Thirsty Metropolis: A Case Study of New York City’s Drinking Water

Case Study

E.C. Vintinner

ABSTRACT

New York City’s drinking water supply has evolved from private wells to a complex system of upstate reservoirs and aqueducts, although not without social and political conflict. In particular, a balance must be found between population pressures both in upstate watershed regions and downstate. This case study is based on a 1995 controversy concerning the regulation of NYC’s water quality following new national laws. Students will adopt the concerns of one of the major groups involved (government entities, upstate stakeholders, downstate stakeholders, or environment groups) to actively come to a decision, with follow up to compare their discussions with what actually occurred.
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CASE STUDY SUBJECT AND GOALS

This case study is divided into two parts to explore many aspects of the development of the drinking water supply for New York City. In Part I, a brief history on the evolution of the water supply system is presented within the social and political context of the system’s history. The case study lesson divides students into groups to examine various perspectives on a pivotal moment in the development of the water supply. This exercise allows students to consider the practical challenges in such a scenario and work through a real life case study in search of a solution. In Part II, an epilogue section allows students to compare their proposed solutions to the actual actions that occurred. Up-to-date information on the status of the water supply system is provided to provoke discussion among students on recent pressing issues for stakeholders.

Through a decision-based format, this case study aims to provide undergraduate level students with a solid understanding of the biophysical, social, and economic dimensions of watershed management while fostering critical thinking and problem-solving skills. The goals of the case are to promote development of analytical and decision-making proficiency in a group setting, as well as encourage evaluation, reflection, and deeper research into conservation and development challenges.

PART I

It is 1995, New York State: Following the passage of a Congressional Act targeting the safety of the nation’s water supply systems, attention is now focused on the current state of New York City’s water supply. Tension is building between numerous stakeholders in the future of New York City’s water supply. Pressures from all sides, along with the prospect of extensive litigation and political maneuvering, are threatening to destabilize years of progress on the safety of the water from upstate watersheds. How to balance the drinking water needs of millions of people with the needs of watershed communities? The controversy over the New York City water supply is about to enter a new phase…

NEW YORK CITY’S WATER SUPPLY

The first settlers on the island of Manhattan in the early 17th century drew their drinking water from private wells. For the next three centuries, the City’s water supply system grew from a series of simple local reservoirs to complex aqueducts systems that carried water to the City from several kilometers away. At the turn of the 20th century, faced with growing demands for reliable water, the city’s Board of Water Supply decided to look to watersheds in upstate New York to supplement existing water supplies.
Construction on an increasing number of reservoirs and aqueducts continued until the 1960’s. Gradually, the upstate system of reservoirs and aqueducts became the primary source of drinking water for one of the largest cities in the world (New York City Department of Environmental Protection [NYCDEP] 2006).

Box 1. Landscape Changes to NYC Waterways

The familiar landforms on today’s atlases are drastically different from the coastline that greeted Henry Hudson as he sailed into the river that now bears his name. The Mannahatta project, sponsored by the Wildlife Conservation Society, provides an interesting perspective on the native habitat and ecology found on Manhattan Island, then home of the Lenni Lenape people, in the 17th century (Wildlife Conservation Society 2006). Since that time, vast portions of shoreline have been modified, channels dredged and wooded coasts and wetlands disrupted as European settlers poured into the New World. These changes were considered necessary to accommodate increases in trade and growing human population by creating more usable land and disposing of waste (Montalto and Steenhuis 2004).

According to the recent Health of the Harbor Report sponsored by the NY/NJ Harbor Estuary Program, 80% of the area’s original tidal wetlands and underwater lands have been lost due to human activities such as dredging or filling (Steinburg et al. 2004). Well-known locations such as LaGuardia, Newark, and Kennedy Airports, Shea Stadium, and the now closed Fresh Kills Landfill were all built on top of former marshlands (Montalto and Steenhuis 2004). In this respect, the evolution and development of New York City followed patterns typical of large urban cities. Some hallmarks of this development include the progressive concentration of population and infrastructure, along with changes in the biological and physical components of the original existing environment (Paul and Meyer 2001; Alfsen-Norodom et al. 2004; Kleppel et al. 2004).

Today, the New York City water supply system is derived from surface water north of the metropolitan area (some parts of Queens rely on a groundwater supply). The surface water network consists of three watersheds: the Catskill and Delaware watersheds about 160 kilometers north of the city in the Catskill Mountains and the Croton watershed about 80 kilometers north of the city and east of the Hudson River. The system encompasses over 5000 square kilometers across eight counties: Westchester, Putnam and Dutchess on the east side of the Hudson River and Delaware, Greene, Schoharie, Sullivan and Ulster in the Catskill Mountains, west of the Hudson (see Appendix 1). The system stretches downstate to NYC via a complex of aqueducts and tunnels to supply 5.3 billion liters of safe drinking water per day to millions of customers including residents, businesses, commuters, and tourists (Foran et al. 2000; Solecki and Rosenzweig 2001). In fact, the system supplies water to nearly half of the population of New York State. In addition, excess water from upstate reservoirs not used for drinking water is released to the Delaware River to sustain adequate flow in the lower Delaware for New Jersey and other downstream users. The reliable function and safety of this water supply was and is absolutely essential to the

As New York City and upstate communities have grown, pressures from two different sides have impacted the water supply. Increasing human population and development in watershed communities exerts pressure on natural water flows that supply the water supply system. In addition, expanding populations in New York City exert pressure on the system in order to supply a growing downstate need. The human presence at both ends of the water supply system creates tensions that affect the decisions that must be made to satisfy needs of all stakeholders.

<table>
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<th>Box 2. American Museum of Natural History’s Survey</th>
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<td>In 2005, the American Museum of Natural History completed a nationwide survey to gauge American’s knowledge of and attitude towards water and water-related issues. Remarkably, most respondents did not recognize that some of the main sources of water quality degradation are flushing toilets (through the effluent of wastewater treatment plants), runoff from treated lawns, and storm water runoff from roads. As further development occurs in upstate watersheds, each of these threats to water quality may lead to lower drinking water quality for New York City. Both upstate and downstate residents are tightly linked. The survey also found that of the 78% of respondents on a municipal water system such as New York City’s system, only one-third gets their drinking water from an unfiltered tap. The rest of the respondents either filter their tap water or drink only bottled water. All respondents were asked to rate the quality of their tap water. Over 65% responded with positive reviews, while 1/3 of the sample gave fair or poor responses.</td>
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**DECISION TIME: CONTROVERSY REGARDING NEW YORK CITY’S WATER SUPPLY**

Prior to the 1980s, drinking water from the Catskill/Delaware watersheds and the Croton water supply system was unfiltered. Due to appropriate management of watershed lands, water quality had been consistently good and there was no perceived need for a filtration facility. However, in the late 1980s, public health concerns regarding outbreaks of water-borne illnesses across the country raised awareness of water quality and health issues (Crotty 2002). In response, Congress passed the Safe Drinking Water Act Amendments of 1986. In 1989, pursuant this Act, the United States Environmental Protection Agency (EPA) promulgated the Surface Water Treatment Rule (SWTR) to protect drinking water sources against microbial contamination. The SWTR required that any public water supply system using unfiltered surface water either filter the source water or demonstrate that it met a series of objective water quality, operational, and watershed control criteria. NYC was faced with a choice between two options: filter the water or satisfy the provisions of the SWTR for unfiltered water.

After a series of initiatives by the City in the early 1990’s to comply with the SWTR, the EPA issued a conditional **Filtration Avoidance Determination (FAD)** in 1993. The
main conditions in the FAD centered on an improved watershed protection plan and a land acquisition program that would regulate activities on water sensitive lands through restrictions and buffer zones. The EPA also required that the City proceed with preliminary design of a filtration facility for the Catskill/Delaware supply, to minimize any delays if the EPA decided that filtration was necessary in the future. These programs directly affected upstate residents and businesses and created potential for conflict between parties concerning property rights and land use regulations. The history of conflict between NYC and upstate communities dates back to the 1950’s, when the City claimed eminent domain to build its reservoirs and flooded whole villages and displaced numerous residents in the process (Catskill Watershed Corporation 2005; Ellison 2006).

Uncertainty regarding the City’s follow-up actions to the FAD and possible use of eminent domain for land acquisition caused relations between the City and upstate communities to deteriorate. Upstate stakeholders, lead by the Coalition of Watershed Towns, filed lawsuits against NYC (Specter 1992; Pfeffer et al. 2002). These lawsuits caused an impasse in efforts by all stakeholders to reach a compromise about a watershed protection program (Rosenburg 1995; Ashendorff et al. 1997; National Resource Council Commission on Geosciences, Environment and Resources 1999; Burnett 2004).

Since the conditional FAD impacted many disparate stakeholders in New York, EPA and other interested parties recommended that the Governor of New York State, George E. Pataki, convene a meeting of stakeholders to mediate the controversy (National Resource Council Commission on Geosciences, Environment and Resources 1999). Subsequent negotiations involved the following four primary stakeholder groups: government entities (City of New York, New York State, EPA, NYS Department of Health-DOH, NYS Department of Environmental Conservation-DEC, NYCDEP); upstate stakeholders (Coalition of Watershed Towns, representatives of eight upstate counties); downstate stakeholders (representatives from NYC, Putnam County, Westchester County); and environmental groups (Hudson Riverkeeper, Catskill Center for Conservation and Development, Trust for Public Land, Open Space Institute, and New York Public Interest Group) (New York State Environmental Facilities Corporation 1997; Wolosoff and Endreny 2003).

As of 1995, the alternative to meeting the stringent criteria mandated by the EPA is the construction of a filtration facility for all of the water coming from the Catskill and Delaware watersheds. It has been estimated that the cost of such an endeavor would be upwards of $6-8 billion dollars, with annual operating costs of $500 million (Chichilnisky and Heal 1998; Ellison 2006).

THE SCENARIO

The FAD is scheduled for re-evaluation within one year of this roundtable meeting. In order to facilitate a compromise between many varied stakeholders that is compatible with legal obligations and economic and environmental concerns, New York State Governor Pataki has assembled representatives from each perspective to present their
viewpoint. Each group is charged with producing a position statement that also contains recommendations for compromise with other stakeholders. One additional group will be given the task of facilitating the discussion as each stakeholder presents their position and works towards a compromise. Possible compromises may consist of a land acquisition agreement, watershed rules and regulations, partnerships, or a determination to explore filtration options.

1. Your task is to adopt the concerns of the stakeholder group you have been assigned to represent. The four perspectives are: upstate stakeholders, federal and state level government agencies, downstate stakeholders, and environmental groups. Strive to understand and accept the validity of your assigned position. You should familiarize yourself with the details of your position so that you can present your particular viewpoints clearly and comprehensively in a discussion.

2. During the roundtable discussion, be open to creative solutions and collaborative approaches. In Part II of the case, you will be able to compare your recommended course of action with the realities of the case. You will further consider how the real outcomes have affected various stakeholders in the years since the decision and the current status of the NYC water supply system.

Information statements on each of the stakeholder groups are provided below. Your assignment is to review the background of your assigned stakeholder group and create a 5-minute position statement on your view of the situation. Discuss your goals for the stakeholder meeting, and prepare suggestions for solutions that can incorporate these goals into plans for the future of the New York City water supply.

**Upstate stakeholders**
Upstate stakeholders who live and work in the rural watersheds of the Catskill and Delaware systems are intimately involved with decisions regarding New York City’s water supply. NYC owns less than 10 percent of the watershed, which covers roughly 5,000 square kilometers (see Appendix 1). The watershed has a year-round population of around 78,000, as well as a significant number of summer residents (Ashendorff et al. 1997). The main economic sectors of the upstate communities focus on tourism, recreation (such as skiing) and the arts, agriculture (mainly dairy farms), small businesses and manufacturing, and natural resource based industries such as agriculture, forestry and mining products. Citizens and businesses in these watersheds have varying degrees of concern regarding the impact that a land acquisition program might have on the character and economic viability of their communities (Hamilton et al. 1998). A majority of residents of Westchester County support the prospect of land acquisition in their county, for example. Notably, these residents depend on the NYC water supply system for their drinking water. However, residents of many towns west of the Hudson River have opposed any land acquisition plans that might devalue private property and have expressed concerns regarding property rights. For example, in 1993, the NYC Department of Environmental Protection (NYCDEP) released a draft impact statement for revised watershed rules and regulations according to the FAD. New regulations called for buffer zones around water bodies and restrictions on the
construction of sewerage and service connections. Residents are concerned that these regulations could reduce property values by making land unavailable for development. Uncertainty over NYC’s intent to use eminent domain to gain control of the watershed lands and the perception that NYC is shifting the costs of watershed protection to upstate communities has resulted in the deterioration of relations between NYC and upstate communities. Watershed residents claim that efforts to protect surface water quality will impose unreasonable costs on property owners directly and indirectly on all watershed residents by reducing economic growth and associated economic opportunities. In responding to the NYCDEP’s statement, the Coalition of Watershed Towns (CWT) (a group that has emerged to represent the interests of upstate stakeholders) has concluded:

“The City has hidden from discussion ... land acquisition programs which it is already beginning to implement. The total program would involve the acquisition of approximately half of the developable land. The net result is that the watershed will suffer unmitigated impacts of both the regulatory program and a land acquisition program.”

The tensions peaked when the CWT, representing about thirty watershed communities, filed suit to prevent NYC from implementing its filtration avoidance plans. The CWT cited economic burdens on watershed residents resulting from restrictions placed on the use of privately owned land. The group claimed that NYC would benefit almost exclusively from environmental measures in the countryside to protect drinking water supplies at their source (Pfeffer et al. 2002).

Government agencies
A diverse array of government agencies has a stake in the outcome of decisions regarding the New York City water supply. The USEPA, New York City Department of Environmental Protection (NYCDEP), NYS Department of Health, and NYS Department of Environmental Conservation are all concerned with compliance with the SWTR and the safety and regulation of an enduring water supply for NYC. In particular, the DEP holds primary responsibility for the water supply system, with a mandate to ensure the public’s continued access to safe drinking water. In New York State, EPA Region II has primary enforcement responsibility for the SWTR regarding the unfiltered Catskill/Delaware systems, and therefore it has ultimate enforcement authority over the state and local agencies.

According to the STWR, filtration avoidance criteria are comprised of three main areas that must be enforced for the water supply system to remain unfiltered.

- Objective Water Quality Criteria – the water supply must meet certain levels for specified constituents including *coliforms*, *turbidity* and *disinfection by-products*.
- Operational Criteria – a system must demonstrate compliance with certain disinfection requirements for inactivation of *Giardia* and viruses; maintain a minimum chlorine residual entering and throughout the distribution system;
provide uninterrupted disinfection; and undergo an annual on-site inspection by
the primacy agency to review the condition of disinfection equipment.
• Watershed Control Criteria – a system must establish and maintain an effective
watershed control program to minimize the potential for contamination of source
waters by *Giardia* and viruses.

Representatives of government agencies are committed to the safety of the New York
City water supply system. Notably, all the surface water and groundwater entering the
City’s water system is treated with chlorine for disinfection, fluoride to prevent tooth
decay, orthophosphate to reduce the release of metals from household plumbing, and in
some cases sodium hydroxide to adjust pH.

The objectives of the government agencies vary. If the system does not meet the
criteria for the FAD, the EPA may decline to renew the FAD and trigger the utilization of
a filtration plant. Therefore, the EPA is solely concerned with maintenance of water
quality either by ensuring quality of unfiltered water, or filtering the water if quality drops.
In contrast, the local agencies such as the NYCDEP are in favor of the most cost-
effective solution for the continued safety of the water supply system. For this reason,
the NYCDEP is most likely to favor the creation of a compromise that allows water to
flow unfiltered from upstate communities to avoid costly filtration.

**Downstate stakeholders**
The New York City metropolitan area is one of the most populous and heavily
industrialized coastal areas on earth. According to the last decennial census by the US
Census Bureau in 1990, almost 17 million people live in the metropolitan area of New
York City, Long Island, Northern New Jersey, and Northeastern Pennsylvania, including
the over 7.3 million people living in the five boroughs of NYC. The pressures of a large
population, with associated requirements such as clean water and waste disposal,
impact the need for a consistent water supply. The City of New York, Putnam County,
and Westchester County currently receive the unfiltered water from upstate watersheds.
Residents, businesses, commuter and tourists in these areas are concerned with a
safe, consistent supply of water.

New York City’s drinking water has long been renowned for its safety and quality, and
has even been described historically as the “champagne of drinking waters.” Some
proponents have argued that the drinking water is the secret ingredient in the famous
New York City bagel and pizza. As the recipients of this drinking water supply,
downstate residents have a considerable stake in maintaining the quality of their supply.

Notably, residents and business would be faced with shouldering the potential costs of a
filtration plant if mandated. NYC faces upfront costs of multiple billions of dollars for the
construction and maintenance of a filtration plant for its Catskill/Delaware water supply.
As the City’s annual budget is about $29 billion, this cost could double water rates in the
City, adversely affecting residents, especially NYC’s large low income population
(Perlee et al. 1994; Appleton 2002) Drastic rate increases could also lead to closure of
housing units in rent-controlled areas of the City where the landlords cannot pass the
additional cost of the water on to their tenants (Mouat 1993; Burnett 2004). However, it is also notable that the costs for administering the requirements of any future FADs and associated agreements are also borne by the City.

Environmental groups
The principal environmental groups involved with the decision regarding NYC’s water supply are: Hudson Riverkeeper, Catskill Center for Conservation and Development, Trust for Public Land, Open Space Institute, and New York Public Interest Group. These groups are concerned with advocacy for safe water for all parties. In addition, these stakeholders are concerned with other aspects of the Catskill, Delaware and Croton watersheds, such as preservation of biodiversity and riparian corridors, which may be protected under the umbrella of water purification (Daily et al. 1999). In addition to supplying NYC’s drinking water, rural upstate watersheds contain wetlands and waterways that provide numerous ecosystem services such as nutrient cycling and mitigation of floods and drought (Baron and Poff 2004).

The freshwater ecosystems in the Delaware, Catskill, and Croton watersheds also support a large amount of biodiversity (Foran et al. 2000; Edinger et al. 2002, also see the New York State Biodiversity Project at cbc.amnh.org/center/cbcnews/state.html). For example, watershed lands serve as a major core area for several regionally rare large mammal species, including black bear (*Ursus americanus*), bobcat (*Lynx rufus*), and fisher (*Martes pennanti*). The waters that supply the reservoirs support healthy populations of coldwater fish such as brown (*Salmo trutta*), rainbow (*Oncorhynchus mykiss*), and brook trout (*Salvelinus fontinalis*), and the reservoirs themselves are important fisheries for smallmouth bass (*Micropterus dolomieu*), redfin pickerel (*Esox americanus*), yellow perch (*Perca flavescens*) (Dowhan et al. 1997).

The watershed lands support numerous endangered and threatened species. Federally listed threatened species include the northern wild monkshood (*Aconitum noveboracense*) and the bald eagle (*Haliaeetus leucocephalus*). Bald eagle pairs have successfully nested at reservoirs such as Ashokan, Roundout, Schoharie, and Neversink, all of which are part of the NYC water supply system. State-listed endangered species include the shoreline sedge (*Carex hyalinolepis*) and roseroot stonecrop (*Sedum rosea*), and threatened species include the timber rattlesnake (*Crotalus horridus*), red-shouldered hawk (*Buteo lineatus*), fragrant cliff fern (*Dryopteris fragrans*), moschatel (*Adoxa moschatellina*), and Appalachian Jacob’s ladder (*Polemonium van-bruntiae*). Other species are state-listed as special concern, including the spotted salamander (*Ambystoma maculatum*), eastern hognose snake (*Heterodon platirhinos*), spotted turtle (*Clemmys guttata*) and eastern bluebird (*Sialia sialis*) (Dowhan et al. 1997). Many environmental groups support environmental protection measures that protect both New York City’s water supply and the resilience and diversity of upstate ecosystems.

**ISSUES FOR FURTHER ANALYSIS AND DISCUSSION**
1) What are some of the benefits and weaknesses of using the approach of conserving watershed integrity rather than relying on a water filtration plant?

2) Consider that the upstate watersheds are experiencing increases in population. Downstate residents have also been acquiring second homes in watershed communities, which has resulted in a new wave of development pressure (Commission on Geosciences, Environment and Resources 2000; The Nature Conservancy 2005). What additional threats might this settlement and development pose to the water supply of New York City?

3) How does this model compare to other urban water supply systems throughout the world (see Fitzhugh and Ritcher 2004)? For example, consider Mexico City’s water supply. The city’s water is delivered from a groundwater system that is experiencing a reduced water table and pollution problems (see Excurra and Mazari-hiriart 1996; Tortajada and Castelan 2003). Comprehensive information in order to make a comparison can be found in Joint Academies Committee on the Mexico City Water Supply et al. 1995. Further comparison can be made to other American cities that depend on surface water systems, such as Los Angeles (Archibold 2007).

**GLOSSARY**

1. Buffer Zones: A defined land area adjacent to a water body on which activities that may impact water quality are regulated or restricted.

2. Coliforms: A group of related bacteria whose presence in drinking water may indicate contamination by disease-causing microorganisms.

3. Disinfection By-products: Products formed when disinfectants used in water treatment plants react with bromide and/or natural organic matter present in the source water. Different disinfectants produce different types or amounts of disinfection byproducts. Disinfection byproducts include trihalomethanes, haloacetic acids, bromate, and chlorite.

4. Downstate: A term for the southeasternmost portion of New York State, in contrast to Upstate New York.

5. Ecosystem Services: Benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services that affect climate and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as nutrient cycling.

6. Eminent Domain: Power of state entities to take private property for public use with compensating payment to the owner.
7. **Eutrophication**: The increase of chemical nutrients, typically compounds containing nitrogen or phosphorus, into a water body, oftentimes resulting in excessive plant growth and decay and subsequent reductions in water quality.

8. **Filtration**: Slowly filtering drinking water through clean sand or a similar filtering medium to eliminate contaminants and make the source water potable.

9. **Filtration Avoidance Determination**: An agreement between the EPA and local and state governments that waives the federal requirement to filter drinking water known as the Surface Water Treatment Rule.

10. **Giardia**: A protozoan parasite that infects the gastrointestinal tract and causes the disease giardiasis.

11. **GIS (Geographic Information System)**: A computer system for capturing, storing, querying, analyzing and modeling geospatial data.

12. **Groundwater**: Water beneath the Earth’s surface, beneath saturated soil and rock that supplies springs and wells.

13. **Hypoxia** (also oxygen depletion): A phenomenon that occurs in aquatic environments as dissolved oxygen is reduced to a point detrimental to aquatic organisms.

14. **Impervious surfaces**: Hard surfaces (rooftops, sidewalks, driveways, streets, parking lots, etc.) that do not allow rain water to infiltrate into the ground. Instead, the rain water runs off these surfaces, picking up heat and other water pollutants that can be transferred to streams, rivers, and lakes, creating water quality problems.

15. **Microbial Contamination**: Concentrations of microbial **pathogens** such as viruses, bacteria, **Giardia lamblia** and **Cryptosporidium** spp.

16. **Non-Point Source Pollution**: Pollutants from many unidentifiable sources such as agricultural runoff. Non point source pollution is from a more diffuse source than point-source pollution.

17. **Pathogen**: A disease-causing organism.

18. **Point Source Pollution**: Pollutants that are emitted from a specific point of discharge or a concentrated originating point like a pipe from a factory. One example of point source pollution from stormwater runoff is NYC’s combined sewer overflows described above in ‘Part II: Issues for Optional Analysis and Discussion Topic 1.”

19. **Runoff**: The flow of water from rain, snowmelt or other sources over the land surface in the form of rivers, lakes and streams to the oceans. **Source Water**: Water in its natural state, prior to any treatment for drinking.
20. Stakeholder: Any entity dependent on the use and management of specific resources. Stakeholders may belong to different socially and politically defined units but all have an interest or ‘stake’ in the same resource.

21. Surface Waters: Water that is on the Earth’s surface, in streams, rivers, lakes, and reservoirs.

22. Turbidity: Cloudy appearance of water caused by the presence of tiny particles. High levels of turbidity may interfere with proper water treatment and monitoring.

23. Upstate: A term generally referring to the Northernmost region of New York State, outside of the core of the New York Metropolitan area.

24. Watershed: The region draining into a river, river system, or other body of water.

25. Wetlands: A general term applied to land areas which are seasonally or permanently waterlogged, including lakes, rivers, estuaries, and freshwater marshes.
APPENDIX 1: NYC WATER SUPPLY SYSTEM

©New York City Department of Environmental Protection
APPENDIX 2: NY/NJ HARBOR ESTUARY – ULTIMATE RECIPIENT OF UPSTATE WATER

Source: USEPA
LITERATURE CITED


Appleton, A. 2002. How New York City used an ecosystem services strategy carried out through an urban-rural partnership to preserve the pristine quality of its drinking water and save billions of dollars and what lessons it teaches about using ecosystem services. The Katoomba Conference, Tokyo.


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New York City Department of Environmental Protection. 1993. Final generic environmental impact statement for the final watershed regulations for the protection from contamination, degradation, and pollution of the New York City water supply and its sources.


**ADDITIONAL LITERATURE**


