NJDEP is currently undertaking a study with USGS to evaluate the effects of freshwater diversions on estuarine water quality. While only preliminary findings are available to date, this study addresses this study region. The preliminary results indicate that ------------. The USGS is also conducting for NJDEP a study entitled "Evaluation and Monitoring of Stress-Induced Hydrologic Responses in Wetland Areas" intended to provide the ground water management tools to effectively manage the resource while minimizing adverse effects on ground water systems in wetland areas. The USGS is also developing siting criteria for shallow water supply wells in the area.

3. General Recommendations

Potential solutions to the water supply situation in this region include utilization of unallocated Manasquan Reservoir water in combination with conjunctive water use of aquifers. This, however, may only be a partial solution. As the table above shows, an estimated deficit of 46 MGD might be realized by 2040. As such, another major regional project may be needed in the decades to come. First, however, the estimated water supply availability and demand numbers need to be evaluated with greater detail and accuracy. In the event that a deficit is verified, the following initiatives should be evaluated: water conservation program, comprehensive depletive water use reduction, management of ground water withdrawals, an interconnections project, flood skimming during high flow and aquifer use during low flow, conjunctive water use of shallow aquifers during winter and confined aquifers during summer. Protection of existing aquifer recharge and water quality (both surface and ground water) is also needed. For a generic discussion of these initiatives, see Chapters 6 and 7.

4. Management Initiative Recommendations

a. Ground Water Resource Assessment

A comprehensive hydrogeologic investigation is currently being conducted by the USGS in cooperation with NJDEP in this region to assess ground water resources and estimate availability that would not impair ground or surface water resources over the long or short term. A detailed analysis of the estimated water supply availability, demand, and deficit numbers generated during the NJSWSP and as previously listed in the table needs to be defined with specific accuracy in order to reach a final conclusion on the region's water supplies. This analysis should address the shallow aquifer and stream system (Phase I) and then link these results with an analysis of the confined aquifer systems (Phase II). As part of this effort, a re-examination of population and demand projections should occur to ensure that demands are not overestimated or underestimated.

Costs - the cost of the assessment would be approximately $500,000, including current studies.

Benefits - the assessment would provide the necessary information needed to estimate ground water availability and then be used to evaluate ground water optimization options. Also, the assessment should help provide information regarding the adequacy of current Water Supply Critical Area cutbacks.

Implementation Schedule - it is recommended that this assessment be completed as a high priority. It can be linked with other efforts in the same region, such as the Barnegat Bay Estuary Project that has a scheduled completion date of 1998.

b. Water Resource Optimization Alternatives

The combined planning areas utilize about 66 MGD and have a total depletive water use of approximately 45 MGD. There is a significant amount (about 70% of total water use) of water which is discharged to the ocean after treatment. The ground water resource assessment should be utilized to evaluate water resource optimization alternatives. If selected optimization alternatives appear to be impractical, then an interconnections project may be required as discussed in the capital project initiatives chapter below. For these planning areas, it is important to determine what types of scenarios can be implemented for the eventual multiple uses of this depletive water.

Several options are available that should be analyzed. Conjunctive water use of shallow and confined aquifers, of surface waters (i.e., through high-flow skimming) and aquifers, and of surface waters and Aquifer Storage and Recovery are possible new sources. Improved locations for wells and well fields should be considered. Interconnections with planning area 13 (the Manasquan Reservoir) is also possible, if more water is available from that system than needed for planning area 12. The potential for increasing Manasquan Reservoir safe yields through conjunctive water use should be considered as part of that analysis. Water conservation is another option, most likely as a complement to other actions. The alternatives analysis should address each of these and others that are developed through the planning process.

This region could benefit from the development of an aggressive water conservation program. The aim should be at reducing per capita residential and commercial demand, as well as unaccounted-for water. Some examples of water conservation measures that should be included are: limited outdoor irrigation, leak detection, installation of water saving devices, reductions in excessive water system pressure, low water use landscaping, and reuse and recycling. Also, there should be a need to develop conservation measures to help prevent baseflow reductions on streams caused by depletive ground water withdrawals in the Cohansey aquifer. Additionally, the water purveyors in the region could have a substantial impact if they were to implement an aggressive water conservation program.

Costs - To be determined based on revised deficit analysis using new ground water availability estimates. The alternatives analysis should be allocated $500,000 until improved estimates are available.

Benefits - This planning region will benefit from a thorough examination of alternatives to select the optimum mix of management and capital project initiatives from water supply, financial cost and environmental cost perspectives. The alternatives analysis will provide a good focus for the feasibility study (see below).

Implementation Schedule - study of these water resource optimization alternatives should be implemented following the ground water resource assessment if it concludes that a significant deficit is still projected, as noted in (a) above. Study would most likely begin in 1998 or 1999.

5. Capital Project Initiative Recommendations

a. Feasibility Study/Interconnections Project

If the water resource optimization options indicate that capital projects are required to address anticipated deficits, then a feasibility study should be conducted to determine the most appropriate scope, sizing, mix, costs and design of capital projects.

Costs - approximately $500,000.

Benefits - The feasibility study will provide sufficient information through a public process to allow final management and capital project initiatives to be selected and implemented by a collaborative approach involving water purveyors, wastewater discharge systems, local governments and the NJDEP.

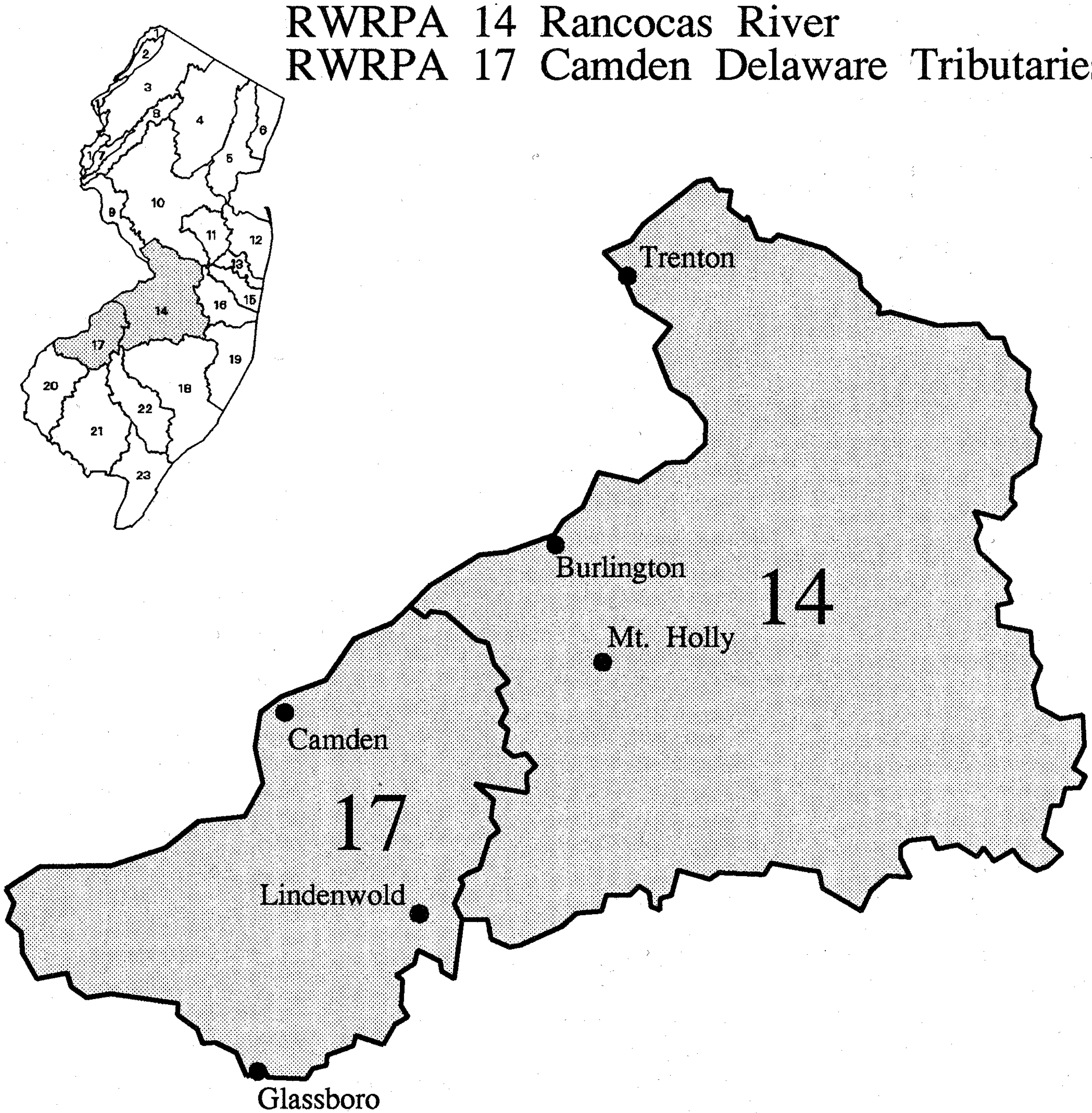
Implementation Schedule - to be developed as a high priority and to be initiated once the results of the Ground Water Resource Assessment previously mentioned under (a) are completed and the results warrant this recommendation.

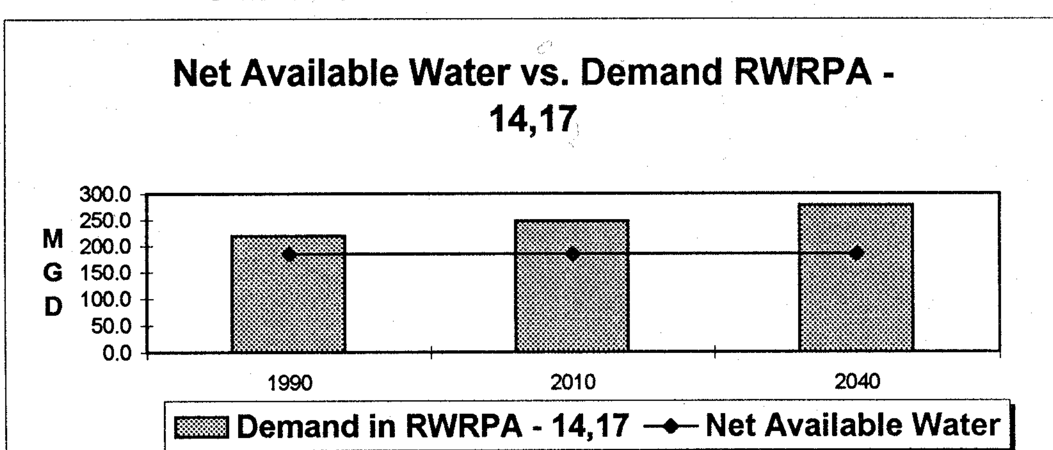
F. Initiatives for Planning Areas 14 and 17 --
Rancocas Creek and Camden Delaware Tributaries Watersheds

1. Description of Planning Areas

Planning areas 14 and 17 cover the west central portion of New Jersey, including the Rancocas Creek and the Camden Delaware Tributaries watersheds. The two planning areas were analyzed jointly due to their proximity and shared water supply problems and potential solutions.

RWRPA 14 Rancocas River
RWRPA 17 Camden Delaware Tributaries





Planning area 14, the Rancocas Creek watershed, is the largest of the two, extending 696 square miles and incorporating portions of Burlington, Camden, Mercer, Monmouth and Ocean Counties. Planning area 17, a group of small tributaries to the Delaware River, is about 295 square miles in size and incorporates portions of Burlington, Camden and Gloucester Counties. The 1990 population for the combined area was approximately 1,232,000 people, which is about 16% of the total statewide population of 7,730,000. The projected planning area populations are:

Planning Area	**1990** Population	**2010** Population	**2040** Population
14-Rancocas Creek	563,000	625,000	692,000
17-Camden Delaware	669,000	702,000	747,000
TOTAL	1,232,000	1,327,000	1,439,000

The major surface water source that supplies this region is the Delaware River. The major aquifer systems utilized for water supply include the Potomac-Raritan-Magothy, Mt. Laurel-Wenonah, Englishtown, Cohansey and Kirkwood formations. The 1990 surface water use in this region was approximately 69 MGD. Ground water use from both confined and unconfined aquifers was about 150 MGD.

The following table shows water availability, water demand, and surplus/deficit estimates for each of the two planning areas:

Planning Area	Net Available Water	**1990** Water Demand	**1990** Surplus/ Deficit	**2010** Water Demand	**2010** Surplus/ Deficit	**2040** Water Demand	**2040** Surplus/ Deficit
14 Rancocas Creek	136 mgd	101 mgd	36 mgd	120 mgd	16 mgd	135 mgd	1 mgd
17 Camden Delaware	49 mgd	118 mgd	-70 mgd	128 mgd	-80 mgd	142 mgd	-94 mgd
TOTAL	185 mgd	219 mgd	-34 mgd	248 mgd	-64 mgd	277 mgd	-93 mgd

2. Planning Issues

The above analysis confirms that planning area 17 possesses a serious estimated water supply deficit and should require alternatives on an immediate basis. Most of both planning areas are located in Water Supply Critical Area #2, where recent restrictions are reducing ground water withdrawals to reduce stress on the aquifer, allow for increased replenishment and recovery of the potentiometric head, and thereby reducing the potential for saltwater intrusion. Another planning issue is that large portions of planning area 14 are located within the New Jersey Pinelands which have water use restrictions, placing further constraints on the water supplies. Last, a significant increase in population is projected for the region through the planning period 1990 to 2040. The challenge for this region is to implement initiatives to ensure an adequate water supply for the projected and current populations while reducing stresses on the aquifers. Based on previous feasibility studies and new laws, actions are taking place to achieve these objectives.

3. General Recommendations

The primary solutions to the water supply situation in this region are the Tri-County Project and subregional alternatives outside of the current service area of the project, such as: A-2250 implementation, water conservation, conjunctive use, aquifer storage and recovery wells, and management of ground water supplies. For a generic discussion of these initiatives see Chapter 6.A and Chapter 7.

4. Management Initiative Recommendations

a. Ground Water Supply Management

Continued evaluation by local entities and NJDEP of alternative water supplies is recommended for those municipalities and new growth areas in the region not anticipated to be tied into the Tri-County service area for water supplies. The ground water supplies have been shown to be overstressed in the confined portion of the PRM formation and are also subject to regional contamination in the outcrop/recharge portions of planning area 17. Additional supplies of approximately 8 to 16 MGD could be obtained locally from the Cohansey Sand aquifer as discussed in the consultant's report for the NJSWSP efforts. An evaluation of potential new Cohansey ground water development opportunities should be undertaken in the southeastern portion of planning area 17 that is not anticipated to have access to Tri-County Project water in the near future, and in the Pinelands area to serve development in planning area 14. In both cases, use of shallow aquifers should be complemented by well head and aquifer recharge protection efforts to ensure that these new supplies are not impaired in the future. The results and findings of ground water studies should be integrated to form a ground water optimization plan for the region. In addition, a Wetlands Impact Study that is now underway will help determine the quantity of water available from the Cohansey. Last, the results of the Confined Ground Water Optimization Study currently in progress should be used to determine if modification of water use patterns is required and what monitoring should be established to verify the study results.

Of future concern in the Camden Metropolitan Area is the maintenance of continued water quality in an area where contamination sites are ubiquitous and interspersed with numerous water supply wells. There will probably be continuing efforts to manage hazardous waste sites in the area; these efforts should include reinjection of treated water from contaminated sites, anticipation of water supply effects and development of suitable treatment technologies. There are also threats of contamination from Pennsylvania under the Delaware River which are being evaluated jointly by Pennsylvania Department of Environmental Protection and NJDEP.

Costs - the cost of the above initiatives, other than existing studies and ground water protection efforts described elsewhere is approximately $200,000.

Benefits - continued analysis of ground water alternatives will provide updates on progress toward reducing stresses on the confined aquifers, improve selection of new well sites to minimize the potential for well contamination and environmental concerns, and highlight priorities for ground water protection.

Implementation Schedule - these initiatives represent a high NJDEP priority and should be initiated immediately following adoption of this plan.

5. Capital Project Initiative Recommendations

a. Tri-County Project

The NJSWSP continues to support implementation of this project, as recommended by the 1982 Plan (as updated). The Water Supply Critical Area legislation (A-2250) which allows the NJDEP to restrict withdrawals on stressed aquifers should be implemented as expeditiously as possible. A critical aspect of implementation is the Tri-County Project (funded and owned by the NJ American Water Company) which is located in planning area 17. This project utilizes the Delaware River as the source of supply. The plans are to expand the treatment plant (constructed with a modular design allowing 10 MGD expansions) as needed based on contracts with water supply systems that must reduce their use of the PRM aquifers. The

Tri-County Project can be expanded in stages up to 100 MGD as necessary. In addition, the Tri-County Project can be complemented by aquifer storage and recovery for purveyors with high peak summer demands.

Costs - the costs of the Tri-County Project are estimated at $170 million, which is being funded fully by New Jersey-American Water Company, including a $100 million loan from the Economic Development Administration.

Benefits - This project will mitigate overpumpage in the confined portion of the PRM aquifer. The Tri-County Project should provide a major portion of the water needed in planning area 17, with the exception of the southern and eastern portions where municipalities are seeking alternative sources, such as the Cohansey Sand aquifer either from planning area 17 or 20.

Implementation Schedule - The initial phase of the Tri-County Project treatment plant was completed in December, 1995.

G. Initiatives for Planning Area 18 -- Mullica River Watershed

1. Description of Planning Area

Planning area 18, the Mullica River watershed, is 733 square miles in size and incorporates portions of Atlantic, Burlington, Camden, Cape May and Ocean Counties. The principle waterway in the planning area is the Mullica River. The total current average water demand (1990) in the planning area is 130 MGD (90 MGD from ground water and 40 MGD from surface water). The majority of the ground water demand is diverted from the Cohansey aquifer. Approximately 62 percent is self-supplied agricultural; 22 percent is purveyor supplied. The remaining 16 percent is self-supplied residential and industrial demand. The projected planning area populations are:

Planning Area	**1990** Population	**2010** Population	**2040** Population
18-Mullica River	220,000	247,000	284,000

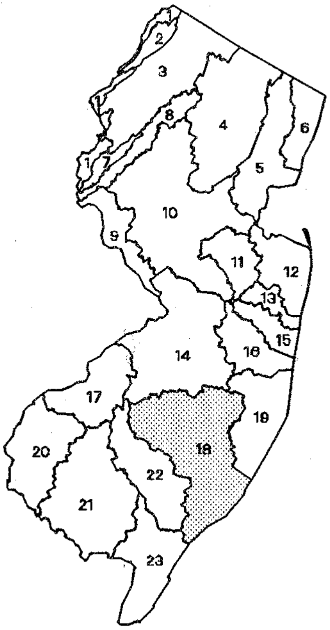
It is estimated that planning area 18 has 64 MGD of available ground water and 9 MGD of surface water safe yield for a total available water supply of 73 MGD. Only 1 MGD is transferred into the planning area. The following table shows water availability, water demand, and surplus/deficit estimates for planning area 18:

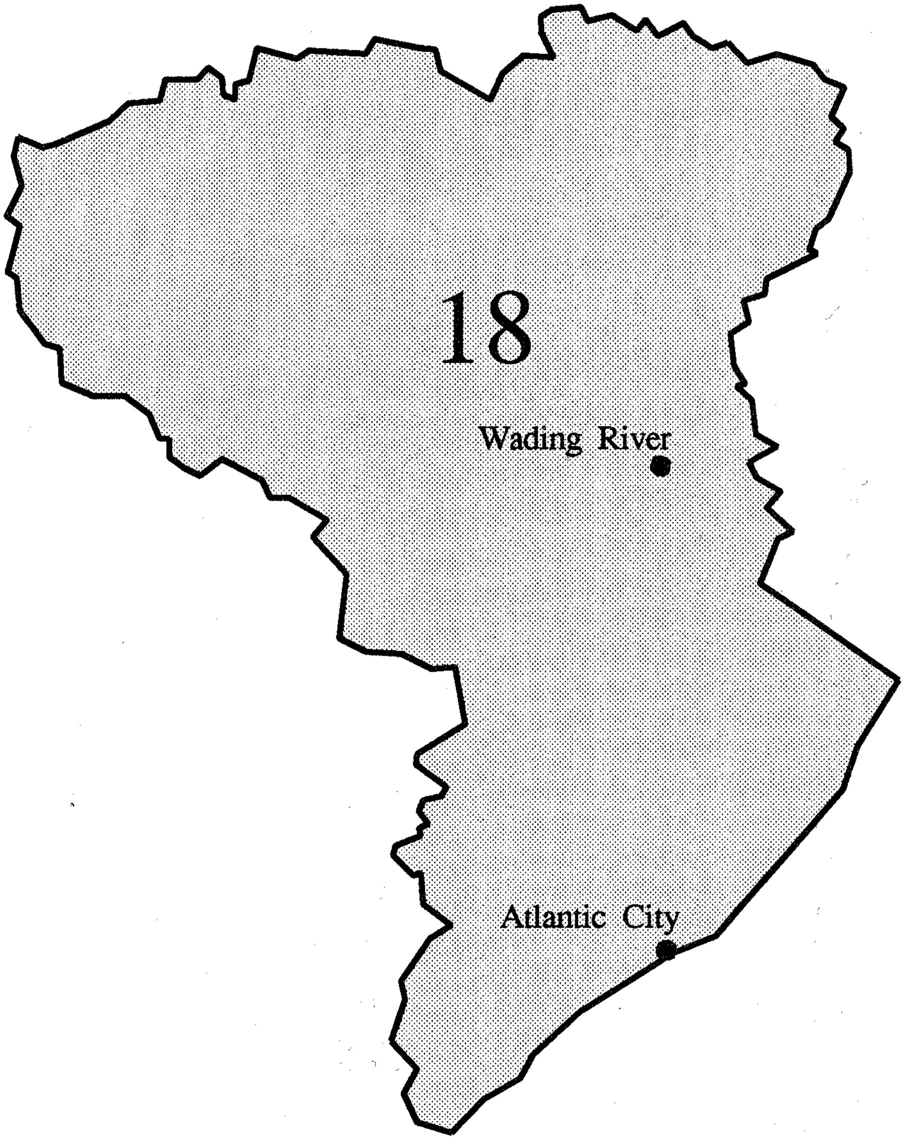
Planning Area	Net Available Water	**1990** Water Demand	**1990** Surplus/ Deficit	**2010** Water Demand	**2010** Surplus/ Deficit	**2040** Water Demand	**2040** Surplus/ Deficit
18 Mullica River	74 mgd	130 mgd	-56 mgd	156 mgd	-84 mgd	161 mgd	-87 mgd

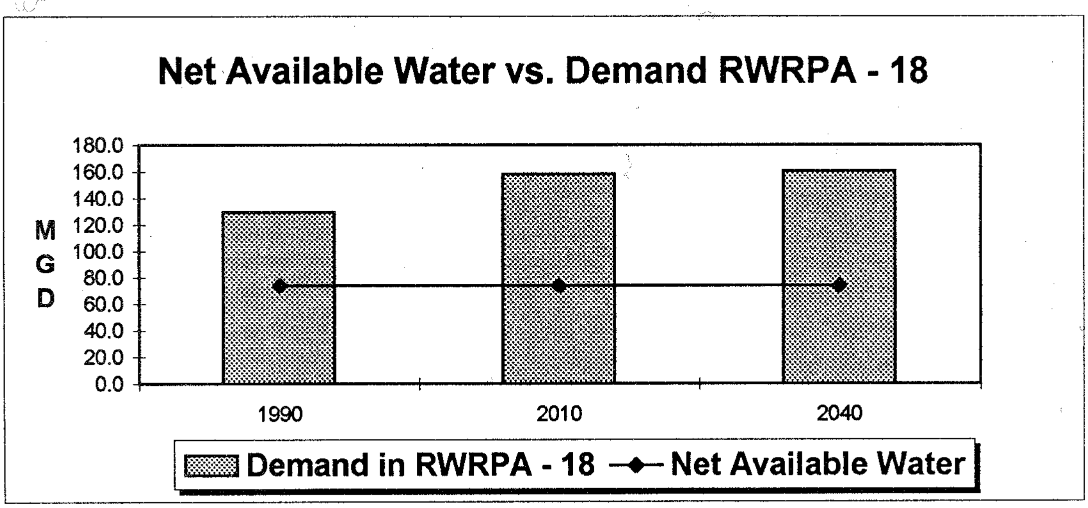
2. Planning Issues

As indicated in Chapter 5, an estimated water supply deficit situation exists in the Mullica River watershed. The reliability of this estimated deficit is highly questionable due to uncertainties regarding the amount of agricultural surface water withdrawals (e.g., for cranberry and blueberry farming) in the area. Revised analyses are needed to determine the actual amount of these withdrawals, the time which they occur and what percentages are consumptive or depletive in nature. If these surface water and shallow aquifer withdrawals are occurring during low-flow periods, there may be an increased potential for saltwater

RWRPA 18 Mullica River







intrusion into the estuaries. There have been some baseline data collected from the "*Estuary Impact Study"* by USGS and NJGS to determine where the salt front is located in the Mullica Basin. In addition, it must be recognized that under severe drought conditions, the farmers in this planning area may face shortages of available surface water because their supplies are not backed by safe yields based on reservoir storage.

3. General Recommendations

The primary recommendation is to develop a more reliable deficit analysis for this planning area. However, regardless of the deficit analyses, the high level of agricultural use indicates that continued attention to water conservation methods for all types of water users in planning area 18 is appropriate. In addition, the Atlantic County Water Supply Implementation Plan (draft) is recommending that a watershed management plan be developed for this planning area. For a more detailed discussion of the water conservation program, see Chapter 7.B. The following initiatives listed below are more specific for the management of the water resources in planning area 18.

4. Management Initiative Recommendations

a. Database for Withdrawals

The NJDEP, along with the New Jersey Department of Agriculture, should coordinate a definitive measurement of ground and surface water agriculture uses, when withdrawals and releases take place, and whether they are consumptive or depletive in nature. The creation of this database should eliminate any "double counting" of water that may be occurring in the planning area. The timing of withdrawals/releases should then be compared to stream flow data to determine if any adverse effects are taking place. Once a standard method is in place, modifications to the NJDEP's Water Balance Model database should be formulated to track the withdrawals.

Costs - $70,000.

Benefits - Water availability for the planning area will be better known. An improved accounting of water use in the planning area may significantly alter the water deficits which are projected.

Implementation Schedule - 1997 or 1998.

b. Shallow Aquifer Study

If information gathered from initiative (a) proves that the amount of water withdrawals reported by agricultural users is correct, an expansion of the recently conducted shallow aquifer study should occur. Approximately 73 MGD of withdrawals from the Cohansey aquifer are being reported at this time. The available ground water based on 10 percent of recharge for the planning area is only estimated to be 63 MGD. Overpumping of the Cohansey could cause adverse effects such as baseflow reductions in the Mullica River or the inducement of the salt front into the estuaries.

Costs - $300,000.

Benefits - Determination of ground water availability would replace the existing 10 percent planning threshold and allow for a better understanding of the resource limits.

Implementation Schedule - Phase 1 completed; Phase 2 (if needed) 1999-2000.

5. Capital Project Initiative Recommendations

No capital project initiatives are recommended at this time.

H. Initiatives for Planning Areas 20 and 21 -- Salem, Cohansey and Maurice River Watersheds

1. Description of Planning Areas

Planning areas 20 and 21 cover the south-west portion of the State and are comprised of the Salem, Cohansey and Maurice River watersheds. These planning areas have been combined in this chapter based on the planning assumption that a water supply deficit exists in planning area 21 that could be resolved in connection with the related water resources in planning area 20 through a regional solution. The two planning areas demonstrate similar hydrogeologic, demographic and environmental characteristics and issues.

Planning area 20 is the Salem River watershed. It encompasses 368 square miles including parts of Salem, Gloucester and Cumberland Counties. Planning area 21 includes the Maurice and Cohansey River watersheds. The area is 605 square miles that includes portions of Cumberland, Gloucester, Salem and Atlantic Counties. The projected planning area populations are:

Planning Area	**1990** Population	**2010** Population	**2040** Population
20-Salem River	69,000	72,000	77,000
21-Maurice River	191,000	215,000	248,000
TOTAL	260,000	287,000	325,000

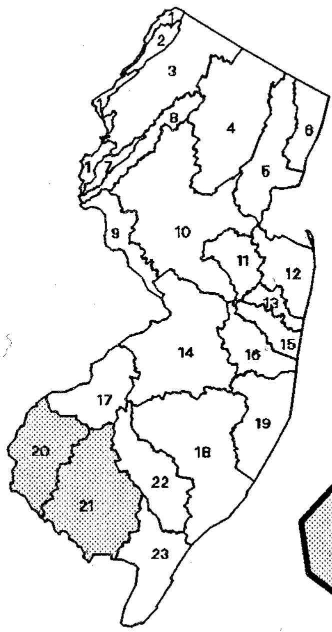
Both planning areas receive their water from ground and surface supplies; however planning area 21 receives nearly all of its average 63 MGD withdrawal from ground water supplies. Planning area 20 is more evenly distributed between surface and ground water uses although industrial surface water withdrawals account for about 10 MGD of the 17 MGD average annual surface water withdrawal. Other than industrial use, the majority of surface water used in the planning areas are stipulated withdrawals for agricultural users (i.e., surface water sources that lack safe yields).

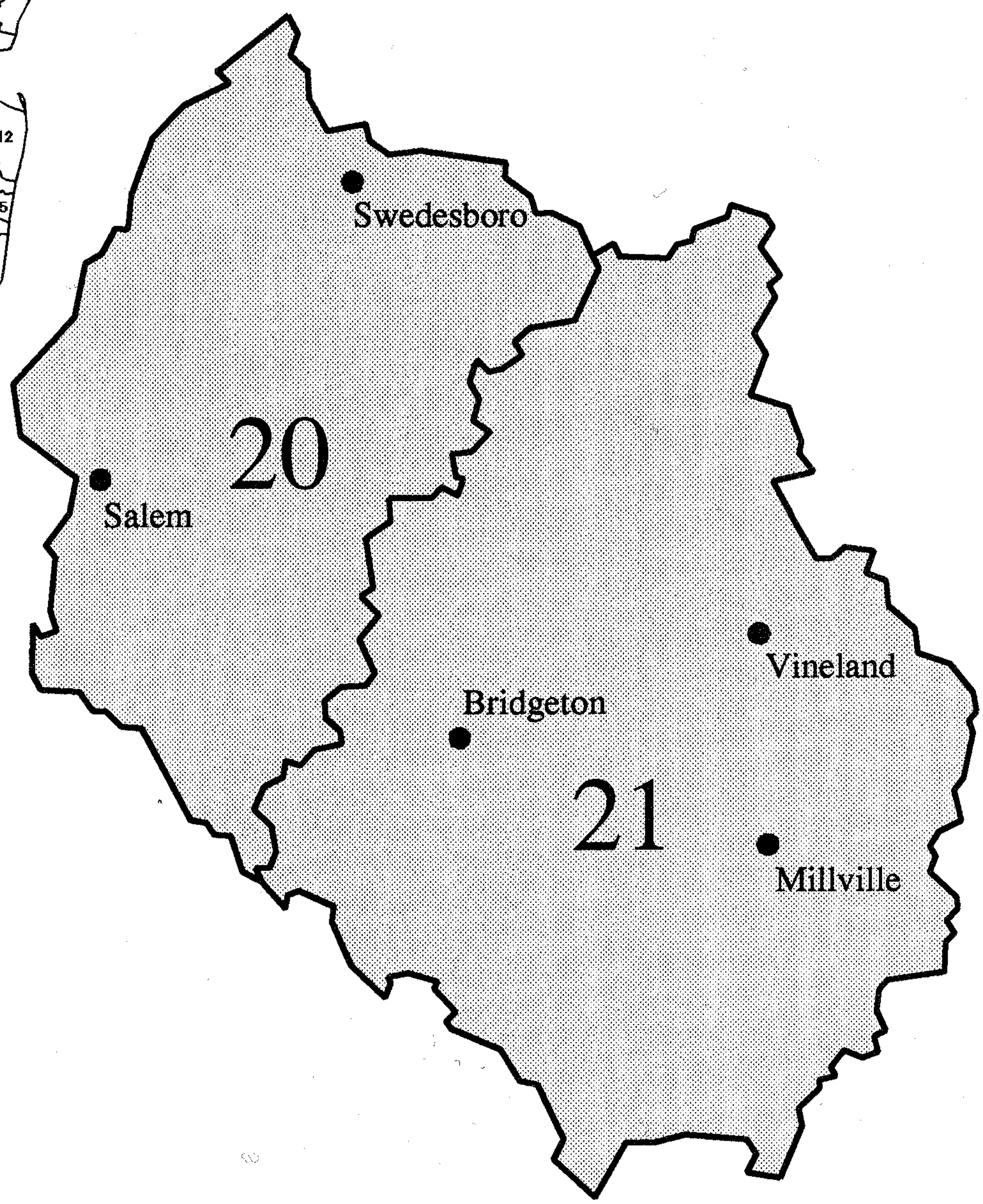
The majority of ground water withdrawn is from the unconfined Kirkwood-Cohansey aquifer system.[12] The confined aquifers are subject to saltwater intrusion, and are contained partially within Water Supply Critical Area No. 2. The following table shows water availability, water demand, surplus and deficit estimates for each of the planning areas:

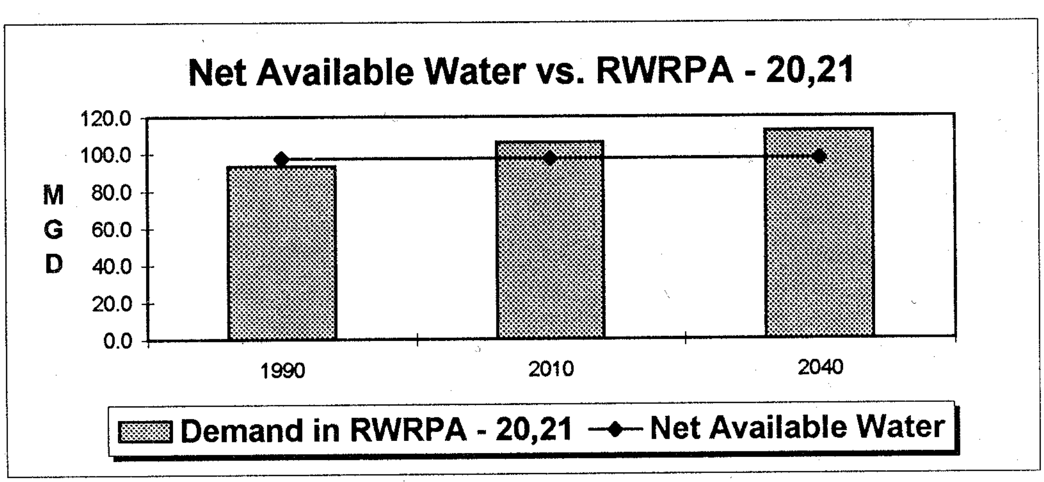
Planning Area	Net Available Water	**1990** Water Demand	**1990** Surplus/ Deficit	**2010** Water Demand	**2010** Surplus/ Deficit	**2040** Water Demand	**2040** Surplus/ Deficit
20-Salem River	43 mgd	31 mgd	12 mgd	34 mgd	9 mgd	35 mgd	8 mgd
21-Maurice River	54 mgd	63 mgd	-9 mgd	72 mgd	-18 mgd	77 mgd	-23 mgd

[12] The net available water from planning area 21 includes consideration of treated wastewater effluent from the Landis Sewerage Authority that is reinjected to ground water, which serves as an addition to natural infiltration from precipitation.

RWRPA 20 Salem River
RWRPA 21 Maurice River







TOTAL	97 mgd	94 mgd	3 mgd	106 mgd	-9 mgd	112 mgd	-15 mgd

2. Planning Issues

Planning area 21 is estimated to be in deficit because there is no surface water storage (and therefore no safe yield) and because ground water use exceeds the estimated total available ground water supply of 54 MGD. Ground water supplies in planning area 20 that are potential water sources to meet planning area 21 demands may not be readily accessible because of their location in the Pinelands, their susceptibility to saltwater intrusion or their location in Water Supply Critical Area No. 2. In addition, the eastern portion of planning area 21 includes a part of the New Jersey Pinelands and the southern portion of the planning area has extensive coastal wetlands, which could limit the potential for unconfined aquifer use. The confined aquifers of the two planning areas are subject to upconing of ancient saltwater that is contained within the hydrogeologic unit.

The challenge facing planning area 21 should be to determine if ground water optimization schemes can resolve potential water supply problems. This should be determined once the extent of the problem is known. Ground water is available in the planning areas; however, it must be developed strategically. Depletive water use and stipulated withdrawals could also continue to challenge planning area 21.

The challenge facing planning area 20 is the protection and optimum use of its present resources. Present supplies in planning area 20 should be carefully monitored in order to prevent the demand from exceeding available water. Base flow reduction could continue to be a challenge for the planning area, because streams in southern New Jersey derive a large percentage (on the order of 80 to 90 percent) of their total annual flow from ground water, with only a small percentage of flow coming from surface runoff. In addition, further evaluation of current surface water uses is needed to determine their impacts during low-flow periods.

Other issues affecting water availability in the planning areas include the inclusion of the Maurice River in the Wild and Scenic River Program and significant ground water contamination problems. Water withdrawals by PSE&G Nuclear Power Plant from wells tapping the Wenonah-Mount Laurel aquifer have been documented with increasing chloride levels as reported by USGS in "Distribution of Chloride Concentrations in the Principal Aquifers of the New Jersey Coastal Plain, 1977-1981"; therefore, this aquifer could also have limited resources.

Recognizing the potential for water supply concerns in this area, NJDEP initiated studies through USGS to analyze water resources in planning area 20 that will complement and be linked to existing studies in planning area 21. A ground water resource assessment (Phase I) already exists for the upper Maurice River watershed and is being completed in planning area 21. The studies result in a water budget to calculate rates of recharge to the Cohansey aquifer in the watersheds. The studies also determine interactions between ground water flow systems of surficial aquifers and the surface water system of the basins. Another study, "Hydrologic Feasibility of Water Supply Development of Confined Coastal Plain Aquifers" will result in identification of hydrologically feasible scenarios and areas for water supply development and identify the locations of the saltwater front for each of the confined aquifers. The study will prioritize watersheds that have the greatest potential for overdraft and will include modeling of the area with a ground water simulation model.

Recent results indicate that most of planning areas 20 and 21 are in close proximity to one or another saltwater front. A study by the USGS in cooperation with the NJDEP entitled, "Water Levels in Major Artesian Aquifers of the New Jersey Coastal Plain" documents saltwater intrusion and cones of depression of the aquifers in the region. The study on the "Evaluation and Monitoring of Stress-Induced Hydrologic Responses in Wetlands Areas" will determine what are baseline or natural effects in the wetlands and how water enters the system.

3. General Recommendations

Planning area 21 water deficits could be a result of: 1) withdrawals from surface supplies that are not supported by storage; and 2) the relationship between available ground water and total ground water withdrawals, depletive water use and contamination. The following management initiatives are meant to assist local water managers to make planning decisions about regional water supplies.

4. Management Initiative Recommendations

a. Stipulated Withdrawal Status Report

Because permitted and agricultural surface water withdrawals that lack safe yields are a concern in planning areas 20 and 21, an examination of these "stipulated" withdrawals should be conducted for both planning areas. This report would serve as the basis for determining if low-flow conditions in streams are reduced or prolonged by such withdrawals. The report would identify and quantify who and where these withdrawals are a actually a problem and result in a modification to the Water Balance Model as appropriate.

Costs - $25,000 for the report.

Benefits - identifying surface water withdrawals that may either face cutoffs during droughts or that may prolong low flow conditions in the planning areas to the detriment of surface water ecosystems.

Implementation Schedule - 1998 "Stipulated Water Withdrawal Report For Planning Areas 20 and 21."

b. Future Ground Water Investigations

The ground water resource assessments are providing baseline data for the shallow aquifer systems of planning areas 20 and 21. A Phase II study will then link the surficial and confined aquifers and the surface water systems of these watersheds to provide an analytical tool that will assist in the selection of water supply alternatives.

Costs - $400,000 for remaining Phase I and all Phase II studies.

Benefits - Understanding the relationships between surface water and surficial aquifer systems could provide water managers with tools for water supply planning by allowing them to create a ground water development plan for their planning area. The data gathered for the region would be used to implement a long-term water supply plan.

Implementation Schedule - 1995 - 1998 Phase I and Phase II Ground Water Resource Assessment for Planning Areas 20 and 21.

c. Future Ground Water Feasibility Study

The Confined Coastal Plain Study should provide the baseline data on the optimal use of the confined aquifers. This information in conjunction with that from the shallow aquifer study will then need to be used to estimate water available and associated costs under various pumping scenarios resulting in a ground water feasibility study.

Costs - The cost of a water supply feasibility study that would explore the benefits of utilizing various optimization alternatives would be approximately $125,000.

Benefits - The near total reliance on ground water, saltwater intrusion concerns and the adjacent water supply critical area, make protection and optimum development of available water resources important to planning areas 20 and 21.

Implementation Schedule
1999 -2001 "Water Supply Feasibility Study for Planning Areas 20 and 21"

d. Create a Water Resources Council

NJDEP has found in several regions that the voluntary development of a Water Resources Association (or Council) by the respective counties provides an excellent forum for regional discussion and the development of cooperative water resource management efforts (See discussion of Cape May, below). Because planning areas 20 and 21 extend across several counties, development of a regional (rather than single-county) advisory body is recommended. It should involve interests from at least Cumberland, Salem and Gloucester Counties, because most of the planning areas are within those counties. NJDEP would work closely with this advisory board.

Costs - Negligible.

Benefits - Regional entity would be involved with issues of the three watersheds, and thus able to avoid a fragmented approach to water supply planning.

Implementation Schedule - 1997-1999 - Pass resolutions by various County Boards of Freeholders creating regional entity.

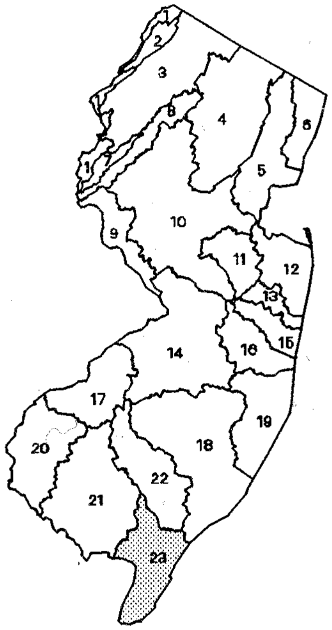
5. Capital Project Initiative Recommendations

The management initiatives identified above should serve as the impetus for the water supply managers of these planning areas to develop capital projects that could help resolve water supply problems and extend current supplies. An update to the NJSWSP should be adopted based on the feasibility study to provide for any necessary capital project initiatives.

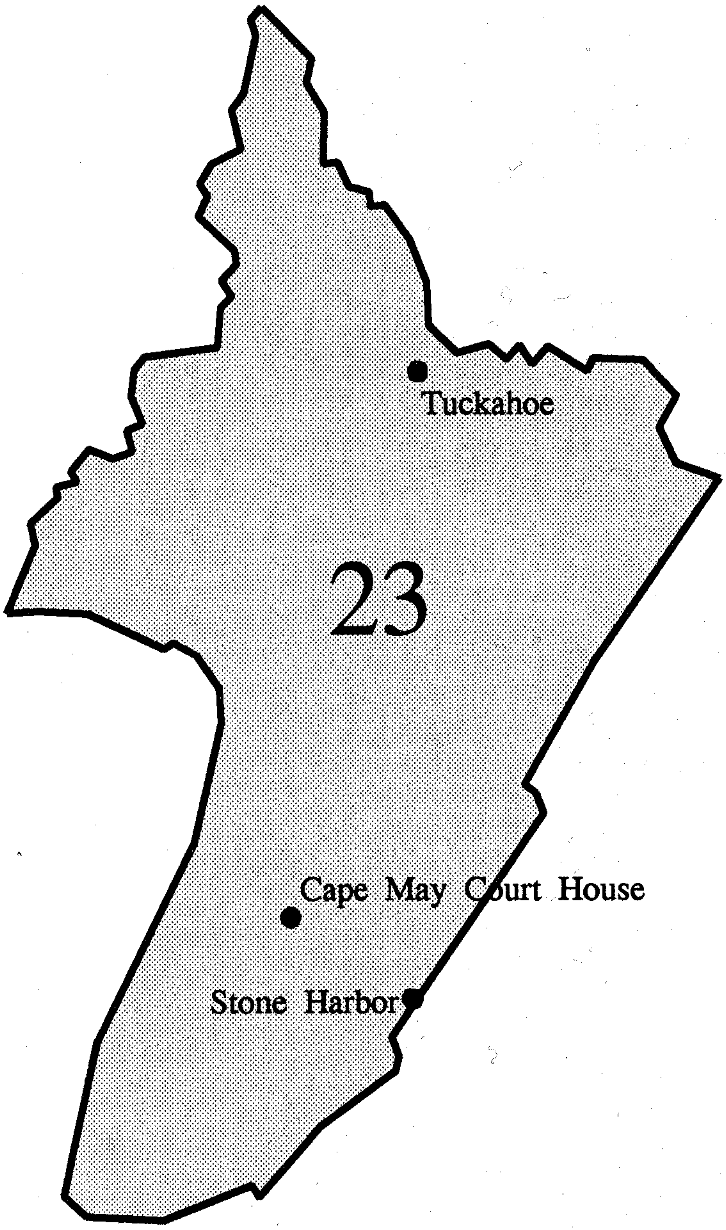
I. Initiatives for Planning Area 23 -- Cape May Coastal Watershed

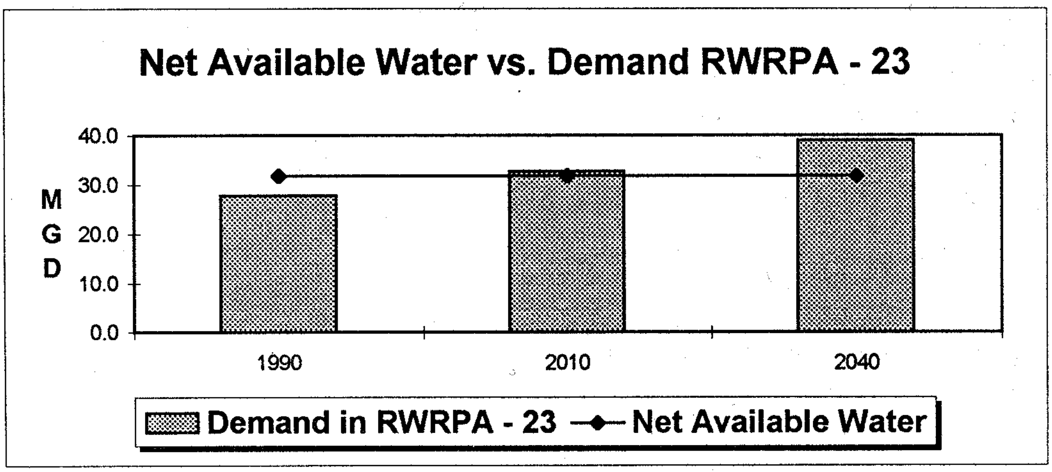
1. Description of Planning Area

Planning Area 23 is the Cape May Coastal watershed. The majority of the planning area is a peninsula and thus is unique. It is vulnerable to saltwater intrusion due to its location, with saltwater to the west, south and east. There is little potential for surface water supplies, especially along the peninsula. Cape May's desirability as a vacation resort places an significant strain on its limited water resources, especially in southern Cape May County and along the barrier islands. The predicted increase in population will increase stresses. A corresponding increase in ground water withdrawals could contribute to declining ground water levels as already documented in the southern Cape May County area. Because public supply wells of the



RWRPA 23 Cape May Coastal





past were typically located near demand they were drilled near the natural saltwater front. The yield of the shallow aquifer system has been exceeded in the southern Cape area, allowing saltwater to replace formerly freshwater supplies.

This planning area encompasses 341 square miles including small portions of Atlantic and Cumberland Counties and all of Cape May County. The projected planning area populations are:

Planning Area	**1990** Population	**2010** Population	**2040** Population
23-Cape May Coastal	95,000	122,000	159,000

The seasonal population of Cape May Coastal planning area fluctuates markedly, with summer populations estimated in excess of 600,000. Water purveyor demand accounts for over 56% of the total average demand and 62% of total peak average demand. Similarly, the peak demand is projected to increase by 46% for the planning horizon from about 49 MGD in 1990 to about 72 MGD for 2040. The following table shows water availability, average water demand, surplus and deficit estimates for planning area 23:

Planning Area	Net Available Water	**1990** Water Demand	**1990** Surplus/ Deficit	**2010** Water Demand	**2010** Surplus/ Deficit	**2040** Water Demand	**2040** Surplus/ Deficit
23-Cape May Coastal	32 mgd	28 mgd	4 mgd	33 mgd	-1 mgd	39 mgd	-7 mgd

2. Planning Issues

The challenge facing water managers for planning area 23 is to pursue regional water supply planning and to locate future aquifer withdrawals optimally with respect to the saltwater front. Particular issues that should be addressed by water supply managers in planning area 23 are: the projected 68% increase in population by 2040, the high seasonal demand placed on the aquifers, and localized saltwater intrusion problems. The recommended actions that Cape May County water managers may utilize to mitigate or prevent these problems are: 1) developing a county-wide water conservation program; 2) conjunctive water use of aquifers during peak demand and 3) relocating or creating new well fields or building a desalination facility.

Specific projects conducted in the planning area to date are the Cape May County Water Supply Study by USGS. The results of this study have included several reports, including "Ground-Water Hydrology and Simulation of Saltwater Encroachment, Shallow Aquifer System of Southern Cape May County, New Jersey," "Saltwater Intrusion Into Fresh Ground-water Supplies, Southern Cape May County, New Jersey, 1890-1991", "Analysis of Saltwater Intrusion in the Atlantic City 800-Foot Sand Toward Public Supply Wells in Cape May County, New Jersey" and the preliminary report on "Environmental Limitations to Water-Resource Availability in Cape May County, New Jersey." The NJDEP will shortly publish a report “Saltwater Intrusion and Proactive Water Supply Planning in Cape May County, New Jersey,” which evaluates various options capable of mitigating the intrusion problem.

The reports indicate that saltwater intrusion is occurring in the southern Cape area in the unconfined and upper confined aquifers. The Atlantic City 800 foot sand aquifer apparently has significant resources available, at least beyond the planning period, but still is a finite resources that is being “mined” and the saltwater front is moving toward existing wells. Cape May County must assess the extent to which it can safely rely on this resource as one of several resources for the area.

3. General Recommendations

Planning area 23 will need to identify and develop replacement ground water supplies for the southern Cape area, reduce water demands to the extent feasible, make careful use of the Atlantic City 800 foot sand aquifer, and develop long-term regional water supplies that optimize the use of all available water resources, including the possible use of alternative technology such as Aquifer Storage and Recovery (ASR) and desalination. The Atlantic County Water Supply Implementation Plan (draft) is recommending that a watershed management plan be developed for this planning area.

4. Management Initiative Recommendations

a. Water Conservation

The County Board of Chosen Freeholders (County) received in 1995 a water conservation grant that was allocated in a previous update to the 1982 Plan. The objective of the grant is to : 1) identify water users that characteristically demonstrate potential for water savings; 2) identify the most cost-effective and practical water conservation technique(s) for those users; 3) implement these techniques; 4) monitor the water savings effectiveness and progress subsequent to implementation; and 5) develop a manual that can be used by other counties to reduce water use. The proposed target goal is to reduce county-wide water use by 15 percent, with special emphasis placed on the barrier islands and southern Cape May County. The Cape May County Water Resources Coordinating Council (WRCC) is assisting in the implementation of water conservation techniques. The County charged via an October 1992 Resolution that the WRCC serve as a regional entity to coordinate and support regional water supply initiatives and solutions.

The southern Cape May County area has already commenced with their own water conservation measures as put forth in the "First Annual Status Report on Water Conservation Programs in The Southern Cape May Region," prepared in August of 1993 by the Southern Cape Regional Water Advisory Commission. Cape May City Water Utility has reduced its water use through water conservation via supply and demand management that translates to a 30% reduction in water use. Programs include retrofitting all municipal buildings with low flow toilets and showers and a new conservation-oriented water rate structure. The knowledge acquired from water conservation practices in Cape May City Water utility will be put to use by those implementing the county-wide water conservation program.

Costs - A 1982 Plan Update allocated $125,000 in 1988 for Cape May County to develop a water conservation program.

Benefits - Reduced water use will prolong the life of the planning area's aquifers. Reduction in water usage lowers wastewater flow to treatment plants and associated treatment costs and lowers energy demand and associated effects.

Implementation Schedule
1995: Develop a data base to identify major water users;
1995: Identification of major water conservation techniques;
1996-1997: Implementation of water conservation techniques;
1996-1997: Assessment of effectiveness of water conservation;
1996-1997: Implementation manual.

b. On-site Management Programs for
Wastewater Reuse and Aquifer Recharge

As more municipalities in the Cape May Coastal planning area allow for sewering instead of going to on-site management of septic systems with shallow wells, the current water supply is stressed. Municipalities utilizing stressed aquifers have the opportunity to zone for future development to require utilization of septic systems under the Municipal Land Use Law. The recycling of shallow aquifer water benefits the surficial aquifer and the deeper aquifers through vertical recharge, if septic system densities are sufficiently low and the systems are properly managed to protect ground water quality.

Costs - $5,000 - 15,000 per new septic system, included as a part of development costs.

Benefits - Recharge to the local aquifer system and reduced need for costly regional water supply and sewer systems.

Implementation Schedule - As soon as possible.

c. Water Resource Protection Programs

Implementation of well head protection and aquifer recharge initiatives are important to protect the quality of the water supply. It is essential that programs be implemented that protect aquifer recharge. In addition, a planning document by the NJDEP, "Saltwater Intrusion and Proactive Water Supply Planning in Cape May County, New Jersey," will be provided to serve as a strategy for Cape May County water managers.

Costs - Negligible.

Benefits - A comprehensive ground water protection plan as outlined by the NJDEP's "Saltwater Intrusion and Proactive Water Supply Planning in Cape May County, New Jersey," will help local water managers make informed water supply decisions. Ground water quality and recharge protection minimizes the loss of existing supplies.

Implementation Schedule - Continuous.

5. Capital Project Initiative Recommendations

The problems that challenge planning area 23 have been identified; the next step is for the local water supply managers to determine how they wish to maintain adequate water supplies in light of saltwater intrusion and increasing peak demands. This may be accomplished in part through capital projects.

a. Institute a Network of Observation Wells

As recommended by USGS, there is a need for a network of observation wells to monitor intrusion in affected aquifers in the planning area. Observation wells need to be put in place inside and parallel to the existing 250 PPM chloride isochlors for each aquifer.

Costs - To be determined once network is designed.

Benefits - A saltwater monitoring network will allow analysis correlating ground water withdrawals with saltwater intrusion. If impairment to an aquifer does occur, the network will allow for an adjustment of withdrawals to control the problem.

Implementation Schedule - 1998 - 2000: Drill observation well nests to monitor for saltwater intrusion.

b. Wastewater Reuse of Existing Supplies

Indirect reuse of wastewater is encouraged by the NJDEP for the Cape May Coastal planning area. The Lower Township MUA has already begun investigating upgrading their Sewage Treatment Plant in order to be able to recycle the wastewater effluent. The wastewater would receive tertiary treatment.

Costs - $2.6 million for the ultraviolet system, filter, pipes, monitoring wells, parts and labor.

Benefits - Land application of effluent to local golf courses and farms. The ability to recharge the local aquifer systems.

Implementation Schedule - 1997 - 1999.

c. Development of Alternative Supplies

Alternative water supplies may need to be developed via: interconnections between systems, a desalination facility, relocating wells or developing a new well field in the Atlantic City 800-foot sand aquifer.

The City of Cape May has identified desalination as its preferred water supply alternative to mitigate the saltwater intrusion threat. The Department intends to support this project if an evaluation concludes that it is a cost-effective sub-regional alternative, that it will not prohibit water supply options that are critical to neighboring municipalities, and it has been demonstrated that the project acts to reduce the rate of saltwater intrusion in southern Cape May County. This project will be included into the NJSWSP if it meets all the above mentioned criteria. Therefore, the project would be eligible for Bond Fund monies.

Costs - Interconnections between systems as proposed by the Southern Cape Regional Water Advisory Commission (SCRWAC) for the interim County Airport alternative were estimated to cost $1.2 - 1.6 million; SCRWAC placed the cost of Wildwood's Rio Grande well field interconnection at $1 million and the cost for a 2 to 6 MGD desalination plant at $3.5 to $9.75 million. The costs for developing a new well field at Cape May Courthouse with two Atlantic City 800-foot sand wells was estimated to be $3.1 million. The costs for constructing a desalination facility and related infrastructure to serve Cape May City has been estimated at $3.5 million.

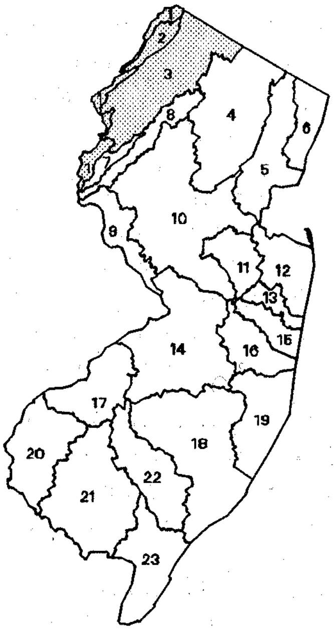
Benefits - The benefits of implementing such management initiatives will be a well-managed, coordinated water resource development program. Implementing feasible water supply options will allow the planning area to grow while maintaining an adequate water supply.

Implementation Schedule - 1997 - 2000: Implement selected plan.

RECOMMENDED INITIATIVES FOR PLANNING AREAS NOT ANTICIPATED TO BE IN DEFICIT DURING THE PLANNING PERIOD

J. Initiatives for Planning Areas 1, 2 and 3 -- Middle Delaware-Flat Brook-Wallkill/Pequest Watersheds

Planning areas 1, 2 and 3 consist of the Flat Brook, Wallkill/Pequest and Middle Delaware planning areas. The Wallkill River drains into New York State through Sussex County. The other rivers are tributaries to the Delaware River. These planning areas have been combined in this analysis due to their geographic and demographic similarities. Present (1990) population of the region is 158,000 and is projected to increase to 292,000 by the year 2040, nearly doubling. Demand is expected to grow from 36 MGD to 51 MGD during



RWRPA 1 Middle Delaware River
RWRPA 2 Flat Brook
RWRPA 3 Walkill/Pequest Rivers/
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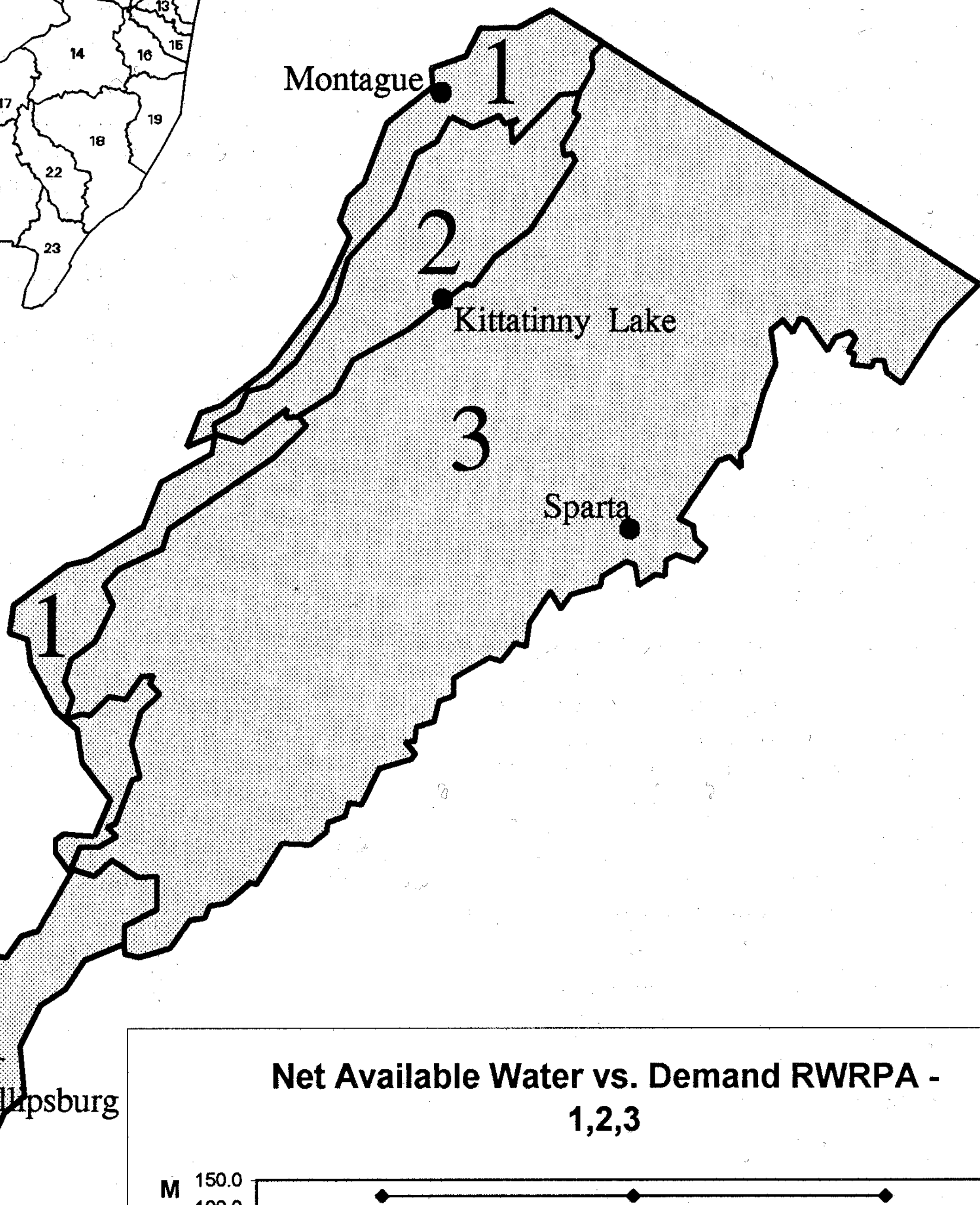
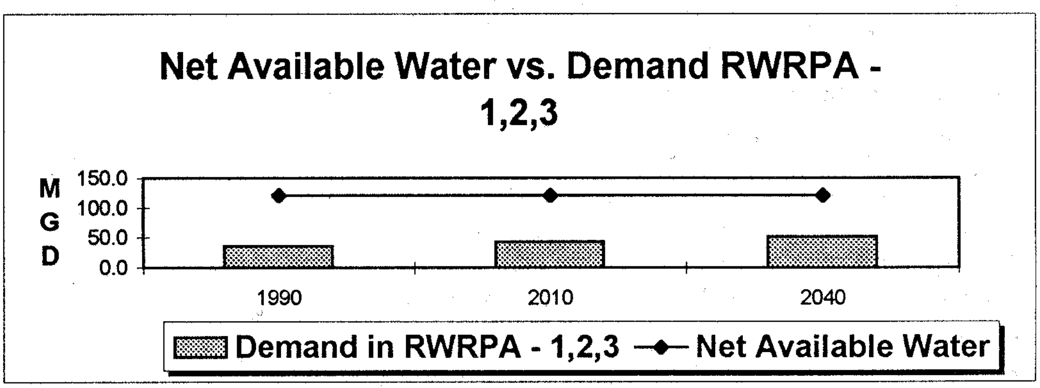




this period. Almost half of present demand is industrial in nature. It is estimated that there is 120 MGD of water available, the majority which is ground water.

Planning Area 1 encompasses 132 square miles including parts of Sussex and Warren Counties. Planning Area 2 encompasses 66 square miles and includes only Sussex County. Planning Area 3 encompasses 542 square miles including parts of Passaic, Sussex, Warren and Morris Counties.

Planning issues in the region are relatively minor. Approximately half of demand is primarily non-depletive industrial demand, mostly that of the Merrill Creek Reservoir, the Jersey Central Power & Light power generating facility and a large quarry. In addition, the rural nature of the region is expected to continue although the Wallkill/Pequest planning area is projected to undergo substantial growth. Of some concern would be significant proposed depletive water uses, both internally and externally. The region enjoys exceptional fishing streams that are vulnerable to water quality degradation and reductions in stream flow that can be caused by substantial depletive ground water withdrawals and stipulated surface water uses.

An investigation by the NJDEP is presently underway in Sussex County (Germany Flats) to define the surface/ground water interrelationship. Currently, some ground water is diverted from the planning area to the Musconetcong River Basin. If the study concludes that surface and ground waters are closely related, significant development may need to consider locating proposed sewage treatment plants so that they discharge highly treated wastewater near withdrawal locations in order to "compensate" for expected stream flow reductions. As an alternative, large-scale development may need to use either the Delaware River as a supply source, construct storage facilities, or skim local surface waters during periods of high flow and turn to properly located ground water supplies during low flow periods. Water conservation, such as water conserving landscaping may be useful in order to prolong the use of surface water supplies (new housing will automatically incorporate water conserving fixtures). Local land use planners will be encouraged by the NJDEP to utilize the findings of the Sussex County (Germany Flats) study when making development decisions.

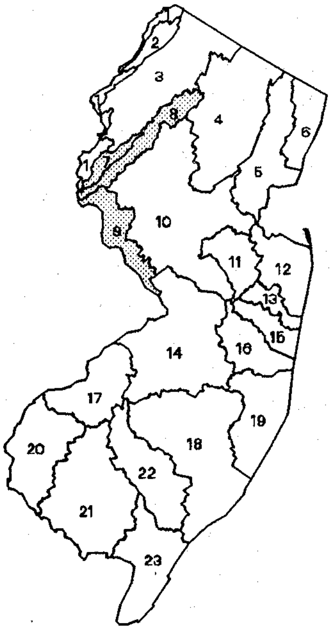
In addition, it is important that depletive ground water withdrawals and stipulated surface water uses be limited upstream of the surface water intakes utilized by Sussex Borough, Newton Town and Branchville Borough. Watershed management efforts may also be merited here to prevent the possibility of contamination within those community's water supplies by improper land uses. Watershed management should also be considered for fishing and other highly valued streams and lakes. In the case of lakes, the absence of watershed management can result in water quality degradation. And, with respect to depletive water use, the Delaware River Basin Commission largely discourages depletive water uses of more than 0.1 MGD from the basin.

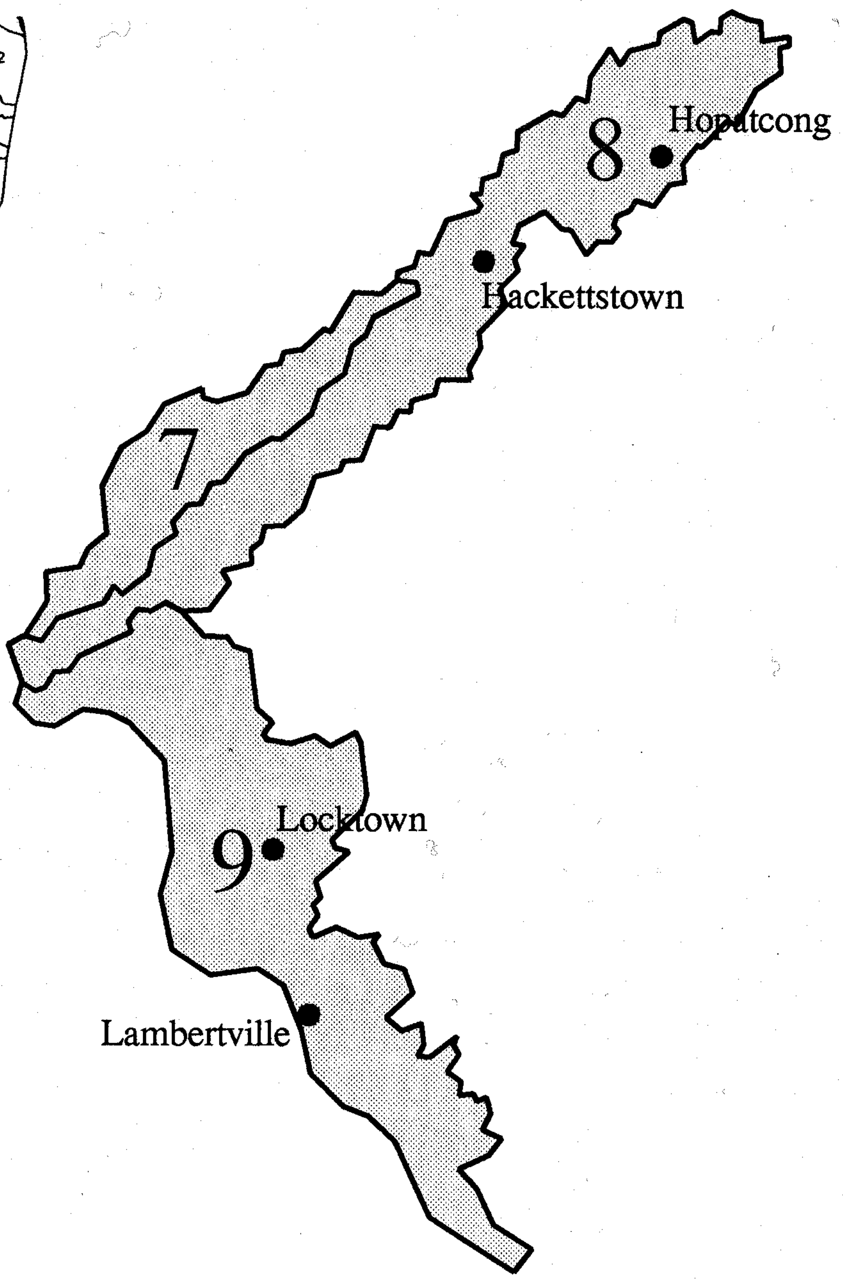
Finally, ground water quality protection programs are merited in this region due to the vulnerability of local aquifers to contamination at or near the surface. Strong consideration should be given to well head protection and septic system management programs. Sussex County has already successfully implemented the latter program.

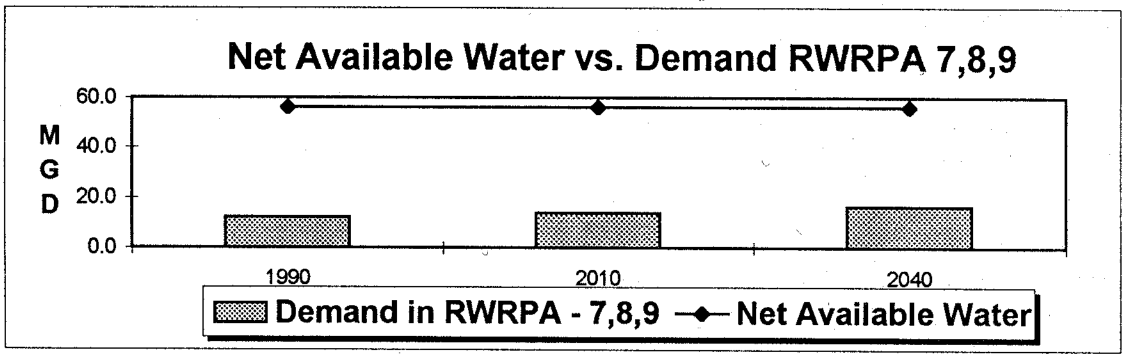
K. Initiatives for Planning Areas 7, 8 and 9 -- Pohatcong/Musconetcong/Trenton Delaware Tributaries

The Pohatcong and Musconetcong planning areas, as well as the narrow strip of land that drains into the Delaware River from Milford Borough to Ewing Township (Trenton Delaware Tributaries planning area), make up this region. These three planning areas have been combined as a result of their small geographical size and their comparatively small demand. The present population of 96,000 uses 12 MGD; the 2040 population is projected to increase to 142,000 and use 16 MGD. Most of present demand is from ground water sources. Water availability is estimated to be 56 MGD, after current interbasin transfers to the Delaware and Raritan (D & R) Canal are taken into consideration.

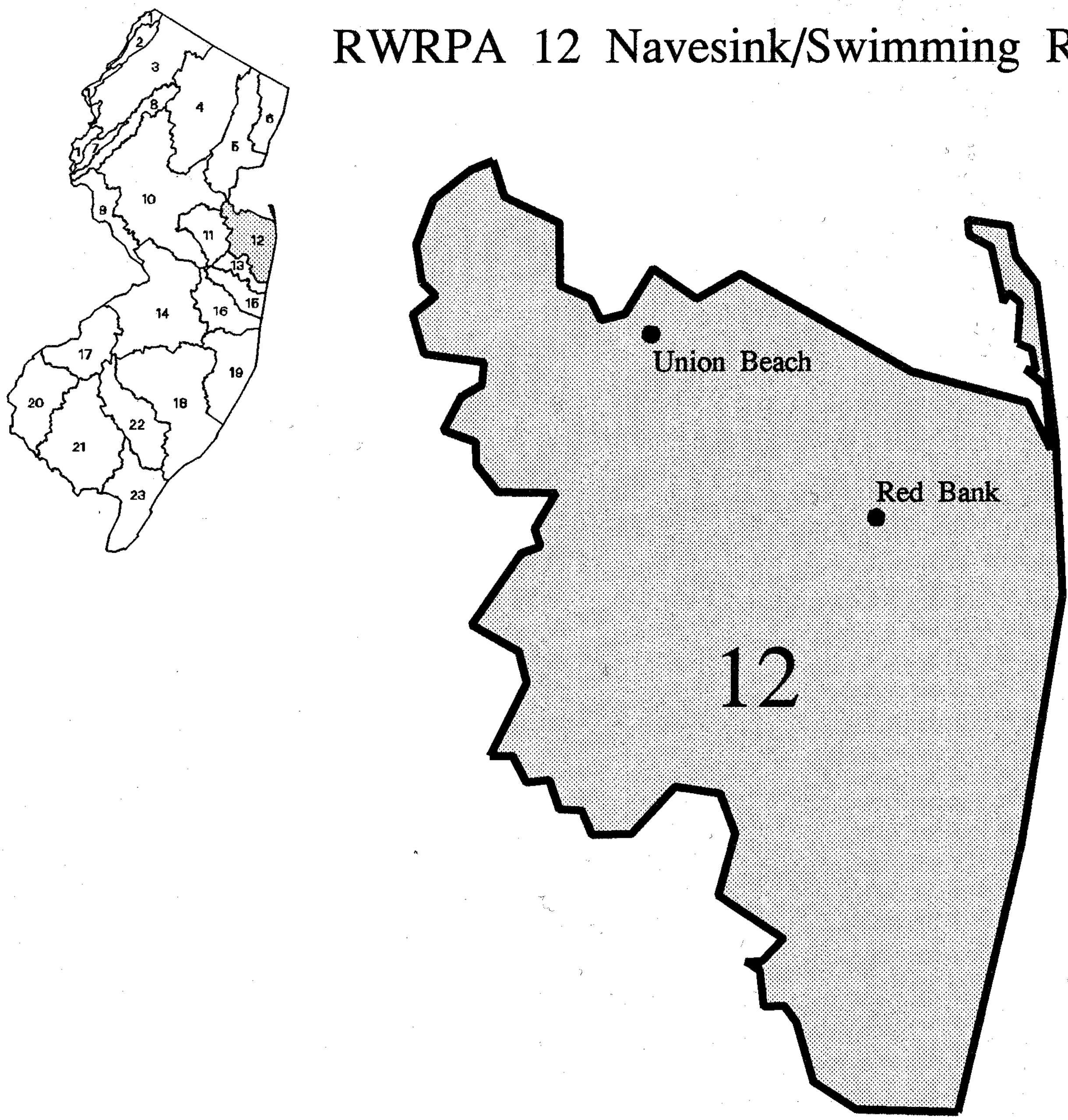
RWRPA 7 Pohatcong River
RWRPA 8 Musconetcong River
RWRPA 9 Trenton Delaware Tributaries

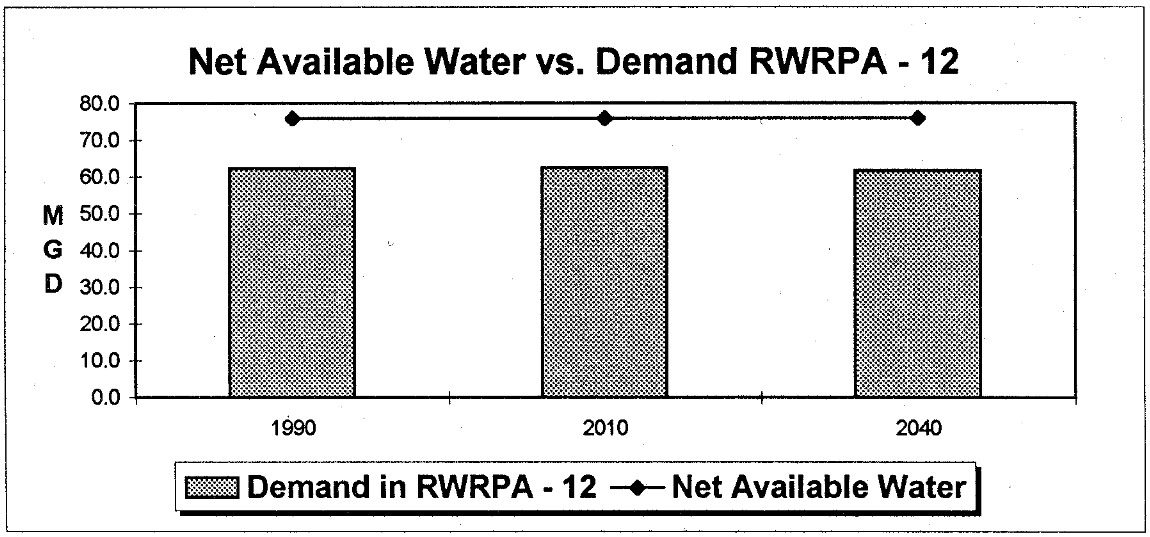






RWRPA 12 Navesink/Swimming River





Planning Area 7 encompasses 57 square miles and includes only Warren County. Planning Area 8 encompasses 157 square miles including parts of Hunterdon, Morris, Sussex and Warren Counties. Planning Area 9 encompasses 181 square miles including parts of Hunterdon, Mercer and Warren Counties.

This region shares many of the planning issues that the Upper Delaware Region faces (planning areas 1, 2 and 3). Caution must be exercised to limit depletive water uses that can result in local stream flow reductions. The region's aquifers are susceptible to contamination. Well head protection and septic system management are important management initiatives. Depletive sewering projects should be carefully scrutinized. Municipalities considering dense development may wish to set aside future reservoir sites or consider use of the Delaware River. Watershed management should be evaluated for fishery streams and local lakes, especially where development pressures are being felt. Lambertville and Hackettstown may wish to consider this proactive initiative to protect their drinking water supplies. Since growth is projected to be evenly spread throughout the region, the proliferation of small water companies can be a potential problem. The Hackettstown Reservoir should be preserved for a potential future water supply. Finally, ground water availability may be over-estimated.

L. Initiatives for Planning Area 12 -- Navesink/Swimming River Watersheds

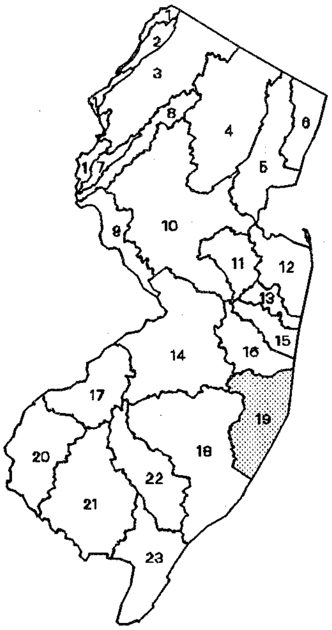
This planning area consists of the Navesink and Swimming River watersheds and some additional small watersheds which is located primarily in Monmouth County. The planning area's present population of about 400,000 is projected to decrease to 363,000 by the year 2040. Water demand is projected to decrease less than one MGD from present use of 62 MGD. The majority of water demand is from local surface water sources. Net available water is estimated to be 76 MGD, of which 12 MGD comes from sources outside the planning area. Planning Area 12 encompasses 250 square miles including parts of Middlesex and Monmouth Counties.

The major water supply-related issues in this planning area are the validity of population projections, watershed management, depletive water use, and safe yield quantification. Watershed management should be examined, especially for the drainage areas upstream of the Glendola, Jumping Brook and Swimming River Reservoirs. Significant depletive water uses within or near these watersheds could affect the yield of these storage facilities and, as such, local planners should take this into consideration when considering land use decisions. Also, the possibility of redevelopment and increasing population along the Raritan Bay area should be investigated.

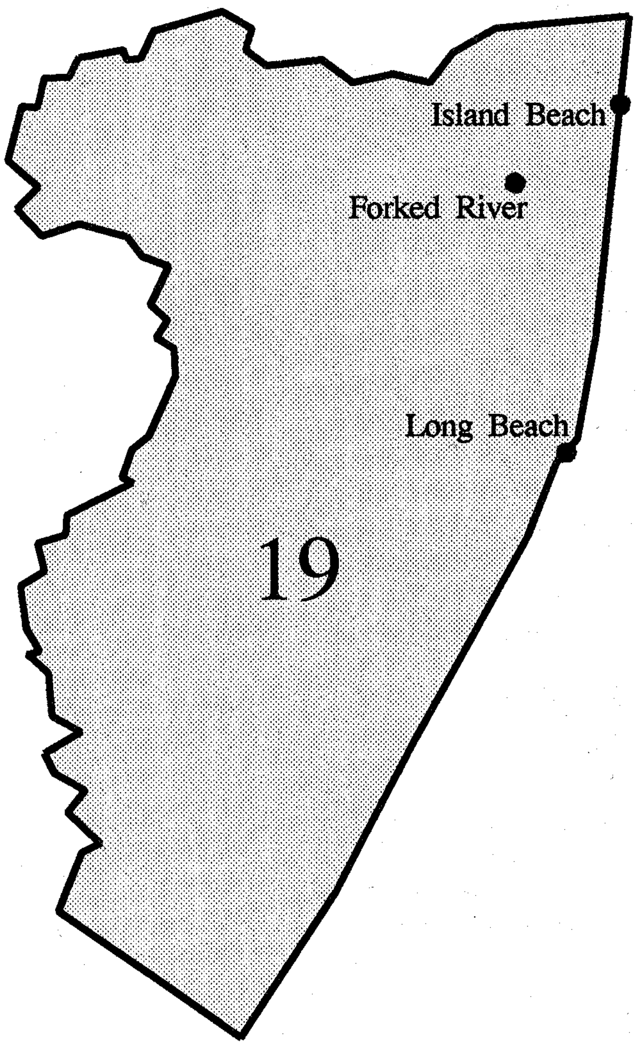
In addition, there is some potential that demand sometimes exceeds the yield of the local surface water supplies; this will need to be addressed. Further, some local purveyors sometime have difficulty meeting peak demand. Water conservation will probably play a larger role in the future. Last, an investigation is underway which will estimate the most efficient location of new well fields with respect to minimizing saltwater intrusion. This may or may not lead to additional water supplies from these sources in the planning area. Since there is little dependence on the shallow aquifers, ground water quality protection does not require the emphasis that is merited in other portions of the State.

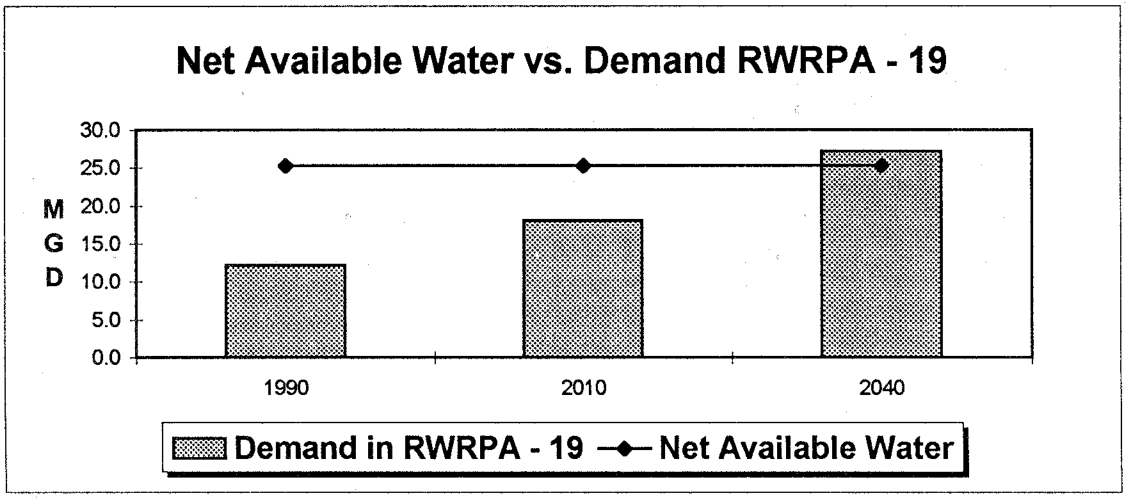
M. Initiatives for Planning Area 19 -- Atlantic Coastal Watershed

This planning area consists of the watersheds between the Metedeconk and the Mullica basins that drains into the Atlantic Ocean, primarily by way of Barnegat Bay. There are presently 81,000 people in the area; this is projected to increase significantly during the planning horizon to more than 200,000. Demand is also projected to substantially grow, from a present use of 12 MGD to 27 MGD by 2040. The planning area



RWRPA 19 Atlantic Coastal





relies heavily upon local aquifers. It is estimated that there is 25 MGD of water available; if this estimate is accurate the planning area could be in deficit toward the end of the planning period. Planning Area 19 encompasses 337 square miles including parts of Burlington and Ocean Counties.

Initiatives that should be considered for the Atlantic Coastal planning area include monitoring for saltwater intrusion, minimizing future depletive water uses, ground water quality protection and recharge augmentation programs, development of a long-term water supply plan, and water conservation. Monitoring is important due to the fact that there already exists some localized saltwater intrusion and there may be additional potential. Several major well fields that use the shallow aquifer are not too far from the bay, while there are a number of confined aquifer wells on the barrier island and on the mainland near the outcrop area beneath the ocean. Ensuring that depletive water uses is minimized is important due to a heavy reliance on the shallow aquifers and the consequent potential for stream depletion and saltwater intrusion.

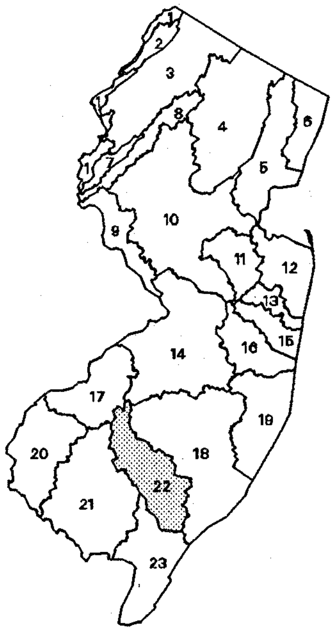
Much of the planning area outside the New Jersey Pinelands has already been sewered. A narrow strip of the New Jersey Pinelands growth areas cuts across the planning area. In the event that this area is totally sewered and served by shallow aquifer wells there may be potential to reduce stream flow in the forest areas to the east. Well head protection and septic system management programs should be evaluated due to the large dependence on the shallow aquifers. A comprehensive water supply/watershed plan for the area should be developed in the not too distant future because of the potential future deficit, the projected rate of growth, vulnerability to ground water contamination and the need to identify options that may not always be available. Water supply sources will be limited since a large portion of the planning area is in the New Jersey Pinelands while the northern portion lies within Water Supply Critical Area No. 1. Water conservation is warranted, especially in light of the substantial peak demand that this planning area experiences.

**N. Initiatives for Planning Area 22 --
Great Egg Harbor River Watershed**

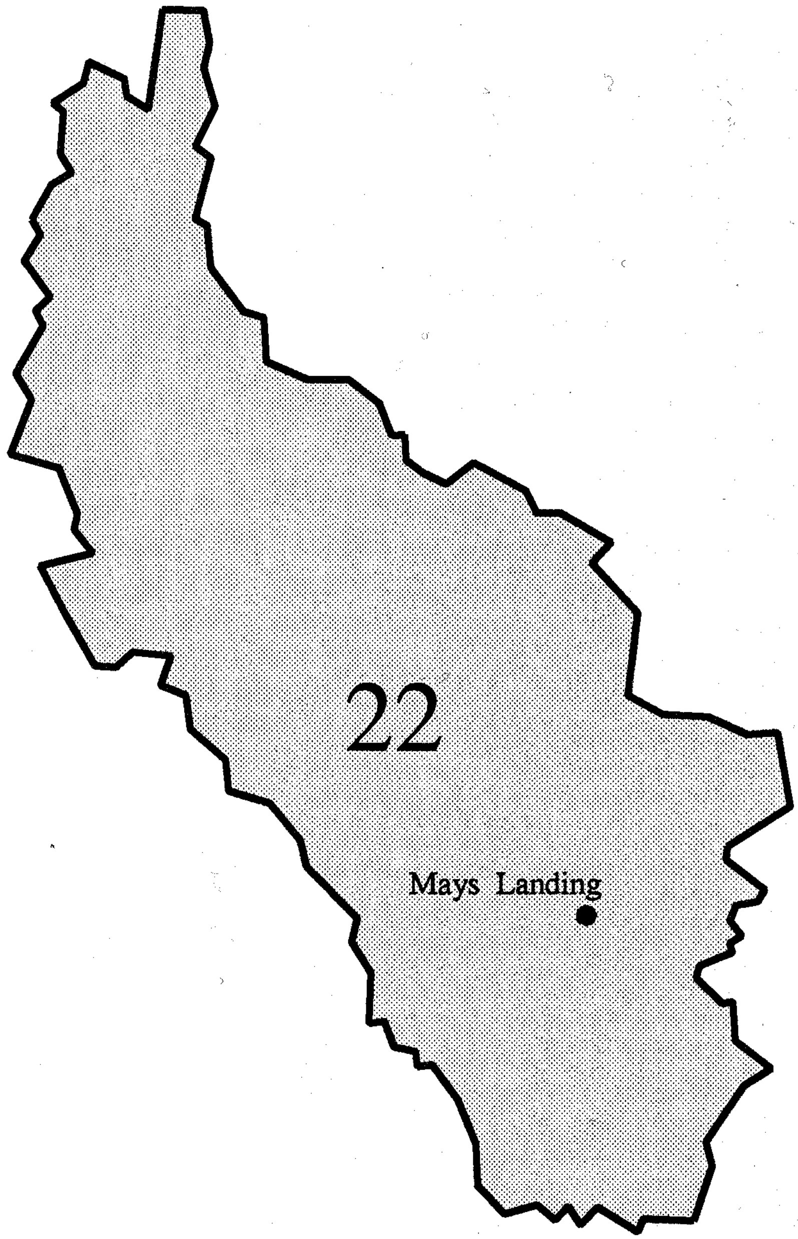
The Great Egg Harbor River planning area extends over Atlantic, Gloucester and Camden Counties encompassing 347 square miles. There is presently a population 96,000 in the area and it is projected to grow to 158,000 by the end of the planning period. Current demand is 21 MGD and is expected to increase to 30 MGD by 2040. It is estimated that there are 32 MGD of available water.

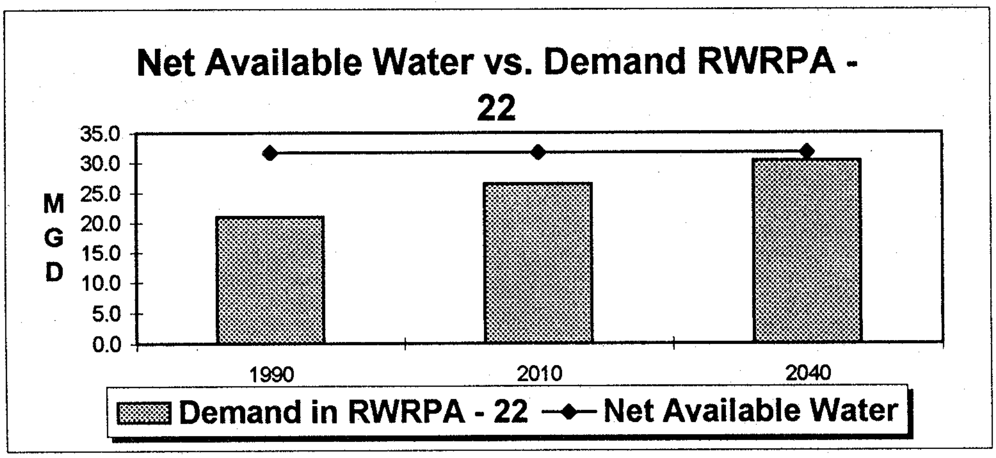
This planning area faces many of the same issues that the Atlantic Coastal area (#19) will face. There may be limits on water availability because the majority of the area is in the New Jersey Pinelands, a portion is within Critical Water Supply Area No. 2, and saline water is thought to exist in some of the deep aquifers in the western portion of the area. It appears that large portions of the river will be in the National Wild and Scenic Rivers program which indirectly encourages free-flowing river characteristics. Since substantial depletive water uses can cause stream flow reductions, these uses may have to be limited. Regional sewering may need to be scrutinized. Numerous ground water withdrawals in the headwaters may already be causing some stream depletion.

The Great Egg Harbor estuary is a productive shellfish resource; it is also sensitive to changes in the freshwater/saltwater interface. An estuary impact study is being proposed for the adjacent Mullica River planning area. Preliminary geohydrologic and water quality baseline data has already been collected for a future estuary impact study of the Great Egg Harbor River. The NJDEP will determine if it is cost effective to include this planning area with the Mullica study (if one takes place) or to defer it to a future time. Consideration will also be given to including the Atlantic Coastal planning area. Also, it is important that ground water protection initiatives be implemented in the Great Egg Harbor River planning area because of the heavy reliance on the shallow aquifers. The Atlantic County Water Supply Implementation Plan (draft) is recommending that a watershed management Plan be developed for this area. Lastly, water conservation



RWRPA 22 Great Egg Harbor River





will play an increasingly important role in ensuring that the planning area does not experience a water supply deficit in the future.

CHAPTER SEVEN

PROTECTION, MANAGEMENT AND CONSERVATION OF WATER SUPPLY RESOURCES

This chapter discusses issues related to the protection of ground and surface water supply resources. It also focuses on methods to make more efficient use of existing water resources, including water conservation, conjunctive water use and improved coordination among water supply systems.

A. Protecting the Resource

Most of New Jersey's economical reservoir sites have already been developed and significant increases in demand upon many of the State's regional aquifer systems could render them vulnerable to depletion or saltwater intrusion. In order to meet the demands placed on our water supplies in the decades to come while simultaneously protecting our ecological resources, emphasis must focus on:

1. protection of water quality and maintenance of water quantity for existing and future supplies through integrated approaches;
2. development of a wide variety of management actions designed to supplement, improve, integrate and make better use of existing water supply systems; and
3. expansion of water conservation efforts.

This first section focuses on the protection of water supplies. Protection efforts are discussed on a statewide basis as well as how these efforts will be employed as the NJDEP engages in a more general watershed management approach.

1. The Watershed Management Approach

Much progress has been made over the past twenty years in reducing the amount of pollutants discharged into New Jersey's surface and ground waters. These gains were primarily achieved through the management of point sources of pollution. A consensus has emerged, however, that these efforts alone will not solve the state's water quality problems nor protect its ecosystems. The potential causes of water quality impairment are as diverse as human activity itself; it is now well recognized that a multitude of human activities contributes to water quality degradation and that current public policy and programs are not sufficient to deal with them.

Significant success has also been made over the past several decades in ensuring that New Jersey's residents and businesses possess adequate water supplies through the development of new reservoir systems and improved management. However, developing new regional supplies to meet all of our future needs will no longer be the fairly straightforward process that it was in the past. As an outgrowth of evolving public values regarding environmental quality, it is now clear that these values will need to be equally considered when planning the development of new regional water supplies in the future.

Last, land use, water quality and water supply policies and programs are often narrowly focused and conflicting, sometimes impeding broader solutions that can lead to an overall environmental benefit. Resolution of a problem in one environmental medium often results in an unplanned problem in another medium. It is now recognized that the environment is highly interactive and that cross-media effects can be substantial.

There is a strong interrelationship between land and water resources. The watershed is a geographic area of land and what happens on and to the land helps determine the quality and quantity of the available water resource. A land use planning segment in watershed management is a absolute necessity, with regard to those land use issues that are closely related to water management. The water resources of one watershed may have different “best” uses from that of another watershed. Therefore, one must consider and take into account all uses and users within each watershed.

In order to overcome these shortcomings, the NJDEP is developing an integrated environmental management approach to **all** water resource issues within targeted watersheds. Proposed amendments to the Federal Clean Water Act being considered by Congress are also in part oriented toward the watershed-based management approach. A watershed approach is a holistic strategy in which the goals are to **restore and sustain** water quality, water supply, ecosystems and other water-related uses for the benefit of our present society and future generations. The approach provides a management framework within which these baseline NJDEP goals, along with goals derived at the local level, can be integrated to protect water and water-related resources. It represents a highly participatory and goal-based management effort that engages stakeholders to focus on managing and living in harmony with the resources of the watershed.

Specifically, the approach provides for:

1. recognizing that most of the resources in a watershed are interrelated and dependent on each other;
2. identifying the "root causes" of environmental degradation or misuse through a watershed characterization process (i.e., linking human activities with environmental degradation of the resources); and
3. prioritizing and implementing integrated solutions to address these causes of degradation or misuse through a "partnership" of Federal, State and local entities, economic interests and the local citizenry.

The NJDEP will prepare a priority list that will identify and rank watersheds for watershed management plan development. Among the factors under consideration for ranking are threatened and impaired waters and ecosystems (including those affected by nonpoint sources of pollution), drinking water supplies, and special and unique watersheds. Some watersheds may not require comprehensive plans; in those cases, limited watershed plans or generic statewide initiatives, as described later in this chapter, will suffice.

2. Water Supply Watershed Protection

The thrust of the water supply component of the watershed approach is to balance water supply needs with other users and uses, and to integrate management of land and water-related activities that can potentially affect the yield and quality of existing and future water supplies. The 1994 New Jersey State Water Quality Inventory Report notes that 17 stream segments declined significantly in quality during the 1980’s; <u>most</u> of those streams are tributaries to existing water supply systems, such as reservoirs.

<u>a. Integrating and Prioritizing Water
Supply Needs with Other Beneficial Uses</u>

The objective of integrating and prioritizing water supply needs with other competing interests reflects the evolving public trust doctrine, which holds that the water resources of the New Jersey are public assets held in trust for the citizens of the State by government to protect public interests. This objective consequently seeks to balance our growing need for additional potable water supplies with other public trust values such as recreation, fish and wildlife habitat, scenic values, water quality and environmental conservation. In addition, by integrating and planning our water supply needs with other beneficial uses such as wastewater assimilation, industrial and commercial needs, future conflict may be reduced.

The watershed management plan is the device employed as part of the overall watershed management process to balance water supply needs with other users and beneficial uses. For water supply purposes, the watershed management plan evaluates both traditional and nontraditional water supply and water quality control alternatives in recognition that water resources are to be managed in the best interest of the public and the environment. The process is essentially a comprehensive and simultaneous evaluation of all relevant water resource needs in a particular watershed, a ranking of those needs, and the development of an integrated plan to fulfill those needs over the long-term. The watershed management plan concludes in an integrated water supply, wastewater and land use plan capable of meeting all relevant public and private objectives to the maximum extent possible.[13] While developing the process, steps are taken to prevent cross-media conflicts due to the interrelationships shared among the resources. Water quality and quantity protection strategies, as described in this chapter, are employed to ensure the integrity of the resources in the decades to come.

The watershed management plan must consider a wide variety of water quality issues regarding their impact on water supply availability, quality and treatability. The impact of the surface and ground water quality standards, permit programs used in the implementation of those standards, nonpoint source pollution control initiatives and nonregulatory management methods are all of critical concern. Historically, the water pollution control programs in New Jersey and nationally have been oriented toward control of point source discharges, with an emphasis on water quality impacts at low flows. The emphasis on low flows reflects concerns with dissolved oxygen and toxicity impacts on aquatic life. However, water supplies are affected by water quality at all flows and thus their protection poses unique challenges regarding nonpoint sources (which often occur during wet weather events) and point source limitations that vary between low and high flows. Effluent limitations that vary according to season must also be considered in light of water supply management concerns, not just aquatic life concerns.

The NJDEP anticipates that the Federal Clean Water Act will be amended in the future to include major new components addressing "watershed management." The Federal Safe Drinking Water Act has been amended recently to include new components addressing "source water protection." Therefore, the NJDEP's efforts regarding watershed management in water supply watersheds anticipate New Jersey's needs and Federal legislative requirements.

Because the watershed management process estimates the water-related needs of all relevant water resources in the watershed taking into consideration all communities and environments that may be affected, selected water supply options may not necessarily be the least-cost options. However, this may be offset by reduced capital and operating costs for water and wastewater facilities, reduced energy costs, and enhanced social and environmental benefits. It is essential that major water users and other affected interests fully participate in the process in order to ensure that the water supplies and other services continue to be reliable and fiscally sound. Incentives should be considered for those who aggressively develop and implement innovative watershed management plans that conclude in reliable least-cost alternatives (see recommendations).

Once the overall watershed management plan has been formulated it is envisioned that NJDEP regulatory and non-regulatory efforts would be adjusted accordingly and permits would be granted only when they would be consistent with the watershed management plan. All permits in the watershed would be "synchronized" so that they would be renewed simultaneously; this would allow for a continuous evaluation of their overall efficiency in meeting the goals of the watershed plan, as well as improve permit issuance efficiency. In addition, the NJDEP would encourage the revision of county and municipal master plans and Water Quality Management Plans to reflect these strategies. It is essential that the strategies be flexible in recognition of the dynamic nature of the watershed.

Water supply watershed planning in specific watersheds will be conducted generally according to a watershed priority list developed by the NJDEP. Watersheds presently in water supply deficit and those vulnerable to growing contamination threats will be among the criteria that will be employed to prioritize when watershed planning should be initiated. Where water supply needs are much greater than other priority issues, it is anticipated that water supply planning will begin prior to the watershed management process for a specific area.

b. Balancing Water Supplies and Water Quality

[13] The land use component of a watershed management plan will address water-related issues only, such as the protection of riparian corridors, nonpoint and stormwater-related pollutants, and aquifer recharge.

A major consideration during the watershed planning process will be the need to balance and integrate water supply withdrawals with water quality needs. As water quality standards become more stringent, the cost of wastewater treatment will increase. Abandonment of wastewater treatment plants presently discharging into the freshwaters of the watershed through connections with regional plants that discharge to tidal waters may be financially attractive to the dischargers. However, if the freshwater discharge is a component of a water supply, the additional cost of developing new water supplies will need to be considered to determine the most cost-effective and environmentally reasonable solution for both issues.

Equal attention will need to be focused on water quality impacts caused by depletive water supply withdrawals. If surface water or unconfined aquifer withdrawals are excessive and cause streamflow depletion, water quality can be impaired as a result through reduced dilution and assimilative capacity. In this case, the development of relatively inexpensive water supplies can be negated by the increased cost to upgrade wastewater treatment plants so that water quality standards are met during low flow conditions. Also, if confined aquifers of coastal New Jersey are used excessively, saltwater intrusion can be a problem in the long-term.

Last, consideration must be given to the impacts on both water quality and water supplies as a result of development and redevelopment. As municipalities attract growth and their consequent ratables in an attempt to stabilize property taxes, there is a need to assess secondary costs that may be associated with increases in point and nonpoint sources of pollution. If the development of pollutant sources force water supply and wastewater treatment plants to upgrade their treatment processes, taxes or user charges may increase in the longer term. For instance, pollutant loading factors need to be considered when addressing septic system management, to reduce the potential for water supply contamination.

It should be noted that none of the above examples take into consideration the effects on ecosystems; these costs are for the most part intangible. However, by taking a "whole systems" approach as watershed management does, various resource configurations can be evaluated to conclude in a plan that can cost-effectively minimize these effects. As previously indicated, the NJDEP is conducting several investigations with respect to ecosystem protection and management. From a water quantity perspective, studies are presently directed to understanding impacts on ecosystems as a result of freshwater reductions caused by water supply withdrawals. From a water quality perspective, models will be prepared in various watersheds to establish point and nonpoint source loading rates that will minimize ecosystem impairment. These loading rates will incorporate factors such as stream flow depletion as a result of water diversions to ensure that ecosystems are not seriously stressed during low stream flow periods. In time, quantity and quality planning thresholds will be developed that can be used for planning purposes in the watershed approach.

3. Water Quality Protection Strategies

Water quality protection efforts integrate land use management activities with water-related activities to ensure that water quality standards and beneficial uses are maintained (and restored, if necessary). These efforts are conducted both statewide and in targeted watersheds, where initiatives are tailored to address specific problem. Care is taken to ensure that these initiatives are properly coordinated with water supply efforts.

Until recently, water quality protection efforts focused on site-specific (e.g., point sources) activities and remedies. Generally speaking, the New Jersey Pollutant Discharge Elimination System (NJPDES) is intended to ensure that water quality standards are maintained through regulation of the hundreds of municipal and industrial discharges in the State. The NJDEP's hazardous site mitigation programs are charged, among other responsibilities, with mitigating contamination of water resources resulting from previous discharges. Both programs have been relatively successful in their intended tasks. Continued improvement can be expected as the NJDEP evolves toward employing water quality-based effluent limitations for wastewater treatment plants.

As described earlier, there are other pollutant sources and other forms of impairment that have not been given adequate attention that can affect our water supplies. While the hazardous site mitigation programs have been making headway in its mitigation of pollution at sites across the State, and the NJPDES program has made significant advances in ensuring the collection and treatment of the wastes generated from **within** our homes and businesses, most wastes generated **outside** of our homes and businesses are entering our surface and ground waters without treatment. It is now suspected that nonpoint sources of pollution as a result of human activities are a major cause of water quality degradation in the State (1994 New Jersey State Water Quality Inventory Report). Therefore, many of NJDEP's water quality protection efforts will now need to focus on these sources. These are described below.

a. Aquifer Recharge Protection

Although ground water provides nearly 50 percent of the drinking water supply for New Jersey, it is only within the last fifteen years that programs have been developed to specifically address its protection. Given the dense population and industrialization of the State, reduced ground water recharge and the potential for contamination of this resource are of great concern and increase the need for its protection. The NJDEP's ground water protection programs are concentrating their efforts on two programs in particular: an Aquifer Recharge Protection Program and, more specifically targeted to drinking water supplies, the Well Head Protection Program. Both of these programs are oriented toward protecting ground water supplies from recharge loss and human-caused pollution. The Water Supply Critical Areas Program has a different but important role in aquifer protection, by reducing the potential for saltwater instrusion due to excessive pumping from aquifers. The NJDEP's watershed priority list will help specify which watersheds should emphasize implementation of these programs.

A ground water recharge area is defined as land surfaces that transmit water downward beyond the plant root zone. This ground water can then recharge aquifers through infiltration (and serve as a water supply source) or can provide base flow for surface waters where it may subsequently serve as a water supply as well as retard saltwater intrusion. Dense land uses with impervious surfaces decrease aquifer recharge, thereby reducing ground water availability. Also, where there is dense development there is generally higher incidence of ground water contamination. Impairment of ground water quality comes from both point and nonpoint sources of pollution. The major known sources are underground storage tanks, landfills, surface spills, lagoons, and septic systems, with 40% of the sources being unknown (1992 New Jersey State Water Quality Inventory Report). Runoff from impervious surfaces contribute a variety of pollutants to recharge water that can impair the quality of ground water.

The thrust of the Aquifer Recharge Protection Program is to ensure that land uses and their associated activities are properly managed to allow adequate quantities of good quality water to recharge the State's aquifers. The NJDEP coordinates with numerous counties and municipalities to implement aquifer recharge protection programs. Local governments, because of their zoning and subdivision authority to regulate land use and associated activities, are key actors in protecting the quality and availability of ground water. Local pollution control agencies play critical roles regarding existing development. The stringency of measures taken to ensure good quality recharge should increase with the amount of impervious area, the densities and types of land uses, and the natural ability of the land to recharge aquifers. There is a need to develop predictive tools that employ these factors to estimate when ground water contamination is likely to occur and when management controls should be implemented in a particular portion of a watershed.

The maintenance of good quality recharge water will at a minimum involve pollutant source controls. Source control is the concept of reducing or eliminating the generation of contaminants so that they cannot be introduced into the environment in the first place; tools such as land use management, regulation and public education are used. Source control can be very effective at the local government level because of greater knowledge of local problems, closer contact to the community and local regulatory tools.

In 1988, the New Jersey State Legislature adopted legislation that requires the NJDEP to establish a method for delineating aquifer recharge areas, to rank and map such areas, and to develop best management practices to encourage environmentally sound development within these areas. The New Jersey Geological Survey (NJGS) published a methodology to map and rank ground water recharge areas. These maps can be used by local planning officials to estimate if their land use plans will allow for sufficient aquifer recharge.

The NJDEP has also published a series of ground water protection practice pamphlets that provide recommendations regarding a variety of land use activities with potential for contamination. The NJGS is currently developing aquifer recharge maps for all counties over a multi-year period.

An integral component of aquifer protection is septic system management. According to the 1980 Census, there were at that time about 350,000 septic systems in New Jersey, discharging approximately 100 MGD of effluent into the State's aquifers. Continued development in rural areas may well have increased the number of systems in existence. This is most likely the largest intentional discharge of pollutants to State ground waters. When these systems are well managed they allow the recycling of treated wastewater into the source supply as long as the density of the systems is not excessive and wells or streams are not in close proximity. However, if homeowners do not operate these systems properly (such as by introducing toxic chemicals or failing to periodically inspect and maintain the systems), they may malfunction and cause ground water contamination.

Septic systems can also fail due to improper siting (involving soil conditions and water table levels) and improper construction. When septic systems begin to fail in a municipality, public sewage collection systems are often installed and denser development often follows in nearby areas. The end result may be increased nonpoint source pollution and reductions in base flow in local streams. The NJDEP will distribute a guidance manual that municipalities can use to ensure septic system management. To complement this effort, the NJDEP will also begin to evaluate the adequacy of septic system density in order to ensure that ground water quality standards can be maintained. Management of these systems will be encouraged through the watershed approach.

Aquifer recharge protection initiatives provide tools for local authorities to protect their local water resources, and emphasize that local governments can -- through planning, regulation and education -- take the primary responsibility and authority for encouraging the maintenance and enhancement of ground water recharge, especially where development is dense and ground water is used in the community. Communities, especially those dependent on ground water, should integrate quantity and quality management practices for recharge. The 1993 Update to the 1982 Plan provided an allocation of $1.0 million to complete the aquifer recharge mapping process. These efforts are scheduled for completion in 1997.

b. Well Head Protection

The Federal Safe Drinking Water Act of 1986 (Section 1428) requires that all states develop a Well Head Protection Program (WHPP) to target areas for special protection of public community and public non-community water supplies. The NJDEP's WHPP Plan was approved by the US Environmental Protection Agency in December, 1991. The purpose of the WHPP is to minimize the risk to public community, public non-community and large groupings of domestic wells from pollutant sources by implementing appropriate protection measures ranging from education to pollutant source prohibition. The special protection for these wells is focused within a delineated geographic area called a Well Head Protection Area (WHPA).

A WHPA can be defined as the zone of an aquifer that contributes water to a well over a specified time period. If ground water pollution occurs in the WHPA, it may pose a significant threat to the well. The NJDEP over the course of several years will be delineating and adopting WHPA delineations for all public community wells in accordance with delineation regulations to be proposed in 1996. Implementation of the WHPP is funded in part by a $1.7 million appropriation from the Bond Fund; these funds are part of a $3 million allocation provided by the 1988 Update to the 1982 Plan.

Plan implementation revolves around the use of the WHPA for risk assessment and management of ground water. Therefore, many existing pollution control programs will be involved in using these areas for management. Relevant regulatory programs of the NJDEP will utilize the delineated WHPAs. Management plans and regulations of these programs will change over time, where necessary, to implement the WHPP plan. Local governments and other land use regulators will be encouraged likewise to use these delineations for their decision-making processes, to refine the delineations using more advanced methods, and develop management strategies for the control of existing or potential pollution sources.

c. Acquisition of Water Supply Watershed Lands

The NJDEP is proposing that legislation be adopted that provides a stable source of revenue to purchase the most critical, developable land tracts within potable supply watersheds, well head protection areas and aquifer recharge areas that serve as major water supplies in order to protect them from water quality deterioration. Numerous complex issues will need to be addressed, including cost-effectiveness, lands previously purchased by purveyors for water quality protection purposes, which revenue source(s) is most appropriate for this purpose, how the revenue source would be collected, who would own, maintain and pay taxes on the properties, coordination with other land preservation programs, integration with other initiatives, etc. Although the total need cannot be estimated at this time, $20 million is allocated initially as loans from the Bond Fund to address the most critical needs. The NJDEP will undertake estimates of land acquisition needs for the protection of water supplies through the ongoing watershed management planning process. The Green Acres Program should continue to support acquisitions of properties that serve to protect water supplies. Additional funding from the Bond Fund would be made to augment and complement the Green Acres Program, such as for acquisition of sites that may have little open space or recreational value and yet provide major water quality protection benefits.

In addition to the acquisition of critical lands, a long-term, stable funding source is needed for the funding of efforts to ensure the long-term preservation of existing water supply watershed and aquifer protection lands. Several issues must be addressed in the development of alternatives for both efforts.

Equity of revenue generation -- The costs of revenue generation should match the benefits to the extent possible. All residents of New Jersey are users of potable water, but not all are served by water supply utilities. To what extent and through what method should individually-supplied users be contributors?

Equity of revenue use -- The Bond Fund by law may not be used for the loans or grants to investor-owned utilities. However, a large proportion of New Jersey's water supplies are provided by such utilities. What funding mechanisms could be used to ensure that the customers of investor-owned utilities benefit from water supply protection funds?

Municipal income loss from ratable loss - A significant issue and topic of recent litigation is the taxation policies for water supply watershed lands owned by one government but located within the boundaries of another. The purchase of water supply lands for protection will have tax revenue implications.

Cost-Effectiveness -- Decisions are necessary regarding the appropriate maximum and minimum project size, whether funds should be distributed as loans, grants or a mix, and methods for aggregating projects to improve cost-effectiveness. In addition, there will be benefits to linking program administration to existing land acquisition programs in the NJDEP as long as the objective of water supply protection remains paramount.

Use of other approaches -- Land-use regulations, voluntary programs, water quality protection strategies, incentives to continue protection of existing lands and other funding sources may be available to achieve some or all of the same purposes. Their use may reduce government costs but require government intervention in the private sector, which may be seen as positive or negative depending on the type of intervention, the affected parties and the benefits for water supply protection.

d. Integration of Surface and Ground Water Protection Programs

Water quantity protection efforts are geared toward the wise use of water through such efforts as water conservation, minimization of depletive and consumptive water uses, increased wastewater reuse, integrated management of water supplies, expansion of existing supplies, aquifer recharge and improvements in defining the yield of the State's regional supplies. These efforts are specifically discussed later in this chapter. Quantity protection also ensures that the integrity of the safe and dependable yield of the State's surface and ground water supplies is not compromised by hydrologic modification, overuse or the inappropriate development of water supplies. Threats to yield include substantial depletive use, ecosystem impairment, saltwater intrusion due to excessive regional diversions or individual withdrawals that induce intrusion, and the reduction of aquifer recharge as a result of excessive impervious cover. These threats reduce the sustainability of the water supplies.

It is essential that water quality and water quantity efforts are not in conflict with each other, or do not inadvertently result in adverse ecological effects. For example, in our efforts to improve surface water quality, we have shifted significant quantities of freshwater from the internal portions of the State into the water supply-wastewater infrastructure where it is ultimately discharged into tidal waters. This same infrastructure has allowed dense development. As a consequence, there is less water available for water supply and ecosystem maintenance, while water quality deterioration has resulted from nonpoint sources of pollution. It is imperative that all water-related decision-making support holistic solutions.

e. Implementation Methods

If we are to be successful in protecting our water supplies over the long-term there will be a need to create partnerships that would be responsible for assisting in the development, implementation and on-going coordination of watershed plans. These partnerships would be active managers with the NJDEP in managing the water supplies and other water resources of the watersheds, including assisting in resolution of conflicts and controversies that undoubtedly will arise. The effectiveness of these partnerships will depend on their commitment to support and fully participate in meeting the plan's long-term objectives.

In all likelihood, there will be a diverse range of partnerships, depending on the particular challenges and circumstances inherent to the watershed. At a minimum, government representatives, land use planners, environmental associations, water supply purveyors and other large users of water, wastewater agencies, developers and local citizens would participate to ensure that the plan represents affected stakeholders and is sufficiently integrated. In some cases, watershed partnerships may need to collaborate with neighboring watersheds due to common objectives or interrelationships, such as shared resources or regional facilities.

f. Watershed Planning and the State
Development and Redevelopment Plan

A key strategy emphasized in the State Development and Redevelopment Plan (SDRP) is to protect the environment by planning for growth in compact forms using existing and planned infrastructure and by increasing infrastructure capacity and growth potential in areas of the State where development will not harm natural resources. The SDRP calls for the reduction of sprawl to alleviate stress on these resources, and also emphasizes the revitalization of urban centers. Watersheds can be protected indirectly by encouraging redevelopment of urban areas and focusing new development within existing transportation and development corridors. The infrastructure already exists in these areas. However, such a focus may also be seen as delaying and not ultimately avoiding the development of water supply watersheds.

The SDRP also suggests land use planning that considers impacts on the surface and ground waters of the State. Land use planning is an important component of a comprehensive watershed plan. Inappropriate land use degrades water resources through the introduction of pollutants and, from a quantity perspective, burdens water supplies in quantity-limited areas. In cooperation with the SDRP, comprehensive watershed planning looks at the future of the resource, how to account for growth effects on the resource, and its efficient use. Since the objectives are similar in many regards, it is envisioned that watershed management and the SDRP should be closely integrated.

4. Technical Issues/Strategic Recommendations:
Protecting the Resource

Issue: Development is occurring upstream of potable surface water supply intakes and on top of aquifer recharge areas throughout the State. The magnitude and the overall effect that nonpoint sources of pollution associated with development has on surface and ground water supplies needs to be better quantified. The amount and the types of development that a water supply can support without being compromised needs to be defined. Management programs need to be initiated before water supplies are impaired.

Recommendation: It is proposed that $500,000 be allocated from the Bond Fund to develop methods to predict the effects of nonpoint sources of pollution on surface and ground water supplies that results from various densities and types of development. These tools would allow local land use planners to implement management practices if proposed development is expected to cause water quality degradation. The NJDEP would utilize existing models and work already completed in this field on a national level. The study would build on this work and focus its efforts on the protection of water supply watersheds of the State. This three-year project will cost $1 million; the $500,000 would be matched from other funding sources.

Issue: Depletive and consumptive water uses that are large in comparison to water supply availability generate the need for alternative water supplies. Wastewater reuse is not actively encouraged.

Recommendation: Incentives and other approaches to encourage cost-effective, nondepletive and nonconsumptive water uses for future water withdrawals should be developed by the NJDEP. Regulations and policies should be evaluated to determine if these are excessively burdensome and discourage wastewater reuse. Incentives and disincentives that could be considered may be in the form of variable allocation fees for new diversions in planning areas nearing deficit based on their depletive nature. In this case, diversions that are highly depletive or consumptive might pay higher fees; these fees could be "banked" in order to fund needed alternative water supplies in the future. This evaluation will take one year and cost $30,000 to be funded by the Bond Fund.

Issue: Absolute protection of source water supplies in a dense State like New Jersey involves the purchase of lands draining into those sources. There is a need to protect these water supply sources from inappropriate land uses in the most sensitive watershed areas.

Recommendation: The NJDEP recommends that $20 million be appropriated from the Bond Fund for loans to public agencies for the acquisition of critical lands for water supply protection, including lands in water supply watersheds, prime aquifer recharge areas and well head protection areas. In addition, other, stable funding sources should be investigated to provide for such aquisition. The Green Acres Program should continue to support acquisitions of properties that serve to protect water supplies. Also, the use of other approaches such as land-use regulations, water quality protection strategies, and incentives to continue protection of existing lands are options to protect water supplies that should be evaluated within the context of watershed management planning efforts.

Issue: The NJDEP's Surface Water Quality Standards need to be evaluated to ensure that they adequately protect water supplies. Improved links between use designations for water supply watersheds and the control of activities in these types of watersheds that may impair water supplies would be the primary objective.

Recommendation: The NJDEP recommends that an analysis be performed that evaluates the standards, especially the critical design flows used to establish effluent limitations for wastewater discharges and the need to include additional parameters in these limitations when they discharge upstream of surface water intakes. A review will be made of the use designations to determine their adequacy to protect water supplies from the effects of development.

Issue: The watershed approach will benefit the water quality of the state's water supplies as well as maintain the integrity of the yield of these supplies. Funds from the Bond Fund should support this initiative.

Recommendation: The NJDEP proposes to <u>partially</u> support the development of watershed plans on an equitable basis (e.g., the portion of the total plan cost that is oriented to protection of water supply resources). There is a fundamental logic in applying the watershed approach to the protection of water supplies. First, protection of the water quality of the State's water supplies and their yields should be enhanced by the approach's comprehensive and integrated efforts, especially for ground water supplies. Second, future water supplies will be identified and protected. Third, the reauthorization in the future of the Clean Water Act may include federal funds for protecting drinking water supplies; this would allow for even more comprehensive protection of our water supplies. Based on the assumption that five watershed management projects will be initiated in the next three years, and that water supply planning costs do not exceed $100,000 per watershed management project, a total of $500,000 is allocated for this purpose. Additional funding will be used from federal Clean Water Act grants, and other sources.

B. Maximizing the Benefits of Water Supplies

1. Water Supply Planning, Conservation and Management

As the impact of water withdrawal on supply sources, other users and the general environment become more severe, the need for maximizing available water supplies becomes greater. Within NJDEP, water conservation has been viewed as part of the overall functions of water resources planning and management. The term water conservation can refer to two types of activities: supply management and demand management.

Supply management usually refers to measures in between the source and the service connection that improve water system efficiency, such as metering, leakage loss reduction, improved interconnections and inter-system operations coordination. Sometimes improvements in the management and use of the basic sources of water (i.e. aquifers and streams) are included, but this is more properly referred to as source management or watershed management. Supply management attempts to reduce the loss of water from the point of withdrawal to the customer's service connection.

Demand management refers to measures which reduce demand or increase efficiency of use at the service connection and beyond. Since they focus on the customer, the water system has much less control and since they may have the short term effect of reducing revenue (as opposed to increasing revenue or reducing costs) system managers may have ambivalent attitudes towards those measures. To be sure, many demand management measures are more complex than the typical supply management measures and require the involvement and cooperation of not only water purveyors, but also customers, governmental agencies and the general public. In sum, demand management measures are less straight forward and sometimes more controversial.

Several of the NJDEP's water supply management program activities help promote water conservation. The water supply critical areas program is directed at discouraging the overuse of ground water systems. One way to reduce critical area water needs is through an aggressive and successful conservation program. Another program involves identification of "unaccounted for" water. Regulations require each purveyor to analyze and report the amount of "unaccounted for" water and to institute a management program to reduce leakage and water losses. In addition, individual water allocation permits have specific conditions that require conservation plans to be developed and implemented by purveyors. Finally, an aggressive NJPDES permit program along with Federal and State hazardous waste programs have caused industrial facilities to devise ways to eliminate or minimize the amount of water that must be discharged as waste. Industrial water conservation technology transfer, which has been implemented by the Delaware River Basin Commission (DRBC) with the support of NJDEP, has helped to further stimulate reduced industrial water demand. The NJDEP should expand its efforts in industrial water conservation technology transfer.

Regulation of water system rates and services by the Board of Public Utilities (BPU) has helped to promote efficient use of water in New Jersey. Within its jurisdiction, the BPU has by and large eliminated the use of declining block rates for those purveyors under its jurisdiction, because they discourage conservation by charging less per unit as usage increases.

Water conservation goals and objectives can also be furthered by changes in plumbing fixture specifications. Responsibility for administration of the plumbing code in New Jersey rests with the Department of Community Affairs (DCA) as part of the Uniform Construction Code. In 1978, the NJDEP recommended that the plumbing fixture specifications be amended to require the use of water closets using 3.5 gallons as opposed to the 5 to 7.5 gallon products then in use. Working with DCA, the NJDEP initiated the process to effect this change and the 3.5 gallon water closet become a requirement later that year.

In 1988, DRBC revised its plumbing fixture regulations (with support from New Jersey) to require water closets using 1.6 gallons of water per flush. Working with the DCA, the NJDEP recommended that DCA evaluate the 1.6 gallon water closet to determine if it should be used in New Jersey. This evaluation was completed and with the support of the NJDEP and DRBC, DCA revised the State's plumbing subcode to this end through regulations which took effect on July 1, 1991. The National Energy Efficiency Act of 1992 subsequently prohibited the manufacture for residential use of water closets using more than 1.6 gallons after January 1, 1994.

2. Water Conservation Strategy

<u>a. Goals and Objectives</u>

Where water conservation is concerned, there is need for reasoned deliberation and wise choice because our future environmental and financial well being will be significantly influenced by the water conservation programs and activities we choose to implement. The goal of the State Water Conservation Strategy (see Appendix B) is to set forth an overall approach to guide the NJDEP's decisions regarding conservation. It seeks to:

explain why the NJDEP supports water conservation;
outline which types of conservation should be applied uniformly across the state; and
indicate how conservation should be encouraged, promoted and/or required.

In doing so, NJDEP also hopes to advance public deliberation regarding conservation by distinguishing among the different types of demand management and examining them individually.

<u>b. Incentives and Education</u>

The analyses set forth in the State Water Conservation Strategy document show that the advantages of water conservation generally outweigh the disadvantages. The case is much stronger where water supply resources or facilities are stressed, and less strong where ample supplies exist for the foreseeable future. The NJDEP should reaffirm its support for the concepts of water conservation and demand reduction as effective and efficient components of water resources planning and management.

A primary issue is the approach to be taken toward planning and implementation of conservation. Water conservation must be an integral part of water supply planning rather than an after thought or a stop-gap measure. Since the mid 1980's, all regional water supply planning studies conducted by the NJDEP have explicitly considered water conservation as an option for meeting part of the projected water demands. The accuracy of future projections of water supply demand in New Jersey would be increased if better data were available from water systems as to the composition of existing water demand. The patterns of residential, commercial and industrial water demand and use are significantly different and water systems should be required to provide a breakdown of use in these categories or in similar categories such as residential vs. non-residential or large user versus small user size.

It is usually assumed that water conservation is a concept that must be implemented through government regulatory mechanisms. Indeed, there have been calls from some quarters for mandatory, swift and dramatic reductions in water customers' usage through direct regulation. While such means are needed to change water user behavior during drought episodes, it would be difficult to maintain such reduced demand levels permanently without extensive hardship.

NJDEP favors non-regulatory and incentive-based means to bring about long term, non-drought period reductions in water demand, other things being equal. There are two basic reasons for this policy. First, in an open and free society, we should be predisposed to non-coercive behavior changes rather than those mandated by statute or regulations. Secondly, as a practical matter, water customers will be much more likely to follow the desired behavior and reduce demand on a sustained basis without governmental enforcement, if they are informed as to the overall benefits to them and to society as a whole. In the long run, public education can be an effective substitute for regulations under certain conditions. Recognizing this, NJDEP has emphasized public education and incentives for conservation, focusing on water awareness in the school curriculum and promoting conservation landscaping among adults. These programs should be expanded and updated. The NJDEP should broaden its school curriculum materials on water conservation, coordinating its activities to complement and further the goals of the New Jersey Environmental Education Plan of Action.

Likewise, NJDEP should continue to strengthen its education programs for water conservation landscaping, particularly in research and demonstration. In particular, greater efforts need to be made in reaching the landscaping and nursery professionals more effectively and also in support of research and demonstration to not only reduce turf area but also improve efficiency of turf irrigation.

Thus far in New Jersey, NJDEP has taken the lead in efforts to encourage efficient residential and commercial water use on the landscape as summarized above. In order to better leverage its staff and financial support in this area, however, NJDEP should form a partnership with the landscaping and gardening community, water utilities, the educational community and water users to promote the wise use of water. Such a partnership, which could be a not-for-profit organization, could utilize both public and private sector funds to promote sound water use practices. Organizations such as this as have been created in Georgia, Florida and just recently in New York. The Georgia and Florida organizations have been quite successful in developing and publishing educational materials, providing technical assistance to communities and small purveyors on emergency water restriction ordinances, and training members of the landscaping community in water conservation. The importance of landscape irrigation must not be under-estimated, as water use for this purpose stresses water delivery systems and peaks in summer months when droughts tend to have their worst impacts.

In a related area, the Delaware River Basin Commission has conducted industrial water conservation technology transfer sessions which have documented significant water saving benefits. In view of these efforts and in keeping with the primarily non-regulatory approach espoused in this conservation strategy, NJDEP should initiate a long term industrial water conservation technology transfer program for selected industries and classes of commercial water users.

c. Structural vs. Behavioral Conservation Measures

There are other approaches to water demand reduction which do not require direct regulation of water customers' behavior. At one end of the continuum is a plumbing fixture code change which reduces water demand without any change in user behavior and at the other end is a user's decision to turn the water off while soaping up in the shower which reduces water demand totally as a result of a change in user behavior. Behavioral changes, while they can be induced by regulatory constraints or stimuli, usually involve a decision or choice by the water user. On the other hand, once a l.6 gpf water closet is installed in accordance with the plumbing code, there is little if any choice left to the water customers regarding its use.

Structural conservation measures (if functional and accepted) are more reliable and certain than behavioral measures since they require no decision or action by the water user. Due to this greater certainty and reliability, structural conservation measures should be favored by the NJDEP over regulatory behavioral measures, other things being equal, especially during non-drought periods. In view of this, when future technological advances are made in fixtures and equipment so that less water is used and equal performance is provided, code changes should be made expeditiously.

One area where outdoor water use could be made significantly less wasteful through the application of new technology would be to require automatic lawn sprinkling systems to have rain sensors so that the systems would not be activated when rain has provided sufficient water for the turf. The NJDEP should consider requesting that DCA amend the applicable construction subcodes to provide for such a requirement.

d. Costs/Benefits of Accelerated Installation of Conservation Plumbing Fixtures

When plumbing codes are amended to require more efficient fixtures, the total water savings from the new products take many years to be realized because of the large numbers of existing fixtures which continue to be used until they become unserviceable and have to be replaced.

The consultants for the NJSWSP calculated that the change of 75% of the existing water closets to units using 1.6 gallons per flush would approximately result in an 18% reduction in indoor residential water use. Applying such calculation to the Cape May Coastal planning area, where commercial water use patterns are similar to residential patterns and there is little industrial usage, a savings of about 4 MGD could be realized out of a total water use of about 29 MGD in the planning area.

We can make some rough assumptions about the number of fixtures which need to be replaced, and calculate a rough cost per MGD of water saved based on the amount of water saved and the cost of the fixtures. This type of demand side analysis can be performed when a feasibility study is being conducted in a planning area that is experiencing deficit conditions or during the development of a specific watershed-based management plan. If it is assumed that there is an average of 2.5 people per dwelling unit and 2 toilets and 2 showerheads per unit in the Cape May Planning Area, a population of about 95,000 would give 38,000 dwelling units. This would mean 76,000 toilets and 76,000 showerheads in the planning area. At an installed cost of $150 per toilet and a water savings of 3.665 MGD, this amounts to about $3,113,000 per MGD saved; for the showerheads this comes to $441,000 per MGD saved. While New Jersey coastal plain ground water is cheaper, even the $3.1 million per MGD for the 1.6 gpf water closet compares favorably with the cost of developing desalination facilities or new surface supplies, which must include impoundment and or intake, transmission and treatment facilities costs. Moreover, the $150 cost of toilet replacement is most likely high, since bulk purchase of products and services through an organized program could result in a cost of $100 or even less.

We can estimate the annual savings in the cost of water which would be realized by a family of four using 2.5 gpm showerheads, given an average of one 7-minute shower per person per day. Assuming that the existing showerheads consume from 3.5 to 5.0 gallons per minute and the retail cost of water ranges from $1.50 per thousand gallons to $3.00 per thousand gallons, the savings realized would be as shown in the table below:

Flow Rate of Original Showerhead	**Water Use Reduction From 2.5 gpm Showerhead**	**Annual Savings in Cost of Water at Various Prices Per 1000 Gals.**		
		$1.50	**$2.00**	**$3.00**
5.0 gpm	2.5 gpm	$38.33	$51.10	$76.65
4.5 gpm	2.0 gpm	$30.66	$40.88	$61.32
4.0 gpm	1.5 gpm	$23.00	$30.66	$45.99
3.5 gpm	1.0 gpm	$15.33	$20.44	$30.66

In addition to the water savings achievable with 1.6 gallon per flush toilets and 2.5 gallon per minute (GPM) showerheads, cost savings to customers would also be realized from reduced water, sewer and energy charges. While the revenue of the water and sewer utilities would be reduced, the effects of these reductions would be offset by the following factors: reduced operating and maintenance costs; longer life of capital facilities and the ability to provide water and treat the wastewater of more residences and commercial facilities; and implementation of retrofit over an extended period (i.e. 3 years) rather than immediately. These benefits are greater as facility capacity becomes stressed, so that conservation extends the life of the facilities and delays capital costs.

Aside from these savings, there are other significant advantages of accelerated installation of more efficient plumbing fixtures from a policy standpoint. First, it is a structural water conservation measure, requiring no further action by the water user. Once the product is installed it will provide the savings regardless of the predisposition toward conservation of the user. In addition, plumbing fixture changes reduce non-discretionary demand for water, as opposed to the largely discretionary usage which takes place outdoors. These measures therefore do not reduce the cushion which is available for reduction during drought emergencies. Finally, when evaluating water supply options, it must be remembered that the sheer number of remaining new supply sources, either ground or surface, is decreasing, not increasing.

e. Accelerated Installation of Plumbing Fixtures

Rather than using mandates, NJDEP should use the incentive of financial assistance to promote accelerated installation of water conservation plumbing rather than relying only on their implementation in new construction and remodeling. The NJDEP should give strong consideration to low or no interest loans to water systems so that existing showerheads could be replaced with 2.5 gpm or less fixtures and existing water closets could be replaced with 1.6 gallon water closets. Such a program would be voluntary for the water system and should be targeted to areas experiencing water supply problems. Such a program would complement the existing water supply system rehabilitation loan program and should provide flexibility for either direct installation of the fixtures by the purveyor or its contractor or for rebates for installation by the customer. For the time being, such a program would have to be limited to publicly-owned water systems since the Bond Fund is the only immediately available source of funds to make the loans and cannot be used for loans to investor-owned purveyors, but modifications to the Bond Fund or other sources of funds should be considered which would allow investor-owned involvement in such a program. (See Chapter 9).

The Board of Public Utilities should evaluate allowing water utilities to treat water saving plumbing fixtures and other water conservation equipment as part of their capital costs. This would allow them to amortize these costs and earn a return on the value of the equipment. Such a practice has been a success in the electric utility industry and while the opportunities for the use in water supply may not be as extensive, it should prove attractive to certain water systems. If the BPU took this action, the accelerated installation of water conservation fixtures would receive additional stimulus. For example, the BPU could adopt a policy of providing an incentive rate of return where these devices are installed. Examples of this are numerous in the electric and gas utilities industries in other jurisdictions.

f. Pricing

A policy favoring structural over behavioral conservation measures should not be used to preclude attempts to reduce demand by affecting behavior. It merely recognizes that human behavior is usually not as reliable as the operation of physical objects. However, no matter how much emphasis is placed on structural water conservation, there will be effective opportunities to influence behavior such as through incentives and education and they should be utilized in the overall NJDEP strategy for water conservation.

The pricing of water can provide an incentive for conservation. The elasticity of demand for water is the change in the quantity purchased brought about by a change in price. It is given as the ratio of the percentage change in the quantity demand to the percentage change in price (i.e., if price doubles and demand reduces by half, the elasticity of demand is 1:1). The more demand changes in response to price changes, the more elastic the demand is.

Of course, there are certain prerequisites for pricing to have any influence at all on quantity used. Meters must be installed, operating and read reasonably often. In addition, at least a portion of the water charges imposed must be based on the quantity used. Meters are necessary both as a basis for pricing to encourage conservation and to improve customer awareness of how much water is being used. The latter is useful so that an attempt to use less water in response to something other than rates (i.e. environmental concern or an anti-waste attitude), can be measured by the customer.

Typically, the inclining block, declining block and uniform rate structures discussed below include a minimum, fixed charge to cover the water system's fixed costs. In some systems, this fixed charge is subsumed in the initial block. However, basing most or part of the water charge on quantity helps provide customers awareness of their usage level and thereby provides an incentive for conservation.

The demand for some uses of water is more elastic than others. Most indoor residential uses, such as drinking, cooking and bathing, represent a basic need and therefore, this demand is more inelastic. Most outdoor uses such as lawn and landscape watering, car washing and recreation are more discretionary and this demand is more elastic.

It is neither possible nor desirable to determine a single, "true" price for water, since so many different factors can affect the cost of providing it to customers. Moreover, it is just as important to send the proper signal to customers through the structure of water rates as it is to depend on high water rates to reduce demand.

g. Inclining and Declining Block Rate Structures

There is considerable disagreement over the impact and value of inclining vs. declining block rates. Proponents of the declining block rate argue that as water production increases, the unit cost drops and so charging less per unit for larger quantities of water only reflects the utility's development, treatment and distribution cost. Opponents argue, among other things, that if the real or true cost of water, including the "externalities," were charged, this would not be the case. Without getting into a detailed discussion of the validity of either claim, declining block rates give the wrong signal to water users about the broader values of water and its place in the environment. A great deal of the impact on demand of these two rate structures depend on the size and number of the blocks. A very large first block, for example, can negate the expected impact on demand, regardless whether it is higher or lower than the second block

Conversely, an increasing block would cause larger users to subsidize smaller users. Since larger portions of a smaller user's demand is relatively inelastic, an inclining block structure can be expected, all things being equal, to have a comparatively greater impact on discretionary rather than non-discretionary water use. While the inclining block rate does send a "good" signal, the difficulty in pin-pointing the effects of this rate structure, as opposed to rate level, would suggest that from an equity standpoint, its use be considered when specific demand reduction objectives are being sought by the utility, rather than when a general reduction in demand is desired.

h. Uniform Rate Structure

The potential disadvantages of the inclining and declining block rate structures are obviously avoided if a uniform rate is adopted. The uniform rate retains the same unit volume price regardless of the quantity used. (Usually, there is a minimum charge to each customer to recover the system's fixed costs.) The uniform rate not only sends a good signal in that there is no incentive to use more than is desired just because the unit price is lower, but there is also equity in treating all users in the same class in the same manner. Another advantage of the uniform rate is that its simplicity is useful if the utility is considering a seasonal surcharge. If the seasonal surcharge is superimposed over numerous blocks, the complexity can blur the signals the utility is attempting to give the customers through the rate structure. A uniform rate structure also tends to avoid the public and political debates.

i. Seasonal Surcharge

In most systems, water usage increases in summer. (In the typical community, this is caused by extensive outside use of water, but in resort areas, the increase in population due to the tourist influx means that the increased demand has a large indoor use component.) In order to supply this additional demand, extra plant capacity is needed which would not be necessary during the rest of the year. This means that customers using the same amounts of water throughout the year are subsidizing uses that contribute to the high summer demands.

In these instances, a surcharge can be applied during the summer months which takes into account the seasonal differences in capacity costs. The surcharge can be imposed as a winter\summer rate or as an alternative seasonal rate. Under the winter\summer rate, the surcharge is applied to consumption above winter use. The alternative seasonal rate is simply a higher rate that is charged for all water consumed during the summer.

Although it is somewhat easier to administer, the alternative seasonal rate is less desirable from a conservation standpoint. First, it does not discriminate between excess use in summer and the more normal usage rates during the rest of the year, because the higher rate is paid regardless of the amount used. Second, and because of this, it does not discriminate between the non-discretionary and discretionary components of total water usage.

While a significant portion of water charges need to be based on the quantity used in order to foster responsible use of the resource, if most or all of the bill is based on quantity used, revenue to the purveyor would fluctuate excessively according to the amount of precipitation received and temperature levels in the area, both of which have major impacts on discretionary use. Water charges invariably contain a fixed charge to cover part or all of the system's capital investment. To the extent that seasonal surcharges increase the sensitivity of water system revenue to precipitation and temperature, the surcharge and the underlying basic rate should be set so as to guard against severe revenue instability.

j. Promoting Conservation Pricing

The BPU has jurisdiction over rates charged by investor-owned water supply systems and those publicly-owned systems which serve 1000 or more customers outside their boundaries. Water rates charged by other county and municipal utilities are not regulated by the BPU.

The BPU has virtually eliminated use of the declining block rate and has replaced it with a uniform rate in most cases. Similar trends are taking place among the non-BPU regulated water systems, but there are a number which retain the declining block structure. Water supply systems with declining blocks should review their rate structure to determine if the declining block structure makes as much sense today as when it was first adopted unless there are highly compelling reasons other than water conservation.

Through the rate regulation function, the BPU is also actively engaged in fostering purveyor water conservation education programs, service metering of all customers, leakage loss reduction programs, as well as improved system technical and financial management. Since a large percentage of the purveyor supplied water is sold through unregulated systems, the impact of BPU's policies are somewhat limited, particularly in the areas of pricing and overall financial planning and management.

At least in the area of rate structure, NJDEP could take some actions to help promote conservation. For example, water systems without conservation rate structures in place as required by N.J.A.C. 7:19-6.5(a)4, should be ineligible to receive public water financing, including financial assistance for accelerated installation of conservation plumbing fixtures. In addition, where demand/supply problems exist, as delineated by the NJSWSP or other studies, systems requesting new or expanded water allocations should not be issued allocation permits if such systems are not in compliance with N.J.A.C. 7:19-6.5(a)4, unless they agree to bring their rates into compliance within a specified time period to be fixed by NJDEP. A similar policy should be applied regardless of location, whenever a new or expanded allocation request results in a total proposed withdrawal equal to or exceeding 1.0 MGD. As presented above, the inclining block, uniform and seasonal rate structures are all considered conservation rates, while the flat rate and declining block are not.

k. Encouraging Regional and Local Initiative

It is evident from the analyses presented in the State Water Conservation Strategy that neither water conservation nor the narrower concept of demand management should be received as a monolithic concept, but rather as a bundle of different measures, practices and activities, each with its own advantages and disadvantages. In addition, there is great variation in water supply and water quality conditions across the New Jersey, due in part to its varied topography and geology. Both ground and surface water systems provide water service in the State.

The ground and surface waters also have significantly different levels of quality, often requiring different levels of treatment, which will affect the appropriate rates and rate structures. Given the variety of conservation measures and supply scenarios, uniform application of a single set of conservation measures over the entire State is inappropriate. The State should therefore allow regional and local entities to design and develop their own conservation programs, tailored to their areas. This policy of regionalized conservation management should guide both the existing water system conservation plan review program administered by the Bureau of Water Allocation, as well as any future financial support provided by the State for conservation. Priorities for financial support for conservation should be first for areas where deficit or system constraints problems are most serious, the proposed measures directly address these problems, and local support for conservation is greatest. Areas with projected problems would receive second priority.

In areas where detailed analysis indicate source or supply problems exist, there are several instances in which conservation related programs should be coordinated and focused on utilizing the benefits of demand and supply management. The following are some examples:

The compliance schedules for systems under the unaccounted-for-water and leakage loss reduction program should be accelerated.

Large self-supplied water users should be required to perform water audits once every five years or when new or expanded allocation permit applications are submitted, whichever is more frequent.

Plumbing fixture code enforcement by municipalities should be monitored through the water system conservation plan review program. This should be coordinated with the Department of Community Affairs.

In a water-rich state such as New Jersey, it should not be the business of the NJDEP to preclude, as a part of its on-going conservation programs, a water customer's opportunity to enjoy a healthy lawn. On the other hand, it should be NJDEP's business to provide the knowledge and incentives to communities and water systems for implementation of practical demand reduction measures. It should also be NJDEP's business to adopt structural changes in water use because they are cost effective and bring about minimal disruption of water user behavior. In this way, the NJDEP can be assured of achieving reductions in water use which are both substantial and lasting and therefore truly protective of the environment.

3. Recommendations for Water Conservation

a) The NJDEP should expand its efforts in industrial and commercial water conservation technology transfer.

b) The NJDEP should reaffirm its support for the concepts of water conservation and demand reduction as effective and efficient components of water resources planning and management.

c) The patterns of residential, commercial and industrial water demand and use are significantly different and NJDEP should require water systems to provide a breakdown of use in these categories or in similar categories such as residential vs. non-residential or large user versus small user size, using uniform definitions to ensure data comparability.

d) The NJDEP has emphasized public education and incentives for conservation, focusing on water awareness in the school curriculum and promoting conservation landscaping among adults. These programs should be expanded and updated.

e) The NJDEP should continue to strengthen its education programs for water conservation landscaping, particularly in research and demonstration.

f) The NJDEP should form a partnership with the landscaping and gardening community, water utilities, the educational community and water users to promote the wise use of water.

g) Structural conservation measures should be favored by the NJDEP over regulatory behavioral measures, other things being equal, for non-drought conservation.

h) When future technological advances are made in plumbing so that less water is used and equal performance is provided, code changes should be made expeditiously.

i) The NJDEP should require automatic lawn sprinkling systems to have moisture sensors so that the systems would not be activated when the turf is sufficiently wet. The NJDEP should consider requesting that DCA amend the applicable construction subcodes to provide for such a requirement. This modification could occur in stages, with commercial properties being first (including apartment complexes) and individual residences second.

j) The NJDEP should give strong consideration to low or no interest loans to water systems so that existing showerheads could be replaced with 2.5 gpm or less fixtures and existing water closets could be replaced with 1.6 gallon per flush water closets (see Chapter 9).

k) Modifications to the Bond Fund or other sources of funds should be considered which would allow investor-owned involvement in such a program (see Chapter 9).

l) The Board of Public Utilities should evaluate allowing water utilities to treat the cost of providing water saving plumbing fixtures and other water conservation equipment to customers as investments on which a rate of return may be earned.

m) Water supply systems with declining blocks rate structures should review their rate structure to determine if the declining block structure is still appropriate for local circumstances.

n) Eligibility for public water financing, including financial assistance for accelerated installation of conservation plumbing fixtures, should be limited to those systems which have conservation rate structures as required by N.J.A.C. 7:19-6.5(a)4.

o) Systems requesting new or expanded water allocations in which the total proposed withdrawal equals or exceeds 1.0 MGD should not be issued allocation permits unless such systems are in compliance with N.J.A.C. 7:19-6.5(a)4 or agree to come into compliance with these rate structure provisions within a specified time period, to be fixed by the NJDEP.

p) Where demand/supply problems exist, as delineated by the NJSWSP or other studies, any system requesting a new or expanded water allocation should not be issued an allocation permit unless the system is in compliance with N.J.A.C. 7:19-6.5(a)4 or agrees to come into compliance within a specified time period, to be fixed by the NJDEP.ock rate, uniform rate and/or a seasonal surcharge, would be beneficial to the system.

q) The state should allow regional and local entities to design and develop their own conservation programs which can be tailored to particular conditions in the area.

r) Where there is regional and local interest in water conservation, NJDEP should encourage that interest by offering planning assistance in developing and designing a water conservation program and providing financial support for plan implementation.

s) Those planning areas which have significant water supply problems should be subjected to a detailed analysis to determine if they should be considered potential beneficiaries of water conservation and if so, the conservation funding and other assistance from NJDEP recommended herein should be utilized first in these priority areas.

4. Integrated Water Supply Systems Management

As the population of New Jersey increases so does the need to more comprehensively manage water supplies. Previous chapters have stressed the interrelationship of surface and ground water supplies within a watershed, as well as the fact that coordinated development and management of these supplies can serve to increase their potential for sustainability. This chapter discusses in detail the initiatives that the NJDEP has already undertaken or is considering to undertake in the near future that will integrate and optimize planning for these supplies. There are two primary methods available to integrate the management of water supplies--coordinated operations of reservoirs in an area, and conjunctive use of multiple types of water supplies.

<u>a. Reservoir System Management</u>

There is significant potential to increase the total safe yield of two or more reservoirs systems if these systems could be operated as a coordinated system, rather than separate entities employing separate objectives, and if there exist sufficient interconnections and treatment facilities whereby water can be systematically and effectively transferred between these systems. The reasons that this potential exists are:

drought conditions can vary among the reservoirs' watersheds,
short-term flows from intense, localized storm events might be "shared" among systems,
variations exist in passing flow requirements,
safe yield surpluses may exist in individual systems, and
there may be an ability to "mix" water having different quality characteristics.

Also, as previously discussed, increased yield can be realized by capturing water in the most downstream portion of the watershed.

Integrated water supply management is especially important during early drought and critical drought periods in order to achieve the above. (Drought emergency management options are discussed later.) The NJDEP's implementation of drought rule curves as a component of integrated water supply management has enhanced the ability of the northeastern portion of the State to forestall drought emergencies. While these measures have improved the water supply capability of this region during normal and extended low rainfall periods, and a certain level of inter-facility management exists, more specific operational "hands-on tools" can further enhance our ability to provide adequate water supplies during these challenging periods.

Several regions have very extensive physical interconnections that allow for improved early or pre-drought and drought management. However, an impediment to integrated water supply management is the fact that purveyors possess individual allocations and that some purveyors may not wish to temporarily cease using their own supplies and have to purchase more expensive water supplies from other purveyors during periods immediately preceding critical drought conditions. Without coordinated management, more severe conditions may result if low precipitation persists. While the NJDEP has the regulatory authority to mandate use of particular sources during declared droughts, it does not generally require such conditions during pre-drought periods.

It is recommended that the NJDEP establish a management protocol with affected purveyors that coordinates source use for the critical period immediately preceeding a drought. As described in Chapter 6, the NJDEP proposes that this approach be initiated in planning areas 4, 5 and 6. This region is the only major surface water supply region that has multiple reservoirs under multiple ownership and no over-arching regulatory management system for conditions prior to declared droughts. The Raritan River basin system is operated by the NJ Water Supply Authority, while the Delaware River Basin Commission is responsible for integrated management of the reservoir systems for that area.

b. Conjunctive Water Use

Integrated use of multiple water supplies other than reservoirs alone can synergistically increase the available water yield within a planning area during extended periods of drought. There are numerous variations of conjunctive use, as defined below.

Conjunctive Use of Surface and Ground Water - Conjunctive use of surface and ground water resources provides a viable strategy for planning areas experiencing growth that are: a) dependent on surface water supplies, but possess no storage facilities (or possess these facilities but demand will exceed yield in the future), or b) facing ground water supply deficits. This alternative is encouraged by the NJDEP. Under this form of conjunctive water use, surface water is utilized preferentially until withdrawals become limited by the occurrence of a specified passing flow (generally MA7CD10 flow conditions). When surface water withdrawals are or will soon be limited by low flow conditions, demand would be met increasingly by ground water supplies. If an unconfined aquifer is utilized, the wells would have to be strategically located so that withdrawals would not reduce stream flow during the low flow period. The amount of ground water that could be withdrawn from the unconfined aquifer to satisfy this criteria would be determined by a hydrologic evaluation; this amount would essentially represent the "safe" yield of the combined systems (the amount of water that can be provided during drought conditions). The aquifer acts much the same as an off-line storage facility by providing yield during drought while simultaneously allowing for sufficient stream flow to be maintained.

Confined aquifers can also be used in tandem with surface water supplies. Unlike unconfined aquifers, from which withdrawals are generally limited by the amount of stream flow depletion that results, confined aquifers are often limited by the amount of saltwater intrusion that will be tolerated over a lengthy period. The confined aquifers most likely can provide water for longer periods without substantial impacts unless saltwater intrusion or excessive withdrawal problems already exist. Thus, when confined aquifers are used in conjunction with surface water supplies that have no available above-ground storage, the amount of water that can be withdrawn from the aquifer without cumulatively causing intolerable intrusion would represent the system yield. The NJDEP will develop and adopt a policy on saltwater intrusion and other ground water thresholds to help ensure that the State's aquifers are protected and conjunctive use alternatives can be properly designed.

Artificial recharge of surface water into aquifers is a variation of this category of conjunctive water use that has significant potential in New Jersey, especially along the coast where there appear to be ground water supply deficits in some planning areas and perhaps in the northeast where this alternative can be used to offset peak reservoir demand. Recharge is generally achieved by any of three methods: recharge basins, enhanced stream bed infiltration and injection wells. Recharge basins augment ground water levels in shallow aquifers using high flows from surface waters. Enhanced stream bed infiltration utilizes shallow wells to induce surface water into an underlying aquifer where the water is stored for later withdrawal during time of need. Injection wells (referred to as Aquifer Storage and Recovery [ASR] systems) are used to recharge surface water to confined aquifers.

Generally, the majority of water for an ASR operation would be pumped from the local stream or river during months when flows are the greatest, and injected after treatment. Since evaporation losses are minimal in aquifers, water may be stored for relatively long periods without depletion, especially in confined aquifers. It is generally recognized that up to 80 percent of water recharged into an aquifer is recoverable for later use. A New Jersey Pollutant Discharge Elimination System (NJPDES) permit is required for ASR systems if the water is treated prior to introduction into the aquifer. Artificial recharge, and surface and ground water conjunctive uses, are thought to be valuable water supply strategies for the developing coastal communities.

Conjunctive Use of Surface Water - This conjunctive water use alternative can be employed when: a) there are significant variations in water quality in two or more surface water sources and there is available storage in the planning area, and b) there is a need to increase the freshwater input into a waterway in order to reduce water quality concerns. In the first case, the surface water that has the most suitable quality is temporarily utilized or pumped into a storage facility. The yield of such a system is dependent on the amount of suitable water and the amount of available storage. An example is the proposed Kingston Quarry Reservoir in Somerset County where either Millstone River or Delaware and Raritan Canal water would be diverted into the storage facility, depending on water quality and passing flow requirements. The reservoir would be tapped during drought periods.

Another surface water conjunctive use alternative is to utilize stored surface water during critical water quality periods. An example of this is the Merrill Creek Reservoir. This facility was constructed in order to replace water evaporated by electrical power generating stations in the Delaware River Basin in order to retard the salt water front migration up the estuary.

Conjunctive Use of Ground Water - This strategy utilizes two or more aquifers. The objective of this strategy is to allow for adequate natural discharge from the aquifer systems to avoid undesirable impacts (baseflow reduction and saltwater intrusion). It is a strategy that "spreads out" potential impacts to tolerable limits and is encouraged by the NJDEP. An example of the conjunctive use of multiple ground water sources is the seasonal use of unconfined and confined aquifers. The unconfined aquifer is pumped during the winter when potential impacts to stream flow and disruption to freshwater-dependent resources are minimized. During the summer, withdrawals from the unconfined aquifer cease or are greatly reduced and pumpage from the confined aquifer commences. Conjunctive water use of two or more confined aquifers also has substantial potential, especially where the aquifers are not well interconnected and saltwater intrusion is not a problem. In addition, there is potential to artificially recharge water from one aquifer to the other in an ASR operation (e.g., winter pumpage of an unconfined aquifer to a confined aquifer where the latter would be used to meet peak summer demand).

Conjunctive water use of multiple water supply sources can be capital and operating cost-intensive, requiring redundant supply, treatment, transmission and interconnection infrastructure, and monitoring. Further, sophisticated analysis may be required prior to approval, especially when large regional facilities are being considered.

5. Technical Issues/Strategic Recommendations:
Conjunctive Water Use

<u>a. Opportunities for Conjunctive Water Use</u>

Issue: Over-reliance on unconfined aquifers in a watershed can result in excessive stream flow depletion while overuse of confined aquifers can lead to regional saltwater intrusion. Stipulated surface water withdrawals (withdrawals that have no storage capabilities) can exacerbate low flow conditions. Conjunctive water use offers opportunities to mitigate these conditions.

Recommendation: The Water Balance Model (WBM) should be refined to estimate where the above conditions may potentially occur take place. Ground water studies currently underway will allow the NJDEP to estimate the current and future magnitude of the stream flow depletion and saltwater intrusion problem in the various planning areas. Concurrently, the NJDEP will propose a definition for ground water dependable yield. When combined, these three action items will permit the NJDEP to predict when conjunctive water use should be considered.

<u>b. Use of Restricted Confined Aquifers During Drought</u>

Issue: Users of the confined aquifers have been required to reduce withdrawals. Some of these aquifers have significantly recovered since Water Supply Critical Area No.1 have been implemented. Short-term use of these aquifers can potentially provide relief during drought as well as increase overall yield. ASR also may be promising.

Recommendation: The NJDEP should assess the potential for short-term drought use of the critical area aquifers in order to determine effects on saltwater intrusion. For example, Raritan River and Manasquan River water is now used in Water Supply Critical Area No.1 to compensate for required cutbacks in confined aquifer use. If these aquifers could be partially used during drought only, without adverse effects, the regional water availability could be increased. In addition, if treated surface water could be injected into these aquifers during high flow conditions and this water could be used during drought, yields could be increased.

c. Multiple Permits for ASR Facilities

Issue: The NJDEP presently requires three approvals for proposed ASR facilities that will recharge treated water into an aquifer for use at a later time. First, applicants for these facilities must obtain a Water Allocation Permit to withdraw water and to subsequently recharge it into the aquifer. Second, the applicant must obtain Safe Drinking Water permit approval to ensure that the supply will meet the State's drinking water standards. Third, the applicant must receive a NJPDES permit to discharge to ground water. The NJDEP encourages ASR facilities and it is anticipated that several of these facilities will be needed in the not-so-distant future. These operations maintain stream flow conditions during low precipitation periods and they eliminate the need for costly storage facilities. The NJDEP needs to make this process less cumbersome.

Recommendation: It is recommended that the NJDEP take steps to initiate a more coordinated permitting process for these facilities. The NJDEP should develop standardized permit provisions and monitoring requirements that satisfy the NJPDES permit requirements. These requirements in turn would be incorporated into the Water Allocation Permit/Safe Drinking Water Approval, issued under both the NJ Water Pollution Control and NJ Water Supply Management Acts. On-going permit requirements would be administered by the Water Supply Element in order to reduce paperwork responsibilities required of the permittee.

6. Management of Depletive Water Uses

Surface and ground water availability in each of the 23 planning areas of the State is limited. Several of the planning areas are frequently subject to drought warnings and sometimes drought emergencies as a result of limited storage capability and reduced streamflow during periods of low rainfall, while others have had to seek alternative water supplies as a result of regional saltwater intrusion. Depletive water uses can exacerbate these events. They may also, depending on their severity, lead to safe yield reductions or ecological impacts through stream flow reductions during low flow periods. (See Chapters 2 and 3 for an extensive discussion of the definition and impacts of depletive water use.) In contrast, as described in B.5 of this Chapter, non-depletive water uses (e.g., wastewater reuse) can ameliorate these circumstances.

Consequently, it is important that we sufficiently manage future depletive water uses by ensuring that water withdrawn from a planning area is returned to the same area and available for reuse, whenever practicable.

a. Relationship to Wastewater Flows

As summarized in Chapter 5, Table 5.2, 1.5 billion gallons of water is withdrawn daily (average) from New Jersey's surface and ground water supplies for potable, commercial/industrial and agricultural use (e.g., water allocations over 100,000 GPD and self-supplied demand). Of the 1.5 billion gallons, about 50 percent of all surface water and ground water withdrawals are depletive and are no longer available for second use within the area of origin. (An additional 0.94 billion gallons is withdrawn daily by certain large industries; an evaluation of the consumptive nature of this specific water use will be made at a later date.)

Over and above New Jersey's large population, one factor that contributes indirectly to the increasing depletive water uses is water quality standards that have become more stringent over time. Over the last two decades numerous sewage treatment plants located within the interior of the State have been abandoned and have tied into regional plants along the coast. It is often more cost-effective (from strictly a wastewater management perspective) to discharge wastewater to the oceans and bays where dilution is substantial, if distances from the service area are not too great. However, if these types of discharges result in an actual reduction in water supply or cause a need to develop additional reservoirs, other substantial costs will need to be incurred that should be evaluated in wastewater management planning. Overall cost savings may be realized in some cases by upgrading the existing, non-depletive plants. As the cost of water increases, this option may grow in importance.

Another contributing factor to increased depletive water use is failing septic systems. When numerous systems in a specific area fail, the solution is usually to construct a sewerage collection system that conveys the wastewater to a regional plant for treatment and discharge. This may result in a depletive water use if the water supply is local and the regional sewage treatment plant outfall is not. On-site septic system management is a potential solution since one of the major functions of this program is to prevent failure.

Consumptive water uses (e.g., power generating station cooling water, spray irrigation of crops and lawns) can have effects similar to depletive water uses in that a significant portion of the water is not returned to the source supply nor can water that is diverted for this purpose be used a second time. The DRBC has found consumptive water uses to have very significant effects, resulting in the need for Merrill Creek, F.E. Walter and Blue Marsh Reservoirs. The NJDEP plans to assess the magnitude of consumptive water uses in an update of the Water Balance Model (WBM). These uses are addressed in detail in B.7 of this Chapter.

b. Relationship to Ground Water Pollution Mitigation

The state and the federal government have expended considerable sums of money during the last decade in the mitigation of ground water pollution. The selected remedy has often been to either treat the contaminated ground water at the site and discharge it to a nearby stream or to convey it to a sewage plant that possesses the capability to treat it. Although NJDEP prefers recharge on site if physically possible, it often is not. Depending on the extent of contamination, pumpage of the aquifer sometimes represents considerable quantities over significant periods of time. There is a need to balance the quality issues of these contamination remedies with the quantity issues regarding the long-term availability of the state's ground water supplies. It is thus recommended that information regarding site mitigation projects be incorporated into the WBM for periodic assessment.

7. Technical Issues/Strategic Recommendations:
Depletive Water Uses

a. Management of Depletive Water Uses

Issue: Depletive water uses represent a significant concern affecting the State's water supplies, water quality and freshwater-dependent ecosystems.

Recommendation: The NJDEP recommends that policies be proposed in the near future to discourage depletive water uses and encourage non-potable wastewater reuse where this practice is suitable, including consideration of costs not directly related to wastewater management. Primary emphasis will need to be placed on managing depletive water uses upstream of surface water intakes and sewage treatment plants and where saltwater intrusion is a concern.

b. Management of Consumptive Water Uses

Issue: Consumptive water uses have much the same impacts on water supplies, water quality and freshwater-dependent ecosystems as depletive water uses.

Recommendation: The NJDEP will first assess the magnitude of the problem by incorporating existing consumptive water uses into the WBM. If found to be significant, the NJDEP will recommend appropriate policy to manage these uses.

CHAPTER EIGHT

THE BALANCE AMONG WATER USES AND USERS THE STATE WATER ALLOCATION PROGRAM:

In order to understand the current state laws and regulations governing water allocations, it is helpful to review their historical development. This chapter reviews the role of state government in water use regulation, how it has changed over the last century and how it needs to change in the future.

A. Historical Perspective

Historically, New Jersey's water supply has been sufficient to meet the needs of the state. However, water supply needs have increased with economic growth and changed with geographic shifts of the state's population. Since the availability of water supply sources is limited, the result is conflict that eventually necessitates government intervention and regulation.

1. Common Law

The allocation of water was originally governed by English common law. Under this system, water rights are obtained through riparian rights that accompanied land abutting a water course. An owner of riparian lands had the right to use the water of a stream flowing by or through their property but did not own the water. Water was considered a common resource and therefore an owner of riparian land could not adversely affect the ability of downstream users to exercise their riparian rights. Traditionally this meant the upstream riparian owner could not diminish the flow nor alter its quality significantly. The riparian owners along a water-course were said to have correlative or interdependent rights of use.

2. Early Legislative Remedies

Over the last two centuries the English common law system has been incrementally modified to meet the increasing demand for water and reflect the changing value society has placed on water. In New Jersey the most recent changes have been to incorporate the concept of the public trust doctrine. Under this doctrine, the waters of New Jersey are viewed as the property of the State, which acts as the trustee of the people. This role of trustee was originally assumed by the Legislature. During the 1800's, the Legislature granted both public and private entities special legislative grants of water rights. In fact there still are current municipal and private water users with water allocation permits based on the water rights originally granted by the Legislature. The legislative approach to water allocation lacked an overall plan for water supply management and did not provide the resources or the capacity to evaluate impacts of withdrawals. As a result, the Legislature chose to establish a separate administrative agency, a Water Supply Commission, to assume the responsibility for the allocation of water.

3. 1907 Water Supply Commission and Early Legislation

The Water Supply Commission was established in 1907. All applications for new or increased withdrawals of surface water for public supply required the Commission's approval. A statute expanding the

Commission's jurisdiction by requiring the Commission's approval for ground water withdrawals for public water supplies was enacted in 1910. Those water users with pre-existing water rights granted by the Legislature were not required to reestablish those rights with the Commission. The approvals granted by the Commission did not contain any time limitation, and there were no provisions for revocation except through abandonment by the recipient. This made it nearly impossible to reallocate waters as demands patterns changed or where conflicting claims to water produced shortages.

It was not until 1947 that private withdrawals of ground water were required to obtain state approval. By this time the Water Policy and Supply Council had replaced the Water Supply Commission. As with the previous legislation, existing private ground water users were "grandfathered", and therefore did not have to obtain state approvals for their diversions.

In 1963, the Legislature enacted a law that required private entities withdrawing surface water in excess of 100,00 gallons per day (gpd) to obtain a permit from the Water Policy and Supply Council. By this time, any new or increased private or public ground water and surface water withdrawal in excess of 100,000 gpd or more were subject to state approval. Anyone with existing water rights obtained through legislative grants or grandfather rights was still not required to obtain a permit.

4. The 1981 Water Supply Management Act

The drought of 1980-1981 focused the Legislature's attention on the problems caused by the uncoordinated enactment of existing water laws. Water users that were exempt from the various laws did not report water use to the State, which hampered efforts to assess water availability and to comprehensively manage the State's water resources. It was clear that grandfathered rights (those exempted from the laws and subsequent regulatory programs) exacerbated problems with the already disjointed state water supply program. In 1981, the Water Supply Management Act (WSMA) was passed in an attempt to adopt a more complete administrative water law. The act states, "the water resources of the State and any water brought into the State must be planned for and managed as a common resource from which the requirements of various regions and localities in the state shall be met." This language meant that all water diverters would be subject to regulatory oversight and be considered in any water resource management strategy. For the first time, grandfathered or preexisting water diversions had to obtain a State permit.

Specifically, the WSMA required the holders of any water privileges previously allowed through legislative or administrative action, including those previously exempted from the requirement to obtain a State permit, obtain a water allocation permit within 180 days of the effective date of the act, if their withdrawals exceeded 100,000 gallons per day. This allowed for a comprehensive evaluation of the actual demand on the State's water supply sources.

B. The Water Allocation Permit Program

The WSMA also abolished the Water Policy & Supply Council and gave to the NJ Department of Environmental Protection the power to manage the water supply by adopting a uniform water diversion permit system. The new permitting system was needed because the Legislature found that "the present regulatory system for these water resources is ineffective and counterproductive." This new system allocates or reallocates all the water resources of the State through the issuance of permits to diverters of more than 100,000 gpd of ground and/or surface water.

1. Minimum Permit Provisions

In order to ensure a uniform permitting program for the allocation of water, the WSMA requires each permit to contain six minimum provisions. All water allocation permits now contain conditions that:

Fix the term of the permit;

Fix the maximum allowable diversion expressed in terms of daily, monthly or annual diversions;

Identify and limit the use to which the water may be put;

Require the diverter to meter the water being diverted and report the quantity and quality of the water;

Require all water diverted for non-consumptive water use be returned to a reasonably proximate body of water identified by the NJDEP;

Permit the NJDEP to modify, suspend or terminate the permit after notice and hearing, for violations of it's conditions, the Act, regulations or orders issued by the NJDEP and when deemed necessary for the public interest.

2. Water Allocation Regulations

The water allocation permit program is administered under N.J.A.C. 7:19-1 et seq., within the NJDEP's Water Supply Element. Under these rules, the NJDEP establishes general permit application procedures, outlines the permit review and approval process, and establishes a fee schedule for permits. The basic application review procedure is similar to that established by the Water Supply Commission, specifically the public notice and public hearing process, the decision making process and the appeal procedures. These have been updated, but contain many of the elements originally developed in 1907.

The current rules require all water withdrawals in excess of 3.1 million gallons per month to obtain a water allocation permit. The threshold is based on the 100,000 gpd threshold that has been historically used, but has been modified in recognition that short term diversions such as 72 hour aquifer/pump tests, even those exceeding 100,000 gpd, should not require formal permits as the users are not requesting formal diversion privileges from the State.

The rules require anyone that files a Short Term Water Use Report must protect existing water users, both permitted and unpermitted. Short-term water withdrawals are required to be metered and the withdrawal data reported to the NJDEP. The short-term diverter is also responsible to repair any damage to other water users caused by their diversion. There is a requirement to notify all potentially affected well owners/water users and the local health department prior to commencing the diversion.

Under the current rules, the diversion of salt water is also exempted from obtaining a permit, provided the NJDEP has determined that the diversion and usage will not adversely affect the freshwater resources of the State. Saltwater is typically used for cooling purposes by large industries and power generation plants in the coastal areas of New Jersey.

3. 1993 Amendments to WSMA

A major deficiency of the 1981 WSMA was exposed in 1989 after the NJDEP lost a court case involving an administrative order that required the reduction of existing water diversion privileges. Language in the act stated that the NJDEP could only reduce existing water privileges to the amount currently utilized, subject to contracts and reasonably required amounts for future use. However, by the time the NJDEP had been delegated the water allocation permit program, there were a number of aquifers that were being overused. Withdrawals were exceeding recharge to the aquifer and water levels were declining dramatically. Studies indicated that unless withdrawals were reduced the aquifers would continue to decline and threaten the long term reliability of the supply. The limitation in the 1981 law prevented the NJDEP from ordering a reduction in the withdrawals absent an emergency order of the Governor, an action usually reserved for drought or other water supply emergencies.

This situation was remedied in July, 1993 through amendments to the WSMA. These amendments allow the NJDEP to establish areas of water supply concern wherever it can be demonstrated that the safe and dependable yield of a water source is being exceeded or threatened by overuse. In these areas the NJDEP can reduce existing withdrawal privileges to the safe and dependable yield of that source even if this action results in a reduction in actual withdrawals. However, before taking such action, the NJDEP is required to identify alternate water supply sources and work with affected permittees to develop these supplies.

4. Water Supply Critical Areas

In the 1982 Plan the NJDEP identified two areas where overuse was threatening the long term reliability of ground water supplies. These areas are referred to as Water Supply Critical Areas (WSCA). In both areas, water levels in the major aquifers were declining and salt water intrusion was evident. The first area, WSCA #1, covers Monmouth County and portions of Middlesex and Ocean Counties and includes four depleted aquifers (the Englishtown, Mt. Laurel/Wenonah, Old Bridge and Farrington). The second area, WSCA #2 is centered on Gloucester, Camden and Burlington Counties and the depleted aquifer is the Potomac-Raritan-Magothy aquifer system. In both water supply critical areas, water allocation permittees were required to reduce the use of ground water from the depleted aquifers and develop a replacement supply.

In WSCA #1, the reductions in withdrawals went into effect in 1990. Since then, USGS has documented substantial increases in the water levels in each of the depleted aquifers. The Englishtown and Mt. Laurel-Wenonah Aquifers have recovered over 100 feet of potentiometric head (a measure of water pressure in a confined aquifer) by 1993. USGS ground water models predict the rise in water levels will continue for approximately ten years before they stabilize. In WSCA #2, orders to reduce withdrawals were sent out in 1993. Cutbacks in aquifer use will not occur until 1996.

C. Water Resource Yields

The recent amendments to the Water Supply Management Act emphasize the need for a refined definition of safe or dependable yield, as discussed in Chapter 3. In order for the NJDEP to make a determination that the dependable yield of an aquifer is being exceeded, there has to be a definition of this term. The definition of safe yield for surface water systems has always been associated with the so called "drought of record." Specifically, a surface water system's safe yield has been defined by NJDEP as "the yield maintainable by a water system continuously throughout a repetition of the most severe drought of record, after compliance with requirements for maintaining minimum passing flows." Safe yield is a term that indicates a supply source can provide a set amount of water supply, defined in annual average daily flows (i.e. MGD), during a specific historical drought. This yield has been determined for most major surface water systems in New Jersey.

Ground water systems also have sustainable yields, referred to as the "dependable yield" in the current regulations. To date, firm figures for the dependable yield of aquifers have not been established. The continuous decline of water levels in an aquifer, and related effects such as the accelerated movement of saltwater, or intolerable reductions in streamflow, are considered evidence that the dependable yield is being exceeded, but the actual yield has not been formally quantified. A method of quantifying ground water yields directly has not be determined and needs to be, in order to guide resource allocations. The definition of surface water "safe yield" is not satisfactory regarding ground water because drought often will not materially affect the availability of ground water in many aquifers, except in small, poorly yielding or already impaired aquifers.

1. Regulatory Factors Affecting Water Resource Yields

The definition of safe yield is flexible in two regards. First, the drought of record can change, and second, the minimum passing flows can change. Changes to either parameter affect the safe yield of a surface water system. A change in the definition of the drought of record would be necessary if severe climatological and hydrological conditions demonstrated the safe yield of a source was over estimated. Currently, many surface water supplies have estimated safe yields based on the 1960's drought. If a more severe drought, or a different drought pattern occurs, these systems may not be able to supply their "safe yield."

The change in minimum passing flow requirements could result from regulatory decisions to increase or decrease the amount of water allowed to pass the point of diversion. The type of regulatory decision can include interbasin transfers of upstream sewage effluent, an increase in stream flow for instream flow protection or an extension of sewerage collection system to upstream areas currently served by septic systems. In times of severe drought, minimum passing flows are often reduced administratively by NJDEP in order to maintain storage in reservoirs.

The dependable yield of a ground water system can also change. In this case, changes in the minimum acceptable water level in the aquifer or a decision to allow a certain amount of saltwater intrusion would alter the definition of its yield. A change in ground water use patterns can increase ground water yields, specifically when pumping centers are moved away from sources of saltwater intrusion.

a. Transfer of Wastewater Discharges

Chapter 3 and 7 presented an extensive discussion of depletive use impacts related to the regionalization of wastewater facilities, both by expansion of collection systems across watershed boundaries and by the abandonment of wastewater effluent discharge points in one watershed and the export of that wastewater to a facility elsewhere. The NJDEP needs to integrate water supply and wastewater planning in order to assess the effects of the regionalization of wastewater treatment and collection on existing and future water supplies.

b. Instream Flows

The concept of instream flows is being discussed by many State and Federal agencies that are responsible for water resource management. Ecosystem maintenance and restoration as well as recreation and aesthetics are the primary reasons for the current reassessment of instream flows. In many areas of the country, damage to aquatic ecosystems has resulted from excessive water withdrawals. To date, there has been no hard evidence that similar situations exist in New Jersey, although clear evidence exists that water withdrawals can reduce low flows, especially in smaller watersheds. However, it is prudent to develop a state policy on instream flows before any damage occurs. It is generally agreed that instream flow rights are public rights and the state may adjust the current system for issuing water allocation permits under the public trust doctrine. Currently, the water allocation permit program uses the seven day ten year low flow (MA7CD10) as an instream flow requirement. Any change in these policies would affect hundreds of existing permits and would have to be based on the overriding need to correct some deficiency or rectify problems caused by the current criteria. Prior to any change in policy there is a need to develop a system to rank and decide preference for water use, especially to decide which use is supplied during seasonal fluctuation, times of drought and in case of competing applications for a limited source.

c. Land Use Changes

Watershed hydrology can be affected by land use, with changes in land cover and storm water conveyance as the primary causes. Land cover affects watershed hydrology by altering the percentage of precipitation that infiltrates in the ground and the percentage that becomes direct surface runoff. Changes in storm water conveyance similarly affects watershed hydrology. By design, these systems move water efficiently, which reduces both infiltration and the travel time of runoff when compared to overland and small channel flow.

The overall impact of urbanization on watershed yield is to increase the variance between high and low flow. This reflects the reduction in shallow infiltration, which sustains low flows. The combination of an increased volume of surface runoff and a decrease in the travel time of the runoff causes higher peaks flows. These changes can reduce the safe yield of a surface water supply system. Pump storage systems would have less water available during non-storm periods. Yields could also be altered if additional releases from storage were needed to supplement minimum passing flows downstream. The storage releases would replace the ground water releases that sustained base flow. Conversely, rainfall during drought periods would be more quickly and completely channeled to reservoir feeder streams. The net impact is not known, and likely varies with each specific case.

2. Impacts of Other Legislation on Water Resources Yields

In New Jersey, the concept of water resource management has been significantly broadened since the first Water Supply Commission was established in 1907. Multi-objective resource planning has become commonplace and is evolving as the interrelationship between ground water, surface water and the ecosystems they support are identified and their interdependency understood.

The Water Allocation Permit program in New Jersey is currently influenced by other regulatory programs, most of which are designed to protect natural resources and can also protect water supplies. The Freshwater Wetlands Protection Act, the Pinelands Protection Act, the Water Quality Planning Act, the Water Pollution Control Act and other statutes have generally constrained the availability of water supply sources, as have provisions of the Water Supply Management Act itself. In some cases supplies have been increased when sewerage effluent has been improved by advanced wastewater treatment.

The Water Allocation Permit program is further constrained by Federal legislation such as the Clean Water Act, the Endangered Species Act, and by the Federal Power Act which allows the Federal Energy and Regulatory Commission to impose license conditions on power projects that may supersede state requirements for minimum passing flows in streams.

The net effect of these State and (to a certain extent) Federal statutes has been to place some constraints on the maximization of water use for water supplies, due to other public policy considerations. The concept of "highest and best" utilization of water has varied over time and across the United States. Power production and irrigation demands directed early water policy in the western two-thirds of the United States. Purveyor needs and environmental impacts were routinely ignored.

The clash between State water rights and Federal water policy continues to shape Federal legislation. To date, most Federal water law was introduced to correct problems created by western states water law. As a result, the actual impact of federal legislation on New Jersey water supply policy has been minimal.

3. Water Resource Issues to be Resolved

In order to continue to develop a water allocation program that meets the legislative intent of the 1981 WSMA and also to allow the program to address other State and Federal statutes affecting water use, the NJDEP must establish policies on a number of key issues. They include instream flows, a ranking system for water use, and how to define and allocate the safe/dependable yields of water sources. After years of NJDEP research and cooperative USGS-NJDEP studies funded under the Bond Fund, the NJDEP has a much greater capability to determine the amount of water available to the State. In order to properly manage its resources these policies are needed to guide decisions on how much of the water to use, and how it gets used. The three key areas are briefly reviewed, with recommendations on how to proceed.

a. Safe yield

In the current regulation (N.J.A.C. 7:19-6) the term safe yield is used with surface supplies, while the term dependable yield is used with ground water supplies. This idea of two separate terms indicates there are two separate sources of water supply; ground water and surface water. In fact, the interrelationship of ground and surface water has been documented through water supply studies throughout the State. It is clear that the use of ground water in many areas directly affects the availability of surface water supplies. This connection has direct implication on how yields are defined and how they will be allocated. This a particular problem with rural ground water supplied systems in the headwaters of rivers feeding major reservoirs and direct intakes. In addition, there are environmental limitations to safe yields; some safe yields are set for ecological reasons such as trout maintenance in streams.

In addition, an increasing number of water systems are using both ground and surface water conjunctively. These factors point to the need for a new discussion on the definition of safe/dependable yield and how the terms should be used by the regulatory programs. There is also a need to distinguish between the sustainable yield of a resource (i.e. an aquifer) and the safe yield of a purveyor's water system. Further, an optimized hydrologic yield of a surface source may not be equal to hydraulic yield, which is often limited by intake and pump design parameters.

Recommendation: Review the existing definition of safe yield for surface water. Specifically, the existing use of the "drought of record" should be analyzed along with other options such as the use of hydrologic conditions for a 95% to 99% recurrence interval (the probability that the worse drought of record will not be exceeded in any one year). There is a need to develop a working definition of conjunctive yields for water systems that combine ground and surface water sources. The state should compare the hydraulic safe yield of existing projects to the theoretical hydrological yield developed from flow models. The State should build on studies completed to date to develop a realistic limit on ground water use by establishing a working definition for the yield of ground water.

b. Instream Flows

The issue of instream flows is directly related to safe yield of both purveyor systems and water sources. It is also a way of asking "what is the purpose of a stream or river?" Instream flow objectives include maintenance of downstream water quality and quantity, navigation, ecosystem maintenance and restoration, aesthetics and recreation. Each of these objectives has a value to society. Streams and rivers can not provide enough water to maximize the value of each objective. Decisions on how to manage our waterways require a workable instream flow policy.

In order to develop a uniform and workable instream flow policy, it is necessary to identify all the objectives and rank them for preference. The effect of existing water allocation rights on any proposed instream flow policy would have to be assessed. There are statutory limitations on the NJDEP's ability to reduce existing water allocation rights. The policy would also have to address the implications of the excess diversion statute (N.J.S.A. 58:2-1 et seq.) which allows public water supplies to divert excess surface water through payments to the State, which are " deemed to be a license." This law allows a public water system to continue to divert surface water when flows are below the minimum passing flow requirements in their permit through the payment of excess diversion fees. This 1907 law was the first legislative attempt to ensure adequate municipal water supplies in times of shortage.

Recommendation: The NJDEP shall develop an approach to the allocation of stream flow among water supply and other uses (especially aquatic ecosystem protection) that addresses and analyzes the following issues:

1. Statutory mandates and authorizations, and differences between statutes regarding the allocation of water for potable, industrial, agricultural and other human uses, the maintenance of aquatic ecosystems and aquatic life and water flows for them, the effects of reductions of streamflow on water quality,etc. Included in this analysis is the impact of court orders and other non-legislative mandates that affect water allocations.

2. Existing and potential water allocation regulatory systems, including implications regarding existing water allocation permits vs new permits, ground water vs surface allocations, on-stream intakes vs reservoirs, etc.

3. Different ecosystem needs for maintenance of natural flow volumes or patterns. Should instream flow management be differentiated based on ecosystem, watershed, sub-watershed? How do concepts of risk-based management apply to instream maintenance issues?

4. Different management approaches, including but not limited to consideration of the following categories of options, for specific situations or aquatic ecosystems or for all permitting actions:

Prohibitions of new water allocations to consumptive or depletive uses within specific high-priority watersheds;
Direct allocation of instream flows through water allocation permits;
Changes in existing passing flow requirements;
Water conservation projects for the purpose of creating instream flow set-asides;
Phasing of instream flow protection based on ecosystem quality, risk of degradation due to future allocations, watershed management priorities or some other priority-driven process.

The instream flow management policy should provide a general approach plus guidance for more watershed-specific approaches as needed. The policy should provide a clear, up-front process that is readily understood. Finally, the policy should be linked to other resource management processes beyond water allocation, such as the wastewater management planning process. NJDEP shall draft an initial approach within one year of NJSWSP adoption, and subject the draft approach to extensive public comment and participation, toward an objective of finalizing the approach within two years of NJSWSP adoption.

c. Ranking of Water Uses

The 1907 excess diversion law appears to indicate that public water supplies are given the license to divert water at all times regardless of flow conditions. This would seem to be the only use currently "ranked" by the State of New Jersey. In other words, drought conditions have resulted in the clear preference for public water supply over water quality, recreation or any other water management objectives. However, it is not clear whether or how other legislation enacted since 1907 establishes any hierarchy of preference for any one use over any other use, other than perhaps agricultural uses during the growing season. The current system has produced unresolved conflicts between program goals. The means of resolving these conflicts has not been articulated. As such, permits for water allocation don't directly address the objectives of other water resource or environmental protection programs.

Recommendation: There are a number of ways to address this issue; one is to establish specific watershed flow objectives that are based on multi-purpose water resource planning. All permits in the watershed would have to be based on the established flow objectives. Another mechanism is to provide an allocation for a set amount of flow to instream uses or other program objectives. This approach is gaining favor in many western states where the prior appropriation doctrine governs water law. In any approach to this issue, the existing water allocation privileges will be a factor in policy development.

The ranking of water use preferences will require interagency discussions with the Department of Agriculture and the Board of Public Utilities. Intra-agency discussion needs to address the conflicting program goals of the water quality, water supply, floodplain management and ecosystem preservation programs in the NJDEP. The NJSWSP should provide specific preferences in times of both normal and drought conditions. This will directly affect the development of an instream flow policy and provide priorities to the water allocation permit program.

CHAPTER NINE

INFRASTRUCTURE CHOICES, DEVELOPMENT AND MAINTENANCE

This chapter focuses on those activities and programs that affect water supply infrastructure and the choices to be made in the next five to ten years. Section A discusses general policy considerations on infrastructure choices and Section B discusses six infrastructure issues. Infrastructure maintenance of watersheds and facilities is highlighted. Section C presents infrastructure recommendations and Section D addresses issues regarding water supply infrastructure financing and use of the Bond Fund.

A. General Policy Considerations

Typical infrastructure choices involve questions such as: Should a ground or surface water supply source be developed? How should an existing water supply system be maintained? Where and when should systems be extended? Should an abandoned source be restored? How much should it cost? What level of service is to be provided?

The New Jersey Safe Drinking Water Act (adopted 1977 and amended in 1983) declared the "paramount policy of the State to protect the purity of the water we drink." The NJDEP adopted regulations (N.J.A.C. 7:10-11 et seq. and 7:19-6 et seq.) to implement that Act and the Water Supply Management Act. These regulations set minimum standards for design and construction of water supply facilities to ensure that water reaches consumers in sufficient quantity and pressure with a quality that complies continuously with minimum physical, chemical and microbiological requirements. However, the regulations apply generally once a source of supply has been chosen.

A primary consideration in the design and construction of water treatment facilities is the character of the source of supply (N.J.A.C. 7:10-11.1, 3, 4, and 5). For purposes of the New Jersey Safe Drinking Water Act there are four classes of natural waters in New Jersey (N.J.A.C. 7:10-11.1(e)). Class 1 is ground water which may be adequately protective of public health by use of disinfection only. Class 1 waters may be considered adequately protected by natural means, such as a clay barrier and hundreds of feet of sandy soil. Class 2 is ground water which may be adequately protective of public health by disinfection and one or more treatment processes primarily for naturally occurring chemicals. Class 3 is for ground and surface waters with variable bacteriological quality which require pretreatment, filtration, disinfection to protect consumers from water-borne diseases. Class 4 is for ground and surface waters which have highly variable or excessive bacteriological contamination and which require additional treatment including pre- and post-treatment chlorination. This classification system initiated in the 1960’s has provided guidance on design, construction and monitoring and appears generally compatible with concepts of vulnerability and enhanced surface water treatment that USEPA is promulgating nationwide. This system recognizes that the nature of the source strongly influences the potential health threats and therefore the treatment needs. The alternative costs of supply development and treatment will in turn influence the choice of water supply source.

It remains the responsibility of the purveyor to utilize the highest quality and best protected available source of supply. The American Water Works Association restates this as Policy Statement #1 in its manual. The purveyor must consider protection of the source watershed or aquifer as the first barrier against contamination. Design and construction of public water supplies assumes that the quality of the source water is consistent and will not be degraded. However, since few purveyors own the watershed or control the aquifer from which their water originates, most purveyors rely generally on State and local governments to protect the quality of the source of supply.

Therefore watershed protection must be considered an integral part of the water supply infrastructure along with water treatment, storage and distribution facilities. However, watershed protection remains a difficult problem in New Jersey for two reasons: the State historically has had direct discharges of wastewater into certain water supply watersheds; and planned and unplanned urbanization of the major water supply watersheds in the Raritan, Passaic and Delaware River basins increases uncontrolled nonpoint and urban runoff which degrades water quality. Chapter 7 addresses watershed management in some detail; the point here is that protection of watersheds affects both existing water supplies and the selection of future supplies. Supplies that cannot be secured through source water protection are less desirable in general than those where source water protection is possible.

The importance of source water protection is recognized to a certain extent in the State Development and Redevelopment Plan (SDRP), through its recommendation that public resources are most wisely spent in and around the existing urban infrastructure and development corridors. In general, this is consistent with watershed protection and maintenance of water supply infrastructure. However, where the corridors parallel major Interstate and State highways and pass through water supply watersheds, the SDRP may conflict with water supply objectives. Access to these areas from highways is unprecedented in New Jersey's history. Future updates of the SDRP should recognize and address these potential conflicts.

Development Corridors & Water Supply Watersheds

SDRP Growth Corridors	**Potable Watersheds**
Interstate 78	Upper Raritan/Upper Passaic
Interstates 80/280	Upper Raritan/Upper Passaic
Interstate 287	Upper Raritan/Upper Passaic
NJ Routes 10/24/46/202	Upper Passiac
NJ Route 22	Upper Raritan
Garden State Parkway	Northern Coastal/Critical Aquifer
NJ Route 55	Maurice/Cape May Coastal

Because financial resources are scarce, infrastructure choice, development and maintenance requires ongoing examination to ensure that New Jersey is making optimum use of its water resources, with due consideration for the long term protection of those resources . In essence, **protection of the source waters must be considered part of the water supply infrastructure**. In addition, proposed Federal drinking water regulations will create additional capital and operating demands, especially, on surface water supplies. The private sector as well as the public sector have a significant stake in these issues.

B. Major Infrastructure Issues

Six major infrastructure issues have been identified that will have a significant impact on purveyor costs, water supply stability and resource use efficiency. These issues address existing treatment, storage and distribution systems, protection of surface and ground water supplies, use of contaminated or abandoned ground water supplies, reuse of reclaimed wastewater for nonpotable purposes, emergency and drought water supply planning and residuals management.

1. Maintain, Rehabilitate and Protect Existing Treatment, Storage and Distribution Systems

Maintenance and rehabilitation of the water supply infrastructure accomplishes many quality and quantity objectives: water is conserved when leaks are plugged; water pressure increases and water quality improves as systems are looped and cleaned; service during peak demands or emergencies is maintained by needed water storage; and outages are minimized as older worn out pipes and plants are replaced.

The statewide estimated value of existing water treatment, transmission, storage and distribution systems is about five billion dollars. This estimate is based on reports prepared by utilities and submitted in accordance with accounting procedures to the New Jersey Board of Public Utilities for 1993. The BPU reported subtotal was adjusted by population to provide a statewide estimate. If one assumes that reinvestment (capital expenditures on existing facilities) should be about 2.5% of assets, then about $125 million is needed annually.

Estimated Statewide Assets of Existing Water Supply Systems
Based on Reports to Board of Public Utilities (BPU)
(millions of dollars, 1993)

Purveyor Name	Total Treatment & Pumping	Distribution Systems	Other
Hackensack Water Company	450	250	200
Elizabethtown Water Co.	425	105	320
New Jersey American Water Co.	600	200	400
Middlesex Water Co.	115	30	85
Trenton	70	20	50
BPU Reported Subtotal	1,660	605	1,055
Statewide Estimate Total	5,000	1,200	3,800

The New Jersey Water Supply Management Act regulations require that 10 percent of the gross revenues should be used for infrastructure maintenance and rehabilitation (N.J.A.C. 7:19-6.6). To estimate gross revenues assume that public community water supplies deliver at least 1 billion gallons per day at a cost between $1 and $3 per thousand gallons. At that rate, a minimum of about $100 million annually should be spent on rehabilitation and maintenance.

The 1981 Water Supply Bond Act established a low interest revolving loan fund for maintenance and rehabilitation of publicly owned (not investor-owned) water systems. A detailed description of the Water Supply Loan fund is provided in a later part of this chapter. The existing program provides about $10 million annually. Therefore between $90 and $290 million annually may be needed for those public and privately owned supplies which do not utilize Bond Fund loans.[14]

As new regulations come into place, replacement of older facilities may occur. In the last ten years, new and major modifications of water treatment plants have been undertaken for United Water-New Jersey (Hackensack Water Company), the City of Newark, North Jersey District Water Supply Commission, Elizabethtown Water Company and the New Jersey American Water Company. Nevertheless, additional needs may arise as proposed Federal drinking water regulations will create additional capital and operating demands, especially on surface water supplies.

2. Protect Existing Surface Water Supplies

Watershed protection of surface and ground water supplies involves consideration of existing and proposed wastewater and contamination sources and the impacts from land use changes. Surface Water Quality Standards are the cornerstone of a watershed protection strategy since they significantly influence wastewater permits and non-point source management. The Ground Water Quality Standards play a similar role for ground water supply sources.

In New Jersey, point sources (such as municipal and industrial wastewater treatment facilities) have been the focus of attention because of their negative impact on stream water quality during low flow/warm weather conditions. During the 1980's, many wastewater treatment plants were upgraded to provide more than secondary treatment. Upgraded wastewater treatment has improved water quality in many streams. Consequently, raw water quality at potable water intakes has improved in some instances and operators have been able to make adjustments in their water supply treatment facilities.

Readjustments and continued coordination are still required as new and sometimes more stringent regulations are implemented. Where wastewater is discharged upstream of water supply intakes, additional water and wastewater treatment may be necessary to ensure that waters are repurified for downstream water supply. Parameters of concern include ammonia, nitrate, phosphorus, volatile organic chemicals, pesticides, pathogens, disinfection by-products and their precursors.

An example of the interrelationship between wastewater and water treatment is developing in the Passiac River. Between 1980 and 1993 ammonia concentrations in the Passaic River decreased significantly, almost certainly due to the construction and operation of advanced wastewater treatment facilities on the upper Passaic River and its tributaries as well as the strict enforcement of permit violations.

Ammonia reacts with chlorine, which is used for water supply disinfection. The decrease in Passaic River ammonia levels correlates well with the recent reduction in chlorine usage at water supply treatment plants. The reduction is dramatic because one part ammonia reacts with 5 to 10 parts of chlorine. Less chlorine usage generally translates into lower concentrations of disinfection by-products at the tap. Fewer byproducts, such as trihalomethanes and haloacetic acids, means lower health risks.

The primary reason for ammonia controls at wastewater treatment plants is to reduce the toxicity of effluent to fish. Fish toxicity of ammonia is generally lower during the colder seasons, leading to generally higher ammonia limits during the winter for wastewater facilities. Additional capital and operating expenses may be incurred at wastewater plants if these improvements are to be maintained during cold weather when the treatment systems are least efficient. Table 9.1 below shows the decrease in ammonia, increase in nitrate and changes in chlorine use at a downstream water treatment facility.

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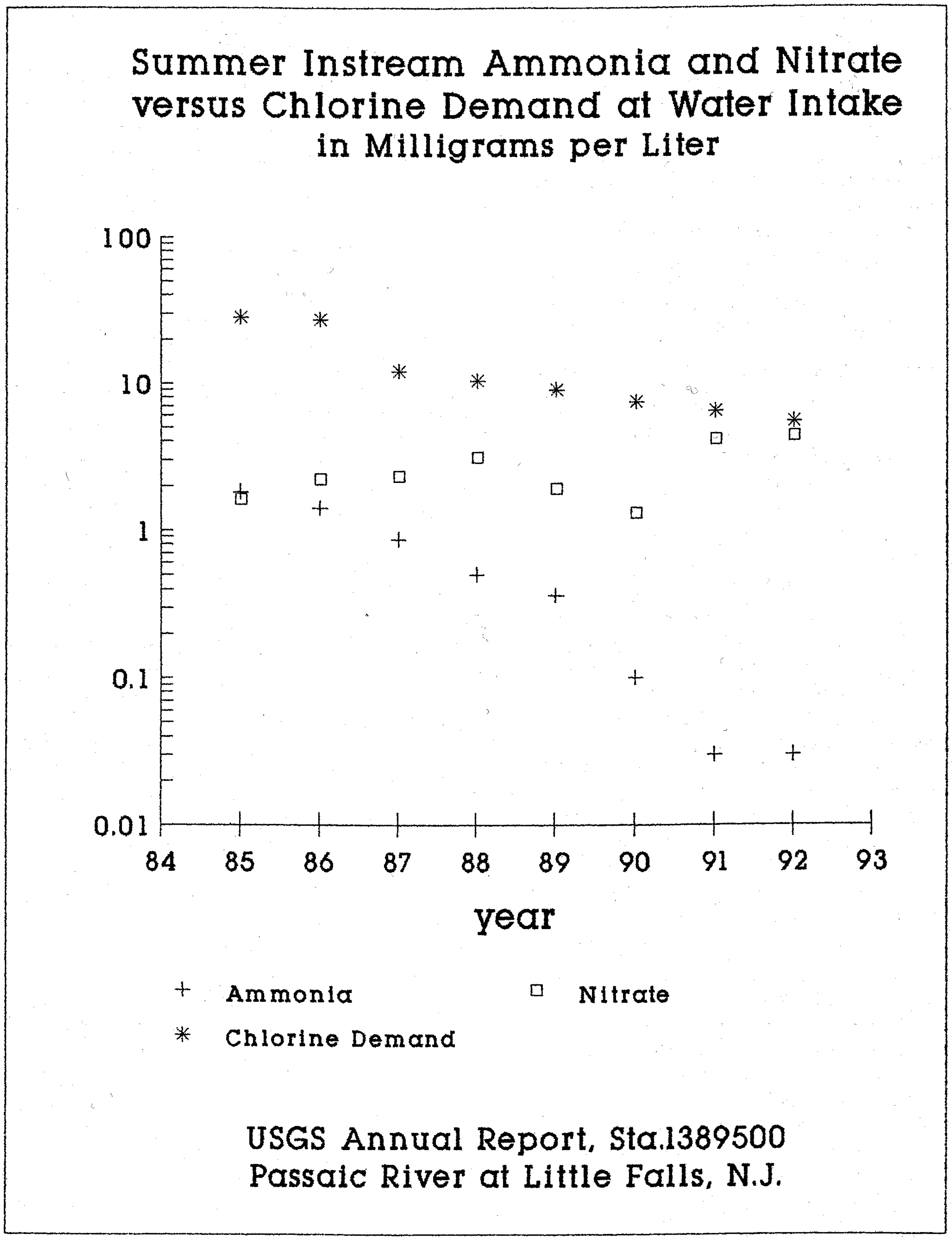
[14] Even the $10 million in Bond Fund loans must be repayed with interest, requiring that the recipient water purveyors include loan repayment in their rate base. Although the cost of financing is reduced, the principal cost of rehabilitation needs is not reduced.

TABLE 9.1


Summer Instream Ammonia and Nitrate
versus Chlorine Demand at Water Intake
in Milligrams per Liter
100
10
1
0.1
0.01
84
85
86
87
88
89
90
91
92
93
year
Ammonia
Nitrate
Chlorine Demand
USGS Annual Report, Sta.1389500
Passaic River at Little Falls, N.J.

However, there is a tradeoff involved with ammonia treatment. Ammonia is converted to nitrate in wastewater plants. Nitrate is a contaminant of concern in drinking water supplies. The concentration of nitrate in the Passaic River has increased to levels of concern, sometimes between 5 and 10 mg/l in downstream water supplies, while ammonia levels decreased. On the Passiac River, instream concentrations of nitrate have been reported as high as 8 mg/l. This nitrate increase was foreseen in NJDEP studies of the 1980's. As seen in this example, stream quality issues should address all potentially affected users to ensure that harmful side effects do not occur.[15]

Similarly, management of nonpoint sources can affect downstream water supplies. Volatile organic chemicals in surface waters are also a concern in some water supply watersheds. A rapid increase in the concentration of a regulated volatile organic chemical in 1993 (possibly from uncontrolled discharges from a Superfund site) contributed to the selection of an alternate source by a major purveyor. This occurrence was significant for three reasons:
the surface water quality standards were not violated (criteria for the chemicals were not adopted until December 1993);
a plume of contaminated ground water was the suspected source; and
the availability of alternate sources was limited due to a regionwide dry spell.

The Surface Water Quality Standards now in effect also raise issues regarding drinking water management. These standards, following federal guidance, now require that stream water quality for human carcinogens meet the numeric criteria at stream flow conditions that are higher than the low flows at which surface water intakes still are allowed to operated (the MA7CD10). Therefore, there could in certain circumstances be periods in which surface water quality that meets all standards for carcinogens (based on lifetime average exposure) will violate the safe drinking water quality standards for those substances at the intake. Because safe drinking water standards must be met at all times by purveyors, this potential conflict could expose them to violations, even if public health is not at significant risk. Therefore, the implications of the new standards for surface water supplies should be considered and the standards modified or augmented if necessary to address this issue.[16] The enforcement of drinking water quality standards should <u>also</u> be assessed for substances of long-term, rather than acute, health impacts to determine whether modifications to the enforcement policies are appropriate. The NJDEP should focus this analysis of water quality policies within the Passaic River Basin due to the high level of wastewater effluent discharged to the river system and the high level of water supply use in those same rivers. These issues will be brought to the attention of the newly formed Passiac River Task Group.

Another nonpoint source issue relates to eutrophication of rivers and reservoirs. Algae contribute to taste and odor problems and also make turbidity standards more difficult to meet for water suppliers. Upstream development activities can release significant quantities of nutrients to streams, increasing the potential for eutrophication.

If infrastructure choices are not made to protect existing water supplies, then the purveyor may abandon an existing supply and choose a higher quality source if available, in part because it may be less expensive to treat or better protect. If that occurs, the rejected supply may be available but not used.

Alternate sources can be compared by evaluating their vulnerability to specific contaminants that can and can not be removed in conventional water treatment and wastewater control programs. In the event of mechanical failure or drought, alternative sources of supply should be available. These alternatives should be proposed and set forth in emergency plans.

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[15] One of the most economical means of reducing nitrate is by biological denitrification to nitrogen gas in wastewater plants. Additional capital would be needed to construct and operate denitrification facilities.
[16] 1995 proposed amendments to the Surface Water Quality Standards would reinstate use of the MA7CD10 design flow for an interim period to ensure protection of water supply facilities while further analysis of this issue occurs.

Alternatives to protect existing water supplies may include the use of highly treated wastewater for agricultural/commercial irrigation. Careful planning is required when using wastewater reuse for agricultural operations (food vs. non-food production). Since irrigation demands are highest during the summer and coincide with peak potable water demands and low stream flows, diversion of wastewater upstream of an intake may be an environmentally sound choice in some instances. The economic incentives to consider this alternative are discussed later. In other instances, treatment and discharge of the wastewater effluent into a water supply stream may be more appropriate. Choices should be based on the circumstances of each watershed.

3. Restore Existing and Abandoned Ground Water Supplies

Where ground water supplies have been abandoned because of contamination or physical obsolescence, restoration should be initiated where cost-effective and practical, especially in planning areas experiencing or anticipating deficit. Similarly, clean up of contaminated industrial sites should be considered a priority when a contaminated or abandoned water supply is directly affected. Hazardous waste cleanup policies and regulations that do not result in restoration of contaminated public ground water supply systems should be reconsidered.

Technology for restoring contaminated ground water may be expensive or ineffective, especially if the scope of the restoration project exceeds any immediate or near term uses. However, if the scope of the project is limited to treatment of water that is withdrawn and will be used (i.e., delivered to customers through a public supply), rather than restoration of the aquifer itself, then effective treatment techniques are available and may be financially viable. Priority should be given to those projects that protect existing potable uses. In other words, the policy of containment and cleanup of contaminated ground water should always be considered within the context of when and how existing uses will be achieved or maintained.

Restoration of these ground water sources will improve system reliability especially during dry spells or periods of stress, especially as many of them are in suburban or urban areas. As with any conjunctive water use facility, maintenance of two sources increases costs. However, if the source had been connected into the system, then the additional costs may be limited to marginal increases in operations.

Since the mid-1980's State, Federal and local procedures and regulations have protected ambient ground water more aggressively than surface water supplies regarding toxic substances. For example, USEPA and NJDEP developed ground water quality standards for volatile organic chemicals found in ground water supplies in the mid 1980's. In comparison, surface water quality and drinking water quality standards for many disinfection byproducts found in chlorinated surface water supplies have yet to be promulgated. A comparison of risk assessment considerations is also noteworthy. Risk assessments of cancer causing chemicals in ground water considers those chemicals individually. However, risk assessments of cancer causing compounds in potable water supplies arising from chlorination/disinfection practices consider the need to continue chlorination to reduce acute risks from microbiological contamination.

Together these administrative approaches have dissuaded some public water supply systems from restoring, maintaining or treating their ground water supplies even when the ground water sources may be more appropriate and have lower total contaminant loadings once treated than treated surface waters. When offered the alternative of purchasing a surface water supply from an outside source, they have opted for that alternative. Once that option is exercised, the ground water source is likely to be abandoned. Once abandoned, the purveyor is unlikely to reactivate the supply. These actions by both large and small utilities have impacts on consumer costs, on drinking water quality and on our ability to respond to droughts.[17]

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[17] Some municipalities, notably Ridgewood, Hawthorne, and Fairlawn have maintained their ground water supplies. Other systems have recently reactivated ground water supplies as well, in response to improved and more cost-effective treatment systems.

The existing classification of source waters (as classified through the Safe Drinking Water Act Regulations) should also be considered by municipalities prior to abandoning ground water supplies. While treated ground and surface waters are comparable as long as drinking water standards are maintained, the vulnerability of surface and ground waters to future contamination is not comparable. Ground waters may be better protected by natural means and by administrative/land use regulations in the future. Ground water also tends to require less chlorination than surface water, and therefore has fewer disinfection byproducts.

Protection of future ground water quality at the local level should be a shared responsibility of State and local entities. Some states, such as Massachusetts, have developed very aggressive programs to encourage the development of water source protection plans by purveyors, through the use of incentives (reduction in monitoring requirements) and disincentives (constraints on water allocation permits).

These actions may help to dissuade abandonment of ground water supplies and to protect their future quality once restored.

4. Nonpotable Reuse of Reclaimed Wastewater

Alternative sources of supply of lower quality water for nonpotable purposes should be considered as long as the alternative supply is dependable and meets appropriate standards. Reclaimed wastewater for nonpotable purposes reduces demand on high quality water supplies and on water treatment facilities. In effect these are structural conservation techniques. Design standards for these projects should be developed to permit their use for agricultural and commercial irrigation, industrial cooling and power generation and cogeneration. *Guidelines for Water Reuse*, 1992 prepared for USEPA and the U.S. Agency for International Development addresses most aspects of planning, implementing and regulating water reuse systems. *Dual Systems Manual* , 1994, by the American Water Works Association provides additional guidance.

The reuse of treated wastewater for agricultural purposes should be cautiously considered and is not recommended on food crops intended for direct human consumption. The NJ Department of Agriculture should be involved in the development of any incentive plan for agricultural use of treated wastewater. Reuse is to be avoided if there is confusion in the public's perception of the edibility of food crops. Public education and information should be considered to overcome public confusion or misperception. However, agricultural irrigation uses for nurseries, turf grass and similar uses could be appropriate.

Alternatives to protect existing water supply quality may include the diversion of treated wastewater from stream discharge to a nonpotable use, such as landscape irrigation. Since irrigation demands are highest during the summer and coincide with peak potable water demands and low stream flows, diversion of wastewater discharges may be considered. Golf course irrigation is an example where wastewater has been reused. In Spring Lake Heights, a dual distribution system had been installed for residential outdoor irrigation uses. Various regulatory issues, some related to protection of ground water quality and others related to construction standards need to be resolved.

Feasibility studies jointly prepared by dischargers, purveyors and utilities could determine what economic incentives if any are needed to initiate these projects and to whom and where benefits may accrue directly and indirectly. For example, reclaimed wastewater for nonpotable purposes may avoid costs for water supply development and wastewater treatment. Reclaimed wastewater used for irrigation may not have to be treated to remove phosphorous or nitrate. Care is needed in the analysis. By simply comparing costs associated with water supply development with costs associated with reuse or conservation, the indirect economic benefit for the region may be lost.

A conceptual evaluation of economic feasibility of a reuse system could be based on a comparison of the annualized costs for new water supplies (including treatment and pipelines to the distribution area as appropriate) versus nonpotable wastewater reuse (including additional treatment and pipelines to the point of use as appropriate). The cost of existing wastewater treatment is a fixed cost of the system and therefore is not included in the analysis. Likewise, the cost of existing water distribution systems are a fixed cost that is not part of this analysis. These systems are most likely to be viable in cases where:

the wastewater reuse is in one, concentrated location (e.g., an electrical power generating plant) as opposed to many places;
new capital expenditures to make use of the wastewater are minimal or can be incorporated into a planned rehabilitation process or a new facility;
the quantity of water needed is relatively large; and
the quality of water needed is not significantly better that the wastewater treatment plant currently provides, so that few or no upgrades to the treatment process are necessary.

As a practical example, one electrical generating facility in northeastern New Jersey has contracted to reuse treated wastewater as make-up water for its cooling system as a method to avoid surface water withdrawals and purchase of potable water. This system was practical in part because a major overhaul of the power plant was planned with a new cooling system that recirculates cooling water, reducing the amount of water needed. While individual arrangements may be developed, areawide arrangements require that both wastewater and water supply agencies are able to share benefits/costs equitably; otherwise needed agreements between agencies and consumers may not be reached.

5. Emergency and Drought Water Supply Planning

In 1989 the NJDEP and the Board of Public Utilities produced a document that describes agency responses to various types of water supply emergencies: mechanical failure, chemical contamination, drought and extraordinary demands. In addition, the major water purveyors are required to prepare conservation and emergency response plans.

Recurrent dry spells in 1985, 1988, 1991, 1993 and 1995 revealed the vulnerability of surface water systems to severe rainfall deficits lasting 3 to 6 months. Construction of the Monksville Reservoir, Great Notch interconnections, Wanaque South pumped storage system and other major treatment, storage and interconnection facilities was critical to meeting northeast New Jersey demands during those years. However, improved strategies of how and when to use these facilities require coordination and timely responses.

Coordinated management of existing systems improves our ability to respond to water supply shortages, as noted in Chapter 7. In practice, NJDEP and purveyors have acted cooperatively to wheel excess water from one area to treatment facilities in another area during declared Drought Warnings since 1986. (A Drought Warning is an administrative declaration by NJDEP based on precipitation deficits and reservoir storage levels.) Knowledge gained during those dry spells should be recorded and used to update NJDEP Emergency Management regulations.

In addition, purveyor conservation and emergency plans should be updated to include the timing of water transfers between systems and other actions before and during Drought Warnings.

Coordinated management extends water supplies. In theory, coordinated management could increase the yield of New Jersey's surface water supplies by 10 percent . Previous modeling efforts for the 1982 Plan in 1980 and by purveyors have not been updated, although some efforts are in progress. Because of the complexity of sources, rainfall patterns, pumping, treatment and distribution systems, the NJDEP needs to update models for watersheds, interconnections, and distribution systems. In addition, a new water quality and water quantity model needs to be developed. This model should be able to evaluate other modes of operation and new raw and finished interconnections. Criteria related to water quality and ground water inflow are needed. Models should be user friendly. Once developed these models should be routinely used so that they remain current and staff is knowledgeable in their use. Recommendations regarding model development for the Passaic and Hackensack River area are included in Chapter 6.

6. Water Treatment Plant Residuals and Disposal

The treatment of water generates water treatment residuals (WTR). Statewide, the estimated quantity of WTR is 30 to 60 tons per day by dry weight. However, most WTR are wet, that is the solids concentration is between only 1% and 15% (NJAWWA Residuals Committee Survey/NJDEP analysis, 1990). WTR are a combination of suspended and dissolved chemicals from the source water plus the chemicals added to water during the course of water treatment. In comparison, industrial and municipal wastewater treatment plants generate approximately 900 dry weight tons of sludge every day (p.3-91., NJDEP Statewide Sludge Management Report, 1987). More importantly, the concentration of regulated metals and organic compounds is significantly higher in industrial and municipal sewage sludges.

As long as WTR's are defined as sludges, pollutants and other waste materials, management techniques approved by the NJDEP may not be cost-effective or environmentally sound. Furthermore, proposed Federal and State regulations are likely to increase the amount of residuals and the difficulty of finding an approvable management technique. To compound the problem, penalties for permit violations regarding WTR are enforced under the Clean Water Enforcement Act of 1990.

The management techniques most typically employed is mechanical dewatering. Mechanical dewatering is costly and the dewatered residual remains a "listed solid waste." Mechanical dewatering facilities will increase the solids concentration of residuals from 1% up to 15%. The supernatant may be returned to the front of the water plant and the thickened residual may be trucked to a landfill.

In part, historic classifications of water treatment residuals as solid wastes and wastewater sludges have blurred the distinctly different chemical nature of these products as well as their actual impact on the environment.

Management techniques, such as "freeze thaw" have been applied to water treatment residuals with success in New Jersey, through both applied research and full scale applications. Freeze thaw techniques are land intensive, not capital intensive, release water that typically may be discharged to ground or surface waters and leave a residue on the soil.

Federal Clean Water Act regulations have not provided cost effective guidance on the management of water treatment residuals. Until a national standard is established for water treatment plants and residuals, the USEPA should support and provide the industry and the State some flexibility in developing solutions.

It is recommended that the NJDEP conduct additional studies and develop a plan specifically for water treatment residual management. The objective would be to determine if WTR can be managed to maintain air, soil and water quality standards without following procedures imposed on sludges, pollutants and other waste materials. The NJDEP also recommends establishing an active technical advisory committee, to help NJDEP develop, oversee and implement research and assistance leading to reasonable disposal methods.

It is also recommended that the NJDEP define water treatment residual and water treatment plant, so that the definition of "solid waste" and "other waste material" (N.J.A.C. 7:26-1.6) and "pollutant" and "industrial treatment works" (N.J.A.C. 7:14A-1.9) are not misconstrued to include WTR or water treatment plants. Water treatment and WTR are a necessity if we are to maintain a high standard of living in a highly urbanized State. Until a national standard is established for water treatment plants under the Clean Water Act, a coherent Statewide plan for water treatment plant residuals should be developed and implemented.

C. Recommendations: Major Infrastructure Issues

Infrastructure choices for water supply systems have become more complicated because of new laws and regulations. However, opportunities to respond to these changes exist. The level of capital availability will constrain the infrastructure choices and to that extent the recommendations presented should be followed.

1. Maintain and rehabilitate treatment and distribution systems in urban centers in support of State Development and Redevelopment Plan objectives. The Water Supply Loan and Wastewater Treatment Funds should continue to support this objective. The Bond Fund provides about $10 million each year. This funding level should be continued or expanded.

2. The NJDEP, through watershed management efforts, should coordinate requirements for the construction and operation of water and wastewater treatment plants to ensure continued use of existing surface water supplies vulnerable to upstream pollution sources. High standards of performance at wastewater treatment plants upstream of potable intakes should be maintained. Where constructed or planned, new facilities at water and wastewater treatment plants should ensure that there are no direct or indirect conflicts with existing and proposed ambient water quality standards and drinking water standards.

3. The NJDEP should encourage the rehabilitation of abandoned or contaminated ground water supplies, especially in urban areas, to supplement existing supplies at comparable quality and cost. Priority should continue to be given to pollution control and remedial projects that achieve these objectives. The substitution of surface water supplies for ground water supplies raises several issues related to cost, overall drinking water quality and availability of water that should be evaluated through the drinking water and water allocation programs. In general, the NJDEP's regulations should encourage the continued use of ground water supplies rather than their abandonment, unless the aquifer is very highly contaminated or overused.

4. The NJDEP should encourage industrial and commercial wastewater reuse (direct or indirect) for non-potable purposes. Feasibility studies by private and public utilities should evaluate reuse alternatives. Reuse has a significant potential to reduce needs for new drinking water supplies.

5. The NJDEP should encourage purveyors to construct and maintain interconnections to improve raw and finished water transfers as necessary. Existing and new watershed and distribution system models should be utilized to reevaluate water supply emergency and non-emergency plans. Reliance on pumping from and between purveyors and raw water supplies is a routine occurrence and management issues need to be updated and resolved expeditiously.

6. The NJDEP should utilize existing regulatory programs to ensure that new or expanded water distribution and treatment systems continue to meet the highest standards of design and construction, especially when they are small systems.

7. The NJDEP and public water supply systems should consider the character of the watershed an integral component of the water supply infrastructure. State and local regulations should be revised and programs established to protect surface water supplies that may be vulnerable to upstream pollution. N.J. Surface Water Quality Standards should be revised if necessary to safeguard downstream supplies from pathogens, organic and inorganic chemicals and parameters not presently specified, at all critical flow conditions. Plans and planning processes required by the Clean Water Act and NJDEP (water supply watershed protection plans) should encompass drinking water objectives and standards.

   The framework for existing discharge regulations is the Federal Clean Water Act. However, the Clean Water Act does not cite as a national goal the protection of drinking water supplies. A USEPA study conducted in 1976 and published in 1980, identified the percentage of wastewater at water supply extraction points for purveyors serving more than 25,000 people. Throughout the country and especially in New Jersey these are significant issues. Until such time as the Federal government identifies the protection of water quality in drinking water supplies as a national goal in the Clean Water Act, the framework for local and state regulations will be incomplete. However, statutory authority and case law based on the N.J. Safe Drinking Water Act, the NJPDES and N.J. Water Quality Planning Act may be sufficient to develop appropriate State and local regulations.

8. The NJDEP should consider the goals of the State Development and Redevelopment Plan in the allocation of public resources for the protection, maintenance and development of water supply infrastructure.

D. Appropriate Infrastructure Financing Roles for the Statewide Water Supply Plan and Bond Fund

The 1982 Plan recommended the development of a low-interest State government loan program to assist in the initiation of local major capital improvement projects, but also recognized the need to promote financial and management independence, toward a goal of self-sustaining public utilities. Consequently, government grants or "deep subsidy" low-interest loans were not recommended as the mechanism and means to promote the desired utility management practices. Additionally, the 1982 Plan recommended that low-interest loans be made available to all water utilities, both public-owned and investor-owned. Further, the 1982 Plan recommended that future revisions to the 1982 Plan consider water treatment needs.

The Bond Fund authorized issuance of $350 million in bonds to provide for planning and construction of infrastructure necessary to assure adequate supplies of potable water. The use of the proceeds of the Bond Fund can be characterized in three areas: loans to State agencies for major capital projects, local loans for non-state infrastructure projects, and water resources evaluations and non-capital initiatives (e.g., ground water studies, feasibility studies, planning, source water protection programs, demonstration projects). As of March 31, 1994, the current funding appropriations are as follows:

Purpose	**Percentage of Funds**	**Amount**
State Loans	38.4	$134,550,000
Local Loans	38.0	$133,068,000
Non-Capital Initiatives	14.0	$48,921,314
Unappropriated to Date	7.5	$26,068,485
Costs *	2.1	$7,392,201
TOTAL	100.0	$350,000,000

* Administrative & Issuance

The Bond Fund excluded loans to investor-owned utilities, due to federal tax law constraints. However, complementing the 1982 Plan, the Bond Fund established a low-interest loan program to help publicly-owned water purveyors with the cost of certain types of improvements.

Accordingly, any political subdivision of the State or agency thereof which operates a public water supply system may apply for a local water supply loan. Water supply infrastructure construction projects eligible for loan funding by the current Water Supply Loan Program (Loan Program) include:

Rehabilitation, repair, reconstruction or replacement of antiquated, obsolete, damaged, leaky or inadequately operating water supply transmission facilities, including water mains, storage facilities, pump stations, service connections and meters.

Construction of new water system interconnections, or rehabilitation of antiquated, damaged or inadequately operating water system interconnections, so as to raise at least one of the involved water supply systems interconnected closer to the status of "Condition A or B," as defined in the Water Supply Management Act Rules. ("Condition A or B" refers to a water system's ability to obtain a desired quantity of water supply from an adjacent water system, without excessively burdening the adjacent water system.)

Construction of the most cost-effective water supply facilities, including but not limited to, main extensions, storage facilities, pump stations, wells and treatment works, to address ground water contamination problems identified by the NJDEP, which adversely affect the potable water service of at least three dwelling units.

The Loan Program operates as a revolving program whereby loans are repaid to the Bond Fund, to be made available for future loans or other projects. The Loan Program does not fund local projects to serve future growth, under the assumption that the private sector and new local revenues will cover such costs.

The Loan Program provides a benefit to the State through promotion of water conservation and revitalization of infrastructure, and to the consumer through improvements to water supply reliability.

The revitalization of water supply infrastructure provides job opportunities to both the professional and the construction industry for the duration of the improvement work. As an indirect benefit, improvements made as the result of the loans may encourage other economic development which is dependent upon reliable water supply.

Water supply infrastructure loans are considered valuable for two main purposes:

to get things done that otherwise won't get accomplished due to lack of either priority or financing capacity, or due to institutional complexity; or

to ease the financial or political impediments to major initiatives necessary to accomplish water supply facilities to meet current and future needs.

However, the NJDEP is not an investment banking business, and should not approach loan funding as either long term lending, or lending for increased water usage, but rather as a means to accomplish a portion of the NJDEP's mission to "conserve, protect, enhance, restore and manage our environment for present and future generations." As such, the appropriate investment is through encouragement of desired water supply infrastructure improvements to <u>existing</u> facilities, which will assist in the State's goal to ensure a safe and adequate supply of potable water to all residents of the State; and which will enhance the reliability of our water supply systems and lend increased support to New Jersey's revitalization and economic development.

The existing Bond Fund appears to provide sufficient authorization for the NJDEP to fund other types of water supply infrastructure construction projects recommended herein.

Regarding the Bond Fund and Loan Program, consideration is given to the following:

Continuation of the Loan Program for a specified duration

Areas of need (infrastructure needs survey)

Loans to privately-owned water utilities (investor or non-profit)

Grants to privately-owned and publicly-owned water utilities

Alternate funding sources

1. Rehabilitation Loan Program

The Loan Program provides relatively small loans, typically under $1 million each. Rehabilitation projects comprise the bulk of the loan program output. As of September 1993, the Loan Program executed and delivered 115 water supply loans totaling $85.96 million. The average dollar amount of a water supply loan is about $747,000. Further, the same average is evidenced in the 53 anticipated loan commitments totaling $41.26 million, based upon current applications in process.

Ten years of experience in the Loan Program indicates that $10 million per year is sufficient for the water supply infrastructure rehabilitation improvements program currently recommended by the 1982 Plan. The 1993 Update to the 1982 Plan was adopted to authorize and request legislative appropriation of repaid loan funds in the amount of $20 million, sufficient to carry the rehabilitation improvements portion of the Loan Program forward for two additional fiscal years, 1993 and 1994. As of early 1995, this appropriation has not occurred.

Consideration has been given to include the current Loan Program in a financing program similar to the current New Jersey Wastewater Treatment Financing Program (in which zero-interest loans by NJDEP are matched by market-rate loans from the Wastewater Treatment Trust). In general, the NJDEP supports the development of a similar program for water supply, but <u>only</u> if it is a supplement, <u>not</u> a replacement, for the current Loan Program. The following is a comparison of the two programs.

The Loan Program offers low-interest loans at about two-thirds of market rate, and does so without the imposition of any fees or closing costs. The Loan Program is strictly oriented to rehabilitation, as opposed to the Wastewater Treatment Financing Program which does fund the upgrade, expansion and growth of wastewater systems.

The "New Jersey Wastewater Treatment Financing Program Financial Plan," (Financial Plan) dated May, 1993, describes the current funding mechanism used to finance wastewater treatment projects throughout New Jersey. According to the Financial Plan, funding for wastewater treatment projects comes from three sources:

A Wastewater Treatment Trust (Trust) market-rate loan to finance generally 50% of the estimated allowable project costs. Each loan is financed by the proceeds of revenue bonds issued by the Trust.

A Wastewater Treatment Fund (Fund) zero-rate loan to finance generally 50% of the estimated allowable project costs. Each loan is financed by the Fund, which receives its money from the USEPA in the form of a grant under the State Revolving Fund program, State appropriations, Fund loan repayments and deobligations of Fund loans made in prior years.

Financing by the borrowers for the unallowable costs of the project and for allowable costs which exceed the amount of the Trust and Fund loans.

Per the Financial Plan, the Trust is currently authorized to charge and collect a loan closing fee of 0.4% and an annual administrative fee of 0.3%, both based upon the face value of the Trust loan. The annual fee is applicable for the entire duration of the twenty year loan maturity. These fees, if accounted for as effective interest, increase the effective loan interest rate by about 42 basis points. For example, a 6.0 percent Trust loan plus fees amounts to the same costs as a 6.42 percent loan with no fees.

The Financial Plan describes a need for the NJDEP to begin imposition of an annual administrative fee, currently estimated at 1 percent, to help defray administrative costs of the Fund portion of the wastewater lending program. The imposition of a 1 percent annual fee, if accounted for as effective interest, increases the effective loan interest rate by about 188 basis points. For example, a zero percent Fund loan plus this fee amounts to the same costs as a 1.88 percent loan with no fees.

Wastewater loans offered by the Wastewater Treatment Financing Program to municipalities require the municipalities to provide loan security in the form of a municipal bond. Preparation of a municipal bond requires local bond counsel involvement and corresponding expenses.

In either the Water Supply Loan Program or the New Jersey Wastewater Treatment Financing Program, there are no specified minimum dollar amounts which may be requested in a loan application. Administratively, the number of zeros in the loan amount does not change the amount of work needed to accomplish a loan or to process an invoice, etc.; therefore, simplicity and control over a small work force, as in the case of the existing Water Supply Loan Program, is more important to the cost-effective administration of a loan.

In each lending program, program experience provides an opportunity for intuitive observation of patterns or trends, such as: What is the practical minimum dollar amount that any loan applicant should request in order to make the loan application processing cost-effective? In the case of the Water Supply Loan Program, the recommended minimum loan application amount is about $125,000. In the case of the Wastewater Treatment Financing Program, the recommended minimum loan application amount is about $1 million, although lower loan amounts have been processed where it was in the local interest to apply.

The Financing Plan indicates 98 wastewater projects have been approved for funding totaling nearly $1 billion, or an average of $10 million per project. Of the 115 water supply loans executed to date, 96 of these loan awards were for less than $1 million. If the Water Supply Loan Program were conducted similarly to the Wastewater Treatment Financing Program, it is likely that 83% of these 115 water supply loan recipients may not have found the state funding worthwhile. A caveat to this analysis is that the planning and environmental review requirements for water supply facilities (which are not controlled by Federal law) should be considerably less costly than requirements for wastewater facility (which are affected by Federal law). For this reason, a loan amount somewhat lower than $1 million might be seen as cost-effective.

Therefore, it is appropriate to continue the existing Water Supply Loan Program for small local project loans, and to consider utilizing a lending program similar to the Wastewater Treatment Financing Program for larger state project loans. To provide maximum flexibility, the two programs could operate simultaneously, with no minimum amount for either but with a maximum funding level placed on use of the Water Supply Loan Program. The New Jersey Legislature is considering new legislation to this end.

The following is a summary of the fiscal comparison of the Water Supply Loan Program with the Wastewater Treatment Financing Program, using estimated figures:

Assumed Market Loan interest rate = 6.0%.
(Actual interest rates fluctuate)

	Water Supply Loan Program	**Wastewater Treatment Financing Program**
Fund System Growth	No	Yes
Loans executed per project	1	2
Average Loan	$747,000	$10,000,000
Loan Maturity	10 years (standard) 20 years (hardship)	20 years
Administrative Fees Charged to Borrower	None	Trust- 0.4% closing costs 0.3% annual fee Bond Fund (proposed)- 1.0% annual fee
Loan Interest Rate	4.0%	Trust Loan - 6.0%

		Bond Loan - 0%
Effective Interest Rate Including Fees	4.0%	4.28%
Example: Borrower Cash Outlay for $1,000,000 Loan	10 year loan: $1,223,134.38	10 year loan: N/A
	20 year loan: $1,462,229.92	20 year loan: $1,498,708.56
Additional Borrower Expenses	Preparation of loan application	Preparation of loan application + Bond counsel fees

Page 4 of the Financial Plan for the Wastewater Treatment Financing Program states, in part: "The participants can once again expect to reduce the cost of financing their projects by approximately 30%." The Water Supply Loan Program offers reduced interest rate loans (two-thirds of market rate), thus providing a 33% cost savings to municipalities and authorities.

Alternate sources of funding are available to water utilities through the:

U.S. Department of Agriculture, Consolidated Farm Services Administration

U.S. Department of Housing and Urban Development,
Community Development Block Grants

New Jersey Economic Development Authority

Proposed federally-funded state revolving fund for drinking water

Recommendation: Continue the water supply infrastructure rehabilitation improvements program, with focus on the specific problems of utilities with the highest unaccounted-for water, and with focus on distressed cities and urban centers, as recommended by the New Jersey State Development and Redevelopment Plan, dated June 12, 1992. Provide funding through the existing Water Supply Loan Program and consider implementation of a complementary program that uses zero-interest loans from the Bond Fund with market rate matching loans through a trust-like arrangement.

2. Infrastructure Development

In consideration of regional water supply deficits (which may also be viewed as a need for new sources of water supplies), nonpotable water reuse projects and water conserving plumbing replacement projects may be considered for funding priority as a means of potable water conservation.

Recommendation: Additional funding priority should be awarded for implementation of projects in conformance with local or regional water supply master plans or feasibility studies, which address present serious deficiencies in meeting the current water supply needs. Water conservation should be eligible as a capital cost.

3. Treatment Upgrades for Drinking Water Quality

The primary financial and operational issues that purveyors face, which involve the construction and operation and maintenance of drinking water supply, treatment and distribution infrastructure, include:

Current and future Safe Drinking Water Act regulatory mandates, including rules on disinfection by-products, lead and copper, radionuclides (radon), volatile organic chemicals, pesticides, treatment of ground water under the influence of surface water, and surface water treatment;

Rehabilitation of existing water system facilities;

Small water system consolidation for operational viability; and

Replacement supplies as required through the Water Supply Critical Area program.

NJDEP should allow water system improvements appropriate to meet these needs to be funded via the Water Supply Loan Program, upon revisions to the Loan Program rules and legislative appropriations:

to address surface water contamination problems (in addition to the currently specified ground water contamination problems);

to address new treatment facilities needed to comply with the primary and secondary Safe Drinking Water Act requirements or Water Supply Critical Area regulations; and

to address rehabilitation of treatment facilities due to age, useful life or deterioration (non-growth related, as in the existing rehabilitation program for water mains, tanks and pump stations).

Other NJDEP programs are available to assist local governmental units in addressing water supply contamination problems due to industrial sources only, including the Spill Compensation Fund and the Hazardous Discharge Bond Funds of 1981 and 1986. This supports the opportunity to redirect the Loan Program away from its current focus on ground water contamination problems, and toward other drinking water issues.

a. Primary Standards

Higher priority should be given in the Loan Program rules for addressing primary drinking water quality standards than for secondary drinking water quality standards.

b. Secondary Standards

Lower priority should be given in the Loan Program rules for addressing secondary drinking water quality needs. However, sodium, chloride, iron and manganese should be at the top of the funding priority for secondary drinking water standards.

Alternative approaches may be considered in the revision of the Loan Program rules for funding of primary and secondary drinking water standards:

1) phase-in funding for secondary standards two years after funding for primary standards, except where water supply management alternatives are adopted or approved by the NJDEP;
2) designate a funding split: e.g. 70% for primary and 30% secondary; or
3) first apply available funding to primary, then to secondary, in each application period.

c. Residuals Management

The present rules for residuals management are prescribed by the New Jersey Pollutant Discharge Elimination System for discharges to sewer systems (pretreatment rules) and for discharges to streams. The

Loan Program could be expanded to provide loans for pretreatment of wastewater and residuals management from water supply facilities.

Wastewater collection and treatment funding is currently available through the New Jersey Wastewater Treatment Financing Program.

4. Interconnections

The NJDEP desires to promote water supply interconnections between water supply purveyors, to address the following types of uses:

emergency use

bulk purchase or sale to supplement existing water supply sources

flexibility in available water supply sources

reinforce or upgrade existing interconnections

interconnections needed to satisfy source development, or to address identified problems, for example: salt water intrusion, water supply critical areas

interconnections consistent with either the NJSWSP, or other water supply management alternatives adopted or approved by the NJDEP.

The NJDEP should not fund any interconnection project which may result in the discontinuation or elimination of any existing, usable interconnection or other acceptable water supply source. Therefore, the NJDEP must be aware of the intent of the proposed water supply interconnection project to be funded by a loan.

The NJDEP should specifically support new loan-funded interconnection projects with neighboring utilities as a result of the Tri-County Water Supply Project and the interconnection needs associated with water allocation reductions in the designated Water Supply Critical Area 2.

The NJDEP should consider the funding of a needs study, alternatives analysis and feasibility study regarding possible interconnections, to be constructed and owned by the New Jersey Water Supply Authority, between water utilities to support alternate infrastructure to maintain the viability of the lower Delaware and Raritan Canal (from the Ten Mile Lock downstream), to address the needs of the Middlesex Water Company in the event of source water disruption or failure or contamination of the Delaware and Raritan Canal. However, there are institutional and operational issues which need to be resolved such as who owns and maintains these interconnections.

5. Small Water Systems

Selected recommendations of the "*Water Industry: Contemporary Issues and Policy Recommendations-Report of the Water Management Task Force*," prepared for Governor Whitman and due to be released shortly, should be considered as a point of focus in providing assistance to small water systems. Regarding the use of the Small Water Company Takeover Act by any local governmental unit, the NJDEP recommends that Loan Program funding be available for all needed costs, including purchase of the source, treatment, storage, pumping stations, mains, etc.

It is inappropriate for the NJSWSP to recommend funding for small water company improvements unless and until the Board of Public Utilities implements the recommendations of the above Task Force report with respect to requirements regarding financing ability, cash flow, rate base, borrowing capacity, simplification of the rate setting/hearing process, acquisition (Small Water Company Takeover Act), allowance of surcharges, taxes (Gross Receipts and Franchise Taxes), and Contributions in Aid of Construction. The lending of money to an insolvent entity, which may not be able to repay, is an unacceptable risk to the State. Loans should be made only to viable, self-liquidating, rate-regulated utilities which can reasonably demonstrate the ability to repay debt. Conversely, small water systems which are not allowed a reasonable and equitable method of rate-setting, or rate adjustments, are essentially not allowed to remain viable.

6. Potential State Revolving Fund for Water Supply Infrastructure

The Clinton Administration proposes a program of federal grants to states to create a drinking water state revolving fund (SRF) in each state to be used to provide loans to water utilities. However, as of March 1996, several proposed bills are under consideration. The House version proposes to authorize $4.25 billion in capitalization grants, including $500 million in 1996, $750 million in 1997, and $1 billion in each of the next three years. The Senate version proposes to authorize $9.6 billion, including $600 million in 1996, and $1 billion in each of the next nine years. The final outcome is pending. These dollars would be made available to states to provide low-interest loans to assist municipalities to comply with the Safe Drinking Water Act.

The significant provisions of the SRF are as follows:

The allocation formula is unspecified. The USEPA would probably use the Clean Water Act revolving fund formula.

States may use federal funds to make loans to public water systems for expenditures, not including operation and maintenance expenditures or monitoring, that the USEPA determines will facilitate compliance with national primary drinking water regulations.

States must provide a 20% match.

States may make loans to those investor-owned water systems having the greatest public health and financial needs.

States cannot provide SRF loans or grants for any expenditure that could be avoided or significantly reduced by "appropriate consolidation" of public water systems. The USEPA, in consultation with states and public water systems, shall establish criteria defining when consolidation is appropriate.

The significant potential drawbacks to the proposed SRF include:

In addition to any State requirements, borrowers must comply with potentially expensive standard federal cross-cutting requirements, such as environmental assessments; cultural resources; wetlands; secondary development growth impacts; Socially & Economically Disadvantaged employment; Davis-Bacon federal prevailing wage rates, etc. Compliance costs may be excessive for small loans, but bearable for large projects.

New Jersey's share of the federal authorization is unknown at this time; however, NJDEP assumes it to be based upon the existing Public Water System Supervision (PWSS) grant formula. New Jersey will need to authorize funds to address the 20% match requirement, once the drinking water SRF is federally authorized and apropriated.

However, the above two assumptions are dependent upon the final outcome of the federal authorization of the drinking water SRF. New Jersey's share of the federal authorization for future fiscal years is unknown at this time; the NJDEP estimates $23 million for each Fiscal Years 1997 and 1998. The 20% match requirement will most likely apply to each Fiscal Year, about $4.5 million each year.

Possible sources for the 20% match include the Bond Fund and repayments from a special appropriation to provide a water supply system to replace contaminated domestic wells.

7. Public Water Supply Development and Relationship to State Development and Redevelopment Plan, Local and County Planning

Wherever possible, the primary focus of the Loan Program should be consistent with the New Jersey State Development and Redevelopment Plan, dated June 12, 1992, and future updates.

The regional ownership and management of small water systems must be promoted. In the event that local governmental units desire to maintain ownership of small water systems, management of the small water systems via a regional public or private entity should be encouraged unless the local government has sufficient technical and fiscal capability to operate the systems.

8. Sealing of Abandoned Wells - Public Property and Publicly-Owned Wells

The costs of well sealing for individual wells is much too small to be cost-effectively addressed through the Loan Program. However, abandoned wells on public property and abandoned publicly-owned wells can be of major concern regarding aquifer contamination and cross-contamination. Therefore, the NJDEP recommends that the sealing of publicly-owned abandoned wells or such wells on public property be an eligible cost when included as part of related, major projects or where a large number of wells will be sealed, so as to ensure that only cost-effective projects are undertaken with the Bond Fund.

E. Recommendations: Water Supply Loan Program

Priorities regarding use of the Water Supply Loan Program should be set for operating programs and capital projects as follows:

1. To maintain and rehabilitate infrastructure in urban centers; to continue the existing Water Supply Loan Program for small local project loans, and to consider utilizing a lending program similar to the Wastewater Treatment Financing Program as a complementary program for loans, and especially for large State project loans.

2. To construct facilities and establish programs that ensure continued use of existing surface water supplies that are vulnerable to upstream pollution sources.

3. To rehabilitate abandoned or contaminated ground water supplies, especially in urban areas.

4. To encourage industrial wastewater reuse for non-potable uses.

5. To promote interconnections between neighboring water supply systems.

6. To provide assistance in water supply treatment to meet Safe Drinking Water requirements, with primary drinking water quality standards receiving a higher priority.

7. To conduct an infrastructure needs survey, either independently, or in conjunction with the USEPA.

8. To fund capital improvements projects as identified in Chapter 6.

CHAPTER TEN

THE WATER SUPPLY ACTION PROGRAM FOR NEW JERSEY

The New Jersey Statewide Water Supply Plan (NJSWSP), as a policy and strategy document, sets forth major initiatives required to ensure that sufficient quantities of water supplies are available to all parts of the State into the foreseeable future at the highest quality possible and for a reasonable cost. The NJSWSP addresses issues regarding reasonable limits on water supplies to protect other uses and users of water resources, including aquatic and water-related ecosystems. As mandated by the 1981 Water Supply Management Act and the 1981 Water Supply Bond Act, it also establishes the eligible projects for appropriations from the Bond Fund and allocates specific amounts of funding to each eligible use, within the constraints of the two acts. The 1981 Water Supply Bond Act mandates that appropriations from the Bond Fund may only be used for purposes included within the NJSWSP.

This chapter summarizes the action items contained in Chapters 3 through 9 of the NJSWSP and lists the eligible projects for funding from the Bond Fund (including allocations identified through the 1982 NJ Water Supply Master Plan -- the 1982 Plan -- and its updates that are continued through this Water Supply Action Program).

A. Overview: Emphasis on Watershed-Based Management

Traditional water supply planning in New Jersey and throughout the nation has generally focused on the development of conventional water supplies. Numerous reservoirs were constructed in previously rural watersheds to serve cities in the northeastern and central regions of the state and aquifers were tapped wherever migrating populations chose to reside. The majority of New Jersey's conventional water supplies are now developed. Although New Jersey’s water supplies are sufficient for the foreseeable future in most regions, some regions (mostly those relying heavily on ground water) are presently in actual or estimated deficit. Other regions are expected to face deficit and water quality degradation conditions before the year 2040. Regarding supplies that will continue to experience surpluses during this time, the effects of development may also impair the quality of these supplies. The remainder of undeveloped conventional supplies are either relatively modest in size, or will be difficult to develop due to land use conflicts and environmental constraints. Consequently, if New Jersey is to meet its future water supply needs, a diverse range of strategic water management actions will be required that focus on better management and judicious use of existing supplies. Some of these actions will involve capital projects, but many will not.

The primary theme of the NJDEP's water supply management initiatives will be directed toward:

protecting the quality of the State's water supplies in concert with traditional and evolving water quality protection programs;

strategically expanding water conservation and reuse efforts;

emphasizing strategies that provide the most efficient means to sustain our water supplies, while simultaneously ensuring that other water-related beneficial uses are maintained;

TABLE 10.1

1995 NJ STATEWIDE WATER SUPPLY PLAN ACTION PROGRAM

(in millions of dollars)

PROGRAMS AND PROJECTS	1982-1993 WATER SUPPLY BOND ALLOCATIONS	NEW WATER SUPPLY BOND ALLOCATIONS	TOTAL WATER SUPPLY BOND ALLOCATIONS	APPROPRIATED WATER SUPPLY BOND FUNDS	UNAPPROPRIATED WATER SUPPLY BOND FUND ALLOCATIONS	PREVIOUS COMMITMENTS FROM OTHER FUNDING SOURCES	ANTICIPATED COMMITMENTS FROM OTHER FUNDING SOURCES	SCHEDULE
MAJOR CAPITAL CONSTRUCTION PROJECTS								
1. Major Projects								
A.. Delaware & Raritan Canal Improvements	20.550	-	20.550	20.550		-	-	completed
B. Wanaque South Including Monksville Reservoir	42.000	-	42.000	42.000		101.000	-	completed
C. Manasquan Reservoir	72.000	-	72.000	72.000		-	-	completed
D. F.E. Walter Reservoir Modification	10.500	-	10.500	-		114.000	-	not in progress
E. Merrill Creek Reservoir	-	-	-	-		217.000	-	completed
F. Tri-County Water Supply Project	-	-	-	-		170.000	-	in progress
G. Water Supply for South River Area	-	-	-	-		40.000	-	completed
TOTAL	**145.050**	**0.000**	**145.050**	**134.550**	**10.500**	**642.000**	**0.000**	
WATER RESOURCES EVALUATIONS								
2. Feasibility Studies								
A. Salem/Cohansey/Maurice Rivers Feasibility Study	-	0.125	0.125	-		-	0.125	1998-2000
B. Estuary Impact Feasibility Study	n/a	-	n/a	1.000		-	-	-
C. Passaic-Hackensack Water Supply Basin Feasibility Study	n/a	-	n/a	0.800		-	-	-
D. Ocean County Feasibility Study	n/a	-	n/a	0.500		-	-	-
E. Manasquan River Water Supply Feasibility Study	n/a	-	n/a	0.800		-	-	-
*F. Growth Areas Feasibility Study **	n/a	-	n/a	1.800		-	-	-
*G. Buried Valley Feasibility Study **	n/a	-	n/a	0.600		-	-	-
H. Northwest Mercer County Feasibility Study	n/a	-	n/a	0.200		-	-	complete
I. Cape May County Regional Area	n/a	-	n/a	n/a		-	-	complete
J. Evaluation of Contaminated Wellfields & Alternate Supplies	n/a	-	n/a	n/a		-	-	-
K. South River Basin Area	n/a	-	n/a	n/a		-	-	complete
L. Camden Metropolitan Area	n/a	-	n/a	n/a		-	-	complete
M. Atlantic County Regional Area	n/a	-	n/a	n/a		-	-	complete
N. Consolidations and Extensions of Service	n/a	-	n/a	n/a		-	-	complete
O. Eastern Raritan Basin Area	n/a	-	n/a	n/a		-	-	complete
P. Hudson Main Stem	n/a	-	n/a	n/a		-	-	ongoing
Q. Delaware River Flow Augmentation Feasibility Study	n/a	-	n/a	0.800		-	-	-
R. General Appropriation	-	-	-	9.231		-	-	-
TOTAL	**20.000**	**0.125**	**20.125**	**15.731**	**4.394**	**0.420**	**0.125**	
3. Ground Water Studies								
A. Analysis of ASR/Conjunctive Use Facilities (South/Toms/Metedeconk/Manasquan River Basins)	-	0.200	0.200	-		-	0.200	1996-1997
B. Refinement of Ground Water Availability Thresholds	-	0.150	0.150	-		-	0.150	-
C. Confirmation of Withdrawals in Mullica Basin	-	0.035	0.035	-		-	0.035	1996
D. Atlantic County Ground Water Study	n/a	-	n/a	0.690		-	-	-
E. Cooperative Map: Statewide Map of Geological Formations	n/a	-	n/a	0.690		-	-	-
F. Confined Coastal Plain Ground Water Study	n/a	-	n/a	0.690		-	-	-
G. Vincetown /Mount Laurel-Wenonah Aquifer Ground Water Study	n/a	-	n/a	0.690		-	-	-
H. Buried Valley Ground Water Study	n/a	-	n/a	0.690		-	-	-
I. Lamington Ground Water Study	n/a	-	n/a	0.690		-	-	-
J. Northwest Mercer County Ground Water Study	n/a	-	n/a	0.690		-	-	-
K. Rockaway Ground Water Study	n/a	-	n/a	0.690		-	-	-
L. Germany Flats Ground Water Study	n/a	-	n/a	0.690		-	-	-
M. General Appropriation	-	-	-	12.140		-	-	-
TOTAL	**19.650**	**0.385**	**20.035**	**18.350**	**1.685**	**3.900**	**0.385**	
4. Regional Water Resources Evaluations								
A. Passaic Basin Mgt./Operation Simulation Model	-	0.400	0.400	-		-	-	1997-1999
B. Passaic Basin Watershed Mgt. Plan	-	0.500	0.500	-		-	0.500	1996-2001
C. Toms River/Metedeconk Estuary Impact Study	-	0.200	0.200	-		-	0.200	1992-1996
D. Toms/Metedeconk River Watershed Mgt. Plan	-	0.250	0.250	-		-	0.250	1995-1998
E. Camden Trib./Rancocas Water Supply Evaluation	-	0.200	0.200	-		-	0.200	1998-2001
F. Mullica River Water Supply Evaluation	-	0.300	0.300	-		-	0.300	1999-2000
G. Ground Water/Surface Water Management	-	0.100	0.100	-		-	0.100	1999-2000

TABLE 10.1

1995 NJ STATEWIDE WATER SUPPLY PLAN ACTION PROGRAM

(in millions of dollars)

PROGRAMS AND PROJECTS	1982-1993 WATER SUPPLY BOND ALLOCATIONS	NEW WATER SUPPLY BOND ALLOCATIONS	TOTAL WATER SUPPLY BOND ALLOCATIONS	APPROPRIATED WATER SUPPLY BOND FUNDS	UNAPPROPRIATED WATER SUPPLY BOND FUND ALLOCATIONS	PREVIOUS COMMITMENTS FROM OTHER FUNDING SOURCES	ANTICIPATED COMMITMENTS FROM OTHER FUNDING SOURCES	SCHEDULE
H. Salem/Cohansey/Maurice Rivers Water Supply Evaluation	-	0.400	0.400	-		-	0.400	1997-2000
I. Great Egg Harbor River Basin Evaluation	n/a	-	n/a	0.200		-	-	-
J. Cape May Aquifer Recharge Evaluation	n/a	-	n/a	0.100		-	-	complete
K. Wetlands Impact Study	n/a	-	n/a	1.000		-	-	1997
L. Metedeconk/Toms/Tuckahoe River Basins Evaluation	n/a	-	n/a	0.600		-	-	1997
M. Cedar Creek/Forked River/Sloop Creek Evaluation	n/a	-	n/a	0.600		-	-	-
N. Lamington Evaluation	n/a	-	n/a	0.400		-	-	complete
O. Rockaway River Basin Evaluation	n/a	-	n/a	0.200		-	-	complete
TOTAL	9.000	2.350	11.350	3.100	8.250	0.000	1.950	
WATERSHED & AQUIFER PROTECTION								
5. Well Head Protection								
A. Delineation of Interim Well Head Protection Areas	n/a	-	n/a	1.000		-	-	-
B. County/Regional Demo. Projects & Competitive Grant Programs	n/a	-	n/a	0.350		-	-	-
C. County/Local Outreach Programs	n/a	-	n/a	0.250		-	-	-
D. Finalized Well Head Protection Areas Demo. Projects	n/a	-	n/a	0.100		-	-	-
TOTAL	3.000	0.000	3.000	1.700	1.300	0.000	0.000	
6. Demonstration Projects/Other Studies								
A. Ocean County Project for Maintenance of Stormwater Basins	n/a	-	n/a	n/a		-	-	complete
B. Mercer County Non-point Source Pollution Control Project	n/a	-	n/a	n/a		-	-	cancelled
C. Middlesex County Aquifer Protection	n/a	-	n/a	n/a		-	-	ongoing
D. Sussex County Septic System Management	n/a	-	n/a	n/a		-	-	complete
E. Watershed Buffers	n/a	-	n/a	n/a		-	-	complete
TOTAL	8.000	0.000	8.000	2.300	5.700	0.000	0.000	
7. Watershed Management Planning								
A. Model to Predict Effects of NPS on Water Supplies	-	0.500	0.500	-		-	0.500	1997-1999
B. Model to Predict Hydrologic Effects on Water Supplies	-	0.100	0.100	-		-	0.100	1999-2000
C. Watershed Management Entity Analysis	-	0.005	0.005	-		-	-	1997-1998
D. Development of Instream Flows/Watershed Ranking	-	0.150	0.150	-		-	-	1997
E. Development of Five Watershed Plans	-	0.500	0.500	-		-	-	-
F. Municipal Guidance Manual to Develop/Protect Water Supplies	-	0.250	0.250	-		-	-	1998-2000
TOTAL	0.000	1.505	1.505	0.000	1.505	0.000	0.600	
8. Water Supply and Watershed Protection								
A. Acquisition of Water Supply Protection Areas	-	20.000	20.000	-		-	-	-
TOTAL	0.000	20.000	20.000	0.000	20.000	0.000	0.000	
9. Water Conservation								
A. Reduction of Depletive/Consumptive Uses Evaluation	-	0.030	0.030	-		-	-	1998-1999
B. Passaic Basin Water Conservation Implementation Plan	-	0.100	0.100	-		-	-	1997-1999
C. Mullica Basin Water Conservation Implementation Plan	-	0.100	0.100	-		-	-	1997-1999
D. Landscape/Industrial Water Conservation Program	-	0.300	0.300	-		-	-	1997-1999
E. Statewide Water Conservation Program	-	0.300	0.300	-		-	-	1997-2000
F. Cape May County Water Conservation Program	n/a	-	n/a	0.125		-	-	1997-1998
G. General Appropriation	-	-	-	1.000		-	-	-
TOTAL	1.600	0.830	2.430	1.125	1.305	0.000	0.000	
10. Water Management Planning								
A. Water Supply Management Data Base	-	0.500	0.500	-		-	0.500	1995-1997
B. Generic Safe/Dependable Yield Analyses	-	0.050	0.050	-		-	0.050	1997-1998
C. Completion of Water Resources Geographic Information System	n/a	-	n/a	0.450		-	-	-
D. USGS Matching Funds for Water Management Planning	n/a	-	n/a	0.500		-	-	completed
TOTAL	2.000	0.550	2.550	0.950	1.600	0.000	0.550	

TABLE 10.1

1995 NJ STATEWIDE WATER SUPPLY PLAN ACTION PROGRAM

(in millions of dollars)

PROGRAMS AND PROJECTS	1982-1993 WATER SUPPLY BOND ALLOCATIONS	NEW WATER SUPPLY BOND ALLOCATIONS	TOTAL WATER SUPPLY BOND ALLOCATIONS	APPROPRIATED WATER SUPPLY BOND FUNDS	UNAPPROPRIATED WATER SUPPLY BOND FUND ALLOCATIONS	PREVIOUS COMMITMENTS FROM OTHER FUNDING SOURCES	ANTICIPATED COMMITMENTS FROM OTHER FUNDING SOURCES	SCHEDULE
11. Statewide Water Supply Plan Revision								1996
TOTAL	1.750	0.300	2.050	1.750	0.300	0.000	0.000	
12. Special Water Treatment Study								
A. Treatment Residuals Study	-	0.400	0.400	-		-	-	-
TOTAL	0.600	0.400	1.000	0.600	0.400	0.000	0.000	
PURVEYOR INFRASTRUCTURE LOAN PROGRAMS								
13. Water Supply Infrastructure Rehabilitation								
A. Infrastructure Needs Survey	-	0.300	0.300	-		-	-	1996-1997
B. Infrastructure Loans	-	40.000	40.000	-		-	-	ongoing
TOTAL	120.000	40.300	160.300	100.691	59.609	0.000	0.000	
14. Interconnection Testing & Improvements								
TOTAL	15.000	0.000	15.000	8.068	6.932	0.000	0.000	
15. Polluted Wellfields & Inadequate Small Systems								
A. Loans for Construction of Water Supply Facilities to Replace Wells	n/a	-	n/a	n/a		-	-	ongoing
TOTAL	25.000	0.000	25.000	25.000	0.000	0.000	0.000	
16. Miscellaneous Appropriations (administrative, etc.)								
TOTAL	0.000	0.000	0.000	8.000	-8.000	0.000	0.000	
GRAND TOTAL	370.650	66.745	437.395	321.915	115.480	646.320	3.610	

Note:
Appropriations and allocations above $350 million rely on loan repayments.
* funding source for projects in various locations in the state.

developing additional water supplies as necessary after consideration of the first three approaches.

These initiatives will not be successful, however, unless new approaches are taken that emphasize more anticipatory and preventive measures. Present institutions, programs and public policy associated with water resources management consist of a "patchwork" of narrowly confined, too often conflicting or competing, objectives and jurisdictions. This phenomenon has led to impaired water supplies, reductions in supply yield and ecosystem degradation in some areas, despite the improvements that have occurred in others. Considerable progress has been achieved since the 1982 Plan was adopted by the NJDEP, but much more progress is required in the near future. In order to succeed, water supply initiatives will need to be part of an overall approach that emphasizes, evaluates and manages the total use and benefits of water within common hydrologic boundaries (i.e, watersheds).

The watershed-based approach to water resource management offers opportunities to improve overall benefits. This consensus-building approach:

views the water resources and water-related uses in a watershed as an interactive "system" that must be managed as such;

establishes goals and objectives that proactively ensure that the water resources of the watershed are managed in the best long-term interests of the public and the environment;

identifies root causes of problems that could prevent these objectives from being met; and

develops innovative and integrated strategies to meet the objectives.

Inherent to the watershed approach are basic principles to sound water supply planning and management. First, the approach is "multiple-use planning" by nature. By stressing the linkage between land use and water resource management, decisions that may potentially affect water supplies and other resources are made within a broad framework. Ideally, cross-media effects are thereby reduced, water quality, water supply and ecosystem efforts are integrated, and an overall environmental and economic benefit is realized.

Second, the approach advances a forum where the perspectives of the general population and stakeholders in the watershed are represented, reflecting regional and local needs and priorities against a backdrop of New Jersey statutes and legal doctrines regarding the “public trust” nature of water resources.

Third, watershed management focuses on responsibility and financial accountability by identifying all levels of government and other institutions involved in water supply and resource management and their respective roles. The structure allows for greater resolution of water supply issues and other resource problems at the local level and promotes self-sufficiency. State government can limit its involvement to those functions that are the most appropriate while still assuming an oversight and leadership role. A new governmental entity will not necessarily be required; rather, existing programs provide an excellent foundation on which to build within the watershed framework.

Fourth and last, the approach seeks to make maximum use of existing water management systems and the development of non-structural alternatives. Resources are thereby conserved for the enjoyment and benefit of future generations.

While recognizing that the challenges will be formidable, the NJDEP embraces the watershed management approach because it provides a comprehensive, integrated strategy to manage all of the state's water resources with all segments of society having a voice in the process. The NJSWSP was developed so as to be compatible with the watershed approach.

B. Statewide Water Supply Plan Implementation

Chapters 3 through 9 pointed out the most significant statewide and regional water supply problems, constraints and issues in New Jersey and made both general and specific recommendations as to how these should be addressed. Each of those topics presents challenges, opportunities and requirements that need to be considered. The principles of sound water supply planning are discussed above; it is on these principles that the NJDEP will base its actions. Several of the issues and problems need to be resolved within the next few years while others can be addressed over more time. Below is a discussion of the methodology that was used to determine the timetable for addressing the state's water supply issues and problems.

This action program employs two approaches (one for statewide initiatives and another for regional initiatives) for implementing the recommendations and initiatives described in Chapters 3 through 9. For statewide initiatives, criteria that receive the highest priorities include those that will achieve the greatest progress in the following categories:

initiatives that minimize public health risks through protection of the source quality of the water supplies serving the largest populations;

strategies that result in sustainable and economical regional water supplies;

efficient water conservation strategies (both demand-side and supply-side) that conserve water for the largest populations;

water management initiatives that maintain ecosystems where these are related to water supply management; and

integrated water management efforts that conclude in multiple benefits by applying multi-disciplinary approaches (i.e., where broader watershed management efforts are initiated).

Risk-based criteria and characteristics are to be employed to determine which planning areas require more rapid regional initiatives. The criteria and characteristics to be used will be incorporated within the NJDEP's watershed priority system. Water supply characteristics such as the amount of deficit (current or future), size and growth of affected population, vulnerability to contamination, and ability to withstand drought will be factors included in this list for future investigations. Until this watershed ranking system is developed, no schedule or costs will be provided. Schedules and costs are provided for investigations currently underway. The actions are described briefly in this chapter; additional details are described in the chapters listed in parentheses after each action item. For many of the action items, supporting documentation may be found in the consultant team reports prepared for this project (see Appendix D for listing).

C. Management Initiatives

These efforts focus on water supply protection, more efficient use of existing supplies and water conservation. They are divided into four categories and are discussed in detail in Chapters 3 through 9. The 1995 Statewide Water Supply Plan Action Program table at the end of this chapter lists the recommendations, estimated costs and planned schedules. Previous and proposed allocations from the Bond Fund and other sources for each program and initiative are also summarized in the table, continued from the 1982 Plan and its periodic Updates. Programs will be both statewide, where appropriate, and targeted in watersheds pursuant to the watershed ranking system being developed by the NJDEP.

1. Water Resources Protection

These programs are designed to protect the quality of the State's surface and ground water supply sources. A great deal of progress has been made over the last two decades in protecting our water supplies, especially from contamination that emanates from site-specific sources. However, significant development continues to occur in the water supply watersheds and over ground water supplies. Consequently, the new focus of water resource protection programs must be on the management of nonpoint pollution sources and the maintenance of aquifer recharge, but will include the integrated management of point source pollution where necessary. In a State with finite water resources, water quality degradation can place an major strain on our water supplies. Contamination of our water supplies often increases the cost of water because new treatment systems must be installed. In the worst-case scenario, contamination can render an entire supply useless. Managing nonpoint pollution sources will represent a formidable challenge. The NJDEP has consequently initiated the watershed approach and several statewide efforts to address the nonpoint source and point source problem together.

Surface Water Protection - This initiative emphasizes the protection of surface water supplies used for drinking water. It is recommended that this initiative continue in full force and that models be developed that allow the NJDEP and local land-use agencies to quantify the effects of land use activities on surface water supplies so that management practices can be developed to reduce these effects. Also, the NJDEP will cooperate with the Legislature to ensure that any proposed watershed protection legislation will sufficiently protect surface water supplies.
(Chapters 3.J and 7.A)
Funding Source: *1981 Bond Fund Allocation: $0.505 million (new allocation)*

Aquifer Protection - Delineating aquifer recharge areas and managing activities in these areas that potentially can degrade or reduce drinking water supplies are the objectives of this initiative. The NJDEP recommends that this program be continued and that analytical tools be developed which will allow the NJDEP and local land-use planners to estimate the impacts of land use activities on the state's ground water supplies and to design programs to reduce these impacts, especially those caused by nonpoint sources.
(Chapters 3.J and 7.A)
Funding Source: *1981 Bond Fund Allocation: $1 million (no change)*

Well Head Protection - The objective of this initiative is to minimize the risks to public water supply wells by delineating areas around them that are most vulnerable to contamination and managing activities within these areas. Well head protection areas for over 2700 public community water supply wells in 20 counties are being delineated by the NJDEP. Public noncommunity water supply wells and large groupings of domestic wells are also included in the program. It is recommended that this program be vigorously continued.
(Chapter 7.A)
Funding Source: *1981 Bond Fund Allocation: $3 million (no change)*

Acquisition of Critical Water Supply Protection Areas - The NJDEP recommends that legislation be adopted that provides a stable source of revenue to purchase the most critical, developable or developed lands within potable supply watershed lands, aquifer recharge areas and well head protection areas that serve as major water supplies in order to protect them from imminent or major water quality deterioration. Numerous complex issues will need to be addressed, including cost-effectiveness, lands previously purchased by purveyors for water quality protection purposes, which revenue source(s) is most appropriate for this purpose, how the revenue source would be collected, who would maintain the properties, coordination with other land preservation programs, etc. Until this legislation is adopted, $20 million for loans is allocated from the Bond Fund for the purchase of some limited lands for critical water supply protection.
(Chapter 7.A)
Funding Source: *1981 Bond Fund Allocation: $20 million (new allocation)*

Municipal Land Use Law - The NJDEP proposes to develop a guidance document that describes various methods by which municipalities may carry out the water supply and water quality objectives of this statute in the development of their natural resource inventories, municipal master plans and development review

ordinances. Demonstration studies in volunteer municipalities will be performed.
(Chapter 7.A)
Funding Source: *1981 Bond Fund Allocation: $0.25 million (new allocation)*

Regional Aquifer Studies and Research - There is a need to continue investigations of ground water resources where excessive use and its consequent effects (saltwater intrusion, stream flow depletion, etc.) may be threatening supplies. Once these studies are completed, feasibility studies that evaluate alternate water supplies are generally performed. Planning areas where additional analysis or research will be needed are the Toms/Metedeconk, Salem/Cohansey/Maurice, Mullica, and Camden Tributaries/Rancocas watersheds. In addition, portions of other planning areas may require investigations as a result of an assessment made during the watershed characterization process.
(Chapters 6 and 7)
Funding Source: *1981 Bond Fund Allocation: $0.385 million (new allocation in addition to $19.65 million existing allocation)*

Watershed Management - The objective of the water supply component of watershed management is to balance and prioritize water supply needs with other beneficial uses, and to integrate management of water and water-related land use activities so as to ensure that the yield and the quality of the watershed's water supplies are maintained. The NJDEP recommends that future water supply planning be conducted within the watershed management context. It is recommended that the Toms/Metedeconk, Mullica/Great Egg and Upper Passaic/Lower Passaic/Hackensack watersheds have management plans developed to protect water quality as water supply priority areas. Funds are also allocated for up to two more areas.
(Chapter 6)
Funding Source: *1981 Bond Fund Allocation: $0.5 million for five watershed management areas (new allocation)*

2. Issues for Future Analysis

State Development and Redevelopment Plan - Current piecemeal development patterns are often to the detriment of the State's water supplies (e.g., local development of ground water supplies in close proximity to the saltwater front, depletive ground water diversions upstream of potable surface water intakes). The NJDEP recommends that water supply planning and the State Development and Redevelopment Plan be more closely coordinated to ensure that objectives of both initiatives are met; potential conflicts need to be resolved, including the prevention of the proliferation of non-viable water utilities. Proposed efforts regarding an Environmental Master Plan may be useful toward this end.
(Chapters 4.F, 7.A and 9.D)
Funding Source: General State appropriations - Watershed management

Water Supply Protection Aspects of the Surface Water Quality Standards - Efforts will be made in the future to better integrate the NJDEP's surface water quality standards with surface water supply management so as to ensure that both initiatives' objectives are met. A portion of this effort will be to evaluate the surface water use designations and water quality criteria with respect to their adequacy to protect surface water supplies.
(Chapters 7.A and 9.A)
Funding Source: General State appropriations

Wastewater Treatment Plant Upgrades - It is important that wastewater treatment plants that discharge upstream of existing and future surface water supplies continue to meet high standards and that these discharges continue to allow water treatment plants to meet drinking water standards. The Upper Passaic/Hackensack planning areas will be specifically evaluated to determine the adequacy of the regulatory process. There are other planning areas in the state where similar evaluations will need to be

performed, as wastewater inputs increase over time. Additionally, policy will need to be developed which ensures that wastewater regionalization does not have significant negative effects on the state's water supplies. (Chapter 6.D)
Funding Source: Federal Clean Water Act Grants

3. Water Supply Development and Management

Ensuring that adequate water is available to meet current and future demand is the primary objective of this initiative. New approaches to water supply development and management must be considered as demand increases and as the NJDEP watershed approach evolves for managing water resources. Emphasis must be placed on enhanced management of existing supplies, in conjunction with the water quality protection initiatives discussed above. Included among the structural options are interconnections among various users, conjunctive water use of two or more sources, direct (for non-potable uses) and indirect wastewater reuse, aquifer storage and recovery, desalination and the use of new and improved treatment technologies that are capable of transforming previously impaired water into potable supplies. Significant technical and cost analyses are often necessary prior to developing and implementing these approaches. There are also non-structural water supply management initiatives that, when implemented, provide opportunities to extend existing and new water supplies. Among these initiatives are improved drought rule curves, optimum withdrawal strategies, and coordinated wastewater and water supply development.

Water Supply Management Data Base - Since the 1982 Plan was developed, the NJDEP's water supply management data base has been significantly improved. There is much information, however, that needs to be incorporated. An up-to-date GIS-linked data base for water supply management is critical to water supply management. More detailed water use information will also be required from the major water purveyors in order to better understand water use patterns. Finally, periodic updates will be appropriate to incorporate new water use, wastewater discharge and population data and projections.
(Chapter 4.J)
Funding Source: *1981 Bond Fund Allocation: $0.5 million (new allocation)*

Water Use Ranking - The NJDEP proposes to rank and determine preference among uses of the various water resources used for water supply. The issue is the primacy of needs (e.g., public water supply, agriculture, manufacturing, recreation, aquatic life, pollutant discharge attenuation) during critical flow periods. While this initiative will be conducted in detail on a watershed-specific basis, it will be many years before all watershed planning is completed. Consequently, the NJDEP recommends that in the interim a more generic policy be developed as the basis for water use ranking.
(Chapters 7.A and 8.C)
Funding Source: *1981 Bond Fund Allocation: $0.15 million (new allocation in combination with In-Stream Flows allocation, below)*

In-Stream Flows - In conjunction with water use ranking, in-stream flow maintenance goals for ecosystem protection, recreation, wastewater assimilation and other uses should be established. The NJDEP plans to conduct research that identifies the quantity of water required for particular sets of uses and needs, analyze the implications of these requirements, and develop policy based on its findings.
(Chapters 3.J and 8.C)
Funding Source: *1981 Bond Fund Allocation: See Water Use Ranking, above.*

Optimum Withdrawal Strategies - The NJDEP proposes to develop a guidance document that describes appropriate optimization strategies that municipalities and purveyors should implement in order to ensure that reliable long-term water supplies are maintained, as well as to meet the objectives of the water use ranking and in-stream flow initiatives. Conjunctive water use with aquifer storage and recovery will likely evolve as a major water supply alternative in the future. Analysis is recommended, including the potential for using recovering critical water supply area aquifers during drought.

(Chapters 3.J, 6.B and 7.B)
Funding Source: *Water allocation fees, existing contracts (no additional allocation)*

Effects of Hydrologic Modifications on Water Availability - Changes to the natural landscape that accompany development can stress water supplies during low rainfall periods and impair freshwater-dependent ecosystems. The NJDEP proposes that a hydrologic model be developed that can estimate the hydrologic effects of development in water supply watersheds so that proactive strategies can be implemented.
(Chapters 3.J and 8.C)
Funding Source: *1981 Bond Fund Allocation: $0.1 million (new allocation)*

4. Issues For Future Analysis

Analysis of Safe Yield - There is a need to re-analyze the definition and the methods the NJDEP employs to quantify water availability to avoid overuse, as well as to implement the water use ranking initiative. Also, purveyors that employ conjunctive water use and wastewater reuse systems should be required to quantify their safe or dependable yield where it has not been clearly defined. Last, purveyors that are constrained by water quality concerns should have the opportunity to re-analyze their yields if source quality has improved since these constraints were invoked.
(Chapters 3.J and 8.C)
Funding Source: *1981 Bond Fund Allocation: $0.05 million (new allocation, including Dependable Yield, below)*

Dependable Yield/Refinement of Planning Thresholds - The planning threshold for ground water availability requires refinement to ensure that ground water supplies are not over- or under-allocated, either of which could result in inefficient water supply decisions. Also, the dependable yield definition needs to be re-evaluated to ensure that its use maintains long-term reliability and does not result in negative effects on other users and uses.
(Chapters 3.J and 8.C)
Funding Source: *1981 Bond Fund Allocation: see Analysis of Safe Yield, above.*

Water-Banking - The NJDEP needs to analyze the concept of water-banking if it is to encourage conjunctive water use. Banking consists of allowing water to be preserved in the present for water supply purposes and other beneficial uses in the future. In addition, the NJDEP needs to ensure that all viable, future reservoir sites are protected from infringement and diminishment.
(Chapter 7.B)
Funding Source: *General State appropriations*

Effect of Withdrawals that Stress Supply Availability - NJDEP policy is needed where requests are made for water allocations that exceed the water availability planning threshold. Also, there is a need to evaluate the 100,000 GPD threshold for water allocation permits in some areas. Numerous withdrawals less than this threshold can have the same effect as one major withdrawal. Last, the NJDEP will prepare draft policy that will determine who will be responsible for conducting additional hydrological investigations and related studies, when they will need to be performed, how they will be funded, legislative needs, etc.
(Chapter 3.J)
Funding Source: *General State appropriations*

Water Availability Monitoring - The importance of monitoring the regional effects of numerous withdrawals cannot be overestimated. While the existing monitoring network is generally adequate, increases in demand will require a more comprehensive and regional network to methodically provide baseline information, detect trends, serve as an early warning system and provide sufficient data for computer models. The NJDEP plans to assess its monitoring program in the near future and determine how this program can be funded.

(Chapter 3.J)
Funding Source: *to be determined.*

Use of Contaminated Ground Water Supplies - The NJDEP needs to develop policy concerning under which circumstances users of ground water supplies that become contaminated should treat that supply or turn to other supplies. In addition, there is a need to better coordinate water supply management and contaminated ground water sites. It is imperative that remedial actions at these sites do not employ depletive disposal methods if feasible, especially in planning areas prone to water supply shortages. The NJDEP should require pump-treat-reinject methods, unless impractical or the treated water is used as a supply.
(Chapters 7.B and 9.E)
Funding Source: *to be determined.*

5. Water Conservation

While New Jersey has significantly improved its water conservation efforts over the last few years through its requirements for water-saving plumbing fixtures and water conservation plans for all major users of water, much will need to be done in the future as a means of deferring water supply deficits. Until recently, water was viewed as an inexpensive, unlimited resource. There is a need to refocus our attention. Very few "conventional" water supplies remain available, and those that remain generally will yield less supply at a greater cost and will be subject to a larger number of environmental and other siting constraints.

There are several other trends that, when combined, create an impetus for reevaluating the way we use water. The cost to treat potable and waste water has escalated over the years as new water quality standards are implemented. In many parts of the State, combined water and sewer service costs are more than $1,000 annually for the average household. In other parts of the State new connections to sewage treatment plants are not allowed because the plants are at capacity. More efficient plumbing fixtures and appliances are available which could reduce sewage flows and defer sewage treatment plant expansion. They can also delay the need for new water supply storage, treatment and distribution facilities.

It is estimated that there can be a 10-30 percent reduction in water use in individual homes if water conservation devices were installed and certain outdoor water uses were reduced, such as through the use of developed turf and other landscape designs that are drought-tolerant.

Reducing the unnecessary use of water will be a major objective of the NJDEP. The initiatives specified in this chapter should serve to meet this objective. It should be noted, however, that a distinction needs to be made regarding statewide and regional water conservation initiatives because different circumstances will often deserve different strategies. There are numerous forms of water use and water users; cost-effective strategies will need to be developed for each.

State Water Conservation Strategy - This recent document concluded that the NJDEP should reaffirm its support for the principles of water conservation and demand reduction as effective and efficient alternatives in water resources planning and management through an educational, non-regulatory and incentive-based approach. The approach would provide for the following:

1. Expansion of the water conservation public education program, especially in the school curriculum and conservation landscaping for adults.

2. Formation of a public-private partnership to improve the efficiency of turf irrigation.

3. Emphasis on structural conservation measures rather than behavioral conservation measures (except during drought), due to the greater certainty and reliability of the former.

4. Acceleration of structural conservation measures and other efforts in water supply deficit areas, including expediting unaccounted-for-water-loss reduction compliance schedules and provisions for low or no-interest loans, especially to those public utilities that agree to implement conservation rate structures. Continued support should be given to such efforts in Cape May County and other deficit-prone areas. (Chapter 6.C and 6.G)

5. Application of proven, new plumbing technological advances that use less water and provide equal performance. A proposal should be made to the NJ Department of Community Affairs that automated lawn sprinkler systems have rain sensors that activate them rather than being time-activated regardless of need.

6. Proposal to the Board of Public Utilities to evaluate allowing water utilities to treat water saving plumbing fixtures as capital costs, as is currently the case for residential energy conservation fixtures.

7. Promotion of conservation rate structuring for those utilities using declining block rates, especially those utilities seeking expanded water allocations.

8. Encouragement to local and regional entities to tailor their conservation plan to meet particular local conditions. Offer planning and financial support.

9. Proposal to require large self-supplied water users that experience source or supply problems to perform water audits every five years.

10. Proposal for monitoring plumbing code enforcement.
    (Chapter 7.B):
    Funding Source: *1981 Bond Fund Allocation: $0.83 million (new allocation for various purposes outlined above, in addition to existing allocation of $1.6 million)*

6. Other Water Conservation Initiatives

Unaccounted-For-Water - Unaccounted-for-water is the result of water service infrastructure leaks, illegal or unmetered hookups, fire protection, etc., and typically represents 10 to 30 percent of total demand. The NJDEP recommends that the program to require reduction of excessive unaccounted-for-water continue.
(Chapter 9.D)
Funding Source: *General State appropriations and water supply systems*

Industrial Water Conservation - Industrial demand (excluding large self-supplied, industrial cooling demand) represents a significant portion of total statewide demand. There are often cost-effective opportunities to reduce industrial demand. The NJDEP proposes that industries depletively or consumptively utilizing the largest quantities of water perform water audits once every five years or when new or expanded water allocation permit applications are submitted.
(Draft State Water Conservation Strategy, Appendix B)
Funding Source: *General State appropriations*

Water Supply Infrastructure Loan Program - The Water Supply Infrastructure Loan Program has accomplished much over the last decade, providing $86 million in loans to rehabilitate inadequate systems (September 1993). The NJDEP should consider expanding this program to provide loans for nonpotable water reuse and water conserving plumbing replacement projects in planning areas experiencing deficit conditions.
(Chapter 9.D)
Funding Source: *1981 Bond Fund Allocation (see Water Delivery Management-Water Supply Loan Program, below)*

Consumptive Water Use Management - Consumptive water use is the permanent removal of water from its source supply, primarily through evaporation at or near the location from where it was withdrawn. The NJDEP needs to develop an inventory of consumptive water uses in order to assess their impacts on water supplies. The results should be incorporated into the Water Balance Model. Once completed, the NJDEP will evaluate initiatives that could reduce consumptive water uses. Among the initiatives to be considered will be incentives for the non-consumptive use of water.
(Chapter 7.B)
Funding Source: *1981 Bond Fund Allocation (see Section 3 above, regarding Water Supply Management Data Base).*

Depletive Water Use Management - Depletive water use refers to the exportation of water whereby there is no opportunity for reuse within its source area. Wastewater system regionalization is considered to be the largest depletive water use. Policy has recently been drafted that discourages depletive water uses in various circumstances. This policy should be finalized and implemented. It is recommended that consideration also be given to factor the costs of alternative water supplies when evaluating the cost-effectiveness of proposed depletive wastewater facilities.
(Chapters 3.J and 7.B)
Funding Source: *General State appropriations*

7. Water Delivery Management

The primary objective of this program is to ensure that adequate quantities of suitable quality water are available at the point of use. Being the most densely populated state in the nation, New Jersey's water delivery system is both extensive and complex. In many cases, also, the systems are very old. There is a need to continuously monitor, maintain and develop interconnections between systems to ensure an adequate supply of water for emergency and regular uses. The NJDEP will continue its efforts in this regard, as well as provide funds for the rehabilitation of inadequate systems.

It is proposed that the Water Supply Loan Program will undergo fundamental changes with respect to which systems are provided funds for rehabilitation. A priority system is being considered based on public safety needs, the amount of water saved and the status of the regional water supply with respect to potential deficit. It is suggested that some of the funds that were traditionally used for infrastructure improvement be shifted to water conservation improvements in deficit regions, when it is concluded that this is the more cost-effective option. It is also proposed that funding be expanded for treatment upgrades to meet new drinking water standards, with treatment to meet primary standards having priority over treatment to meet secondary standards but both being eligible.

Water Supply Loan Program - This program provides low-interest (revolving) loans from the Bond Fund to public-owned water purveyors for certain types of water system improvements. Approximately $120 million has been allocated to date (of which $20 million is from repaid loans); $100 million has been appropriated and is presently committed or pending commitment. These priorities will be set by regulations rather than the NJSWSP to allow flexibility year-to-year. The NJDEP proposes to re-prioritize the loan program in the following ways:

1. Emphasize maintenance and rehabilitation infrastructure in urban centers, in recognition of principles set forth by the State Development and Redevelopment Plan and the greater age of such systems.

2. Continue the existing program for small local project loans and consider utilizing a program similar to the Wastewater Treatment Financing Program for other projects.

3. Construct facilities that ensure continued use of existing surface water supplies.

4. Rehabilitate contaminated ground water supplies where cost-effective and practical, especially in urban areas, and especially where the loss of such supplies would result in increased stress on existing surface water supplies or on ground water supplies from already-stressed aquifers.

5. Construct wastewater reuse facilities for direct (nonpotable) and indirect (potable and nonpotable) water supply, especially where such reuse would reduce the stress on existing water supplies
(Chapters 7.B, 9.C and 9.D).

6. Construct interconnections to ensure adequate system redundancy and drought response capabilities.

7. Construct facilities to meet Safe Drinking Water Act requirements, with a priority for meeting primary standards but with eligibility for projects to meet secondary standards.

8. Conduct an infrastructure needs survey to determine the overall financing needs of public and investor-owned water supply systems in New Jersey for near future (completed in 1995).

9. Construct capital projects identified in Chapter 6 of the NJSWSP.
(Chapter 9.E)
Funding Source (for items 1 through 7): *1981 Bond Fund Allocation: $40.0 million (new allocation for fiscal years 1995, 1996 and 1997, in addition to $120 million existing allocation), and $10 million per annum (new allocation beyond fiscal year 1997)*
Funding Source (for item 9): 1981 Bond Fund Allocation and other sources (new and existing allocations as shown on Water Supply Action Program table)

8. Other Water Delivery Management Initiatives

Drought Management in the Passaic and Hackensack River Watersheds - The densely populated areas of the northeast are typically more vulnerable to the effects of drought than the rest of New Jersey. The NJDEP recommends that a Passaic/Hackensack River watershed hydrologic model be developed that would:
1) update and verify the safe yields of the system, including factors related to interbasin water and wastewater transfers and ground water availability and use;
2) allow for "testing" of several water supply alternatives (e.g., interconnections, conjunctive water use, altered reservoir management, wastewater reuse and improved river water quality) that could potentially increase yield;
3) improve the drought rule curve for the system;
4) provide the NJDEP with improved capabilities to manage the water supplies of the system during various kinds of stresses (e.g., repeat drought of record, short but severe drought); and.
5) allow the evaluation of water quality impacts on different drought scenarios.
These efforts will be coordinated with affected purveyors.
(Chapters 6.C and 9.B)
Funding Source: *1981 Bond Fund Allocation: $0.4 million (new allocation)*

Statewide Drought and Emergency Management - The management of water use during drought and emergency conditions is of paramount importance. Recent dry spells have provided the NJDEP with experiences on how to better deal with drought situations which should prove useful in cooperative water management endeavors undertaken between the NJDEP and water purveyors. In addition, purveyor conservation and emergency plans need to be updated to include defined "triggers" when specific management actions will be initiated to avert a water emergency. The NJDEP recommends that policy be developed to this end.

(Chapter 9.B)
Funding Source: *to be determined.*

Water Supply Treatment Residuals Management -- A number of relatively new drinking water treatment, industrial pretreatment and sludge (residuals) management regulations have resulted in significant technical, technological and regulatory issues for water purveyors. NJDEP recommends that a Treatment Residuals Study be performed to provide guidance to all water purveyors regarding residuals management.
(Chapter 9.B)
Funding Source: *1981 Bond Fund Allocation: $0.4 million (new allocation)*

9. Issues For Future Analysis

Non-Viable Water Systems - There is a demonstrated need to improve the management of existing non-viable (inadequately operated or financed) water supply systems. Further, since there is the potential for the proliferation of non-viable systems in the future as development continues to shift to suburban and rural areas, the NJDEP recommends an evaluation of necessary legislative and regulatory revisions be made in concert with the Board of Public Utilities to reduce the potential for such systems to be created.
(Chapter 9.D)
Funding Source: *General State appropriations.*

Loans to Privately-Owned Water Utilities - The 1981 Water Supply Bond Act does not authorize the NJDEP to provide loans to investor-owned water utilities, despite the fact that all taxpayers pay for publicly-owned water system subsidies and State management efforts funded by the Bond Fund and that over half of the water provided by community water supply systems in the state is provided by investor-owned utilities. The NJDEP recommends that a funding mechanism be developed that increases the equity between consumers of publicly-owned and investor-owned water purveyors.
(Chapter 6.J)
Funding Source: *to be determined.*

Federal Drinking Water State Revolving Fund - The federal government is considering the creation of a drinking water revolving fund in which the states would be provided with upwards of $1 billion annually to provide low-interest loans to public water supply systems. It is envisioned that this program would require a 20 percent State match. Funding sources need to be evaluated. The State should recommend to Congress that this fund should provide loans to investor-owned water systems.
(Chapter 9.D)
Funding Source: *matching fund source to be determined.*

Infrastructure Choices - There is the need to integrate our land use, water supply, water quality and wastewater infrastructure planning efforts to ensure that water continues to be of suitable quality and of ample quantity. The NJDEP plans to prioritize watershed planning initiatives in regions of the state where such opportunities exist to improve overall water quality and quantity. A cooperative project with the Office of State Planning and the NJ Department of Transportation will be undertaken to address this issue.
(Chapters 3.J, 7.A and 9.A)
Funding Source: *1981 Bond Fund Allocation; portion of Growth Areas Feasibility Study appropriation.*

D. Capital Projects

1. Overview

These types of projects are capital-intensive, structural projects that provide additional water in a specific planning area or areas in order to reduce, eliminate or avoid projected water supply deficits. The majority of these projects were identified in regional feasibility studies conducted after approval of the 1982 Plan using the Bond Fund and generally are "conventional" projects by nature. Examples include such facilities as reservoirs, regional pipelines and new well fields. Precursor activities such as feasibility studies, interconnection studies and hydrogeologic investigations fall in this category if it appears that major capital projects will result from them.

As a result of the 1982 Plan and earlier planning efforts, a total of $786.55 million in public and private funds has been expended on or committed to several major capital projects, including $217.55 million from the Bond Fund. Consequently, the most densely populated portions of the State possess or will soon possess sufficient regional supplies well beyond the turn of the century (as long as water quality problems are avoided and delivery systems are adequate; sub-regional problems still may exist). There may be a need to improve surface water operations in the northeastern and central portion of the State, including some new interconnections to meet local needs. These needs will be addressed by various studies described below and continuous updating (and improvement) of the NJDEP's data base, which will monitor demand and availability.

The New Jersey shore and the southwestern portion of the State, however, are expected to experience the greatest growth: several planning areas in these regions may potentially be in water supply deficit and thus will need special attention over the next decade. Several investigations are currently underway in these areas, but others will need to be initiated soon. It is anticipated that these studies will conclude that conjunctive surface/ground water capital projects and well field relocation (including multi-aquifer use) projects will be needed to meet the growing water supply needs of these areas. Future reductions in depletive water use, including water conservation, may also be necessary.

2. Recognized Capital Projects

South River Regional Pipeline - The Middlesex Water Company's South River Regional Pipeline is now completed and providing water to meet the cutbacks specified for Water Supply Critical Area #1.
(Chapter 6.D)
Funding Source: Investor-owned utility.

Tri-County Project - The NJ American Water Company Delaware River water treatment plant is complete (initial phase) and the regional pipeline to meet mandated cutback for Water Supply Critical Area #2 is currently under construction. The NJDEP supports new loan-funded interconnections for publicly-owned utilities to tie into the regional pipeline.
(Chapter 6.F)
Funding Source: *Private sector for pipeline and treatment plant; public sector and 1981 Bond Fund for connections to project*.

Southern Cape May Alternative Water Supply - A feasibility study is nearly complete which evaluated the saltwater intrusion problem in the southern portion of Cape May County and measures of mitigating this problem. Withdrawals from the Cohansey aquifer in the southern-most part of the county need to be reduced and alternative supplies implemented to compensate for the reduction. The NJDEP would support funding for capital projects that mitigate the intrusion problem as a long-term solution.

The City of Cape May has identified desalination as its preferred water supply alternative to mitigate the saltwater intrusion threat. NJDEP intends to support this project if an evaluation concludes that it is a cost-effective sub-regional alternative, that it will not prohibit water supply options that are critical to neighboring municipalities, and it has been demonstrated that the project acts to reduce the rate of saltwater intrusion in southern Cape May County. This project will be included into the NJSWSP if it meets all the above mentioned criteria. *The costs for constructing a desalination facility and related infrastructure to serve Cape May City has been estimated at $3.5 million.*However, there is the potential that the criteria may not be met and that other projects will be more effective in addressing the problems of the area, or that

supplementary projects will be necessary to address the full scope of water supply issues in the area. Therefore, an allocation from the Bond Fund up to an amount of $5.0 million in low-interest loans is made to fund the selected project(s).
(Chapter 6.I)
Funding Source: *1981 Bond Fund authorization: up to $5.0 million from the Water Supply Loan Program (see above)*

Kingston Quarry Reservoir - The Eastern Raritan Water Supply Feasibility Study determined that the most cost-effective water supply project to be implemented in the Raritan and South River planning areas is the Kingston Quarry Reservoir. The New Jersey Water Supply Authority will be the project sponsor. If this project is not feasible due to complications with the quarry owners, the Confluence Pipeline would be the alternate selected project with the same project sponsor. Although the projects will not be needed for some time, commitments are required in the near future.
(Chapter 6.D)
Funding Source: *1981 Bond Fund Allocation: Deferred until project selected (approximately $57 million for Kingston Quarry Reservoir, or $71 million for Confluence Pipeline)*

Manasquan, Metedeconk and Toms River Area Study - The Metedeconk and Toms River planning areas have significant projected water supply deficits, while the Manasquan River planning area is anticipated to experience surplus supplies due to the existence of the Manasquan Reservoir. It is recommended that a feasibility study be conducted to determine the extent of the long-term problem in the Metedeconk/Toms River areas in more detail, and then determine the most cost-effective and environmentally sound methods for ensuring adequate supplies, such as alternate supplies in the deficit areas or a regional interconnection between them and Manasquan River planning area.
(Chapter 6.E)
Funding Source: *1981 Bond Fund Allocation: Existing allocation (Ocean County Feasibility Study)*

Alternative Supplies for the Salem, Cohansey and Maurice River Watersheds - The Maurice River planning area is vulnerable to saltwater intrusion and stream flow depletion. In contrast, the Salem/Cohansey planning area may have adequate water supplies for the duration of the planning period and perhaps beyond. An investigation is necessary to define the magnitude of the problem in the deficit area. In the event that the problem is relatively severe, a feasibility study will need to be performed.
(Chapter 6.H)
Funding Source: *1981 Bond Fund Allocation: $0.125 million (new allocation for feasibility study. Allocations exist for initial ground water investigation)*

F.E. Walter Reservoir Expansion - The expansion of the F.E. Walter Reservoir in Pennsylvania would significantly reduce the frequency of drought warnings and drought emergencies in the Delaware River Basin. The NJDEP has allocated $10 million for the State's share of the project from the Bond Fund. However, this project has been delayed because of changes needed to the 1961 Delaware River Basin Compact. In order to overcome these shortcomings, the US Congress would have to revise the Compact. New Jersey, as a Compact member, supports this revision.
(Chapter 6.D)
Funding Source: *1981 Bond Fund Allocation: $10.5 million (no change)*

E. Funding Strategy

The NJDEP will continue to play an active role in providing financial assistance for water supply projects and programs throughout the state. Local government, water utility fees and the private sector will continue to be key sources of capital funding for projects, and in fact will provide the majority of future funding as they have in the past. The primary benefit of the Bond Fund is its ability to provide funding for critical needs, initiatives that provide public benefits beyond any one water supply system, correction of longstanding infrastructure needs, and support to innovative efforts and major capital projects that otherwise might not take place or be successful.

The NJSWSP has concluded that management, protection and rehabilitation of existing water supplies in conjunction with conservation of water will for the most part defer the need to seek large regional supplies for several decades. Consequently, it is recommended that most of the remaining Bond Fund be used to extend these supplies as far as possible through an array of management options as described above, including system rehabilitation, conservation, protection of water resources and improved water system management. (Chapter 6.J)

1. Issues for Future Analysis

Financial incentives need to be provided to the private sector to provide important water supply improvements recommended in the NJSWSP. A major reason for such incentives is to provide equity to the affected ratepayers, who currently help support incentives for publicly-owned systems while also paying market rates (through the investor-owned purveyors) for their own needs. It is recommended that the NJDEP perform an analysis of incentives that ultimately can reduce water use, and protect and extend supplies. Included in this analysis will be a re-examination of excluding investor-owned purveyors from the Bond Fund, along with incentives to water users themselves. If found to be viable, the State could recommend to Congress that Federal tax laws be revised to allow for water supply loans to be made to the private sector. In the interim, direct State support of activities that benefit investor-owned water supply systems without directly subsidizing them will be continued.
Funding Source: General State appropriations for analysis; *to be determined for investor-owned funding.*

A needs survey should be conducted for all purveyors to determine the infrastructure and financial needs throughout the State. The needs survey should use existing surveys as a foundation for more detailed analysis. This survey will be increasingly important if the proposed Safe Drinking Water Act amendment includes funds for a revolving loan program.
Funding Source: *1981 Bond Fund Allocation: $0.3 million (new allocation)*

An assessment needs to be made of restructuring Bond Fund repayments so that more funds can be recycled back into the loan program. Also, an assessment should be made of a renewable funding source so that the burden of water supply management is shared among the state's population.
Funding Source: *General State appropriations.*

A further review of the existing loan program should be made to determine if its present priorities will meet future needs.
Funding Source: *General State appropriations.*

F. Legislative and Regulatory Actions

Several existing or proposed statutes will need to be revised if the NJSWSP is ultimately going to be fully successful.

There have been many proposals for the State to purchase several watershed lands in New Jersey as well as watershed lands in other States where water from those lands flow into New Jersey. While the Bond Fund can and should be used as a funding source for some of these purchases, it would quickly be depleted if it were to be used for the purchase of a significant portion of any one of the larger watershed lands under consideration. It is therefore recommended that other sources of funding and other land conservation approaches be considered for this purpose in the long term.
(Chapter 7.A)
Funding Source: Green Acres Program (partial); additional sources *to be determined.*

Proposed watershed protection laws are intended to protect the water quality of reservoirs and surface water withdrawals. Since these proposals will have profound effects upon these water supplies, the NJDEP should closely coordinate with the legislative sponsors. Major issues include the cost-effectiveness of management measures, the protection of ground water, integration with existing and developing programs, management of existing land uses, creation of a cooperative relationship between various water laws (water supply and water quality) and between various levels of government (including the role of municipal governments.
(Chapter 7.A)
Funding Source: *to be determined.*

Statutes and regulations dealing with stream passing flow deserve to be re-considered, especially in consideration of our knowledge of the interrelationship between surface and ground water as well as the fact that NJDEP is evolving toward a watershed management approach. It is possible that some passing flows defined by law or court order are no longer defensible due to major changes in water quality and environmental concerns since the time of their adoption.
(Chapters 3.J, and 8.C)
Funding Source: *to be determined.*

If analysis concludes that it would be to the State's advantage to expand its loan program to serve investor-owned purveyors, the NJDEP would recommend that the 1981 Water Supply Bond Act be revised or that a supplemental funding source be developed.
(Chapter 6.J)
Funding Source: *to be determined.*

In order to prevent the proliferation of non-viable water companies throughout the State the NJDEP, in concert with the Board of Public Utilities, will recommend that laws and regulations be reviewed to determine their adequacy, and then revised to the extent necessary to minimize the development of non-viable systems.
(Chapters 4.B and 9.D)
Funding Source: *General State appropriations.*

The NJDEP should renew its efforts to have the United States Congress revise the 1961 Delaware River Basin Compact so that the F.E. Walter Reservoir can be expanded to serve as a water supply. (Chapter 6.D)
Funding Source: *General State appropriations.*

G. Relationship of the NJSWSP to Regulatory Programs

The NJSWSP establishes a planning framework that identifies water supply problems and public issues, and proposed activities, objectives and policies to address these problems and issues. It is important that State and local decision makers involved in water supply matters are aware of these activities, objectives and policies in order to reduce the potential for future conflict, especially in deficit areas. The NJSWSP is not binding on any government, government agency or regulatory program except to the extent that the use of Bond Fund is proposed, at which point the NJSWSP is fully binding.

H. Updates, Revisions and Progress Evaluations of the NJSWSP

As required by the 1981 NJ Water Supply Management Act, the NJDEP shall revise and update the NJSWSP periodically, which NJDEP intends to interpret as being at least once every five years. Each revision and update shall be accompanied by a progress evaluation. In addition, progress evaluations shall be prepared and submitted to the New Jersey Legislature as and where required by individual appropriations from the Bond Fund.

Funding Source: *1981 Bond Fund Allocation: $0.3 million (new allocation)*

I. NJDEP Organizational Responsibilities

The Office of Environmental Planning and the Water Supply Element (or their organizational successors) will have the primary responsibilities for coordinating, overseeing and carrying out the initiatives set forth in the NJSWSP. The Office of Environmental Planning will have the primary responsibility for coordinating the periodic update and revision of the NJSWSP, and for general water supply planning initiatives.

J. 1995 Statewide Water Supply Plan Action Program

GLOSSARY

"Adverse impact upon wells" means a forced reduction in pumping rate or a required changed in the construction of an affected well or any impairment of water quality.

"Aquifer" means any water-saturated zone in sedimentary or rock stratum which is significantly permeable so that it may yield sufficient quantities of water form wells or springs in order to serve as a practical source of water supply.

"Aquifer storage and recovery (ASR)" is the injection of treated drinking water through wells into a suitable aquifer during periods of surplus water treatment plant capacity and recovery from the same wells during periods of peak demand for treated drinking water. The only treatment required for the recovered water is chlorination.

"Allocation permit" means the document issued by the NJDEP to a person, granting that person the privilege, so long as the person complies with the conditions of the permit, to divert water for any purpose other than agricultural or horticultural use.

"Base source" means the water resource in its natural, undisturbed state. A groundwater base source would be a particular aquifer recharge area and the associated aquifer. A surface water base source would be a drainage basin and the associated water body.

"Class A standard" means the capacity of one or more interconnections with adjacent water systems having the combined capacity to supply 75 percent of the average water usage of the receiving system, while relying on no more than one adjacent system for more than 25 percent of the average water supply of that adjacent system.

"Class B standard" means the capacity of one or more interconnections with an adjacent water system, having the combined capacity to supply 50 percent of the average water usage of the receiving system, while relying on one adjacent system for no more than 35 percent of the average water supply of the adjacent system.

"Class 1 purveyor" means a water purveyor which serves a population of up to 10,000 persons.

"Class 2 purveyor" means a water purveyor which serves a population of 10,001 to 50,000 persons.

"Class 3 purveyor" means a water purveyor which serves a population of over 50,000 persons.

"Confined aquifer" is an aquifer which contains groundwater confined under pressure between relatively impermeable or significantly less permeable material so that its groundwater surface rises above the top of the aquifer.

"Confining Unit" means a body of relatively impermeable material that is above or below one or more aquifers, restricting the flow of water to or from the aquifer(s)

"*Consumptive water use*" means the use of water in such as way that a portion of the water used is lost to evaporation, transpiration, incorporation in product, etc., and not discharged to any location.

"Critical water supply area" or "critical area" means a water supply area in which it is officially determined by the New Jersey Department of Environmental Protection, after public notice and a public meeting, that adverse conditions exist, related to the ground or surface water, which require special measures in order to achieve the objectives of the Water Supply Management Act.

"Dependable yield of combined surface/ground water sources" means the yield of water by a water system which is available continuously throughout a repetition of the most severe drought of record, without causing undesirable effects, as described in the definition of "Dependable yield of subsurface sources" above.

"Depletive water use" means the withdrawal of water from a water supply resource (ground or surface water) where the water, once used, is not discharged to the same water supply resource in such a manner as to be useable within the same watershed.

"Drought" means a condition of dryness due to lower than normal precipitation, resulting in reduced stream flows, reduced soil moisture and/or lowering of the potentiometric surface in wells.

"Facility" means a medium through which the base source is transmitted to the user. It is wither man-made or manipulated in an attempt to maximize the water that may be derived from a base source. A facility for groundwater is a well or wellfield and for surface water a reservoir or intake facility.

"Fresh water" means all nontidal and tidal waters generally having a salinity due to natural sources of less than or equal to 3.5 parts per thousand at near high tide.

"Interbasin transfer" means the movement of water (as raw, treated or used water) from one watershed to another.

"Interconnection" means a water supply connection with another water supply system or systems.

"Multiple sources" means one or more production wells, surface water intakes, or interconnection or a combination of wells, surface water intakes or interconnections utilized to meet the demands of a public community water system.

"Negative Environmental Effects of Withdrawals" means those environmental impacts of water withdrawals which are deemed to be undesirable by NJDEP.

"Nonpoint source" means any source, other than a point source, from which pollutants are or may be discharged; any man-made or man-induced activity, factor, or condition, other than a point source, that may temporarily or permanently change any chemical, physical, biological, or radiological characteristic of waters of the State from what was or is the natural, pristine condition of such waters, or that may increase the degree of such change; or any activity, factor, or condition, other than a point source, that contributes or may contribute to water pollution.

"Normal demand" means the annual average demand during the three preceding non-drought years, including normally occurring peaks.

"Point source" means any discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel, or other floating craft, from which pollutants are or may be discharged. Return flows from irrigated agriculture are not considered point sources.

"Potable water" means water that does not contain objectional pollution, contamination, minerals, or infective agents and is considered satisfactory for domestic consumption using conventional water treatment processes(e.g., chemical coagulation/flocculation, clarification, filtration, disinfection).

"Purveyor" means any company, authority, or person who owns or operates a public community water supply system.

"Public community water system" means a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

"Safe yield from surface sources" means the yield maintainable by a water system continuously throughout a repetition of the most severe drought of record, after compliance with requirements of maintaining minimum passing flows, assuming no significant changes in upstream or upbasin depletive withdrawals.

"Single prime source" means a single diversion of surface or groundwater, including an interconnection, capable of providing the peak water demand of a public community water supply system.

"Stipulated surface water withdrawals" these are surface water uses that are not supported by storage, have no associated safe yield, and can be rescinded during droughts.

"Treated wastewater" means the treated spent water of a community. From the standpoint of source, it may be a combination of the liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present. In this study, treated wastewaters will be segregated into municipal treated wastewater and industrial treated wastewaters. Consistent with available information, municipal wastewaters will be categorized into less than secondary level treatment, secondary level treatment, and advanced treatment.

"Unaccounted-for-water" means water withdrawn by a purveyor from a source and not accounted for as being delivered to customers in measured amounts.

"Unconfined or semi-confined aquifer" means an aquifer close to the land surface with continuous layers of materials with permeabilities in the high to low range, extending from the land surface to the base of the aquifer.

"User" means any person or other entuty which utilizes water.

"Water allocation: or certification" means the authority to withdraw surface or groundwater for use, pursuant to a permit issued under N.J.A.C. 7:19-1 et seq. or 7:20A-1.1 et seq.

"Water closet" has the same meaning as "toilet", that is, a plumbing fixture for the receipt and disposal to a wastewater system of human bodily wastes.

"Watershed" means a geographic area in which all water, sediments and dissolved material drain to a particular receiving body.

"Watershed Management Plan" means a strategy of which the goals and objectives are to achieve the restoration, protection and management of the water resources and any associated uses within the watershed.

"Water supply deficit" means the amount or amounts by which the available resources fall short of a given demand.

"Water supply system" means a facility for providing potable water.

"Water system improvement" means any action or actions which increases the capcity, capability, or effciency of a water system.

"Water table" means the water surface in the uppermost part of the water saturated zone which is at atmospheric pressure.

"Water table aquifer" means a geological formation which carries water at atmospheric presssure at the top of the saturated zone.

"Yield of a water resource system" means the output of water from a system, available with monthly variations corresponding to the needs of the system.

APPENDICES

Appendix A

Legislative Authorities

Water Supply Bond Act of 1981
Water Supply Management Act
NJ Water Supply Authority Act

Appendix B

State Water Conservation Strategy

Appendix C

1994 Statewide Water Supply Plan Progress Report

Appendix D

NJ Statewide Water Supply Plan Reference Documents

Appendix E

Depletive Water Use Project for RWRPA of NJ

Appendix F

Map of 23 Planning Areas of NJ