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New York State

WATER RESOURCES MANAGEMENT STRATEGY

January, 1989

New York State Water Resources Planning Council

New York State Department of Environmental Conservation
New York State Department of Health

NEW YORK STATE

WATER RESOURCES MANAGEMENT STRATEGY

JANUARY, 1989

APPROVED BY: NEW YORK STATE WATER RESOURCES PLANNING COUNCIL

PREPARED BY: NEW YORK STATE DEPARIMENT OF ENVIRONMENTAL CONSERVATION
NEW YORK STATE DEPARIMENT OF HEALTH

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WATER RESOURCES PLANNING COUNCIL
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

TO: ALL INTERESTED PARTIES

On behalf of the **WATER RESOURCES PLANNING COUNCIL**, a body created by the New York State Legislature in 1984, I am pleased to announce the approval of this statewide water resource management strategy. The Council has also approved water resource management (substate) strategies for each of 13 regions of New York State.

These "strategies" are intended to provide for each of the regions of the state "...a framework upon which future specific actions that respond to water supply needs..." would be based. The Legislature, in assigning the Council the responsibility of approving such strategies on a biennial basis, recognized that water resources planning and management issues had to be addressed as an evolutionary process. Such a process explicitly acknowledges that climatic, ecological, hydrologic, demographic, and socio-economic changes greatly influence and affect the availability and uses of the water resource.

In the course of developing these strategy documents we were pleased to find that water resources, particularly as they relate to the quantity and quality of drinking water supplies, are matters of great concern and interest to the general public, environmental and public interest groups, and public officials and is indicative of the importance these resources play to the economic and social viability of New York State.

As the Water Resources Planning Council begins the process of reviewing this and all other strategy documents in fulfillment of its statutory obligations it welcomes comments, suggestions and recommendations.

Respectfully,

Walter R. Lynn

Walter R. Lynn, Chairman

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1988

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A RESOLUTION
WRPC-88-14

WHEREAS, the New York State Department of Environmental Conservation and the New York State Department of Health surveyed municipal water supply systems in order to determine their current and future water needs; and

WHEREAS, the Department of Environmental Conservation and the Department of Health gathered information on agricultural, commercial and industrial current and future water needs; and

WHEREAS, the Department of Environmental Conservation and the Department of Health held public information meetings to gather information and opinions from interested public parties on this strategy; and

WHEREAS, the Water Resources Planning Council held public hearings on this strategy in order to receive public responses to the Department of Environmental Conservation and Department of Health recommendations; and

WHEREAS, the Department of Environmental Conservation and the Department of Health revised and modified their draft recommendations in response to many of the suggestions and comments provided by members of the Water Resources Planning Council, as well as those offered at the public hearings and meetings; and

WHEREAS, the New York State Water Resources Management Strategy shall be the general framework and conceptual basis for recommendations for water supply planning and actions;

THEREFORE, BE IT RESOLVED,
That the Water Resources Planning Council hereby approves the New York State Water Resources Management Strategy.

William N. Lee
Executive Secretary

Walter R. Jones
Chairperson

12/8/88
Date

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EXECUTIVE SUMMARY

New York State Water Resources Management Strategy

New York State receives more water in precipitation than it uses to support its population and is therefore regarded as water-rich. However, droughts and population concentrations cause periodic water shortages, particularly in southeastern New York. The frequency of these problems is unacceptably high. Distributing water resources to these areas is becoming an increasing concern. The New York City system, for example, today uses an average of nearly 300 million gallons per day (mgd) more than its calculated safe yield. An approach that combines demand reductions and supply supplements will be needed to continue providing adequate quantities of drinking water into the 21st century.

The New York State Water Resources Management Strategy evaluates the water resource problem in detail. It analyzes management, financing and the problems presented by different geographies and population densities around the state. Strategies prepared for 13 substate regions contain additional recommendations for managing particular regions' water resources. This statewide strategy recommends actions for major regional issues in southeastern New York which affect the state's water resources as a whole in addition to statewide issues. The goal of this strategy is to ensure the availability of reliable supply when and where it is needed, in adequate quantity and quality, at reasonable cost, consistent with sound environmental practices.

The strategy is intended to be an evolving document, responsive to needs and conditions throughout the state. It provides the guidelines for developing an ongoing Water Resources Management Program. The Strategy will be reevaluated and revised, as necessary, every two years beginning in 1990, to reflect changing times and circumstances.

The New York State Departments of Environmental Conservation and Health are the lead agencies. However, implementation of the strategy will require the combined efforts of state and local governments, public and private water purveyors, and water users who draw from municipal systems or from their own supplies, in all economic sectors.

The Strategy includes recommendations for a wide range of state and local actions to improve water resources management and supply systems in the state. Some actions will need extensive funding, and some will cost little or nothing. Many of the recommended improvements are already begun. The strategy recommendations will also require new legislation, a summary of which is in Chapter V. The major recommendations are as follows:

1. Major Regional Issues - Southeastern New York

   Adequacy of supply for the New York City system is a major concern in southeastern New York and for the state as a whole

because the system serves almost half the state's population. Normal demands on the system now exceed the dependable yield by about 300 million gallons per day. The city experienced water shortages in the 1980-1981 and 1985 droughts, and severe water use restrictions were necessary. Even with conservation, a deficit of 300-800 mgd has been estimated for the year 2030. The ongoing detailed water demand study must be completed to determine the projected water supply deficit more accurately. Water conservation and metering programs, short-term supplemental supply actions and long-range planning are required to meet demands on the New York City water supply system.

Long Island's vast aquifer system is the largest and most important groundwater resource in New York State. It is the only source of drinking water for over three million people. High demands on the aquifer have stressed the system. The aquifer also is particularly vulnerable to pollution from development and associated sources of contamination. Increased concern about the magnitude and complexity of groundwater problems, particularly the threat of pollution by toxics, led to a review of resource management needs and development of the Long Island Groundwater Management Program (LIGMP). The LIGMP Report (DEC, June 1986) contains the framework for program actions to protect and improve the quantity and quality of groundwater. The LIGMP recommendations should be implemented.

2. Water Conservation and Metering

The state should require each water supplier serving more than 5,000 people to have a water conservation plan. The state should establish clear guidelines, conservation goals and provide technical assistance to suppliers on how to calculate and document water conservation savings and report on such savings.

State law should mandate universal metering of all major self-supplied water uses and all public water supply systems, including both service connections and production sources, within ten years. Although agricultural self-supplies and household wells would not be included except when already mandated by law, the agricultural component will be monitored by statewide representative sampling and monitoring.

Water conservation measures and metering of public water systems are most needed in the New York City supply system and on Long Island.

3. Infrastructure Improvement

The capital improvement estimates for all water supply systems surveyed in the regional studies total $9.224 billion, including $8.986 billion for the large systems and $238 million for the small systems.

The information to estimate infrastructure needs was derived from water system operators, from the most recently published engineering reports, and data on file in local and state government offices. Proposed projects were reviewed for overall compatibility. All systems serving 5,000 or more people (large systems) were surveyed. A representative sample of systems serving less than 5,000 people (small systems) were surveyed. The cost of the infrastructure needs of the small systems not surveyed was extrapolated from the surveyed system's costs.

As a first step in meeting these needs, the state should establish a program to provide technical and financial assistance to municipal and investor-owned public water supply systems, to complete detailed system studies of improvement needs and to prepare capital expansion and improvement plans.

Programs to generate this money are suggested, the most desirable of which is a leveraged equity loan program discussed in Chapter III.

4. Registration of Major Water Supply Withdrawals

To gain crucial data on how much and where water is used and to help sustain the capabilities of the state water resources to serve present and future users, the state should enact legislation requiring registration with DEC of any withdrawal of water exceeding 100,000 gallons per day during any 30-day period, anywhere in the state.

In addition, the state should evaluate the need to establish permit programs or an allocation system for other uses in addition to public water supply.

5. Water Quality Protection

Greater efforts are needed to protect and preserve water supply sources through vigorous enforcement of water pollution control laws, more effective watershed rules and regulations and stronger local land use controls. The state Department of Health should consider mandating filtration of all surface water supplies and should develop priorities for compliance. All water suppliers serving more than 5,000 people should report annually to their customers on issues affecting the water supply, including specific water quality data.

The state Department of Health and localities should continue working to achieve adequate treatment of groundwater, to monitor for contaminants, and to promulgate and implement state standards for organic chemicals in drinking water.

6. Improved Management of Small Water Supply Systems

The state should expand existing programs to improve the physical condition, operation and management of small water supply systems (those serving fewer than 5,000 people.)

Such programs should also provide technical and financial assistance to small systems on water resources and adequacy of supply, including water conservation. The Department of State should continue the Self-Help Support System to assist small communities in using their own resources to alleviate local water supply problems, including system operation, maintenance, financing and management.

7. Data Needs

An adequate and reliable data base is essential to manage water resources. Existing data are not integrated, there are significant data gaps, and the reliability of data is often suspect. The state should develop an expanded data base that will provide the character and quality of information required for sound water resources and water supply management. The state should integrate and coordinate state, federal, and local agency programs relating to water resources data in order to facilitate data collection, storage, retrieval, and analysis.
The state should establish uniform criteria and methodologies for determining dependable yield of surface and groundwater sources and provide technical assistance to water suppliers for making these determinations.

It is imperative that this program go forward if our precious water resources are to remain the strength of the Empire State.

Summary of Recommendations in the Statewide Water Resources Management Strategy

Background

New York has an abundance of good quality water that historically has provided safe and reliable supplies for domestic and municipal purposes, industry, agriculture, power generation, recreation and fish and wildlife. However, recent water shortages due to drought, increased contamination of groundwater supplies, increased water demands and the deteriorated condition of water supply systems point out the need for a sound, efficient water resources management strategy for the state.

The New York State Water Resources Management Strategy has been developed in response to this need. The strategy is designed to meet the water supply requirements of residential, agricultural, industrial and commercial users and to assure the highest possible quality and quantity of New York State's water resources. The strategy includes recommendations for a wide range of state and local actions to improve water resources management and water supply systems in the state.

Recommendations

A. Water Quantity

1. Water Conservation

The state should:

- Require each large water supplier serving more than 5,000 people to have a water conservation program as part of a water supply management plan.
- Establish clear guidelines on how to calculate and document water conservation savings and require large water suppliers to report on savings.
- Help large water suppliers evaluate the benefits, reliability, and economic, environmental and social costs of water conservation measures in their conservation plans.
- Provide technical assistance on long-term and emergency demand management, leakage and waste control, conjunctive management, operating rules, and public education and information to water suppliers.
- Require large water suppliers to file reports with the state containing specified information; report annually to their customers on water-related issues, including conservation; and use billing formats that highlight water use.

- Provide guidelines for large water supplies to establish water conservation goals based on water supplier specific information.

- Identify special problem areas.

- Evaluate modifications of the state low flow fixtures law.

- Conduct feasibility study on retrofitting water saving plumbing fixtures in state facilities.

- Establish and maintain comprehensive public information and education programs on water conservation.

- Advise businesses, industries and institutions to reduce water waste.

- Retrofit plumbing fixtures in state government facilities.

Localities, should develop comprehensive water conservation programs that include measures to:

- Distribute water conservation materials.

- Conserve water used for public purposes.

- Retrofit plumbing fixtures in local government facilities.

- Promote water-saving plumbing fixtures in residences; consider the feasibility of a residential plumbing fixtures retrofit program.

- Incorporate the state low flow fixtures law into local codes.

- Make local plumbing codes more restrictive than the state law.

- Consider limitations on the size of turf planted areas (lawns).

- Establish a clear process for enforcement of local water conservation programs.

- Establish effective control over stolen water and unauthorized water use.

- Impose water use restrictions during droughts and other water supply emergencies.

2. New Water Supply Source Development

The state public water supply permit system should require water suppliers seeking to develop new sources to demonstrate that the following conditions have been met:

- They have effective water conservation programs in place.

- They are using existing sources as efficiently as feasible.

- They have made any feasible facility adjustments or expansions for the efficient delivery of water from existing sources.

- They have identified all alternative water supply sources.

The state should identify water surplus/deficit areas.

3. Registration of Major Water Supply Withdrawals

To better understand how much and where water is used and help sustain New York State's water resources to meet present and future uses, the state should enact legislation requiring registration with state Department of Environmental Conservation of any withdrawal of water exceeding 100,000 gallons per day during any 30-day period anywhere in the state.

4. Large Diversions and Consumptive Uses

The state should enact legislation establishing a DEC permit program to control large diversions and consumptive uses (more than two million gallons per day, during any 30-day period, anywhere in the state,) from all New York drainage basins.

5. Water Use Regulation

To more adequately protect sources from overuse the state should evaluate the need to establish permit programs or an allocation system for other uses in addition to public water supply.

6. Instream Flow Management

The state Department of Environmental Conservation should:

- Adopt a policy and develop criteria for minimum flows in all streams to balance competing uses, with drinking water supply receiving the highest priority.

- Review all impoundments in the state to identify problems and opportunities to balance competing uses through instream flow management.

- Make recommendations to minimize impacts upon fish and wildlife resources and other instream uses such as recreation, transportation, navigation, and power generation.

- Require that new water intake structures be designed to minimize impacts to aquatic organisms, and that impacts of existing structures be reviewed during license or permit renewal processes.

7. Economic Development

The state departments of Economic Development and Environmental Conservation should help municipalities to use their available excess water supply capacity to promote economic development which takes advantage of available water supplies, and should guide water-intensive development toward areas with readily available supplies in a manner consistent with other resource management objectives.

Localities should consider the availability of water when making local land use and economic development decisions.

B. Water Quality

1. Protection of Water Supply Sources

The state Department of Environmental Conservation should:

- Continue to vigorously enforce state water pollution control laws.

- Set priorities for environmental management programs (e.g., discharge permits, solid and hazardous waste disposal, hazardous waste site cleanup) to take into account water quality protection for water supply sources.

- Continue to ensure that state standards and classifications for surface water and groundwater are adequate to protect water supply sources.

- Link compliance with discharge permits for sewage treatment plants to state assistance on operation and maintenance and disseminate information on permit violations to all concerned local entities.

- Require the continuous disinfection of wastewater tributary to sources of public water supply through SPDES permits as necessary.

- Take steps to assure full implementation of the federal and state sole source aquifer programs, including the Incompatible Uses Law.

- Provide technical assistance and information to local governments on protecting water supply sources.

The state Department of Health should:

- Continue to vigorously enforce state drinking water protection laws and regulations.

- Ensure that state drinking water standards are stringent enough to protect public health and safety.

- Issue final guidelines for watershed rules and regulations programs, require watershed rules and regulations programs for all water suppliers, and develop a program for enforcement of approved watershed rules and regulations.

- Require water suppliers to report annually on water quality.

The two departments jointly should:

- Ensure that surface water, groundwater and drinking water standards are coordinated for consistency.

- Identify priority areas for watershed protection, establish special standards for critical watershed protection areas.

- Develop alternative methods for watershed protection, involving coordination among state programs for control of point and non-point sources, watershed rules and regulations, and protection of sole source aquifers and wellheads.

Local governments should adopt and aggressively apply watershed rules and regulations or land use controls to protect water supply sources including land acquisition program.

2. Water Treatment

DOH should require filtration of all vulnerable surface water supplies and develop guidelines and priorities for compliance, and also should consider mandating filtration for all other surface water supplies.

Local governments should initiate efforts toward the construction of filtration facilities on surface water supplies.

The state should provide technical and financial assistance to small water supply systems for treatment facility planning.

DOH and localities should continue working to achieve adequate treatment of groundwater, to monitor for contaminants, and to promulgate and implement state standards for organic chemicals in drinking water.

C. Water Supply System Management

1. Water Rates That Reflect the True Cost of Water

To achieve the goal of charging the true cost of water, DEC, DOH, PSC and Office of the Comptroller should:

- Establish uniform accounting procedures, including a separate water account, for better financial control and more effective management of water supply systems.

- Establish guidelines and audit procedures for determining the true cost of water, including costs of both water supply and sewerage where one utility provides both services.

- Condition state financial or technical assistance upon water utilities charging the true cost of water.

- Repeal the current provision making water districts ineligible to accumulate capital reserve funds.

2. Water Metering

State law should mandate universal metering of all public water supply systems, including both service connections, and production sources and metering of major self-supplied water uses, within ten years. Agriculture and Household wells would not be included except where already mandated by law and/or are significant users.

Localities should be required to maintain accurate records of water consumption by major categories so that rates and billing can be tied to use, and unaccounted-for water can be identified and corrected.

3. Supply Management

DEC should provide technical assistance to water suppliers on sound management of current supplies, including measures for long-term and emergency demand management, leakage and waste control, operating rules, conjunctive management and public education and information.

4. Improved Management of Small Water Systems

DOH should continue to place emphasis on the regulation of small systems in order to improve the physical condition, operation and management of small water supply systems.

DEC should provide technical assistance to small systems on water resources and adequacy of supply, including water conservation.

The Department of State should continue the Self-Help Support System to assist small communities in using their own resources to alleviate local water supply problems.

DEC and DOH should develop a computerized uniform data collection and reporting system and provide training for small system operators.

Localities should:

- Improve operation, maintenance, financing and management of small systems.

- Overcome the limits of small systems by assisting small systems to join with others through such measures as regionalization, privatization or joint service contracts.

5. Regional Water Supply Systems and Interconnections

To encourage regional water supply systems and interconnections, DEC and DOH should:

- Further identify opportunities for regionalization and interconnections and determine necessary research, studies, or analysis.
- Make a detailed assessment of impediments to regionalization and ways to overcome them.
- Provide technical assistance to localities to investigate regional water systems and interconnections.
- Require interconnections between water supply systems for permanent use where technically, economically, and environmentally feasible, and for temporary use during emergencies.

6. Water Supply Planning

DEC and DOH should require suppliers providing water to more than 5,000 people to submit water supply management plans, that include:

- A water conservation program.
- Assessment of the safe yield and capacity of existing sources and facilities.
- Analysis of present and future demands, including the evaluation of the effectiveness of water conservation.
- A source and facility development program to meet current and projected demands.
- A system rehabilitation and improvement program, and preventive maintenance plan.
- A capital expansion and improvement plan.
- A contingency plan, including emergency sources (especially for droughts), interconnections for flexible and reliable system operation, water use restrictions, emergency response, and other appropriate actions.
- The creation of or revision to watershed rules and regulations.

DEC and DOH should provide technical and financial assistance for preparation and implementation of water supply management plans, including a guidance manual and pilot management plan.

DEC and DOH should ensure that the management plans prepared by suppliers and counties are mutually consistent and are consistent with this statewide strategy.

DOH should require community water suppliers to prepare and submit emergency plans in accordance with recent legislation.

DEC and DOH should conduct comprehensive water resources planning in preparation for revisions of the statewide and substate strategies. Such planning should be directed toward both site - specific programs and projects and further development of the substate strategies.

D. Water Supply System Improvements

The state should establish a program to provide technical and financial assistance to municipal and investor-owned public water supply systems to complete detailed system studies of improvement needs and prepare capital expansion and improvement plans. These plans should be consistent with the statewide and appropriate substate strategies.

DEC, DOH, Comptroller and the state Public Service Commission should develop uniform accounting procedures, establish audit procedures to determine the "true cost" of water, and improve each community's ability to represent its need for and its financial capacity to support capital projects to rehabilitate, improve, or expand existing water supply systems.

DEC, DOH and PSC should assist water suppliers to establish water service delivery goals based on state policies and local conditions.

The state should establish a capital reserve fund from funds obtained primarily through federal grants to provide low interest revolving loans to water suppliers to improve water supply systems.

The state should continue to seek and support federal technical and financial assistance for improvement of water supply systems.

Local governments should continue to establish local water authorities to obtain the capacity for revenue bond financing and for other benefits provided by authorities.

E. Data and Research

The state should integrate and coordinate state, federal, and local agency programs relating to water resources data in order to facilitate data collection, storage, retrieval, and analysis.

The state should develop an expanded data base that will provide the character and quality of information required for sound water resources and water supply management.

To obtain adequate water quantity data the state should:

- Complete regional mapping of surficial waters across the state.
- Support the National Weather Service climatological data program.
- Expand the present cooperative data program on water resources between the state and the U.S. Geological Survey.
- Establish a statewide well registration program.
- Require statewide registration of well drillers.

To obtain adequate water use data the state should:

- Utilize an integrated standard data base for all water use data in the state, and develop a computerized data base management system, such as a GIS.
- Require major (more than 100,000 gpd during any 30-day period) self-supplied users to file quarterly reports on monthly and maximum day use.
- Develop improved estimates of present and projected self-supplied water use.
- Establish an agricultural water use data research and monitoring system to develop improved and reliable estimates of present and proposed agricultural water use.
- Compile and integrate data on other water uses, such as power generation, navigation, and recreation.

Water suppliers should be encouraged to purchase and use micro-computers for their data collection and reporting system, where appropriate, and the state should provide a computer program and training.

The state should establish uniform criteria and methodology for determining dependable yield of surface and groundwater sources, and provide technical assistance to water suppliers for making these determinations.

The state should evaluate supplemental irrigation water use and establish a supplemental irrigation technology program.

Research Needs

The Water Resources Planning Council with the assistance of the New York State Water Resources Institute, should establish a research agenda, based on broad input and review, giving priority consideration to areas of research most needed to further development of the water resources strategy for New York State.

F. Public Awareness, Education, and Involvement

DEC, DOH and other agencies within state and local governments should coordinate and expand public involvement, and should develop new programs and materials to increase understanding of water resource management issues.

Substate Regions

These recommendations reflect findings of the substate water resources management studies. Full discussions of those findings can be found in the respective substate strategy documents. The two substate regions discussed in this document are the most significant in terms of changes and improvements which affect overall water resources management in New York State.

A. Delaware-Lower Hudson Region

1. New York City Water Supply Deficit

New York City should eliminate present and projected water supply deficits through an integrated program to reduce demand, supplement supply, and plan for droughts and emergencies to include:

- A long-term water conservation program requiring metering, water conserving plumbing fixtures, and leakage control.
- A detailed water demand study.
- Evaluation of potential sources for additional supply.

New York City should:

- Continue preliminary engineering planning for the possible development of Chelsea and alternative sites to determine the maximum potential capacity of the facilities acting as a supplemental supply and utilizing existing aqueducts. The planning should include provision for filtration of all water drawn from the Hudson. As soon as possible, a maximum practical pumping/treatment rate should be established taking into account site constraints, connections to and capacities of the existing City aqueducts, etc. Based on feasibility studies to date, it is expected that the maximum rate will be between 200 and 300 mgd.
- Due to the present uncertainty of actual and projected water deficits for the New York City system, short-term and long-term planning which addresses the development of supplemental supplies is prudent and should be continued. This planning activity should look at supply alternatives, demand management, water conservation, hydrologic, and ecological impacts, the high flow skimming project and groundwater development in order to provide a thorough cost-benefit analysis of all viable supply options.

The state should remain an active participant in New York City's water management planning program, and should:

- Support New York City efforts to develop and implement comprehensive water conservation and metering programs.

- Continue the joint effort with New York City and other regional interests to complete the detailed water demand study.

- Continue to participate in the evaluation of impacts of the water conservation and metering programs.

- Assist New York City in developing contingency plans for major droughts that may occur during the interim period before other actions to reduce the deficit are completed.

- Participate on the Mayor's Intergovernmental Task Force to evaluate alternatives for long-term water supply.

2. Regional Institutional Framework

The state and regional utilities should explore alternative regional institutional frameworks for long-term water supply management within the Delaware-Lower Hudson Region, in cooperation with local interests, and develop a mutually acceptable framework to be established in the region.

B. Long Island Region

To meet the special needs of Long Island (including Nassau, Suffolk, Kings and Queens counties), the state, with appropriate assistance from federal and local agencies, should:

- Maintain a comprehensive ground and surface water monitoring system, an island-wide hydrologic data base and an integrated data management system.

- Develop specific criteria for determining quantity aspects of the Region's water resource; identify present and future quantity shortfall areas; and require appropriate local agencies to develop specific plans to decrease consumptive water use in affected areas.

- Continue to enforce pumpage limitations and requirements for water conservation, where applicable, with adjustments as conditions and new information warrant.

- Continue to require water conservation plans from all Nassau County water suppliers and as part of all Long Island Well Permit Applications.

- Make additional investigations of the Lloyd and Magothy Aquifers in Nassau County.

- Coordinate state, regional and local groundwater management activities through annual meetings and program audits.

- Implement site-as-a-system management in select areas.

Nassau County should:

- Update and finalize the draft Master Water Plan for Nassau County to provide a clear framework for county water resource management activities.

- Conduct more detailed studies, including studies of environmental impacts, for development of an intra-county transmission system.

Suffolk County should:

- Implement recommendations of the Suffolk County Water Resources Management Plan.

- Via the Suffolk County Water Authority, efforts should continue to extend service into areas presently not served, particularly areas experiencing contamination of private wells.

New York City should prepare a Brooklyn/Queens Water Resource Management Plan, based on work already performed as part of the Section 205(j) Study.

Local governments and water suppliers should implement additional water conservation measures in areas where supply is a major concern, including all of Nassau County and the insular areas of Suffolk County.

The Long Island Groundwater Management Program is incorporated into this Strategy, and all pertinent agencies and interested parties should continue to implement its recommendations.

The Long Island Coordinating Council should meet on a regular basis.

C. Major Inter-Region Water Management

1. Conjunctive Management

New York State, New York City and appropriate federal agencies should investigate in detail all aspects of conjunctive management of New York City water supplies and Long Island groundwater and develop a definitive recommendation on the feasibility of this option for long range inter-region water management.

D. Upstate Groundwater Management

The Upstate Groundwater Management Program has been incorporated into the statewide water resources management strategy. The following recommendations are summary of some of the recommendations in the Upstate Groundwater Management Program report, December 1987.

The state should:

- Maintain existing groundwater classification and standards to support the policy objective that all fresh groundwater in the state will be preserved for the best usage as potable water.

- Establish sound and defensible standards for both drinking water and ambient water quality and reconcile any inconsistencies that may exist.

- Use the following order of priority for state actions affecting groundwater: wellhead, primary aquifer, including sole source aquifer, principal aquifer, other areas.

- Require all upstate public water supplies using more than 100,000 gallons per day from groundwater to define the wellhead areas of their supply wells.

- Evaluate the scope of rural drinking water problems and alternatives for state action.

- Conduct adequate monitoring programs for primary and principal aquifers and for public water supplies.

- Maintain the groundwater problem inventory.

- Maintain the Public Water Supply Well Closure List.

- Amend the Incompatible Uses Law to add upstate primary aquifers and implement the law.

- Encourage local governments to develop critical area protection programs for primary and principal aquifers and develop a technical guidance manual on local land use controls.

- Aggressively pursue watershed rules and regulations for public water supply wellhead areas.

- Maintain an adequate, balanced groundwater contamination response capability.

All agencies and interests should continue to implement recommendations of the Upstate Groundwater Management Program.

Chapter 1. Introduction

Legislation

Preparation of a water resources management strategy is mandated by the Water Resources Management Strategy Act (Article 15, Title 29, New York State Environmental Conservation Law) of 1984. The law directs the state Department of Environmental Conservation (DEC), with participation of the state Department of Health (DOH) and regional planning and development boards, to precede the strategy with a statewide inventory of significant deficiencies in water systems and an assessment of local funding capabilities.

The law stipulates that the statewide strategy shall be composed of substate water resources management strategies which "recognize the natural boundaries of the water resources basins, watersheds, and aquifers and existing significant deficiencies of water supply." Thirteen substate regions were established for planning purposes (Figure 1). All the strategies address present water supply problems and future water supply needs with the goal of "(meeting) the water resources requirements of residential, agricultural, industrial and commercial users of these resources."

The law further provides for establishment of a 15-member Water Resources Planning Council within DEC. The council is required to receive the substate and statewide water resources management strategies from DEC, hold public hearings in each substate region and determine whether the strategy shall be "approved with modifications or disapproved." The approved strategies must be adopted by DEC and DOH and other appropriate state agencies in a form determined by the council. Finally, at least once every two years, the strategy must be reviewed and, if necessary, amended.

Objectives

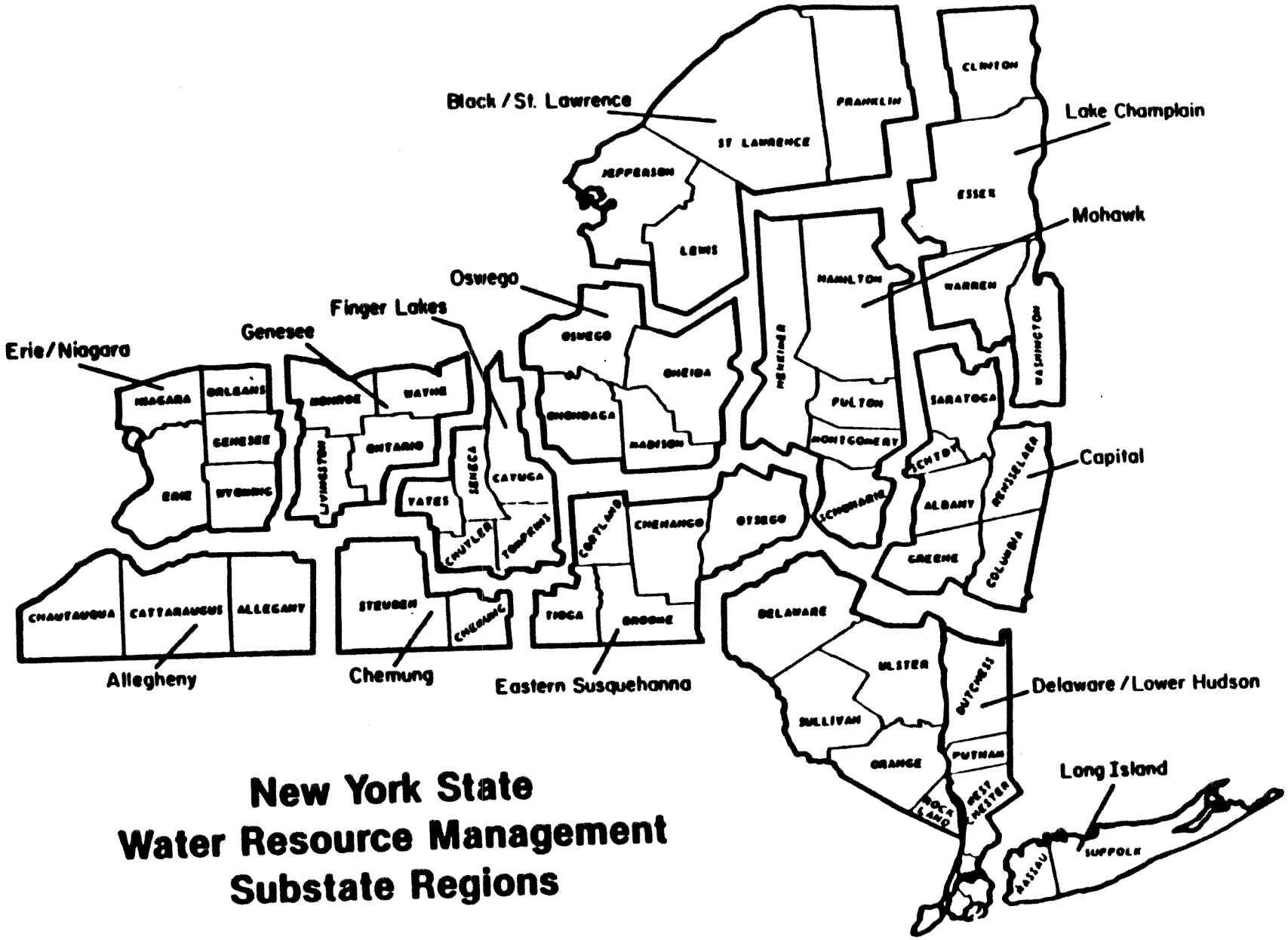
The broad overall objective of the state water resources management strategy is to meet the water resources requirements of residential, agricultural, industrial and commercial users and to assure the highest possible quality and quantity of New York State's water resources. Within this broad framework the strategy is designed to meet a number of other major criteria. These include:

- Providing quantities of water necessary for the requirements of residential, agricultural, industrial, institutional and commercial users while protecting environmental quality.

- Ensuring the delivery of a safe and aesthetically pleasing supply of drinking water to all residents of New York State and providing water of acceptable quality for agricultural, industrial, institutional and commercial uses while protecting environmental quality.

- Improving overall management of water supply systems to help ensure the optimum use of the water resources of the state.

- Encouraging the improvement, restoration and enhancement of water development and delivery from source to user.



New York State
Water Resource Management
Substate Regions

New York State
Department of Environmental Conservation

Figure I-1

- Fostering the development of means for research, data-gathering and management to facilitate informed decision-making.

- Ensuring and expediting adoption by appropriate state agencies, biennial review and implementation.

Procedure

DEC and DOH began preparation of the state water resources management strategy in 1985, and a draft was completed in 1987. The draft was based on information from the substate studies and strategies that had been completed or were in progress at the time and on other available studies and reports.

Common features of the substate studies and strategies were incorporated into the statewide strategy, which also addressed other water resources management issues of statewide concern that were not considered in the substate studies. Together, the state and substate strategies were conceived as a comprehensive set of actions recommended to meet statewide water resources management needs and to address regional and local system-specific problems and conditions.

Concurrent with preparation of the draft strategy, the Water Resources Planning Council considered criteria for the state and substate strategies and finalized the criteria in January 1987. The draft strategy could not satisfy all the criteria because of data gaps and other lack of information, and it was recognized that additional studies would be needed during the strategy updating process.

The Water Resources Planning Council requested DEC to hold public hearings on the draft state strategy and substate strategies to receive comments. One or more hearings were held in each of the 13 substate regions from July 1987 through April 1988. Many comments were received and have been taken into account in revising the draft.

The Water Resources Planning Council also undertook a detailed review and discussion of the draft state strategy by sections and the views of the Council members are reflected by numerous revisions in the draft.

Additional assistance in the state and substate strategies has been received from regional planning and development boards, local health departments and other local agencies, consultants, and water suppliers.

Chapter II. Water Resources Availability and Uses -- Concepts and Terminology

A. Available Water Resources

Water is a renewable resource that constantly circulates between the oceans, atmosphere and land in a natural process called the hydrologic cycle. Water evaporates into the atmosphere from the oceans and land and then condenses and falls back as rain or snow. Part of the precipitation flows over the land surface to streams and lakes and to the ocean. Another part enters the soil and is transpired by plants or becomes part of the groundwater system.

New York is rich in water throughout the hydrologic cycle, where it occurs as precipitation, surface water and groundwater . However, the state's water resources are not uniformly distributed, either temporally or geographically. Consequently, there are significant variations in available water supplies which in turn greatly affect water management and use. These variations are detailed in the following sections.

1. Climate and Precipitation

The climate of New York is humid-continental. Additional tempering influences of the Atlantic Ocean occur on Long Island and in southeastern New York, and of Lakes Erie and Ontario on their adjoining areas.

Under normal conditions, New York receives average annual precipitation of 40 inches with a range from about 30 inches along the western Lake Ontario shore and in the Lake Champlain valley to about 52 inches in the southern Catskills and southwestern Adirondack Mountains. The areal distribution of precipitation generally conforms to relief patterns and storm tracks across the state. Precipitation is fairly evenly distributed on a seasonal basis. The least amounts generally occur in January and February and the highest amounts may occur in several other months depending upon location. Statewide droughts are comparatively rare; the most extended and severe droughts have occurred in southeastern New York.

The state's average annual precipitation is equivalent to 91 billion gallons of water per day, or about 5,000 gallons per capita per day. Slightly less than half (43 billion gallons per day) is lost to the atmosphere through evapotranspiration. About a third (27-31 billion gallons per day) runs off into surface waters, and the remainder (14-18 billion gallons per day) seeps into and recharges groundwater resources.

2. Surface Water Resources

Surface water occurs in the many miles of rivers and streams and the large number of lakes, ponds and reservoirs in the state. These include:

- 70,000 miles of rivers and streams.
- 242 miles of rivers bordering other states and Canada.
- 3,100 miles of coastline.
- 7,500 lakes and ponds with at least 5,300 square miles of surface area.
- 1,477 square miles of marshes and wetlands.
- 22,164 billion gallons, or 68 million acre feet, of surface waters.
- 324 reservoirs.
- 4,074 billion gallons, or 12.5 million acre feet, of reservoir storage capacity.

About 10 percent of the state area is covered by surface water. Major rivers include the St. Lawrence, Hudson, Susquehanna, Oswego, Mohawk, Delaware, Black, Genesee and Allegheny. The largest interior lakes are Lake George, Chautauqua Lake, Oneida Lake and the major Finger Lakes: Canandaigua, Keuka, Skaneateles, Seneca and Cayuga. Freshwater supplies in the two Great Lakes, Erie and Ontario, and Lake Champlain are shared with other states and Canada. The Barge Canal system is a unique combination of streams, lakes and reservoirs tying together about 40 percent of the drainage area of the state.

Average annual runoff ranges from about 13 to 30 inches per year (Figure II-1). Almost half the annual runoff occurs during the three-month period from mid-February through mid-May. Water supply reservoirs depend on this spring runoff to sustain withdrawals during the summer and fall. Most of the time from July to the end of the growing season in October, streamflow is derived from groundwater.

Although there are large quantities of surface water stored in ponds, lakes and reservoirs and occurring in streams as runoff, only a portion of the total resource is available for water supply purposes. Utilization is limited by lack of reservoir storage capacity and withdrawal facilities, competing uses and other factors. The extent to which such limitations apply and specifically how much surface water is available for development and use are difficult to determine. Nevertheless, credible estimates of surface water availability are needed so that comparisons can be made with present and projected demands to identify resource problems and opportunities.

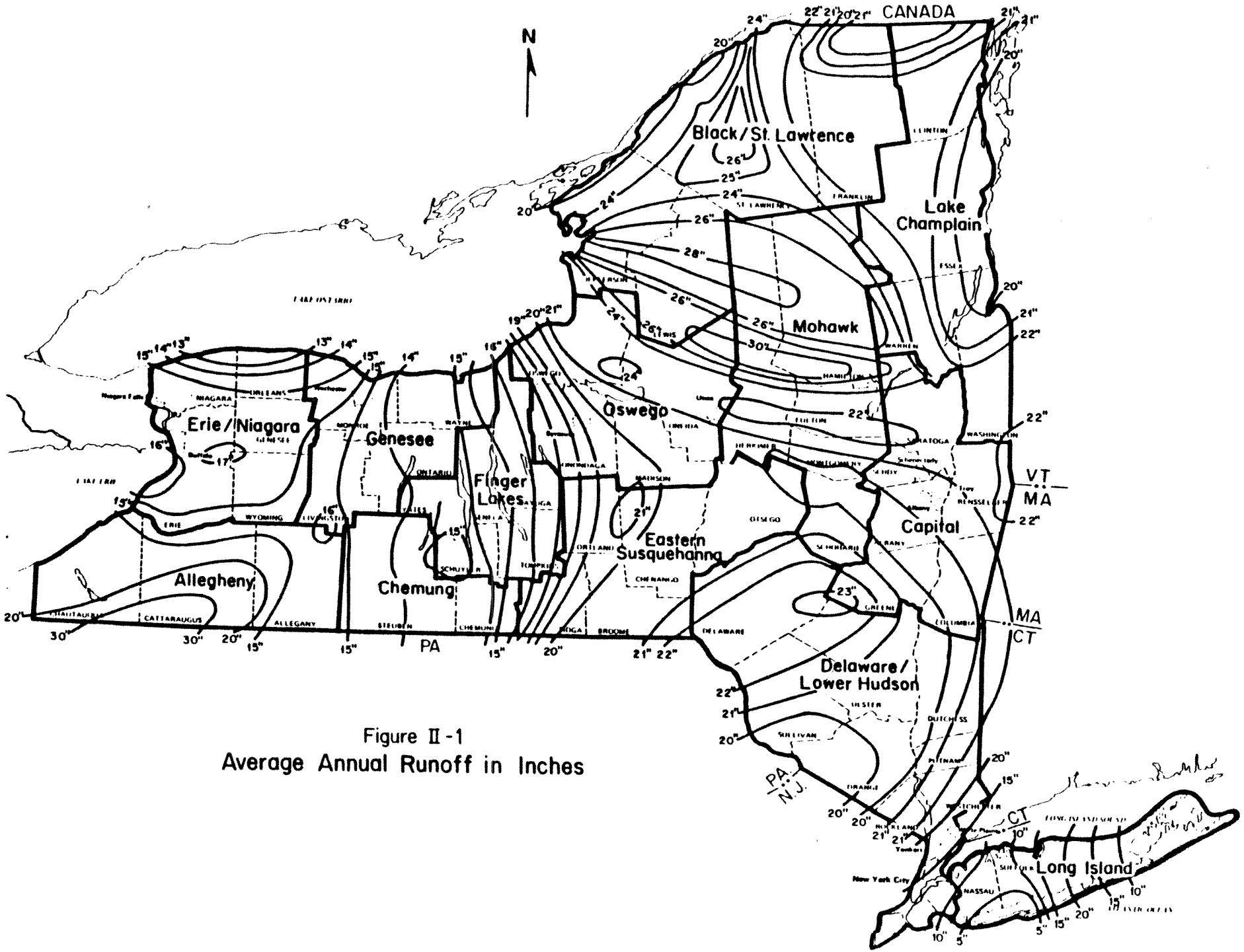


Figure II-1
Average Annual Runoff in Inches

Three streamflow characteristics are of particular importance for estimating available supplies. These are the lowest daily flow of record; the 7-day, 10-year low flow and the average discharge. The lowest daily flow of record is the lowest mean discharge in one day during the period of record. The 7-day, 10-year low flow is the lowest mean discharge during 7 consecutive days of a year occurring, on the average, once every 10 years. The 7-day, 10-year low flow varies from 0.03 to 7.0 inches (Figure II-2). The average discharge is the arithmetic average of annual average discharges for the period of record or analysis.

The lowest daily flow of record is used to define the dependable yield of the stream and should take into account existing uses. The 7-day, 10-year low flow is used as the criteria for wastewater treatment and represents the minimum flow required to meet instream flow needs for water quality. Additional flow is required in most streams for fish and wildlife and for recreation. The difference between the latter flow and average discharge is the portion of stream flow potentially available for water supply development. Runoff characteristics for all the substate regions are shown in Table II-1. The highest runoff occurs in the Black/St. Lawrence, Delaware/Lower Hudson, and Mohawk substate regions.

Water supply storage in the Great Lakes, Erie and Ontario, and Lake Champlain is virtually unlimited in terms of potential uses in New York. Other lakes and reservoirs, except those built specifically for water supply, may have drawdown constraints that limit use of the available storage. Useable storage and dependable yields must be determined on a case-by-case basis.

Surface resources provide drinking water to more than 10 million New York residents through public water supply systems. In addition, numerous industrial, commercial and agricultural operations are dependent upon surface waters.

3. Groundwater Resources

Groundwater is the water lying below the earth's surface in a saturated zone where all the interconnected openings between soil and rock particles are filled with water. The top of the saturated zone is called the water table and is usually located near the land surface. The saturated zone may extend downward to depths ranging from a few feet to several thousand feet, depending on underlying geologic formations. Land surface areas through which groundwater enters the earth are called recharge areas.

Groundwater moves very slowly through a complex network of spaces between grains of sand and silt, between particles of clay and along fractures in bedrock. It may appear in springs, discharge into surface streams, wetlands or the ocean, and it may be pumped from wells. Not all groundwater can be drawn readily into wells. The capacity of the soil to hold water (porosity) and to allow water movement (permeability) are the main characteristics which determine whether a geologic formation can supply adequate quantities of water. An aquifer is a formation that can supply water in significant amounts.

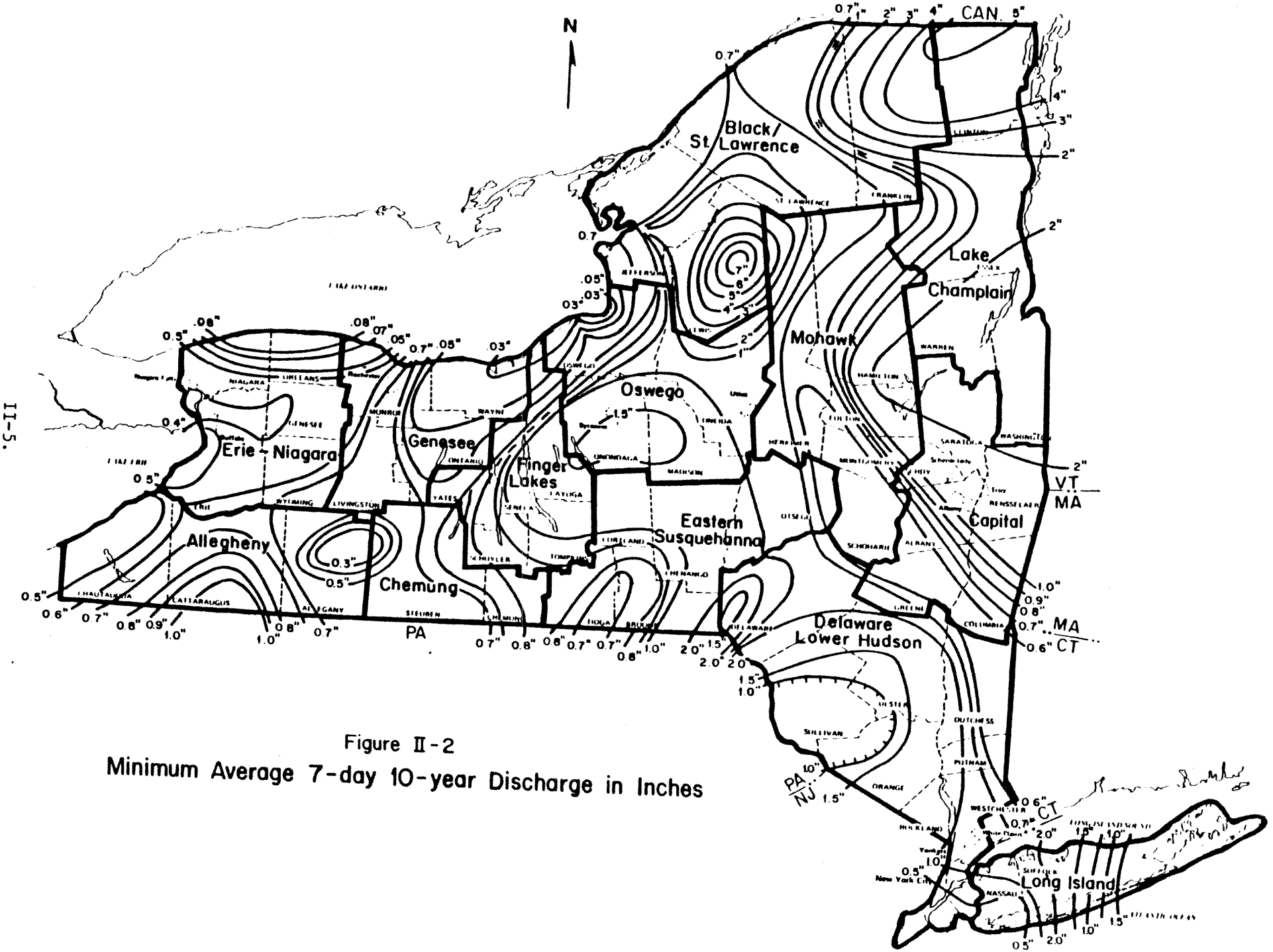


Figure II-2

Minimum Average 7-day 10-year Discharge in Inches

Table II-1. Runoff Characteristics for Substate Regions

Substate Region	Area SM	Annual Runoff CFS	Annual Runoff CFS/SM	7 Day, 10-Year Low Flow CFS	7 Day, 10-Year Low Flow CFS/SM
Allegheny	3,402	5,028	1.48	119	0.04
Black/St.Lawrence	6,926	11,694	1.69	1,000	0.14
Capital	3,481	4,660	1.34	126	0.04
Chemung	1,807	1,771	0.98	93	0.05
Delaware/Lower Hudson[1]	6,321	10,431	1.65	460	0.73
Eastern Susquehanna	3,631	5,664	1.56	214	0.06
Erie/Niagara	3,053	3,366	1.10	70	0.02
Finger Lakes	2,167	1,987	0.92	148	0.07
Genesee	2,545	2,375	0.93	21	0.01
Lake Champlain	4,567	7,183	1.57	747	0.16
Long Island	1,198	1,220	1.02	113	0.09
Mohawk	4,662	8,982	1.93	386	0.08
Oswego	3,613	5,524	1.53	141	0.04
Total	47,373	69,885	1.48	3,638	0.08
		(45,146 MCD)		(2,350 MCD)	

Abbreviations

SM = Square Miles
CFS = Cubic Feet Per Second
MCD = Million Gallons Per Day

1 Including New York City (300 SM).

New York State soils vary greatly in their ability to hold and transmit water. Shale, limestone, sandstone or crystalline bedrock underlie the land surface and are covered by layers of soil varying widely in thickness. The bedrock generally has few open spaces and offers limited opportunity for water storage and movement. Clay soils can hold significant amounts of water because they have high porosity, but the water has difficulty getting out because of the low permeability. Glacial till, an unsorted mixture of soil and rock fragments, is common in upstate New York. Openings in the till for holding and transmitting water are limited.

Coarse sand and gravels are the best aquifer materials because of the large pore openings. The vast aquifer system underlying Long Island is the most important groundwater resource of this type in New York. Valley sand and gravel deposits in upstate areas also have large quantities of groundwater. Primary water supply aquifers and principal aquifers which have the potential for high yields are shown in Figure II-3. Aquifer and well characteristics for different types of aquifers are shown in Table II-2. About 11 percent of the state is underlain by sand and gravel aquifers capable of yielding significant amounts of water.

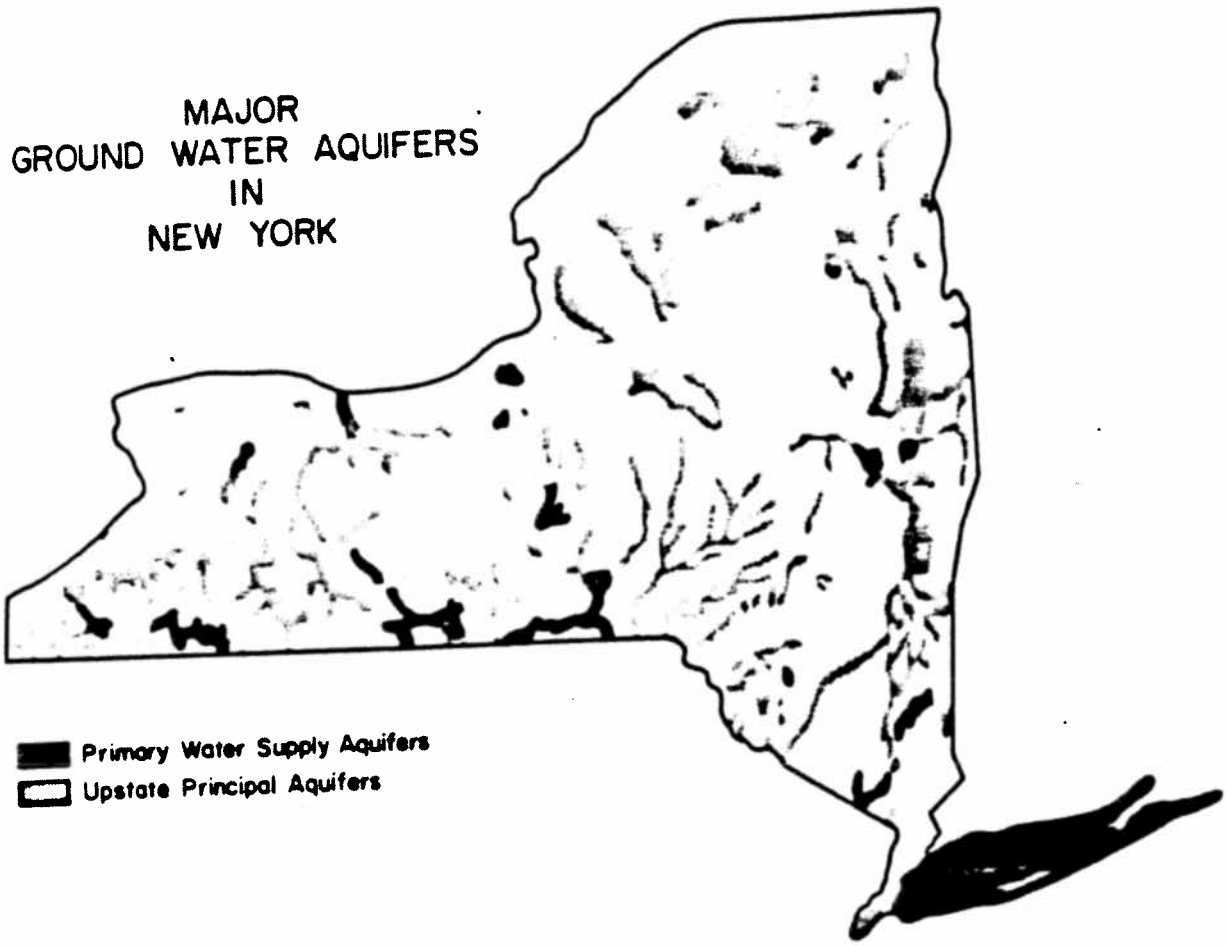
Eighteen upstate areas are designated as primary water supply aquifers and provide more than two-thirds of the groundwater used for community water supplies (Figure II-4). The other potentially high yielding, but less used, principal aquifers are considered important resources for the future.

More than 6 million New York residents obtain their drinking water from underground sources through public or individual systems. On Long Island alone, freshwater aquifers are the sole source of water supply for about 3 million people and for thousands of industrial, commercial and agricultural enterprises.

Although groundwater is present in large gross quantities, particularly in aquifers, only a portion can be developed for water supplies. Information is generally lacking on groundwater resource availability, except for certain aquifers and specific groundwater supplies. An estimate of the yield of primary and principal aquifers in the upstate area has been developed for the strategy (Table II-3). The total yield of the aquifers is estimated to be over 13 billion gallons per day; the highest yields are in the Black/St.Lawrence and Capital substate regions.

B. Water Use

Water is used and reused for many purposes. It is withdrawn or diverted from groundwater and surface water sources for public and individual supplies and for industrial, commercial, institutional and agricultural uses. Water use may also take place in streams, channels, lakes and reservoirs for purposes such as power generation, navigation, recreation, supplemental irrigation, water quality management, and fish and wildlife enhancement.



* Adapted from Heath Ground Water in New York, U.S. Geological Survey Bulletin GW-51, 1964.

Figure II-3

Table II-2

Aquifer and well characteristics in New York

[Ft = feet; gal/min = gallons per minute. Sources: Reports of the U.S. Geological Survey]

Aquifer name and description	Well characteristics			Remarks
	Depth (ft)	Yield (gal/min)		
	Common range	Common range	May exceed	
Upstate				
Stratified-drift-Lacustrine and ice-contact deposit aquifers: Sand and gravel. Unconfined.	10 - 300	10 - 50	100	In most areas, deposits consist entirely of sand. Excessive iron concentrations.
Valley-fill deposit aquifers: Sand and gravel. Generally confined.	3 - 200	100 - 1,000	3,000	Glacial outwash and alluvium interbedded with clay and silt in many valleys are most productive water-bearing material in New York. Locally excessive iron or manganese concentrations.
Carbonate-rock aquifers: Limestone, dolomite, and marble. Unconfined in most areas.	10 - 300	50 - 150	200	Carbonate rocks are most productive bedrock unit in State. Water from this unit usually hard and contains hydrogen sulfide gas in some areas. From Niagara Falls to vicinity of Syracuse and in St. Lawrence valley, deep wells yield slightly salty water and, in places, water with a sulfate concentration that may exceed 300 mg/L.
Sandstone aquifers: Includes both sandstone and conglomerate. Confined in most areas.	3 - 500	50 - 100	100	Sandstone is the second most productive bedrock unit in New York. Water commonly slightly hard and has excessive iron concentration locally.
Long Island				
Upper glacial aquifer (includes Jameco and Port Washington aquifers): Outwash deposits (mostly between and south of terminal moraines but also interlayered with till) consist of quartzose sand, fine to very coarse, and gravel, pebble to boulder sized. Unconfined.	50 - 500	50 - 1,000	1,500	Main source of drinking water in central and eastern Suffolk County. Contains high concentration of nitrates and organic compounds in western Long Island. Saline water problems in extreme eastern end of Long Island.
Magothy aquifer: Sand, fine to medium, clayey in part; interbedded with lenses and layers of coarse sand and sandy and solid clay. Gravel is common in basal 50 to 200 ft.	150 - 1,100	50 - 1,200	2,000	Supplies most of the ground water for public-supplied drinking water in Queens, Nassau, and western Suffolk Counties. Saline water in North and South Forks and near Jamaica Bay.
Lloyd aquifer: Sand, fine to coarse, and gravel, commonly with clayey matrix; some lenses and layers of solid and silty clay; locally contains thin lignite layers and iron concretions.	150 - 1,100	50 - 1,000	1,200	Main source of drinking water for northwest shore of Long Island barrier islands to south. Saline water in North and South Forks and extreme west end of barrier islands.

Source: National Water Summary 1984, Hydrologic Events, Selected Water Quality Trends and Ground-Water Resources, United States Geological Survey Water-Supply Paper 2275

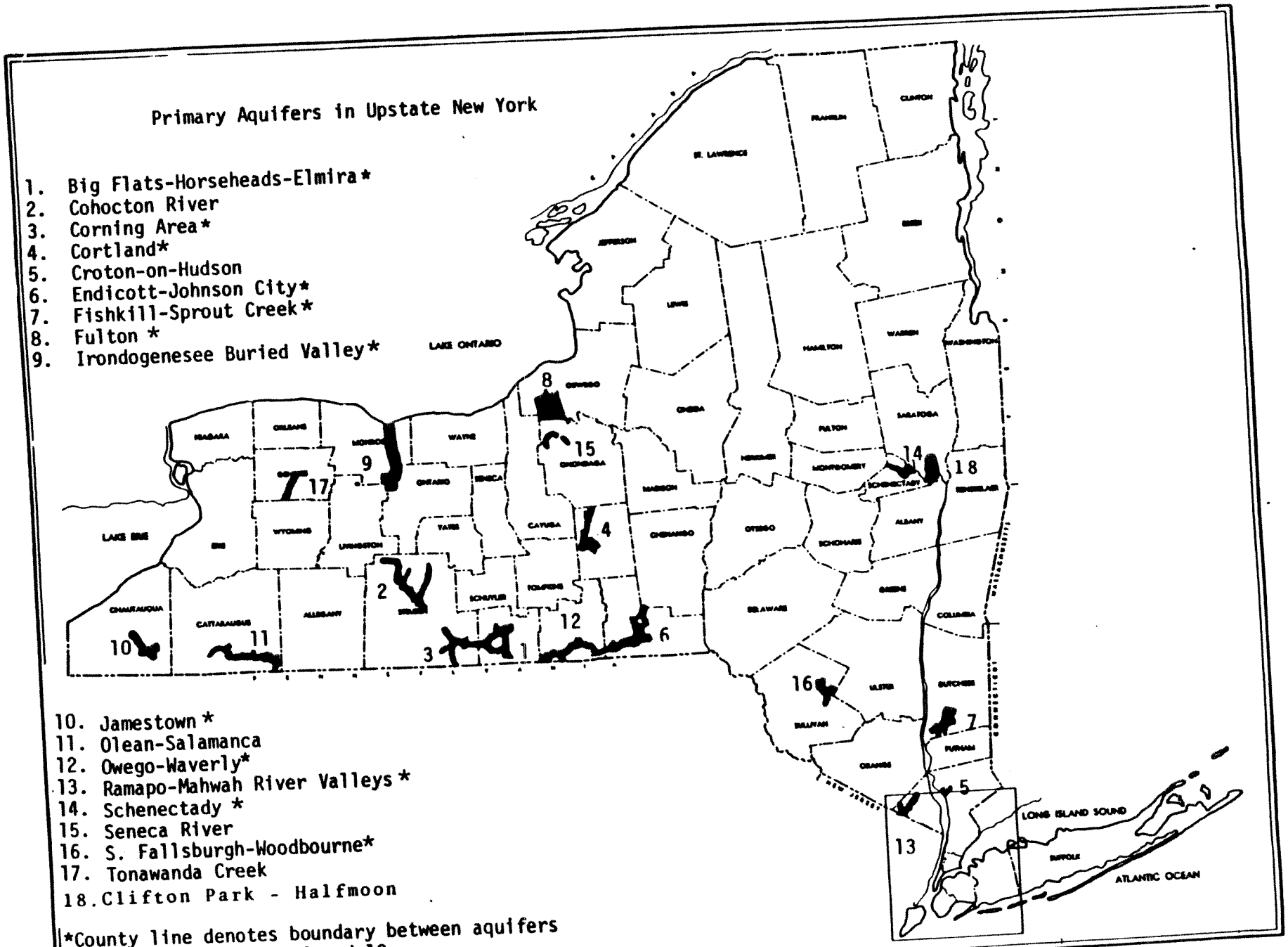

Primary Aquifers in Upstate New York
1. Big Flats-Horseheads-Elmira*
2. Cohocton River
3. Corning Area*
4. Cortland*
5. Croton-on-Hudson
6. Endicott-Johnson City*
7. Fishkill-Sprout Creek*
8. Fulton *
9. Irondogenesee Buried Valley*
10. Jamestown *
11. Olean-Salamanca
12. Owego-Waverly*
13. Ramapo-Mahwah River Valleys *
14. Schenectady *
15. Seneca River
16. S. Fallsburgh-Woodbourne*
17. Tonawanda Creek
18. Clifton Park - Halfmoon
*County line denotes boundary between aquifers 1 and 3 and aquifers 6 and 12.
LAKE ONTARIO
LAKE ERIE
LONG ISLAND SOUND
ATLANTIC OCEAN

Figure II-4

Table II-3. Yield of Primary and Principal Aquifers in Substate Regions, MGD

Substate Region	Primary Aquifers	Principal Aquifers	Total
Allegheny	512	792	1,304
Black/St. Lawrence	0	4,800	4,800
Capital	600	1,578	2,178
Chemung	470	330	800
Delaware/Lower Hudson	411	809	1,220
Eastern Susquehanna	588	666	1,254
Erie/Niagara	80	55	135
Finger Lakes	0	144	144
Genesee	108	176	284
Lake Champlain	0	490	490
Long Island	646[1]	0	646
Mohawk	0	106	106
Oswego	40	174	214
Total	3,455	10,120	13,575

[1] Dependable yield estimates for Nassau and Suffolk Counties from Long Island Groundwater Management Program

1. Public Water Supply

Public water supply refers to water withdrawn by public and investor-owned water suppliers and delivered to a variety of users for domestic or household use, public, industrial, institutional, and commercial use. Domestic use includes such activities as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Public use includes such activities as firefighting, street washing, and municipal parks and swimming pools. Many industrial and commercial establishments use public supplies, especially when the volume of water required is small and the quality of water must be high. Among commercial users are hotels, restaurants, laundry services, offices and institutions.

Public water supply is generally provided by a municipal water system, which is a public or investor-owned utility operated by a municipality, water district or authority, or by a private corporation, supplying water year-round. There are 1,799 municipal and investor-owned public water supply systems serving almost 16 million people in the state, or 87.7% of the population. The remaining 12.3% have individual supplies (Table II-4). About two-thirds of the municipal water supply is from surface water and one-third from groundwater (Table II-5).

Present water use data for municipal water systems were collected on a substate basis through surveys and inventories of all large water supply systems (over 5,000 people) and selected smaller systems. Future water requirements to the year 2000 were determined by using population projections and daily per capita water use estimates. Maximum day demands were calculated from the average day demands using peak flow to average flow ratios.

Total municipal water supply demands in the state were 3.9 billion gallons per day in 1985. More than 16 million people, or about 90 percent of the state's 1980 population, are served by 3,317 community water supplies, including nearly 1,800 municipal water systems. Water systems serving 5,000 people or more constitute more than 94 percent of the total municipal water demand in the state. However, systems under 5,000 constitute over 92 percent of the total number of public water systems.

2. Domestic Self-Supplied

Domestic self-supplied water use includes individual supplies for drinking water and a variety of household uses. Present and projected uses in this category were estimated on a substate basis by assuming that the number of people with self-supplied domestic water is represented by the difference between the population served by municipal water supply systems and the total population. It is also assumed that 60 gallons per capita per day is the average water use for domestic self-supplied.

TABLE II-4
NEW YORK STATE
MUNICIPAL AND INVESTOR OWNED PUBLIC WATER SUPPLY SYSTEMS

POPULATION RANGE	NO. OF SYSTEM	TOTAL POPULATION SERVED	% SERVED
Over 1,000,000	1	6,728,200	37.0
75,000-1,000,000	18	4,379,213	24.1
5,000-75,000	213	3,787,862	20.9
Under 5,000			
Surveyed	135	305,450	1.7
Not Surveyed	1,432	730,937	4.0
Sub Total	1,799	15,931,662	87.7
Individual Supply		1,822,338	12.3
State Total		17,754,000	100.0

TABLE II-5
SOURCES OF MUNICIPAL WATER SUPPLY

REGION	POPULATION IN MILLION	SOURCE OF SUPPLY	
		SURFACE WATER PERCENT	GROUNDWATER PERCENT
Upstate Counties	6.7	80	20
New York City	6.7	96	4
Long Island	2.4	1	99
Individual Wells	1.8	0	100
Total	17.6	67	33

About 2.3 million people statewide rely upon their own sources of supply for drinking water and other domestic uses. Virtually all individual supplies depend upon groundwater. The individually supplied population of Long Island and upstate are about 300,000 and 2,000,000, respectively. Approximately 138 million gallons per day (mgd) are used for individual supplies.

3. Large Self-Supplied Industrial, Commercial and Institutional

Many industries, commercial establishments and institutions require large amounts of water and have developed their own supplies. They may also use a public supply for principal or auxiliary water. Self-supplied water-using industries that ordinarily use large quantities include steel, chemical and allied products, paper and allied products, mining and petroleum refining.

There is little precise data available on industrial usage statewide or regionally for self-supplied firms. Neither is there quantitative information on water resource availability compiled to promote industrial water use. Industrial surveys have indicated that heavy emphasis is placed on water availability for site location decisions with this being the prime factor in 20 percent of cases.

Various prior studies and methods of obtaining data and making reliable estimates of self-supplied industrial use were considered in the substate strategy process. It was concluded that a thorough survey of each industrial facility is necessary for the best estimates. Since this was not possible within existing time and resource constraints, a more limited questionnaire-type survey was undertaken. Industrial facilities identified from various sources as possibly using large quantities of water (more than 20,000 gallons per day) were surveyed. The survey data and other available information were utilized to estimate present and projected industrial self-supplied use. Based on the above procedure and limited additional information, it was determined that about 2.2 billion gallons per day are withdrawn by self-supplied industries.

In some substate regions, water used by large self-supplied institutions was also estimated, based on available information. Commercial self-supplied use is believed to be insignificant.

4. Agricultural

Agricultural water use includes water used for irrigation of food crops and for livestock.

Agricultural irrigation in a humid state like New York is used to offset seasonally periodic rainfall deficiencies to sustain the yield of crops and reduce the risk of crop failures during drought periods. Generally, irrigation is used by producers of high value crops like vegetables and fruits to assure relatively consistent yields. Intermittent sprinkler irrigation is the most common method of supplemental irrigation in New York.

Data on irrigation water use are extremely limited and estimates are difficult to make because of the intermittent nature and the variable extent of areas irrigated from year to year. For the strategy, an estimating procedure was developed based on an historic relationship between growing season rainfall and irrigated acreage and rainwater available for irrigation.

According to the state Department of Agriculture and Markets, about 51,300 acres were irrigated in 1982 in the state. Water use for irrigation in 1982 was estimated to range from 7,300 million gallons to 11,000 million gallons. About 1,680 farms have some acreage which is irrigated. The trend in the past few years has been toward stabilization of the number of farms with irrigated acreage after an increase in the mid-70s. The largest irrigation water use is in the Long Island region.

Livestock water use includes direct consumption, as well as farm-cleaning activities and harvesting of livestock products. Since livestock water use is mostly by cattle and calves, estimates were made based on 1982 census data and a daily use rate of 20 gallons per livestock unit. On a statewide basis, livestock water use amounts to 35.6 mgd.

5. Other

Quantitive estimates of water use for other purposes, such as power generation, navigation and recreation, are beyond the scope of the strategy at this time and were not developed in the substate region studies. The following information is intended to give a general perspective. Implications of other water uses also may be inherent to some extent in the yield estimates for particular systems surveyed.

a. Power Generation

Water is used for power generation in thermoelectric power plants and hydroelectric plants.

Thermoelectric power plants can be powered by fossil fuel such as coal and oil, or by nuclear energy. Large quantities of water are withdrawn from both fresh and saline surface water sources in New York for thermoelectric power. Statewide withdrawals for this purpose were estimated by the United States Geological Survey (USGS) to be 12,000 mgd in 1980. Almost all the water is used on a "once through" basis for condenser and reactor cooling of generators.

Much larger quantities of water are used for hydroelectric power generation in New York. The USGS estimated that this use amounted to 310,000 mgd in 1980. Most plants are run-of-river. Only a very small quantity of water is lost through evaporation and quality is not affected usually.

b. Navigation

New York has over 525 miles of waterways within the state and hundreds of additional miles of border waters that are used for navigation.

The Barge Canal system links major watersheds across the state from Buffalo to Albany and Plattsburgh. Over 40 temporary and permanent dams have been constructed for pool maintenance purposes, and additional reservoirs are available for feeder supplies. Portions of the system are used for public water supply and industrial and agricultural supplies as noted in the substate strategies.

c. Habitat Uses

Fish and wildlife resources are owned by the state and are held in public trust for the use and enjoyment by the people. These organisms are legitimate users of the state's water resources, and many species are wholly dependent upon having adequate water of suitable quality for their survival and propagation.

Nearly all the surface waters of the state are classified according to best usage, and this water use as habitat is recognized in those classifications. All classified surface waters of the state at a minimum have "fish survival" as a designated usage, and perennial surface waters have both fish propagation and fish survival as designated uses.

Where these designated habitat uses are supported, minimum standards of quality and quantity must be maintained to prevent degradation and maintain attained uses. In those areas where the designated habitat use is impaired, improvement in water quality and quantity will be sought to end this use impairment, in conformance with the policies of the Water Resources Law and the federal Clean Water Act.

d. Recreation

New York has over 4,000 lakes, ponds and reservoirs that provide water-based recreational opportunities. In addition, there are thousands of miles of streams that provide recreational benefits. Water use for recreation is of major importance and is a significant factor in relation to water supply withdrawals.

C. Balance Between Supply and Demand

1. Statewide

The water supply-demand balance in the state is good, except in southeastern New York and localized upstate areas. With these exceptions, the state has adequate surface and groundwater resources to meet present and projected water supply needs to the year 2000 and beyond. Available resources also appear more than sufficient to meet needs to the year 2030. A number of water supply systems currently have excess capacity.

A preliminary comparison of available water resources with major categories of withdrawal use indicates that all the substate regions, except Erie-Niagara, have surplus water that is not being utilized (Table II-6). However, the Erie-Niagara region has access to Lake Erie, Lake Ontario and the Niagara River which are not included in the comparison.

Available resources could be developed to meet additional water supply needs and to stimulate economic growth. System evaluations in the substate studies indicate more specifically where surpluses or shortages exist and identify the potentials for new source development, interconnections, water conservation and other means for balancing supply with demand.

2. New York City Water Supply

The New York City water supply system experienced serious shortages in the 1960s record drought and more recently in the 1980-1981 and 1985 droughts. Water use restrictions were necessary to conserve the supply. Normal demand on the city system now exceeds dependable yield, based on the 1960's drought, by about 300 million gallons per day (mgd). Depending upon the projection of future water demand, recent deficit estimates to the year 2030 have ranged from 400 to 1200 mgd. Based on the Delaware/Lower Hudson Region study, the deficit for the city system is expected to be in the range of 300-800 mgd before the year 2030, even with conservation, but a more detailed study is under way to determine the water demands.

3. Long Island Groundwater

The vast aquifer which underlies Long Island, including all of Nassau and Suffolk Counties and parts of the Boroughs of Brooklyn and Queens in New York City, is the largest and most important groundwater resource in New York State. It is the only source of drinking water for more than 3 million people.

High demands on the aquifer have resulted in overpumping, stressing the system even though it contains large quantities of water. The aquifer also is particularly vulnerable to pollution from the overlying development and associated sources of contamination. Studies and programs to address the critical water resources management problems on Long Island have been underway for many years. Increased concern about the magnitude and complexity of the problems, particularly the threat of toxic pollution of the groundwater, led to a review of these programs and the resource management needs on Long Island in the early 1980's. This analysis resulted in preparation of the Long Island Groundwater Management Program in 1986. The program is a comprehensive set of recommended actions needed for effective management and protection of the aquifer system. They involve a large number of federal, state, and local agencies within an integrated overall framework.

4. Other Considerations

It should be noted that determinations of supply and demand and decisions on the need to increase supply or reduce demand by various means involve assumptions and judgments on a number of factors that cannot be determined precisely with available information.

Table II-6. Preliminary Estimate of Fresh Water Availability and Use by Regions, MGD

Substate Region	Gross Resource: Average[1] Annual Runoff	Gross Resource: Groundwater[2] Yield	Gross Resource: Total	Waste[3] Assimilation	Minimum Fish and Wildlife[4] and Other Environmental	Water[5] Demands	Total[6]	Net Resource Available
Allegheny	3,248	1,304	4,552	77	1,701	64	1,842	2,710
Black/St. Lawrence	7,555	4,800	12,355	646	3,463	91	4,200	8,155
Capital	3,011	2,178	5,189	81	1,740	305	2,126	3,063
Chemung	1,144	800	1,944	60	904	51	1,015	929
Delaware/Lower Hudson	6,734	1,220	7,954	296	3,020	1,918	5,234	2,720
Eastern Susquehanna	3,659	1,254	4,913	138	1,816	73	2,027	2,886
Erie/Niagara	2,175	135	2,310	45	1,526	1,671	3,242	(-932)
Finger Lakes	1,284	144	1,428	96	1,084	59	1,239	189
Genesee	1,535	284	1,819	14	1,272	171	1,457	362
Lake Champlain	4,641	490	5,131	484	2,284	111	2,879	2,252
Long Island	788	6467	1,434	73	599	433	1,105	329
Mohawk	5,803	106	5,909	249	2,331	38	2,618	3,291
Oswego	3,569	214	3,783	91	1,806	267	2,164	1,619
Total	45,146	13,575	58,721	2,350	23,546	5,252	31,148	27,573

1 DEC estimate
2 DEC estimate for primary and principal aquifers.
3 7-day, 10-year low flow.
4 Gross estimate of 0.50 cfs/sm.
5 From Table III-4.
6 Does not take into account other uses for navigation, hydroelectric power generation and recreation.

a. Demand Projections

Projections of demand for public water supply systems can vary considerably based on differences or changes in population, economic growth and per capita water use. In the 1960s and early 1970s most water supply planning studies were based on highly optimistic projections of population growth and per capita use, resulting in gross over-estimates of long range water demands in the state. In some cases, high, medium and low ranges or projections were made in an effort to deal with this problem. Projecting water demands is most critical in the Delaware-Lower Hudson and Long Island substate regions. An intensive study is under way at present to develop a long-range projection of water demand for the New York City water supply system. Although it is recognized that other factors may affect water-demand projections, a uniform procedure based on population and per capita use was adopted for the strategy process. This method should be reasonably reliable for the time period to the year 2000. System studies are required for more detailed consideration of demand projections.

b. Water Conservation Effectiveness

Another factor affecting water demand projections is the influence of long-term water conservation measures. The effectiveness of water conservation was evaluated in the substate studies on a county basis using an available methodology. Determinations were made of the effectiveness of conservation programs that include such measures as leak detection and repair, conservation ordinances, public education, distribution of low-flow shower heads, toilet displacement devices, and commercial and industrial reuse and recycling. The results provide some guidance, but actual reductions in water demand that may be achieved vary from system to system and must be evaluated with site-specific data. Since the supply-demand balance is not critical in most of the state, the demand projections in the strategy do not include an allowance for effects of water conservation. Where there are supply-demand balance problems, such an allowance should be made.

c. Water Supply Yields

On the supply side there are similar uncertainties regarding water supply yields on a system basis. Definitions and interpretations of yield vary, even among professionals, and may be described by such terms as safe, dependable or reliable, each subject to specified conditions. The lack of a standard definition makes difficult the evaluation and comparison of system capabilities. In addition, many systems have no yield determinations by any definition that reflect the adequacy of supply. In the strategy process, common definitions of dependable yield were used for reservoirs and lakes, rivers and streams, wells and springs.

d. Drought Frequency and Acceptable Risk

Closely related to yield and adequacy of supply are questions of drought frequency and acceptable risk of water shortages. The frequency and severity of shortages that can be accepted in a water supply system are issues that have not been addressed to any significant extent, yet they are fundamental considerations in attempting to balance supply and demand. High priority should be given to research on this aspect of water supply.

Design of a water supply system is usually based on the drought of record. The probability of such a drought occurring again in any given year is problematic since frequencies of future droughts cannot be determined accurately with present analytical techniques. Thus, the reliability of systems can vary considerably depending upon the local drought experience during relatively short historic hydrologic periods. If the drought of record is a rare event, the system will have a low probability of water shortage and may, in fact, be over-designed. If the drought of record is a more frequent event, the system will be under-designed and have a higher probability of water shortage. No criteria have been established for drought probabilities to be used for water supply system design.

The risk of water shortages is closely associated with drought probabilities. All water supply systems have some degree of risk or shortage because of the high costs of no risk/no inconvenience/100 percent "safe" systems. Voluntary and mandatory water use restrictions must be included in any system management scenario to bridge the shortage periods. The problem is to determine an acceptable degree of risk and the public tolerance for individual, social and economic disruptions that result from water shortages. New York City has attempted to evaluate this factor by analyzing the frequency of drought warning and drought emergency periods under various assumptions for their period of record.

A strong research program is necessary to investigate these and other issues. They also should be considered in more detailed system analyses and in the decision-making process on specific actions relating to system improvement and management.